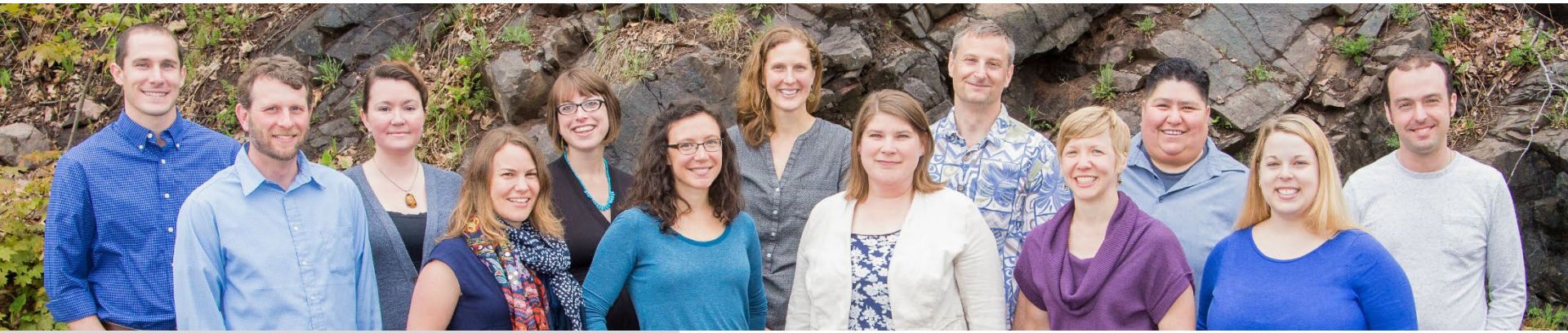
Climate Change and the Ottawa National Forest Drumloid and BPI Projects

November 2019

NIACS
Northern Institute of Applied Climate Science

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

Northern Institute of Applied Climate Science



- Practical information on **climate adaptation** and **carbon management**
- Adaptation resources
- Technical assistance

Chartered by USDA Forest Service, universities, non-profits, and tribal organizations:

The University of Vermont

American Forests

NCASI

Michigan Technological University

College of Food, Agricultural and Natural Resource Sciences
University of Minnesota

Great Lakes Indian Fish & Wildlife Commission

Forest Service U.S. Department of Agriculture

www.NIACS.org

Two Key Questions

1. How might climate change affect the resources that I manage?

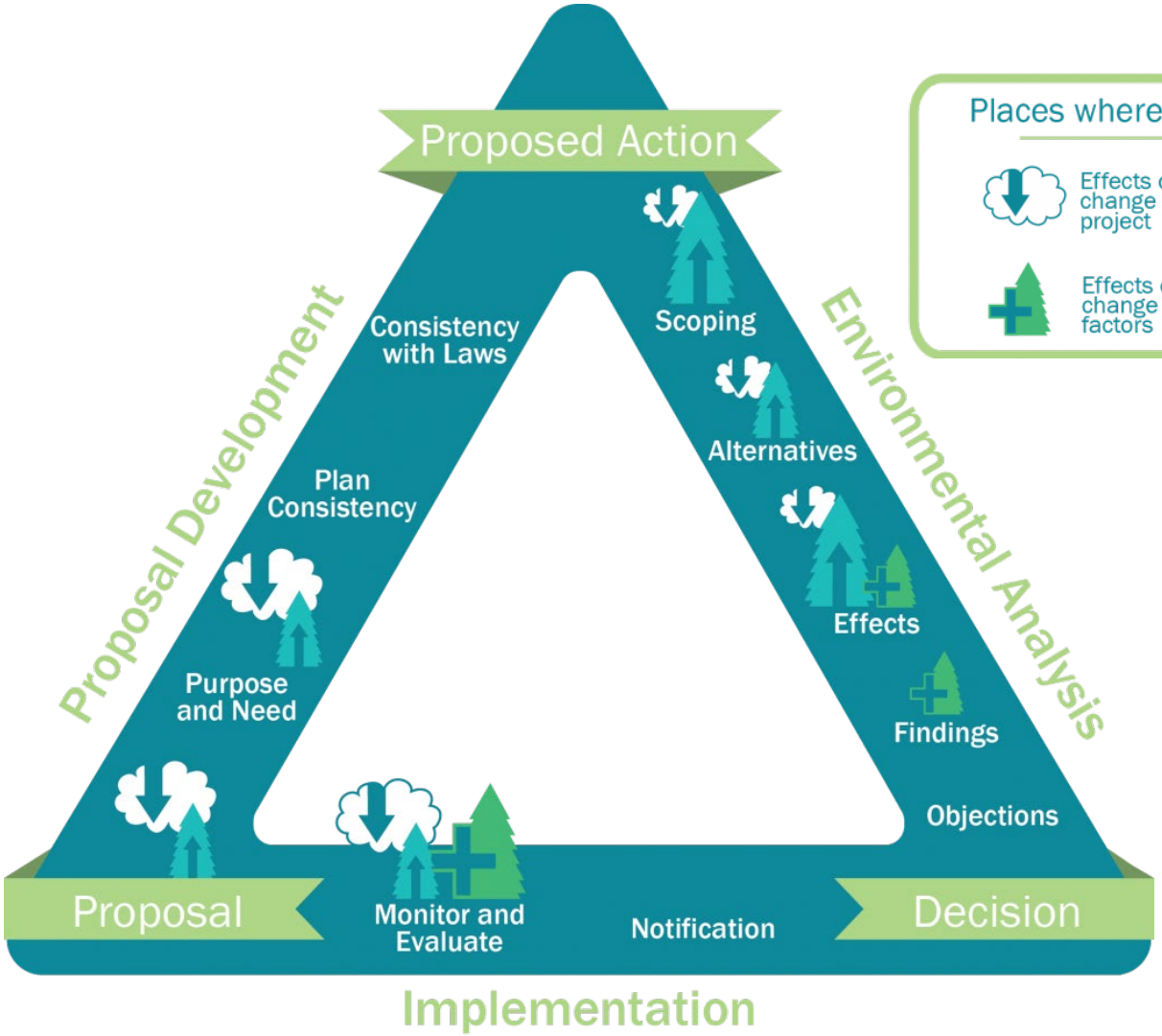
2. What management actions could help prepare for those effects?

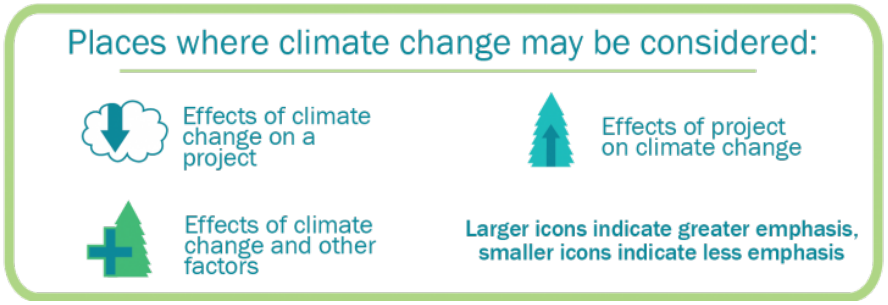
Twin concepts for responding to climate change

- Mitigation = actions that reduce the human contribution to the greenhouse gas effect.

- Adaptation = actions to prepare for and adjust to new conditions.

Climate Change and NEPA





Source: https://www.fs.usda.gov/ccrc/topics/nepa

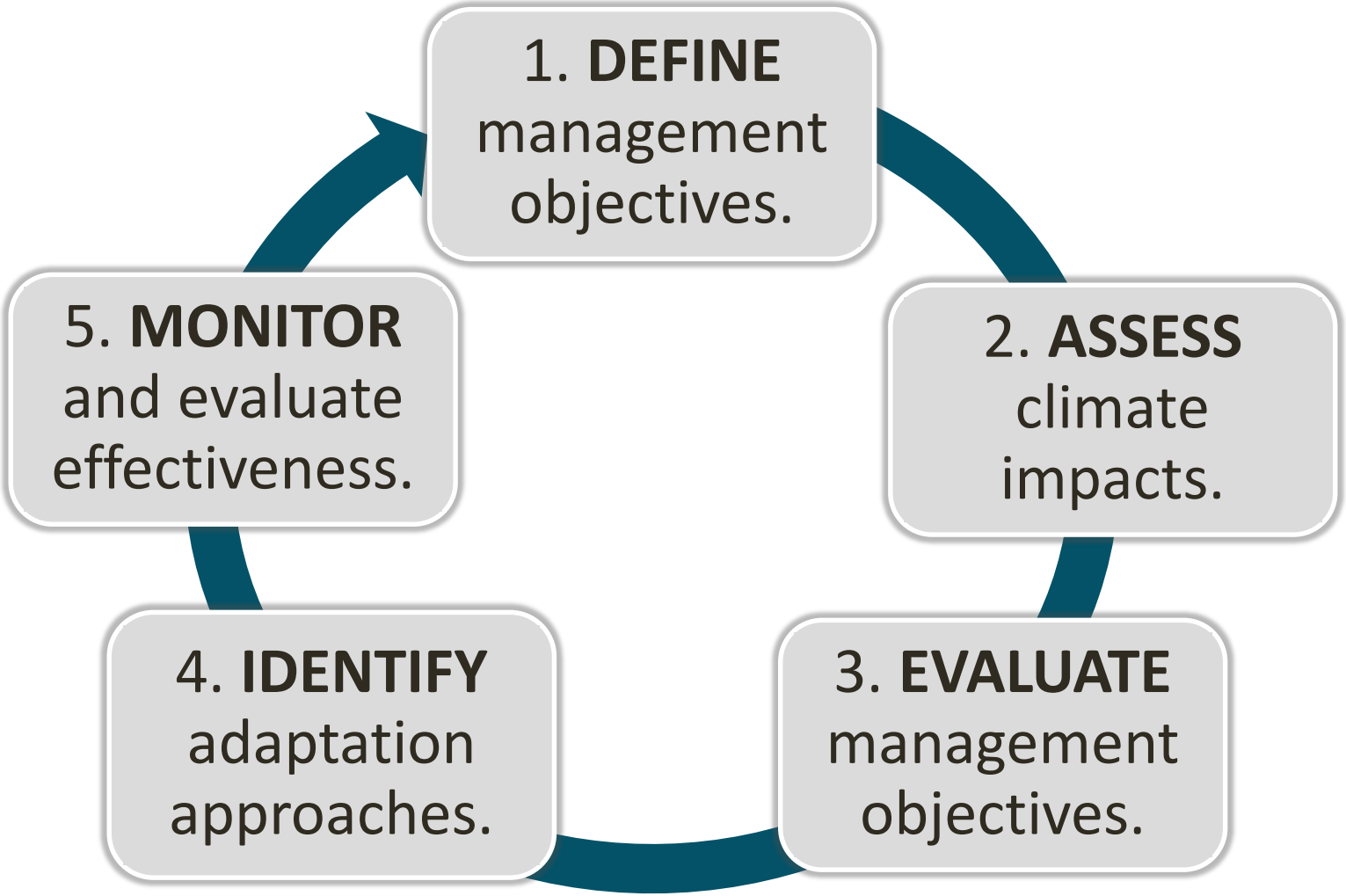
Forest Adaptation Resources

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 and approaches for forest management
- New online version!

www.nrs.fs.fed.us/pubs/40543 and www.AdaptationWorkbook.org

Adaptation Workbook



www.nrs.fs.fed.us/pubs/40543

A systematic process…

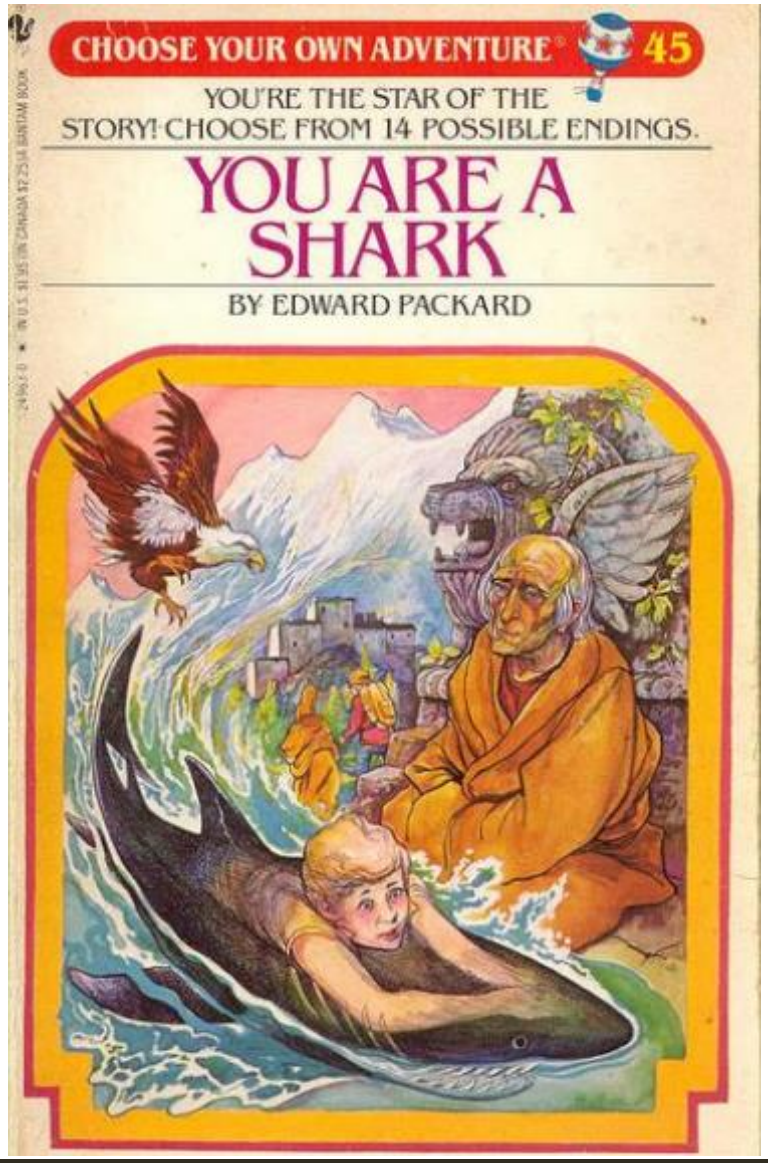
Management Objectives	Challenges	Opportunities	Feasibility	Other Considerations

Adaptation Actions			Benefits	Drawbacks/ Barriers	Recommend Tactic?
Approach	Tactics	Time Frame			

Intentional

- Explicitly consider and address climate change
- Sure we might get lucky…
- Intentionally assessing risk and vulnerabilities **makes our plans more robust!**

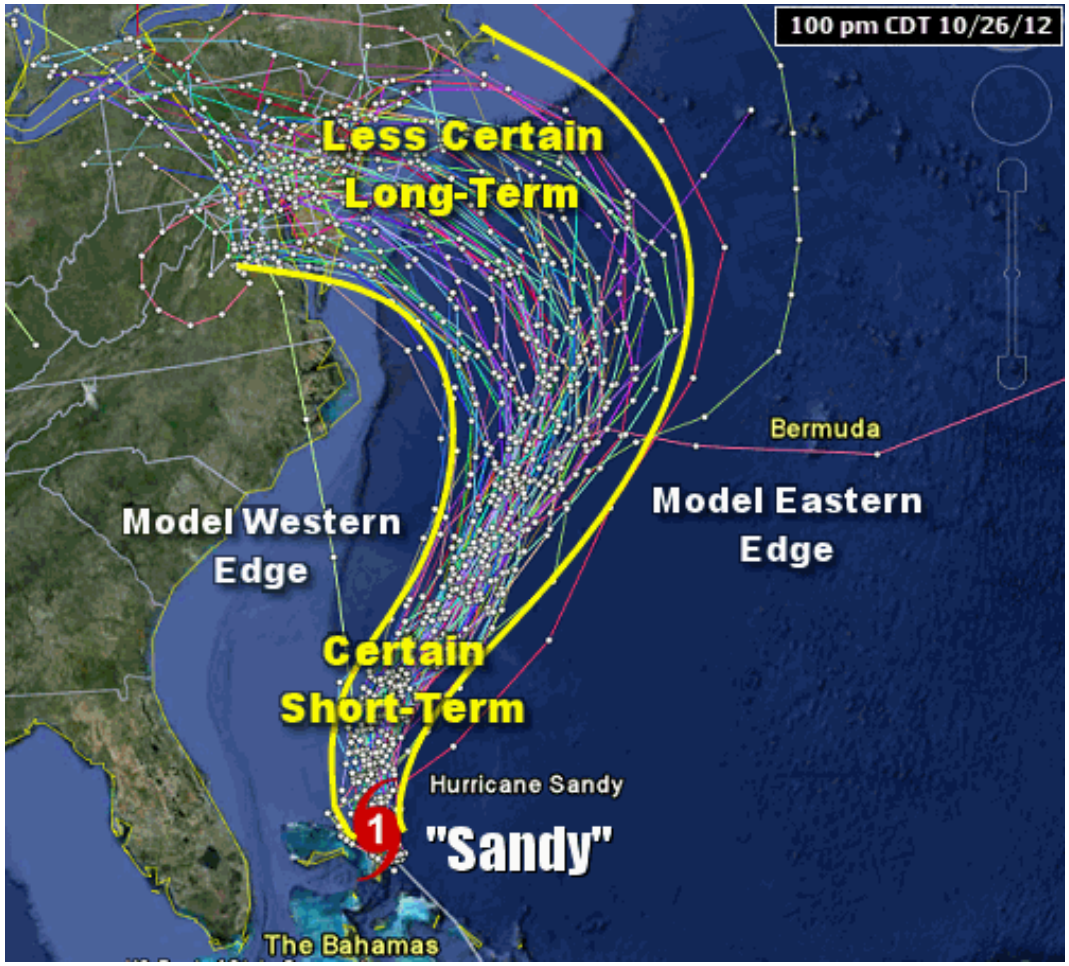
Flexible


CHOOSE YOUR OWN ADVENTURE®
45
YOU'RE THE STAR OF THE STORY! CHOOSE FROM 14 POSSIBLE ENDINGS.
YOU ARE A SHARK
BY EDWARD PACKARD

An Uncertain Future

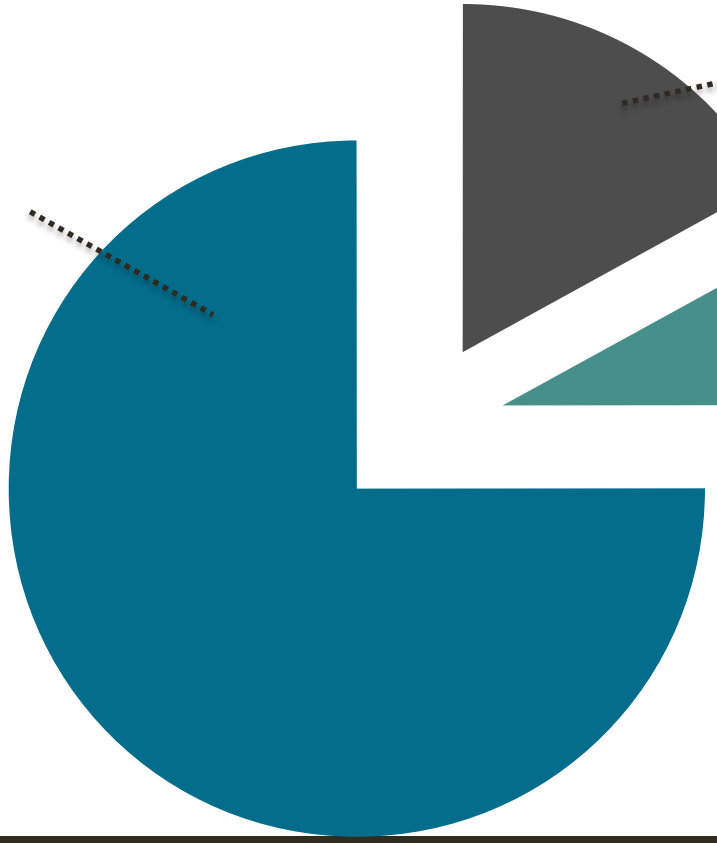
We Don't Need Certainty

- Instead: think about risk management!



Adaptation

- Adaptation actions may not look that different from current management actions, especially in the near term.

