

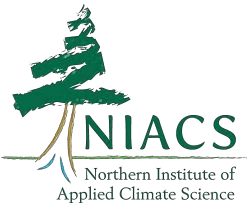


United States Department of Agriculture
Northern Forests Climate Hub

Climate Change Vulnerabilities of Driftless Area Forests

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Northern Institute of Applied Climate Science
USDA Forest Service
USDA Northern Forests Climate Hub



Roadmap

Recap of Climate
Trends and
Projections

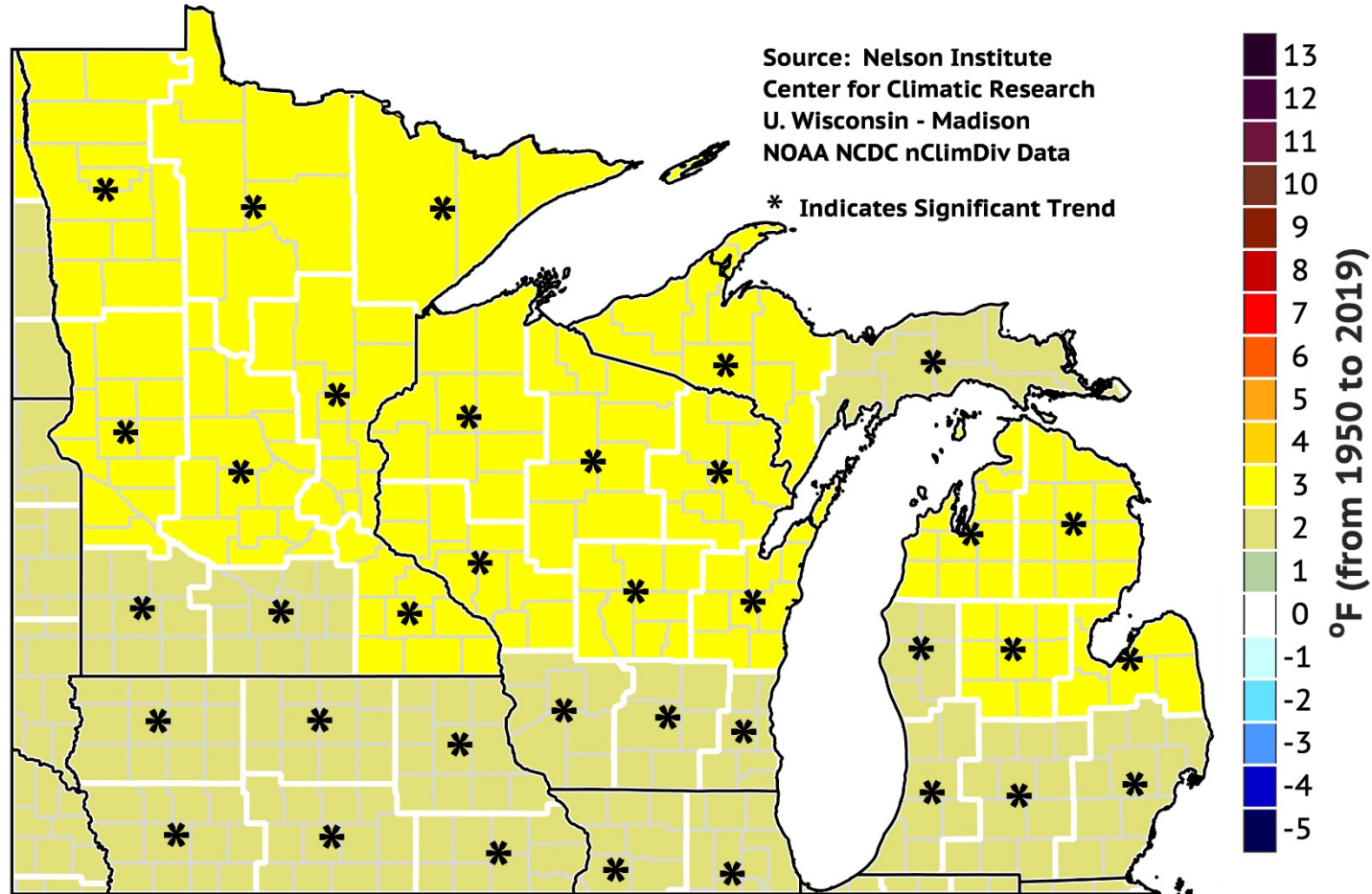
Tree Atlas Results

Vulnerability
Assessment

Forest
Disturbances

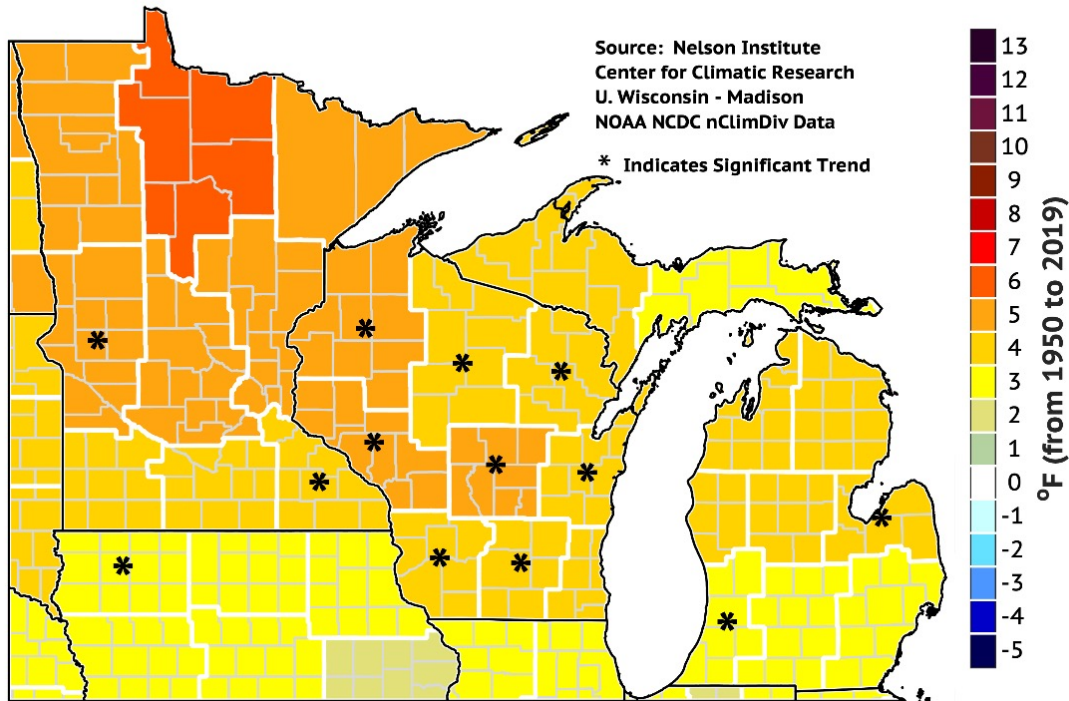
Temperature Change - Observed

Historical Change in Annual TMEAN from 1950 to 2019

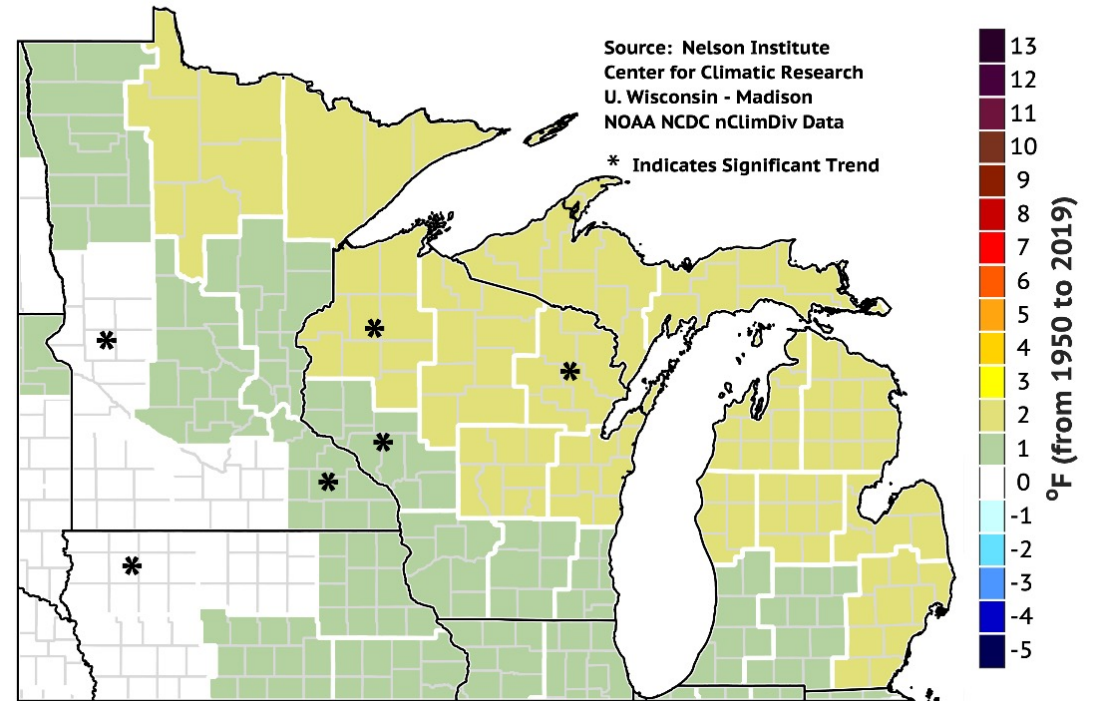


Temperature Change - Observed

Historical Change in DJF TMEAN
from 1950 to 2019

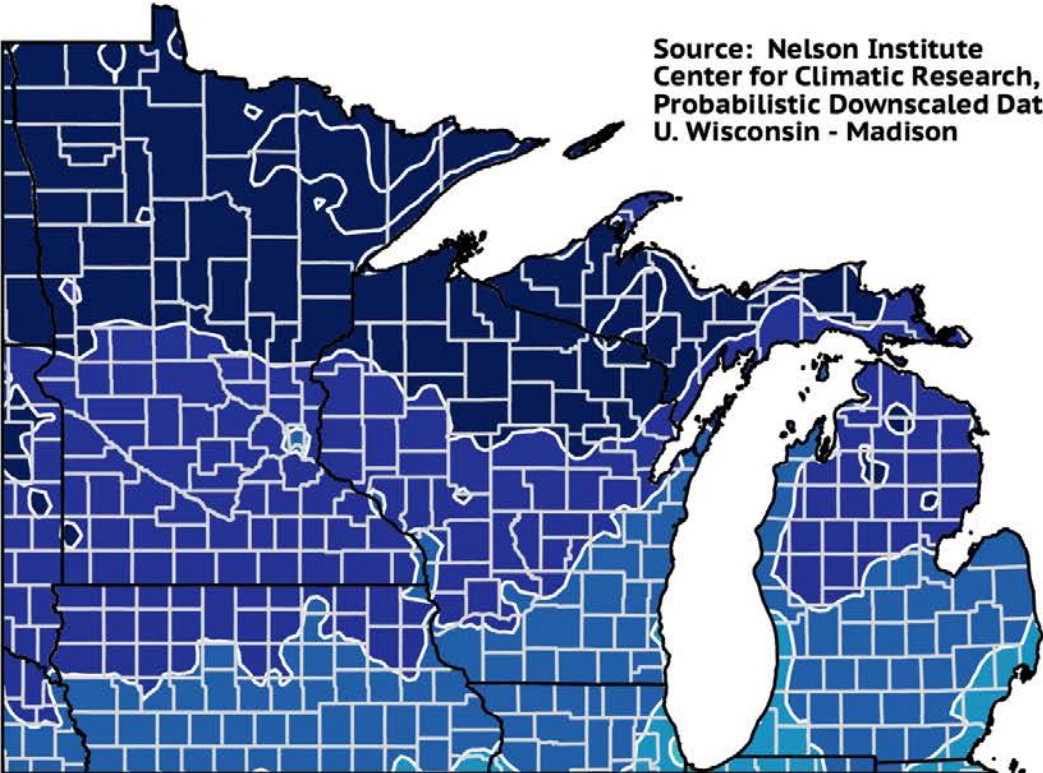


Historical Change in JJA TMEAN
from 1950 to 2019

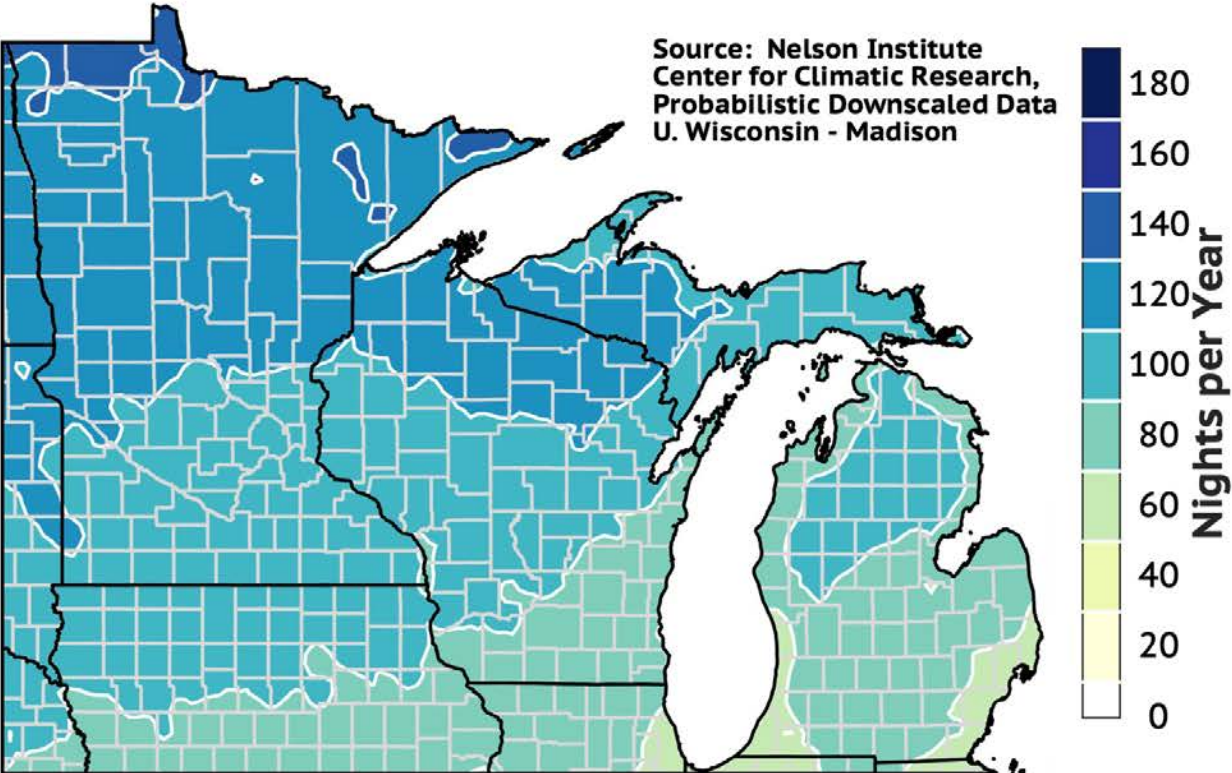


Growing Season - Projected

**Nights per Year with TMIN < 32°F
1981-2010 Conditions (HISTORICAL)**

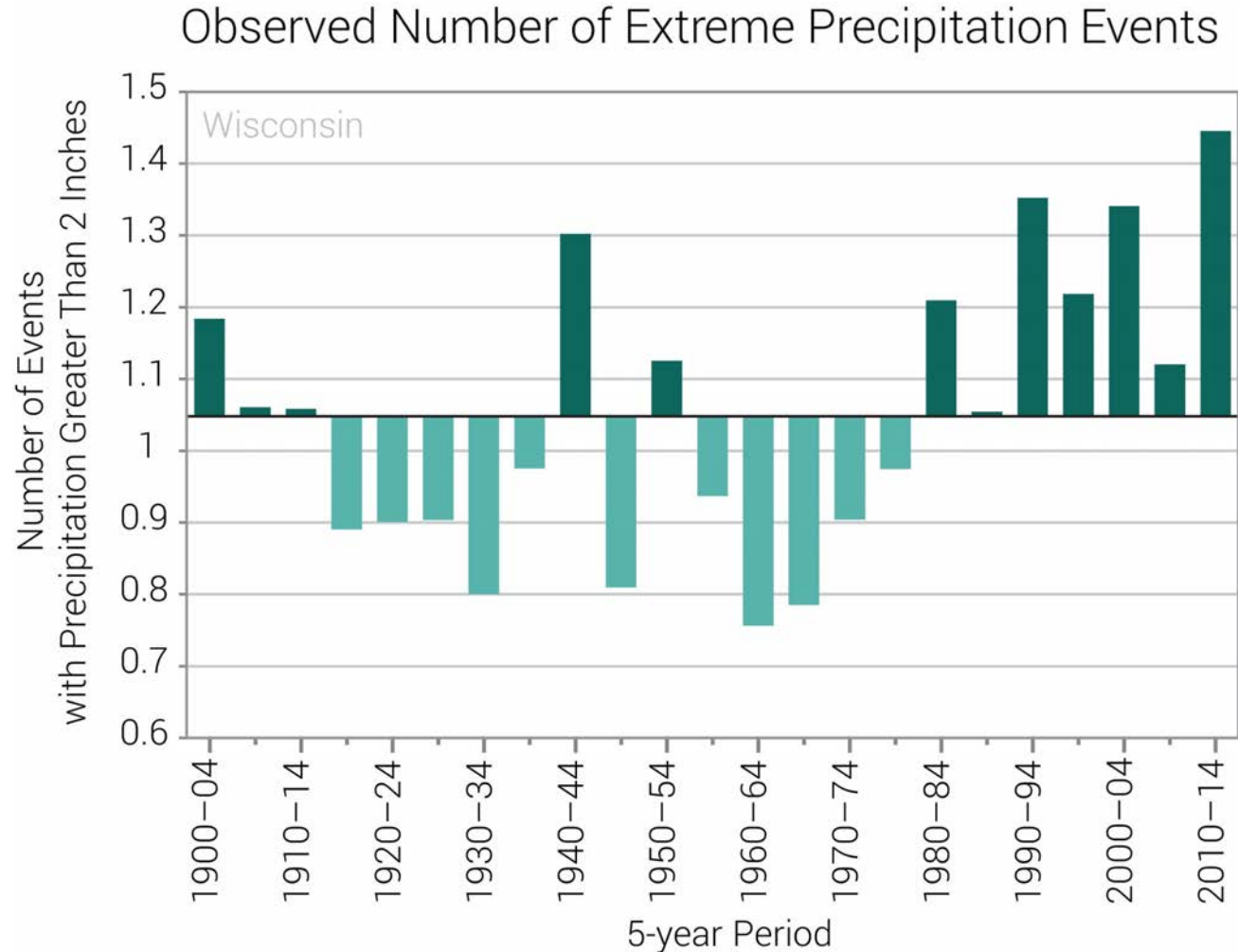


**Nights per Year with TMIN < 32°F
2081-2100 Conditions (HISTORICAL)**



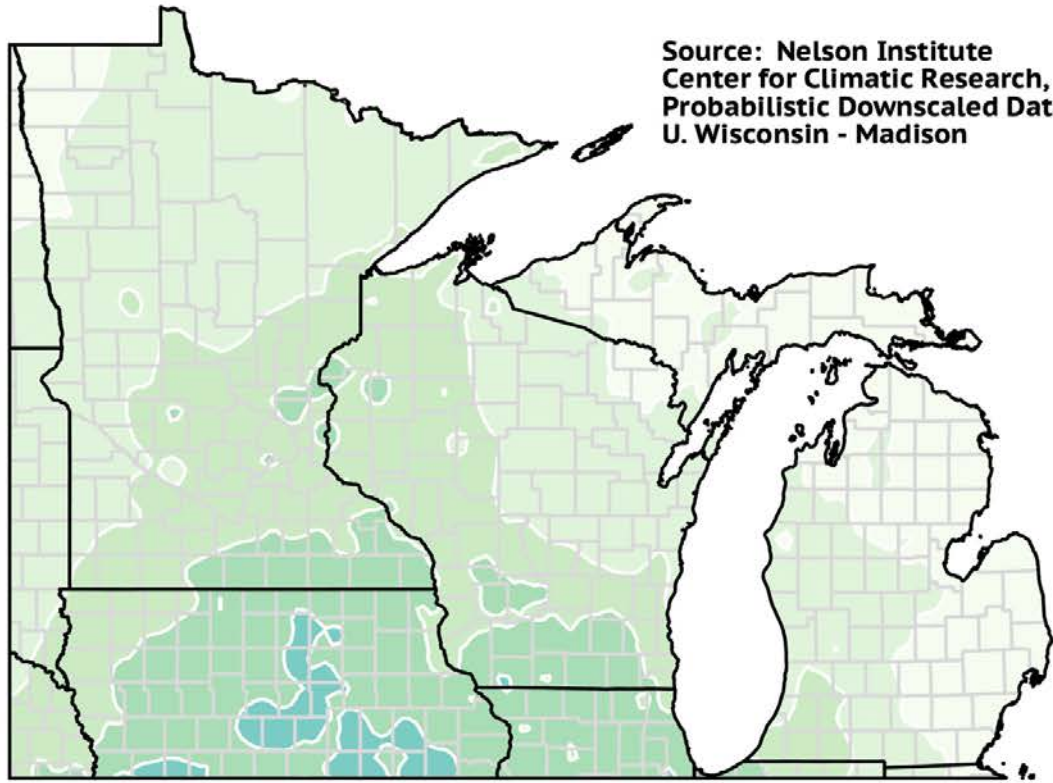
Heavy Precipitation - Observed

