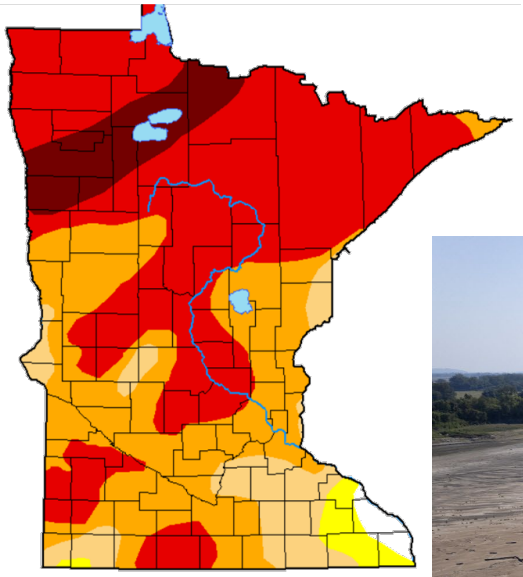
2023 Flash Drought:
Hydrologic Response & Water Use Trends

Adam Freihoefer, Aaron Pruitt & Will Dougherty
Wisconsin DNR, Water Use Section

What Drought?

2021:
Precipitation Patterns Change in Upper Midwest



Drought Monitor
August 24, 2021

REGION

Fighting drought, potato farmers in northern Minnesota overdrew their water permits by tens of millions of gallons

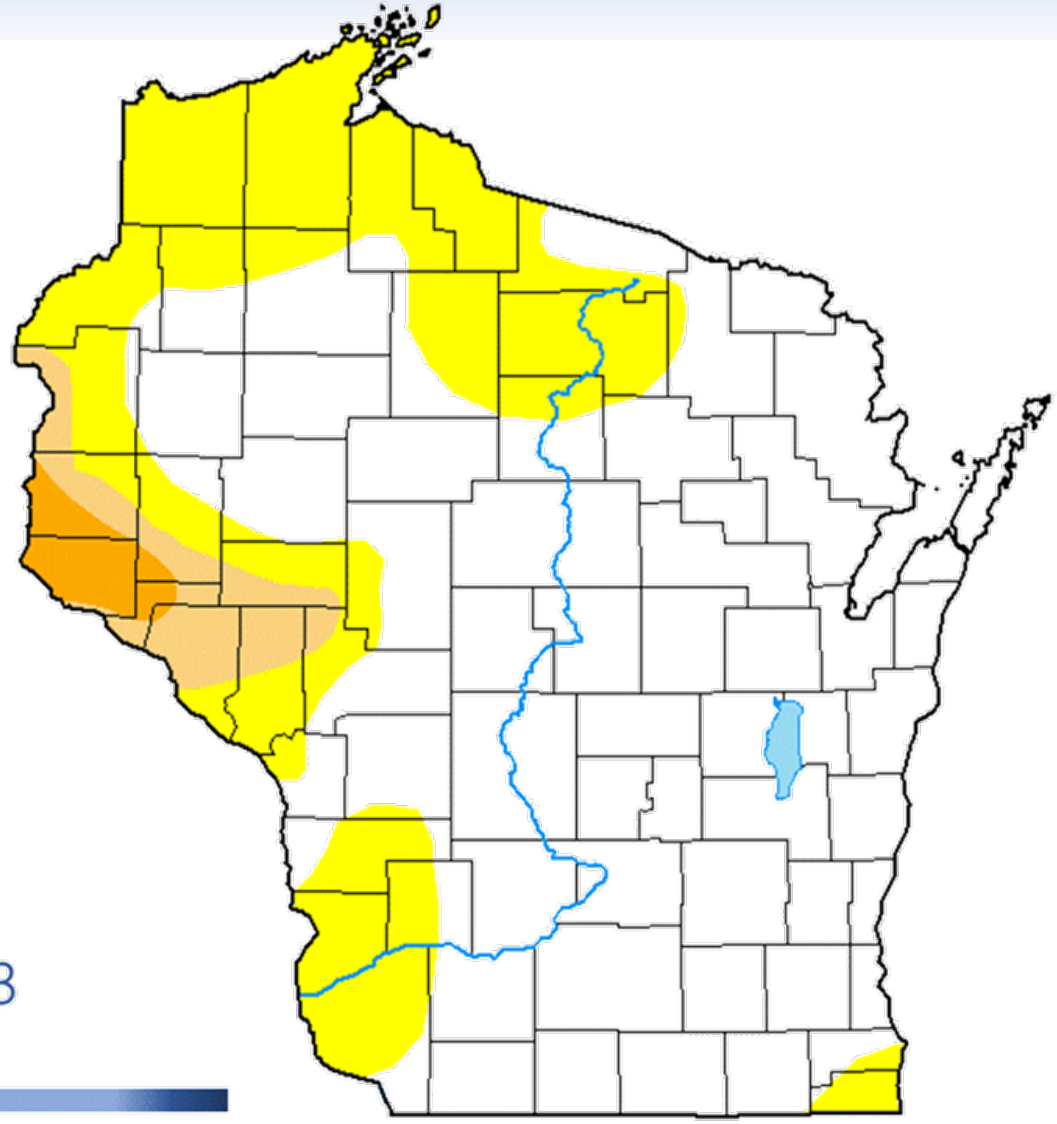
They likely face few consequences, because of laws that one regulator says are inadequate.

by **Greg Stanley, Star Tribune** February 21, 2023 Why you can trust Investigate Midwest

Jeff Roberson | Credit: AP

Nick Cooper - TSM Duluth

2023: Wisconsin's Flash Drought



January 3, 2023

January April July October December

Intensity:

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

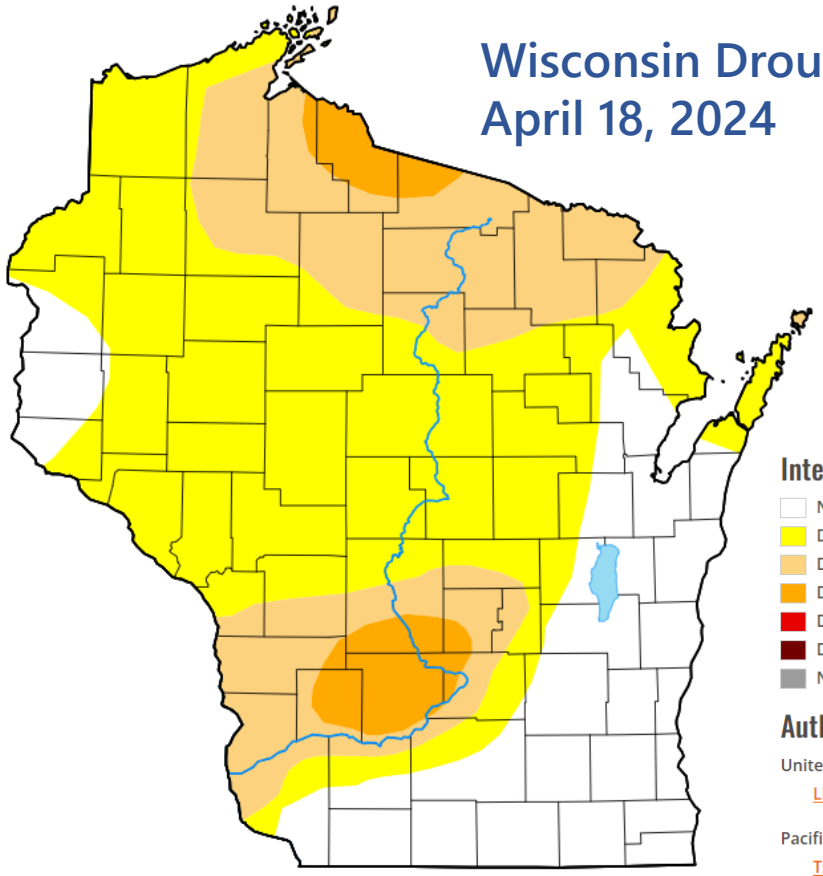
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Brad Pugh
CPC/NOAA

droughtmonitor.unl.edu

Types of Drought



Wisconsin Drought Map
April 18, 2024

Intensity

- None
- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
- No Data

Authors

United States and Puerto Rico Author(s):
Lindsay Johnson, National Drought Mitigation Center

