

Weather: Past, Present, and Future

Iron Range Resources and Rehabilitation:

Nov 8, 2023



Tower-Sudan State Park: May 20, 2023

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MN State Climatology Office

The DNR State Climatology Office manages, analyzes, and disseminates data and resources related to Minnesota's historical climate conditions to allow users to make informed decisions about future activities.



- Started watching weather at age 9
 - St. Cloud State University
 - Degrees in Meteorology and Broadcasting
- DNR State Climatology Office
 - 25 years
 - Lots of media interviews
 - Weather and History



Catch and Release at Lake Vermilion
Courtesy: Nancy Boulay

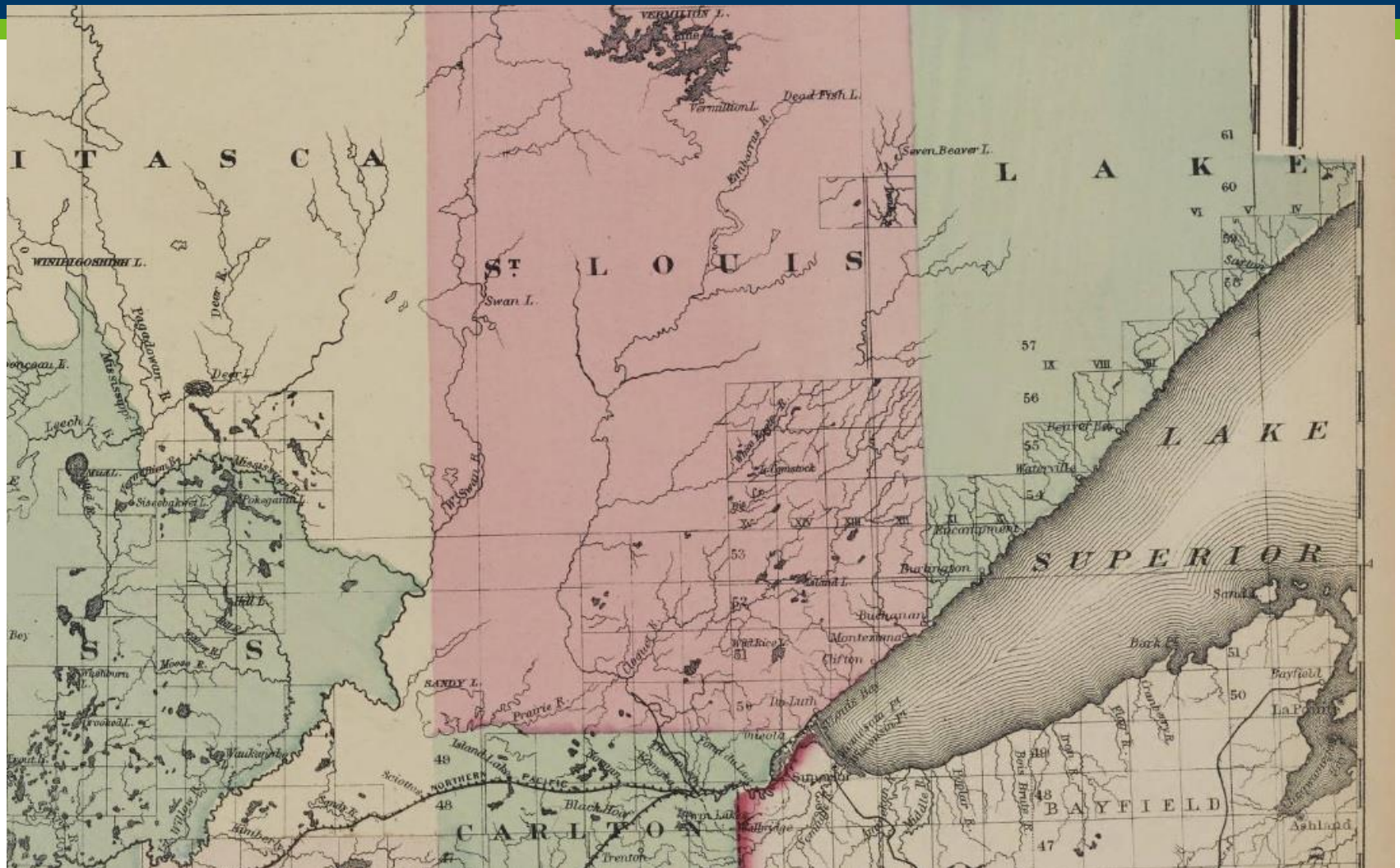
General Information

- A little bit of history.
- Really Wet then Drought.
- Climate Trends.
- Current Conditions.
- What does the future hold?
- Ask questions anytime.



Walleye Chop on Lake
Vermilion: May 18, 2022
Courtesy: Pete Boulay

The Past



Northeast Minnesota in the 1870s

Courtesy: Borchert Map Library, University of Minnesota.

The Past



FIG. 2. VIEW OVER VERMILION LAKE, FROM THE NORTH RIDGE. (p. 522.)

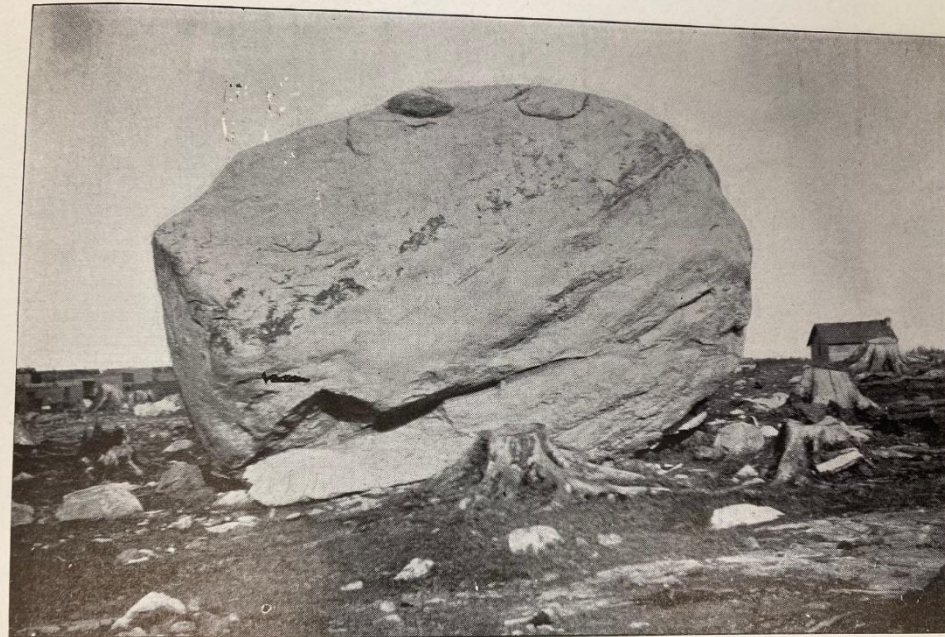


FIG. 2. BOULDER OF GRANITE LYING ON THE AGGLOMERATE AT ELY.

View of Vermilion Lake and a Boulder in Ely: 1890s

Courtesy: Geology Of Minnesota

The Past



FIG. 2. VIEW OVER VERMILION LAKE, FROM THE NORTH RIDGE. (p. 522.)

What's Missing?

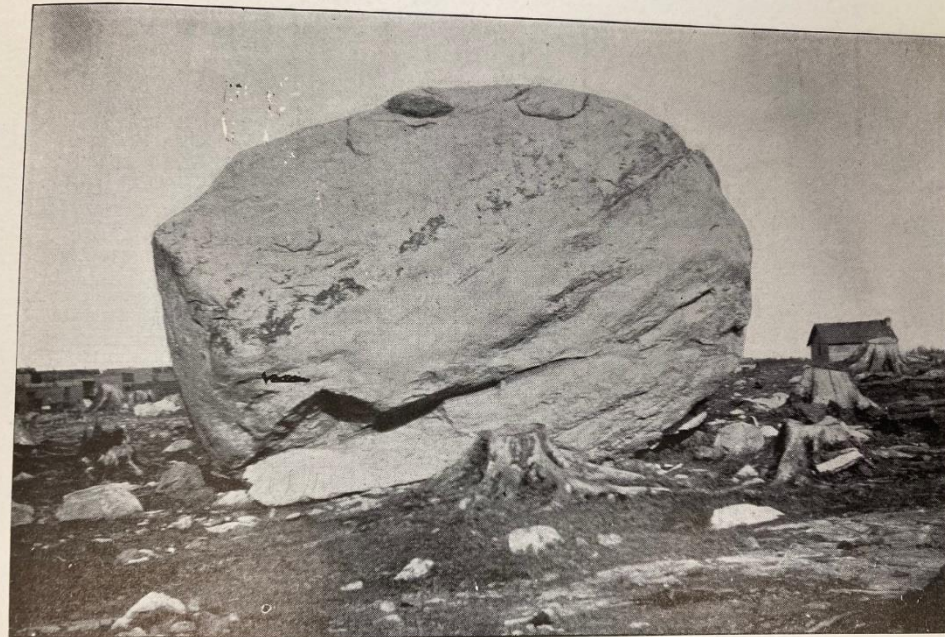


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View of Vermilion Lake and a Boulder in Ely: 1890s

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The Past



FIG. 2. VIEW OVER VERMILION LAKE, FROM THE NORTH RIDGE. (p. 522.)

Trees!

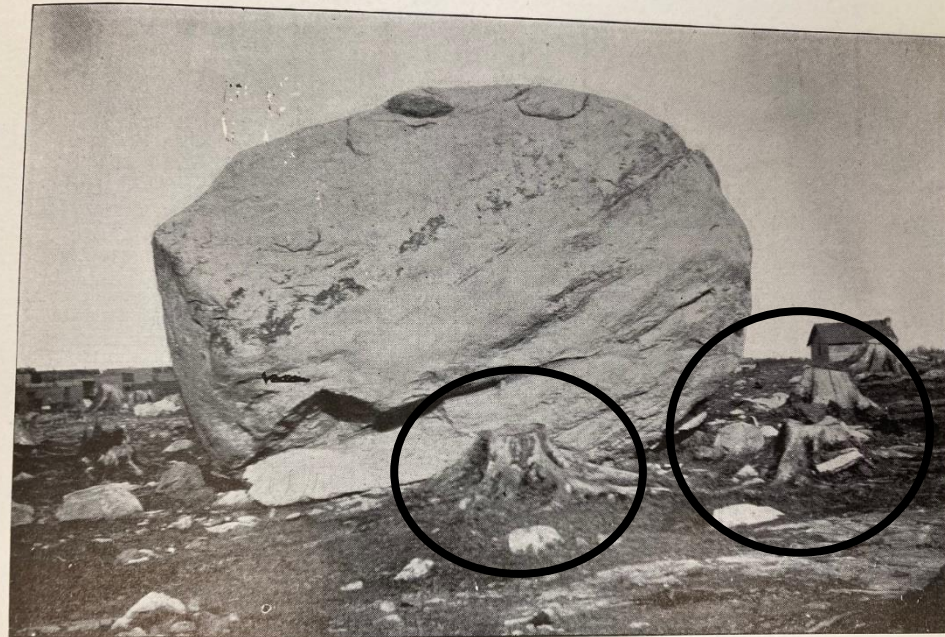


FIG. 2. BOULDER OF GRANITE LYING ON THE AGGLOMERATE AT ELY.

View of Vermilion Lake and a Boulder in Ely: 1890s

Courtesy: Geology Of Minnesota

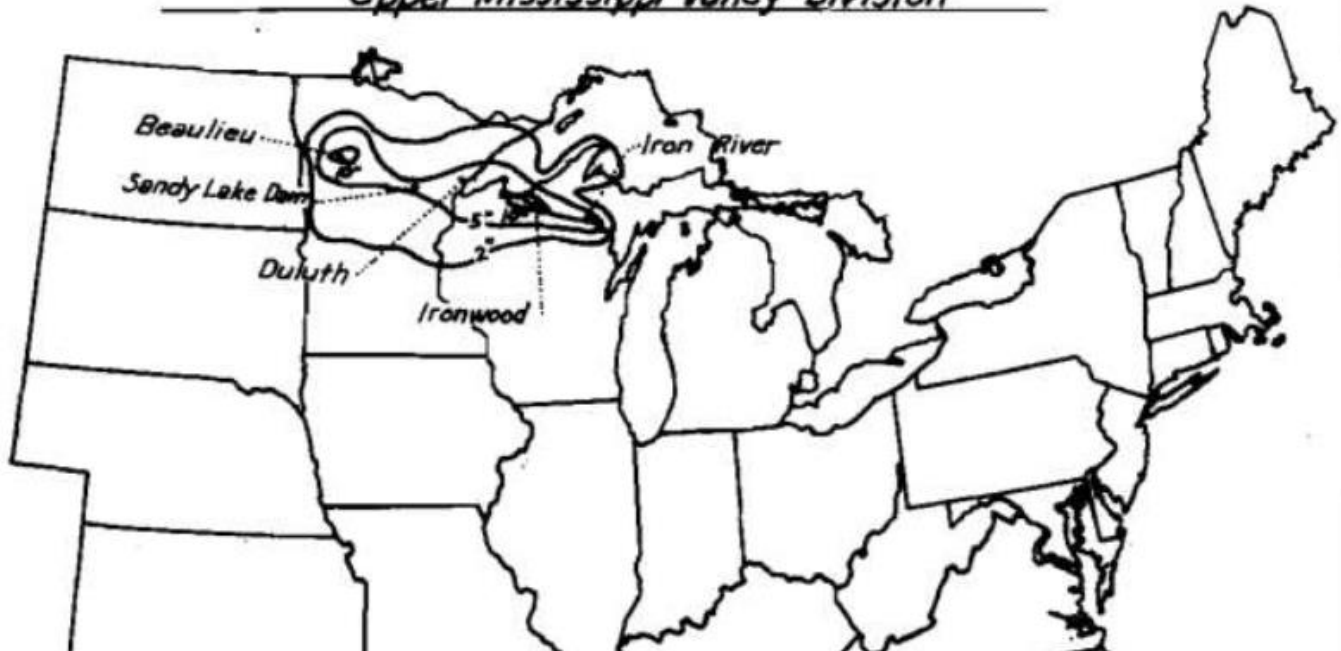
The Past: Flood of July 19-23 1909

DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

STORM STUDIES - ISOHYETAL MAP

Storm of July 18-23, 1909 Assignment UMV 1-11
Study Prepared by St. Paul, Minn. District
Upper Mississippi Valley Division



Highest one day rainfall total was 10.75 inches at Beaulieu in Mahanomen County. This storm also did extensive damage in Duluth and killed two children in the city when they were swept out of their mother's arms."

