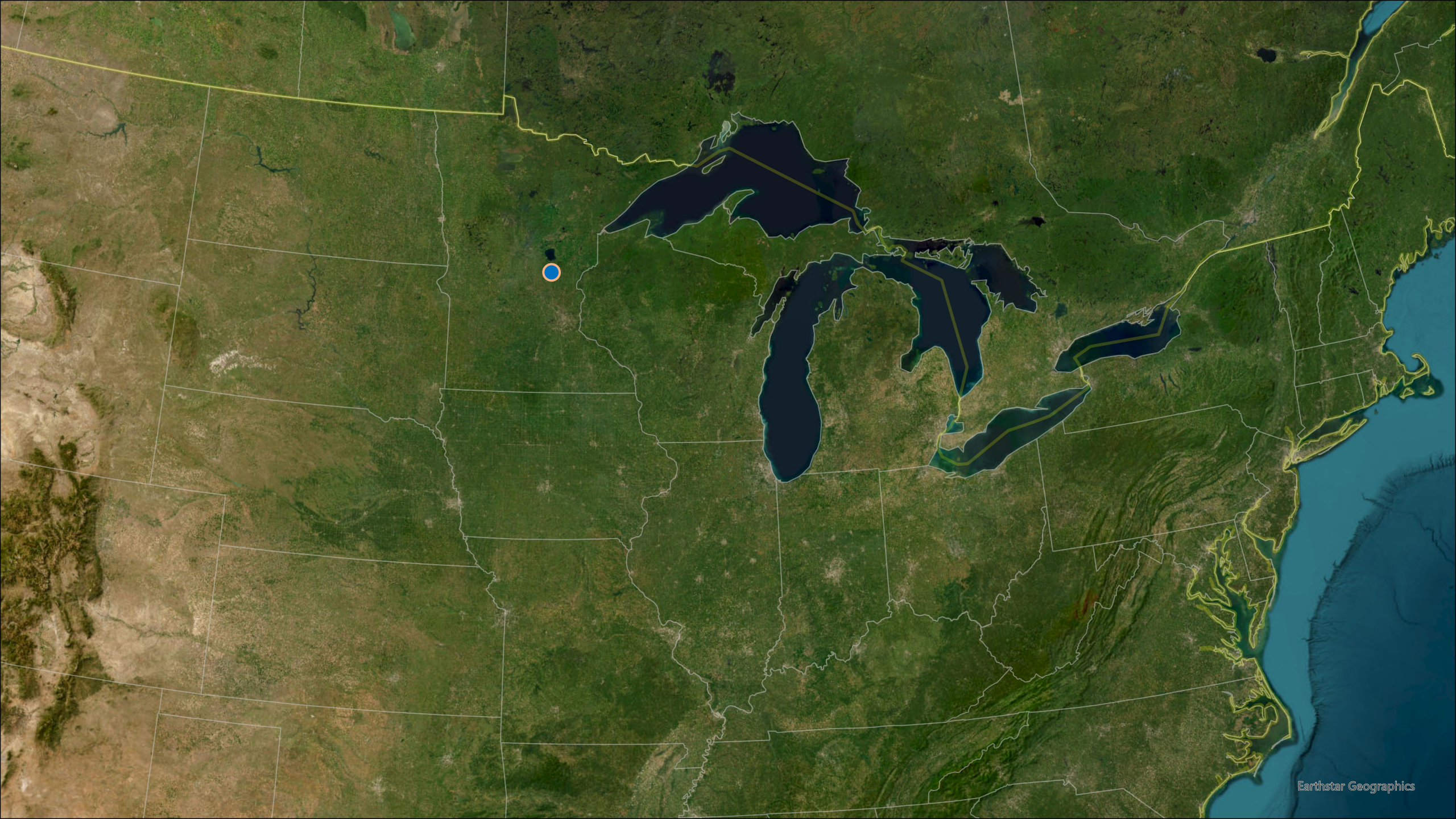
Tree-ring Perspectives on Wisconsin Water Resources

Evan Larson

Professor and Chair | Dept of Environmental Sciences & Society
University of Wisconsin-Platteville

along with

Innumerable Student Researchers & Landowners!


Earthstar Geographics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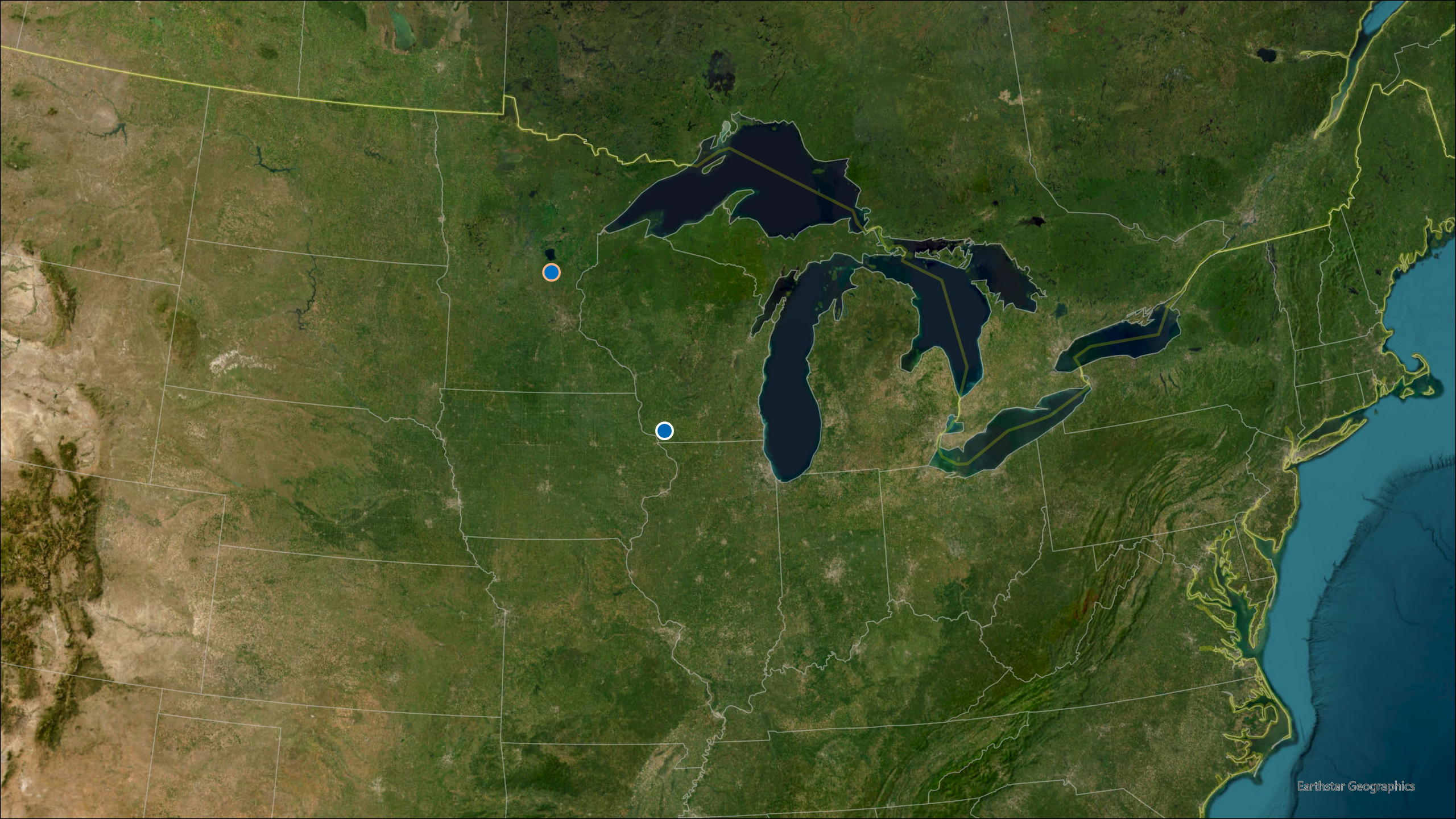
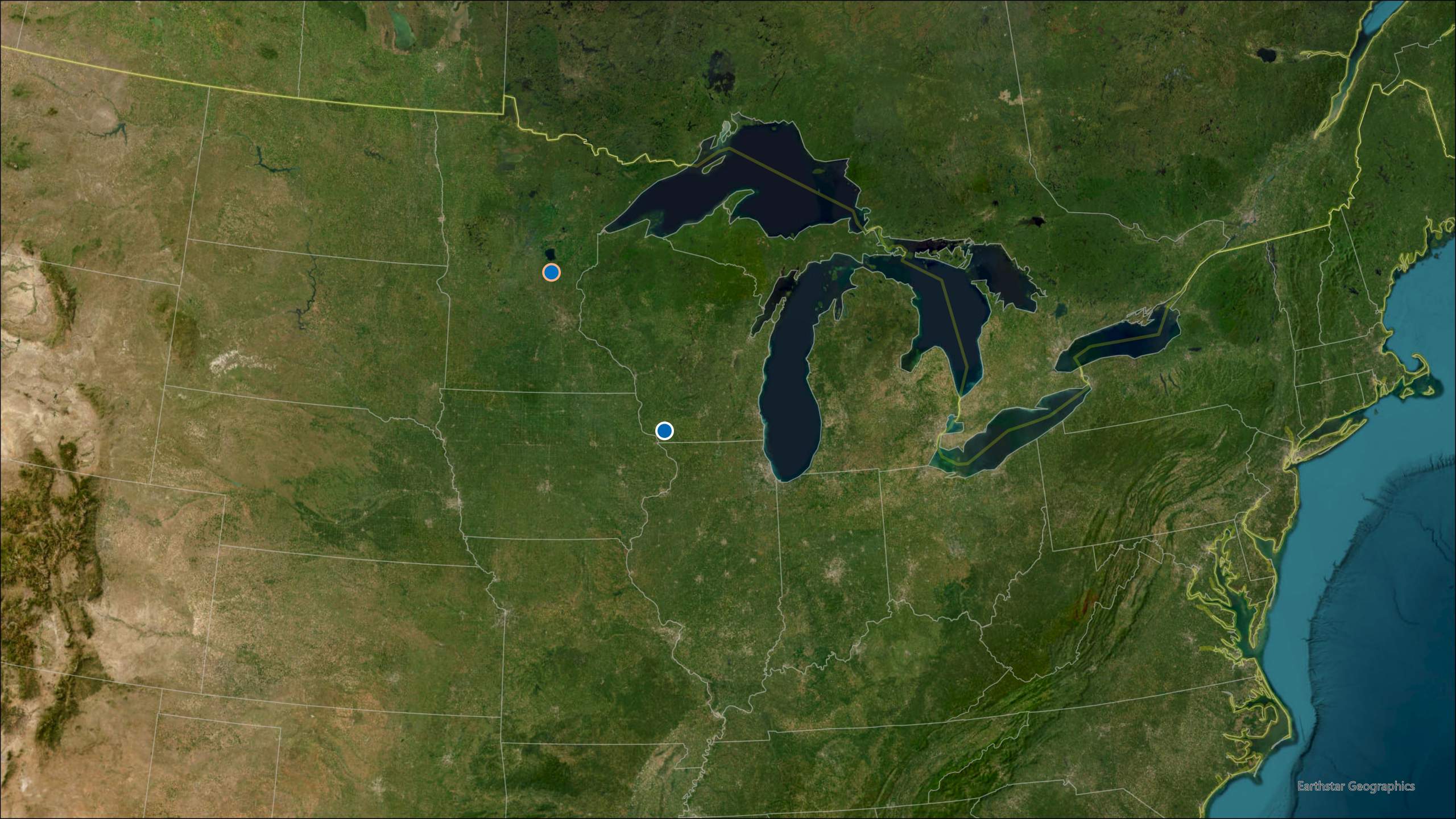

Earthstar Geographics


UNIVERSITY OF WISCONSIN
PLATTEVILLE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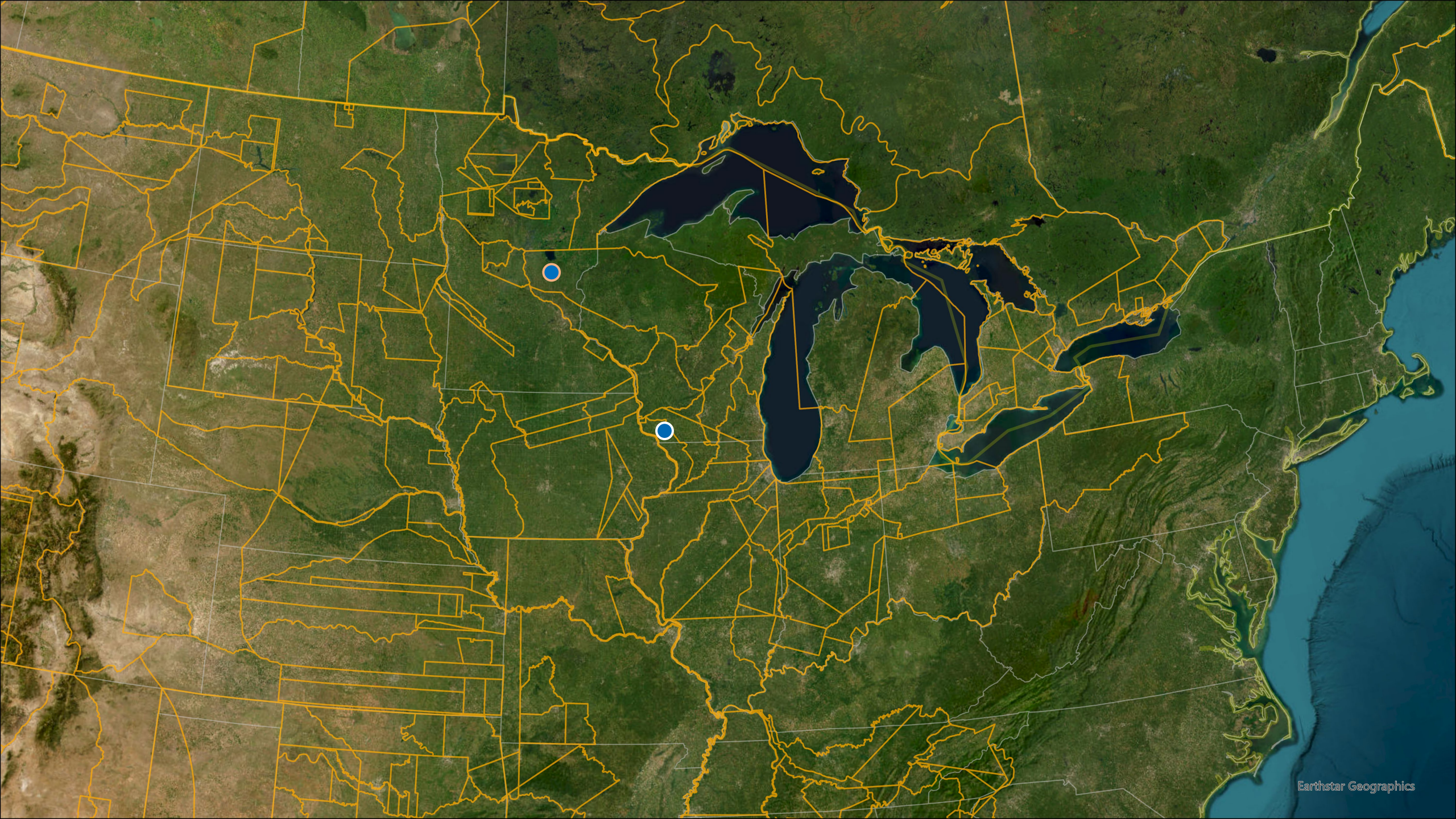
Earthstar Geographics

UNIVERSITY OF WISCONSIN
PLATTEVILLE

Department of
Environmental Sciences & Society

Department of Environmental Sciences and Society

Evan Larson
Department Chair

Laura Dev
Assistant Professor

Lynnette Dornak
Associate Professor

James Riser
Research Scientist

Chris Underwood
Associate Professor

Jim Valiga
Instructor

The Department of Environmental Sciences and Society is vibrant and growing. Our faculty and staff work hard to cultivate a positive, supportive, and rigorous environment that catalyzes student learning and professional development. We offer degree and curriculum options to prepare students for meaningful work that promotes beautiful, diverse, and resilient cultures and environments. Through hands-on, field-based, and research-infused coursework, our students build practical knowledge, high-demand skills, and a reflective perspective ideally suited for work in the complex spheres of conservation, land stewardship, environmental research, and graduate school or other advanced studies.

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- -Geographic Information Systems
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- -Natural Science
- -Social and Environmental Justice

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- -Geographic Information Systems
- -Social and Environmental Justice

Learn more through our website or by contacting Evan Larson, Department Chair:
larsonev@uwplatt.edu

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TREES LAB

Research

Facilities

Publications

The Tree-Ring, Earth, and Environmental Sciences Laboratory (TREES Lab) is a hub of undergraduate research at the University of Wisconsin-Platteville. Faculty, staff, and students collaboratively integrate teaching and research to answer questions about past environments that shape understanding of current and future environmental change and the integral role of people in shaping that change. Housed within the Department of Environmental Sciences & Society, the TREES Lab provides students with high-impact learning experiences as they engage in authentic research that increases their knowledge of our world while building a robust set of skills and experiences that are in high demand by employers and graduate programs.