Pacific Islands and Virgin Islands Author(s):
Tsegaye Tadesse, National Drought Mitigation Center

METEOROLOGICAL DROUGHT

The degree of dryness, expressed as a departure of actual precipitation from the expected average precipitation amount, based on monthly, seasonal, or annual time scales.

HYDROLOGICAL DROUGHT

Effects of precipitation shortfalls on stream flows, reservoir, lake, and groundwater levels.

AGRICULTURAL DROUGHT

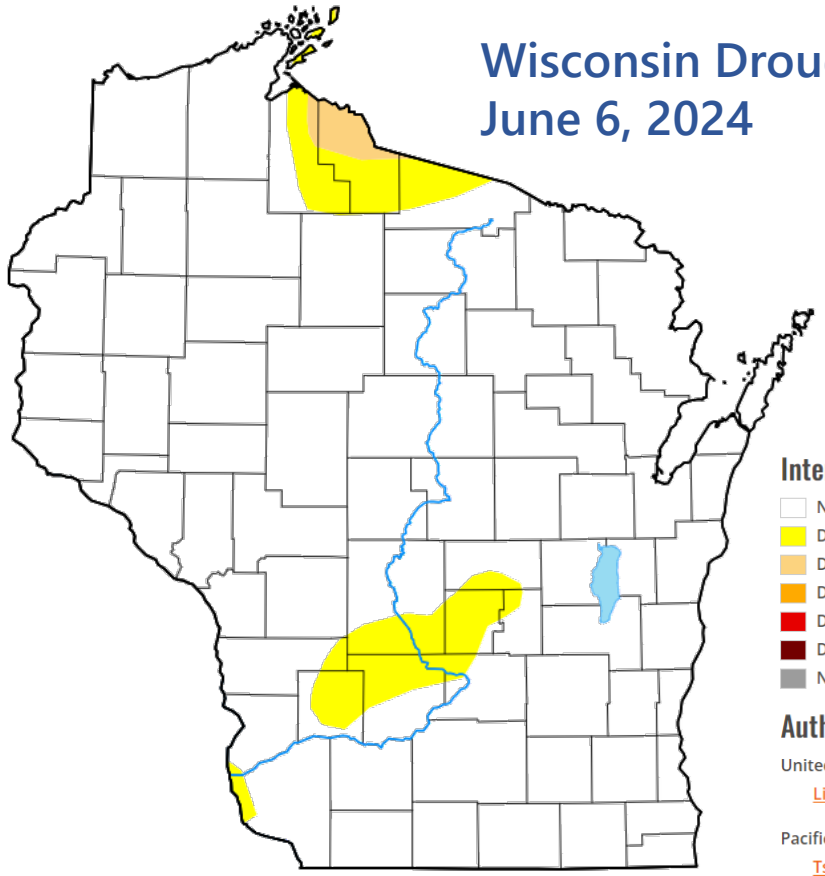
Soil moisture deficiencies relative to water demands of crops.

SOCIOECONOMIC DROUGHT

Shortage of water due to the demand for water exceeding the supply.

What did this flash drought mean to the hydrologic response and reliance on water?