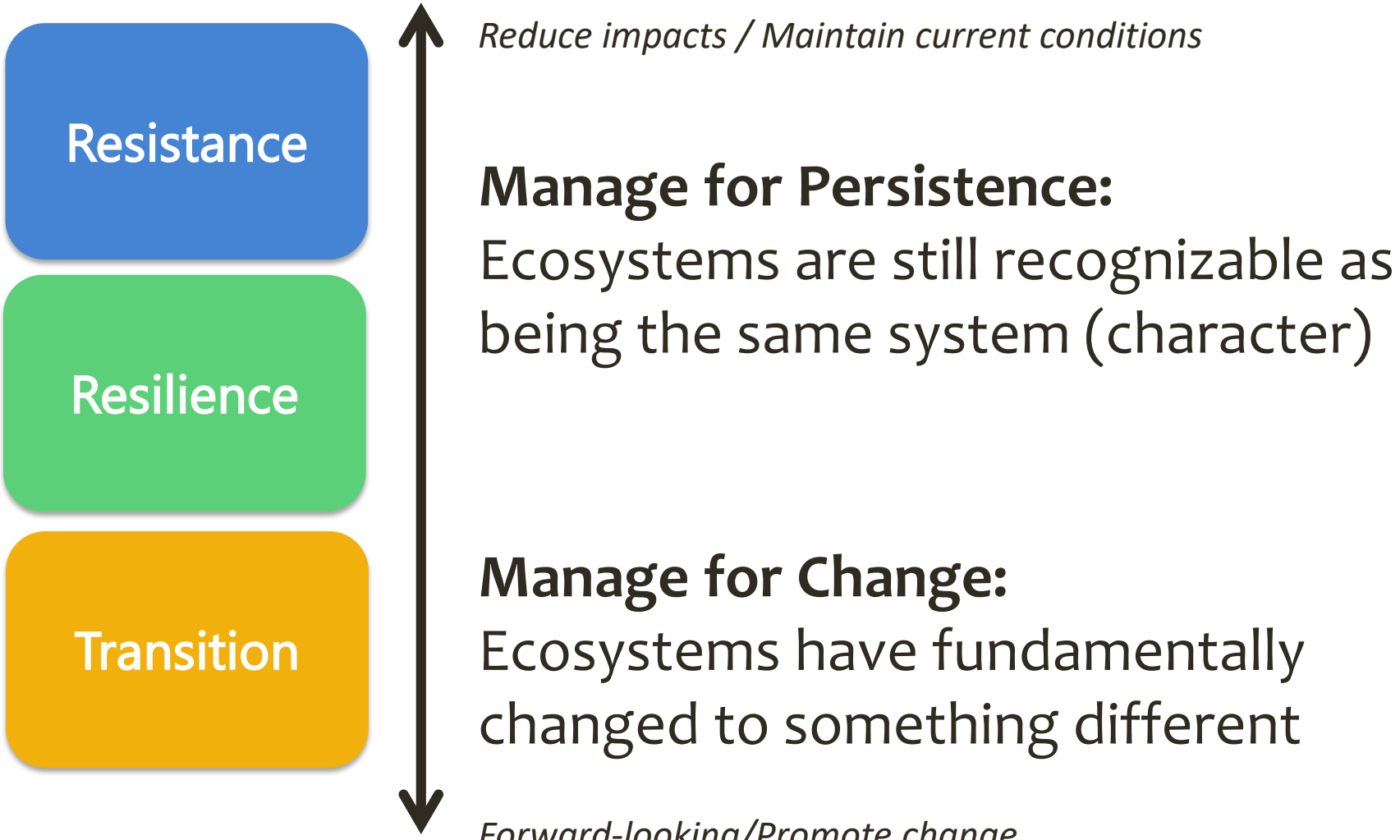


Small "tweaks" *that improve effectiveness*

Same actions– *climate change just makes them that much more important*

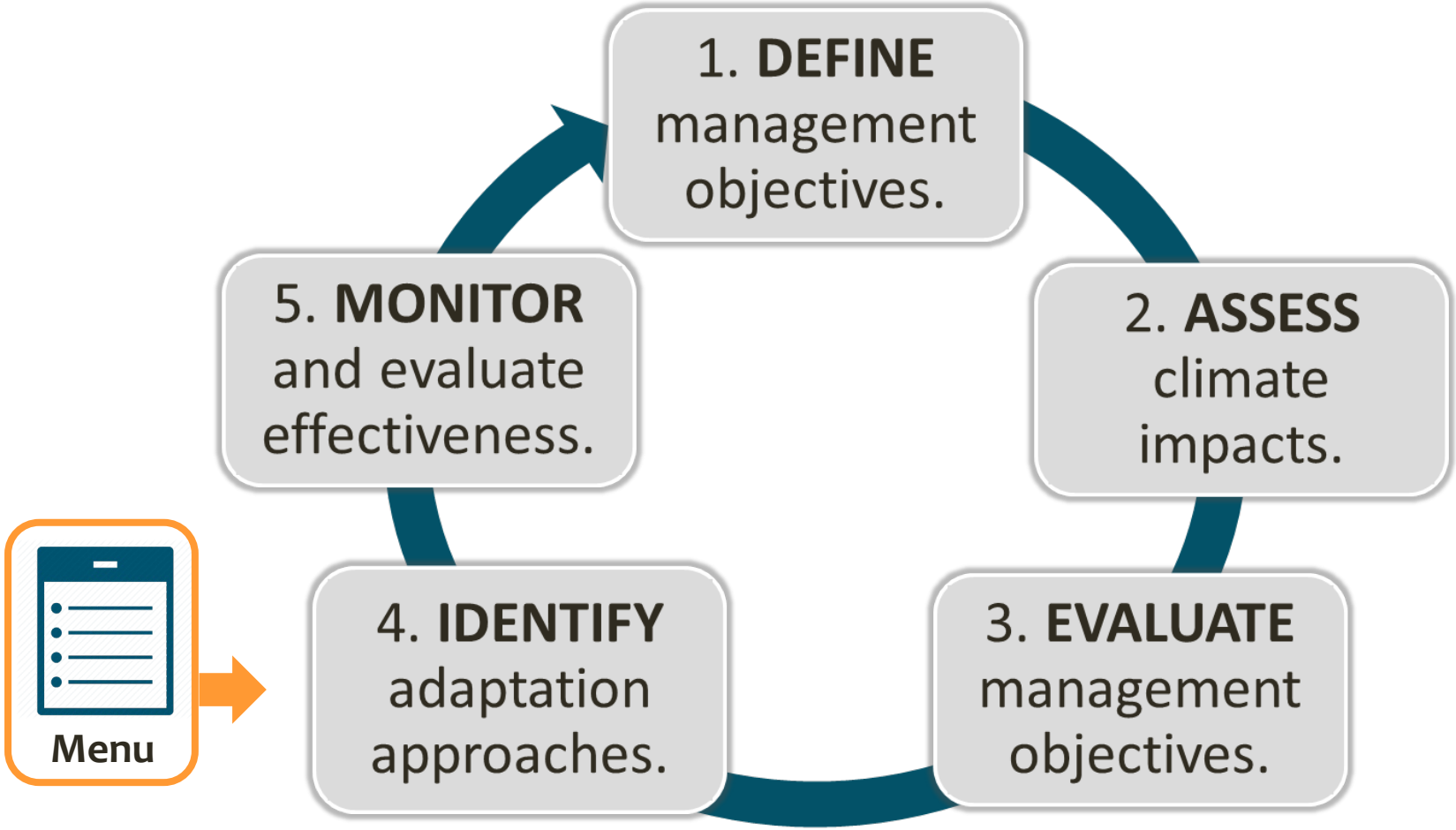
New & different *actions, even some that seem* ***wild & crazy***

Adaptation Options



Adaptation Workbook

A workbook process provides "structured flexibility"



Adaptation Menus

A collection of plausible adaptation actions that is:

- Specific to a discipline
- Organized into a tiered hierarchy
- Thorough and comprehensive (including opposing ideas!)

Brunch

Classics

Lemon Ricotta Pancakes Whipped Mascarpone Maple, Berries	15	**AJ's Omelet** Fontal Cheese, Spinach, Mushrooms	14
Cornflake Crusted French Toast Berries, Maple Syrup	15	**Eggs Florentine** Spicy Capicola, House-Made Cheddar Biscuit, Spinach	15
Bacon, Egg & Cheese Bacon, Two Eggs, Taleggio Cheese, Ciabatta	14	**Porchetta Hash** Poached Egg, Calabrian Chili Hollandaise	16
Avocado Toast Poached Eggs, Tomatoes, Chili Flakes, Sea Salt	15	**Chia Pudding** Chia Seeds, Toasted Coconut, Banana, Strawberry	14
Chicken Parmigiana Spicy Marinara, Fresh Mozzarella	22	**Farmhouse Breakfast** Two Eggs, House-Made Cheddar Biscuit, Chicken Sausage	14
Squid Ink fettuccine Vongole Little Neck Clams, Garlic, White Wine, Butter, Chili	22	**Chicken Kale Caesar** Chicken, Kale, Croutons	16

Create Your Own Pasta

Shapes		Sauces	
Rigatoni Semolina, All-Purpose Flour, Olive Oil	14	**Marinara** San Marzano tomatoes, Garlic, White Wine, Basil, Chili	
Cavatelli All-Purpose Flour, Durum Flour, Eggs, Ricotta	15	**Arrabiata** All-Purpose Flour, Durum Flour, Eggs, Ricotta	+1
Tagliatelle All-Purpose Flour, Durum Flour, Eggs	15	**Broken Meatball** House Tomato Sauce with the Addition of Broken Meatballs	+4
Gluten-Free Rigatoni Gluten-Free All-Purpose Flour, Olive Oil, Eggs	16	**Sunday Sauce** House Tomato Sauce with Short Rib, Sausage, Veal	+4
Spaghetti Semolina, Durum Flour, Olive Oil	15	**Roasted Garlic Pecorino** Semolina, Durum Flour, Olive Oil	+2
Four Cheese Herb Ravioli Fontal, Ricotta, Parmesan, Pecorino	18	**Carbonara** Pancetta, Eggs, Peas, Pecorino	+3

Sides

Pecorino Truffle Fries	8
Potato Hash	6
Bacon	6
Turkey Sausage	6
Field Greens	7
Two Eggs Any Style	6
Beignets	8
Baked Goods	10

Brunch Cocktails

Bloody Mary Vodka, Spiced Fresh DOP Tomato Juice, Horseradish	10/45
Cointreau Spritz Cointreau Spritz, Aperol, Crème de Peche, Sparkling Wine	12/55
Green Side Reyka Vodka, Green Juice, Lemon	12/55
Morning Derby Bourbon, Grapefruit, Ginger, Carrot Juice	12/55
Sangria Red Wine, Fresh Fruit, Pisco, Crème de Peche	10/45
Firing Squad Milagros Tequila, Cointreau, Fresh Lime, Grenadine	12/55
Tall Mimosa Reyka Vodka, Cointreau, Jake's Mimosa Juice, Sparkling Wine	12/55

www.nrs.fs.fed.us/pubs/40543 and www.AdaptationWorkbook.org

Adaptation Menu Benefits

Address challenges in implementing adaptation:

1. Connecting broad ideas to specific actions
2. Making actions intentional
3. Communicating your ideas
4. Boosting creativity

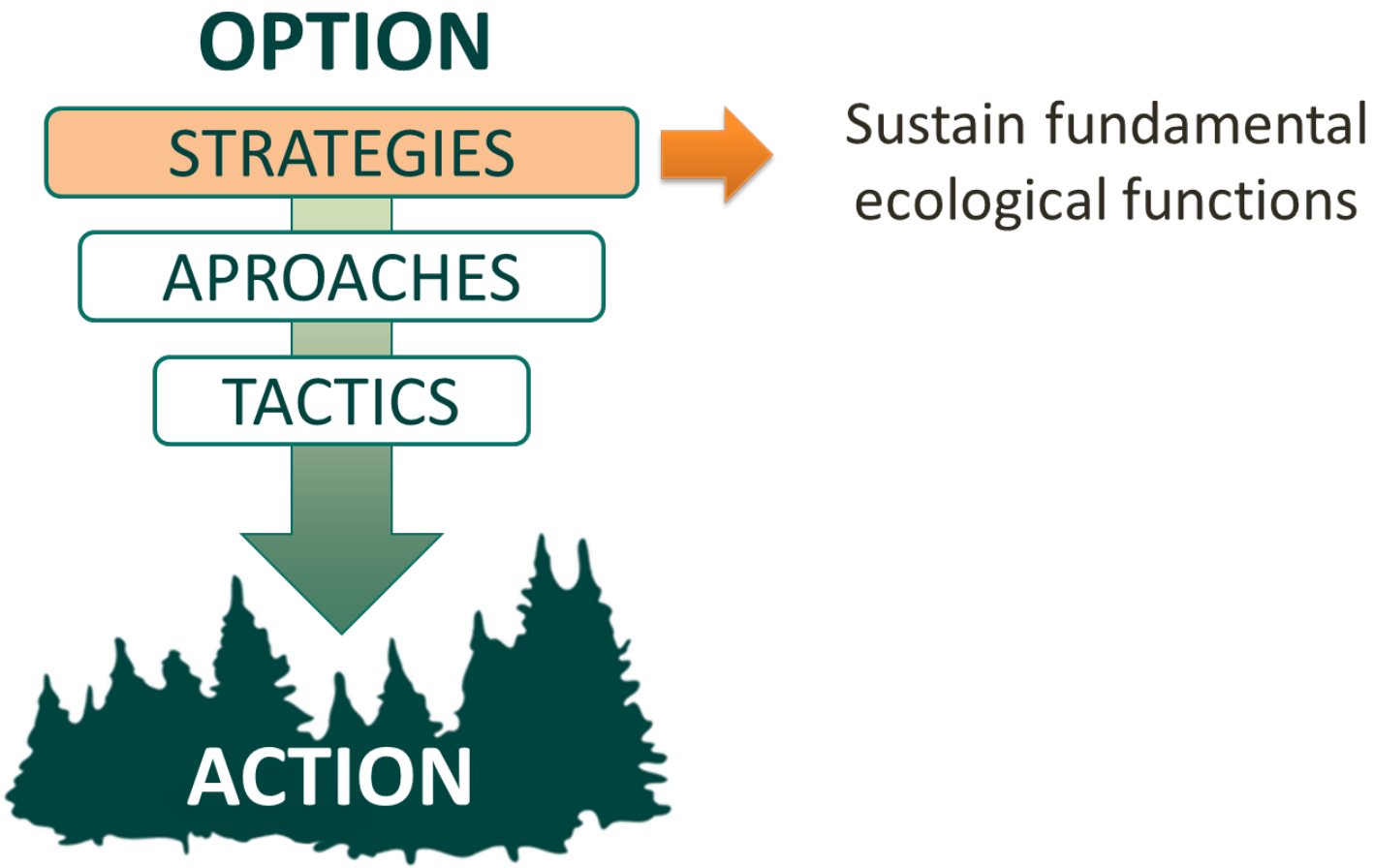
Adaptation Menus

1. Connecting Broad Ideas to Specific Actions

Option: Resistance
(forestall change)

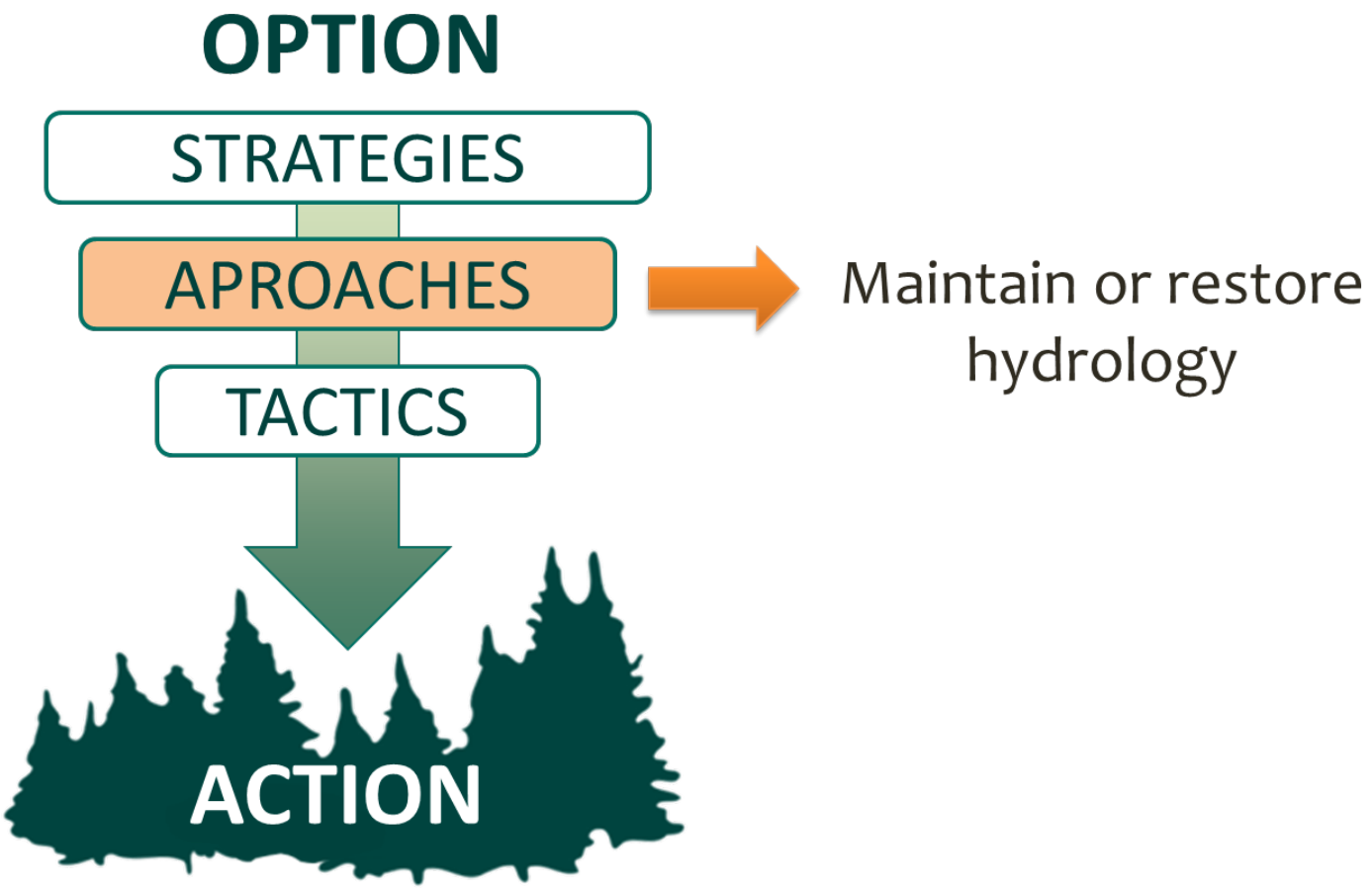
Adaptation Menus

1. Connecting Broad Ideas to Specific Actions



Adaptation Menus

1. Connecting Broad Ideas to Specific Actions



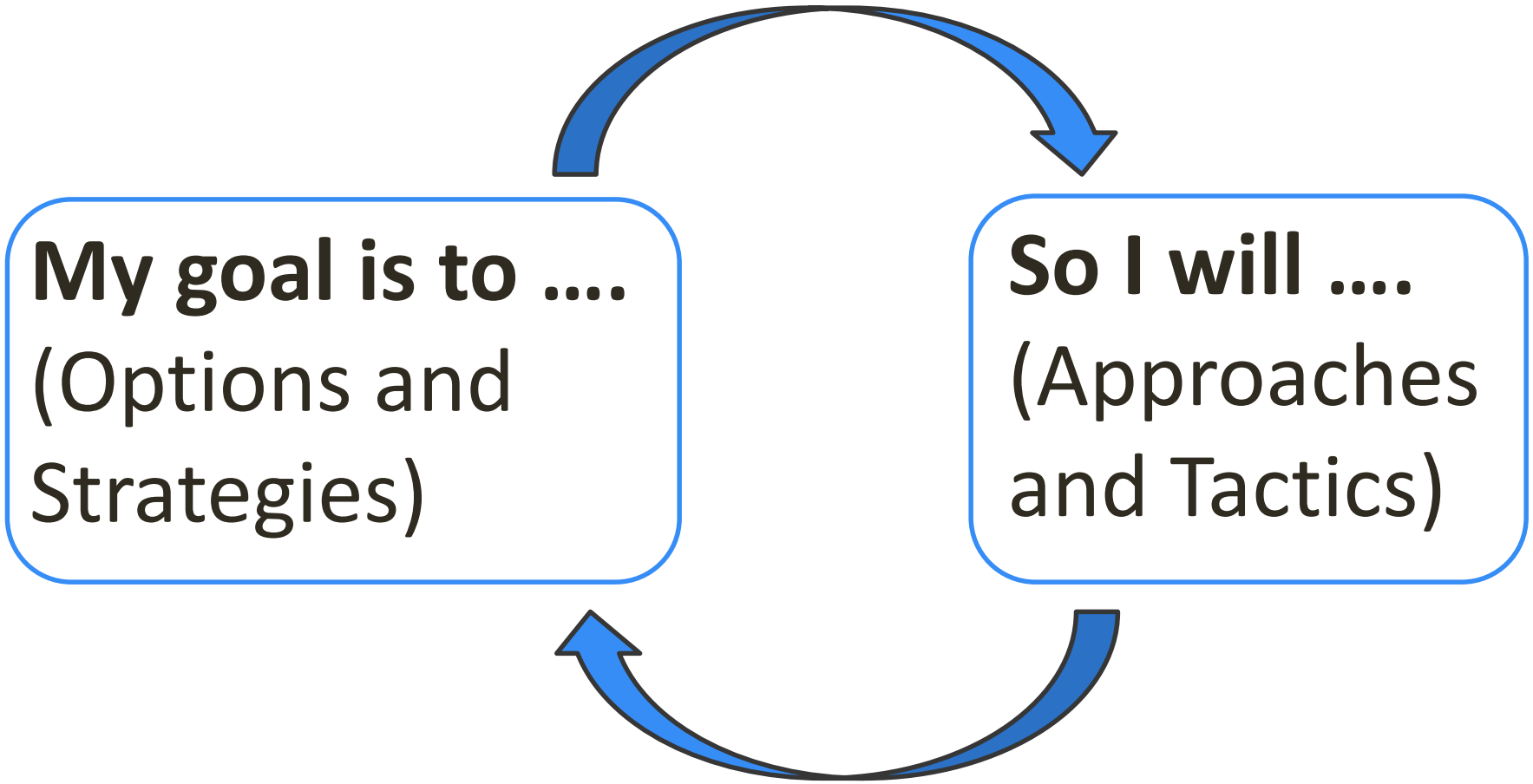
Adaptation Menus

1. Connecting Broad Ideas to Specific Actions

Install water control structures at road crossing to maintain peatland water level

Adaptation Menus

2. Making Actions Intentional



Adaptation Menus

3. Communicating your Ideas

Adaptation Menus

3. Communicating your Ideas

Adaptation Menus

4. Boosting Creativity

A Growing Collection

Published:

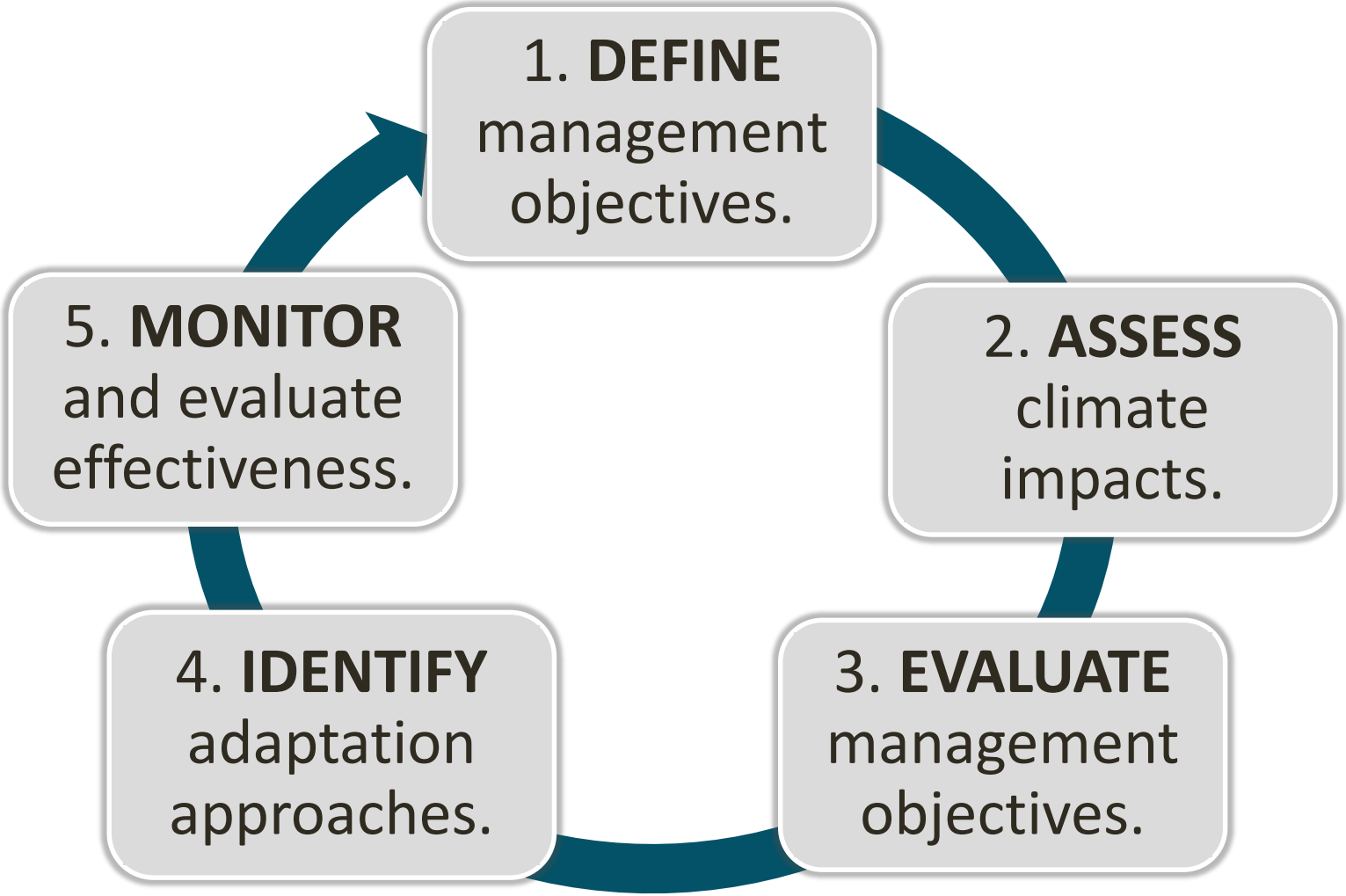
- Forestry
- Urban Forestry
- Agriculture
- Forested Watersheds
- Tribal Perspectives

In Preparation:

- Wetlands
- Wildlife Management
- Coastal Ecosystems
- Forest Carbon Management
- Recreation
- Fire (western?)