The Past: Flood of July 19-23 1909



Cleaning up after the Flood in Downtown Duluth

Courtesy: Minnesota Reflections

Storm of September 9-10, 1947



AUTO FLOODED IN IRON RANGE DELUGE—This car was one of scores damaged Tuesday night after a six-hour downpour in Hibbing stranded them in flooded streets. Both train and highway traffic were halted by more than eight inches of rain.

....75 percent of all the basements in Hibbing were flooded (with water and sewage).

Cloudbursts Sweep Over Iron Range

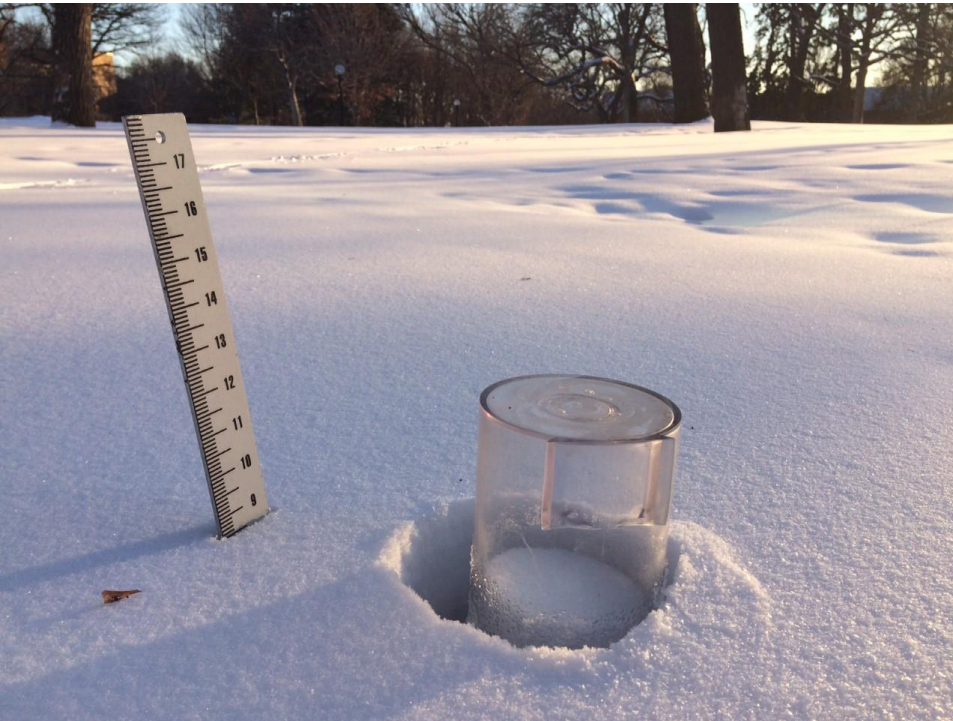
Cloudbursts driven by high winds dumped 8.6 inches of rain across the Minnesota Iron Range overnight, closing mines, flooding houses and severing highway and telephone communications.

Minnesota forest service weather observers said it was the worst electrical and rain storm in 55 years of records in that area. They measured the record rainfall in four hours at Hibbing.

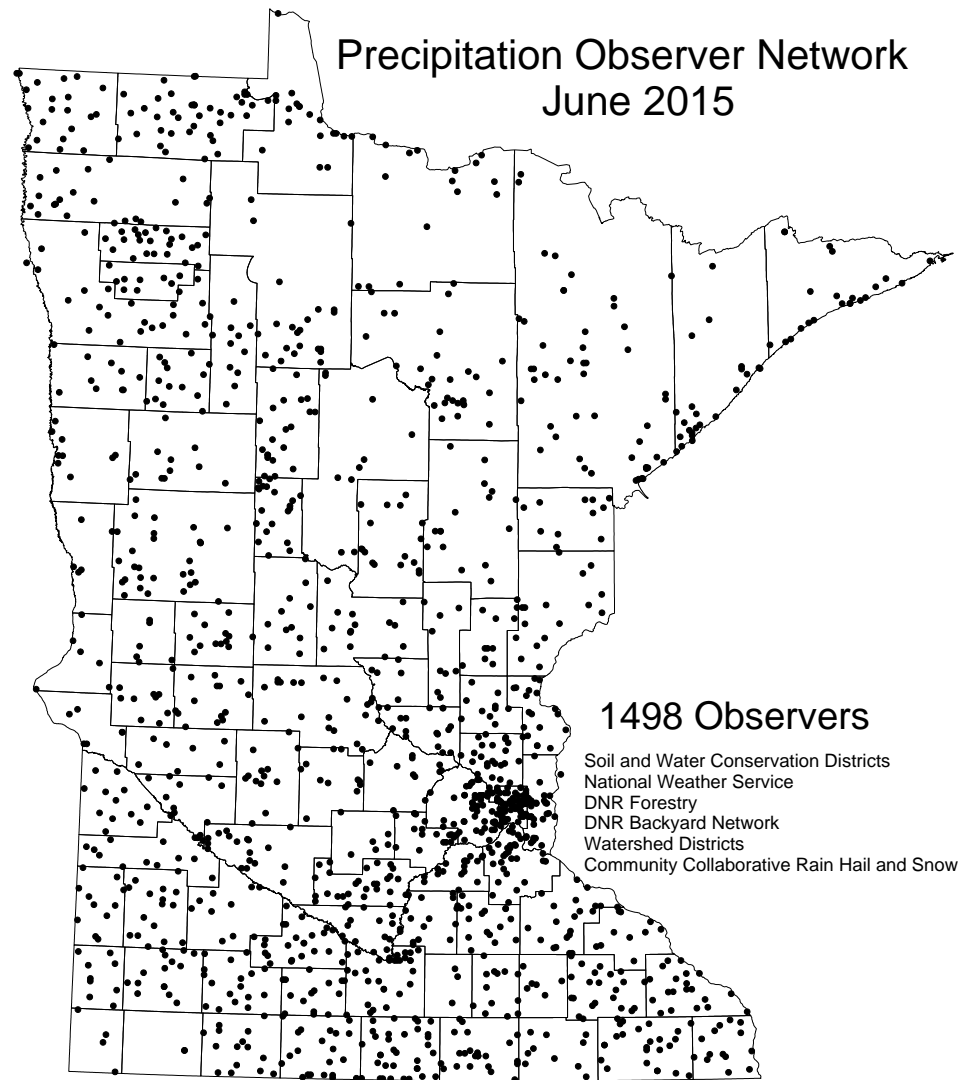
After a sultry day, a huge black cloud appeared at the western end of the storm area.

Residents feared a tornado. Then high winds whipped out ahead of the cloud.

MNgage Volunteer Rain Gage Network

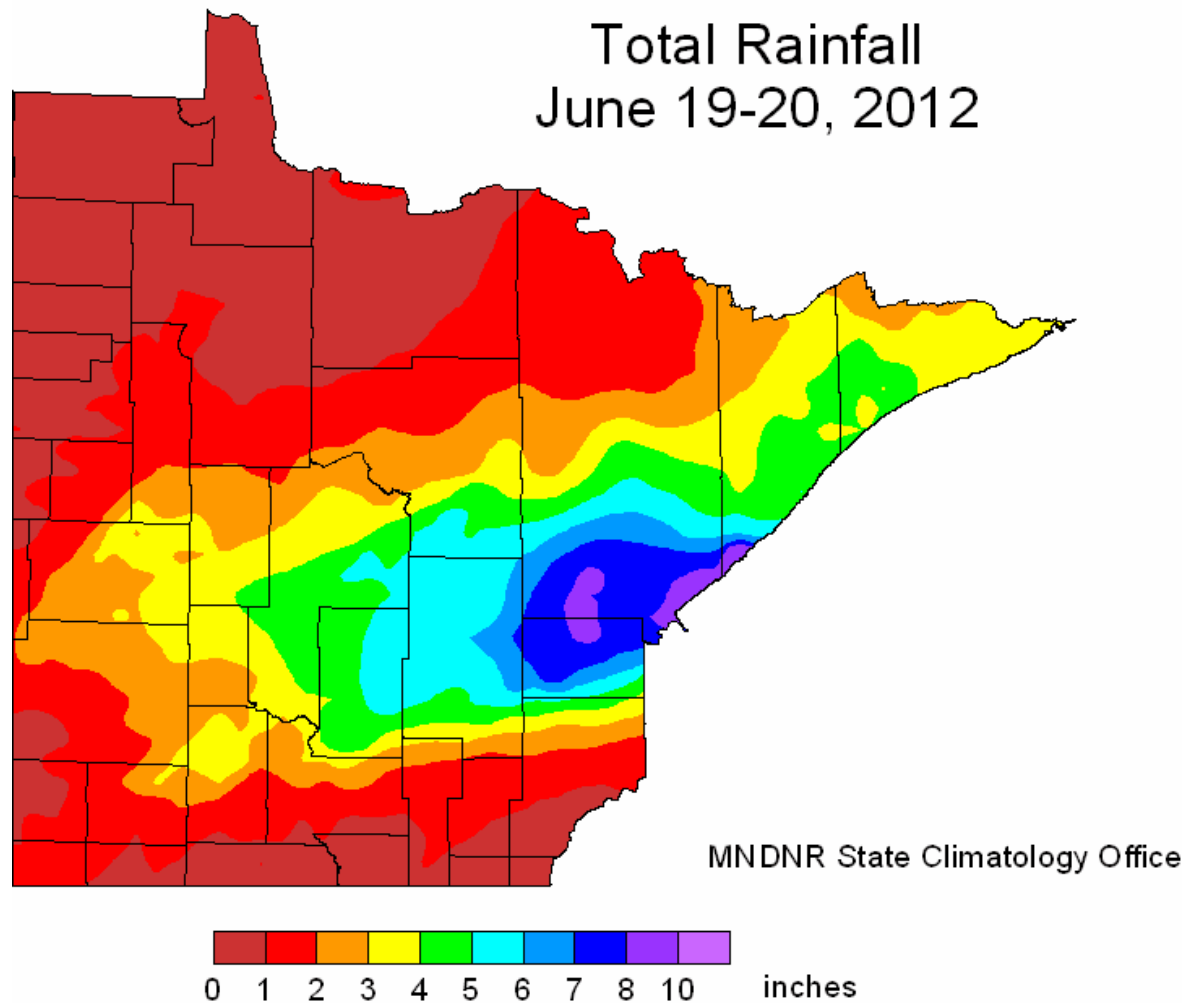


MNgage Volunteer Rain Gage Network

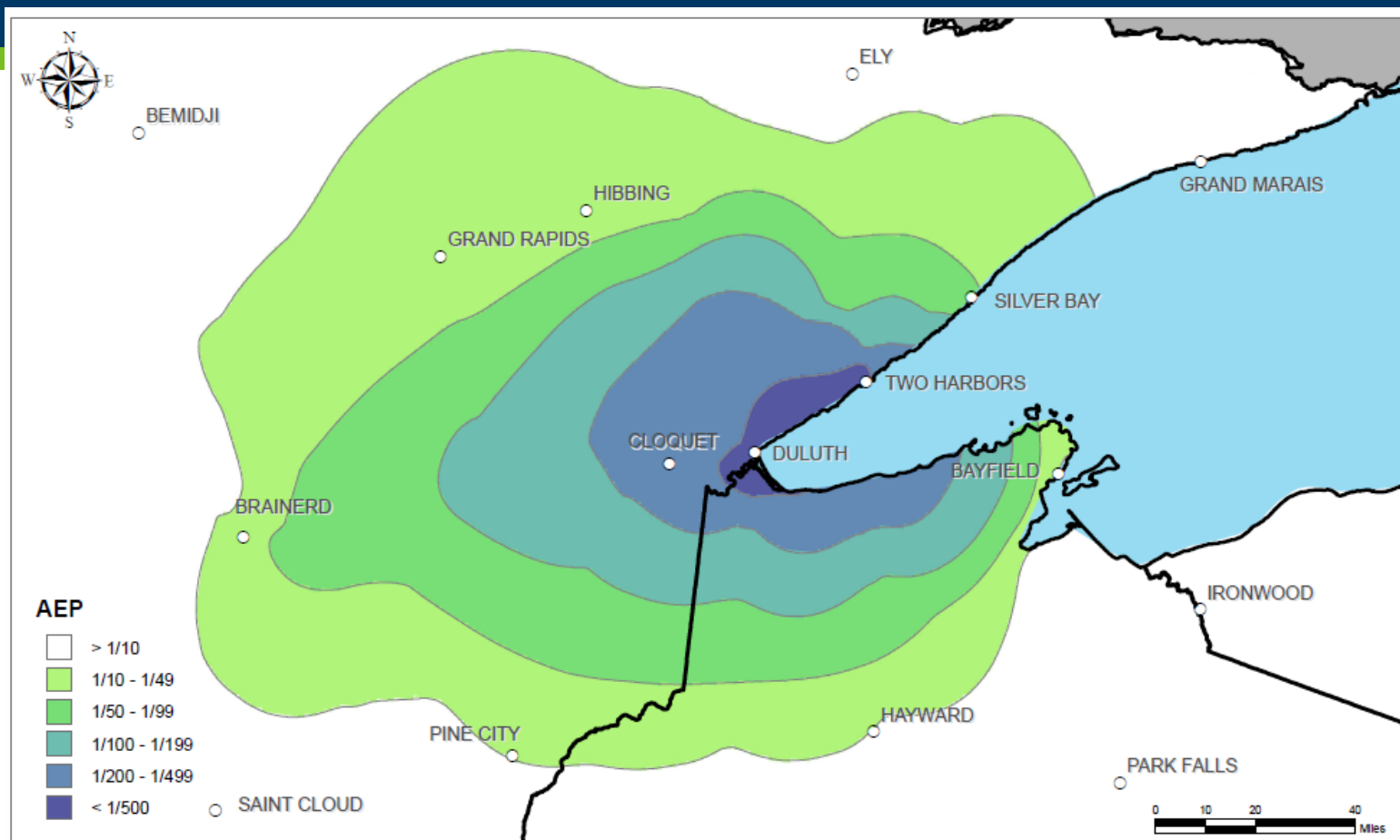


State Climatology Office
DNR Division of Ecological and Water Resources

Flood of June 19-20, 2012



Flood of June 19-20, 2012



Duluth, MN Event, 19-20 June 2012

Annual Exceedance Probabilities (AEPs) for Worst Case 24-hour Rainfall

Hydrometeorological Design Studies Center
Office of Hydrologic Development, National Weather Service
National Oceanic and Atmospheric Administration