- Large rain events (2"+) have become more frequent

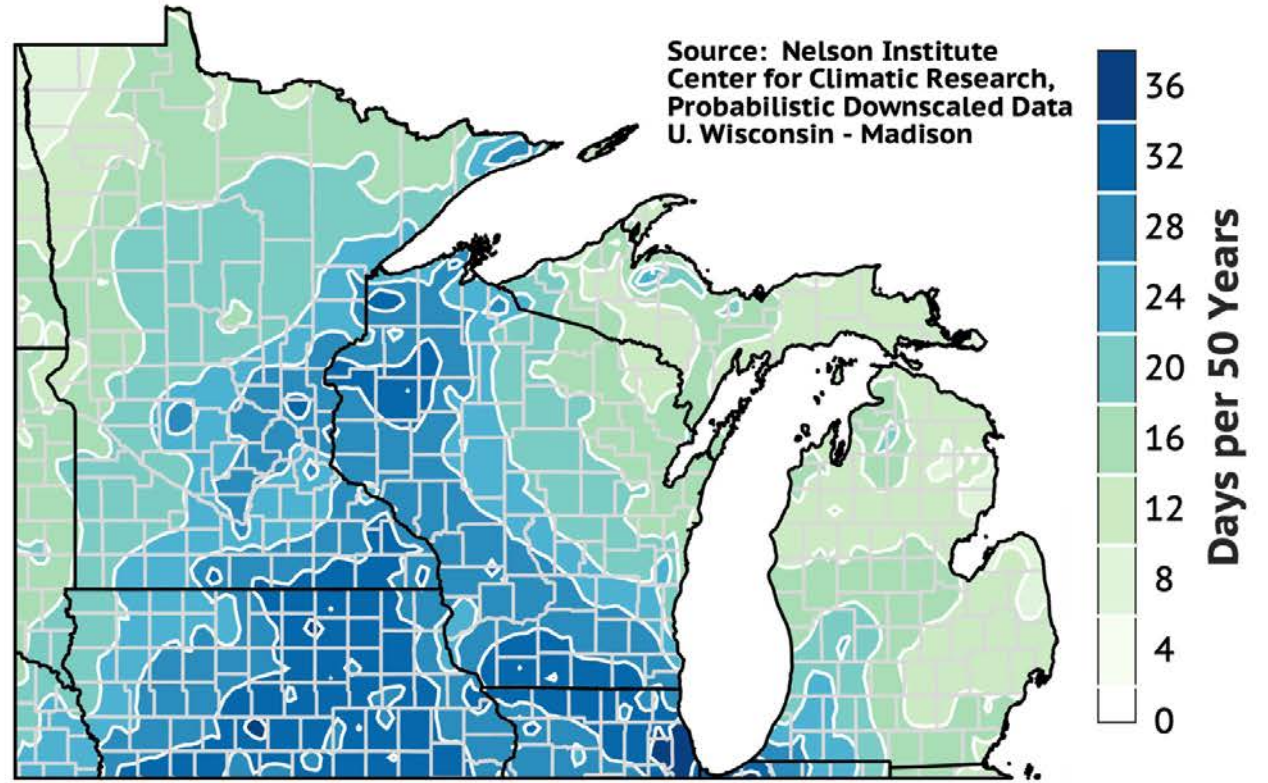


Heavy Precipitation - Projected

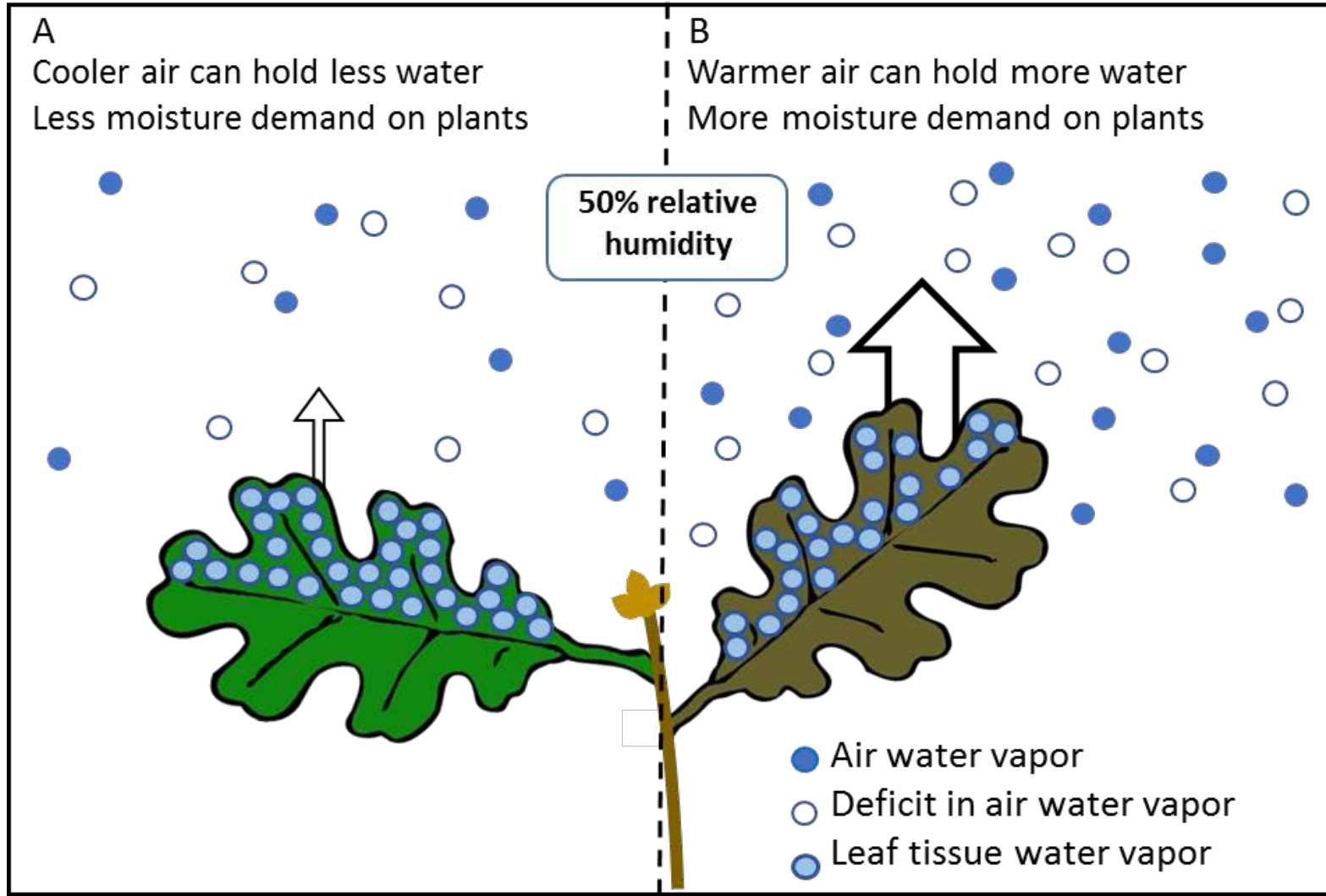
**Days per 50 Years with PRCP > 3in
1981-2010 Conditions (HISTORICAL)**



**Days per 50 Years with PRCP > 3in
2081-2100 Conditions (HISTORICAL)**

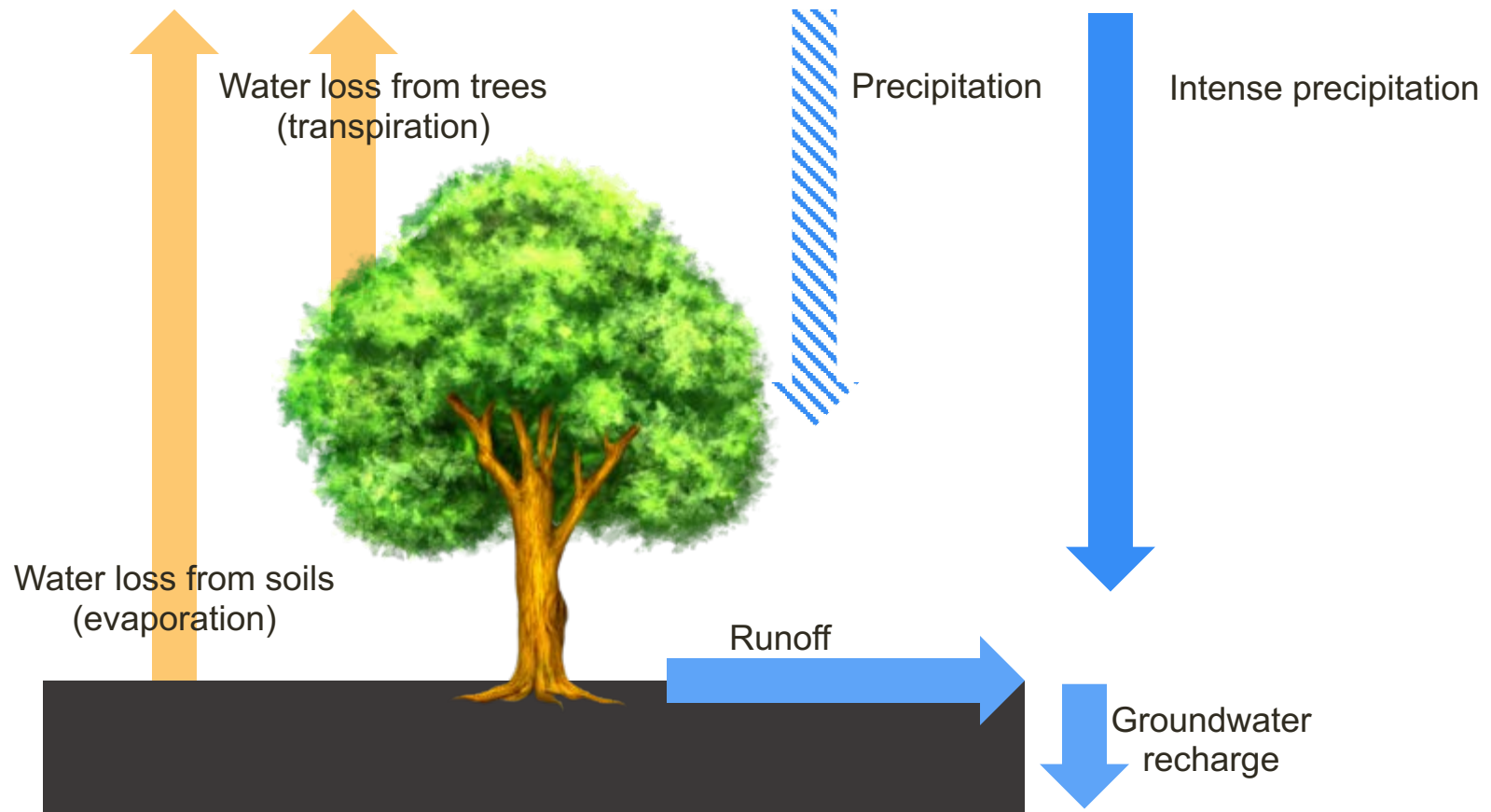


More Drought Stress



More Drought Stress

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



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Climate Change Tree Atlas Results

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES DRIFTLESS AREA (ECOLOGICAL SECTION 222L)



This region's forests will be affected by a changing climate and other stressors during this century. A team of managers and researchers created a field guide that includes information on the vulnerability of forests in the region (Händler et al. 2021). This report includes information on observed and future climate trends, and also summarizes key vulnerabilities for forested natural communities.