Types of Drought



Wisconsin Drought Map
June 6, 2024

Intensity

- None
- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
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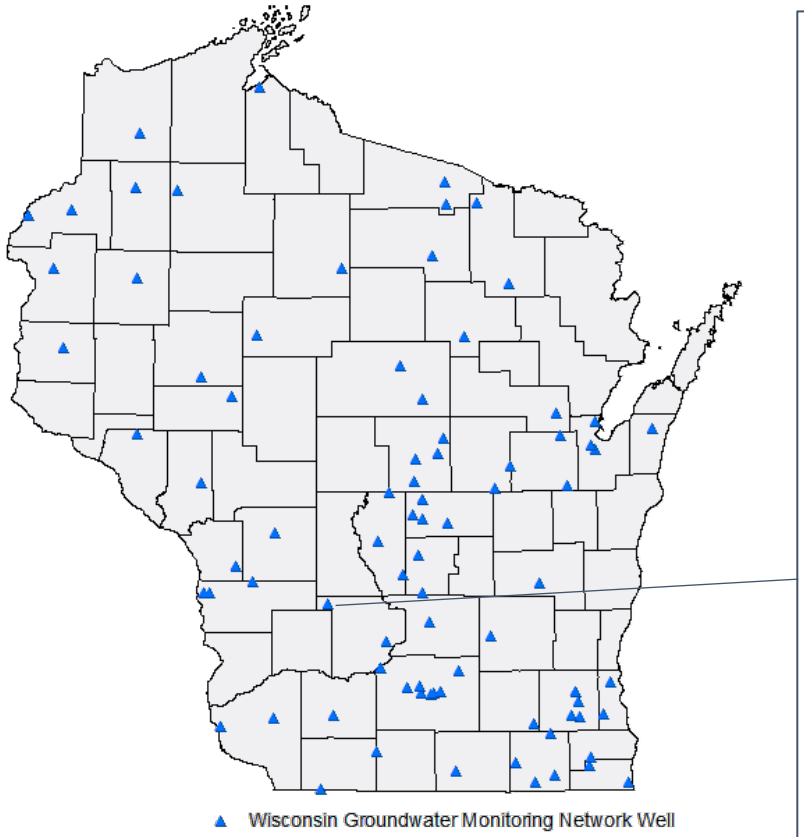
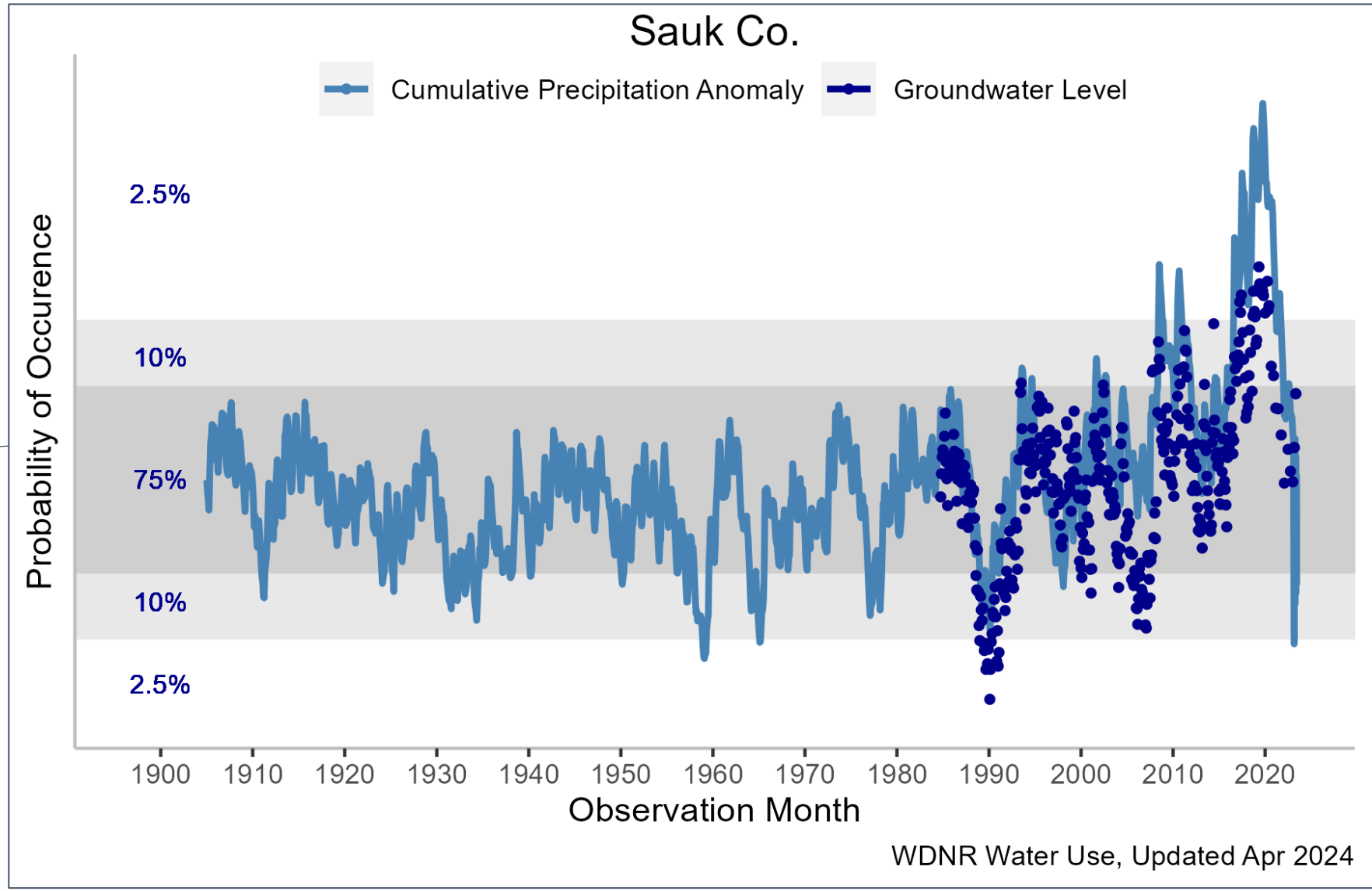
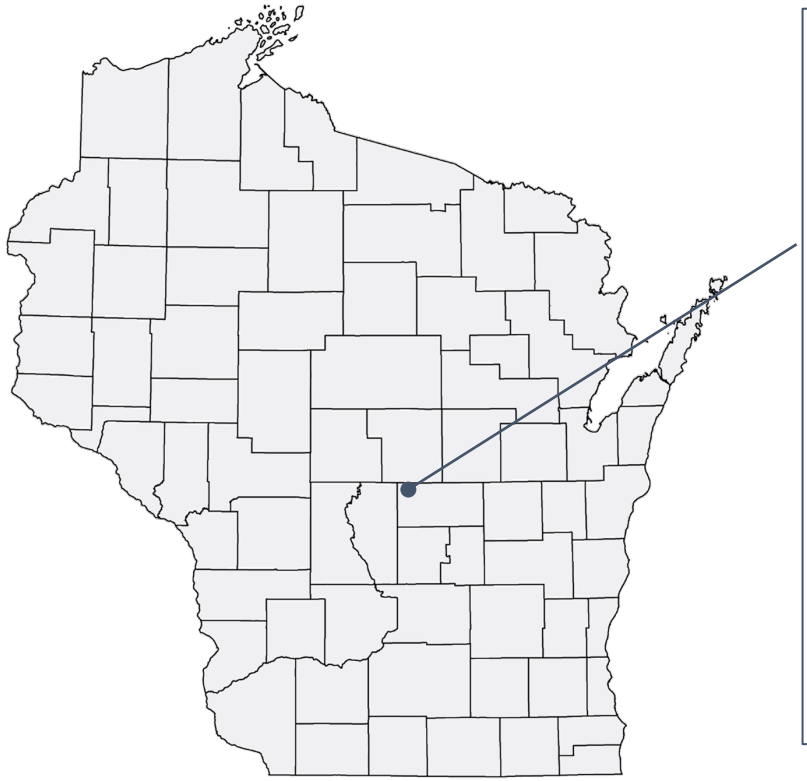
What did this flash drought mean to the hydrologic response and reliance on water?