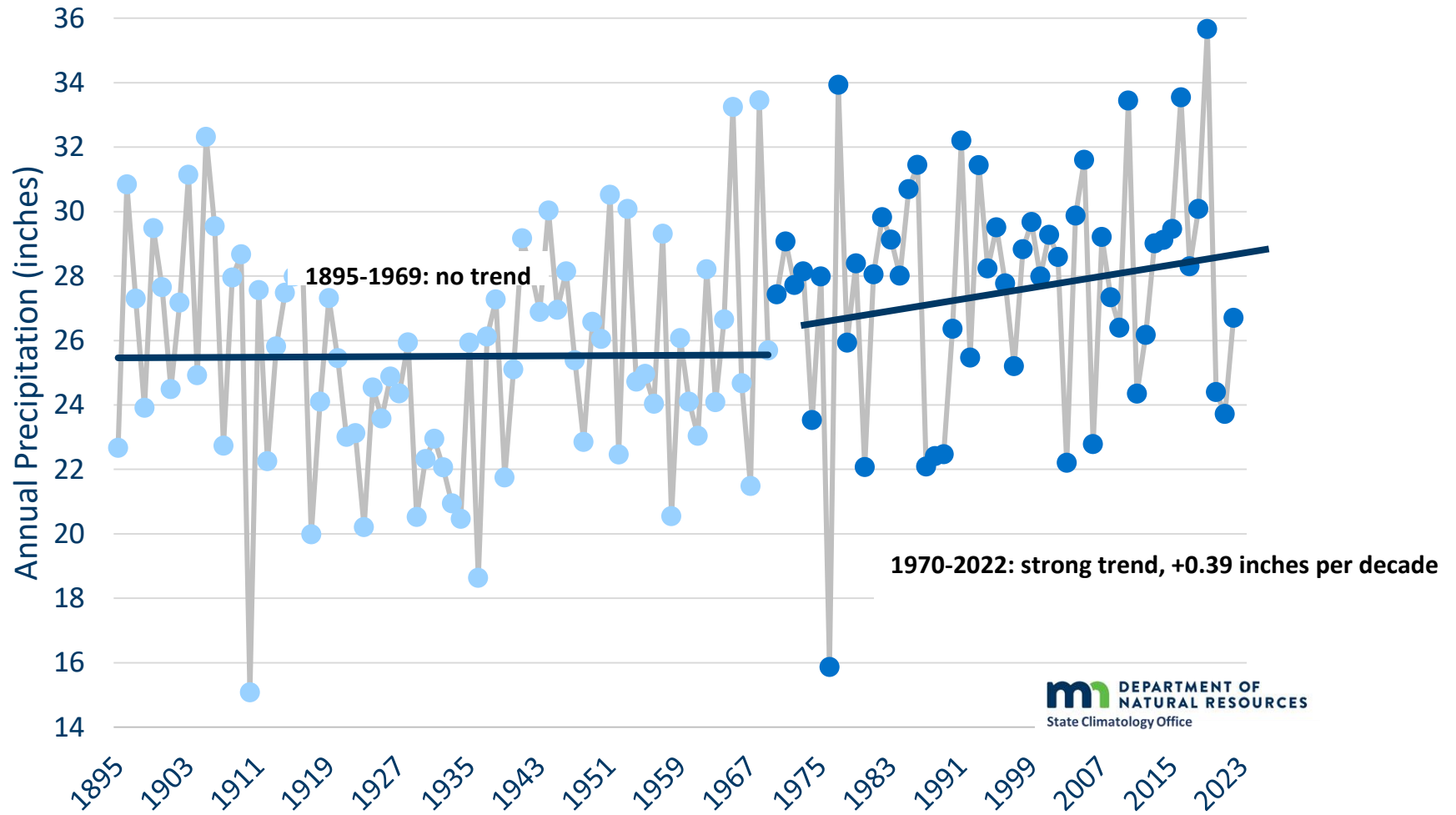
<http://www.nws.noaa.gov/oh/hdsc/>

Map created on 12 July 2012.

Rainfall frequency estimates are from NOAA Atlas 14, Volume 8 Version 1 (to be published in 2013).
Observations come from COOP, CoCoRAHS, and ASOS datasets. Not all data have been verified.

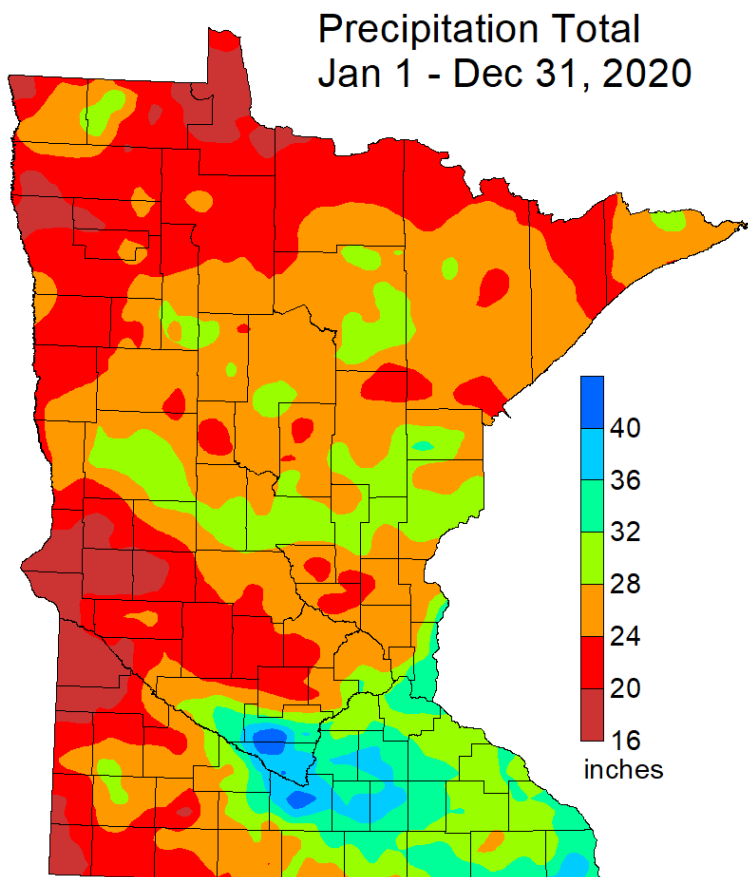


Minnesota Annual Precipitation, 1895-2022

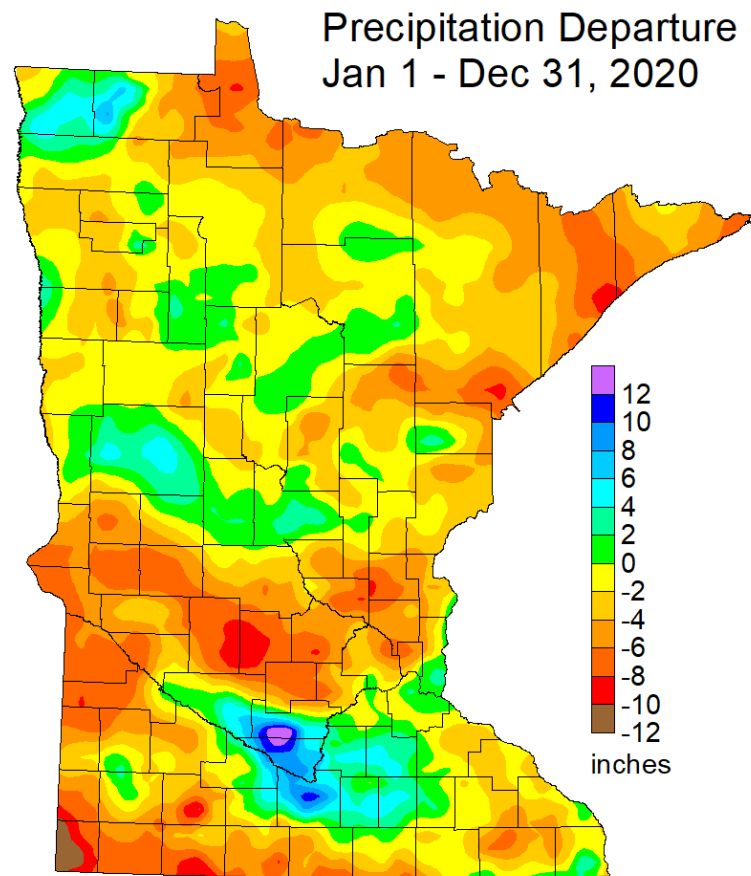


Then it turned dry...