Gameplan for Drumloid and BPI

Adaptation Workbook



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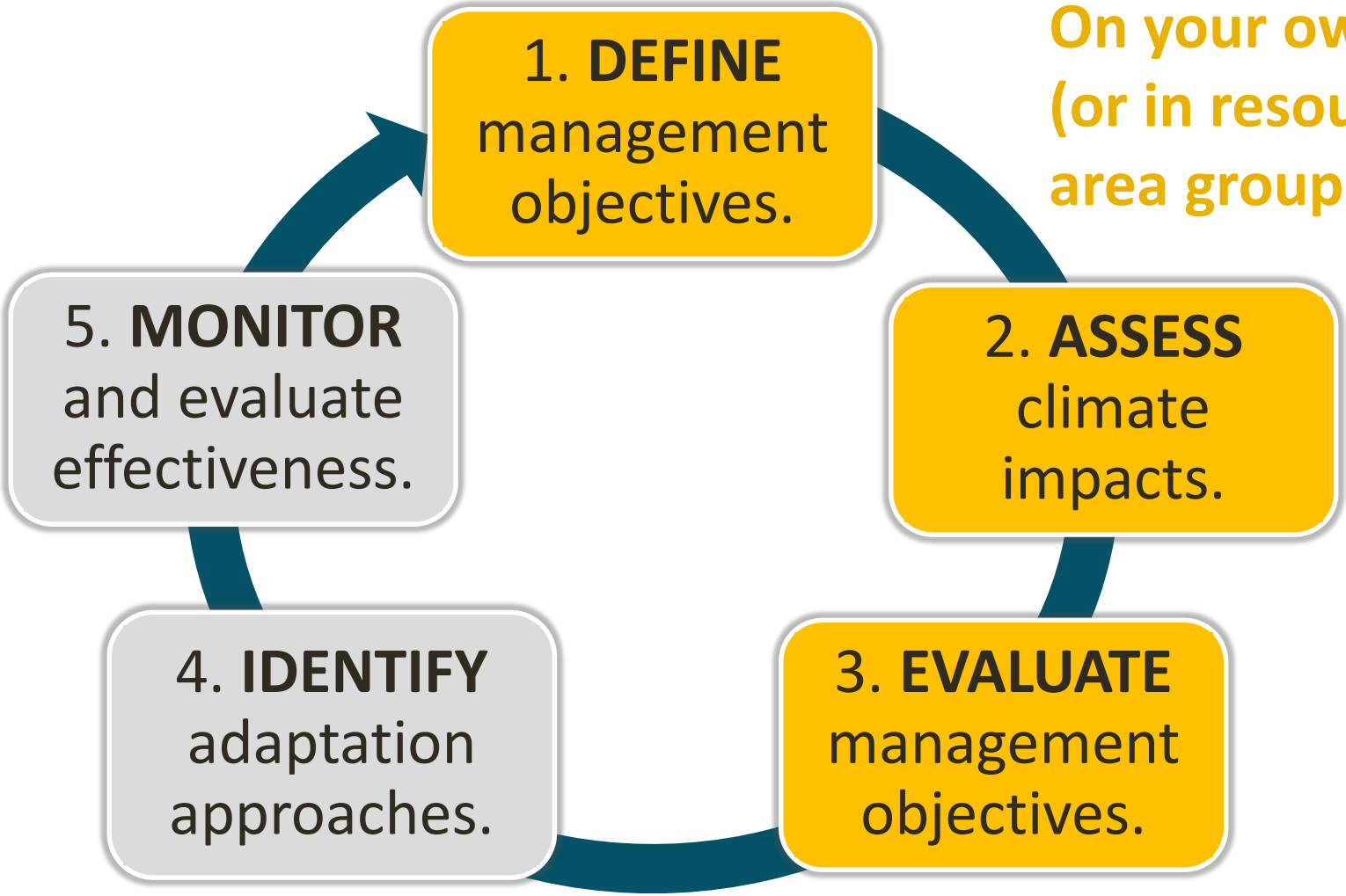
Adaptation Workbook

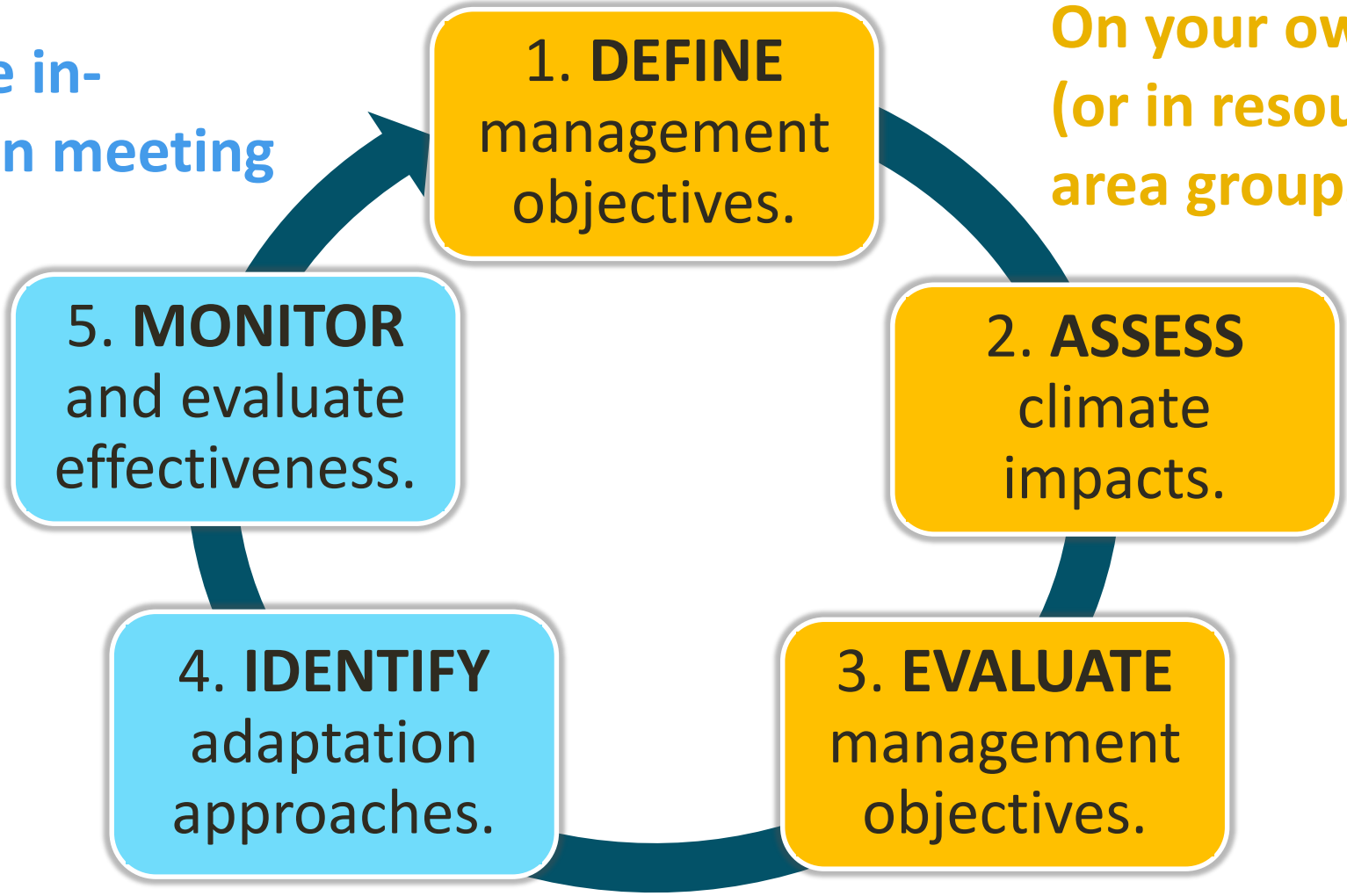


On your own (or in resource area groups)

Adaptation Workbook

At the in-person meeting

On your own (or in resource area groups)



www.nrs.fs.fed.us/pubs/40543

Step 1 Prep

Write down your key management goals and objectives for your resource area!

Resource Areas	Goals (Made-up examples…)	Objectives
Wildlife	• Increase large red and white pine for eagle nest sites • Prevent brush encroachment into marshes • Restore waterfowl habitat and wild rice production within Summit and Cyrus lakes	• How/ where/ how much?
Vegetation/ Silviculture	• Increase the amount of young forest • Improve forest diversity in aspen stands • Expand an mature spruce-fir forest patch	• How/ where/ how much?
Water resources	• Maintain coldwater trout habitat • Correct AOP barriers	• How/ where/ how much?

Step 2 Prep

1. Which climate change impacts are most important (positive or negative) for your resource area?
2. Are there particular features or conditions within the project area that might increase/decrease climate risk?

Step 2. Assess climate change impacts for your Resource Area.

General Climate Change Trends and Projections	**Impacts for Forest Action Plan Cooperative Programs**	**Points** (20 Total)
*General climate change impacts across **Michigan**:*	*Why is this important for your Resource Area? Are there particular features or site conditions in the project area that might increase/decrease risk?*	
1. Average temperature increases		
2. Warmer winters (warmer mean temps and greater variance)		
3. Fewer days with extreme cold		
4. Nighttime temperature increases year-round		
5. Decreasing ice cover (Great Lakes and inland		

Regional to Site-Specific

- Research and assessments describe **broad trends** but **local conditions** and **management** make the difference.

Step 3 Prep

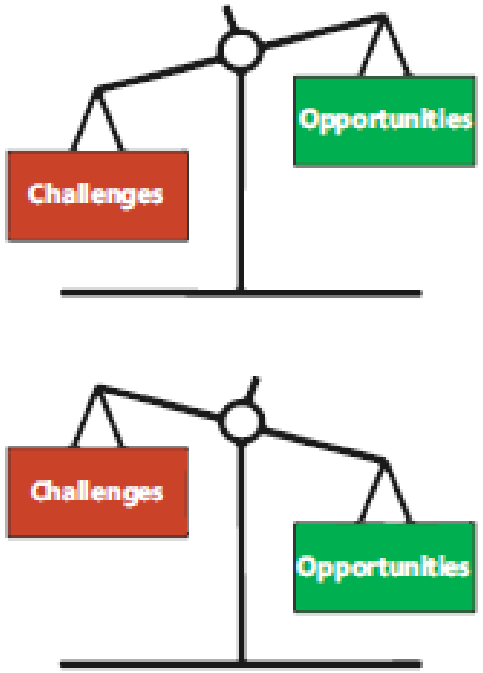
- Evaluate your management objectives (Step 1). Are they still feasible with **current management** (same management tactics, same investment of time and resources)?
- Hold on to these ideas for our discussion.

Feasibility definitions:

High – Current management actions can overcome the challenges presented by climate change. Opportunities outweigh challenges.

Medium – Current management can likely overcome challenges. Extra resources may be necessary to counteract key challenges or promote new opportunities.

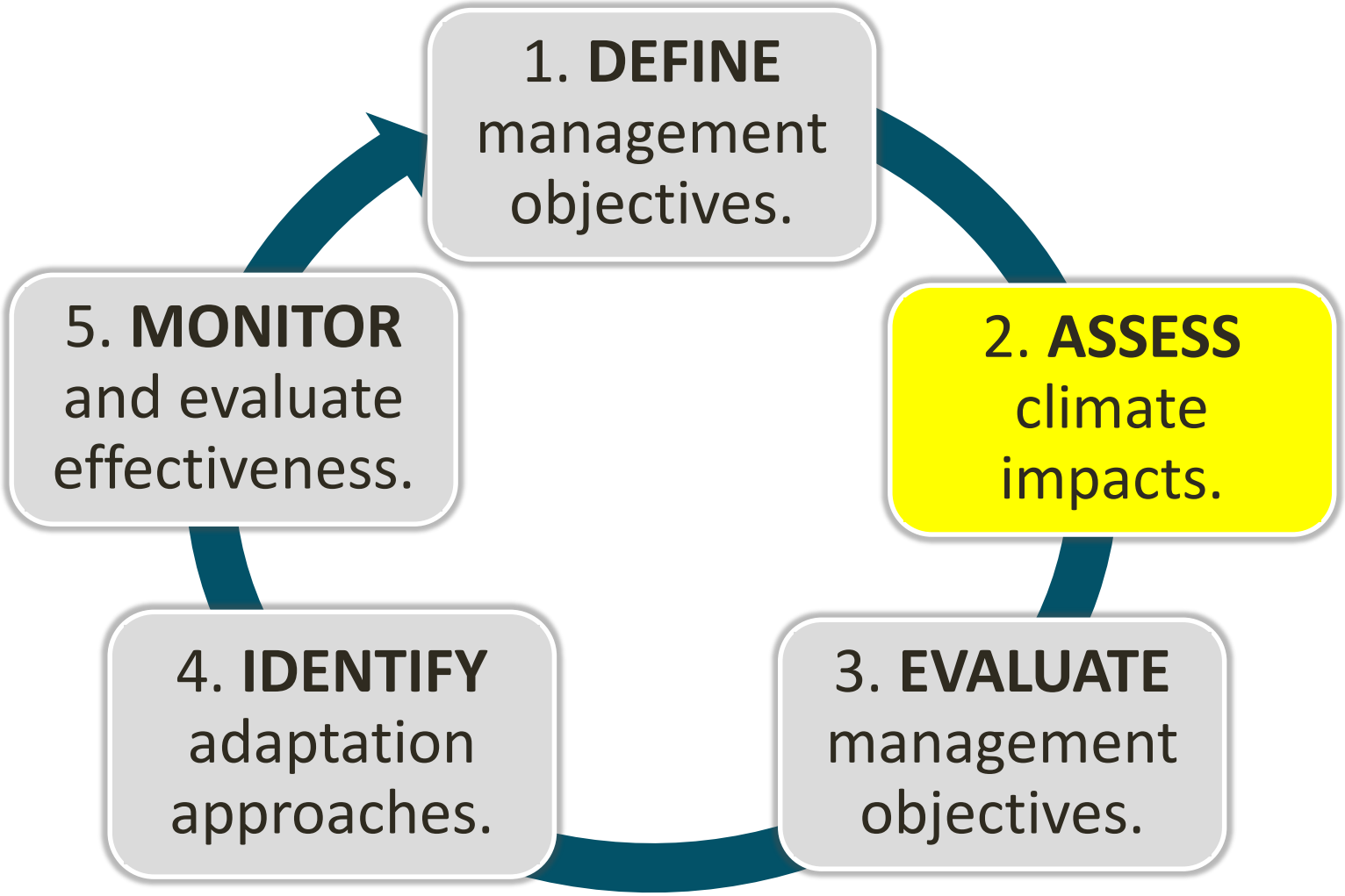
Low – Current management may not overcome climate change challenges. Extra resources or new efforts will be necessary.



Next Steps

- Stephen will send presentation and pre-work
- Pre-work! (Send to Stephen and Christy by 11/27.)
  - List major Goals and Objectives for your resource area (Step 1)
  - Complete climate change impacts worksheets for your resource area. (Step 2)
  - Consider feasibility of your Objectives (Step 3)
  - Review adaptation menus (optional)
- Get in touch with questions!
- Plan to meet on Dec 2nd!

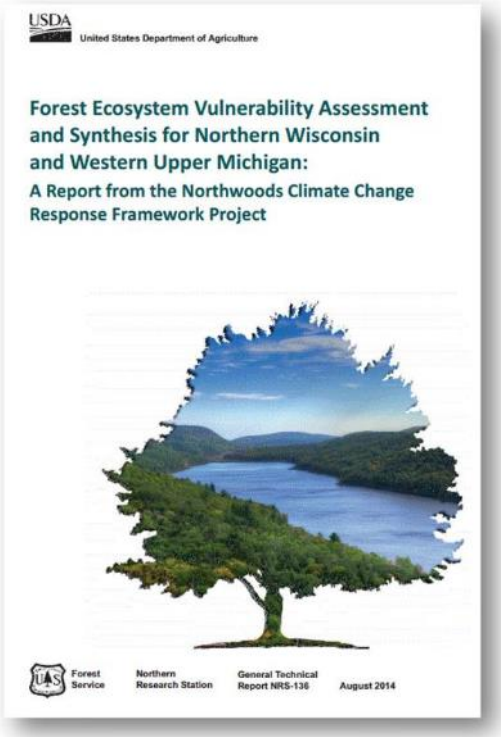
Adaptation Workbook



www.nrs.fs.fed.us/pubs/40543

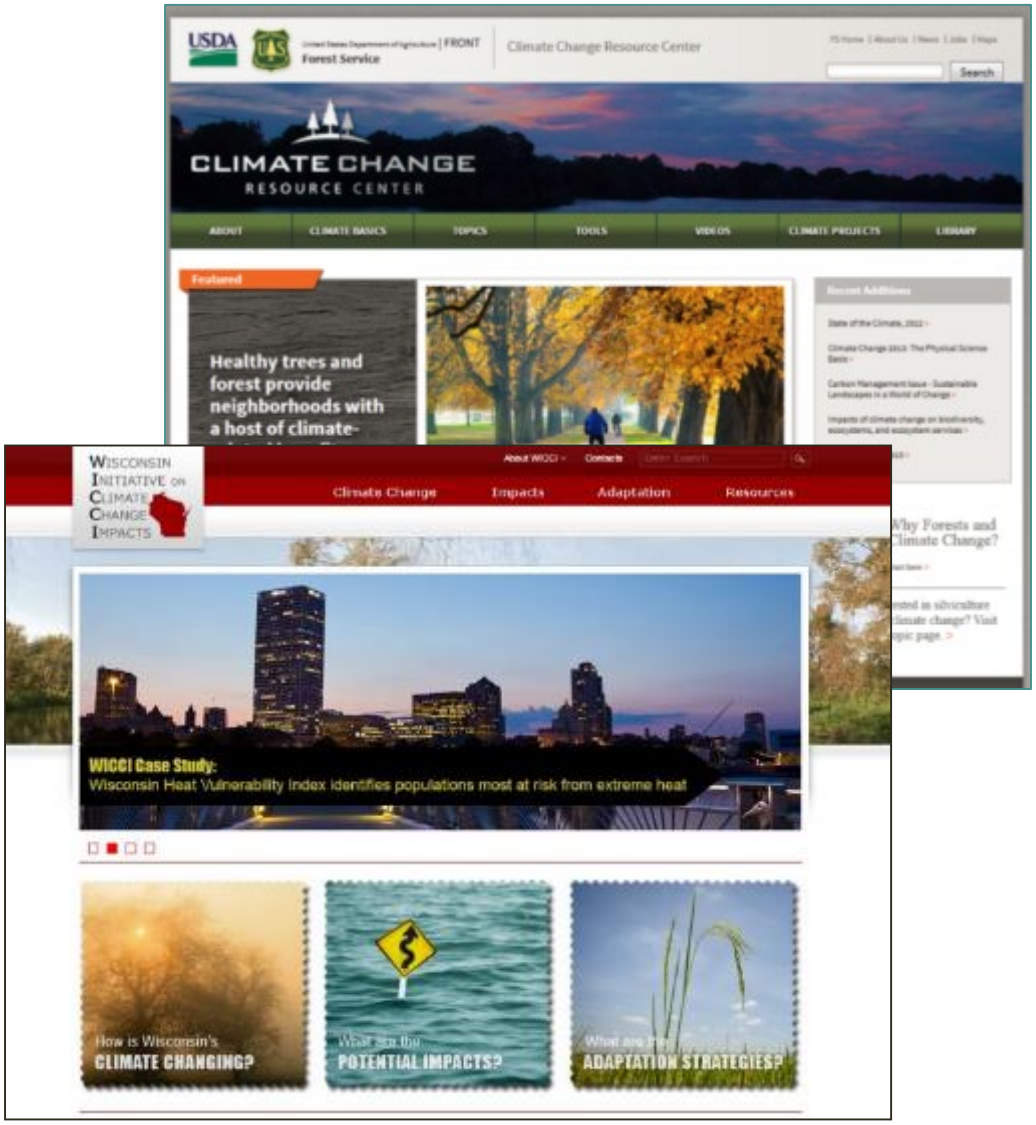
Climate Change Information

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



More Information

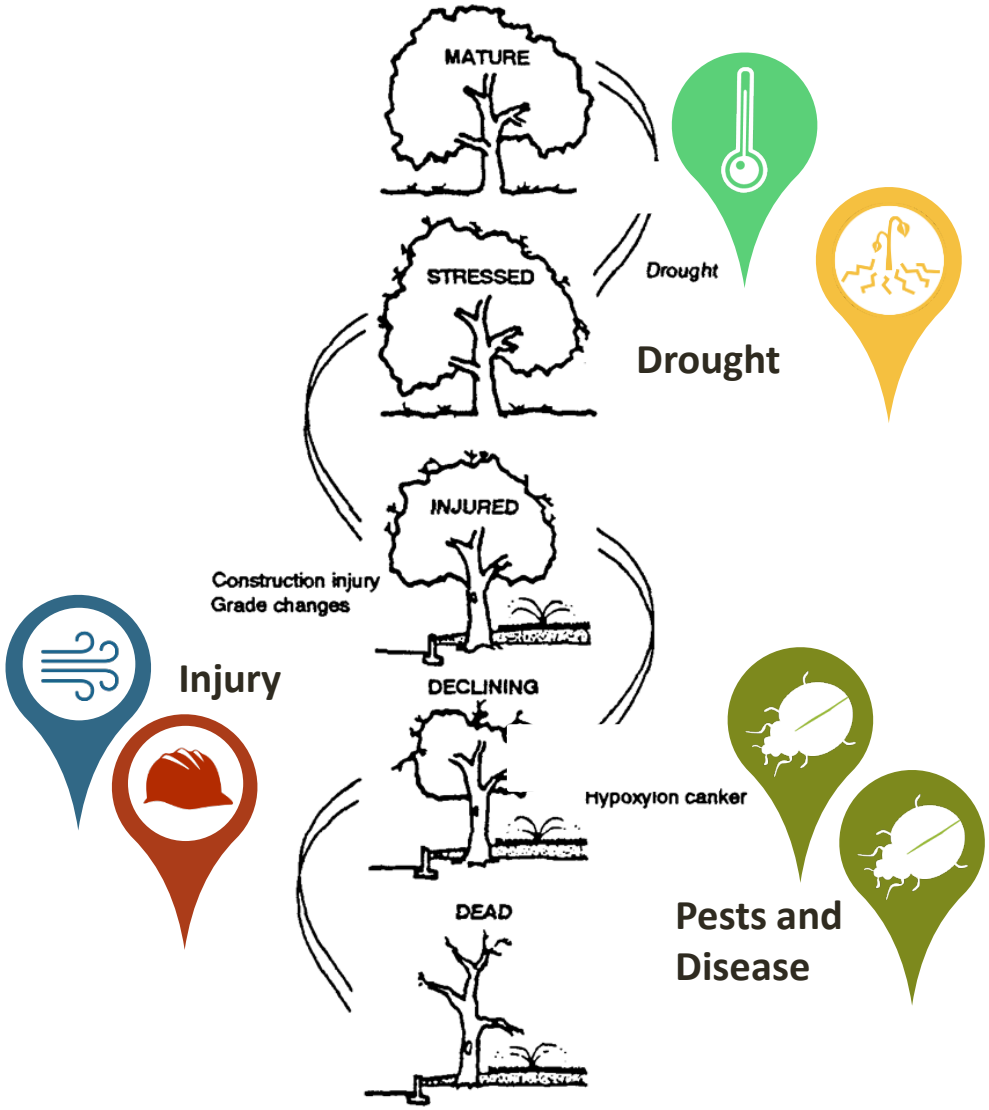
- Climate Change Resource Center
- WI Initiative on Climate Change Impacts (WICCI)