CONTACT INFORMATION
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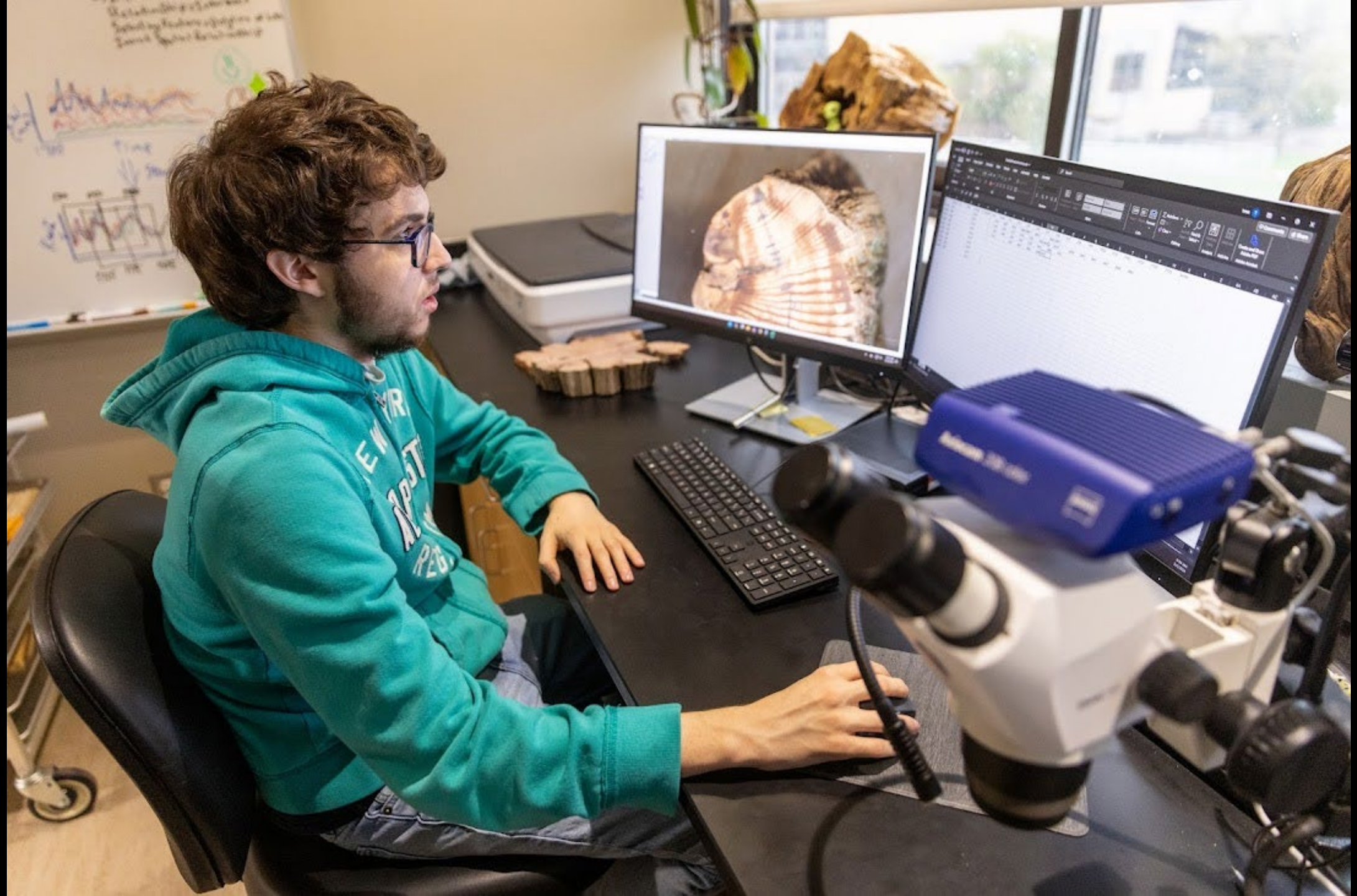
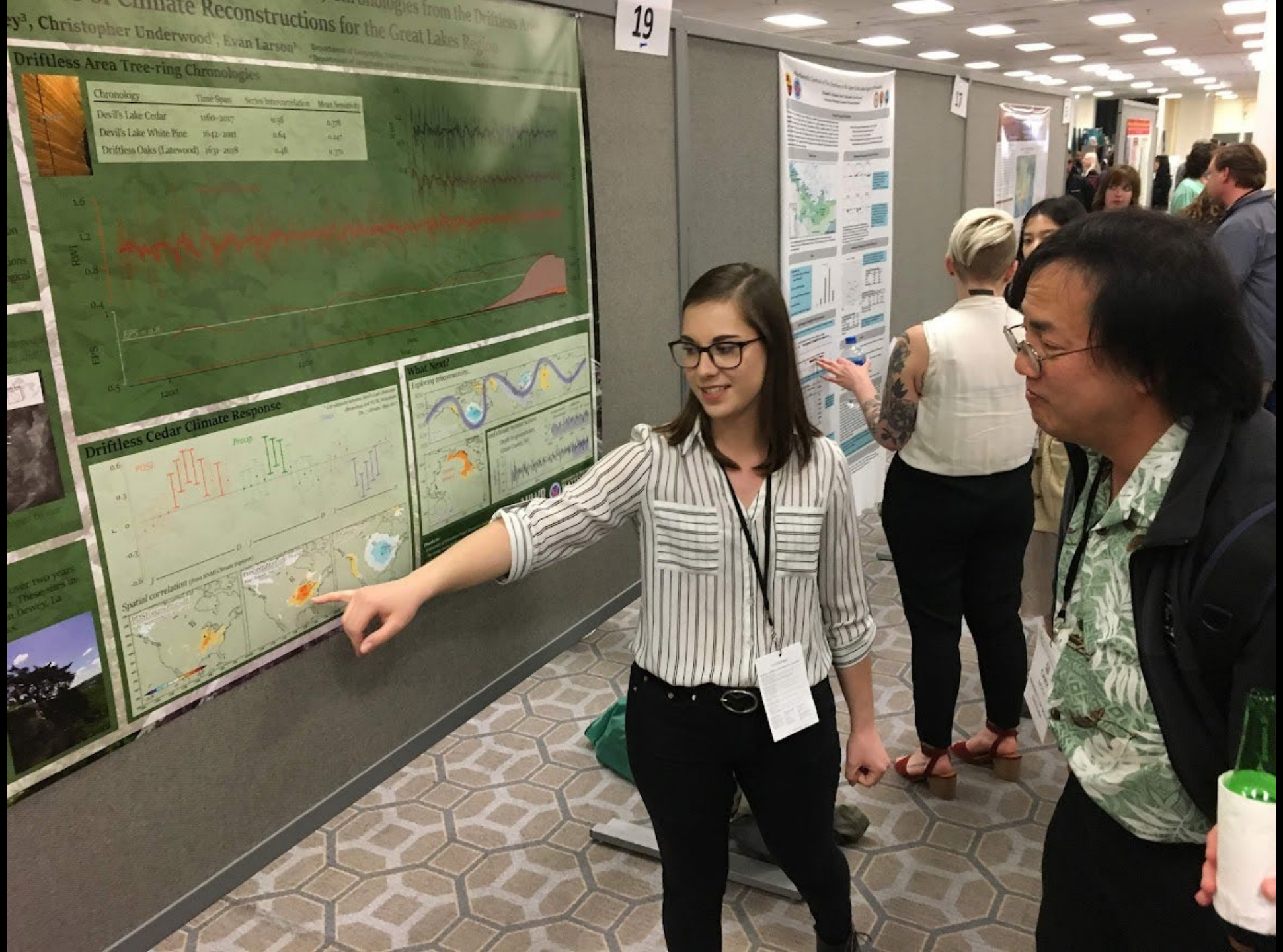
larsonev@uwplatt.edu

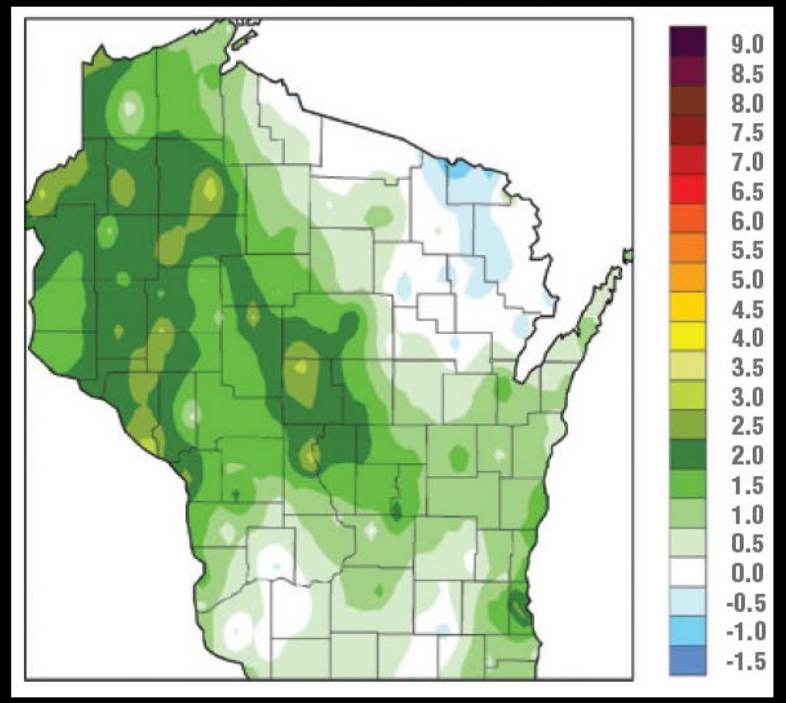



64
Submerged Treasure: Dendroprovenancing
Lake Superior Sunken Timbers
Liz Winkler[1], Dr. Evan Larson[1],
Tamara Thomsen[2], and
1870
1880
1890

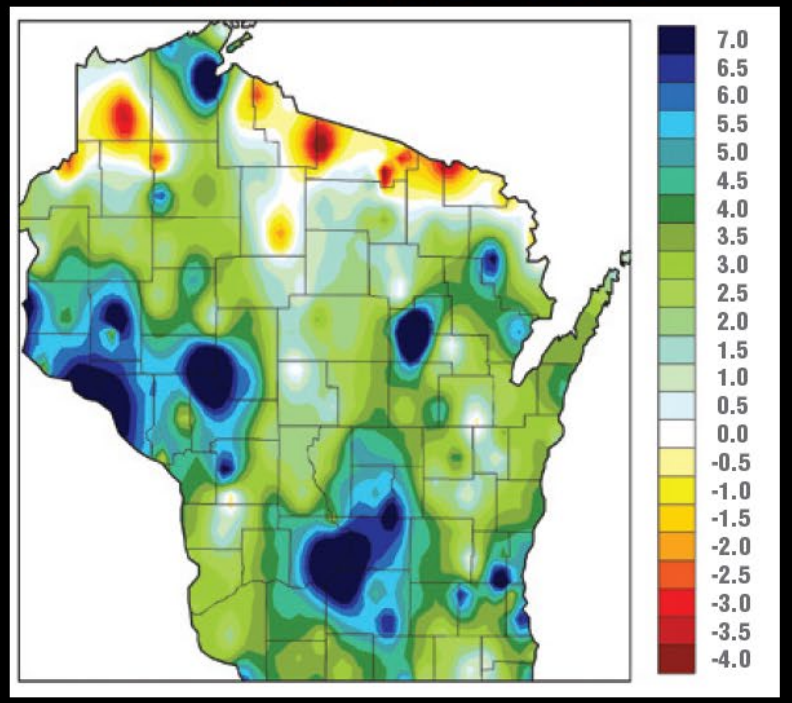

19
Christopher Underwood, Evan Larson
Driftless Area Tree-ring Chronologies
Chronology
Time Span
Series Intercorrelation
Mean Sensitivity
Devil's Lake Cedar
1160-2017
0.56
0.378
Devil's Lake White Pine
1642-2013
0.64
0.247
Driftless Oaks (Laterwood)
1631-2018
0.48
0.379
RWI
PDSI
Driftless Cedar Climate Response
Precip
Spatial correlation
What Next?

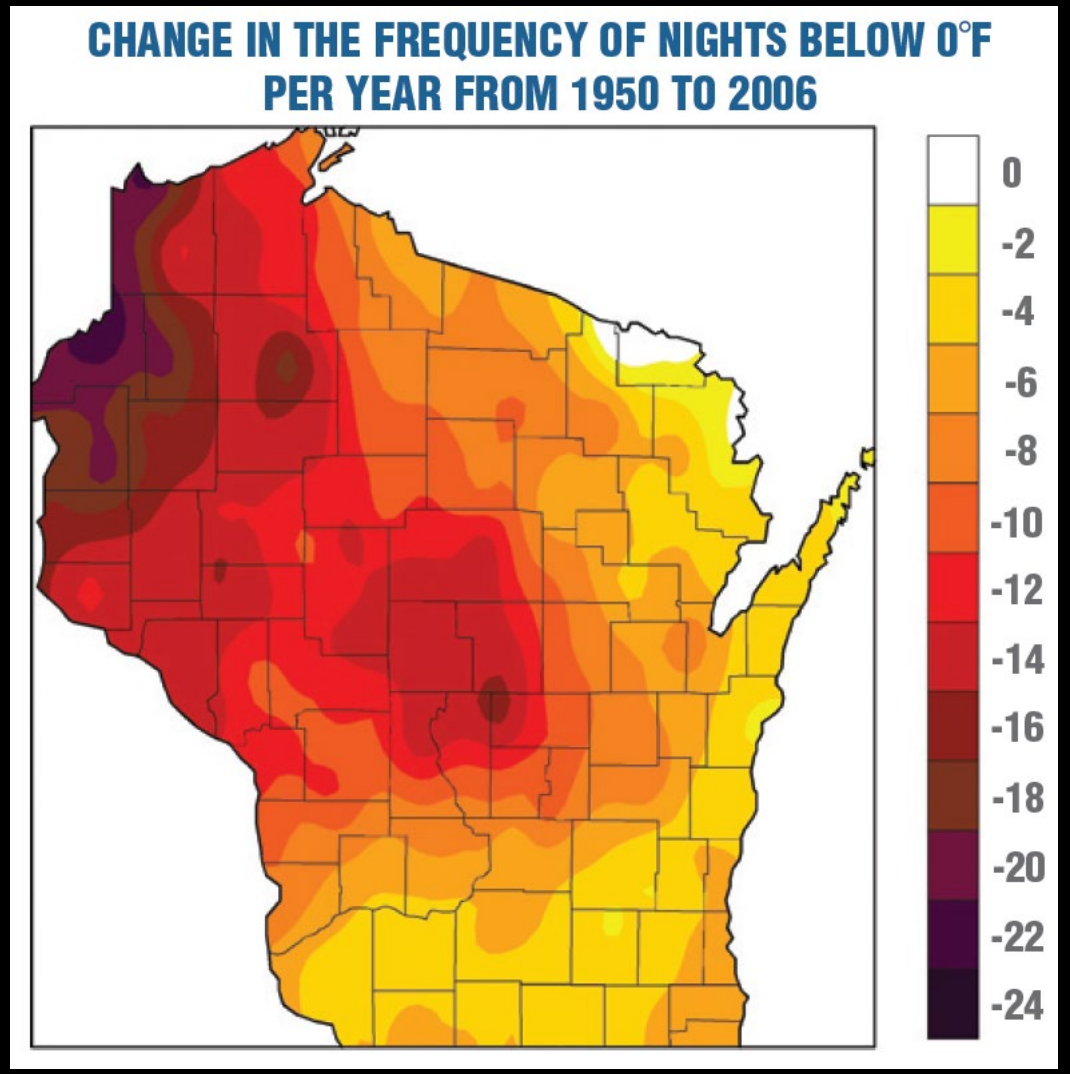
WISCONSIN
INITIATIVE ON
CLIMATE
CHANGE
IMPACTS

CHANGE IN ANNUAL AVERAGE TEMPERATURE (°F) FROM 1950 TO 2006



CHANGE IN ANNUAL AVERAGE PRECIPITATION (INCHES) FROM 1950 TO 2006




CHANGE IN THE FREQUENCY OF NIGHTS BELOW 0°F
PER YEAR FROM 1950 TO 2006
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24

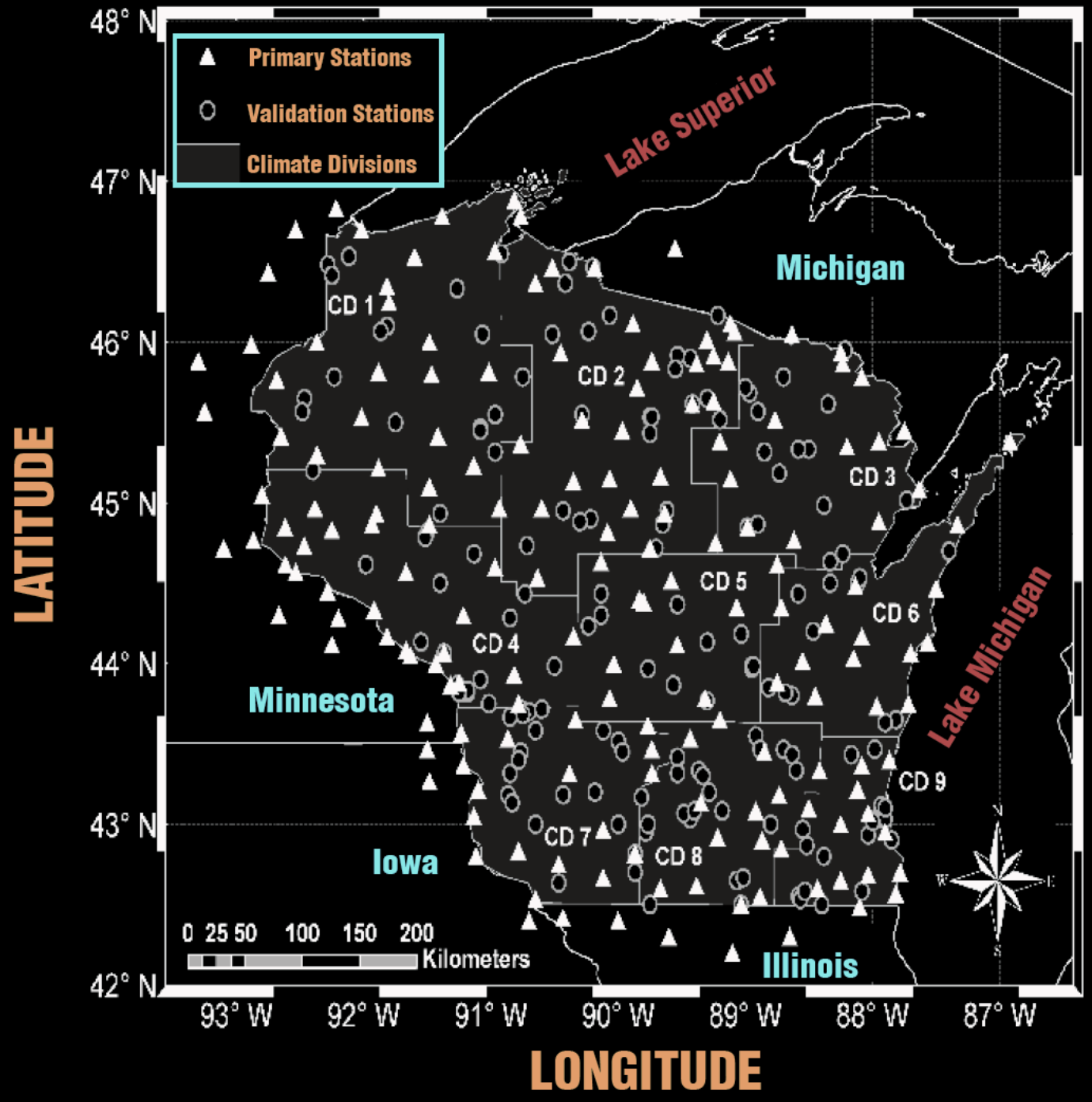
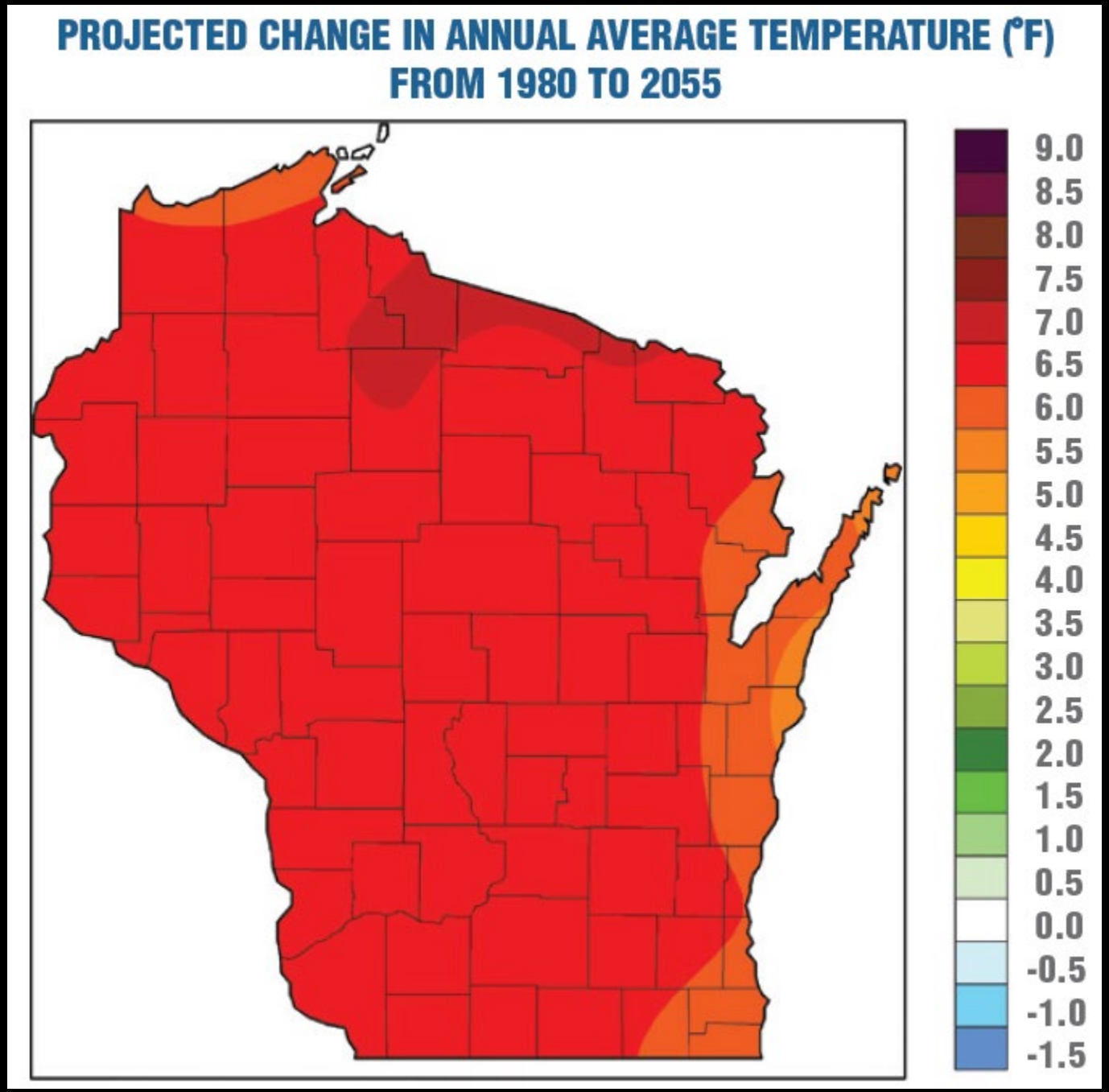
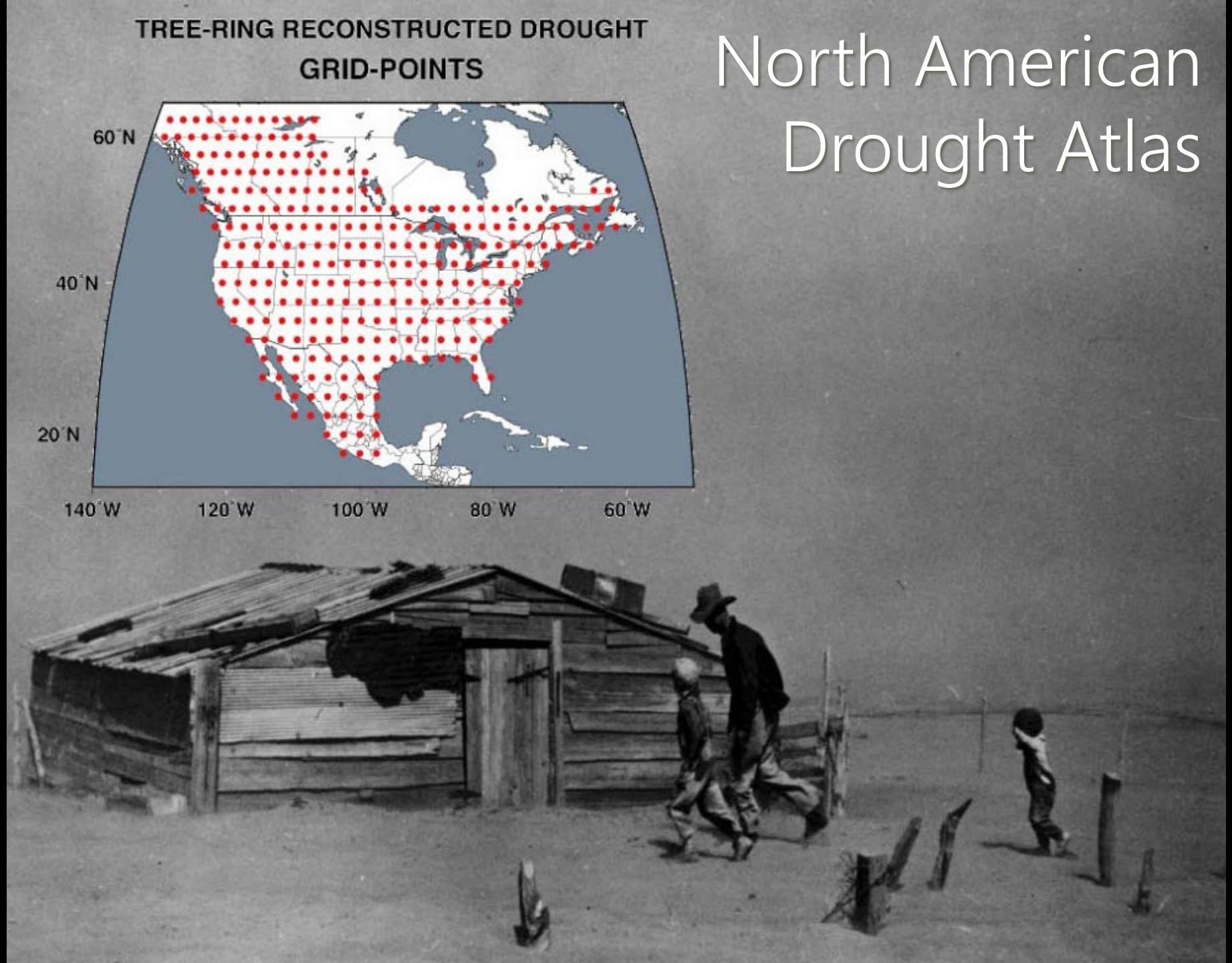