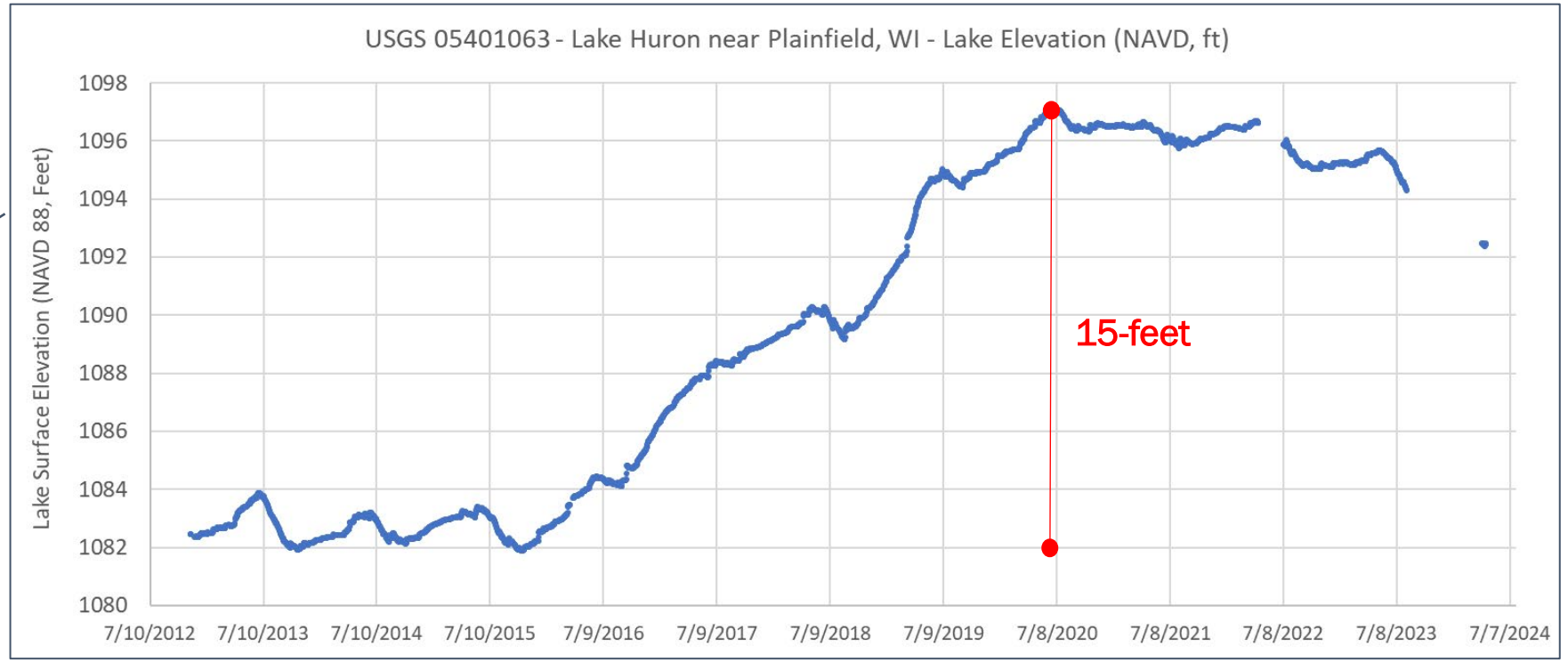
Hydrologic Response: Groundwater





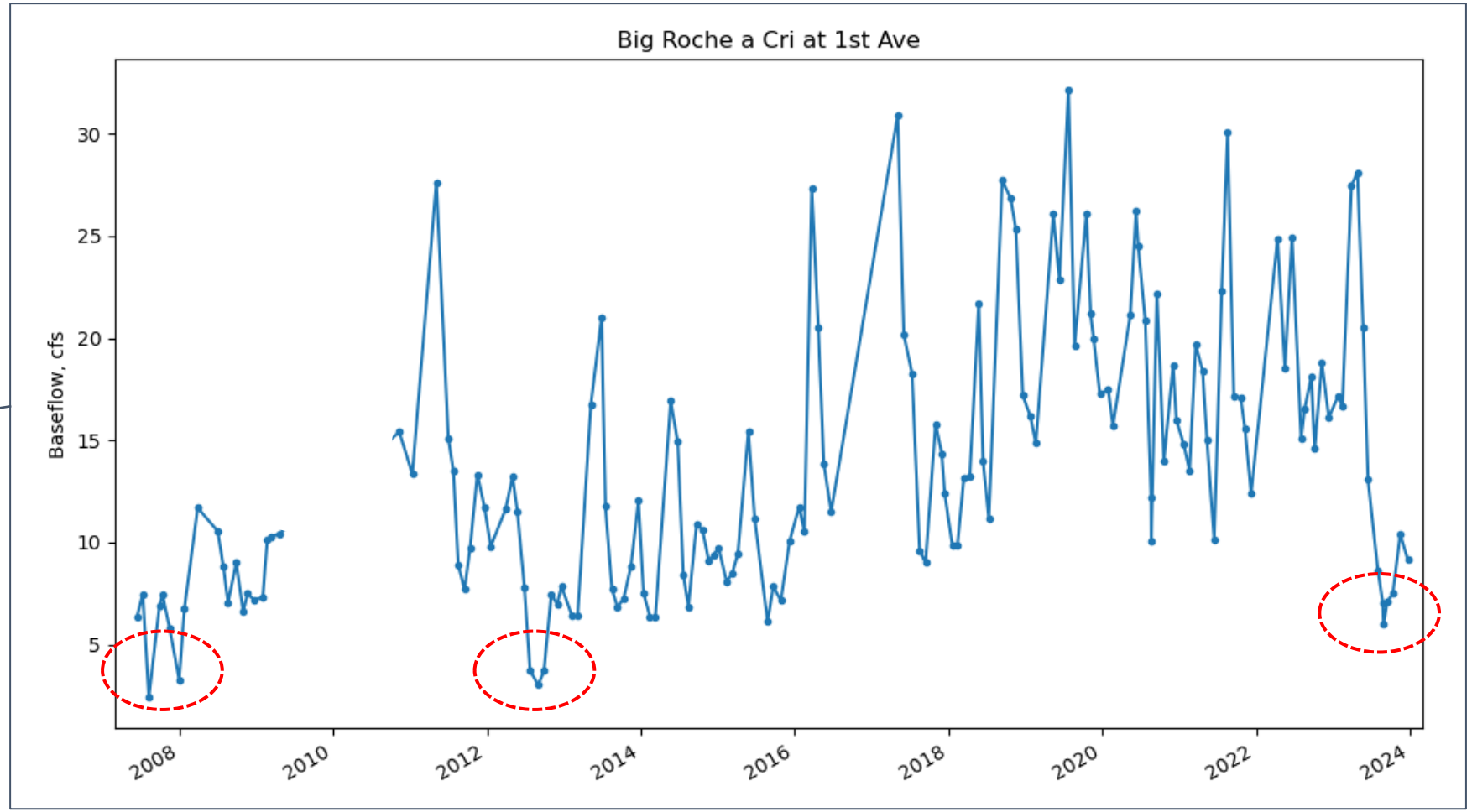
Hydrologic Response: Lakes (Seepage)



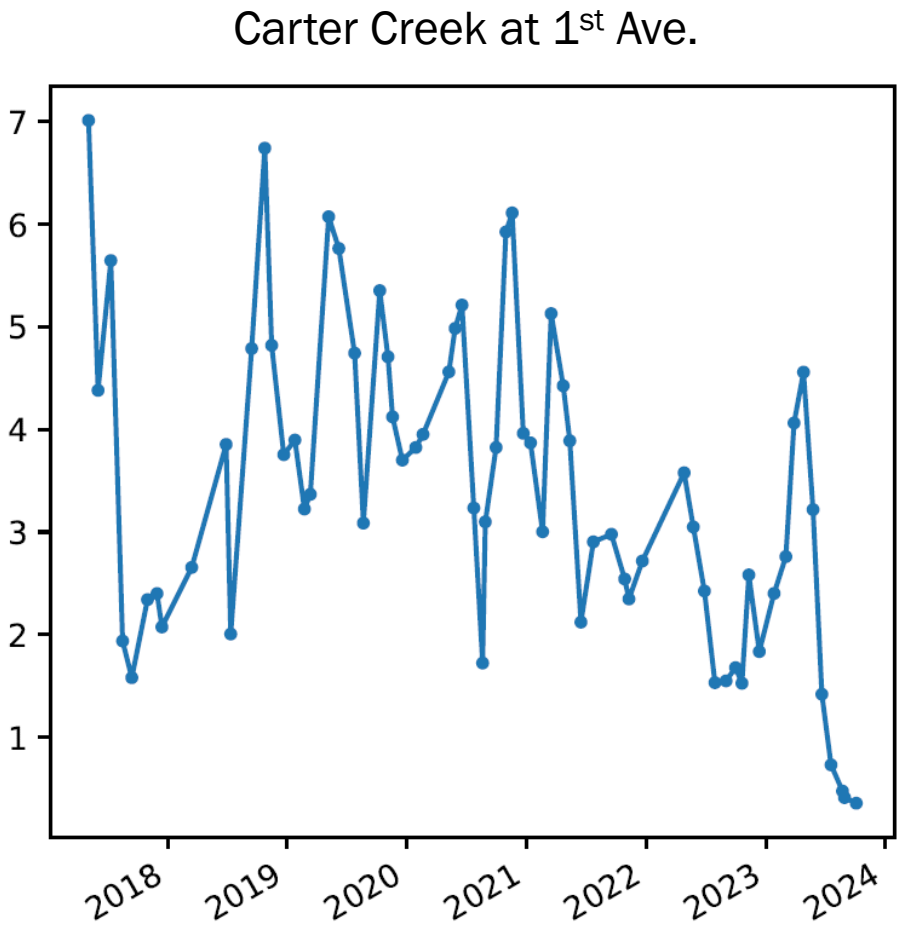


- 15-ft response in lake level within 5 years (2015 – 2020)
- 5-ft decline since 2020 peak