http://www.fs.usda.gov/ccrc/, www.wicci.wisc.edu

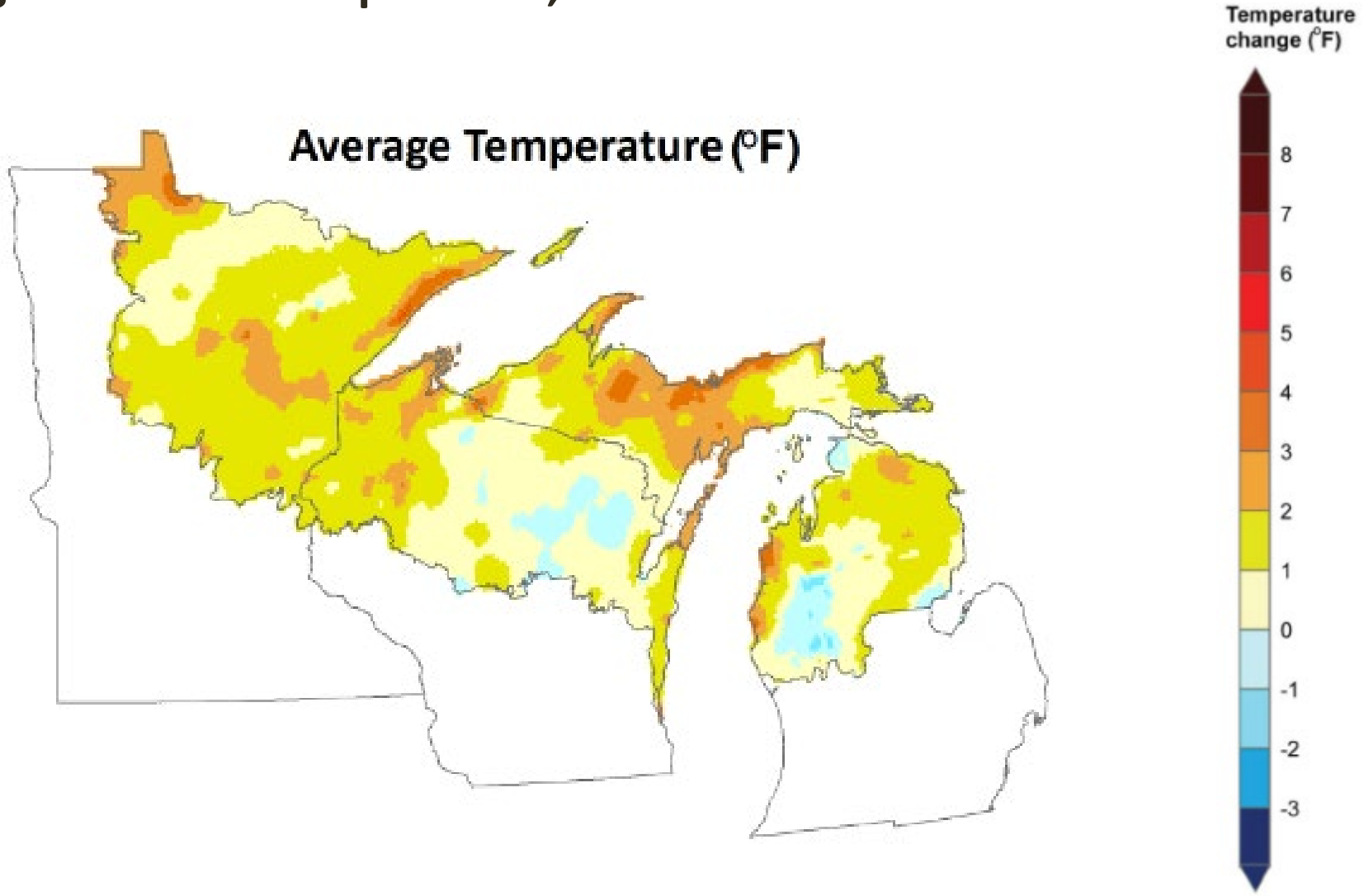
A "Threat Multiplier"

- Interactions can trigger big changes
  - Stress
  - Disturbance
  - Invasive species
  - Insect pests
  - Forest diseases



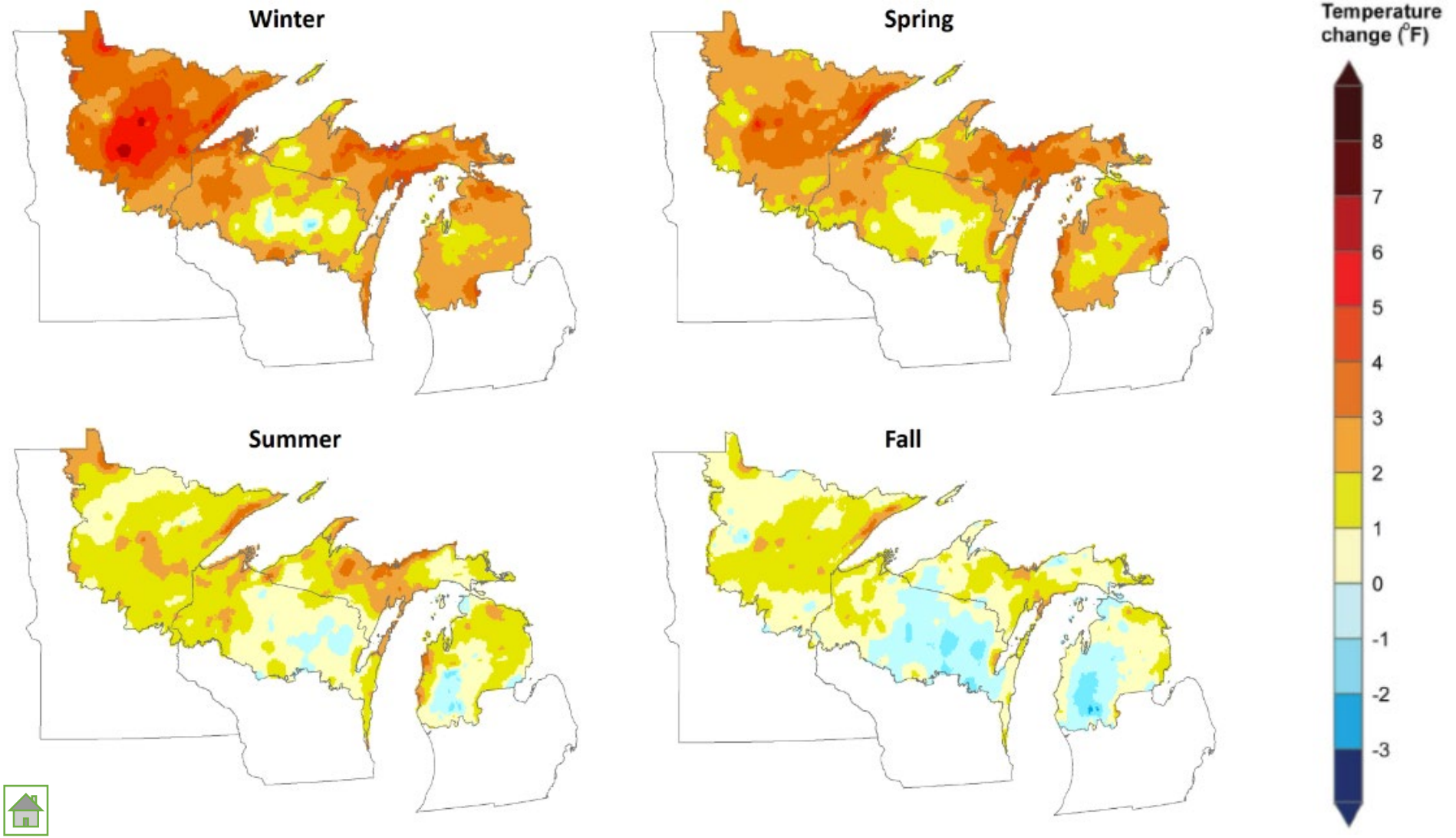
Observed Temperature Changes

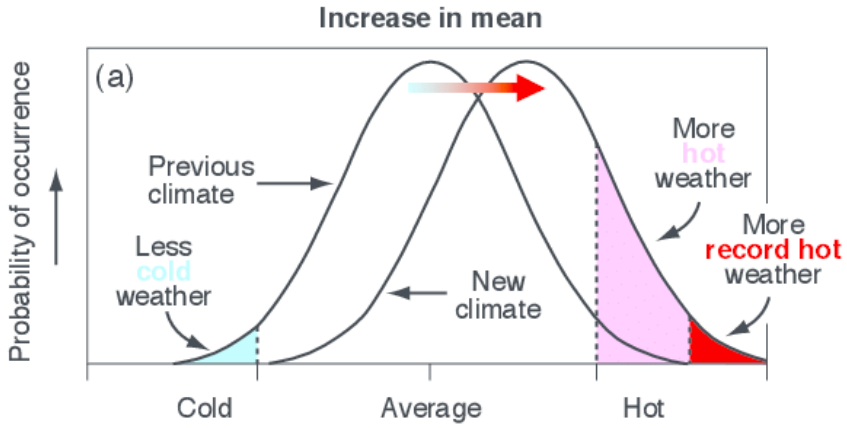
Change in Annual Temperature, 1901-2011

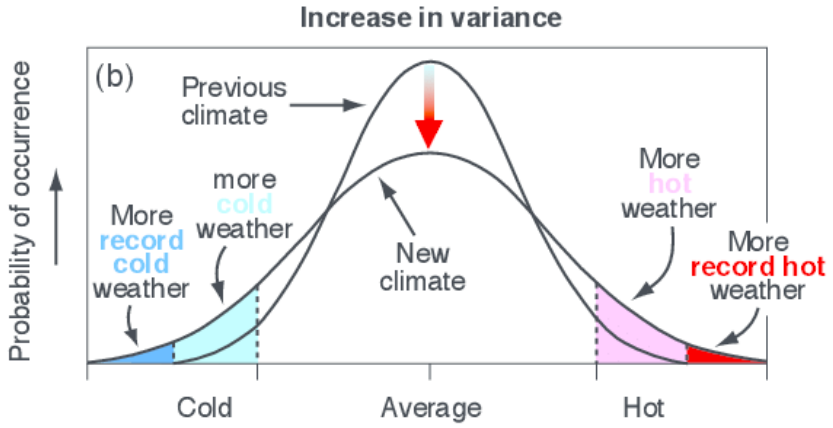


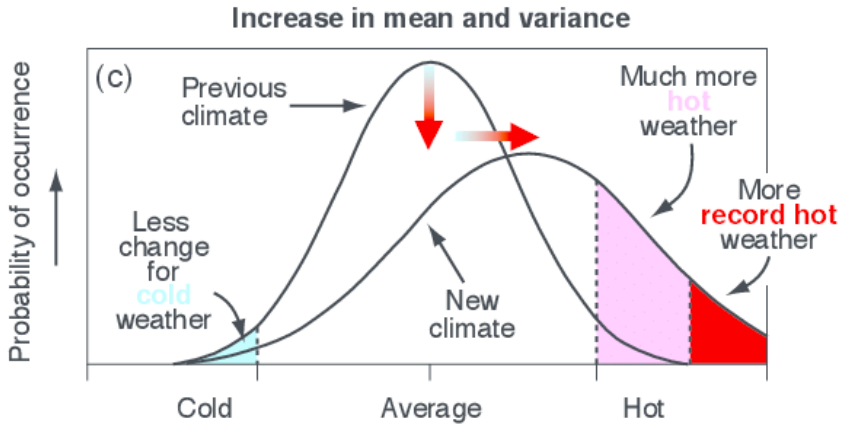
Observed Temperature Changes

Change in Seasonal Mean Temperature, 1901-2011







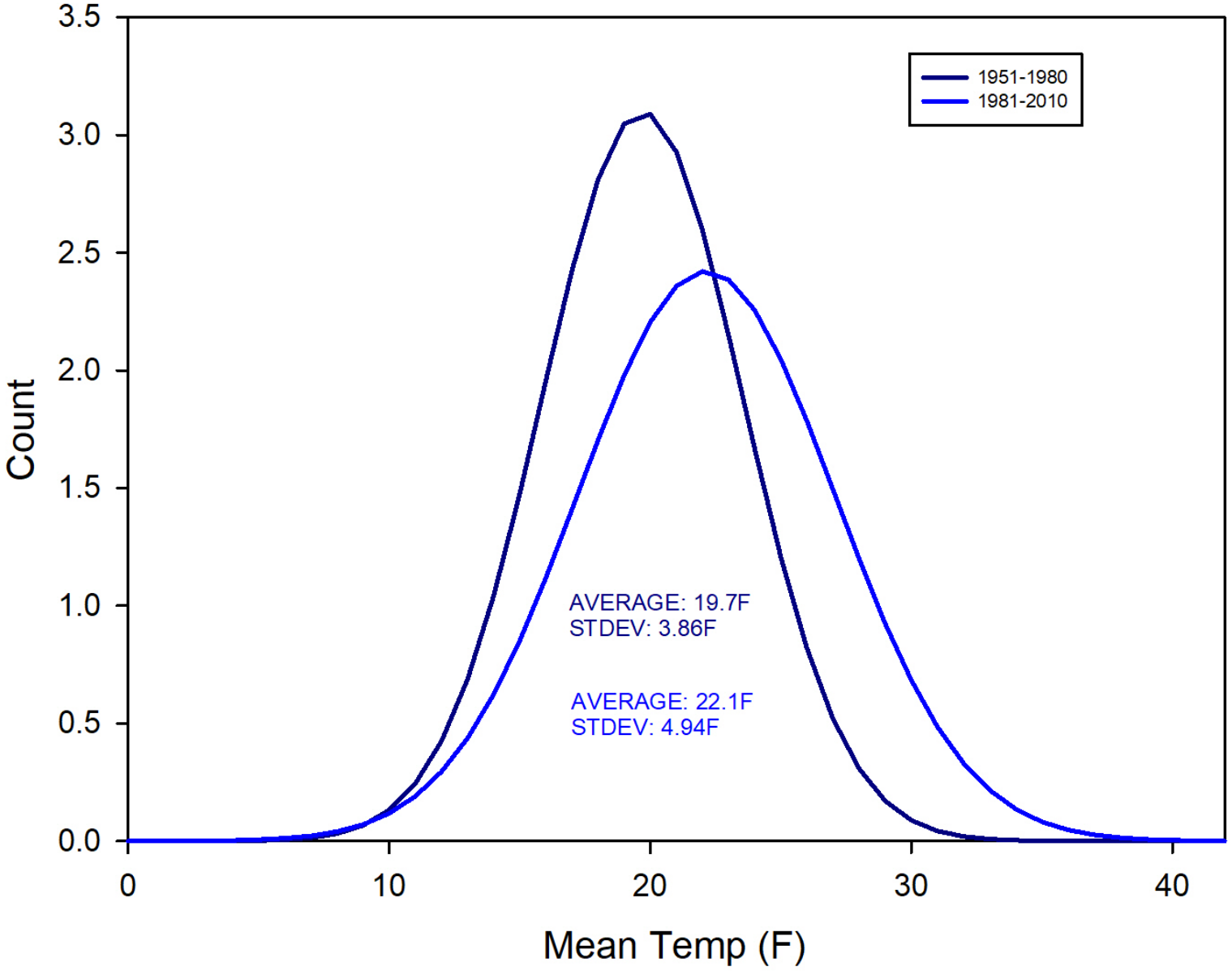


Climatic changes and trends can occur as changes in:

1) the mean state
2) variability
3) both

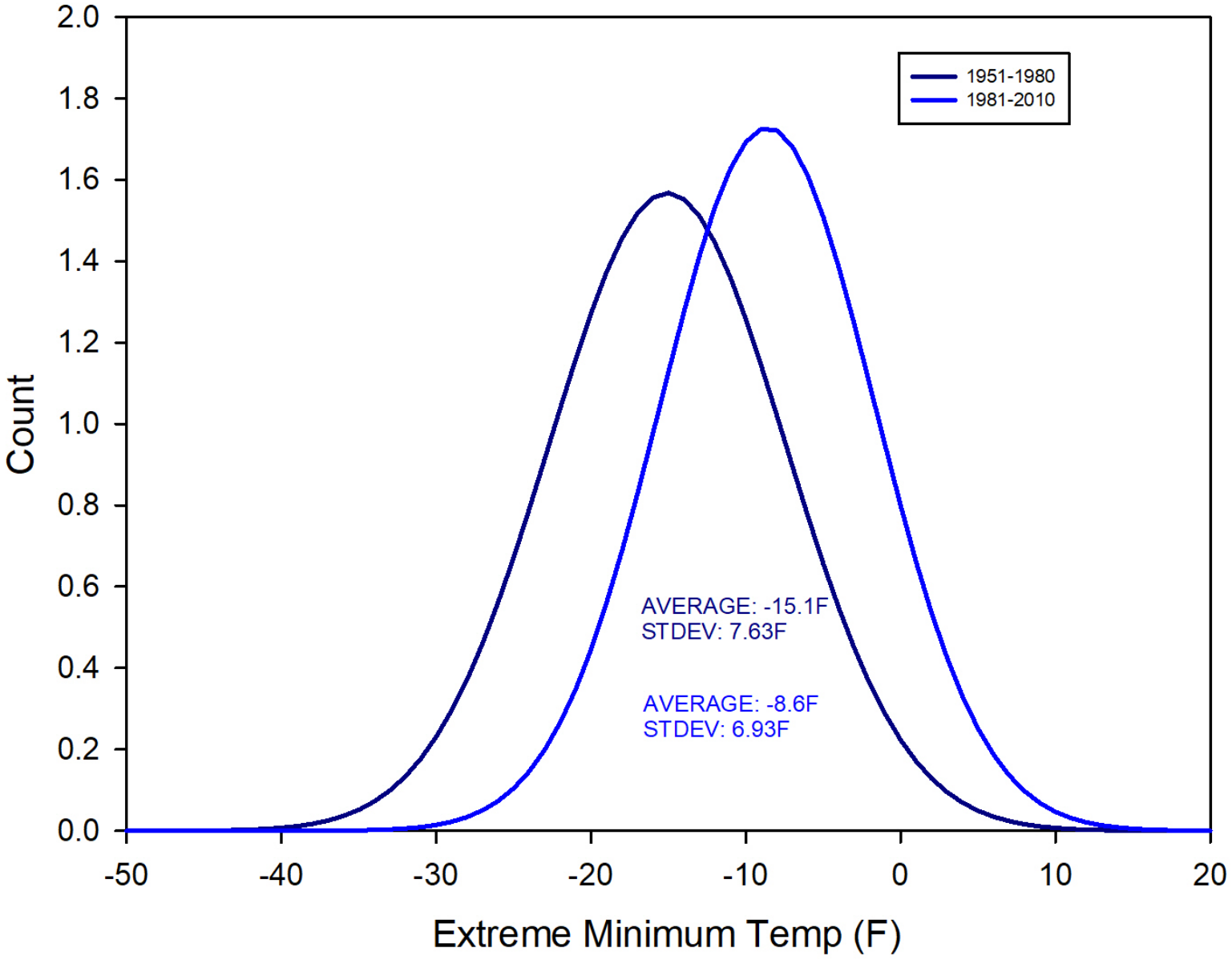
Mean January Temperatures

Traverse City, MI 1951-1980 vs 1981-2010

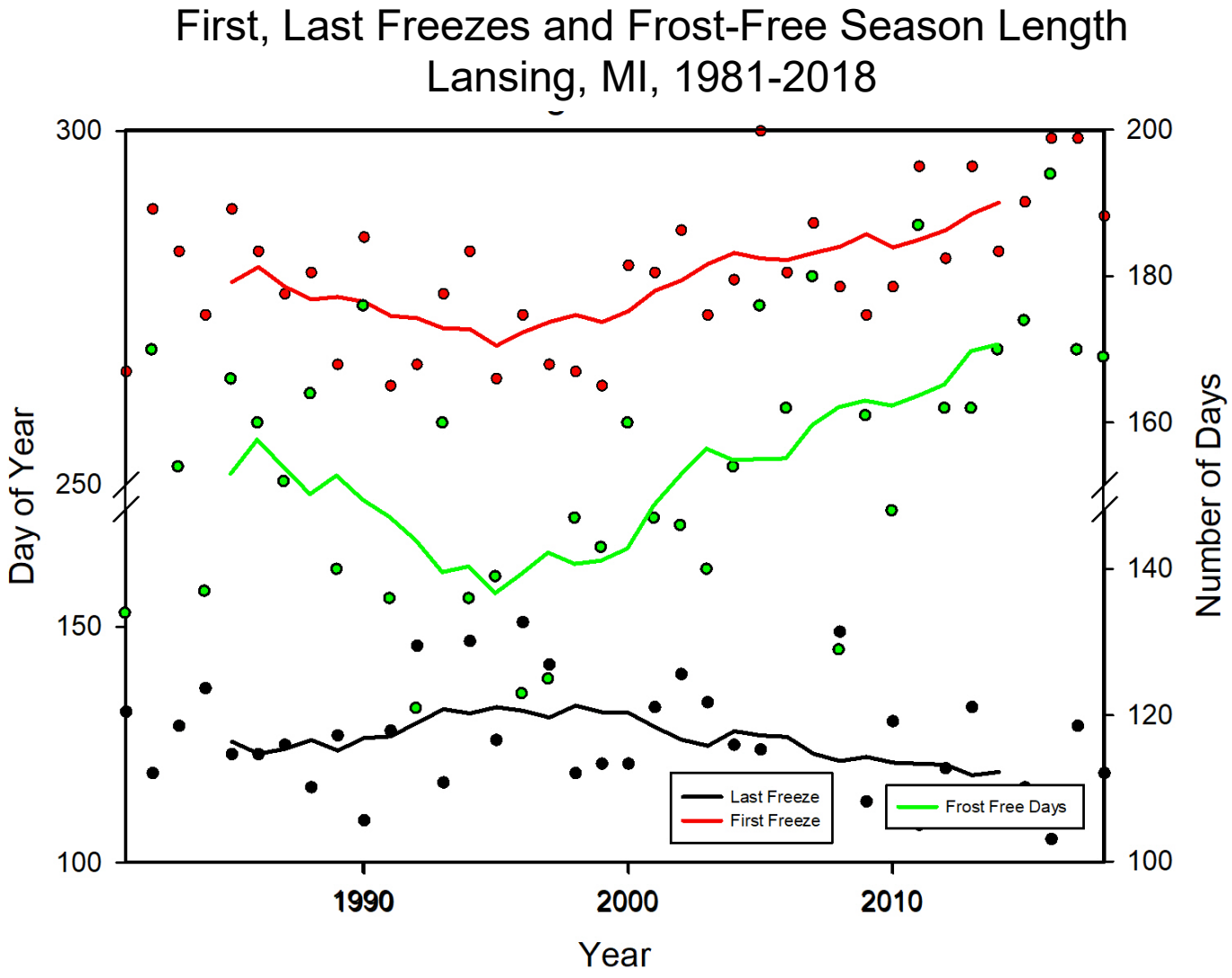


Extreme Annual Minimum Temperatures

Traverse City, MI 1951-1980 vs 1981-2010



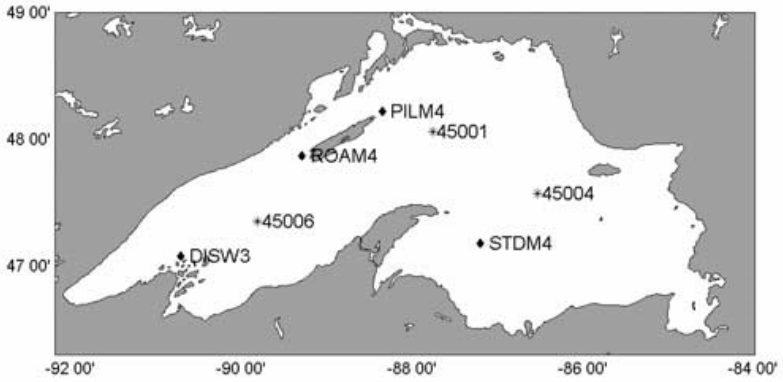
Longer, Warmer Growing Seasons

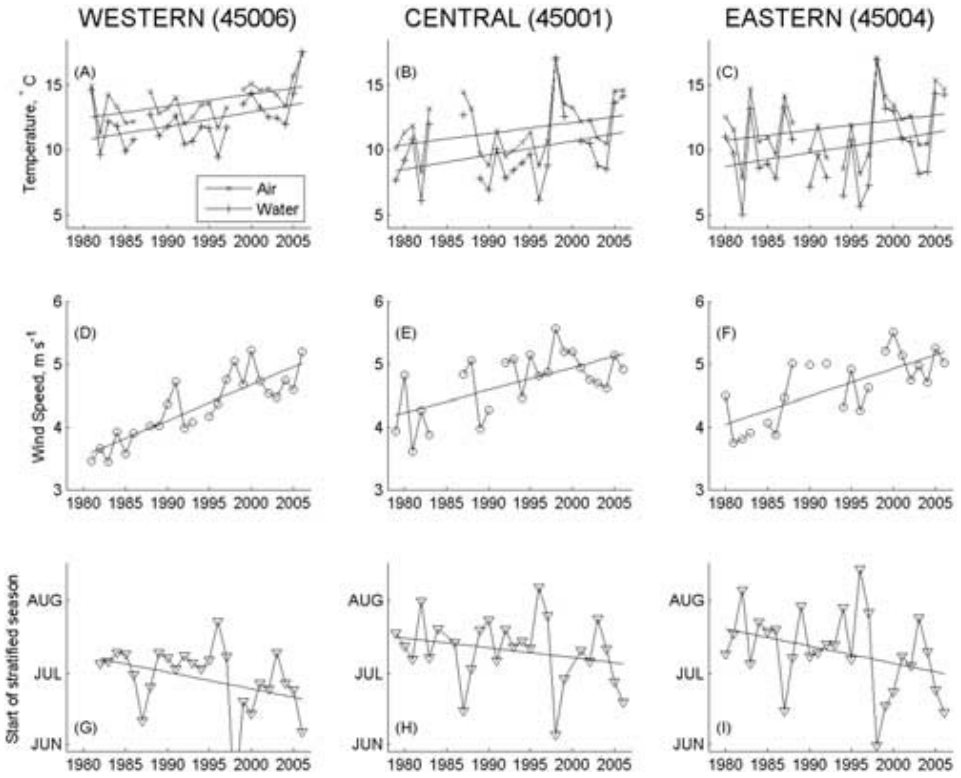


Sources: Jeff Andresen, GLISA and MSU

Warmer Lake Temps

Lake Superior near-surface temp increased 4.5°F from 1979-2006

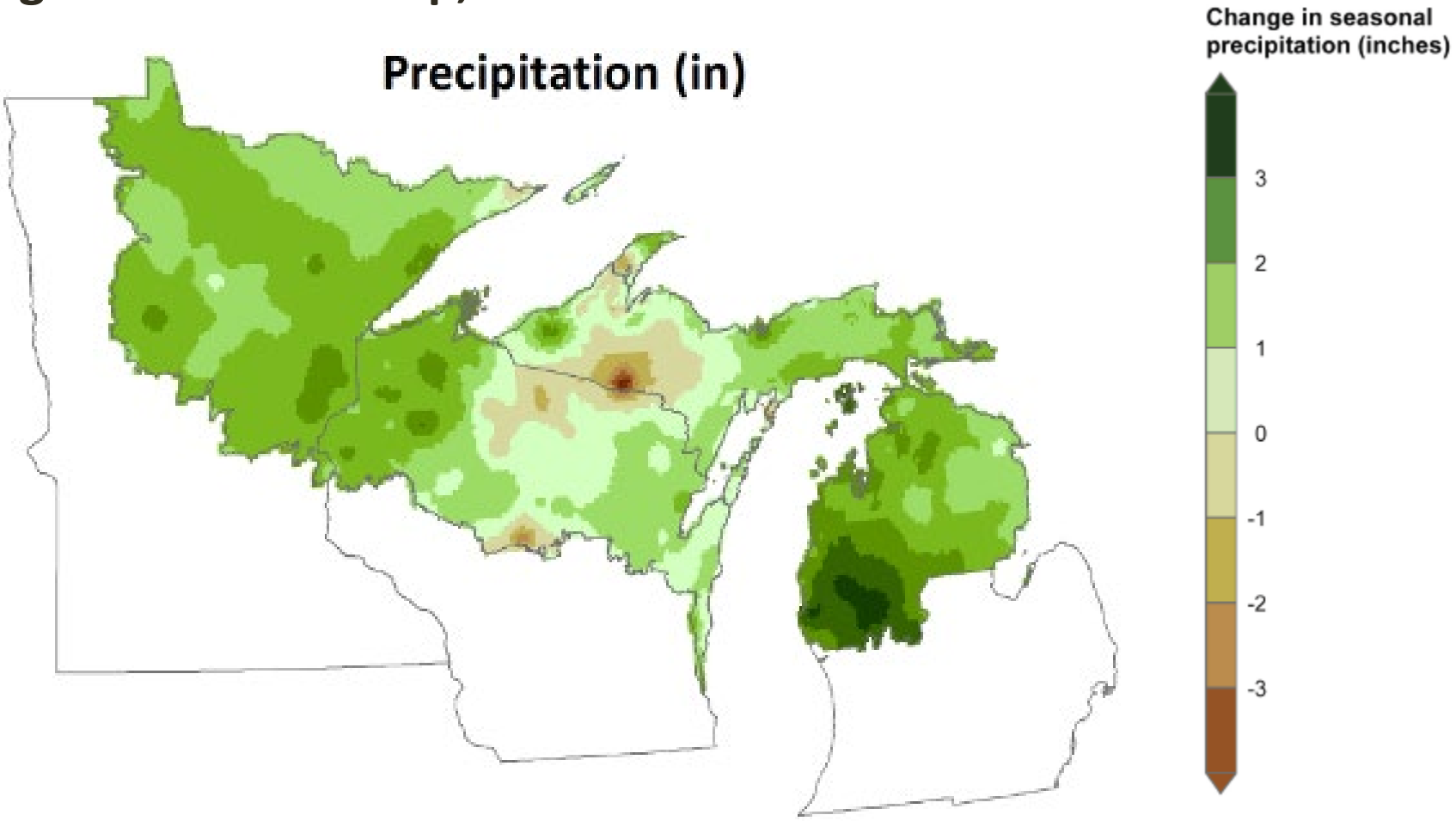




Source: Austin and Coleman 2007

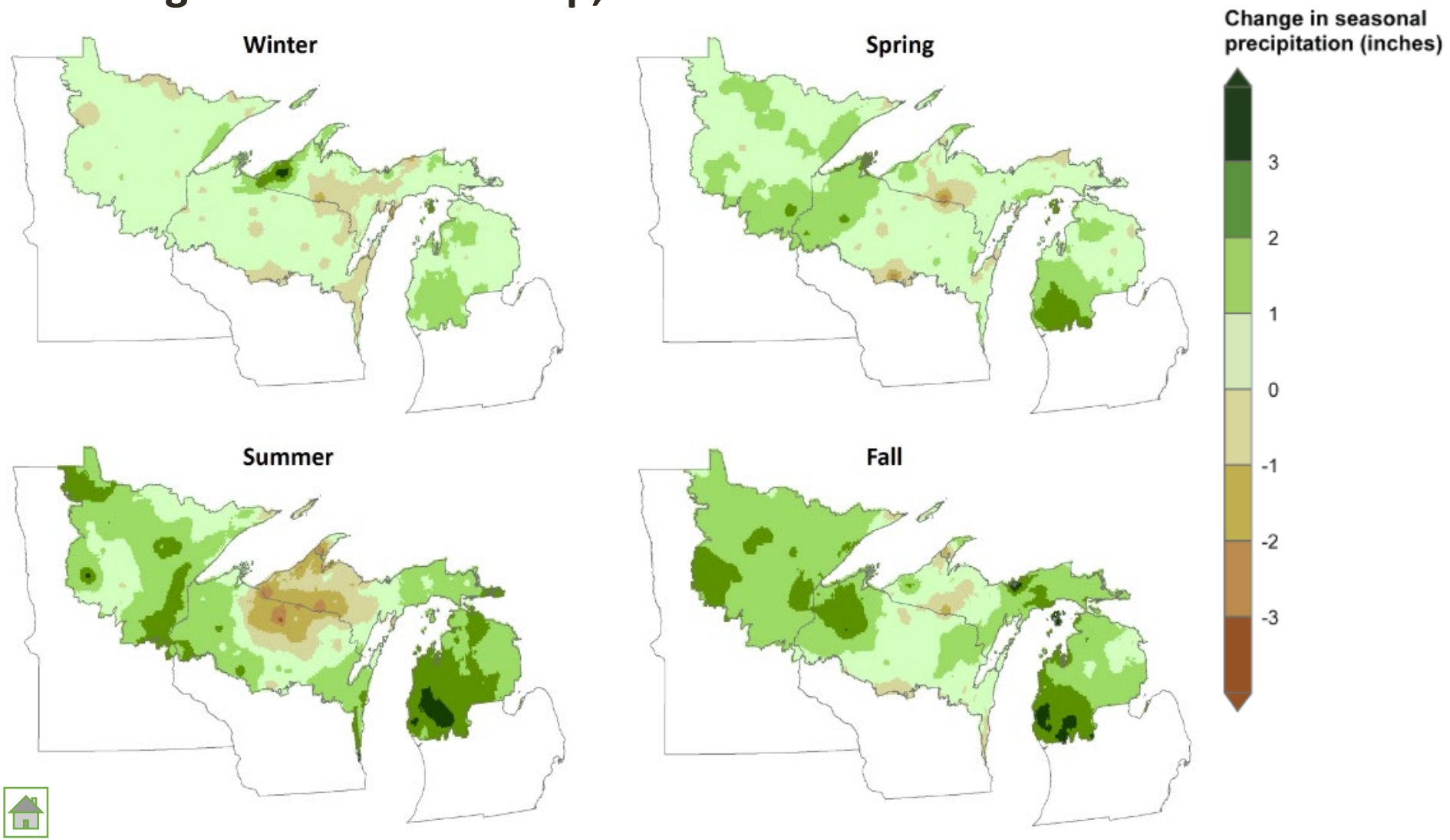
Observed Precipitation Changes

Change in Annual Precip, 1901-2011

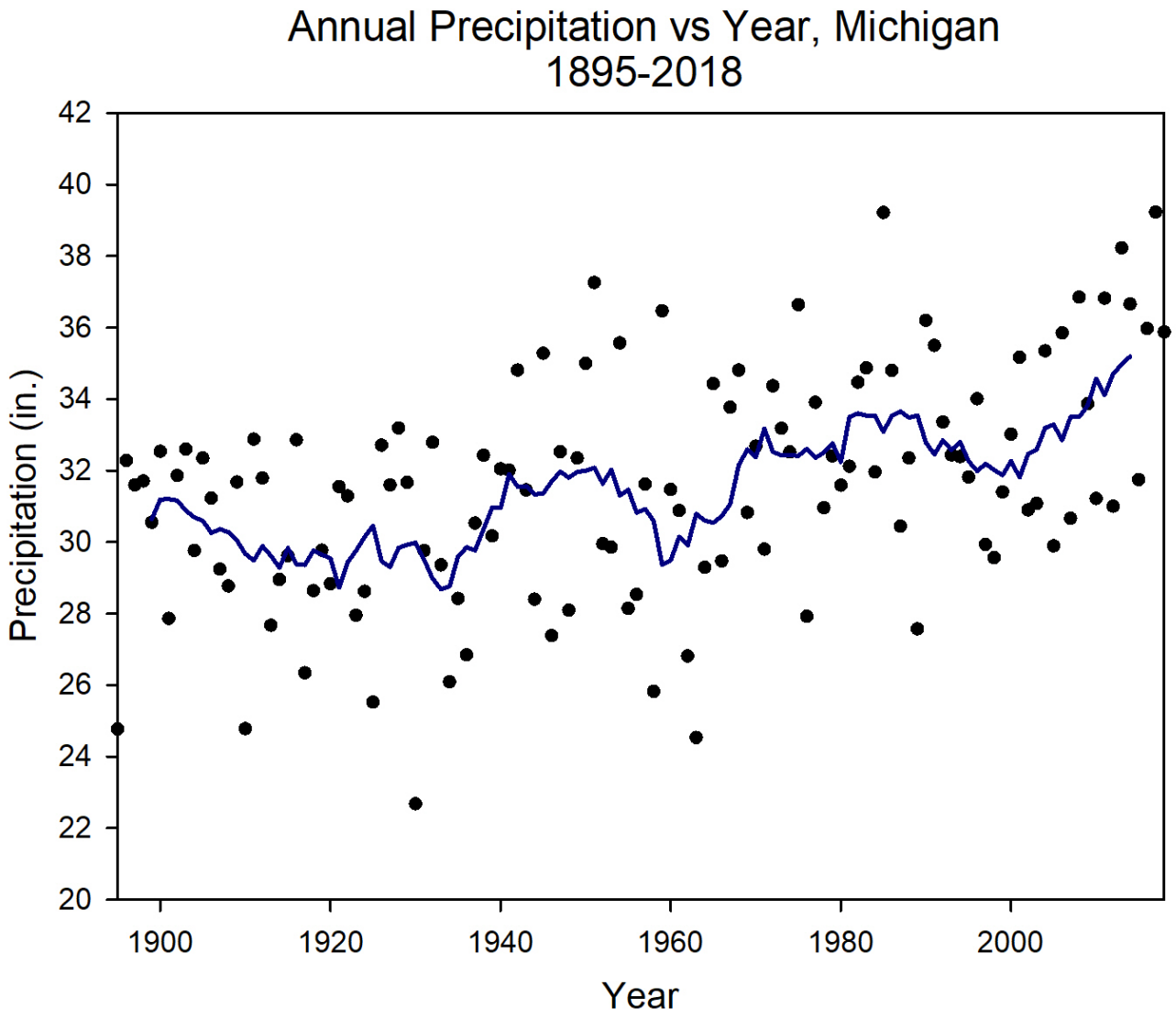


Observed Precipitation Changes

Change in Seasonal Precip, 1901-2011

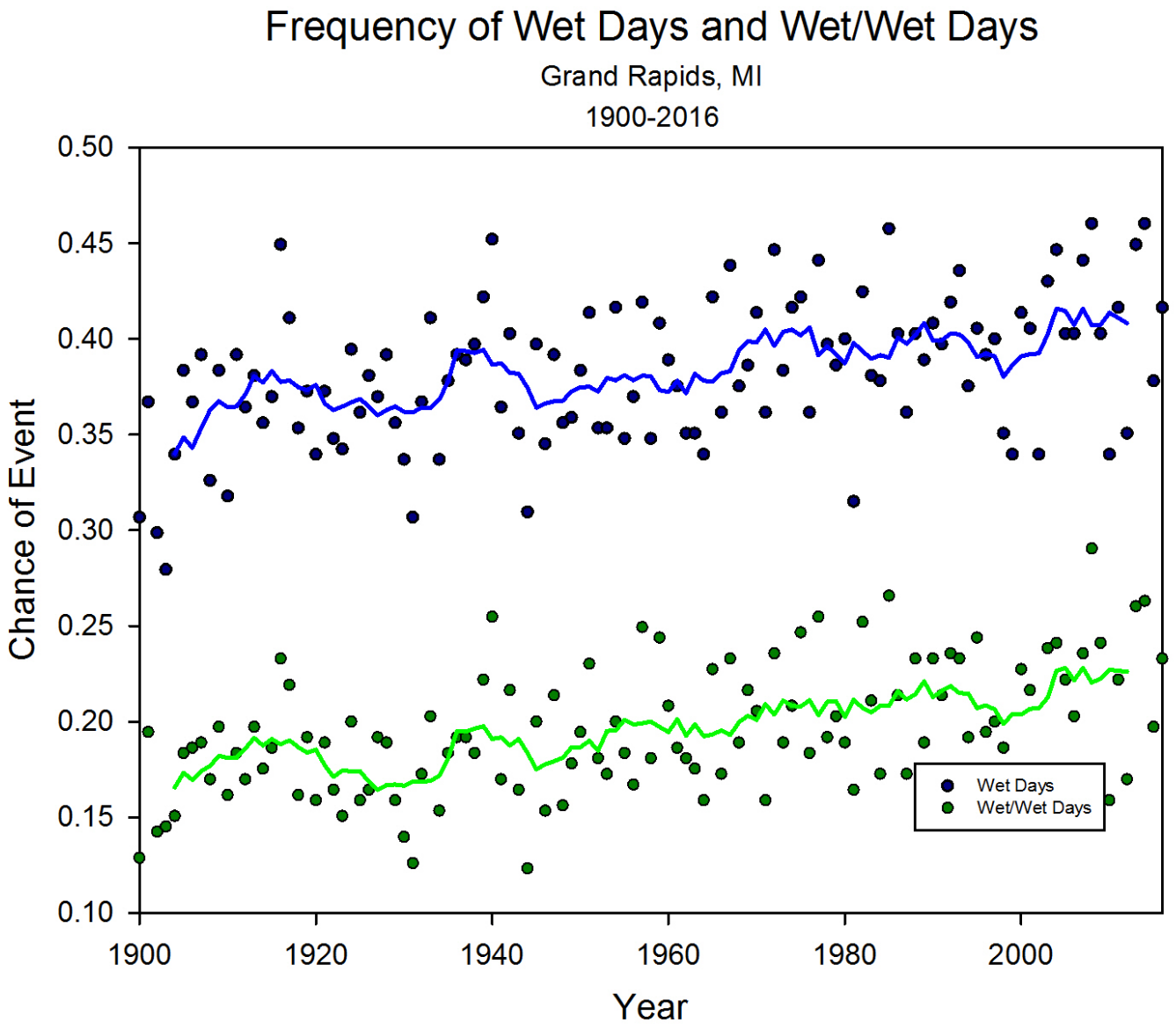


Observed Precipitation Changes



Sources: Jeff Andresen, GLISA and MSU

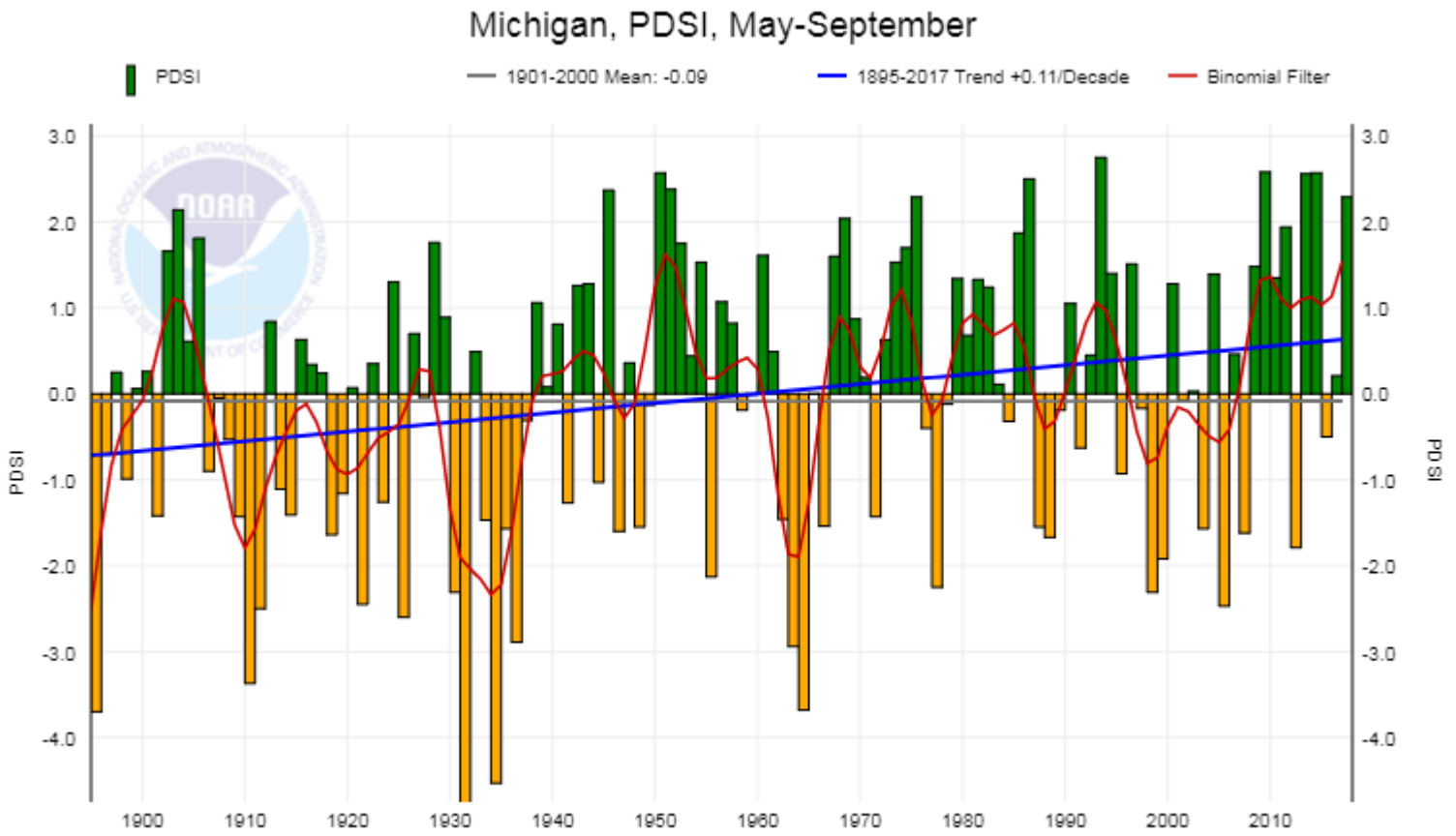
Observed Precipitation Changes



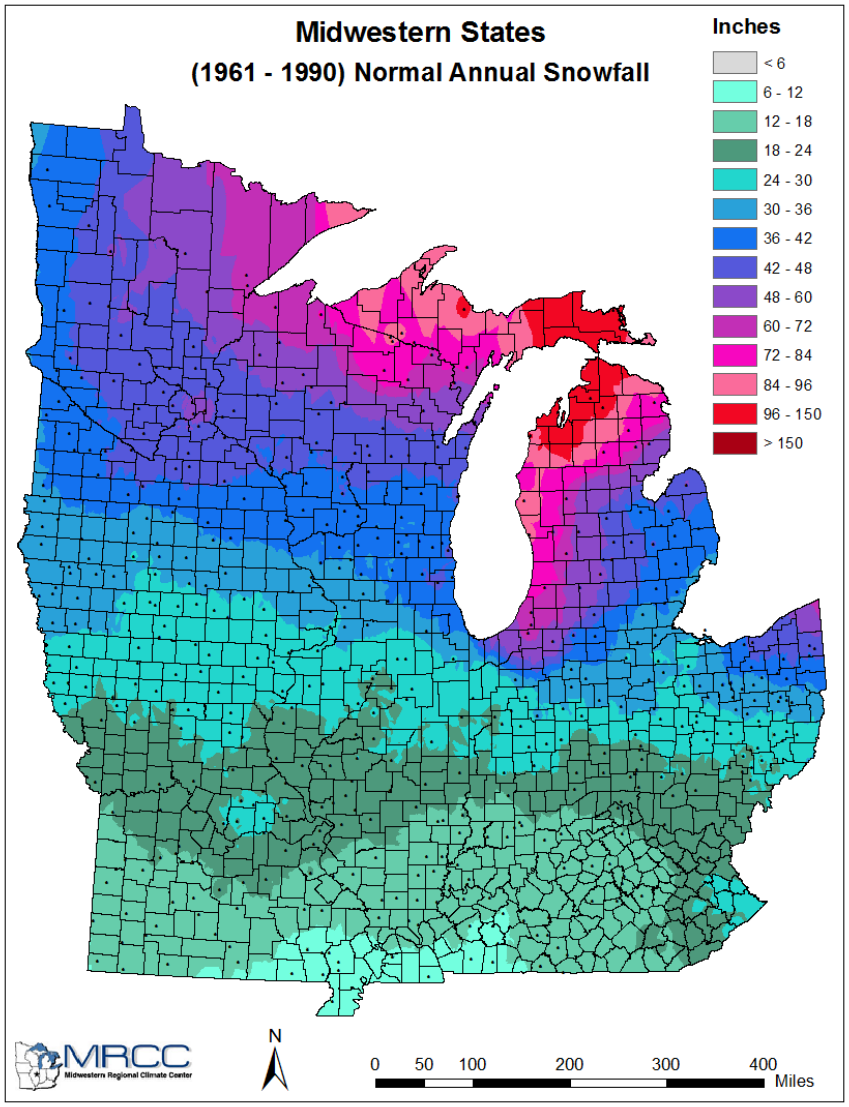
Sources: Jeff Andresen, GLISA and MSU

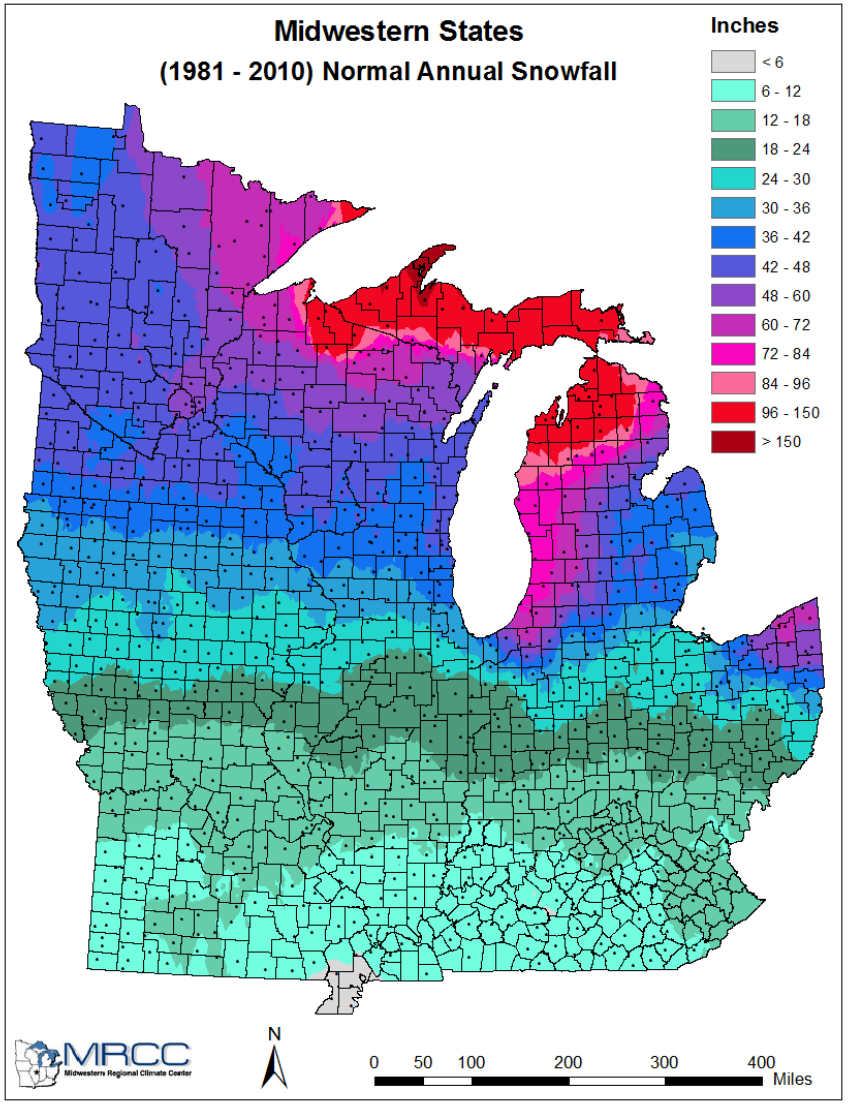
Growing Season Drought Severity

Michigan, 1895-2017



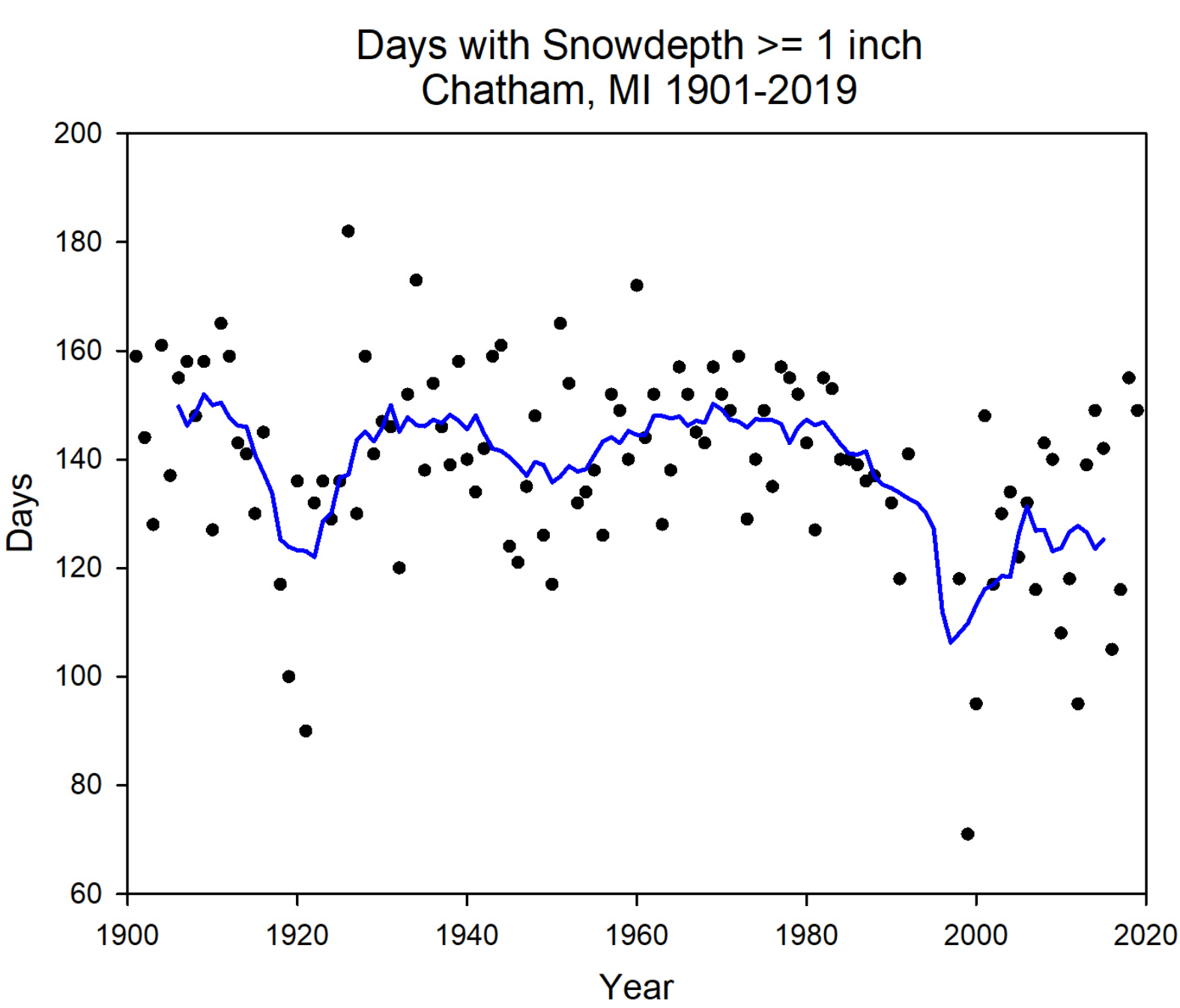
(Source: NOAA/NCEI, 2018)





Mean seasonal total snowfall (inches)

(Midwestern Regional Climate Center)

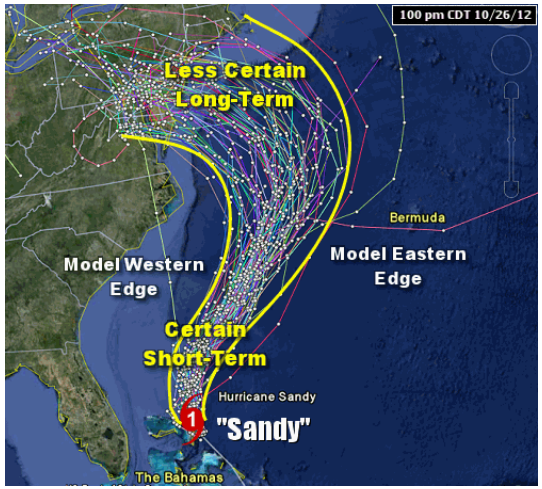