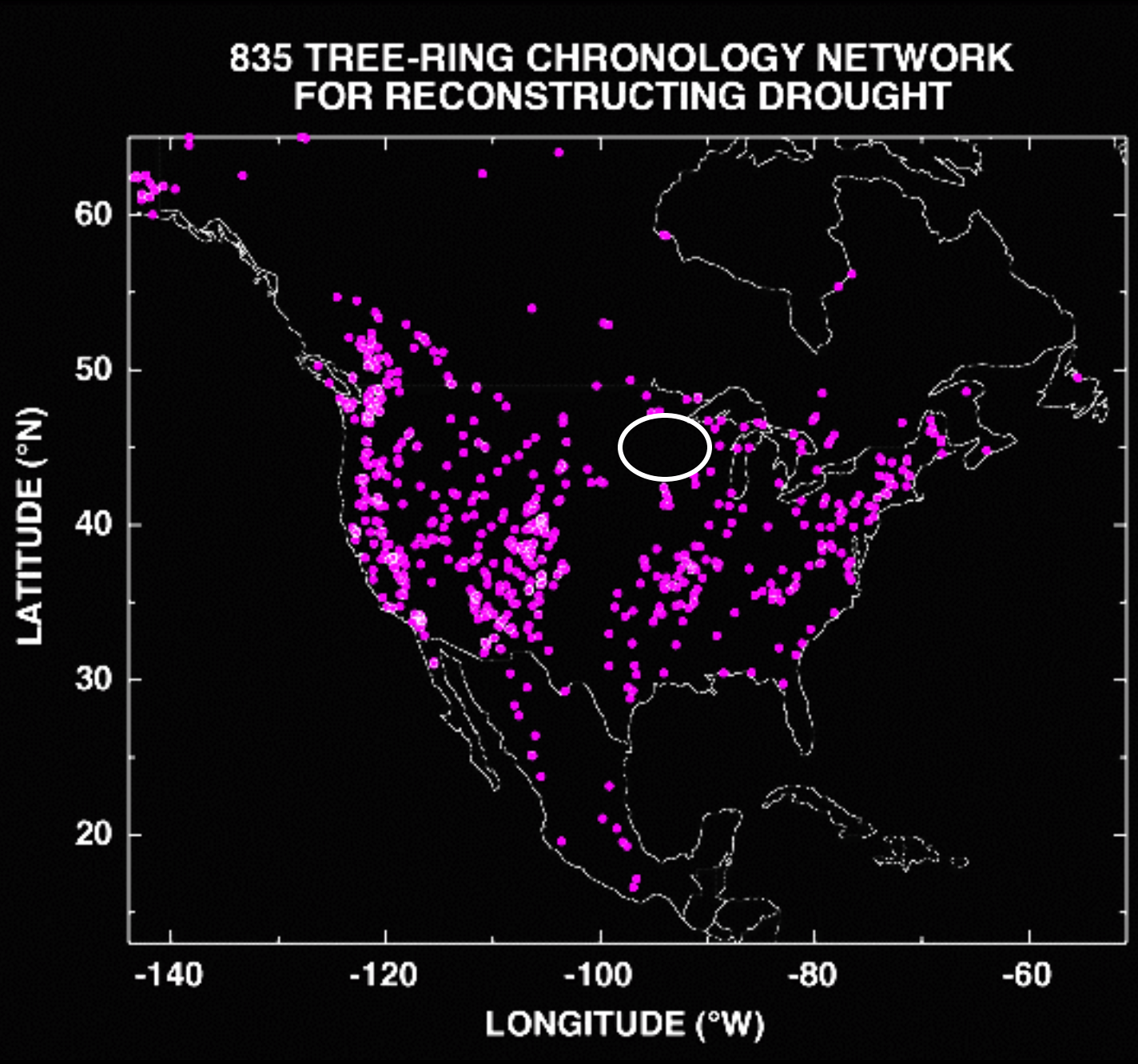
Figure 4. Daily temperature and precipitation data collected over more than five decades at scores of weather stations across Wisconsin were used to analyze the state's climatic trends since 1950. Stations in the neighboring states of Illinois, Iowa, Michigan, and Minnesota were included to help validate the Wisconsin data and identify errors and anomalies.

PROJECTED CHANGE IN ANNUAL AVERAGE TEMPERATURE (°F) FROM 1980 TO 2055

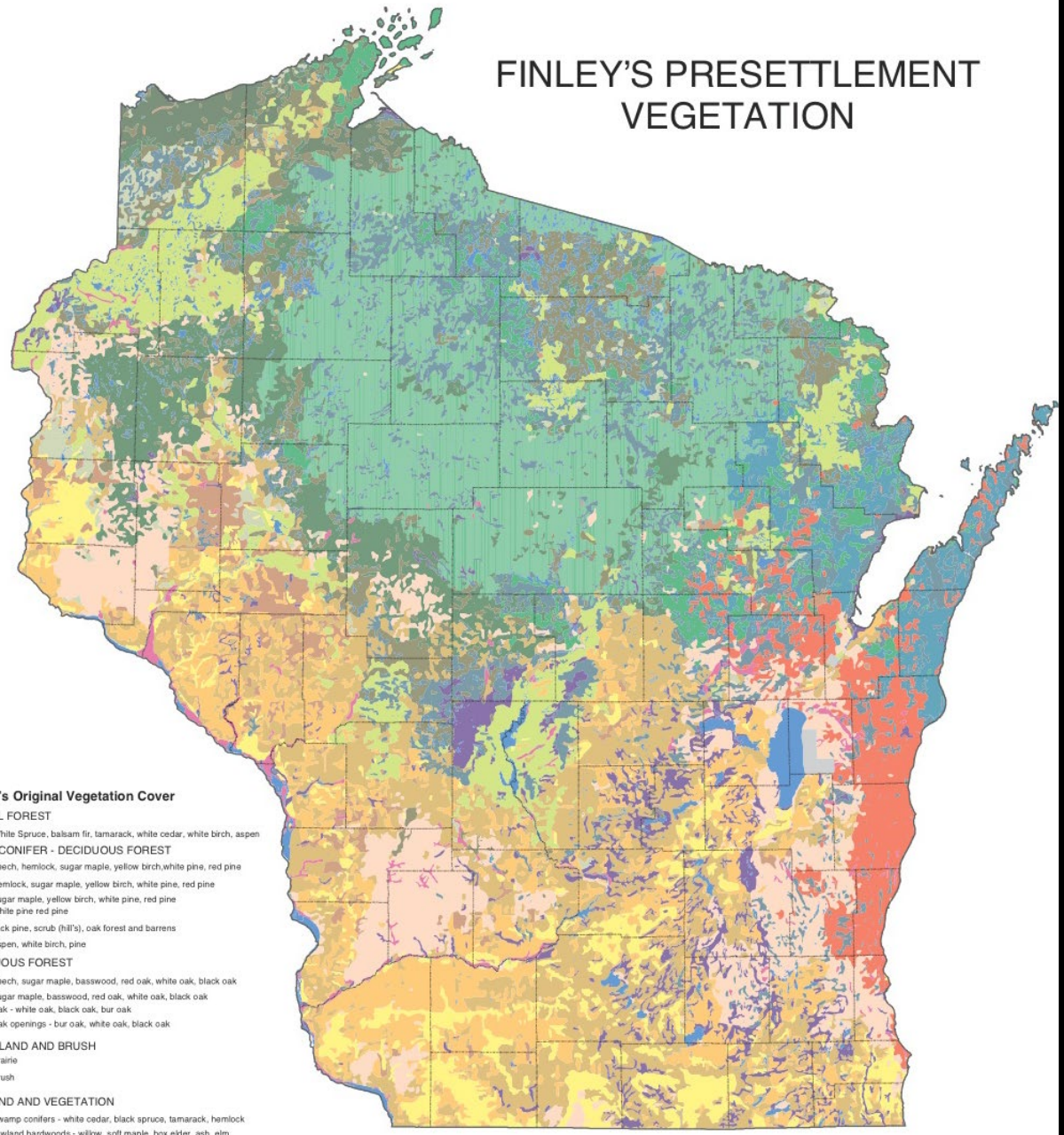


North American Drought Atlas




835 TREE-RING CHRONOLOGY NETWORK
FOR RECONSTRUCTING DROUGHT
LATITUDE (°N)
60
50
40
30
20
-140
-120
-100
-80
-60
LONGITUDE (°W)

FINLEY'S PRESETTLEMENT VEGETATION



Finley's Original Vegetation Cover

BOREAL FOREST
- White Spruce, balsam fir, tamarack, white cedar, white birch, aspen

MIXED CONIFER - DECIDUOUS FOREST
- Beech, hemlock, sugar maple, yellow birch,white pine, red pine
- Hemlock, sugar maple, yellow birch, white pine, red pine
- Sugar maple, yellow birch, white pine, red pine
- White pine red pine
- Jack pine, scrub (hil's), oak forest and barrens
- Aspen, white birch, pine

DECIDUOUS FOREST
- Beech, sugar maple, basswood, red oak, white oak, black oak
- Sugar maple, basswood, red oak, white oak, black oak
- Oak - white oak, black oak, bur oak
- Oak openings - bur oak, white oak, black oak

GRASSLAND AND BRUSH
- Prairie
- Brush

WETLAND AND VEGETATION
- Swamp conifers - white cedar, black spruce, tamarack, hemlock
- Lowland hardwoods - willow, soft maple, box elder, ash, elm
- Marsh and sedge meadow, wet praire, lowland shrubs

OTHER
- Area with vegetation cover type not interpreted on the source map
- Hydrographic area from 1:250000-scale land use and land cover layer


The Driftless Oaks


SWP 001
GPS 003

Driftless oaks

THEIR RINGS TELL THE ENVIRONMENTAL HISTORY OF SOUTHWEST WISCONSIN.

Sarah Allen

The sun is bright and gleaming off the snow-covered hills as my boots crunch across the frozen landscape. I breathe the crisp winter air in deeply as I scan a ridge in search of old oak trees. As I work my way up the slope their gnarled branches fill my vision. I can't help but smile.

The oaks I'm looking at on this bright winter day are located outside of the village of Rewey, tucked away in the southwest corner of Iowa County amidst the rolling hills of Wisconsin's Driftless Region. I have visited similar sites across 10 of the Driftless Area counties in southwest Wisconsin in a search of the old prairie oaks that dot the landscape like weathered sentinels, their spreading canopies iconic and their very presence defining Wisconsin's physical and cultural landscape.

These trees have endured tremendous changes over their life spans — the sweeping fires that maintained the open prairies and savannas of the region, the arrival of the plow and the passing of the seasons with their cycles of rain and drought. All the while, these trees have steadfastly recorded their history — told their story — through the annual growth rings they lay on year after year.

I am here to give a voice to their stories. I am a dendrochronologist and my work is the Driftless Oak Project.

There is a lot of conversation about weather patterns, including dramatic swings in moisture conditions; from the floods of 2008 to the extraordinary drought of 2012 and back to the cold wet spring of 2013.

In Wisconsin, these conversations are more than just academic. We live by the land and feel these droughts and floods in our bones and our pocket books. Southwest Wisconsin is the state's agricultural heartland and extreme events play a decisive role in local and regional economic stability. Recorded history gives us measurements of rain and temperature over most of the state for nearly 100 years, but as the 1,000-year storms of 2008 illustrated, our recorded history does not capture the full range of weather variability in Wisconsin.

We need a broader perspective. That brings us to dendrochronology, the science of tree rings.

In southwest Wisconsin, warm years with plenty of rain typically lead to good growth and a wide annual growth ring within the trees of the region. Short, cool summers and years of drought tend to result in narrow rings. This relationship is often particularly strong in oak trees. Oaks are conservative by nature, with slower growth than many other Wisconsin trees during years of plenty, a strategy that provides insurance against growing more than can be supported during years of drought. Their thick, insulating bark enables oaks to withstand the fires that maintained prairies throughout much of southwest Wisconsin prior to European settlement. Matched with their longevity, which can often span centuries, these traits provide sound reasons for why we still find oaks occupying sites that were too dry, or, in the past, too fire prone for most other tree species in Wisconsin.

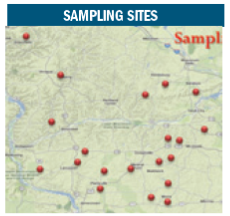
Perhaps it is this rugged persistence of oaks, the propensity to stand alone on a windswept hill or resolutely keep watch over a field, that lead so many people to revere them. It is also these traits that make oaks exemplary candidates for reconstructing drought patterns.

The Driftless Oak Project is a two-year research program being conducted through the University of Wisconsin-Platteville Tree-Ring, Earth and Environmental Sciences Laboratory (TREES Lab for short) with funding from the University of Wisconsin Water Resources Institute.

With this project we are developing a network of tree-ring chronologies, or records of tree growth, across southwest Wisconsin in order to better understand drought patterns. The open-grown bur and white oaks of the Driftless Area are of particular interest. Savanna oaks can often be found growing on south- or southwest-facing slopes, which tend to be warmer and drier than other directions. This setting reduces the ability of other less hardy trees to grow well while also enhancing the link between tree growth and moisture availability.

By collecting tree-ring samples from these oaks and examining their growth patterns, we are developing exactly-dated records of tree growth that can be compared to instrumental records of temperature and rainfall. If a strong relationship is identified, the data can then be used to estimate conditions over the life span of the trees.

To date, we have visited 20 sites and collected samples from 175 trees. A regional picture of tree growth is emerging and many of the oldest trees we have cored so far have inner-ring-dates extending into the early 1700s.



Back on that hill by Rewey, the day is winding down and my arms, as well as those of my colleagues, are exhausted. We have collected our tree-ring samples with a tool called an increment borer, similar to a hollow drill bit, that we turn into the trees by hand. Anyone who has worked with oak knows that this is not an easy task! The bur oaks that we sample on this brisk winter day have experienced their share of drought, and the stories they have to tell are tantalizing, if I am reading their weather beaten trunks and contorted branches correctly.

Later, in the laboratory, I'll find out that these trees have been growing on this site for over 300 years and have seen droughts far worse than any we have recorded over the instrumental record. What are the implications of this work? We are only now getting to a stage where we can begin making inferences about past conditions, but before we do there are more hills to hike, trees to discover and rings to count.

We need your help

One of the most interesting parts of this project has been meeting people from all over the state and from all different backgrounds, but who are unified by their shared love of the Driftless Region and pride in their oaks. As guardians of these oak relics, their pride is justified and, as Aldo Leopold so eloquently states in "A Sand County Almanac," "He who owns a veteran bur oak owns more than a tree. He owns a historical library, and a reserved seat in the theater of evolution."

The response from Wisconsin residents is essential to locating the trees we need for this research and we are once again asking for your help. Although we sampled extensively throughout the region last fall and winter, there are still gaps within our research area that we are hoping to fill.

If you have an oak tree that you think is old, interesting, weathered, unique or just may have a story to tell, please contact Sara Allen at (608) 342-6149 or email allensara@uwplatt.edu, or Evan Larson at (608) 342-6139 or email larsonev@uwplatt.edu at the UW-Platteville TREES Lab.

How do you ask a tree?