The Landscape Change Research Group recently updated the Climate Change Tree Atlas, and this handout summarizes that information. Full Tree Atlas results are available online at www.fs.fed.us/nrs/atlas. Two climate scenarios are presented to "bracket" a range of possible futures. These future climate projections (2070 to 2099) provide information about how individual tree species may respond to a changing climate. Results for "low" and "high" emissions scenarios can be compared on the reverse side of this handout.

The updated Tree Atlas presents additional information helpful to interpret tree species changes:

- **Suitable habitat** - calculated based on 39 variables that explain where optimum conditions exist for a species, including soils, landforms, and climate variables.
- **Adaptability** - based on life-history traits that might increase or decrease tolerance of expected changes, such as the ability to withstand different forms of disturbance.
- **Capability** - a rating of the species' ability to cope or persist with climate change in this region based on suitable habitat change (statistical modeling), adaptability (literature review and expert opinion), and abundance (FIA data). The capability rating is modified by abundance information; ratings are downgraded for rare species and upgraded for abundant species.
- **Migration Potential Model** - when combined with habitat suitability, an estimate of a species' colonization likelihood for new habitats. This rating can be helpful for assisted migration or focused management (see the table section: "New Habitat with Migration Potential").

Remember that models are just tools, and they're not perfect. Model projections can't account for all factors that influence future species success. If a species is rare or confined to a small area, model results may 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. 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.

SOURCE: This handout summarizes the full model results for the Driftless Area, available at www.fs.fed.us/nrs/atlas/combined/resources/summaries. Move information on vulnerability and adaptation in the Northwoods region can be found at www.forestadaptation.org/northwoods. A full description of the models and variables are provided in Iverson et al. 2019 (<https://doi.org/10.1016/j.foreco.2019.05.015>) and Peters et al. 2019 (<https://doi.org/10.1016/j.foreco.2019.05.015>).