Precipitation in 2020 and Departure from Normal

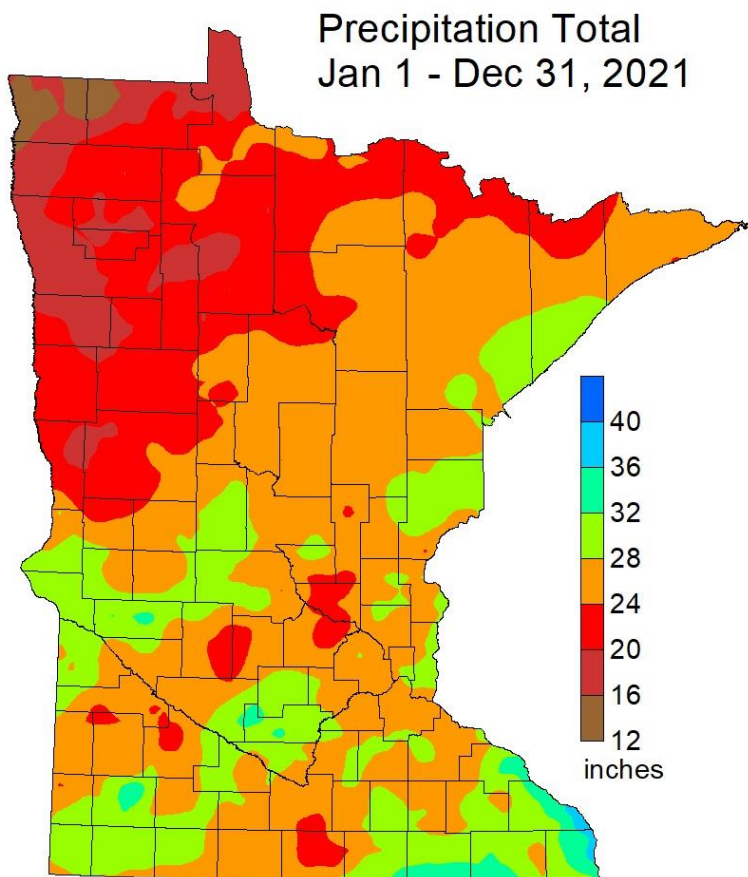


DNR State Climatology Office, March 15, 2021

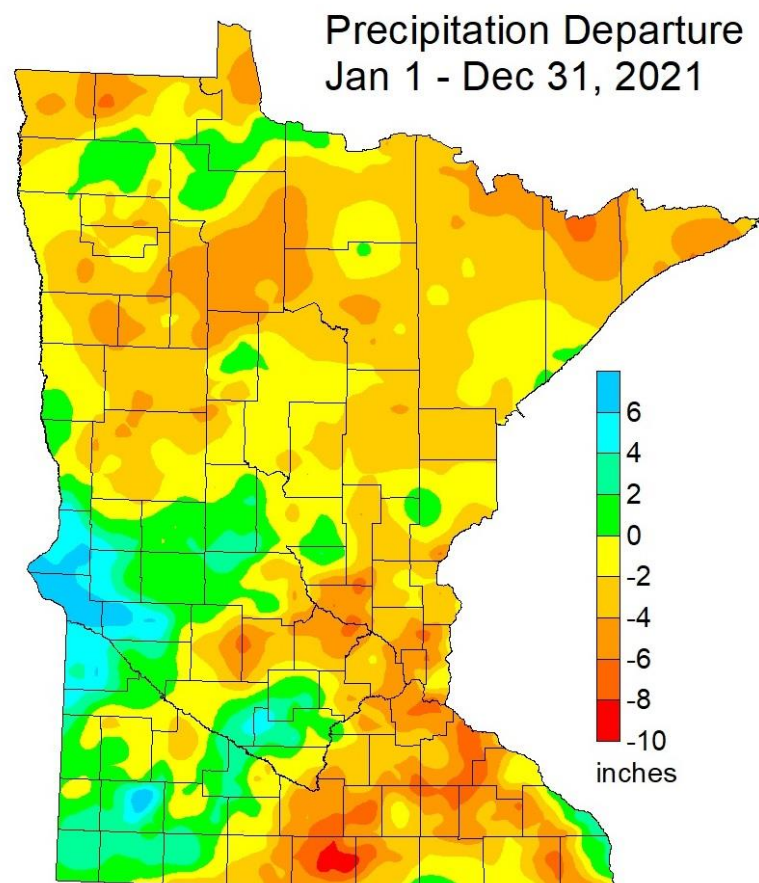


DNR State Climatology Office - March 15, 2021

Precipitation in 2021 and Departure from Normal



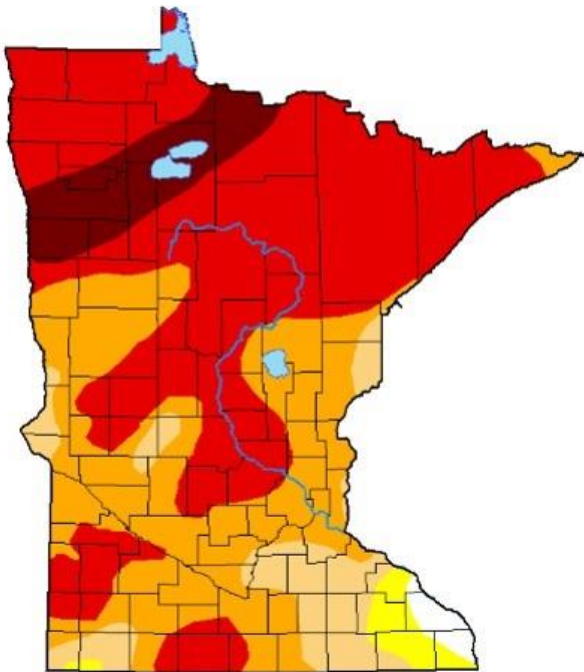
DNR State Climatology Office, January 12, 2022



DNR State Climatology Office - January 12, 2022

The 2021 Drought

U.S. Drought Monitor Minnesota



August 24, 2021
(Released Thursday, Aug. 26, 2021)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	1.15	98.85	96.58	87.63	57.65	8.07
Last Week 08-17-2021	1.15	98.85	96.56	88.29	49.77	8.07
3 Months Ago 05-25-2021	26.79	73.21	13.42	0.18	0.00	0.00
Start of Calendar Year 12-28-2020	1.60	98.40	23.40	0.28	0.00	0.00
Start of Water Year 09-29-2020	54.95	45.05	8.39	0.00	0.00	0.00
One Year Ago 08-25-2020	68.89	31.11	12.23	0.00	0.00	0.00

Intensity

None	D2 Severe Drought
D0 Abnormally Dry	D3 Extreme Drought
D1 Moderate Drought	D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author

Curtis Riganti
National Drought Mitigation Center



droughtmonitor.unl.edu

The peak of the 2021 Drought was August.



Pelican Rapids, above the
dam: August 17, 2021
Kenny Blumenfeld

Then... Spring 2022: Flood!

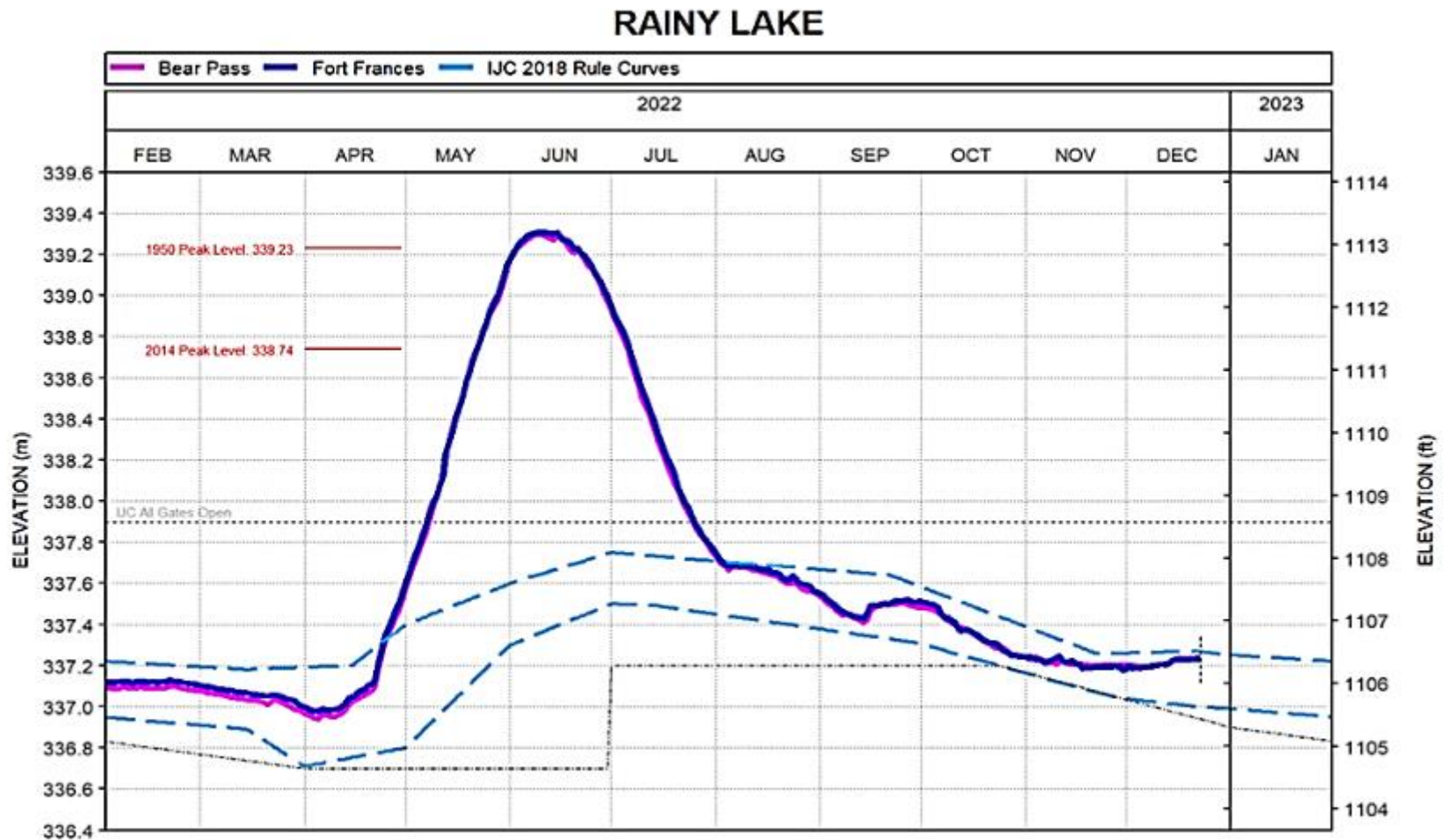
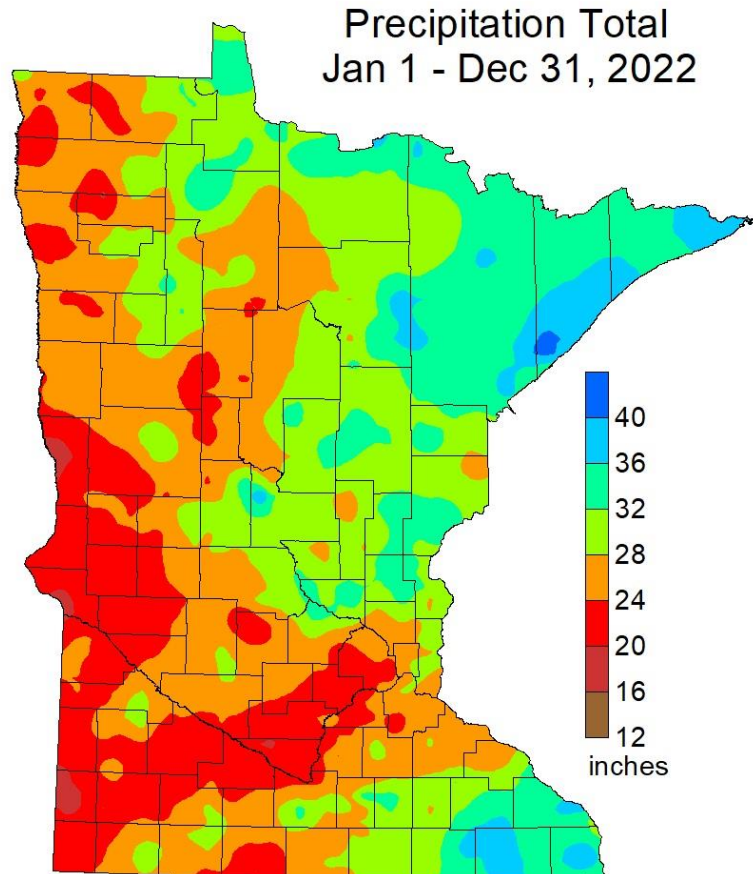
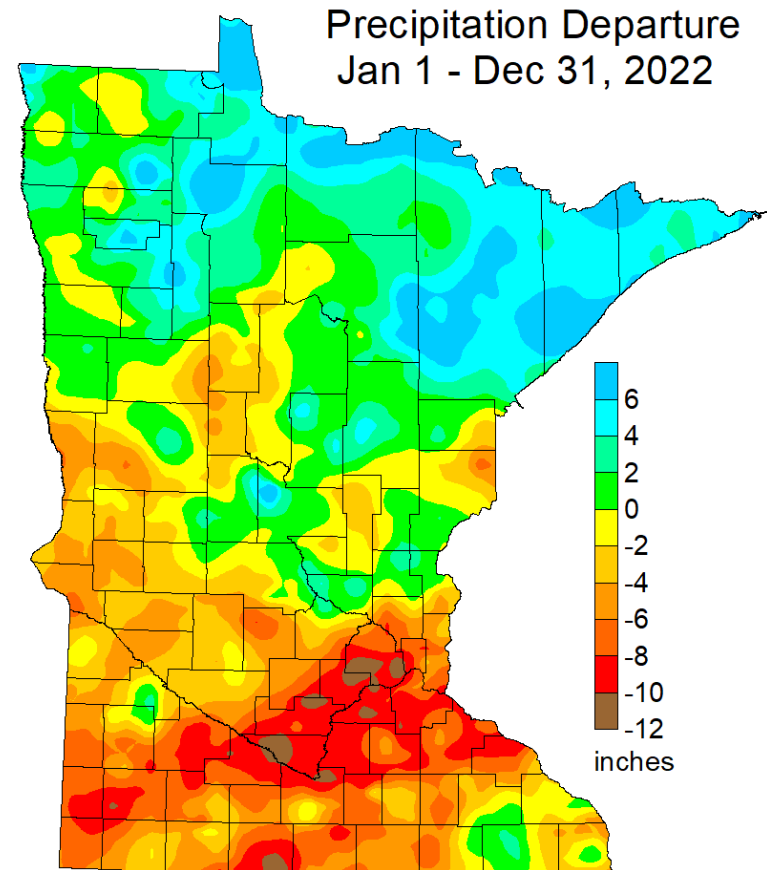


Figure 9. Rainy Lake levels in 2022 with 1950 and 2014 peak levels marked for comparison (LWCB)

2022: Flood in North, Drought in South.