One of the first questions we often get from people potentially interested in offering up their oaks for this study is if we are going to hurt their trees. The answer is "no."

We only core during the late fall, winter and early spring to avoid damaging oaks during the oak wilt season. Even in areas with little or no known oak wilt, we simply don't want to bear the slightest risk of opening up some of the most spectacular trees in the state to potential infection.

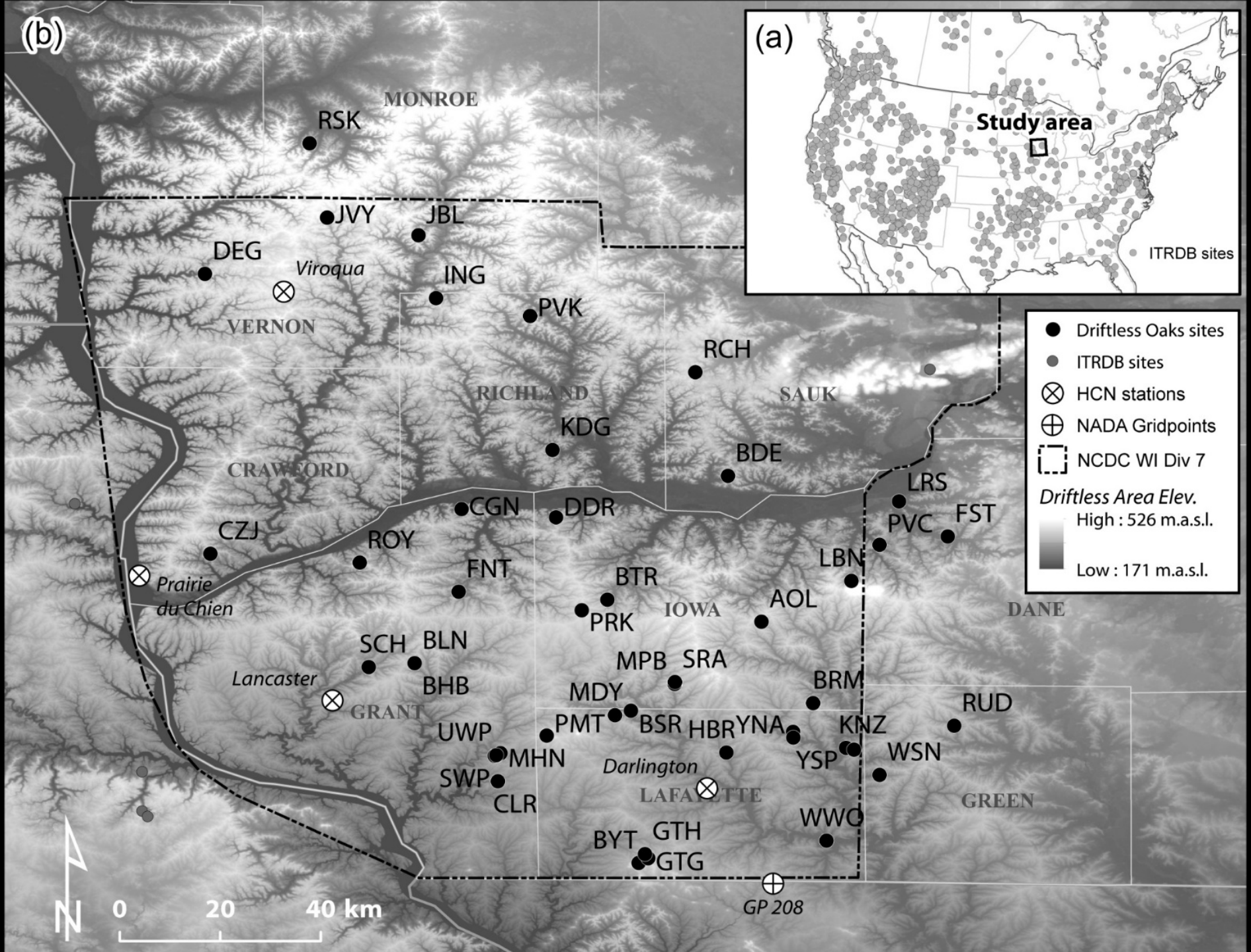
Once we are inside that seasonal window, the process is simple. Using an increment borer, we collect pencil-sized core samples along two radii of each tree included in the study, typically from opposite sides of the tree and parallel to any slope contours. This allows us to determine an average growth rate for that tree, which can then be compared and combined with the growth patterns of other nearby oaks.

In addition to collecting tree-ring samples from living trees, through the scientific principle of cross-dating we can compare patterns of tree growth from living trees to those of trees that are long dead. This includes stumps logs, or even the furniture and timbers in historical buildings. We have already incorporated records of tree growth from timber samples in historical structures near Shullsburg, Mineral Point and Stitzer, with some of these samples extending into the early 1700s. Samples from long-dead trees will be key to moving further into the past.

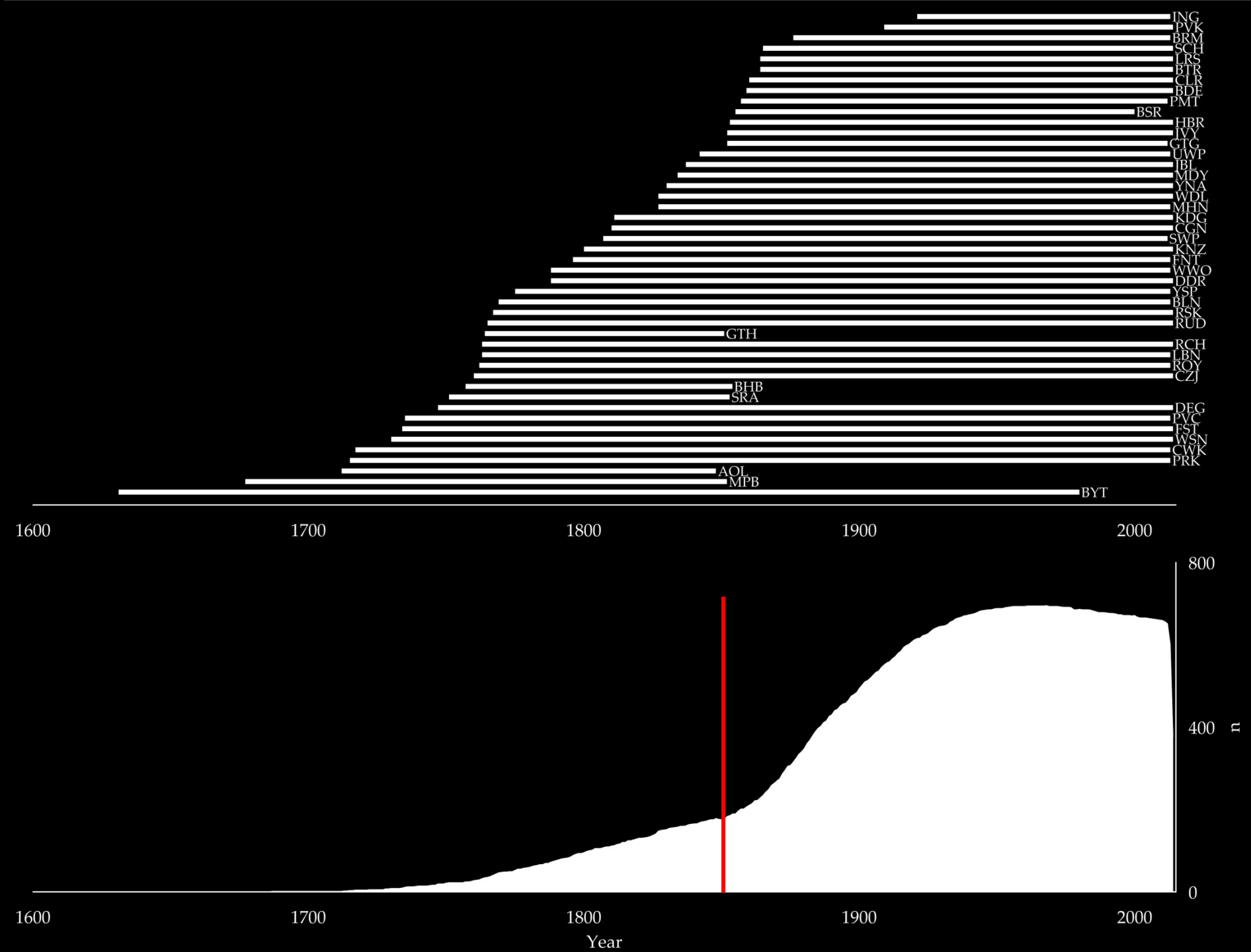
Sara Allen is a research associate at UW-Platteville in the Tree-Ring, Earth and Environmental Sciences (TREES) Laboratory. Evan Larson contributed to this story and is an UW-Platteville associate professor of geography.


University of Wisconsin-Platteville
Western Field Trip 2012
May 19-June 8
drive
hike


VERNON CO-OP OIL & GAS



- 46 sites, 402 living oaks
- 6 structures, 33 timbers
- 731 ring-width series
- 100,576 rings
- MIC = 0.50
- MS = 0.21
- 17 increment borers


ING
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WWO
DDR
YSP
BLN
RSK
RUD
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Year

A Sand County ALMANAC

AND SKETCHES HERE AND THERE

By ALDO LEOPOLD

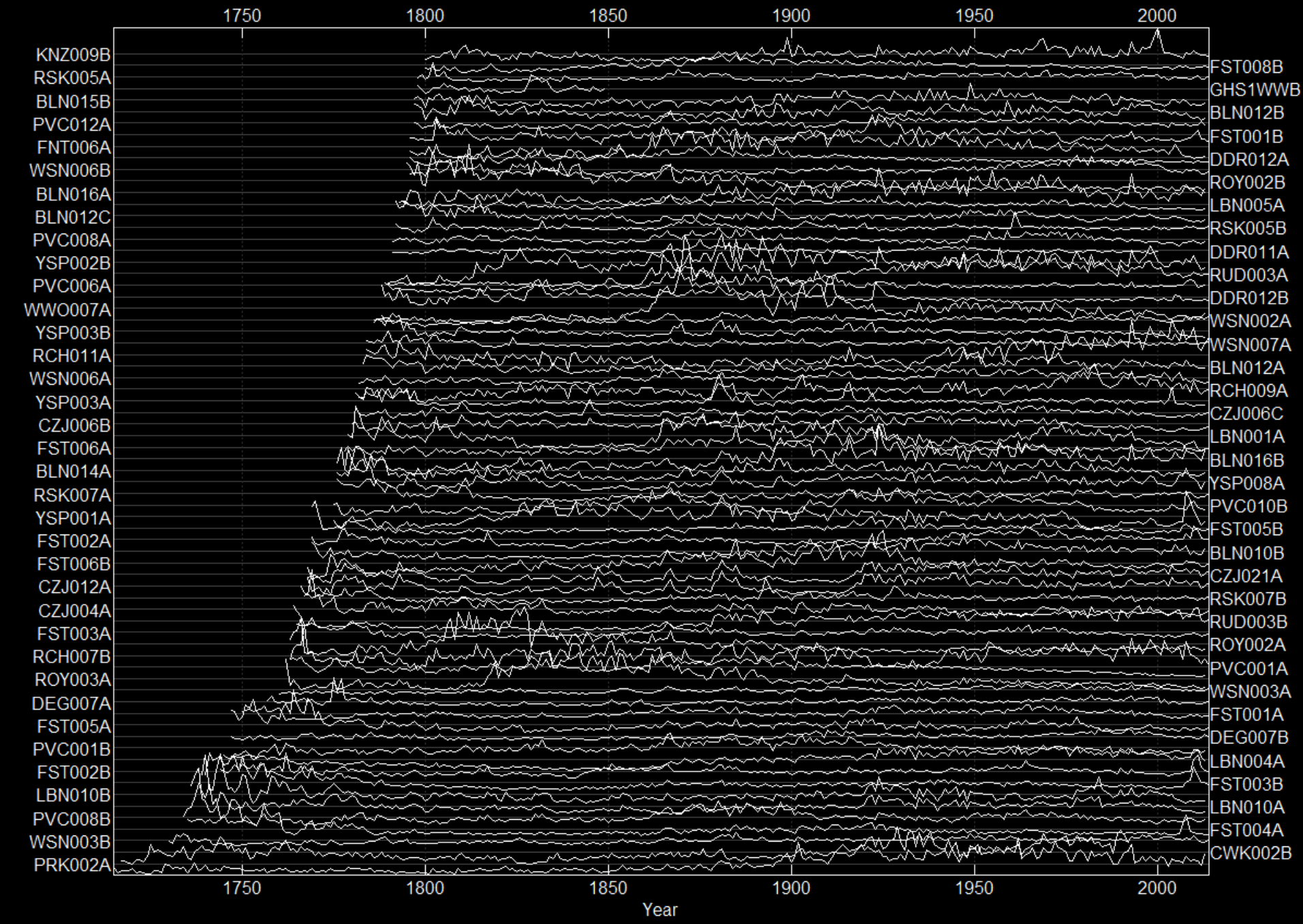
Jonathan Carver has left us a vivid word-picture of the prairie border in pre-settlement days. On 10 October 1763, he visited Blue Mounds, a group of high hills (now wooded) near the southwestern corner of Dane County. He says:

I ascended one of the highest of these, and had an extensive view of the country. For many miles nothing was to be seen but lesser mountains, which appeared at a distance like haycocks, they being free from trees. Only a few groves of hickory, and stunted oaks, covered some of the vallies.

In the 1840's a new animal, the settler, intervened in the prairie battle. He didn't mean to, he just plowed enough fields to deprive the prairie of its immemorial ally: fire. Seedling oaks forthwith romped over the grasslands in legions, and what had been the prairie region became a region of woodlot farms. If you doubt this story, go count the rings on any set of stumps on any 'ridge' woodlot in southwest Wisconsin. All the trees except the oldest veterans date back to the 1850's and the 1860's, and this was when fires ceased on the prairie.

John Muir grew up in Marquette County during this period when new woods overrode the old prairies and engulfed the oak openings in thickets of saplings. In his *Boyhood and Youth* he recalls that:

The uniformly rich soil of the Illinois and Wisconsin prairies produced so close and tall a growth of grasses for fires that no tree could live on it. Had there been no fires, these fine prairies, so marked a feature of the country, would have been covered by the heaviest forest. As soon as the oak openings were settled, and the farmers had prevented running grass-fires, the grubs [roots] grew up into trees and formed tall thickets so dense that it was difficult to


1750
1800
1850
1900
1950
2000
KNZ009B
RSK005A
BLN015B
PVC012A
FNT006A
WSN006B
BLN016A
BLN012C
PVC008A
YSP002B
PVC006A
WWO007A
YSP003B
RCH011A
WSN006A
YSP003A
CZJ006B
FST006A
BLN014A
RSK007A
YSP001A
FST002A
FST006B
CZJ012A
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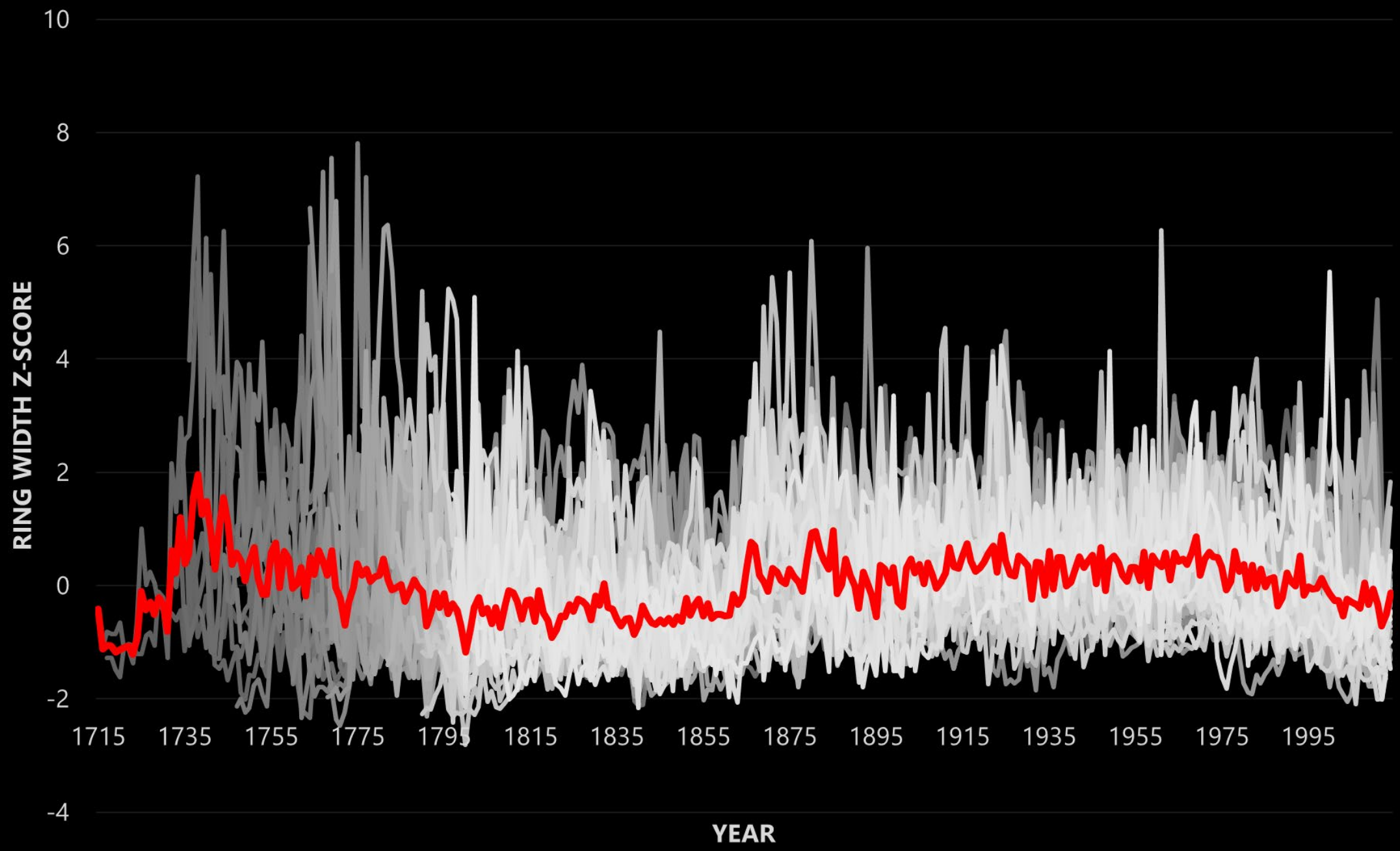
10
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-2
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RING WIDTH Z-SCORE
1715
1735
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1915
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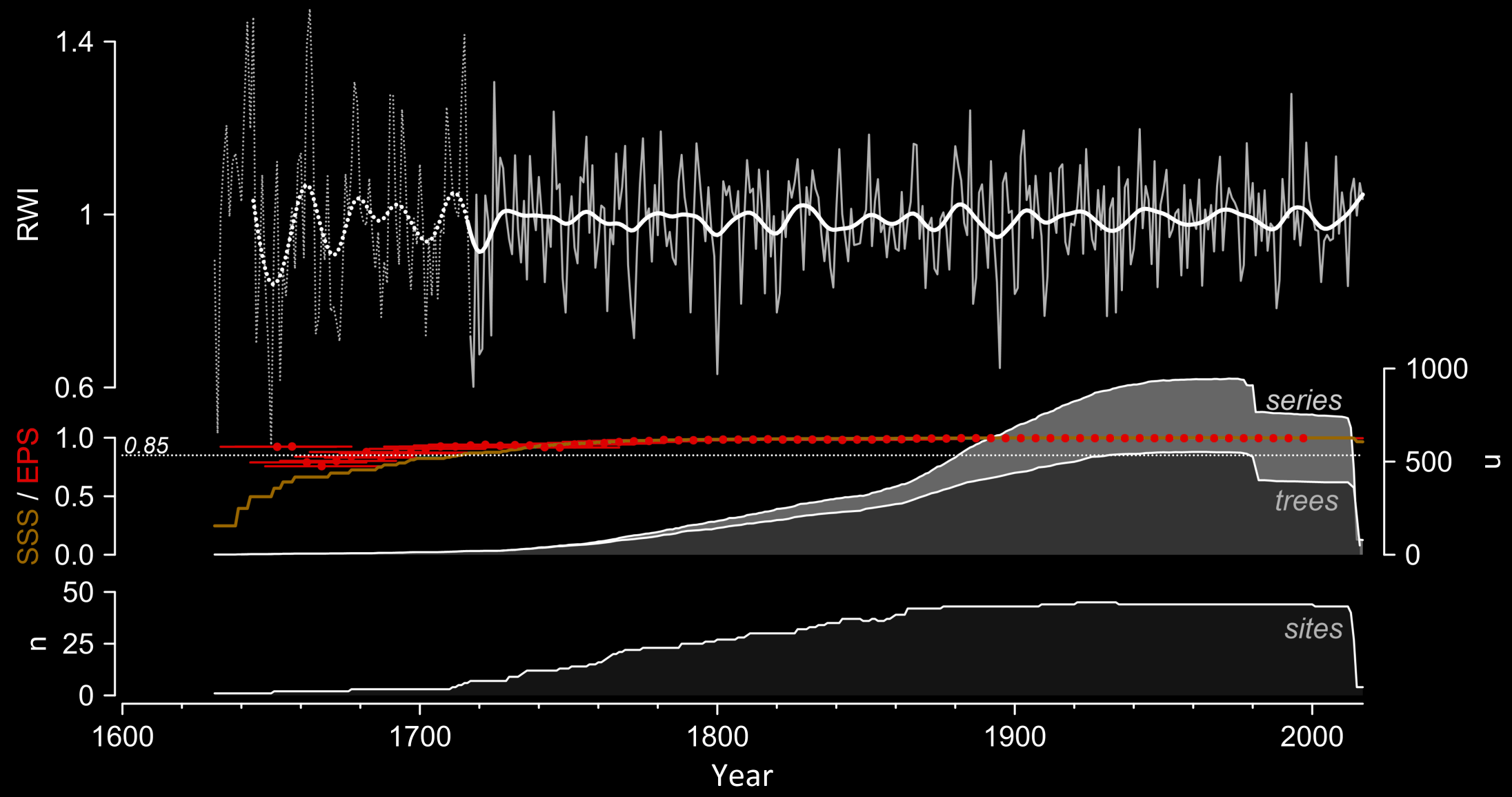
1955
1975
1995
YEAR