CLIMATE CHANGE CAPABILITY

POOR CAPABILITY

American hornbeam*	Pin cherry*
Balsam fir	Quaking aspen
Bigtooth aspen	Red pine
Black ash	River birch*
Black maple*	Serviceberry*
Black spruce	Swamp white oak*
Black willow*	Tamarack (native)
Eastern white pine	White spruce
Paper birch	Yellow birch

FAIR CAPABILITY

Chinkapin oak	Red maple
Jack pine	Red mulberry*
Northern pin oak	Slippery elm*

GOOD CAPABILITY

American elm	Eastern redcedar
Bitternut hickory*	Green ash*
Black oak	Hackberry
Black walnut*	Honeylocust*
Boxelder*	Northern red oak
Bur oak	Silver maple*
Eastern cottonwood*	Sugar maple
Ironwood*	White oak

MIXED RESULTS

American basswood	Northern white-cedar
Black cherry	Shagbark hickory
Black locust*	White ash

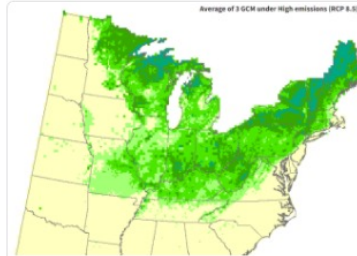
NEW HABITAT WITH MIGRATION POTENTIAL

American beech	Pignut hickory
Black hickory	Post oak
Blackgum	Sassafras*
Blackjack oak	Scarlet oak
Cittarwood*	Shingle oak
Common persimmon*	Shumard oak*
Eastern hemlock	Slash pine
Eastern redbud*	Sugarberry
Flowering dogwood	Sycamore*
Mockernut hickory	Virginia pine
Osage-orange	Yellow-poplar
Pecan*	



www.forestadaptation.org

Climate Change Atlas



Tree Atlas

Version 4

Modeled potential suitable habitat for 125 tree species in the East, with an additional 23 species with current information only

Latest Tree Atlas



Bird Atlas

Version 2

Potential changes in abundance and range for 147 bird species in the East

Latest Bird Atlas

Regional Summary Tree Tables

Current and Potential Future Habitat, Capability, and Migration

Summaries for tree species are available for a variety of geographies, in both PDF and Excel format. These summaries are based on [Version 4 of the Climate Change Tree Atlas](#)

- [National Forest Summaries](#)
- [National Park Summaries](#)
- [HUC6 Watersheds](#)
- [Ecoregional Vulnerability Assessments \(EVAS\)](#)
- [USDA Forest Service EcoMap 2007 Sections](#)
- [National Climate Assessment \(NCA\) 2016 Regional Summaries](#)
- [1 x 1° Grid Summaries](#)
- [Eastern United States](#)
- [Urban Areas](#)

Search or Browse the Atlas

Search for Trees or Birds

Browse Previous Tree Atlas

Version 3

Version 2

Browse Previous Bird Atlas

Version 1

Publications

Browse Publications

Featured Publication



Climate Change Tree Atlas Results

Increasing Habitat

Black walnut

Bur oak (+/0)

Silver maple

Sugar maple

White ash

White oak (+/0)

Decreasing Habitat

American basswood (0/-)

Bigtooth aspen

Eastern white pine

Northern red oak (0/-)

Red maple

Yellow birch

New Migrants

Black hickory

Blackjack oak

Common persimmon

Mockernut hickory

Osage-orange

Pignut hickory

Scarlet oak

Sycamore

Virginia pine

Yellow-poplar

Climate Change Tree Atlas: Get the Info

ADAPTABILITY: Life-history factors, such as the ability to respond favorably to disturbance, that are not included in the Tree Atlas model and may make a species more or less able to adapt to future stressors.

- + **HIGH** Species may perform better than modeled
- **MEDIUM**
- **LOW** Species may perform worse than modeled

HABITAT CHANGE: Projected change in suitable habitat between current and potential future conditions.

- ▲ **INCREASE** Projected increase of >20% by 2100
- **NO CHANGE** Projected change of <20% by 2100
- ▼ **DECREASE** Projected decrease of >20% by 2100
- ★ **NEW HABITAT** Tree Atlas projects new habitat for species not currently present

ABUNDANCE: Based on Forest Inventory Analysis (FIA) summed Importance Value data, calibrated to a standard geographic area.

- + **ABUNDANT**
- **COMMON**
- **RARE**

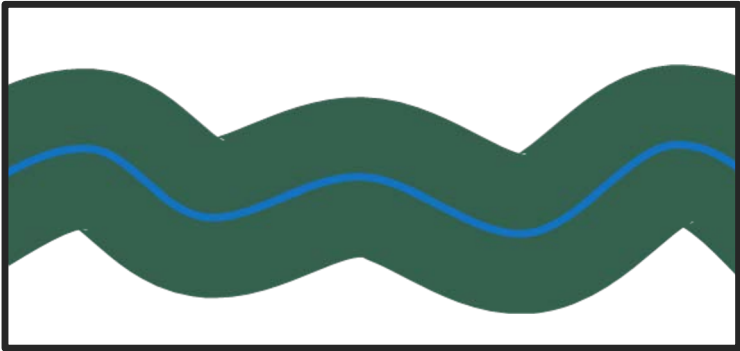
CAPABILITY: A rating that describes a species' ability to cope or persist in a future climate change class (stratification) and expert opinion.

A rating that describes a species' ability to cope or persist in a future climate change based on suitable habitat modeling, adaptability (literature review) and abundance within this region.

- ▲ **GOOD** Increasing suitable habitat, medium or high adaptability, and common or abundant
- **FAIR** Mixed combinations, such as a rare species with increasing suitable habitat and medium adaptability
- ▼ **POOR** Decreasing suitable habitat, medium or low adaptability, and uncommon or rare

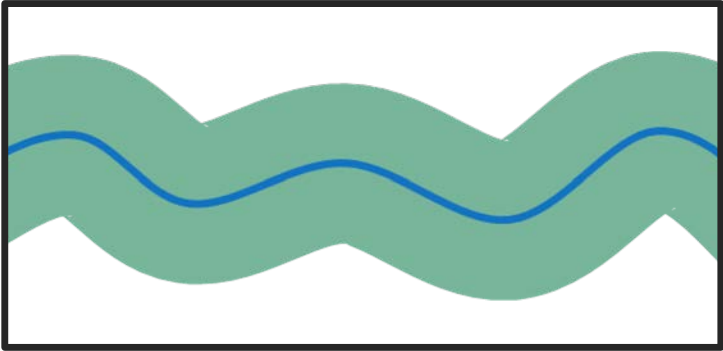
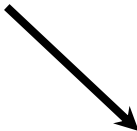
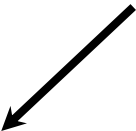
SPECIES	ADAPT	ABUN	LOW CLIMATE CHANGE (RCP 4.5)		HIGH CLIMATE CHANGE (RCP 8.5)	
			HABITAT CHANGE	CAPABILITY	HABITAT CHANGE	CAPABILITY
American basswood	•	-	▲	▲	▲	▲
American beech	•	•	●	○	●	○
American elm	•	-	▲	▲	▲	▲
American hornbeam*	•		★		★	
American mountain-ash*	-	-	▼	▼	▼	▼
Balsam fir	-	+	▼	▼	▼	▼
Balsam poplar	•	•	▼	▼	▼	▼
Bigtooth aspen	•	•	▲	▲	▲	▲
Bitternut hickory*	+		★		★	
Black ash	-	•	▲	▲	▲	▲
Black cherry	-	•	▲	▲	▲	▲
Black locust*	•		★		★	
Black oak	•		★		★	
Black spruce	•	+	▼	○	▼	○
Northern pin oak	+	-	▲	▲	▲	▲
Northern red oak	+	•	▲	▲	▲	▲
Northern white-cedar	•	+	▼	○	▼	○
Osage-orange	+		★		★	
Paper birch	•	•	●	○	▼	▼
Pignut hickory	•		★		★	
Pin cherry*	•	-	▼	▼	▼	▼
Pin oak*	-		★		★	
Post oak	+		★		★	
Quaking aspen	•	+	●	▲	●	▲
Red maple	+	+	●	▲	●	▲
Red mulberry*	•		★		★	
Red pine	-	+	●	○	●	○
Sassafras*	•		★		★	

Changes in Forest Composition

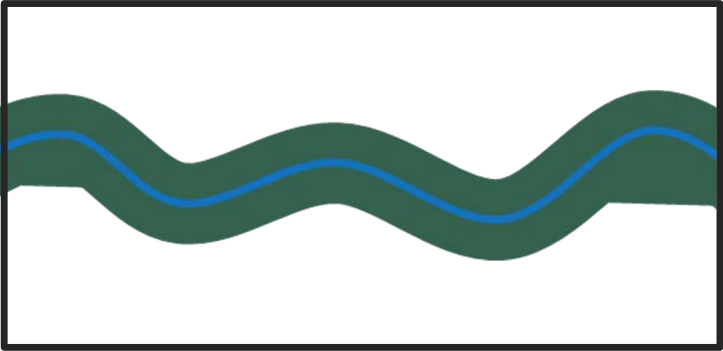


 = species X
quality habitat

50% Reduction in Habitat:



Habitat reduced equally



Best habitats remain

Changes in Forest Composition

- Many common tree species are projected to have reduced suitability in the future
- Changes will occur slowly—not instant dieback
- Mature and established trees should fare better
- Immense lags to occupy habitats
- Critical factors: competition, management, & disturbance