MNDNR State Climatology Office

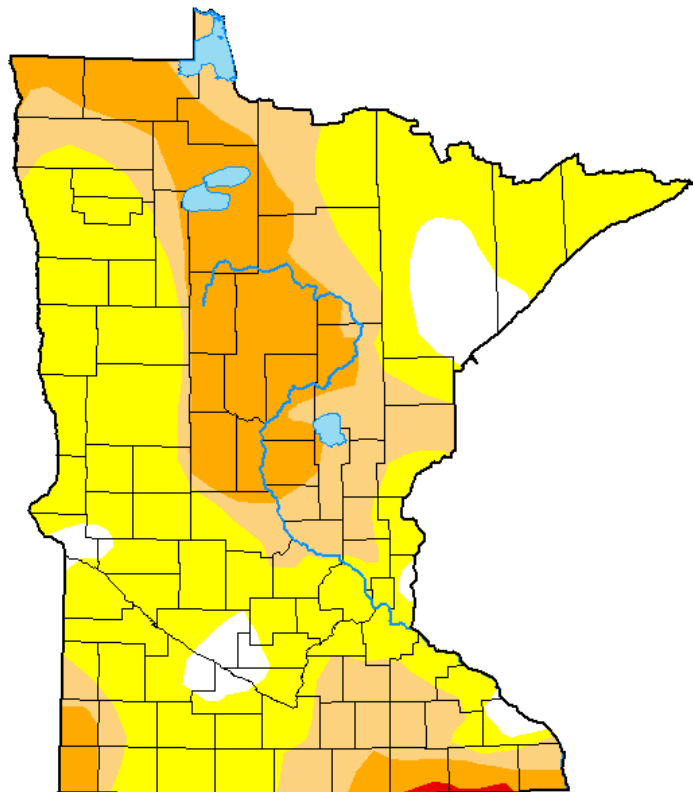


MNDNR State Climatology Office

The 2023 Drought (Currently)

U.S. Drought Monitor **Minnesota**

October 31, 2023
(Released Thursday, Nov. 2, 2023)
Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>

Author:

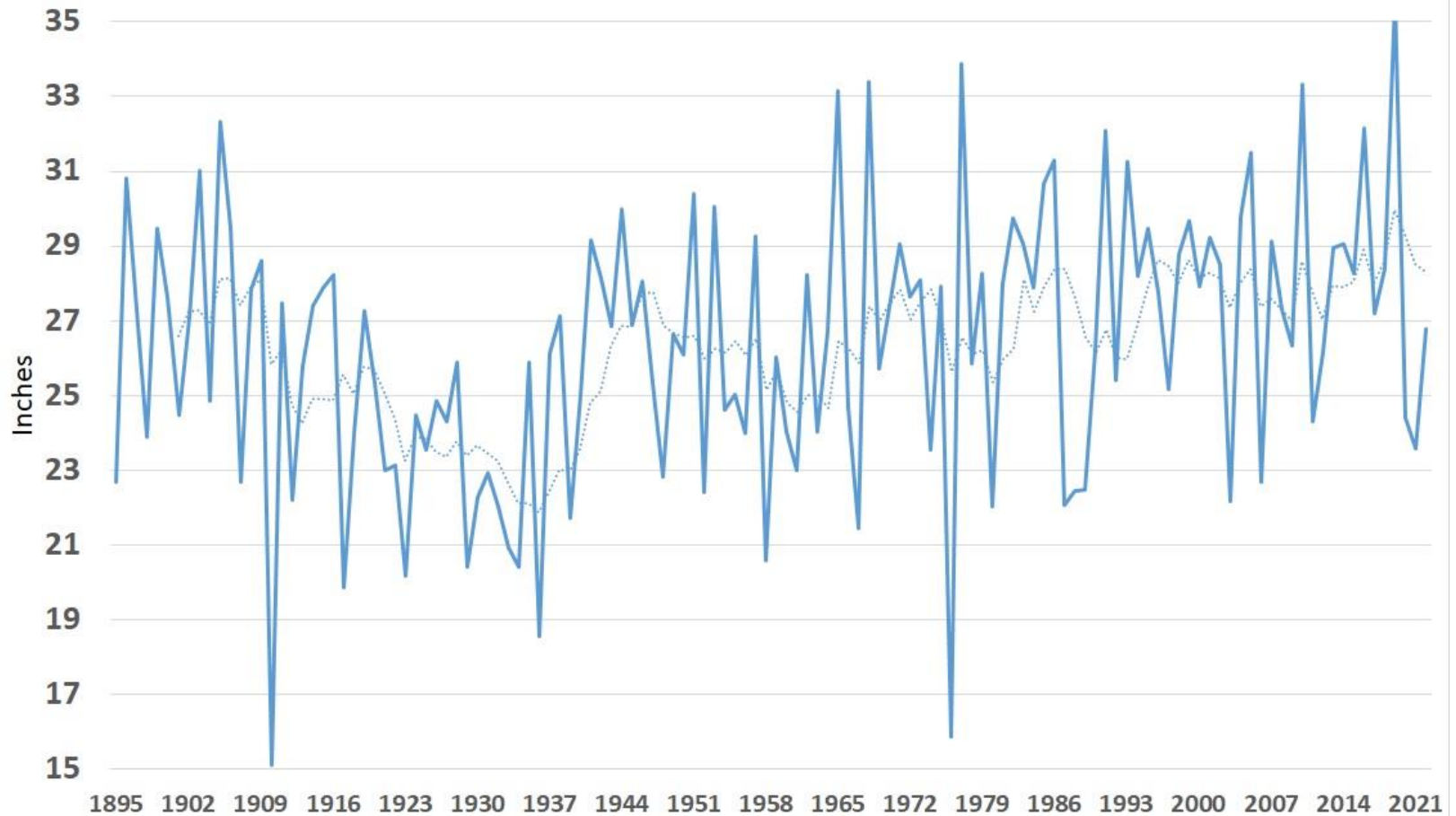
Brian Fuchs
National Drought Mitigation Center



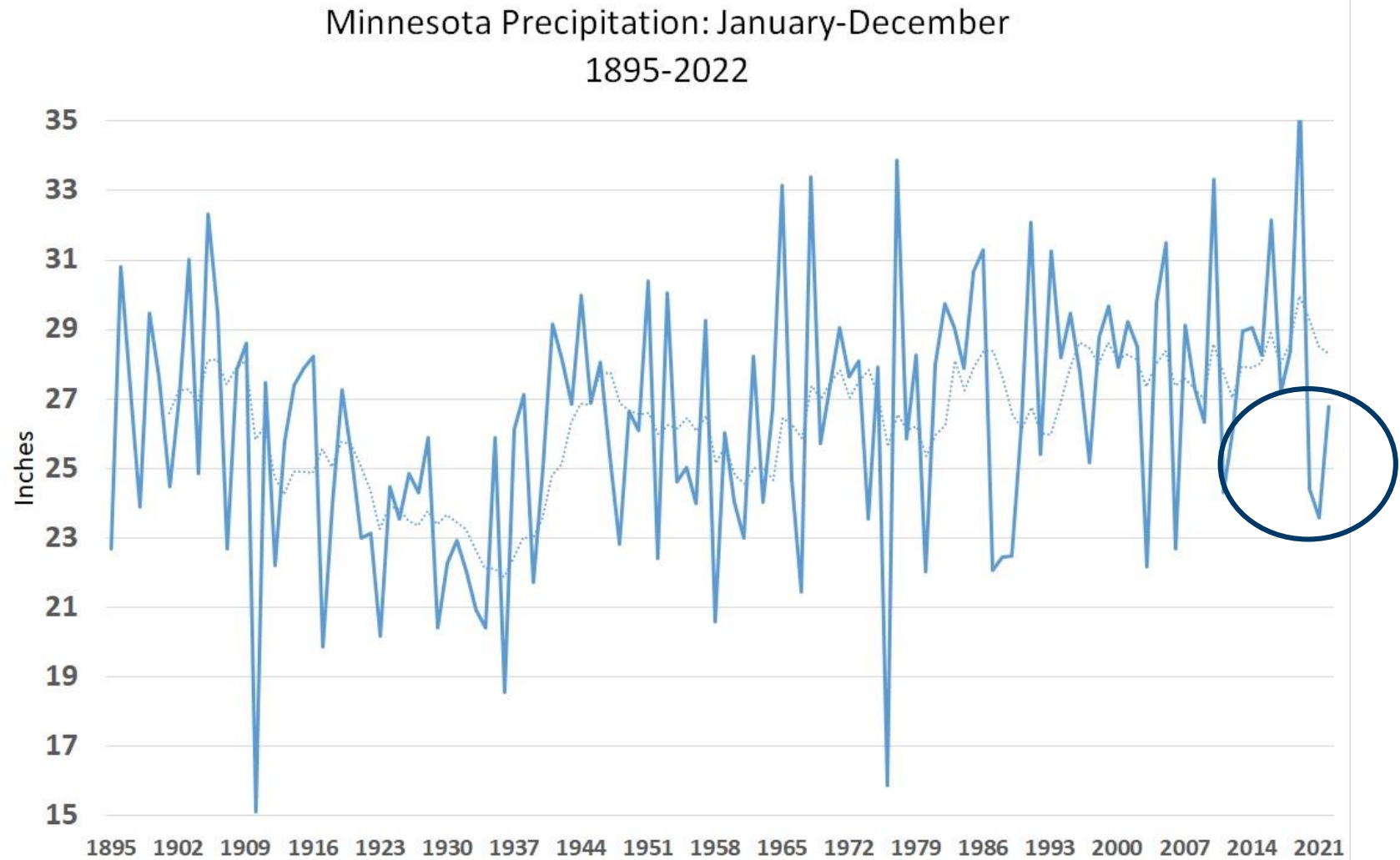
droughtmonitor.unl.edu

The “wettest” of the droughts?

Minnesota Precipitation: January-December
1895-2022



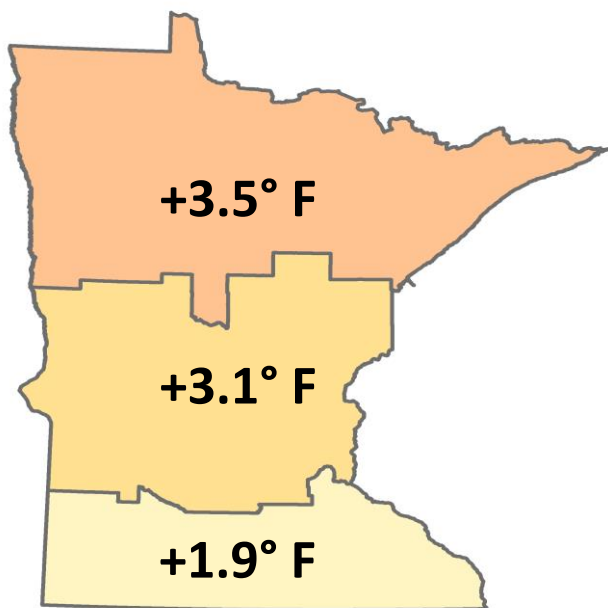
The “wettest” of the droughts?



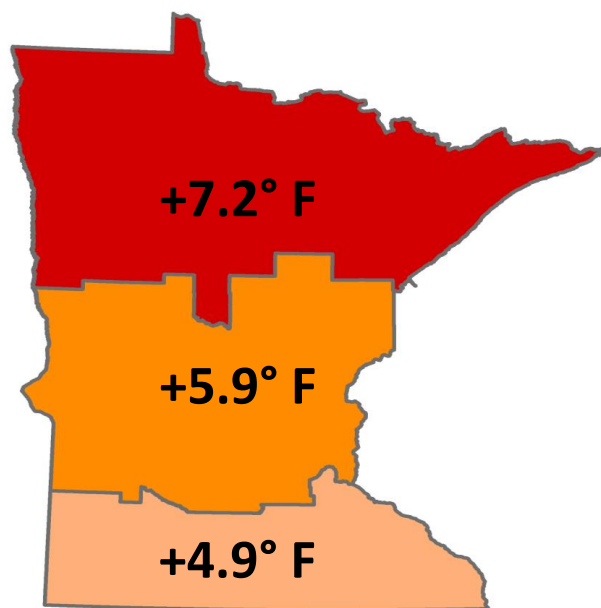
Faster Warming in Winter, at Night, and With Northward Extent

Total temperature change since 1895

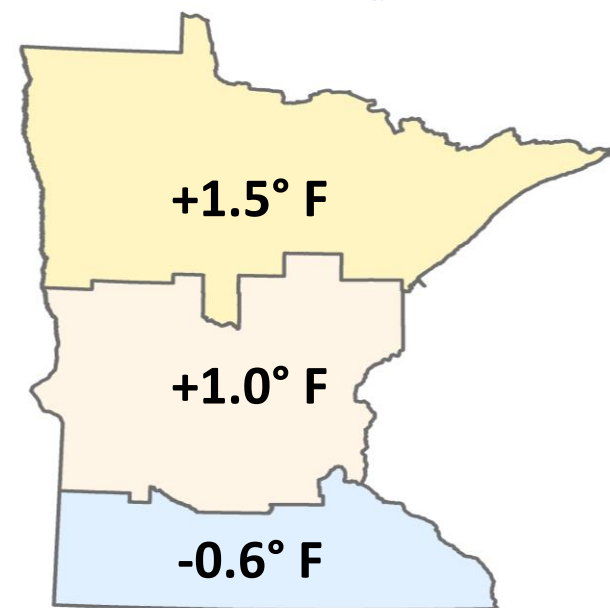
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State Climatology Office



Annual Average
(through 2022)

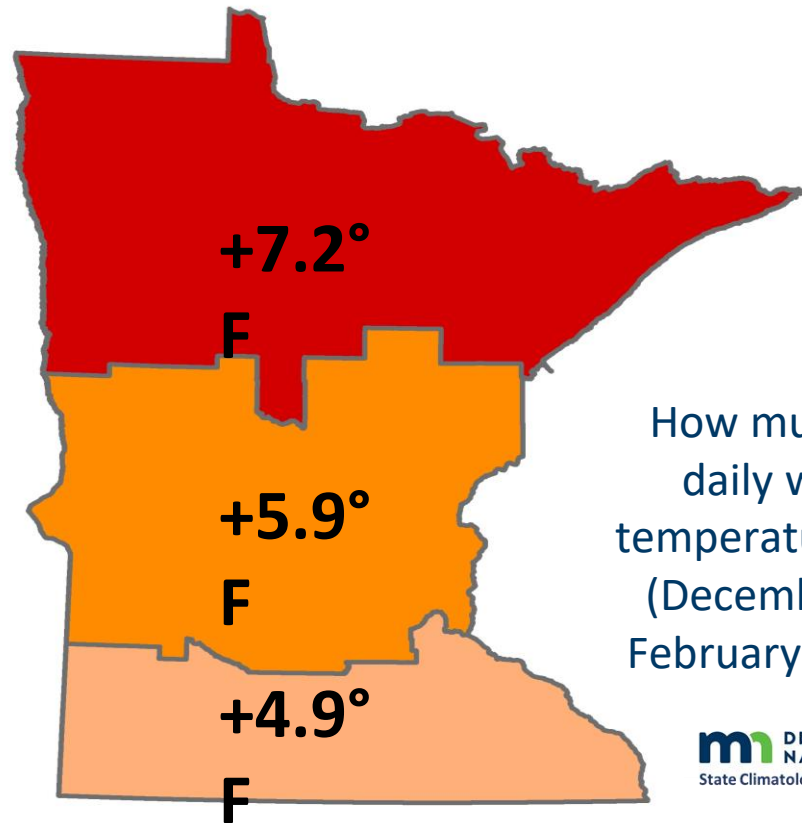


December -
February Lows
(through 2023)