RWI
1.4
1
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series
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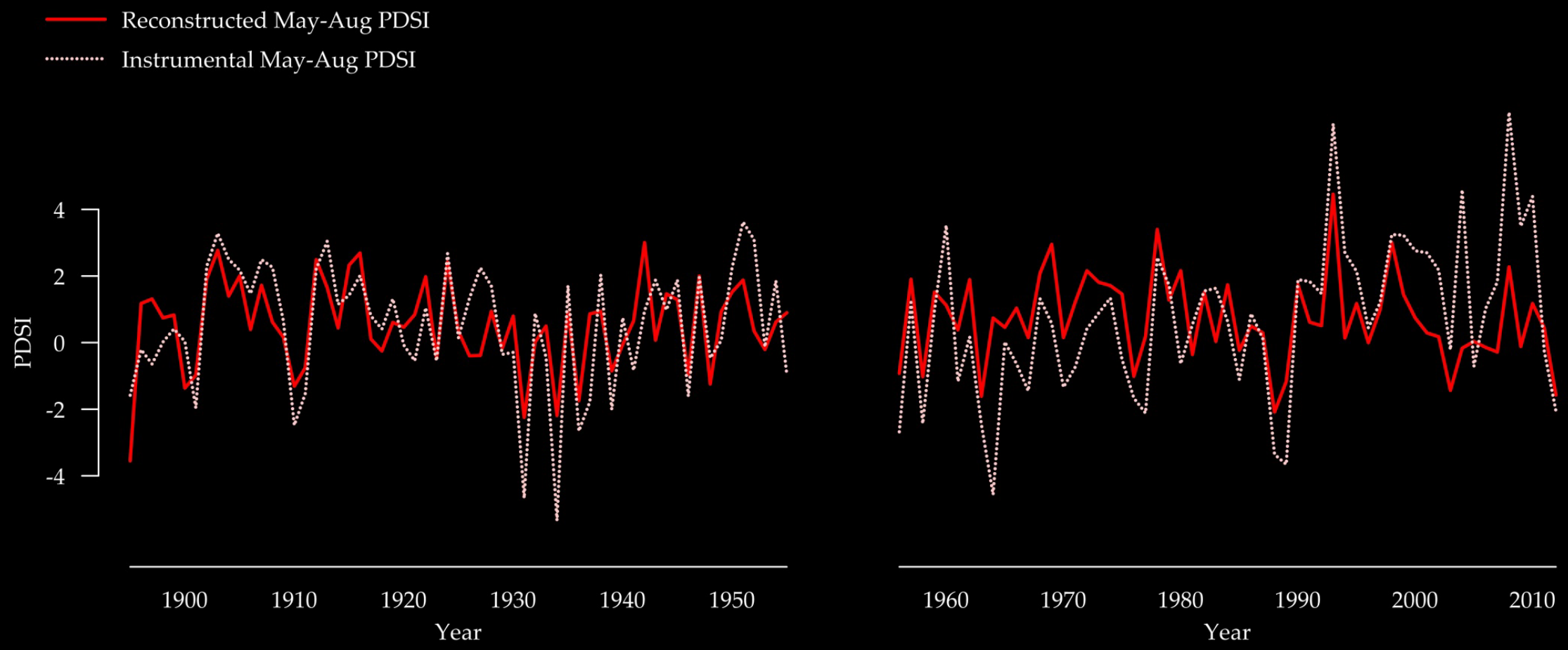
2000
Year


Reconstructed May-Aug PDSI
Instrumental May-Aug PDSI
PDSI
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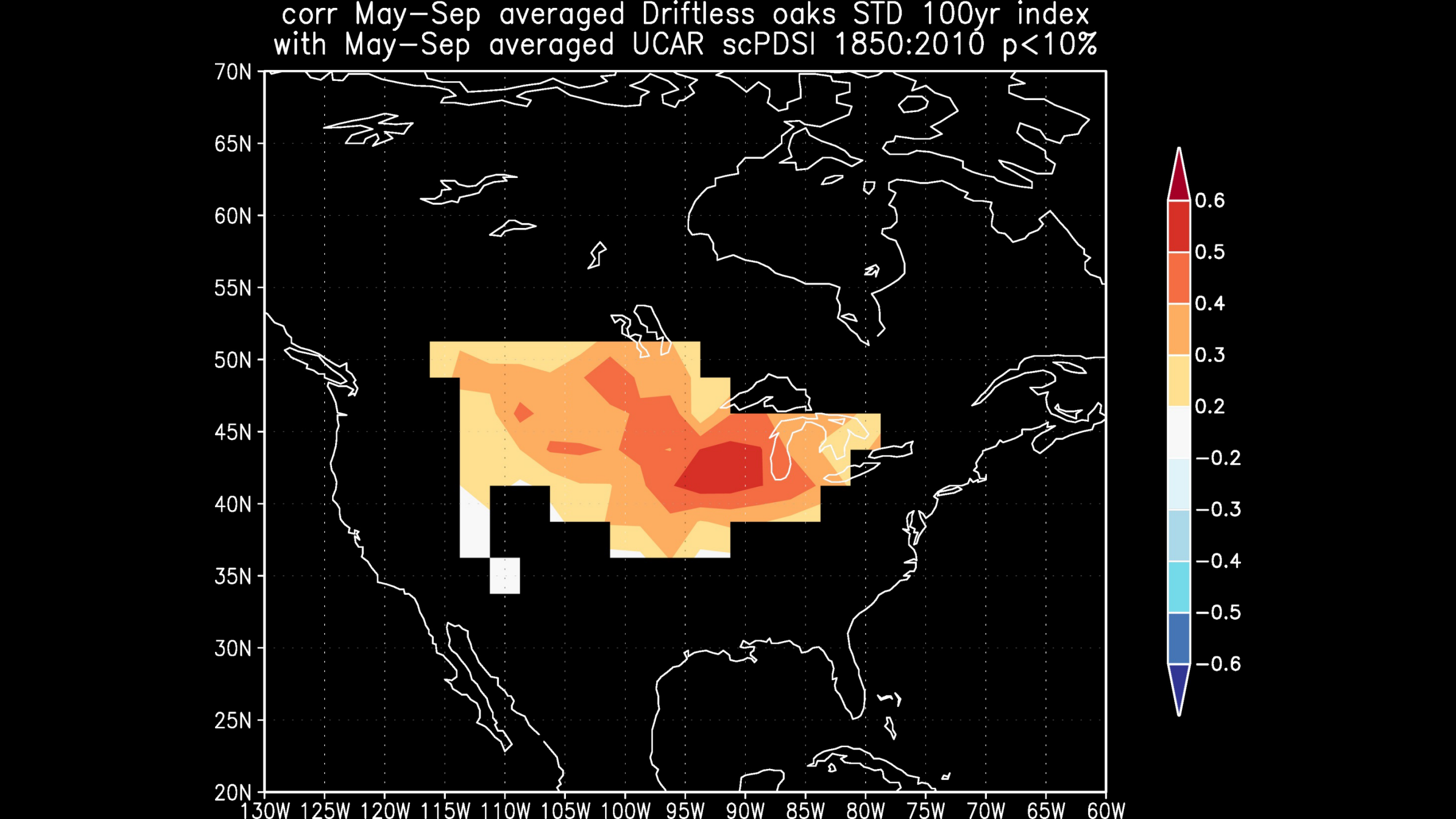
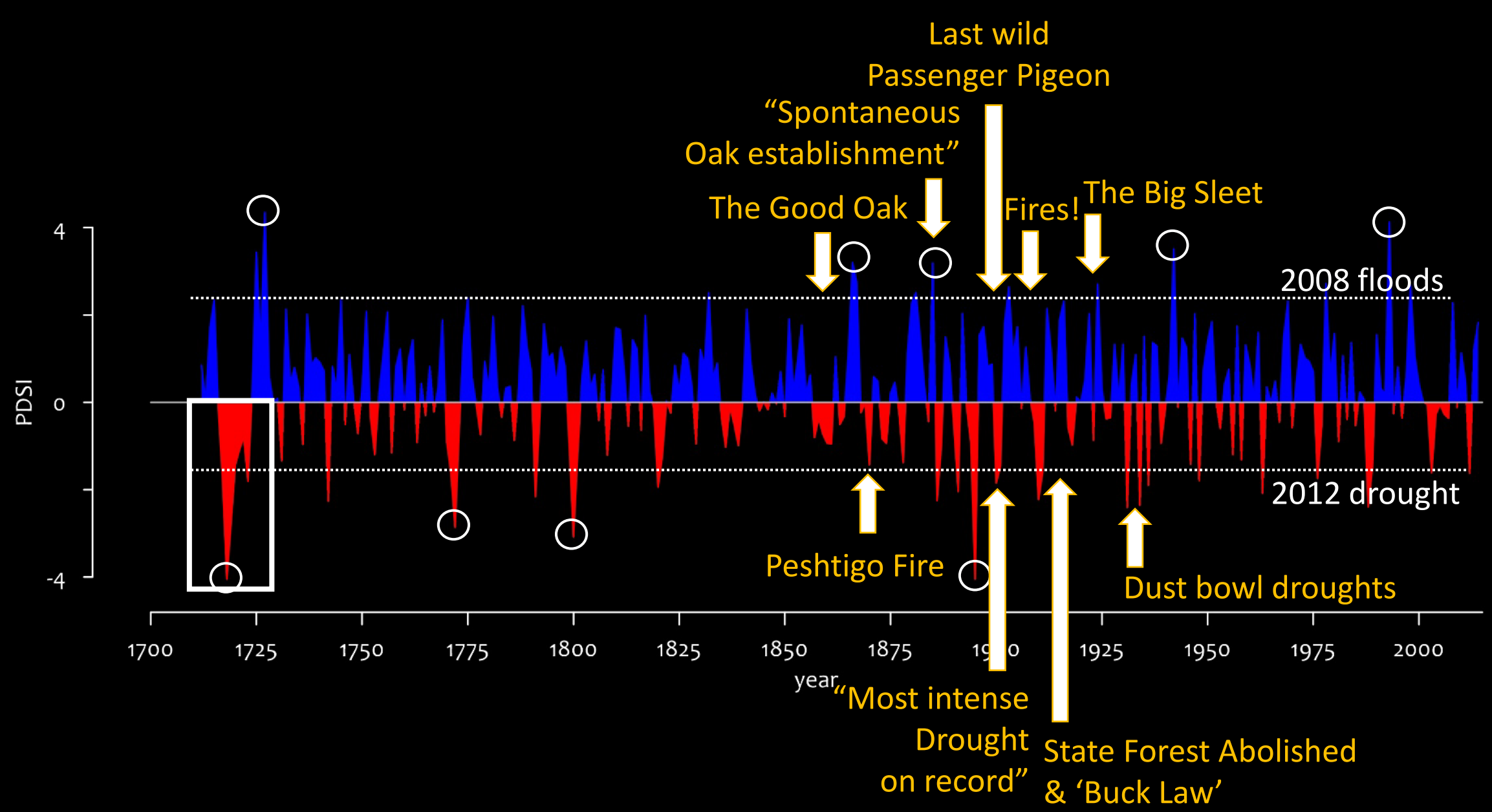
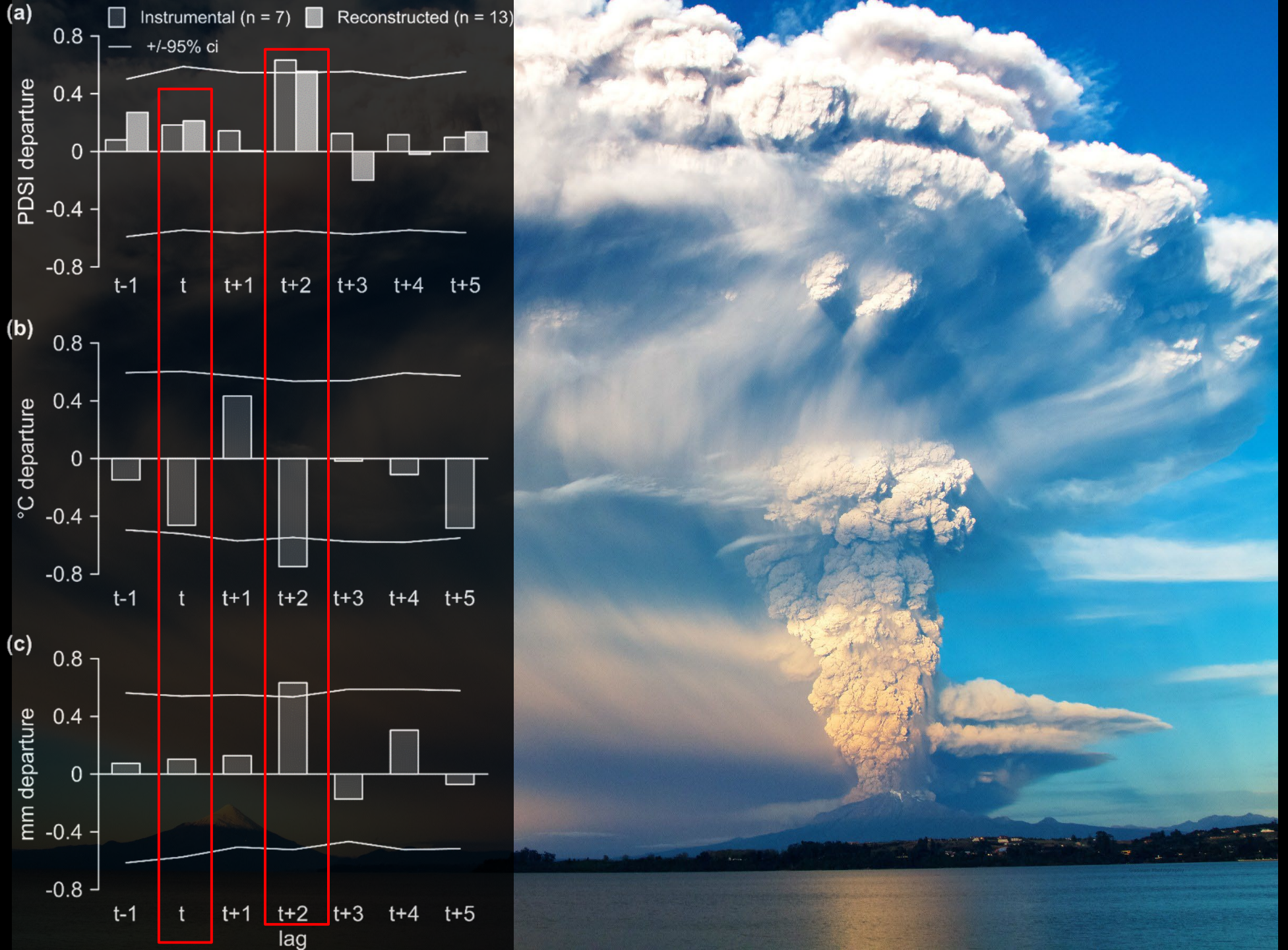
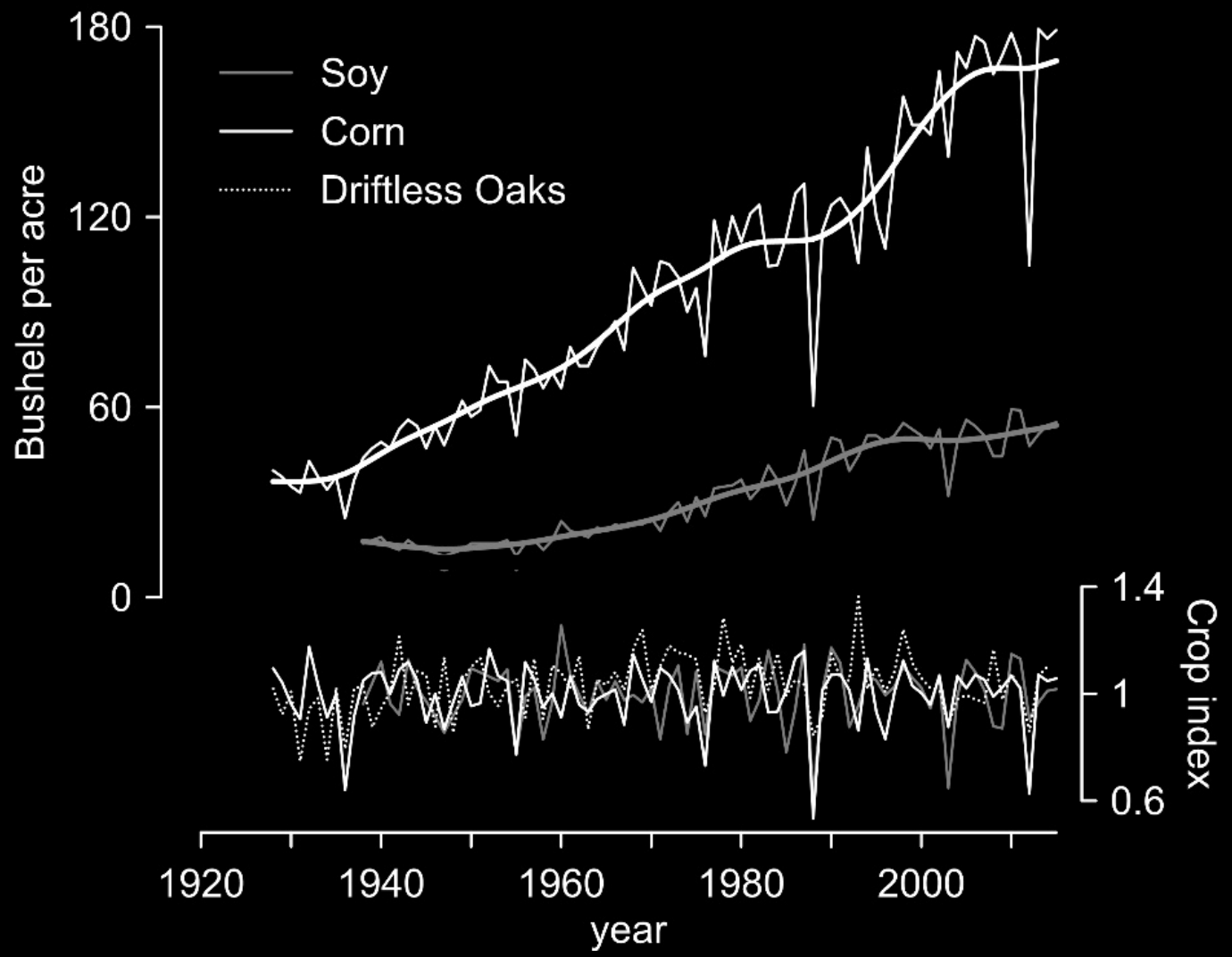
2010
Year
Year


corr May–Sep averaged Driftless oaks STD 100yr index
with May–Sep averaged UCAR scPDSI 1850:2010 p<10%
70N
65N
60N
55N
50N
45N
40N
35N
30N
25N
20N
130W 125W 120W 115W 110W 105W 100W 95W 90W 85W 80W 75W 70W 65W 60W
0.6
0.5
0.4
0.3
0.2
−0.2
−0.3
−0.4
−0.5
−0.6