Days with Snowdepth >= 1 inch
Chatham, MI 1901-2019
Days
Year
200
180
160
140
120
100
80
60
1900
1920
1940
1960
1980
2000
2020

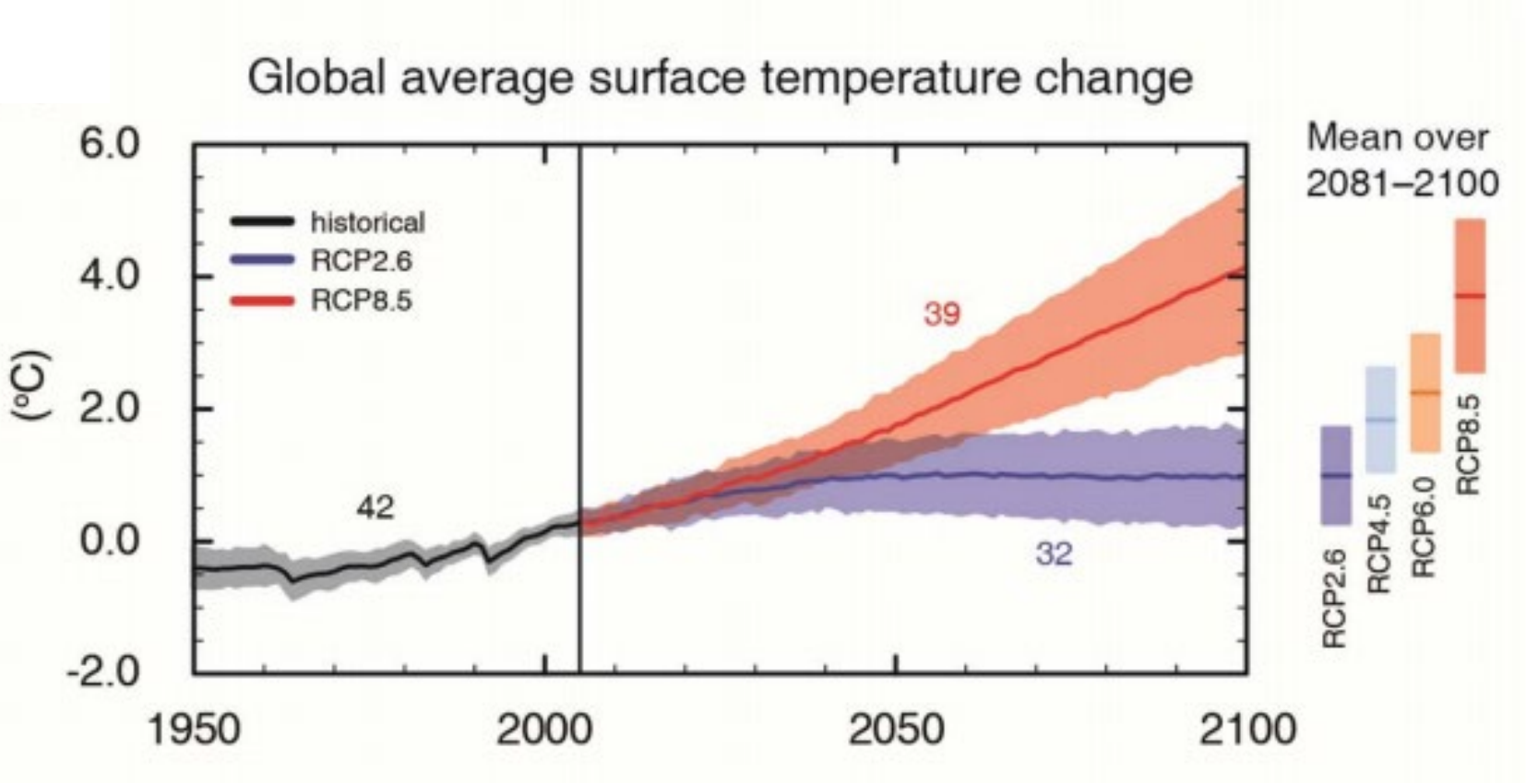
Future Climate Projections

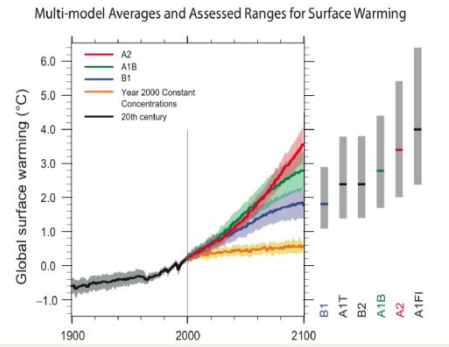
Known Unknowns

Two main sources of uncertainty in climate projections:

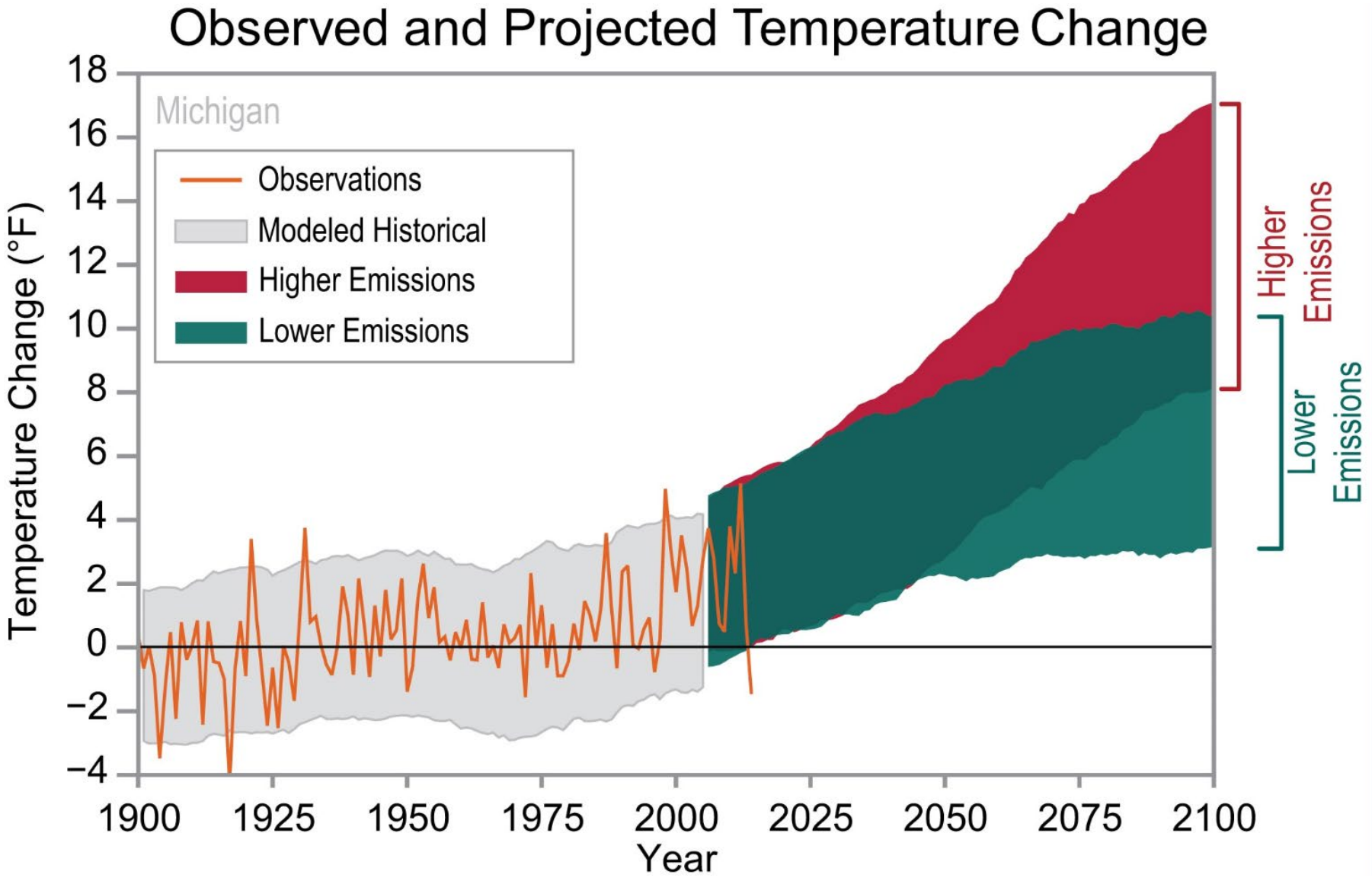
1. Climate models
2. Future greenhouse gas emissions




Global average surface temperature change
6.0
4.0
2.0
0.0
-2.0
(°C)
historical
RCP2.6
RCP8.5
42
39
32
1950
2000
2050
2100
Mean over
2081–2100
RCP2.6
RCP4.5
RCP6.0
RCP8.5


Multi-model Averages and Assessed Ranges for Surface Warming
Global surface warming (°C)
A2
A1B
B1
Year 2000 Constant Concentrations
20th century
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
1900
2000
2100
B1
A1T
B2
A1B
A2
A1FI

(IPCC, 2013)


Observed and Projected Temperature Change
Michigan
Observations
Modeled Historical
Higher Emissions
Lower Emissions
Temperature Change (°F)
18
16
14
12
10
8
6
4
2
0
−2
−4
1900
1925
1950
1975
2000
2025
2050
2075
2100
Year
Higher Emissions
Lower Emissions

(NCICS, 2017)

Projected Temperature-Related Changes

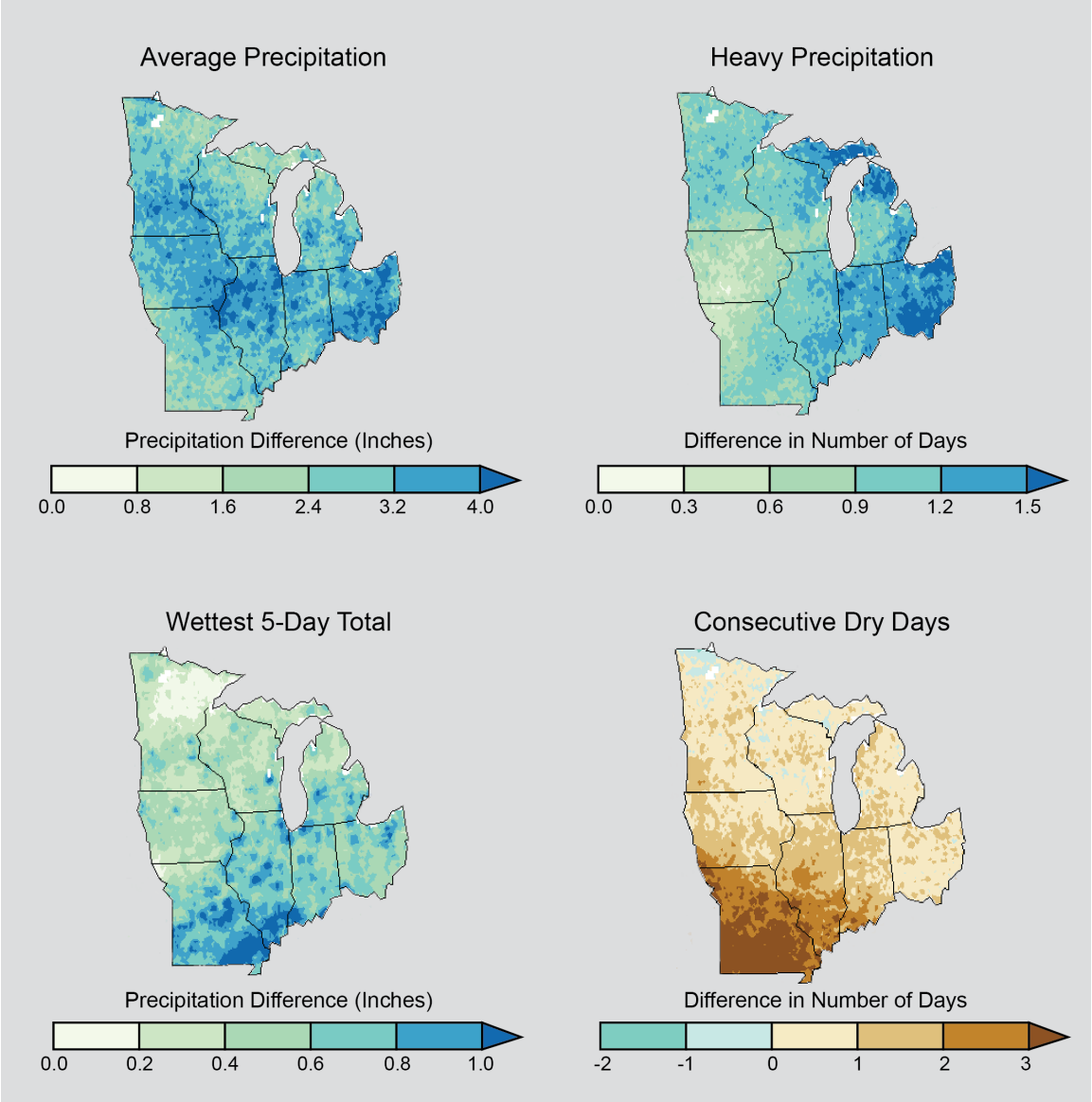
2041-2070 vs. 1971-2000

(Pryor and Scavia, 2013)

Projected Preciptation-Related Changes

2041-2070 vs. 1971-2000

While annual precip could increase, precipitation becomes more extreme and <u>erratic</u>