Hydrologic Response: Streams

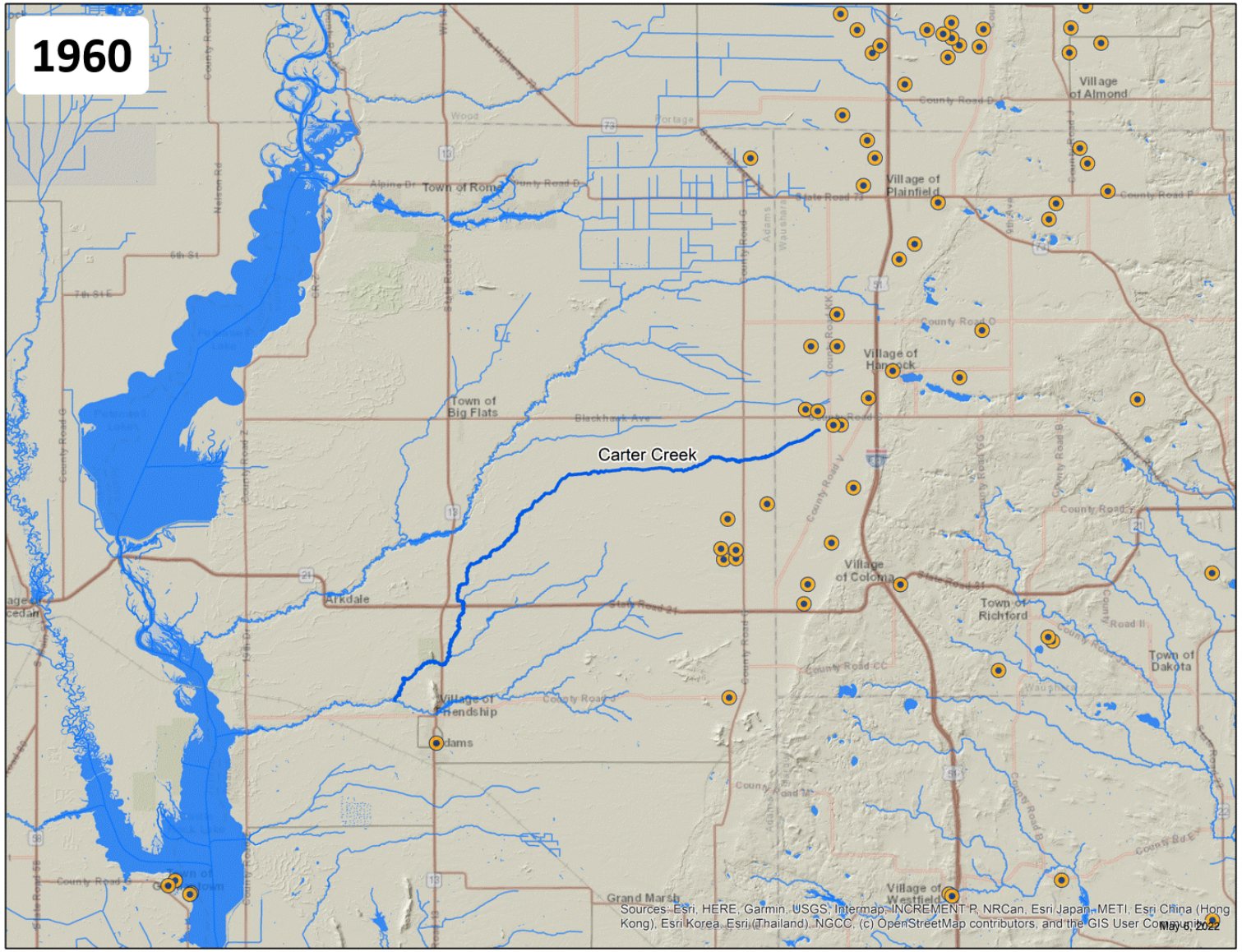


Hydrologic Response: Streams - Carter Creek Goes Dry



Credit: Jessica Haucke, UWSP

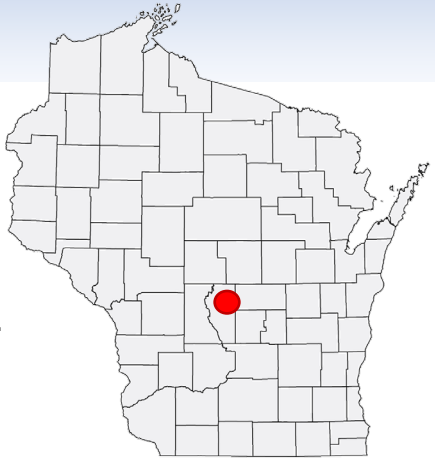
Hydrologic Response: Streams - Carter Creek Goes Dry