Last wild
Passenger Pigeon
"Spontaneous
Oak establishment"
The Good Oak
Fires!
The Big Sleet
2008 floods
2012 drought
Peshtigo Fire
Dust bowl droughts
"Most intense
Drought
on record"
State Forest Abolished
& 'Buck Law'
PDSI
4
0
-4
1700
1725
1750
1775
1800
1825
1850
1875
1925
1950
1975
2000
year


(a)
Instrumental (n = 7)
Reconstructed (n = 13)
+/-95% ci
PDSI departure
0.8
0.4
0
-0.4
-0.8
t-1
t
t+1
t+2
t+3
t+4
t+5
(b)
°C departure
(c)
mm departure
lag


180
120
60
0
Bushels per acre
Soy
Corn
Driftless Oaks
1.4
1
0.6
Crop index
1920
1940
1960
1980
2000
year

RUI: Collaborative Research: Medieval to modern climate variability and climate change in the Great Plains

NSF Paleo Perspectives on Climate Change

Award #2201352

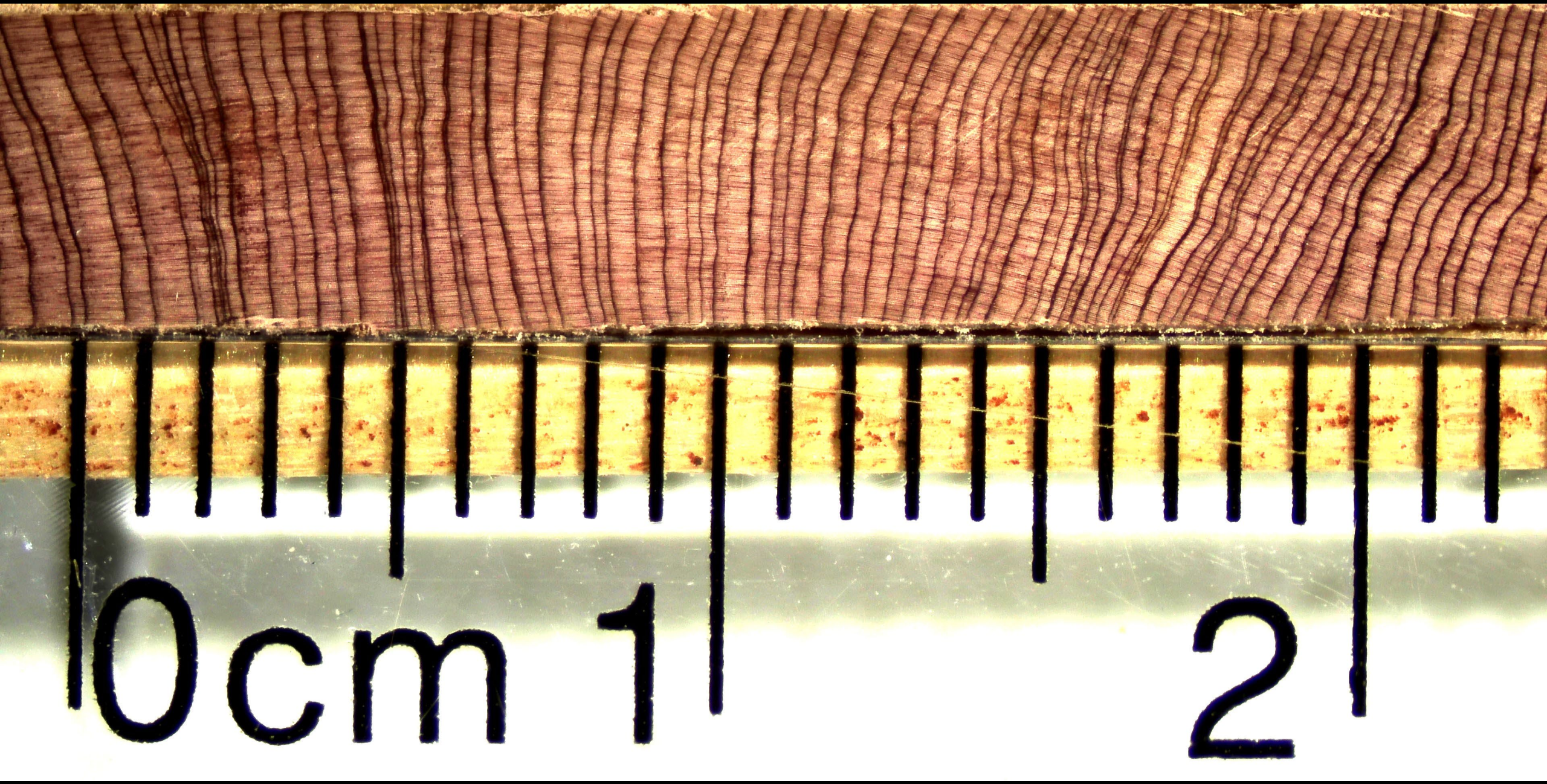
Dr. Dave Stahle, University of Arkansas

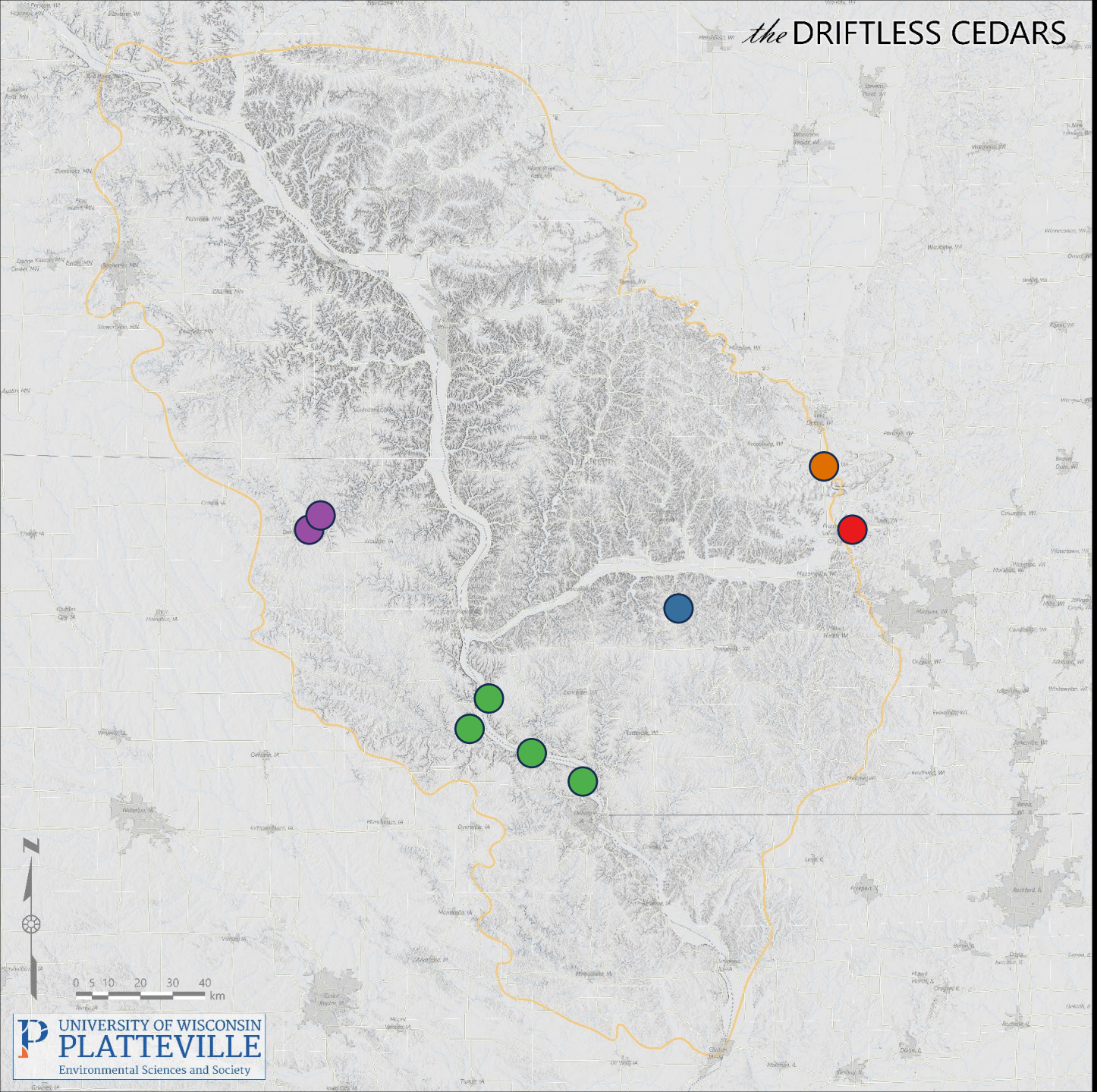
Dr. Ed Cook, Columbia University

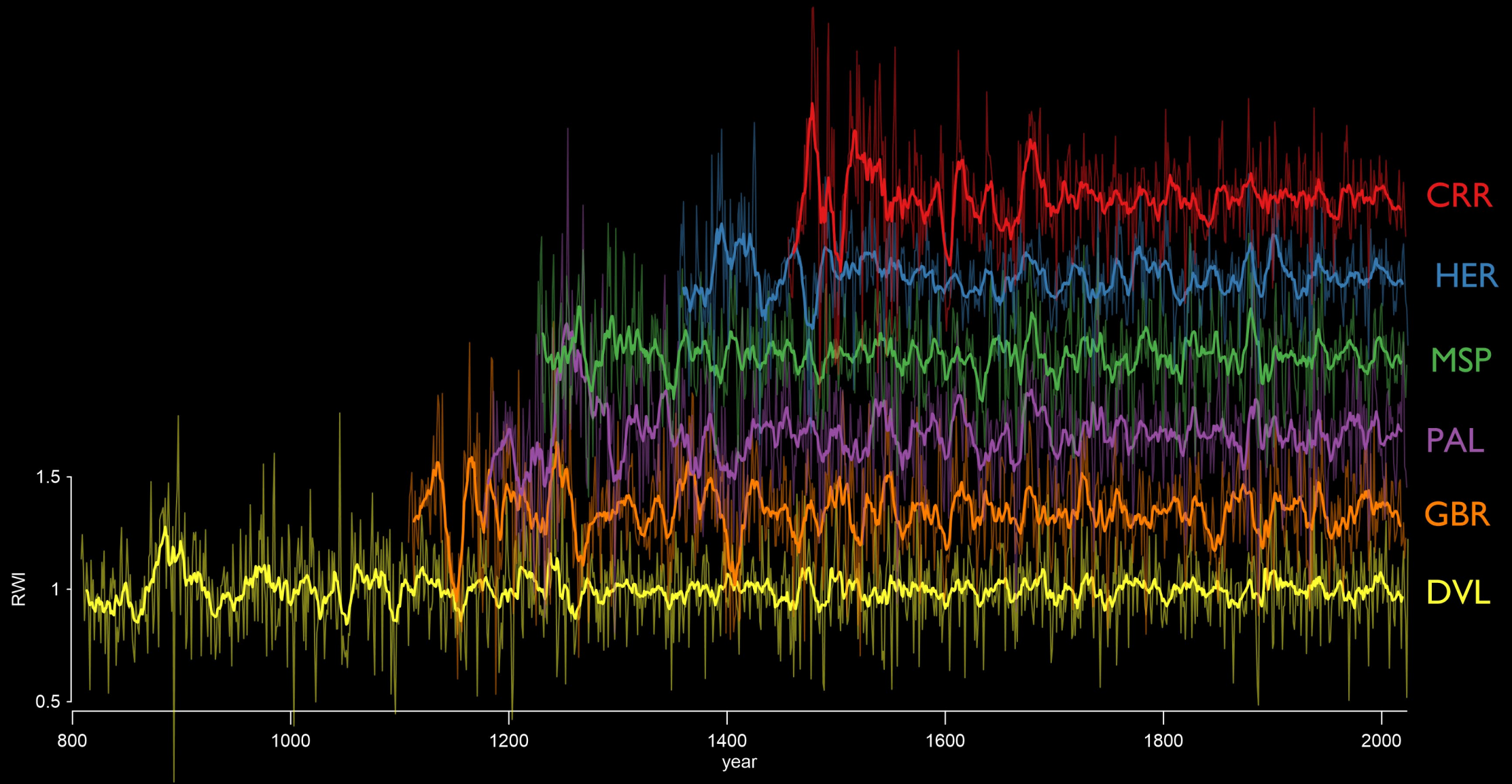
Dr. Dorian Burnette, University of Tennessee-Memphis

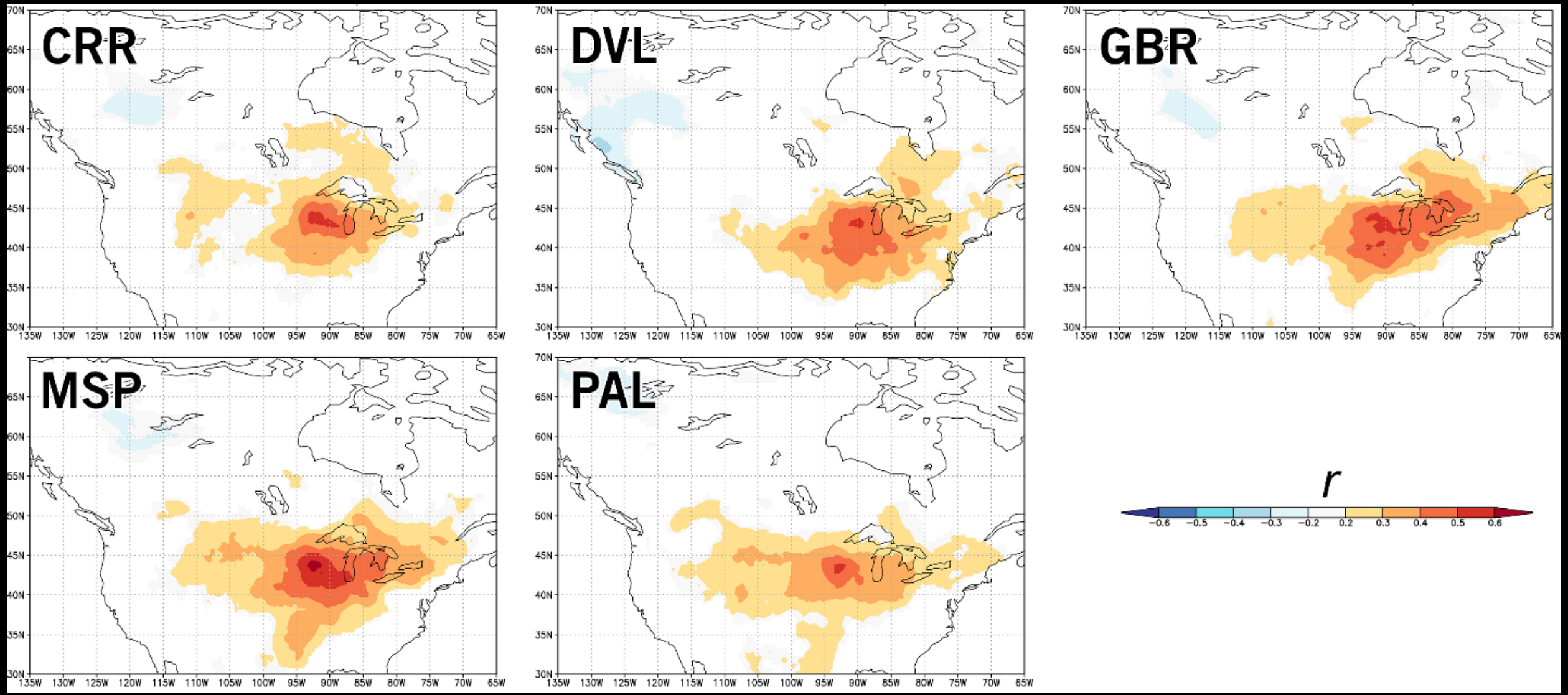
Dr. Mike Stambaugh, University of Missouri

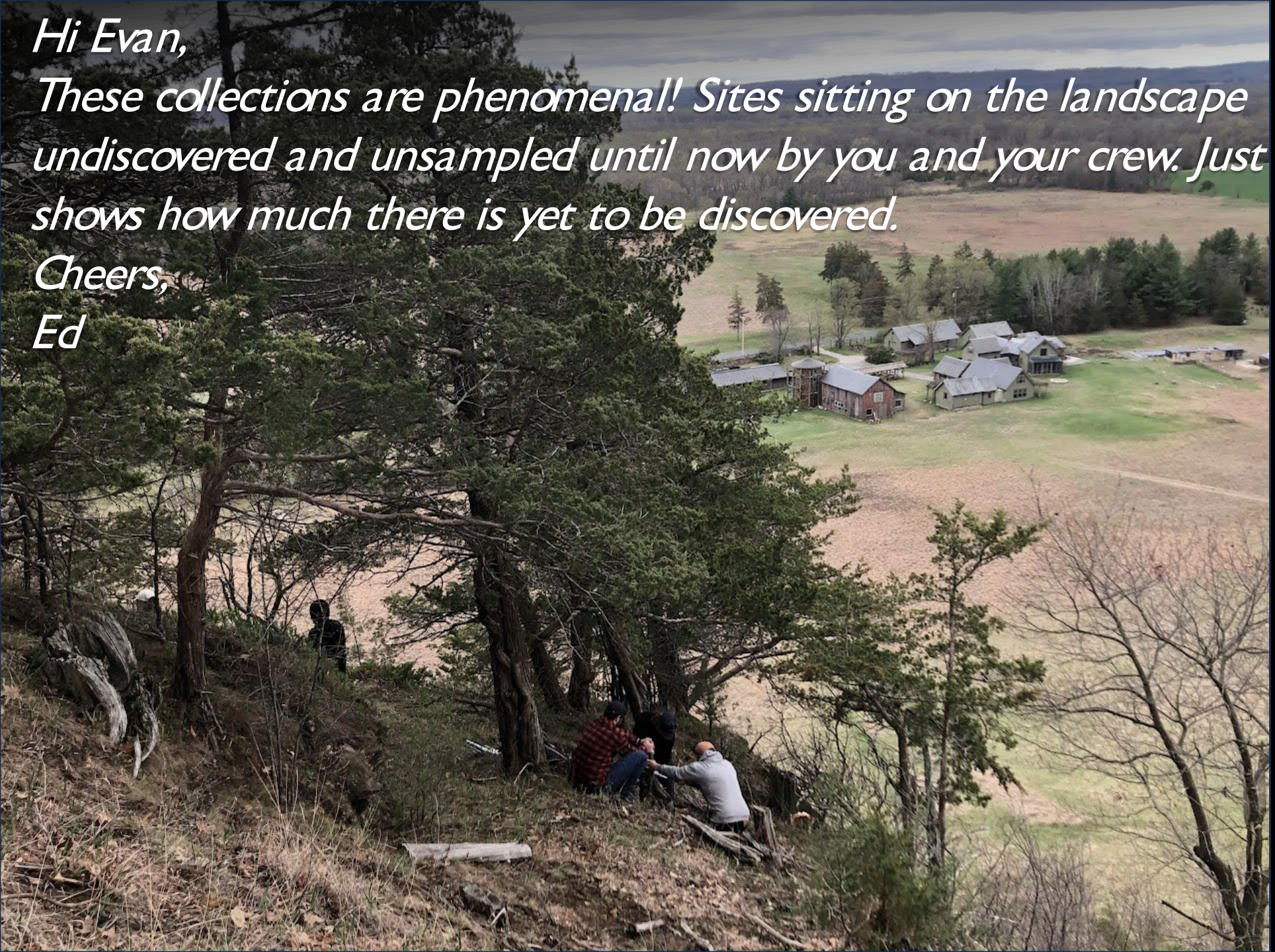
Dr. Evan Larson, University of Wisconsin-Platteville