Roadmap

Recap of Climate
Trends and
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Tree Atlas Results

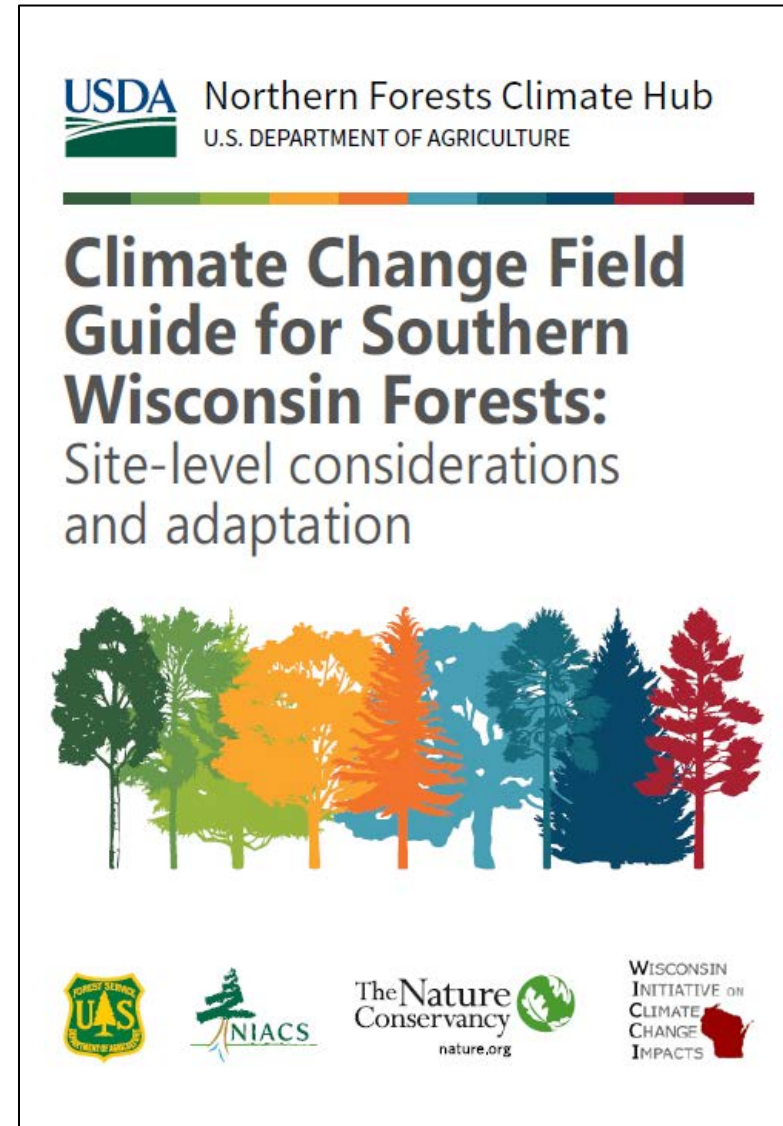
Vulnerability
Assessment

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NEW: Southern WI Field Guide

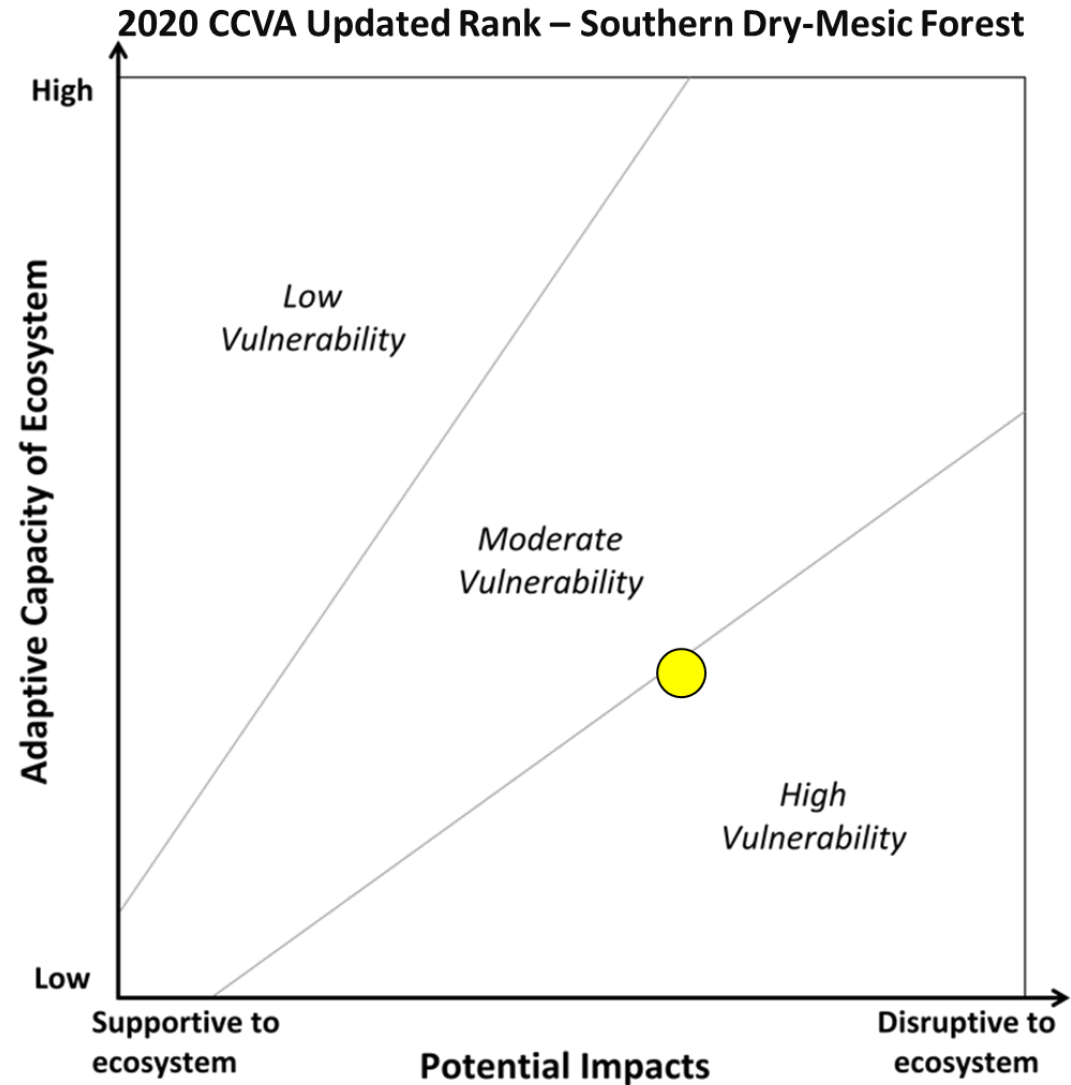
- Based on WICCI vulnerability assessments
- Organized around WI Natural Communities
- Climate impacts, site-level considerations, + **adaptation actions**
- www.wicci.wisc.edu/forestry-working-group/

	Floodplain Forests
	Southern Hardwood Swamp
	Central Sands Pine-Oak
	Pine Barrens
	Oak Barrens
	Oak Opening
	Oak Woodland
	Southern Dry Forest
	Southern Dry-Mesic Forest
	Southern Mesic Forest



Southern Dry-Mesic Forest

Vulnerability



Southern Dry-Mesic Forest

Climate Change Impacts: Disruptive

- Northern red oak, white oak, and shagbark and bitternut hickory are expected to maintain or gain suitable habitat.
- Red maple is currently common but expected to decline in suitable habitat, while sugar maple is often common and expected to increase slightly.
- Disturbances in these forests without fire will likely hasten the conversion to mesic species.
- Invasive species such as buckthorn and honeysuckle readily invade dry-mesic stands and may benefit from longer growing seasons.

Southern Dry-Mesic Forest

Adaptive Capacity: Moderate-Low

- Many dry-mesic forests will be degraded because they haven't had regular fire. Sites that have been managed with fire may have more favorable conditions to perpetuate oak.
- Past high-grading may have damaged some stands and made them less resilient to future change.
- Oak regeneration is limited by competition with mesic species, deer herbivory, and other factors. Oaks may not be able to capitalize on projected suitable habitat gains.
- Sites that have been grazed often have degraded understory plant communities.
- Stands with several tree species may be more able to adapt to changing conditions.
- Sites with high earthworm activity will have less leaf litter and it will be harder to conduct prescribed burns.