Carter Creek

Trout Stream

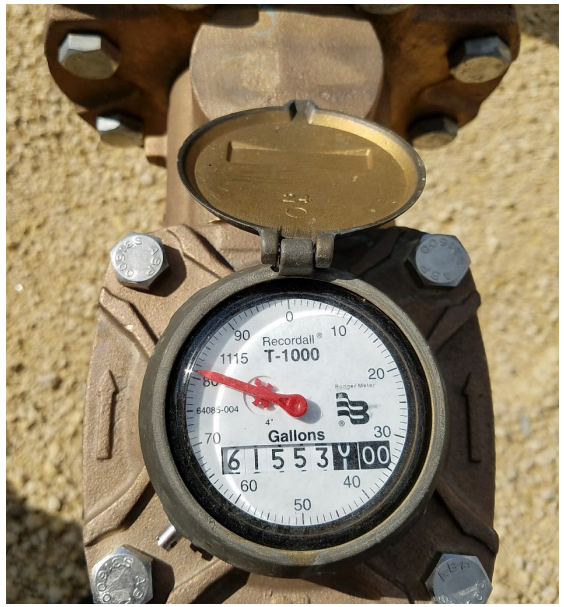
Exceptional Resource Water

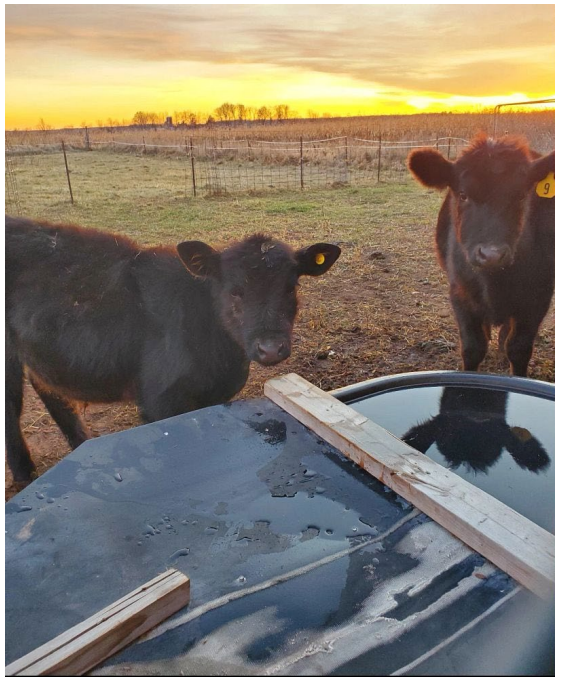


Carter Creek (July 2023)
Jessica Haucke, UW-Stevens Point

2023 Groundwater Use

Irrigated Agriculture, Dairy and Municipal Water Use Sectors





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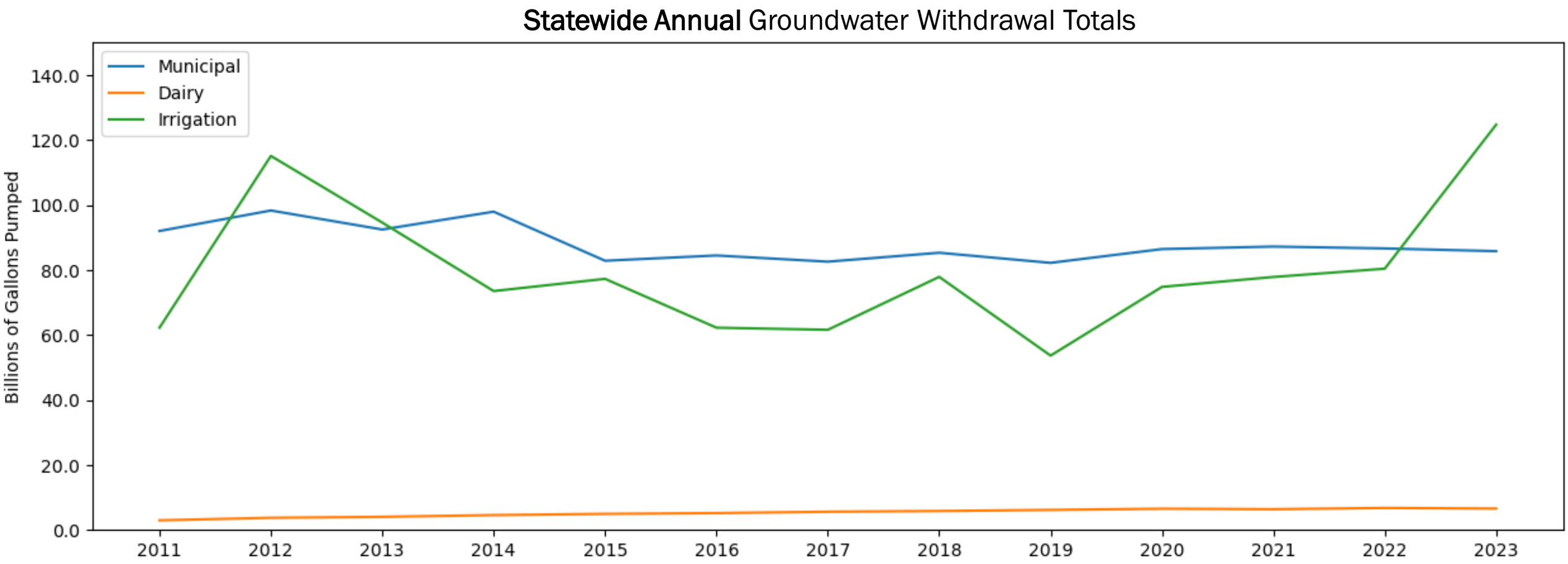
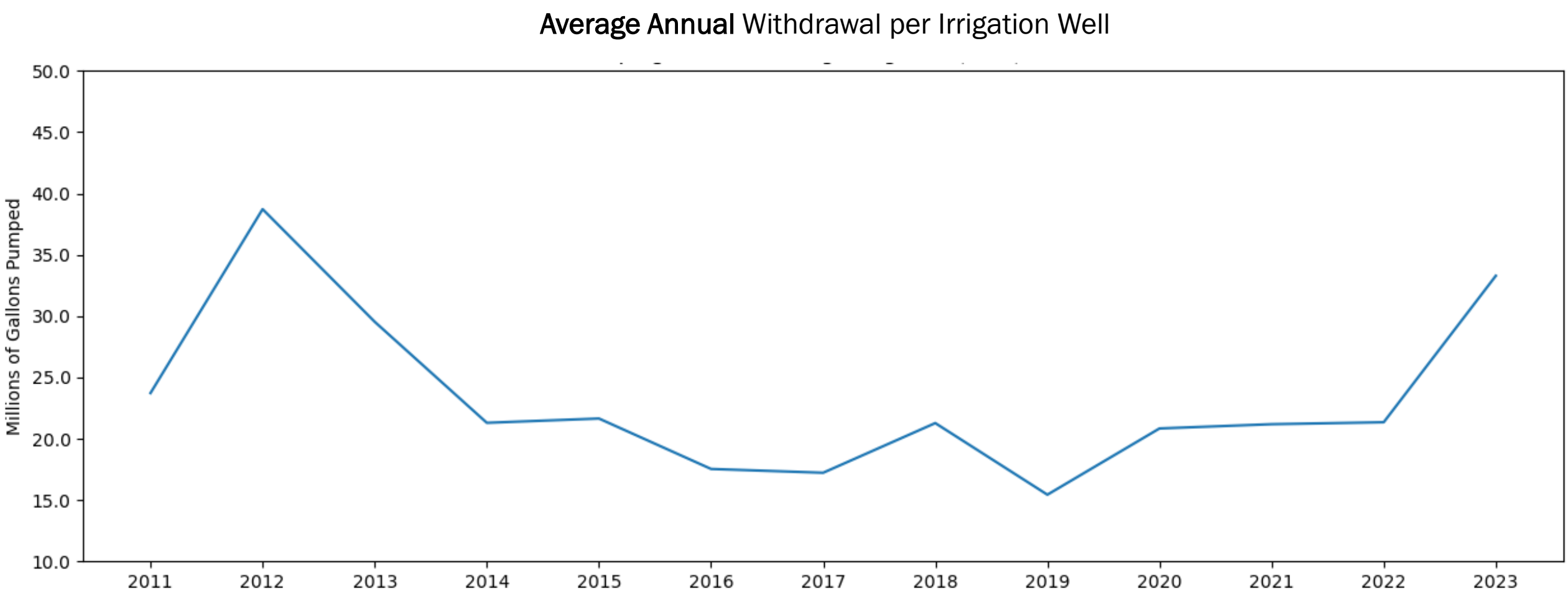
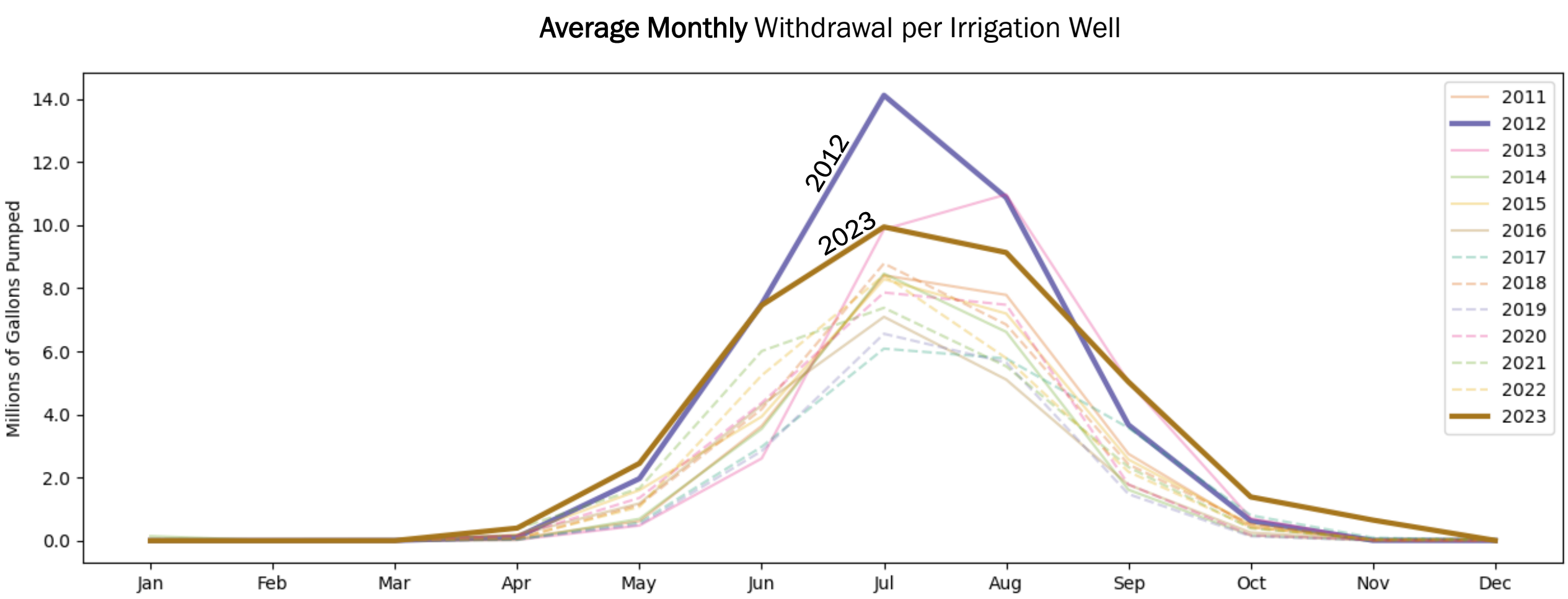