0cm 1
2

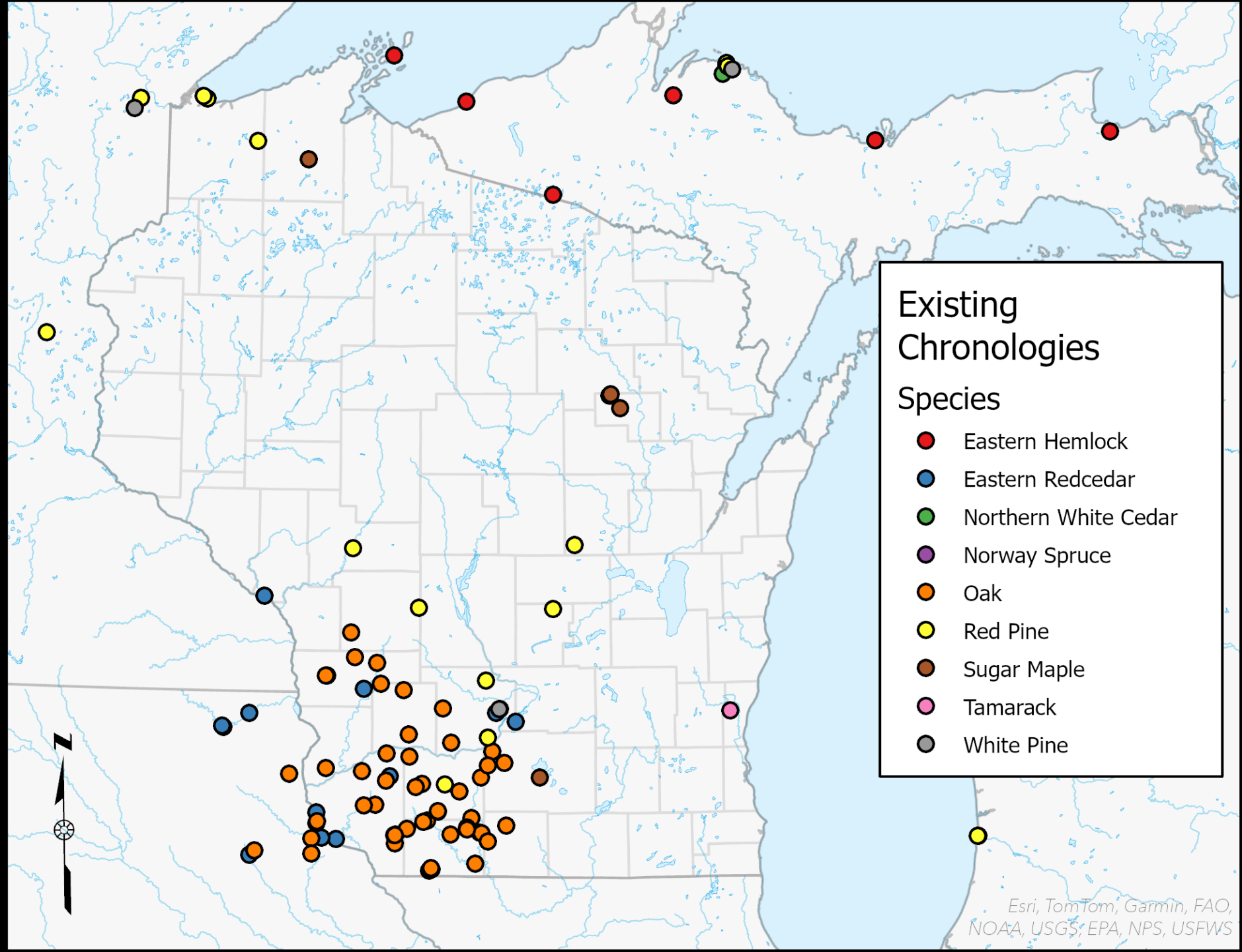

the DRIFTLESS CEDARS
N
0 5 10 20 30 40
km
UNIVERSITY OF WISCONSIN
PLATTEVILLE
Environmental Sciences and Society


CRR
HER
MSP
PAL
GBR
DVL
RWI
1.5
1
0.5
800
1000
1200
1400
1600
1800
2000
year


CRR
DVL
GBR
MSP
PAL
r
−0.6 −0.5 −0.4 −0.3 −0.2 0.2 0.3 0.4 0.5 0.6


Hi Evan,
These collections are phenomenal! Sites sitting on the landscape undiscovered and unsampled until now by you and your crew. Just shows how much there is yet to be discovered.
Cheers,
Ed

Our work to date…



Freshwater Collaborative
OF WISCONSIN

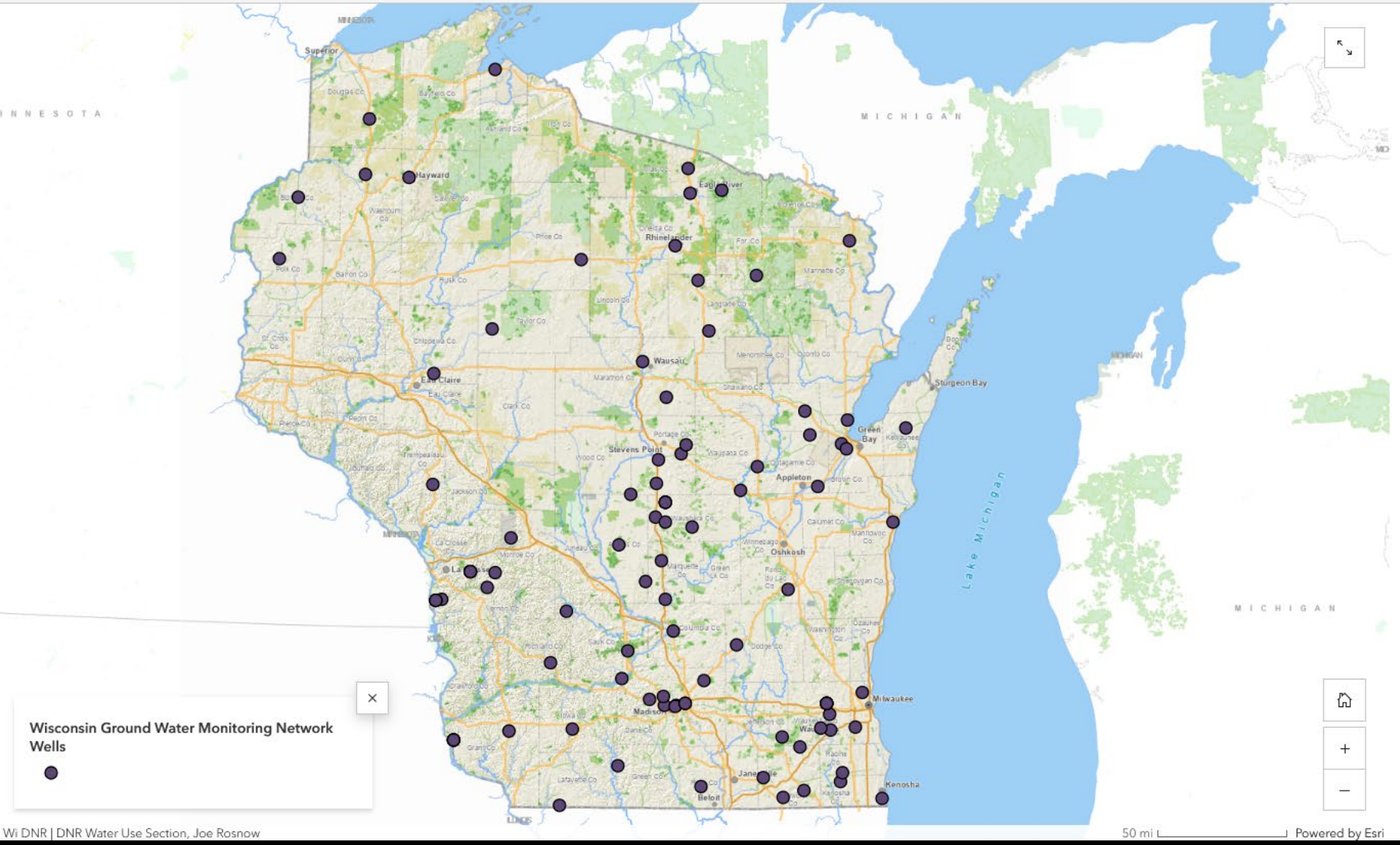
About Us | Our Work | For Students | For Academic Partners | Partner With Us

Aquatic biology fieldwork at UW-Whitewater

Training Wisconsin's workforce to solve freshwater challenges

Working Together To Collect Wisconsin Water Quantity Data

Groundwater Levels | Spring Flows | Stream and River Flows | Lake Levels | Credits

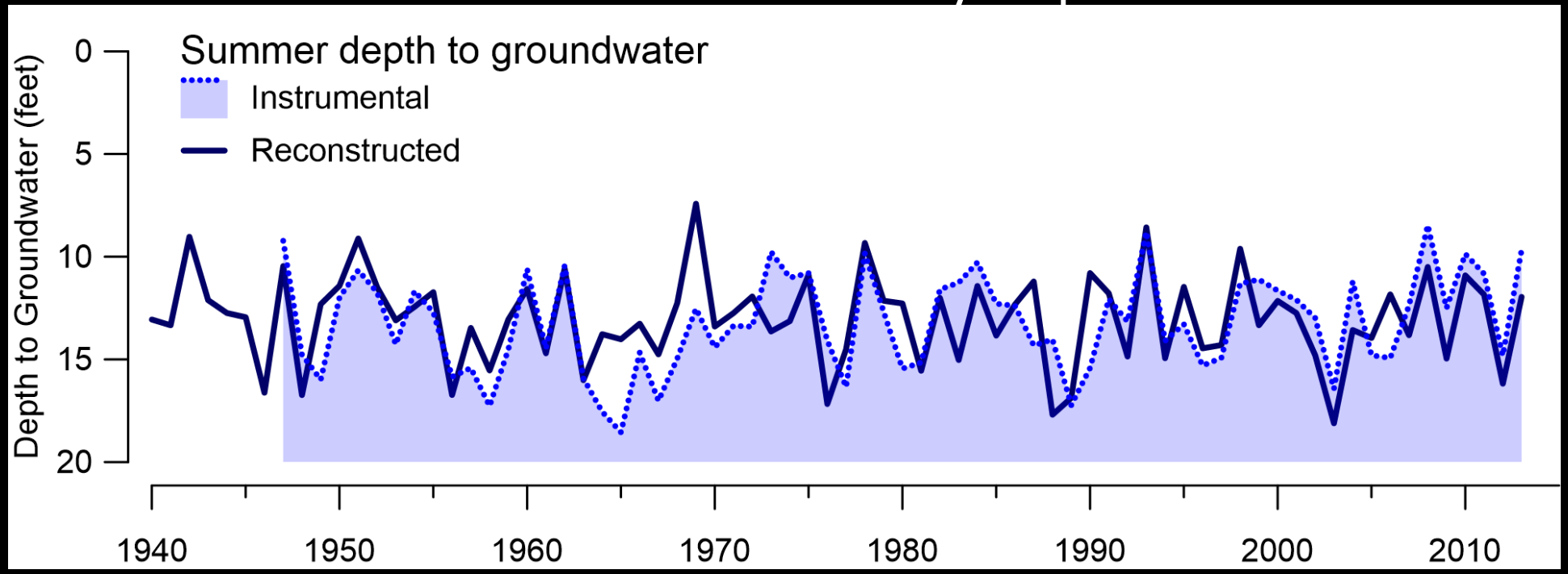


Network Well Locations

The DNR manages this network with the United States Geological Survey (USGS) and the Wisconsin Geological and Natural History Survey (WGNHS). USGS monitors the wells, checks the well data and uploads it to the National Water Information System. Additional groundwater level monitoring wells exist throughout the state to provide insight into groundwater flooding and more significant projects like the Central Sands Lakes Study. See the Water Quantity Data Viewer for short-term project wells.

Check out this video on the WGNHS webpage about Wisconsin's Groundwater-Level Monitoring Network.

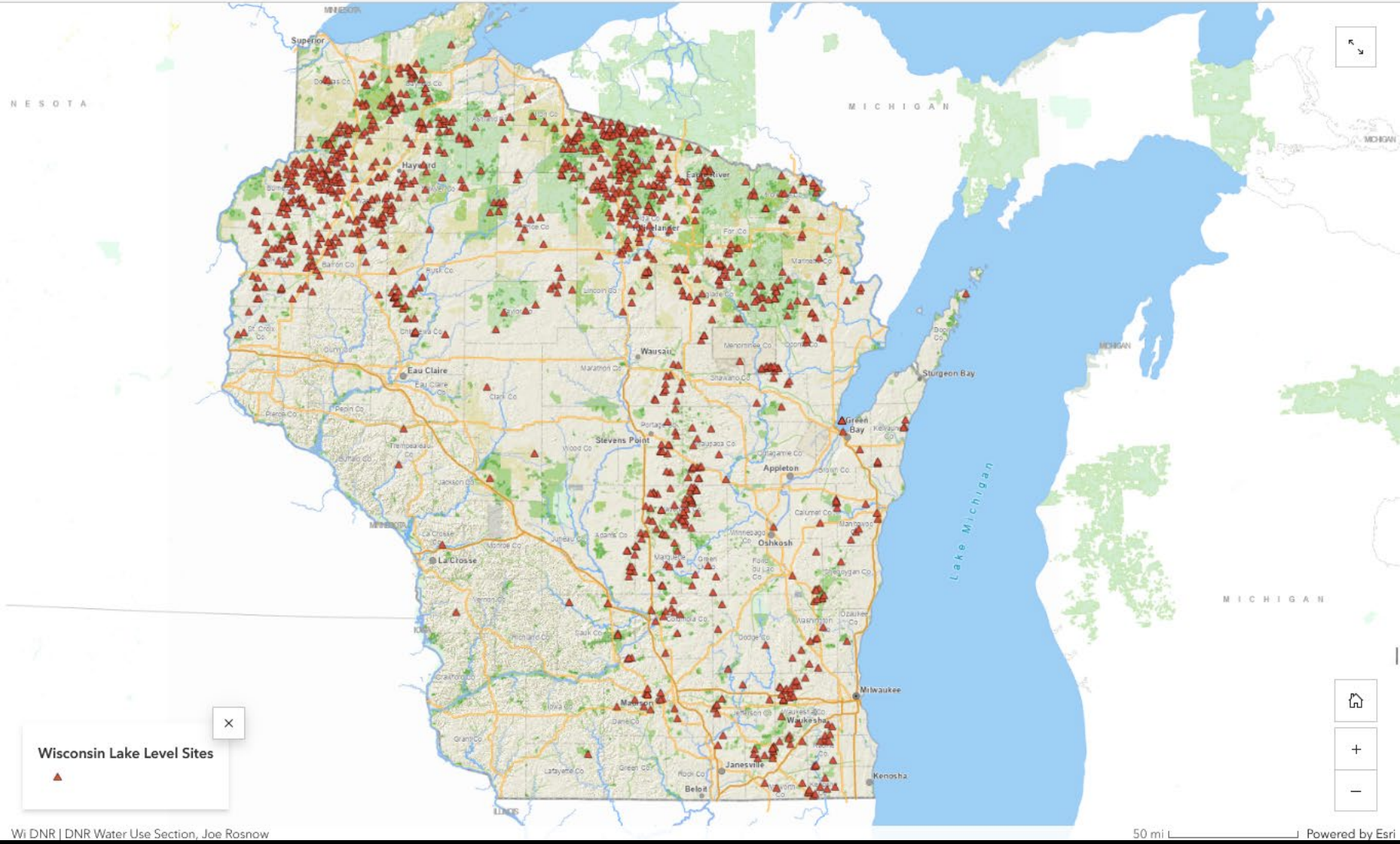
Grant County Depth to Groundwater



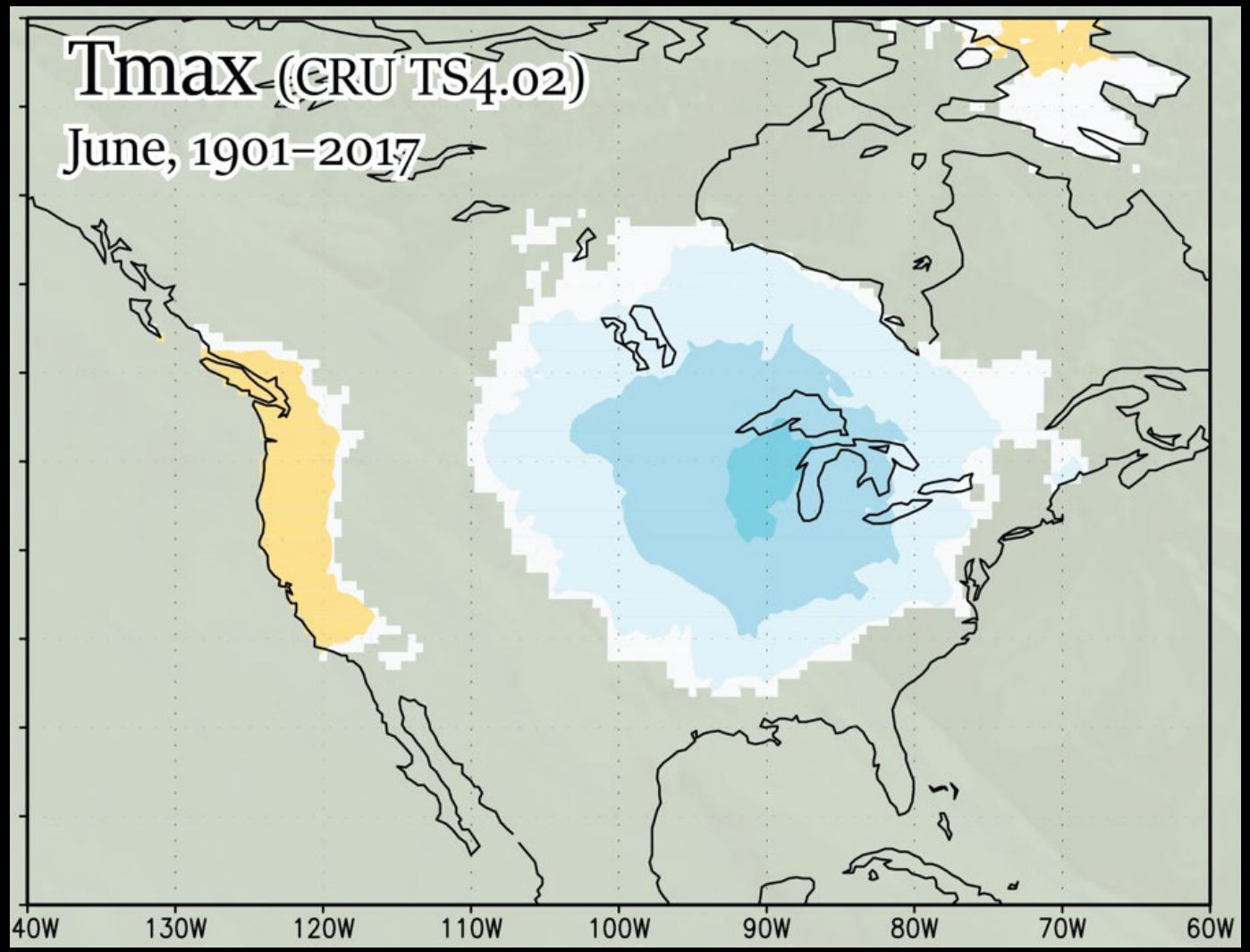
Wisconsin Lake Level Sites

The red triangles on this map represent sites coordinated by the DNR and supported by other agencies, non-profit groups and volunteer monitors. Our volunteers build and maintain staff gages and make weekly lake-level observations to better understand their local lake's behavior. County staff, and others, survey the staff gages each year.