Roadmap

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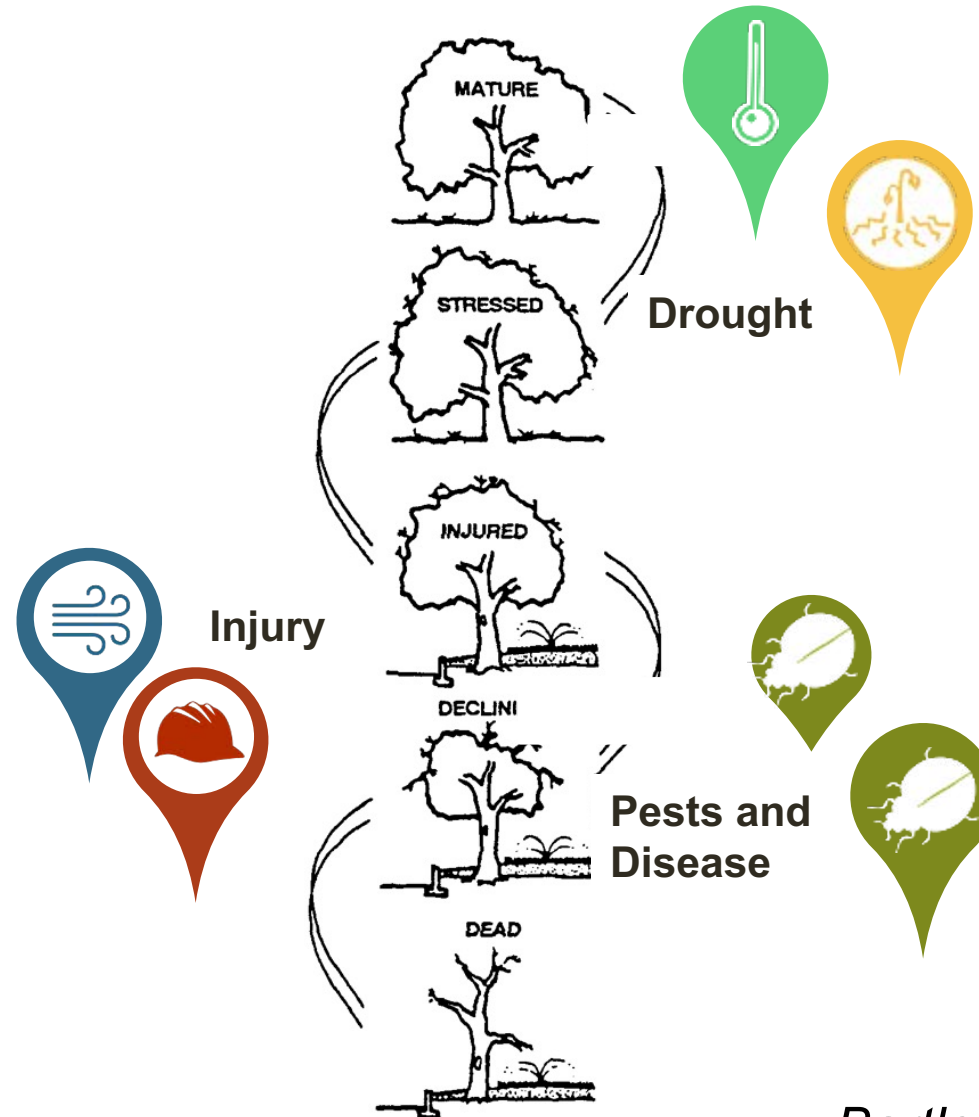
Tree Atlas Results

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A “Threat Multiplier”

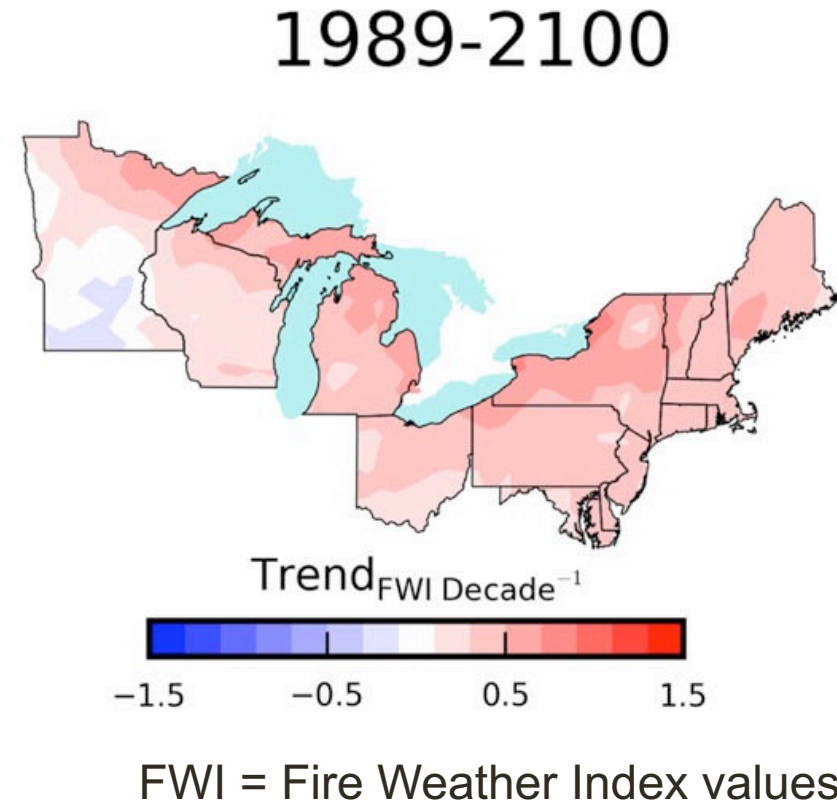
- Interactions can trigger big changes
 - Stress
 - Disturbance
 - Invasive species
 - Insect pests
 - Forest diseases



Wildfire Risk

Fire may increase, because:

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



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



Prescribed Fire Application

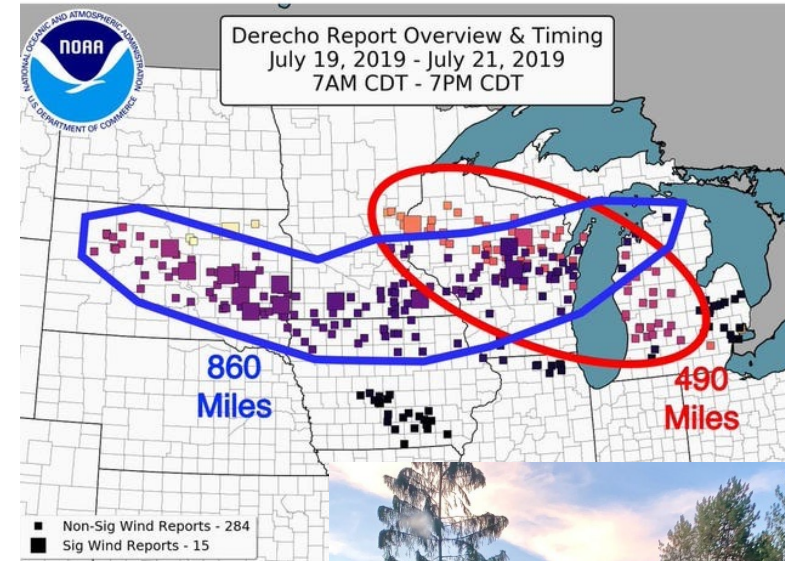
Will it be easier or harder to use this tool?

- Warmer, drier conditions may support prescribed fire and lengthen the window of opportunity for burning.
- Conversely, widespread tree mortality, wetter conditions, and on-going mesophication could limit local prescribed fire implementation.
- Prescribed fire depends on advanced planning and staff availability, so erratic conditions will be a serious challenge.



Extreme Wind Events

- Extreme events are rare and hard to model.
- Uncertainty is very high
- High wind events may increase in northern latitudes (above 40-50°)
- Average wind speeds may decrease slightly across the central US
- Regeneration may not follow the usual pattern



Invasive Species

- Stress and disturbance creates more opportunity.
- Invasive species may be better able to take advantage of new conditions (expanded ranges, elevated CO₂, etc.)



Pests and Diseases

- Existing pests and diseases cause more damage
- Pests and diseases may expand to new locations
- Seasonal timing may shift



Thank you!