2023 Groundwater Use: Irrigated Agriculture



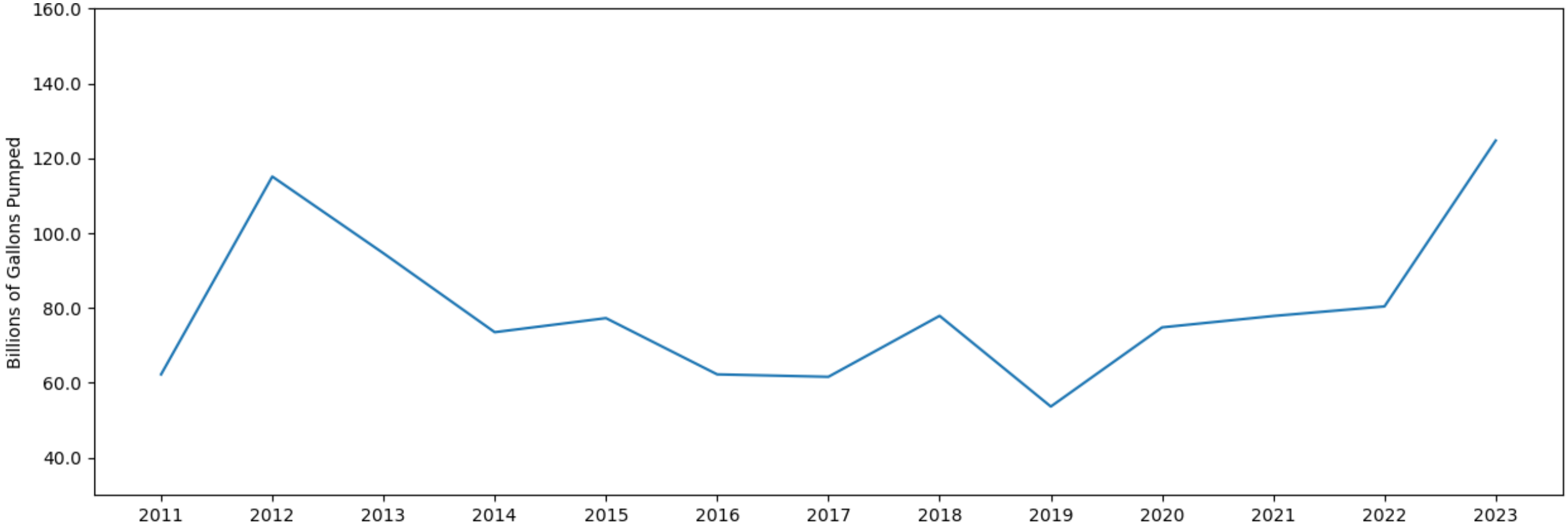
2023 Groundwater Use: Irrigated Agriculture



2023 Groundwater Use: Irrigated Agriculture

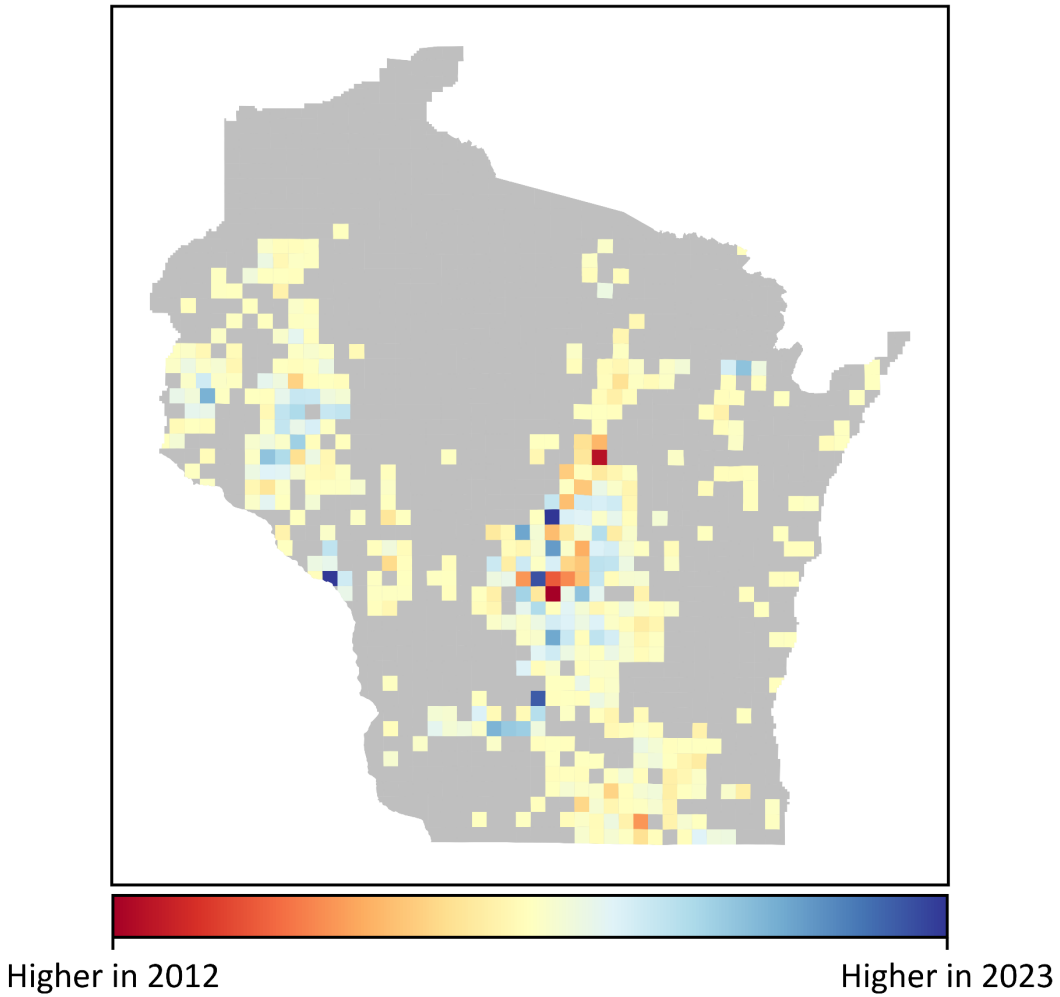
While *average* pumping in 2023 was less than 2012, but there was an increase of 700+ irrigation wells during the period