June - August Highs
(through 2022)

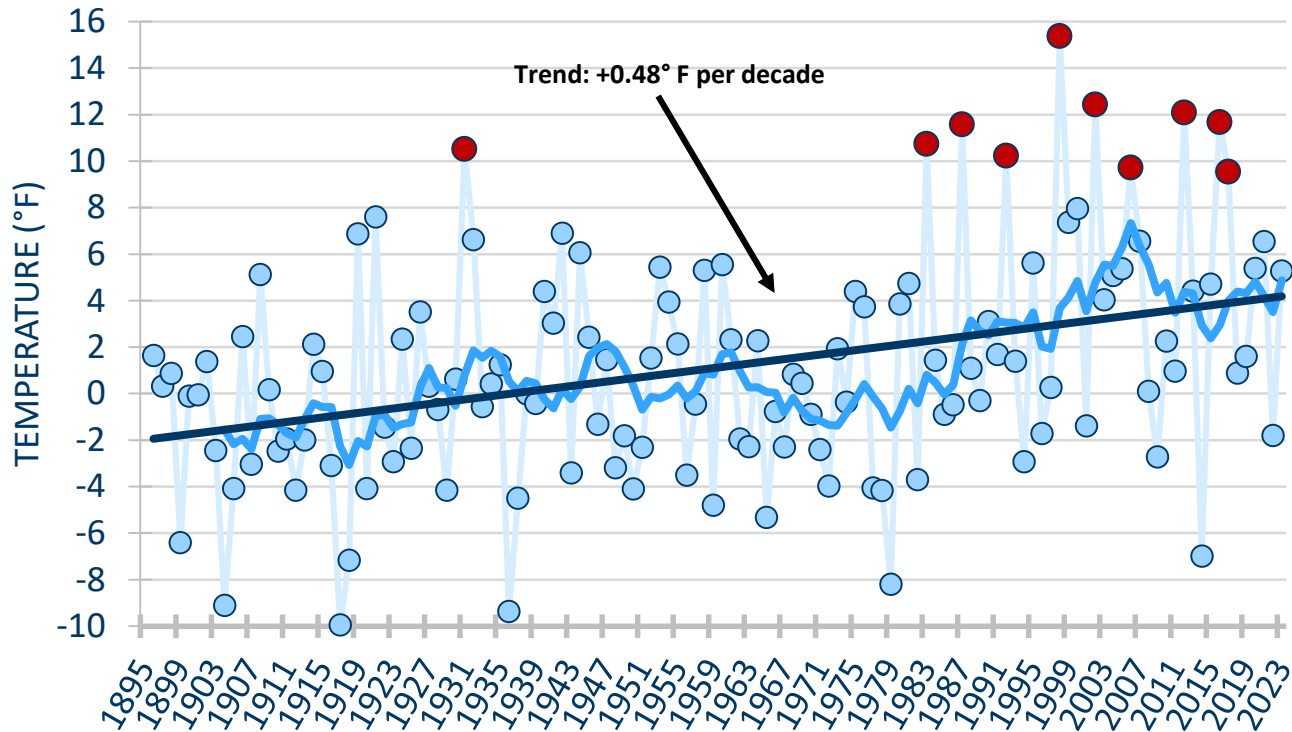
Average Daily Low Temperatures: 1895-2023



How much average
daily winter low
temperatures changed
(December through
February), 1895-2023

Minnesota Average Winter Daily Minimum Temperatures (December through February, 1896-2022)

m DEPARTMENT OF
NATURAL RESOURCES
State Climatology Office



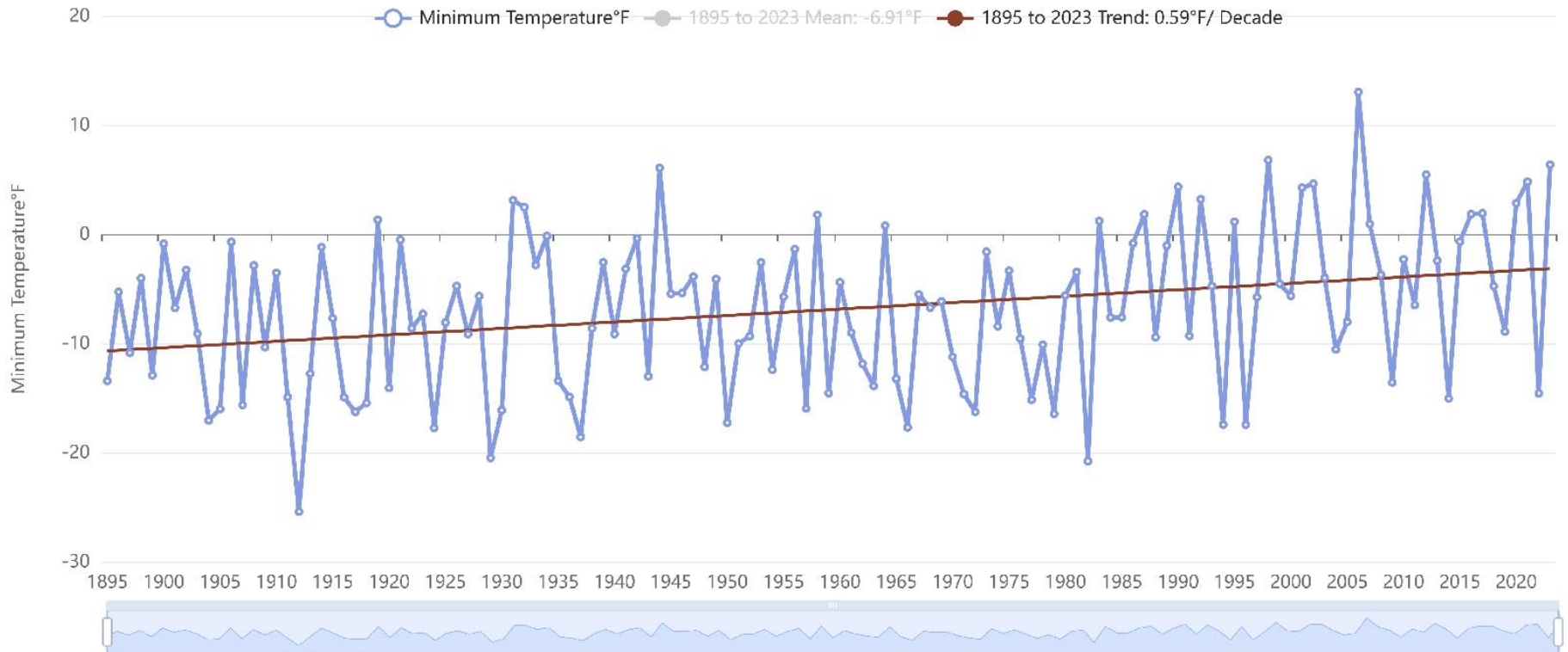
All data from NOAA and accessed as state-averaged values via Minnesota Climate Explorer
<https://arcgis.dnr.state.mn.us/ewr/climateexplorer/main/historical>

Loss of Extreme Winter Cold



Minimum Temperature For St. Louis; January

All graphs generated by Minnesota Department of Natural Resources, using temperature and precipitation data from NOAA.



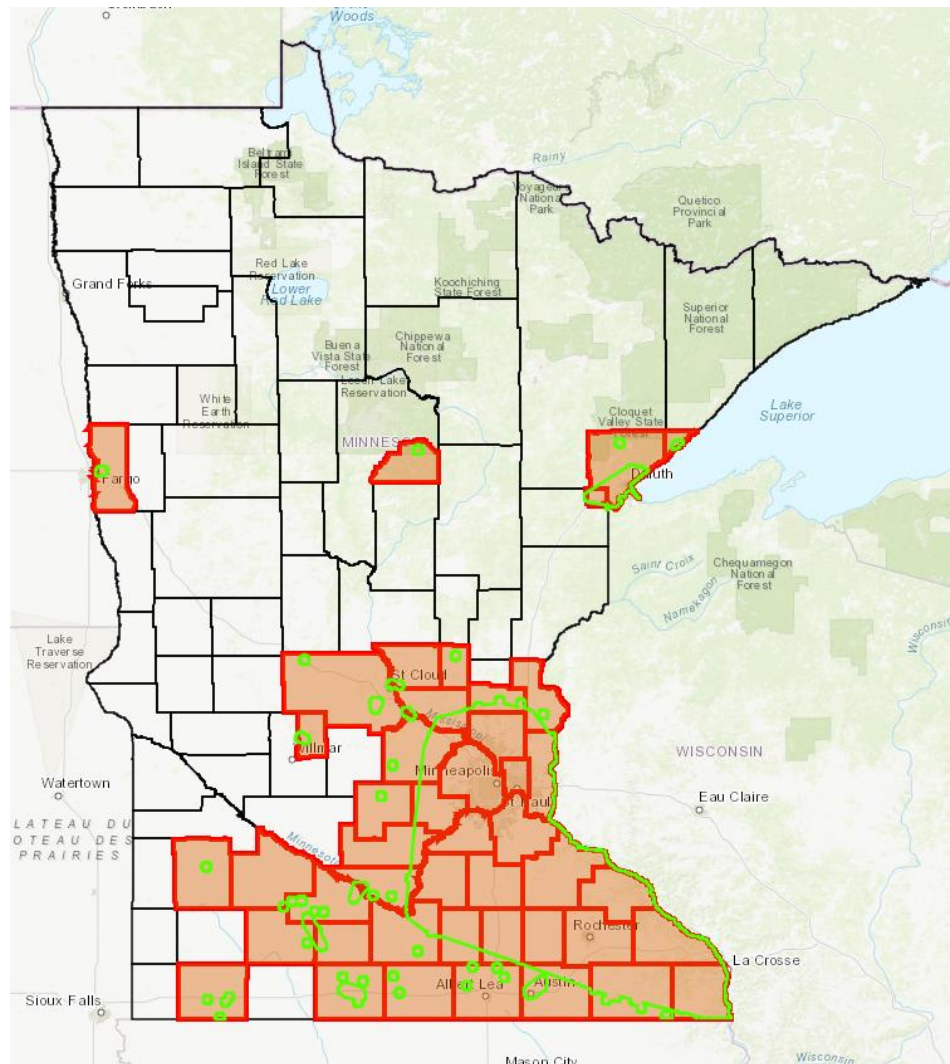
Trend of January Minimum Temperatures for St. Louis County.

From MNDNR Climate Explorer <https://arcgis.dnr.state.mn.us/climateexplorer/main/historical>

Loss of Extreme Winter Cold

Emerald Ash Borer arrived in St. Paul in 2009 and Duluth in 2015. Greatly aided by human transport.

Map of Emerald Ash Borer Status
courtesy MN Department of Ag



Loss of Extreme Winter Cold



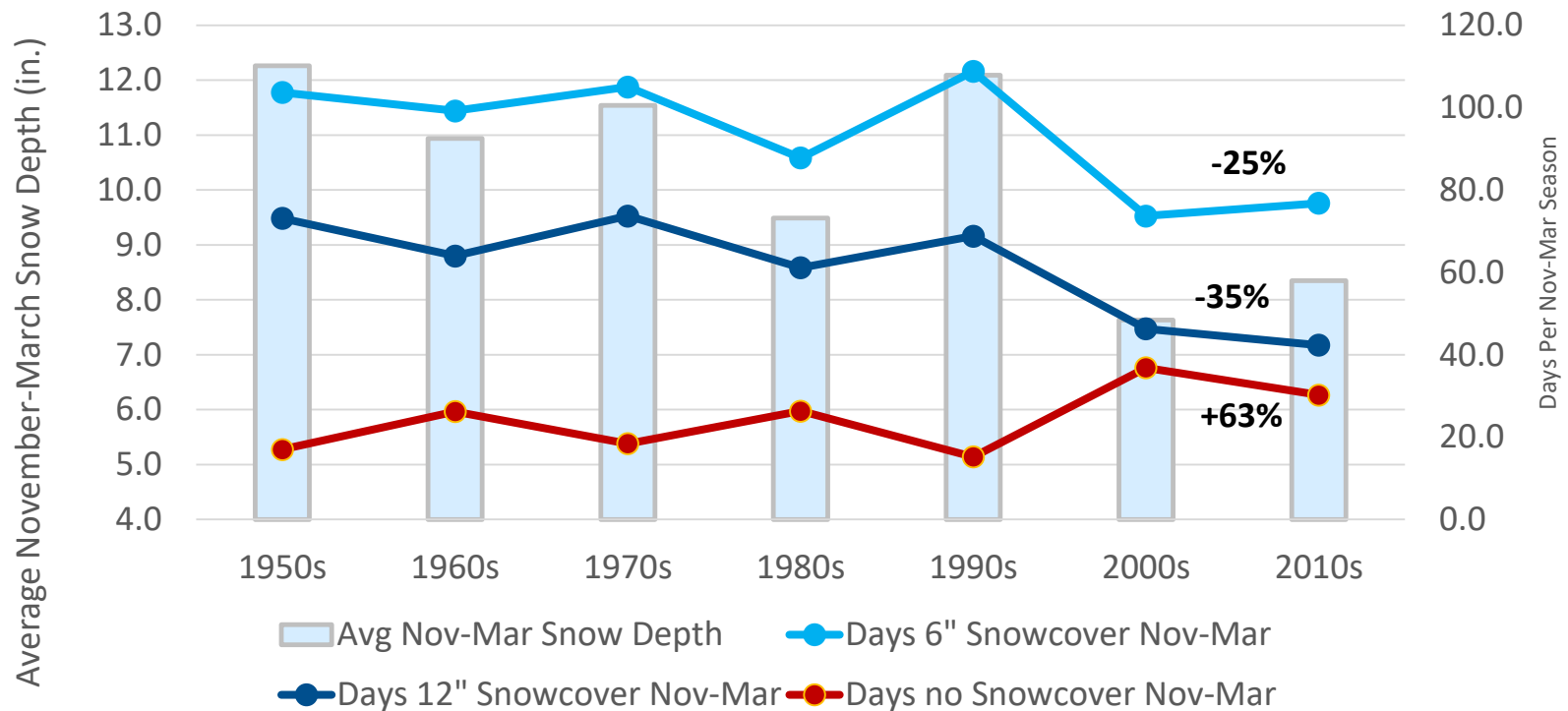
How cold is too cold for Emerald ash borer?