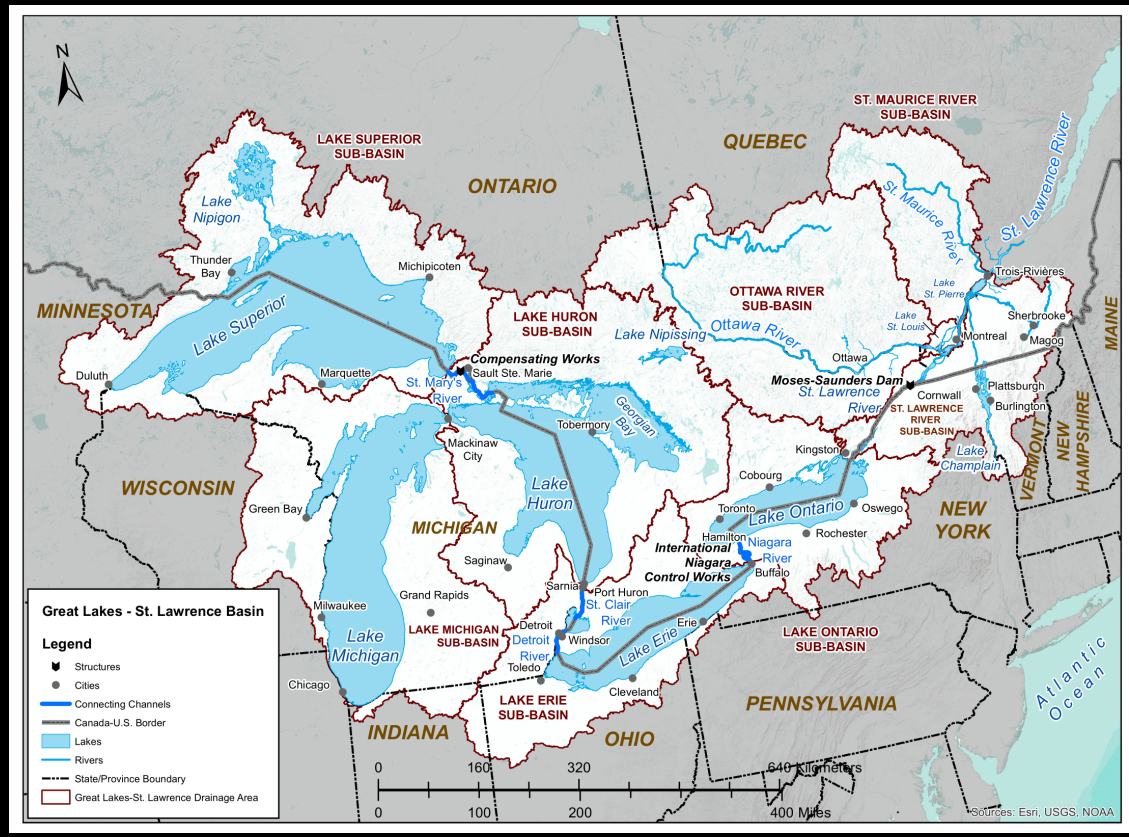
If you'd like to learn more about monitoring lake levels, check out the DNR's Citizen Lake Level Monitoring Program.



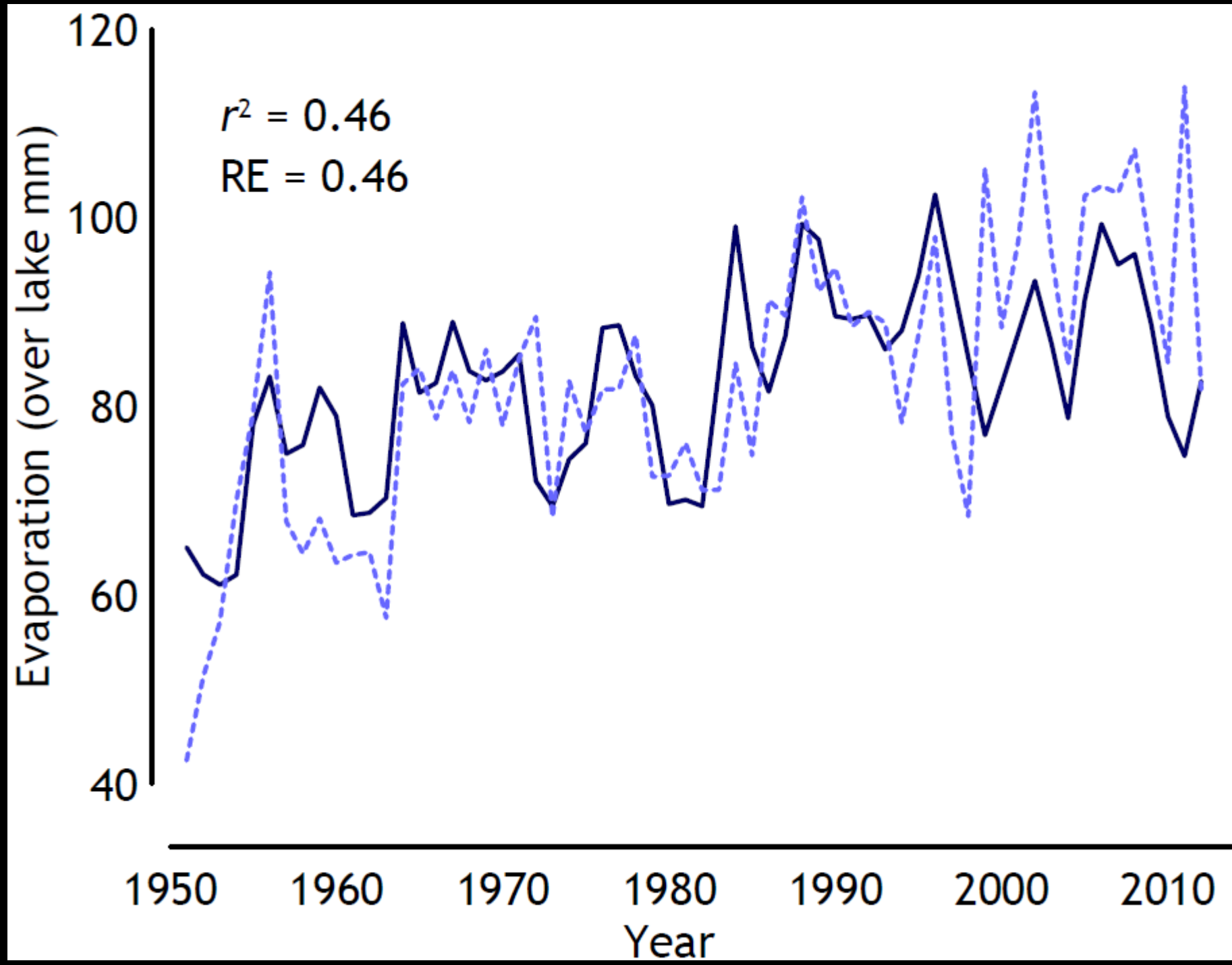
DVL Climate Response



Great Lakes Water Levels



Great Lakes Hemlock Calibration with Lake Superior Evaporation



DROUGHT SUPPLY CHAIN TRANSPORTATION WATER WEATHER

Barges Limited by Low Mississippi River Levels as Farmers Look to Move Crops Downstream

AGROTECHNOIRE — NO COMMENTS · SEPTEMBER 20, 2023 · 1 MIN READ · 712 VIEWS

Heat and dry weather have affected the Mississippi River, forcing barge firms to restrict their loads as Midwest farmers harvest crops and ship tons of grain and soybeans to the Gulf of

TAGS

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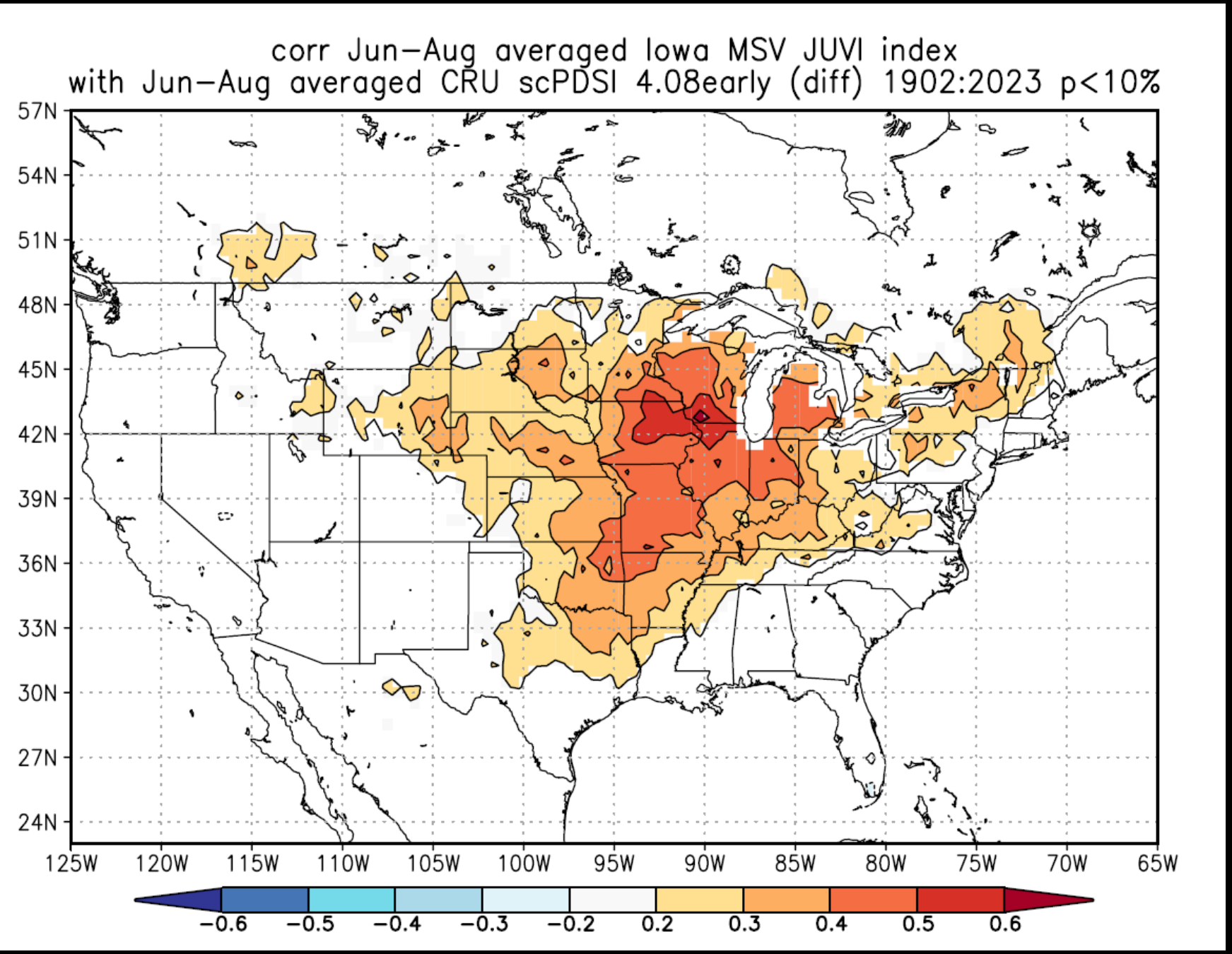
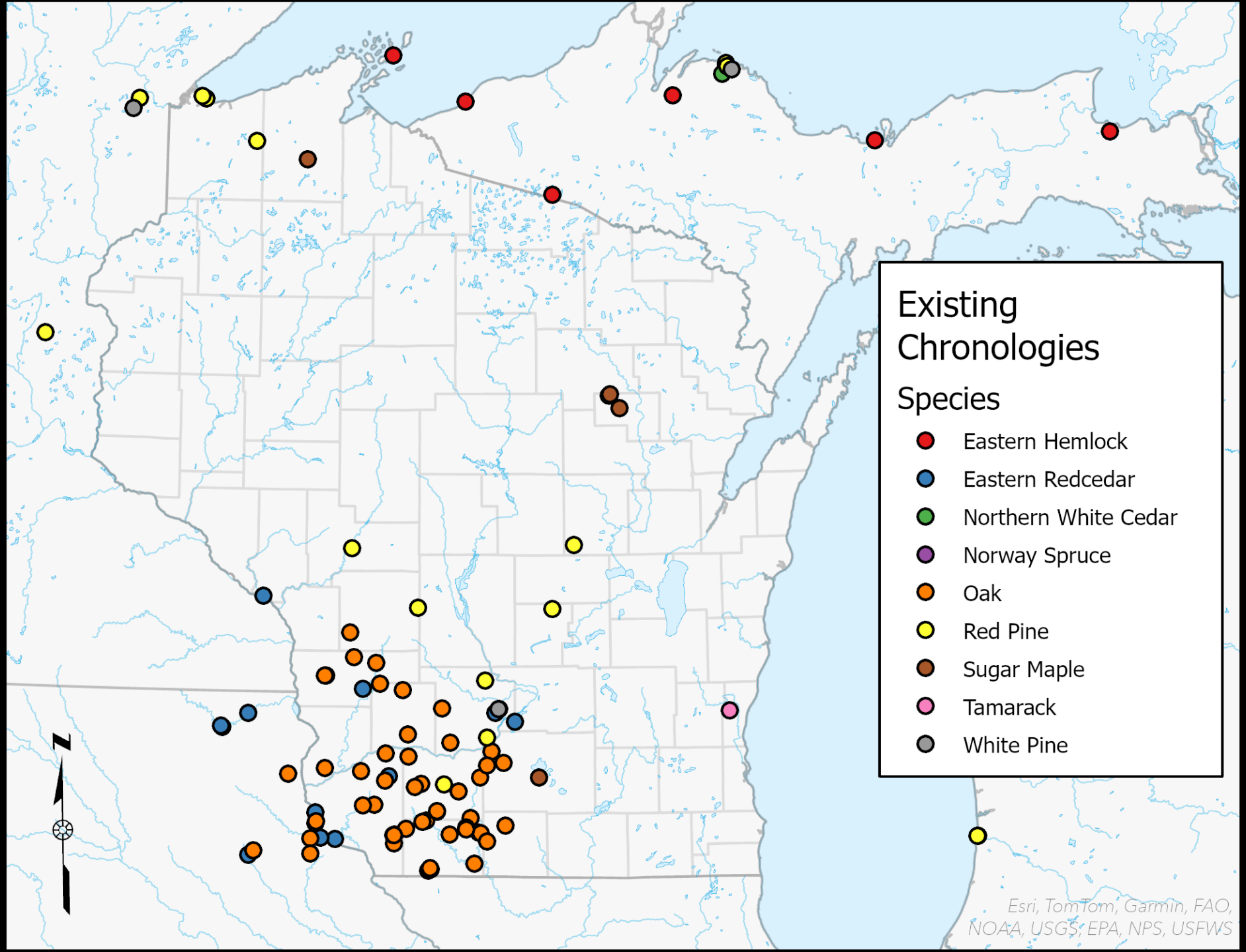
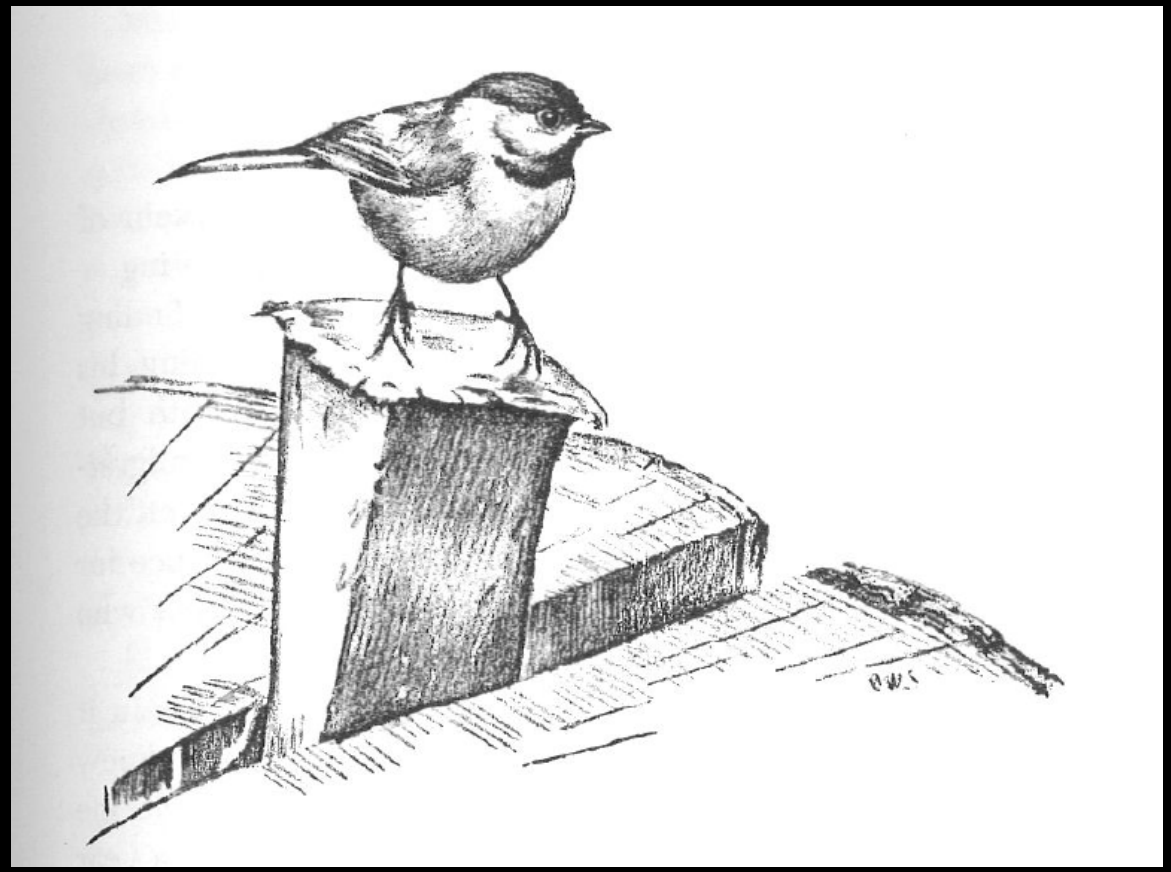


Upper Mississippi Watershed


Existing Chronologies
Species
Eastern Hemlock
Eastern Redcedar
Northern White Cedar
Norway Spruce
Oak
Red Pine
Sugar Maple
Tamarack
White Pine
N
Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NPS, USFWS



"These things I ponder as the kettle sings, and the good oak burns to red coals on white ashes."

~Aldo Leopold, The Good Oak

Thank you for listening

Funding provided by:

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TREE-RING, EARTH, AND ENVIRONMENTAL SCIENCES LABORATORY