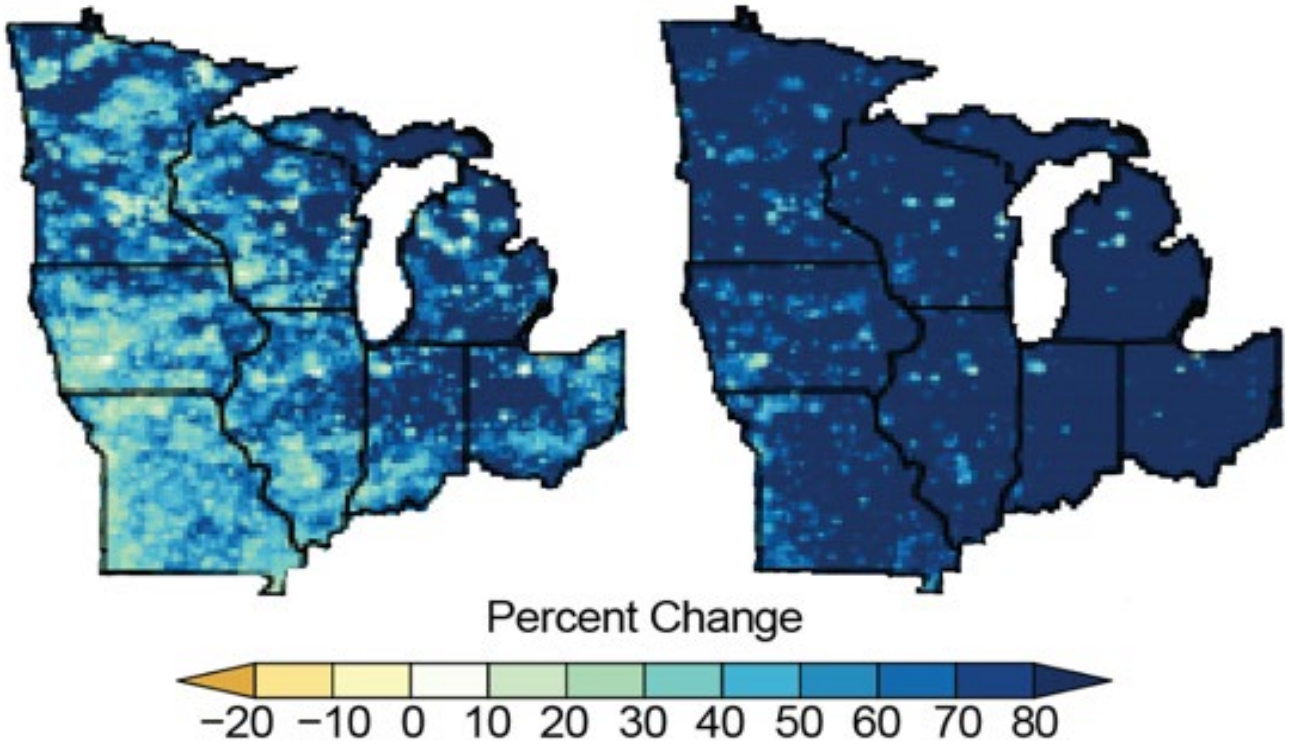


(Pryor and Scavia, 2013)

Extreme Rain Events

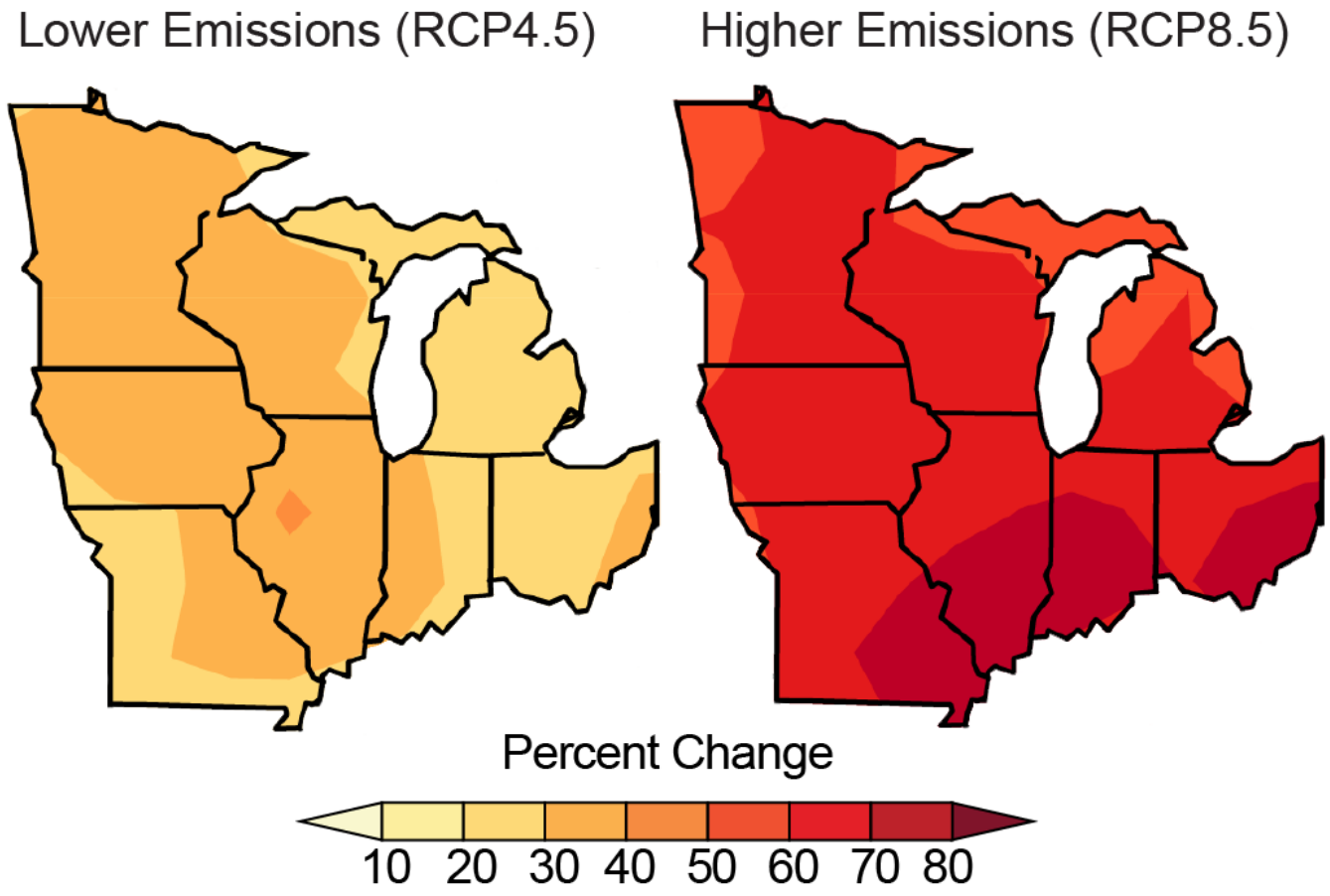
Change in Annual Number of Extreme Precipitation Days,
Late 21st Century

Lower Emissions (RCP4.5) Higher Emissions (RCP8.5)

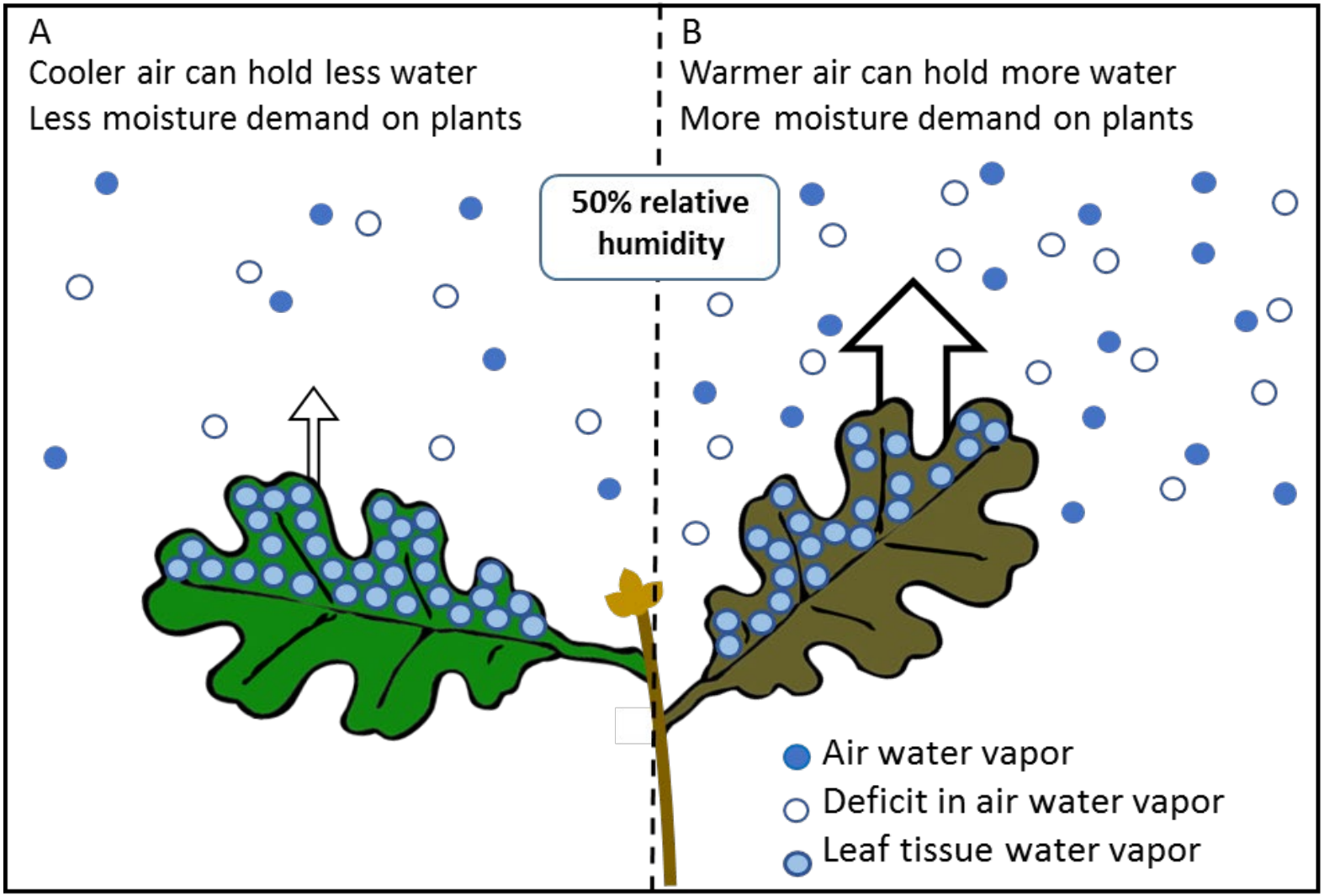


More Drought Stress

Change in Annual Maximum 5-day Vapor Pressure Deficit, Late 21st Century

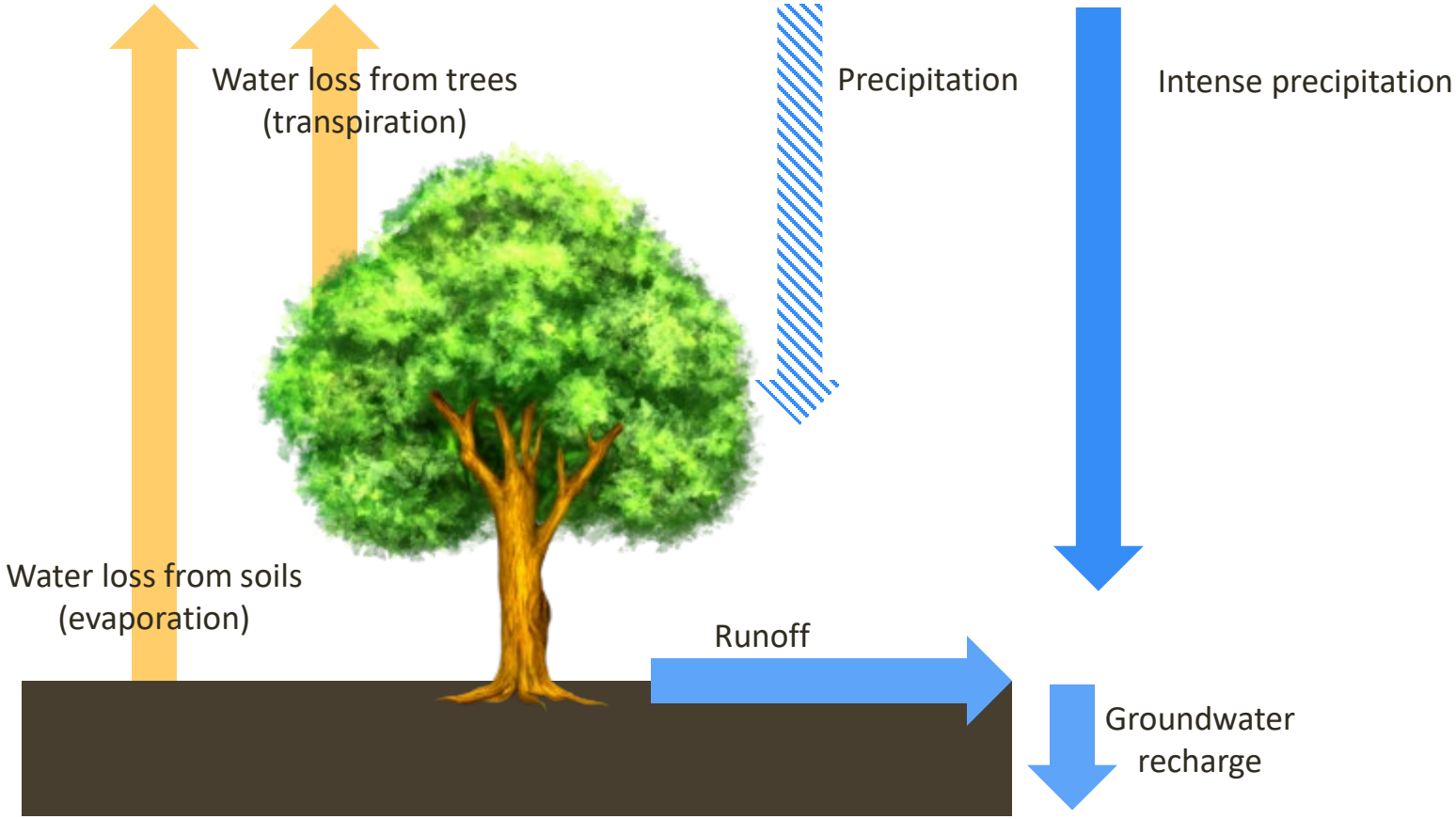


More Drought Stress



More Drought Stress

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



Species Range Shifts

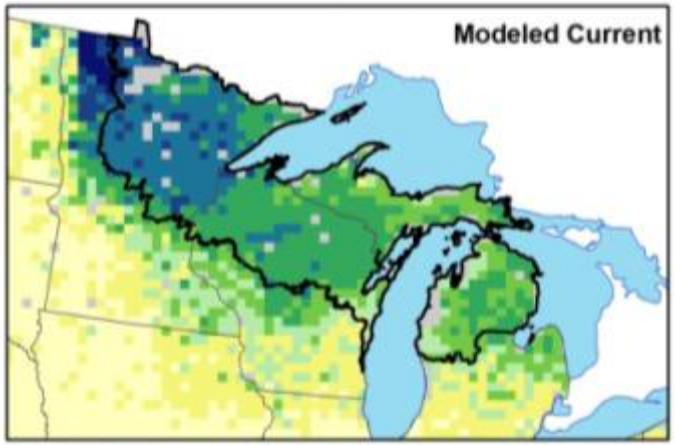
Quaking Aspen

Importance Value

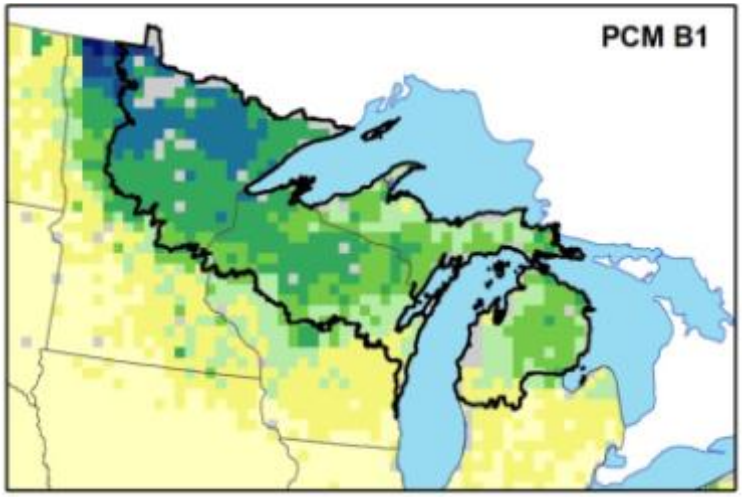
Low

High

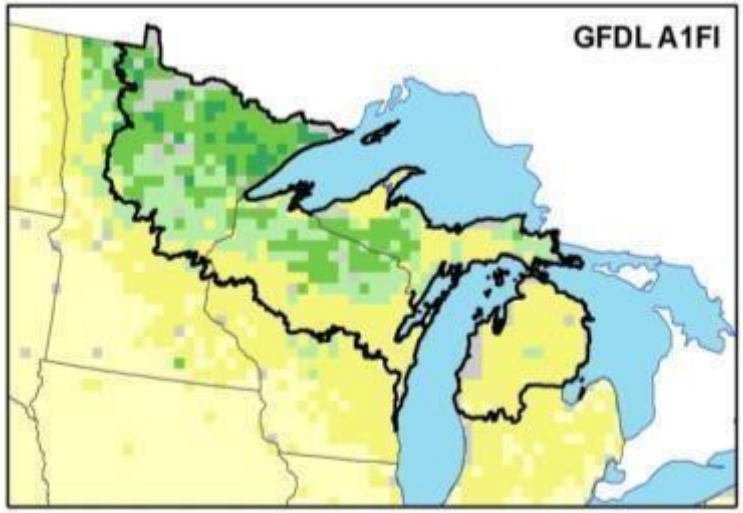
Current



2070-2100 Low



2070-2100 High



Species Range Shifts

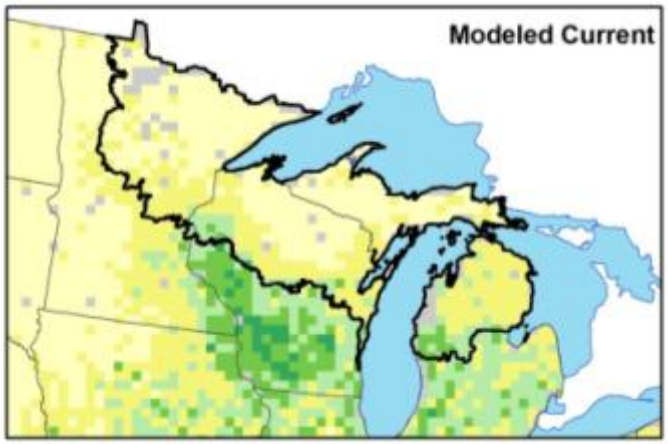
White Oak

Importance Value

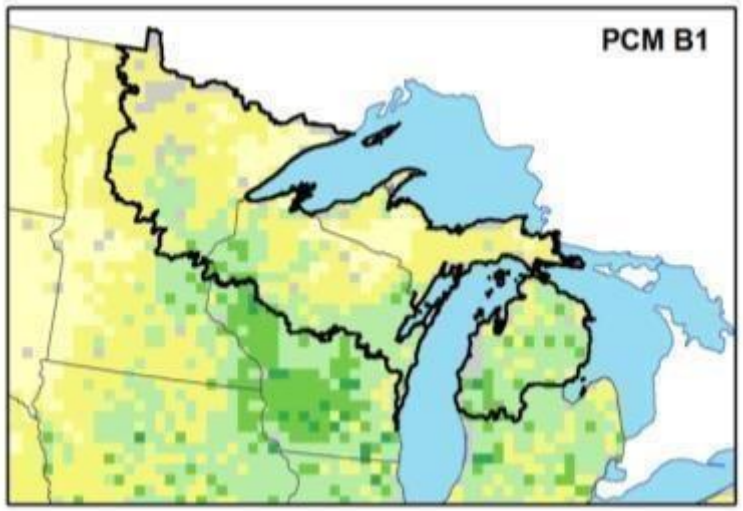
Low

High

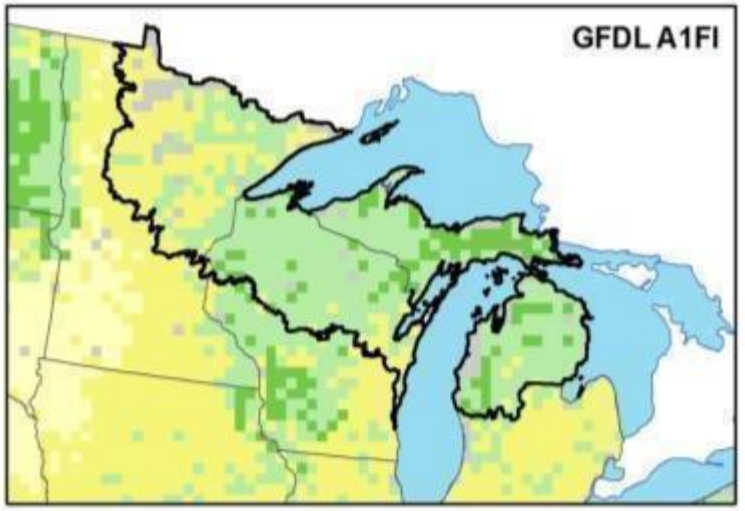
Current



2070-2100 Low



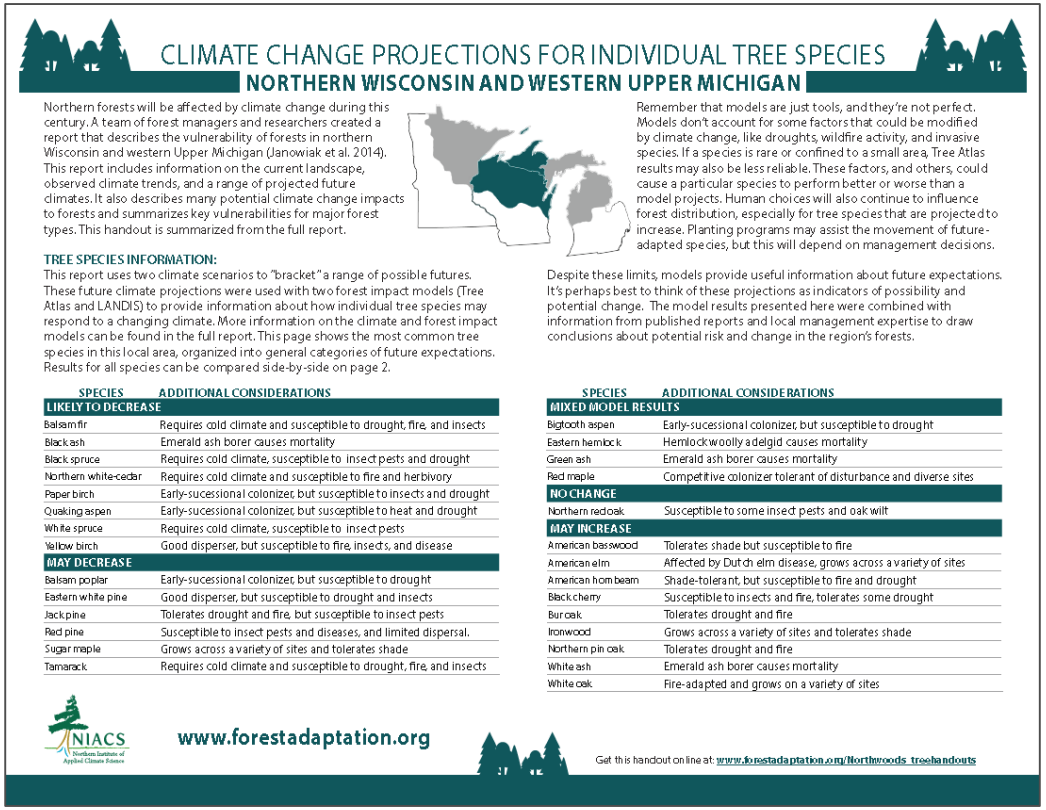
2070-2100 High



Species Range Shifts

Handouts for many different regions:

- Northern MN
- Northern WI & western UP
- Eastern UP & northern LP
- Driftless Area
- Southern WI
- Southern MI



CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES
NORTHERN WISCONSIN AND WESTERN UPPER MICHIGAN

Northern forests will be affected by climate change during this century. A team of forest managers and researchers created a report that describes the vulnerability of forests in northern Wisconsin and western Upper Michigan (Janowiak et al. 2014). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full report.