Five percent of EAB larvae should die when temperatures reach 0°F, 34 percent at -10°F, 79 percent at -20°F, and 98 percent ***should*** die at -30° F.

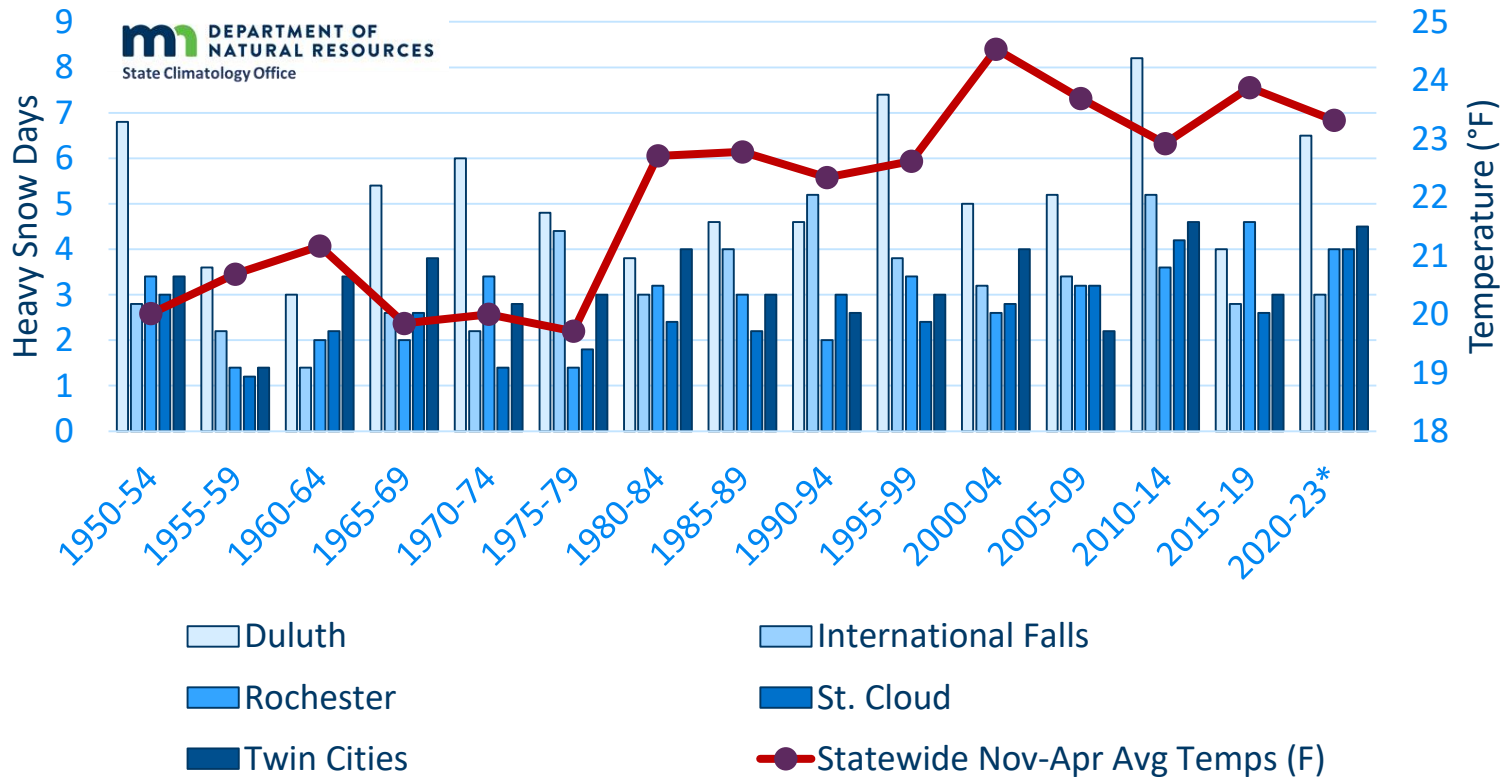
Snow Depth Declining

November-March Snow Depth Statistics
Duluth



Heavy Snow Increasing, Even as Winters Warm

Average Seasonal Heavy Snow Days (4+ inches) and
Statewide Average November - April Temperature



- Snow data from NOAA/NWS Cooperative Network, accessed via Applied Climate Information System (ACIS) (<https://xmacis.rcc-acis.org/>).
- Temperature data obtained from NOAA via Minnesota Climate Explorer (<https://arcgis.dnr.state.mn.us/ewr/climateexplorer/main/historical/>)

The Future???



Early October Weather?

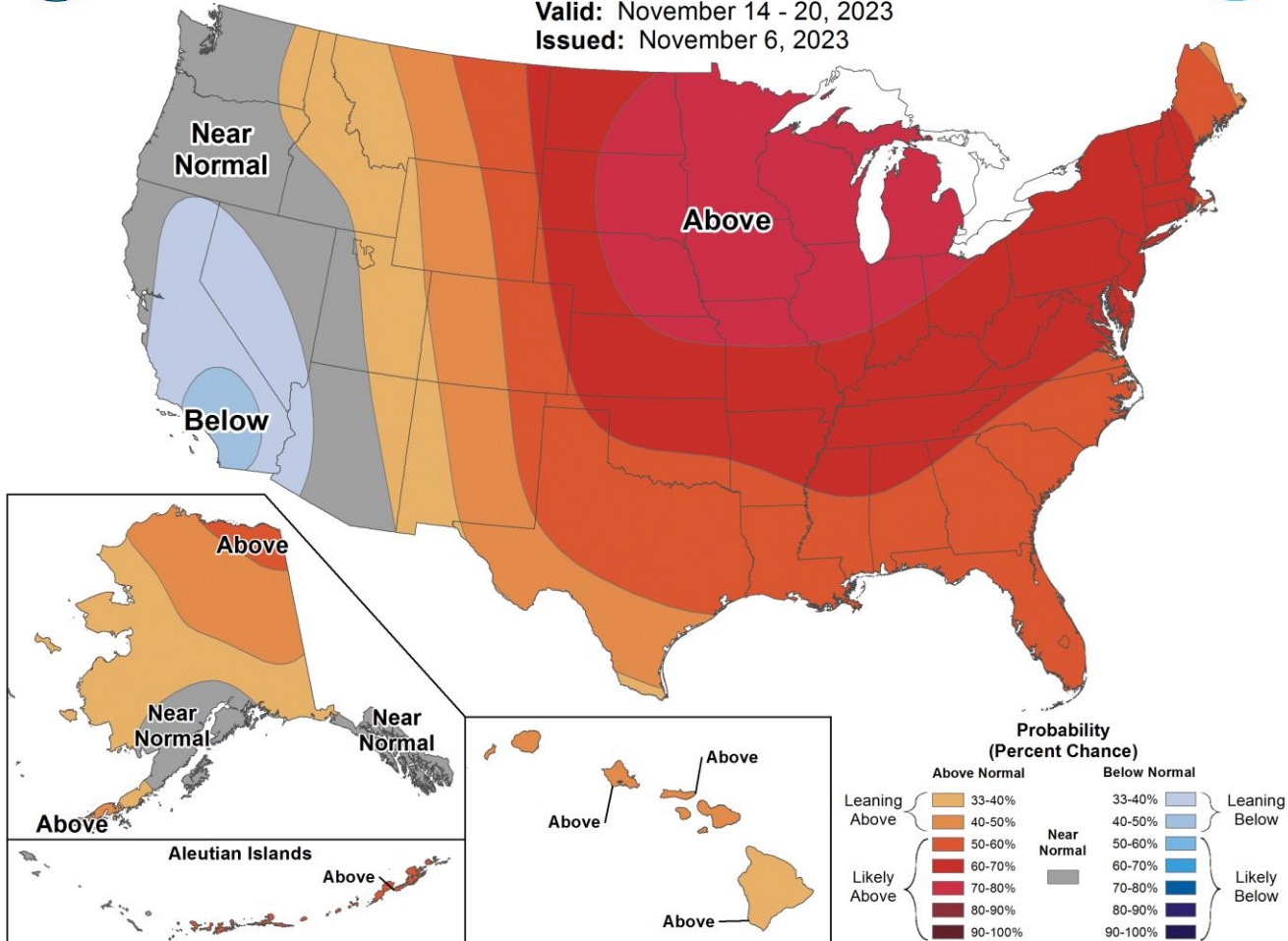


8-14 Day Temperature Outlook



Valid: November 14 - 20, 2023

Issued: November 6, 2023



Early October Weather?