Climate Hubs

www.climatehubs.oce.usda.gov

Climate Change Resource
Center

www.fs.usda.gov/ccrc

Climate Change Atlas

www.fs.fed.us/nrs/atlas/

Forestadaptation.org

AdaptationWorkbook.org

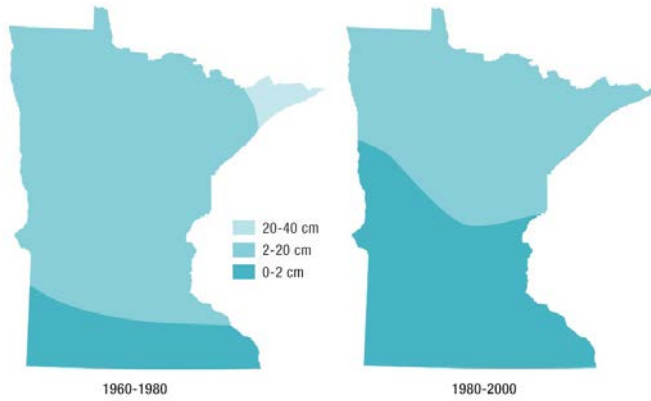
Stephen Handler

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Climate Change: It's everywhere you look

Average snow cover in early April



Source: Jamie L. Dyer and Thomas L. Mote, Geophysical Research Letters, Aug. 2006

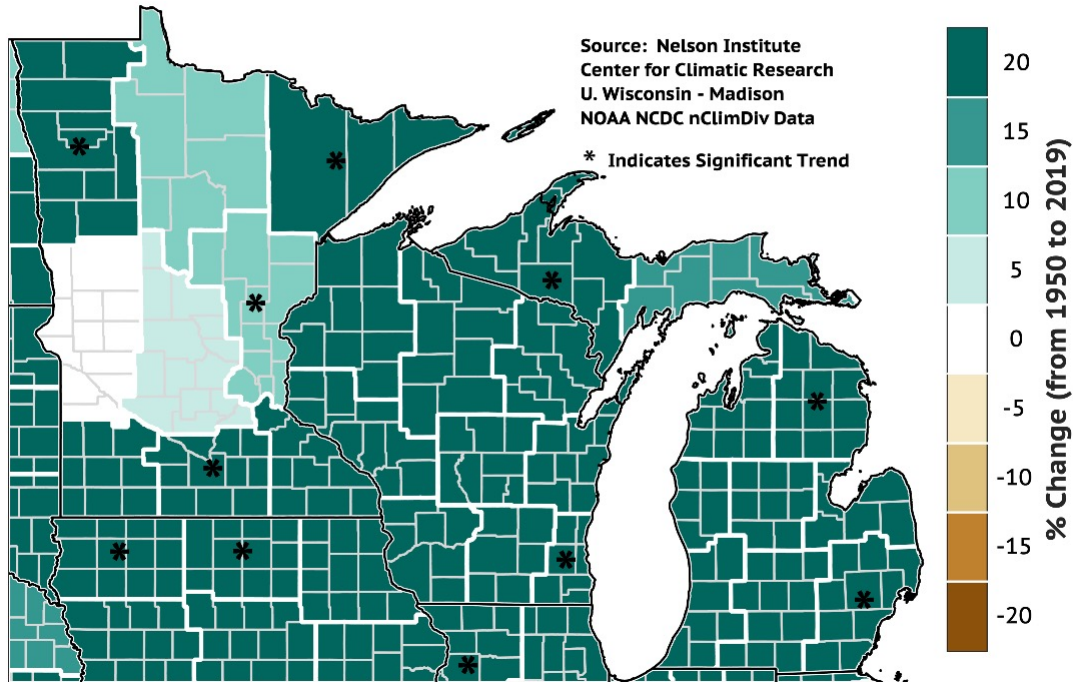


**Solid Wood Locks
Away Carbon**

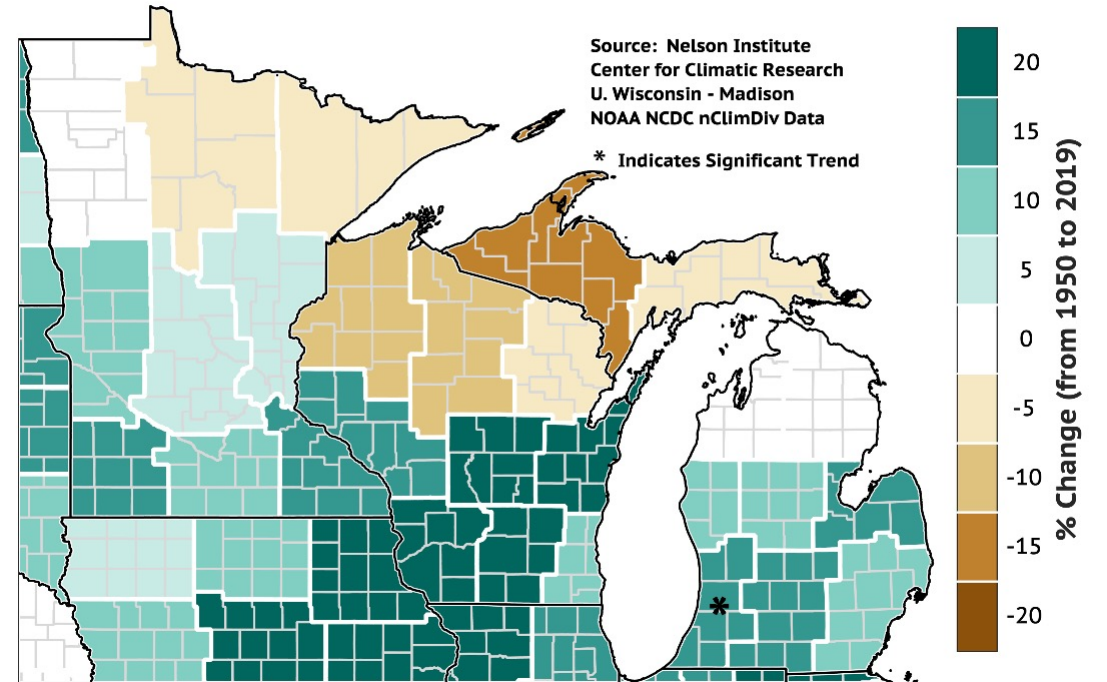


Precipitation Change – Observed

Historical Change in DJF PRECIP (%)
from 1950 to 2019



Historical Change in JJA PRECIP (%)
from 1950 to 2019

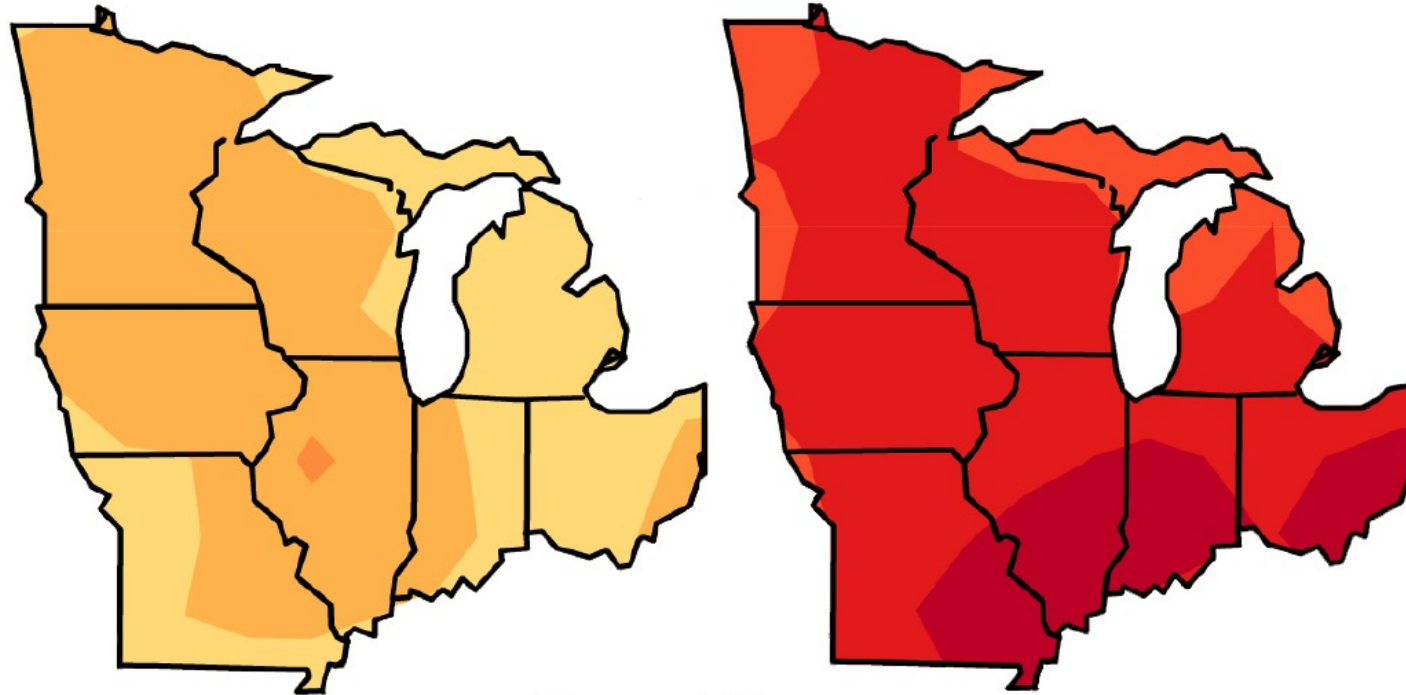


More Drought Stress

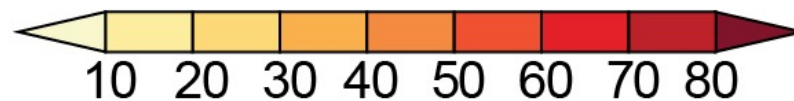
Change in Annual Maximum 5-day Vapor Pressure Deficit, Late 21st Century

Lower Emissions (RCP4.5)

Higher Emissions (RCP8.5)



Percent Change



4th National Climate Assessment, 2018