Remember that models are just tools, and they're not perfect. Models don't account for some factors that could be modified by climate change, like droughts, wildfire activity, and invasive species. If a species is rare or confined to a small area, Tree Atlas results may also be less reliable. These factors, and others, could cause a particular species to perform better or worse than a model projects. Human choices will also continue to influence forest distribution, especially for tree species that are projected to increase. Planting programs may assist the movement of future-adapted species, but this will depend on management decisions.

TREE SPECIES INFORMATION:
This report uses two climate scenarios to "bracket" a range of possible futures. These future climate projections were used with two forest impact models (Tree Atlas and LANDIS) to provide information about how individual tree species may respond to a changing climate. More information on the climate and forest impact models can be found in the full report. This page shows the most common tree species in this local area, organized into general categories of future expectations. Results for all species can be compared side-by-side on page 2.

Despite these limits, models provide useful information about future expectations. It's perhaps best to think of these projections as indicators of possibility and potential change. The model results presented here were combined with information from published reports and local management expertise to draw conclusions about potential risk and change in the region's forests.

SPECIES	ADDITIONAL CONSIDERATIONS
LIKELY TO DECREASE	
Balsam fir	Requires cold climate and susceptible to drought, fire, and insects
Black ash	Emerald ash borer causes mortality
Black spruce	Requires cold climate, susceptible to insect pests and drought
Northern white-cedar	Requires cold climate and susceptible to fire and herbivory
Paper birch	Early-sucessional colonizer, but susceptible to insects and drought
Quaking aspen	Early-sucessional colonizer, but susceptible to heat and drought
White spruce	Requires cold climate, susceptible to insect pests
Yellow birch	Good disperser, but susceptible to fire, insects, and disease
MAY DECREASE	
Balsam poplar	Early-sucessional colonizer, but susceptible to drought
Eastern white pine	Good disperser, but susceptible to drought and insects
Jack pine	Tolerates drought and fire, but susceptible to insect pests
Red pine	Susceptible to insect pests and diseases, and limited dispersal.
Sugar maple	Grows across a variety of sites and tolerates shade
Tamarack	Requires cold climate and susceptible to drought, fire, and insects

SPECIES	ADDITIONAL CONSIDERATIONS
MIXED MODEL RESULTS	
Bigtooth aspen	Early-sucessional colonizer, but susceptible to drought
Eastern hemlock	Hemlock woolly adelgid causes mortality
Green ash	Emerald ash borer causes mortality
Red maple	Competitive colonizer tolerant of disturbance and diverse sites
NO CHANGE	
Northern red oak	Susceptible to some insect pests and oak wilt
MAY INCREASE	
American basswood	Tolerates shade but susceptible to fire
American elm	Affected by Dutch elm disease, grows across a variety of sites
American hornbeam	Shade-tolerant, but susceptible to fire and drought
Black cherry	Susceptible to insects and fire, tolerates some drought
Bur oak	Tolerates drought and fire
Ironwood	Grows across a variety of sites and tolerates shade
Northern pin oak	Tolerates drought and fire
White ash	Emerald ash borer causes mortality
White oak	Fire-adapted and grows on a variety of sites

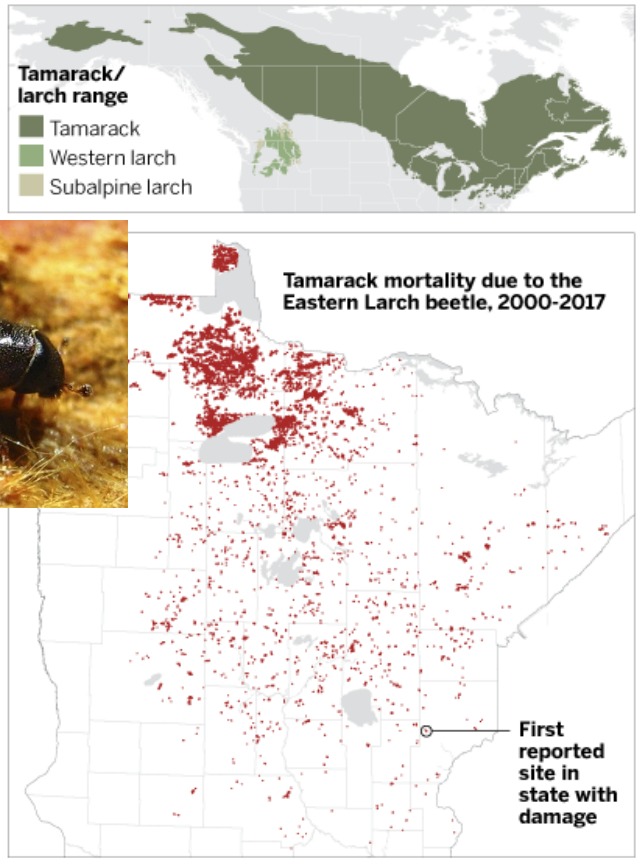
NIACS Northern Institute of Applied Climate Science

www.forestadaptation.org

Get this handout on line at: www.forestadaptation.org/Northwoods_treehandouts

Pests and Diseases

Climate change can trigger more damage from pests.

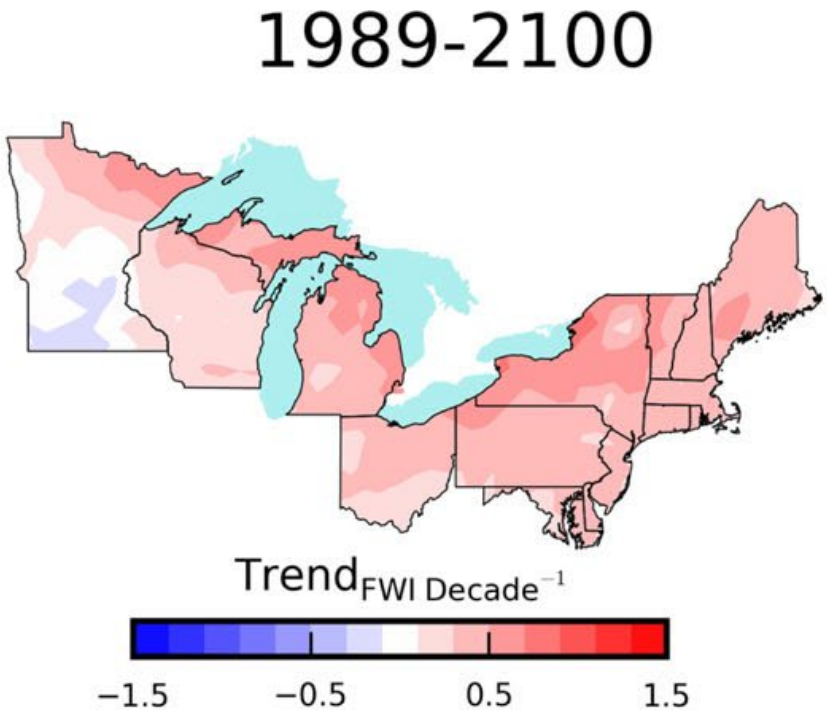


Ray Grumney, Star Tribune. Photo: Fraser McKee

Wildfire Risk

Fire may increase, because:

- Warmer/drier summers
- Increased mortality from stress, pests, events
- More frequent weather conditions that promote large fires



FWI = Fire Weather Index values

Guyette et al. 2014, Tang et al. 2014, Miranda et al. 2012, Moritz et al. 2012, Nowacki et al. 2014, Kerr et al. 2017

Wildfire Risk

Fire may increase, because:

- Warmer/drier summers
- Increased mortality from stress, pests, events
- More frequent weather conditions that promote large fires

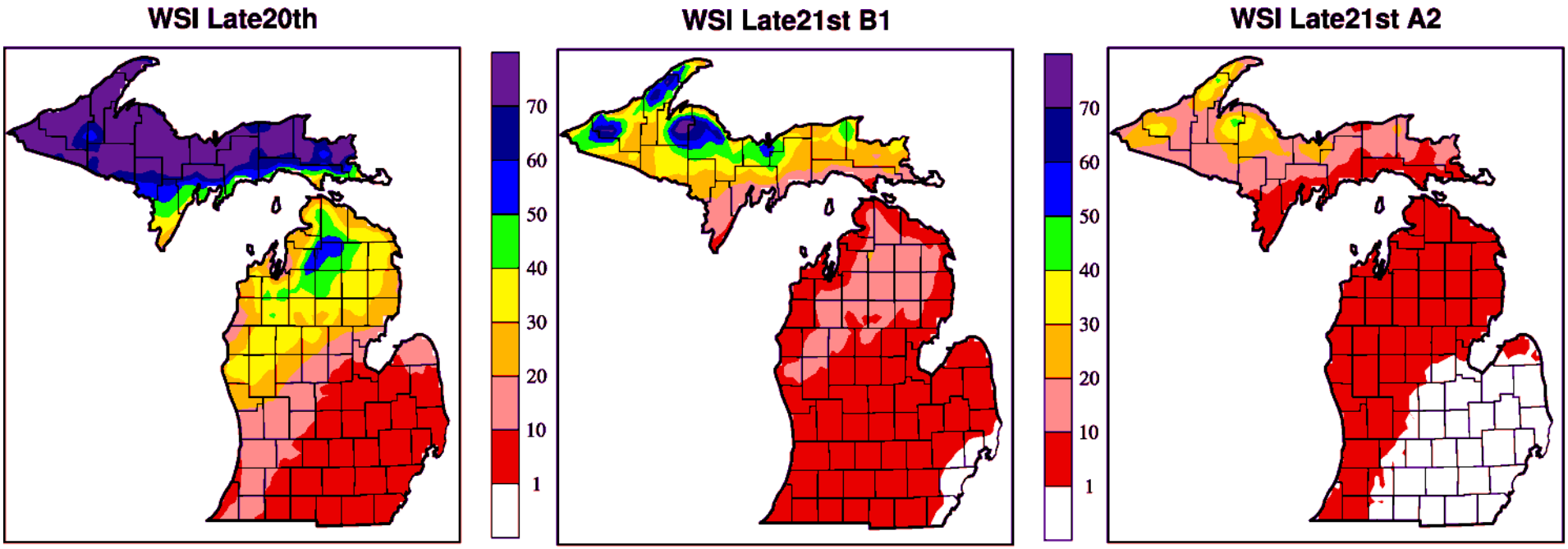
…or maybe not, because:

- Fire suppression will continue
- Spring/early summer moisture
- Current regeneration of more mesic species
- Spatial patterns of land use and fragmentation

Source: Guyette et al. 2014, Tang et al. 2014, Miranda et al. 2012, Moritz et al. 2012, Nowacki et al. 2014

Winter Severity Index

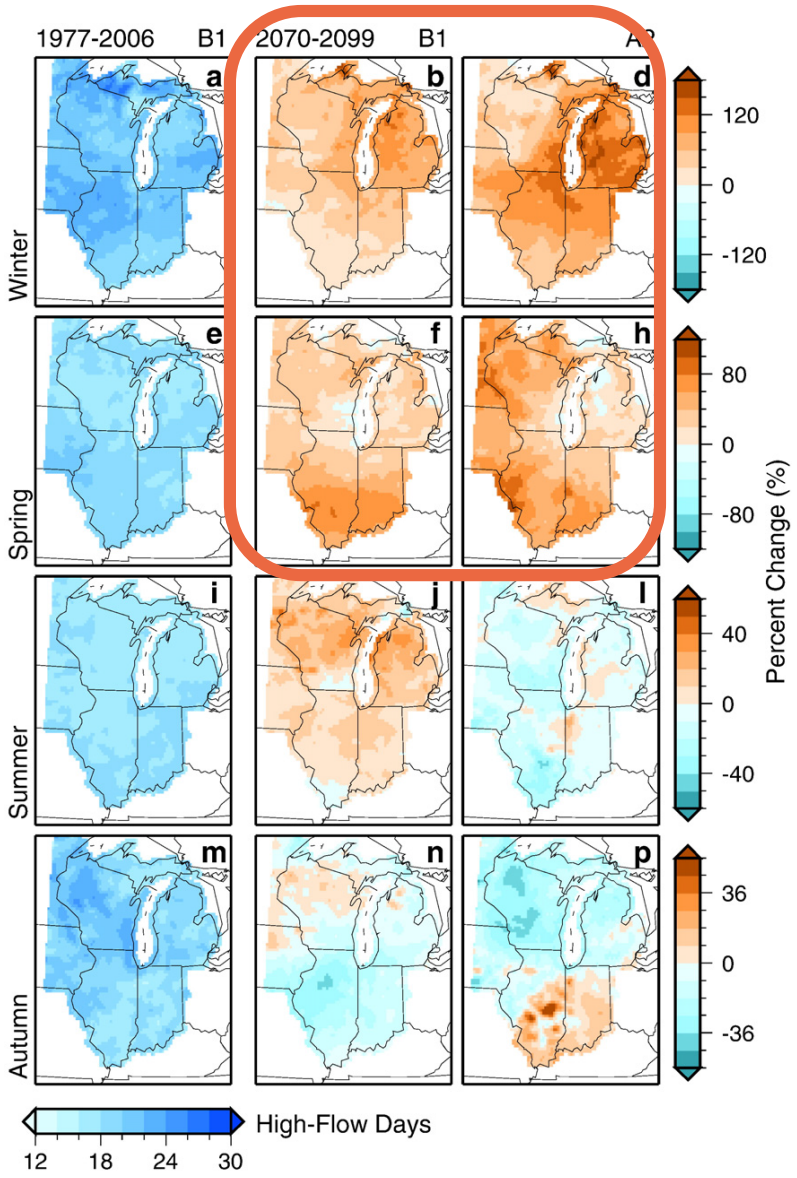
Current **Low** **High**



Sources: http://ccr.aos.wisc.edu/resources/data_scripts/LCC_MI/

Streamflow Changes

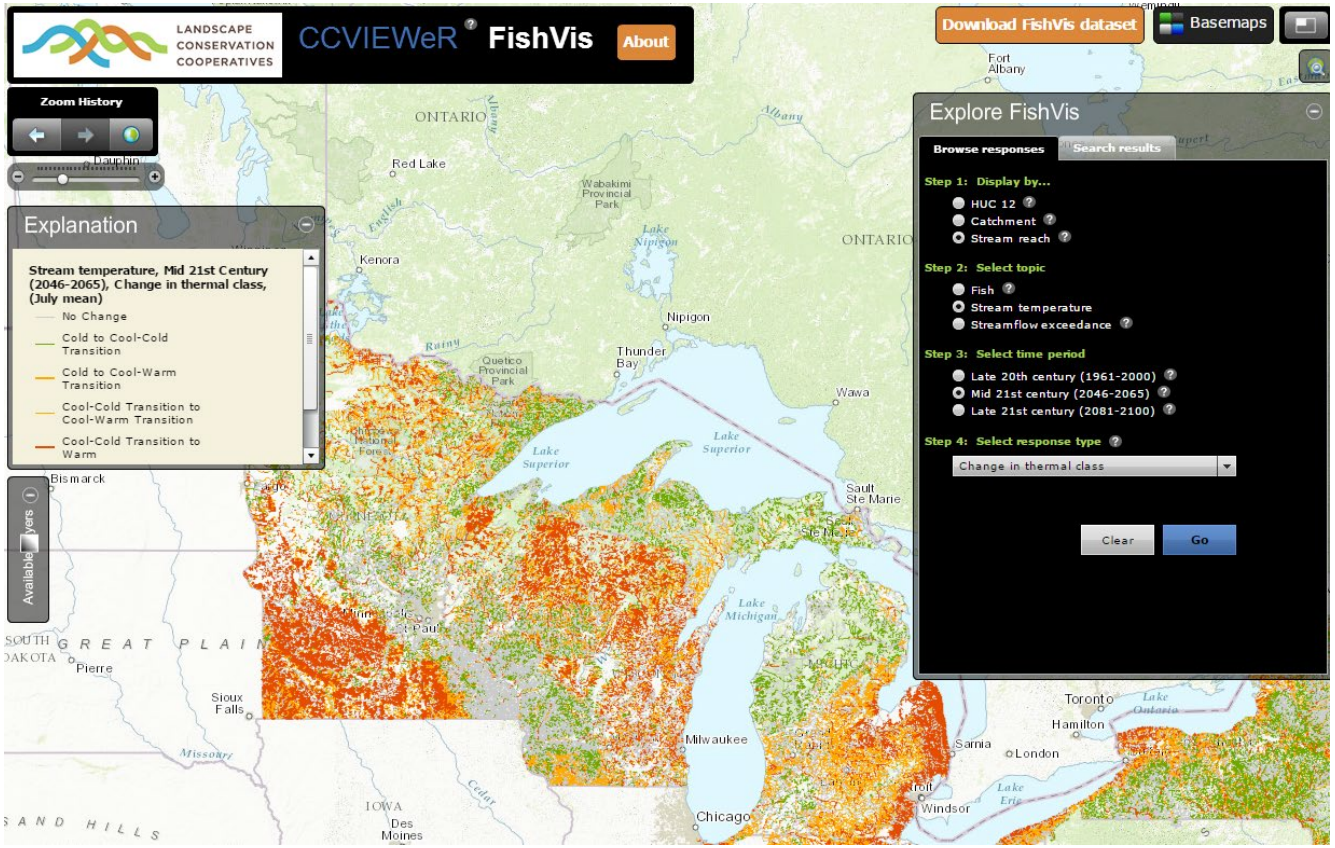
- High-flow days become much more common in winter and spring
- Low-flow days become much more common in summer and fall



Cherkauer and Sinha 2010, also Christiansen et al. 2014

Warmer Stream Temps

- Stream temp. class changes
- Streamflow exceedance



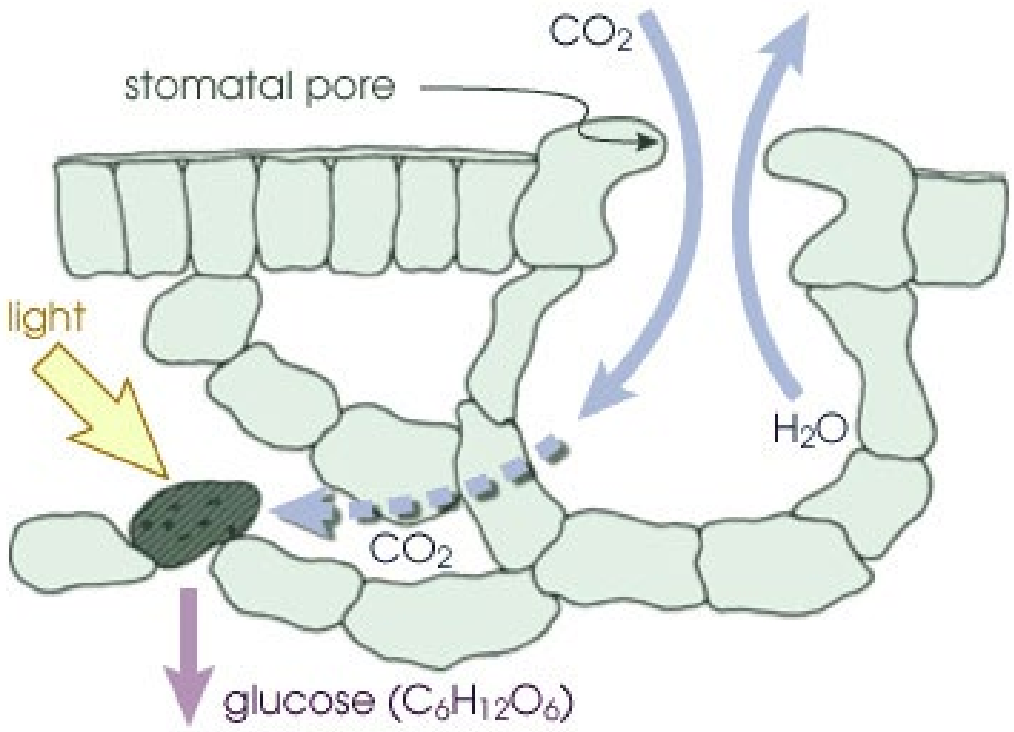
CO_2 Fertilization

Benefits:

- Increased growth
- Water-use efficiency

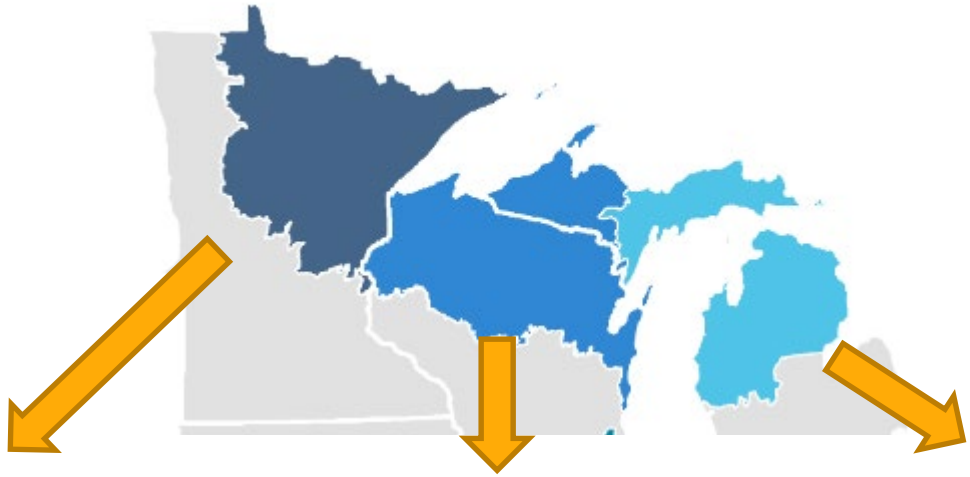
Limits:

- Other nutrients or water
- Stressors or disturbance



Ainsworth and Long 2005, Ainsworth and Rogers 2007, Norby and Zak 2011, Coture et al. 2015

Forest Type Vulnerability



Acid peatland
Forested rich peatland
Wet forest
Managed aspen
Managed red pine
Fire-dependent forest
Mesic hardwood forest
Floodplain forest

Lowland conifer
Upland spruce-fir
Aspen-birch
Lowland/riparian hardwoods
Red pine
Northern hardwoods
Jack pine
Oak
White pine

Upland spruce-fir
Lowland conifer
Red pine/ white pine
Jack pine
Aspen-birch
Northern hardwoods
Lowland/riparian hardwoods
Oak associations
Barrens

Regional to Site-Specific

- Research and assessments describe **broad trends** but **local conditions** and **management** make the difference.

Be like Wayne