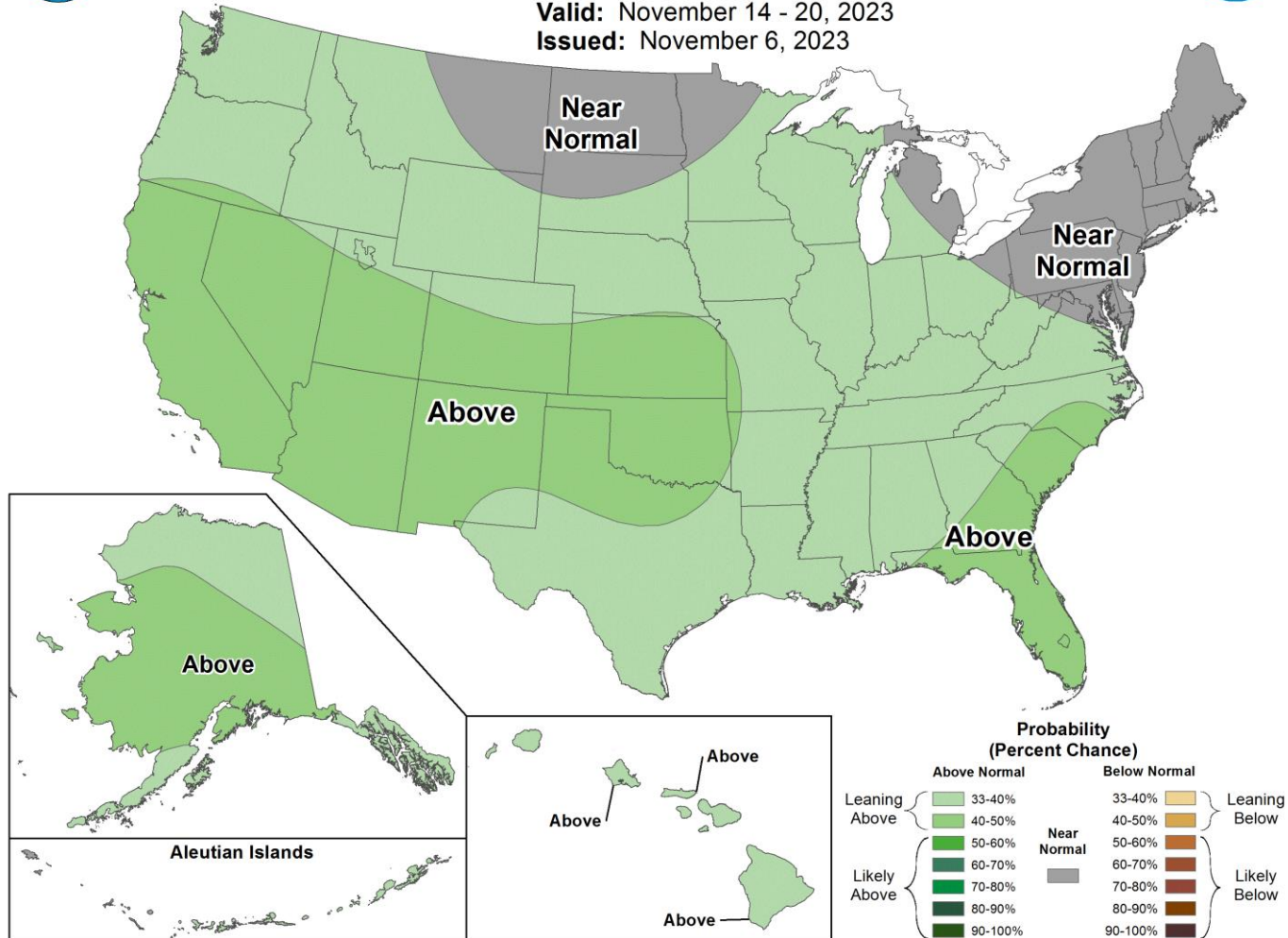


8-14 Day Precipitation Outlook

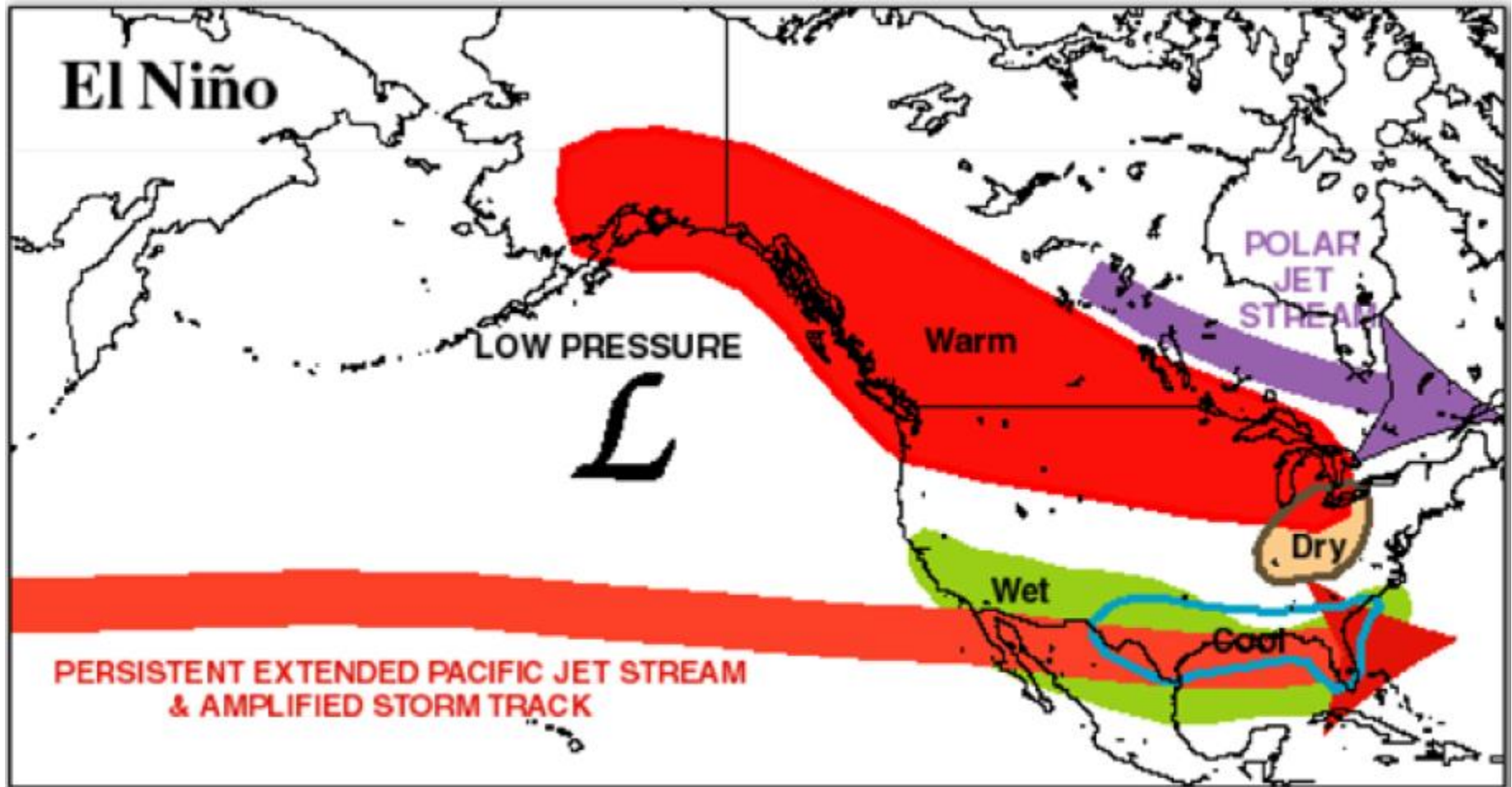


Valid: November 14 - 20, 2023

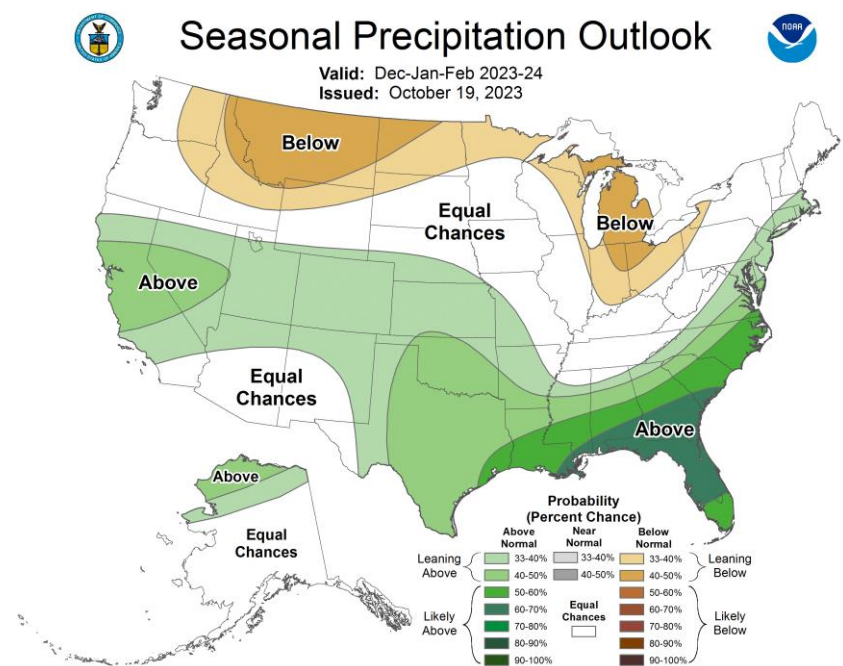
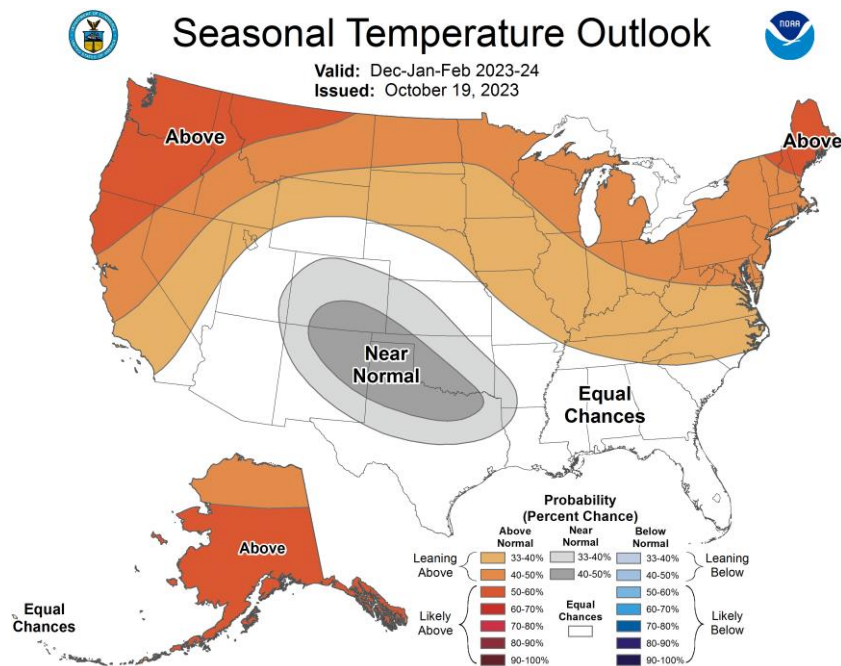
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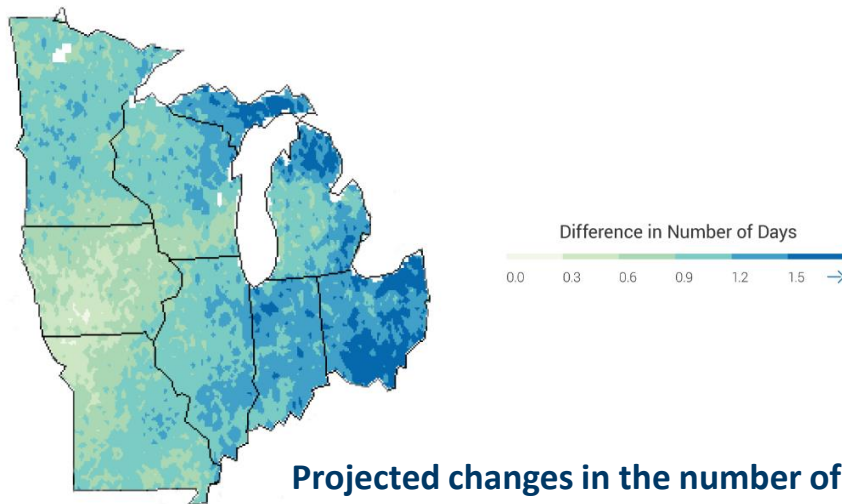
What about the winter of 23-24?



What about the winter of 23-24?

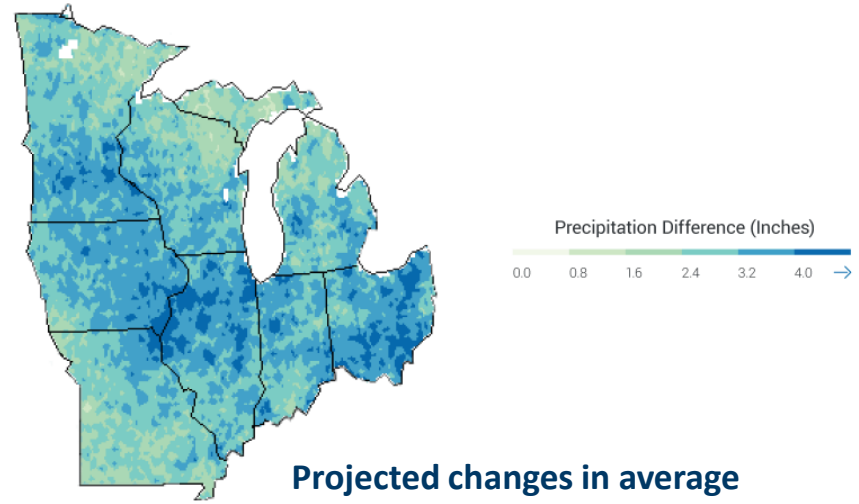


What about 2041-2070?



Projected changes in the number of days with very heavy precipitation (top 2% of all rainfalls each year) for the middle of the current century (2041-2070) relative to the end of the last century (1971-2000) under continued emissions (A2 scenario).

Source: 2014 National Climate Assessment, [Midwest Chapter](#)



Projected changes in average annual precipitation for the middle of the current century (2041-2070) relative to the end of the last century (1971-2000) under continued emissions (A2 scenario).

Source: 2014 National Climate Assessment, [Midwest Chapter](#)

More precipitation and more heavy precipitation projected

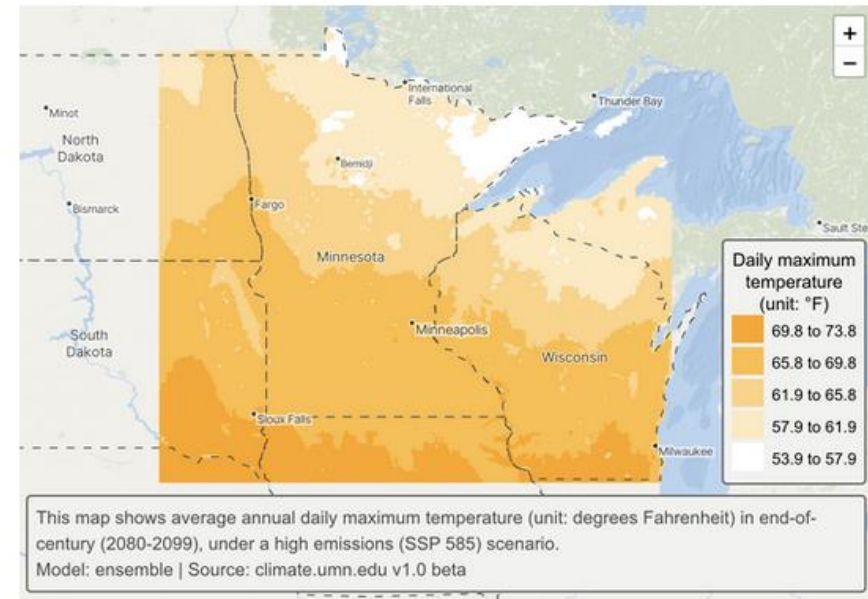
Climate Mapping and Analysis Tool

Minnesota CliMAT - Climate Mapping and Analysis Tool (CMIP6)

Welcome to Minnesota CliMAT (Climate Mapping and Analysis Tool).

Minnesota CliMAT is an interactive online tool that provides highly localized climate projections for Minnesota. Users can view climate projections down to the 4km/2.6mile scale across the state, visualizing even how specific towns will likely be impacted in the coming decades.

MN CliMAT uses the latest generation of global climate models, called CMIP6. Before launching the tool for the first time, we encourage you to explore the resources below, including [Climate Modeling: an introductory primer for practitioners](#), which provide helpful context on climate modeling.



<https://climate.umn.edu/MN-CliMAT>

In Summary

1. The 2010s were an extraordinary wet period statewide.
2. Dryness began in 2020, picked up speed in 2021 and eased in late 2021. A new drought arrived in 2022. 2023 drought returned again.
3. After three winters of La Niña, a fairly strong El Niño in store for the winter of 23-24.
4. Even though the trend is for a warmer and wetter climate, **expect variability.**

Any Questions?

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651-539-2150