Statewide Annual Total Withdrawal from Irrigation Pumping

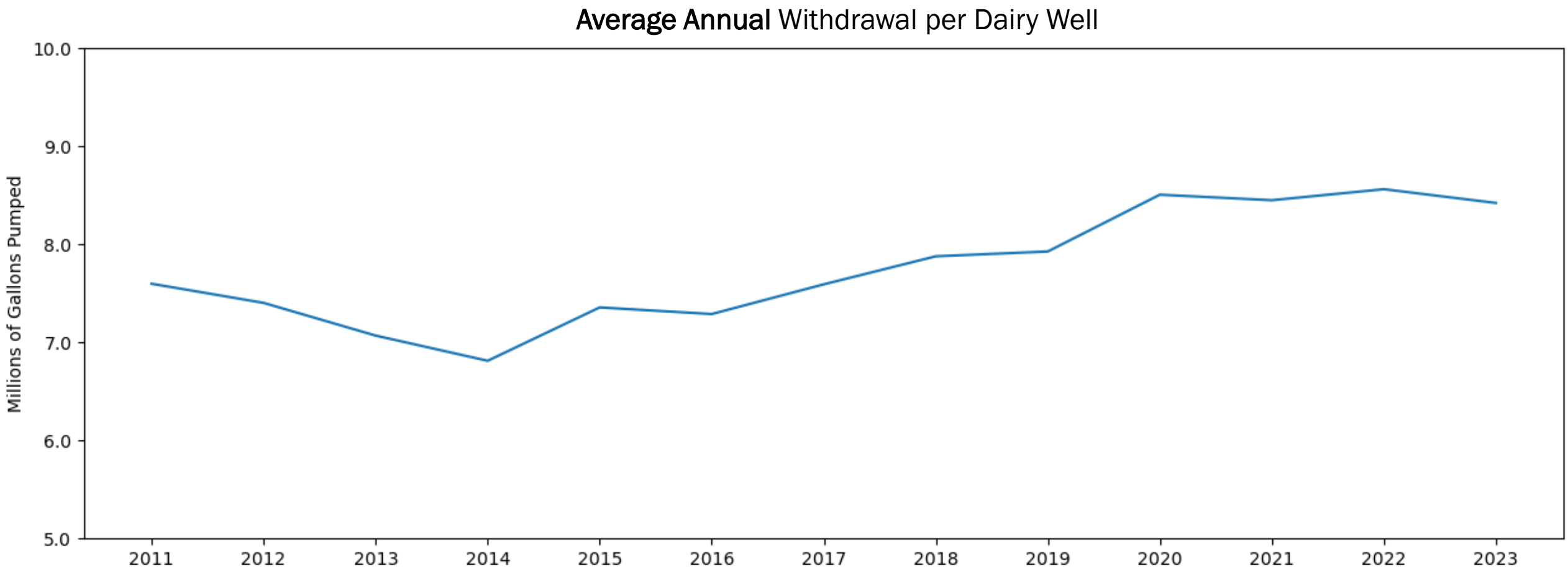


2023 Groundwater Use: Irrigated Agriculture

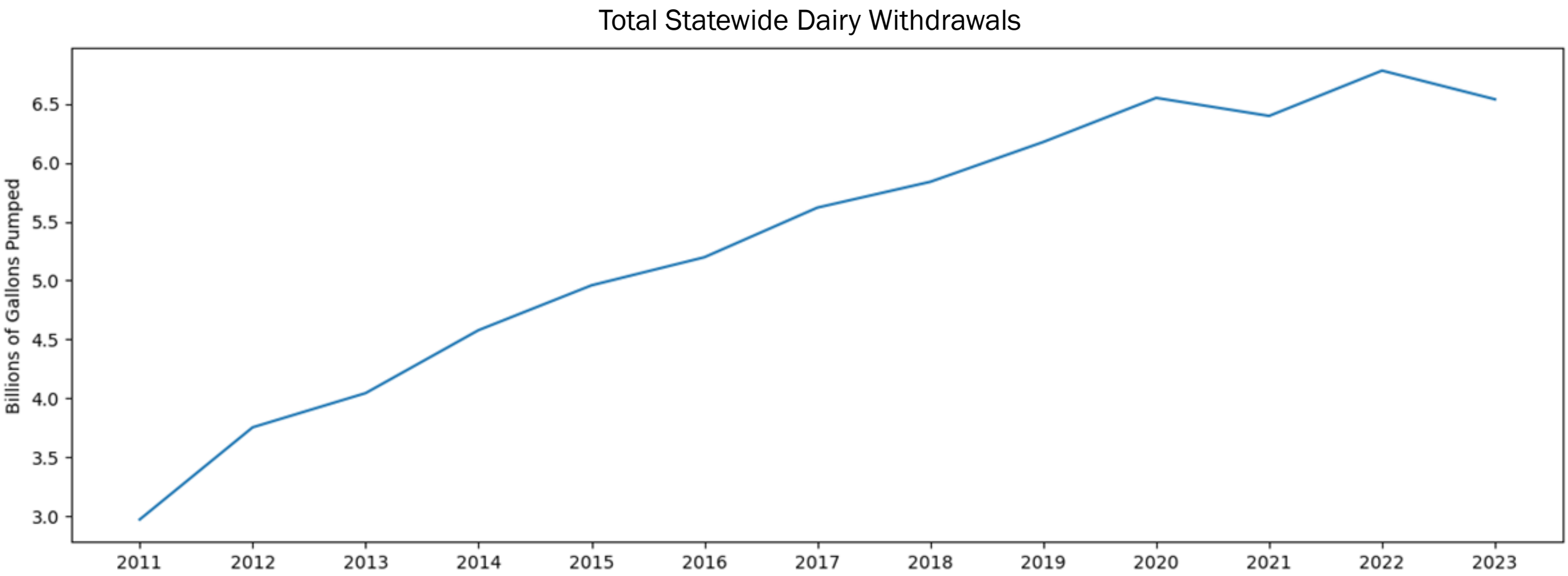
Groundwater - Change in Annual Pumping at Township Level
Agriculture Irrigation



2023 Groundwater Use: Dairy

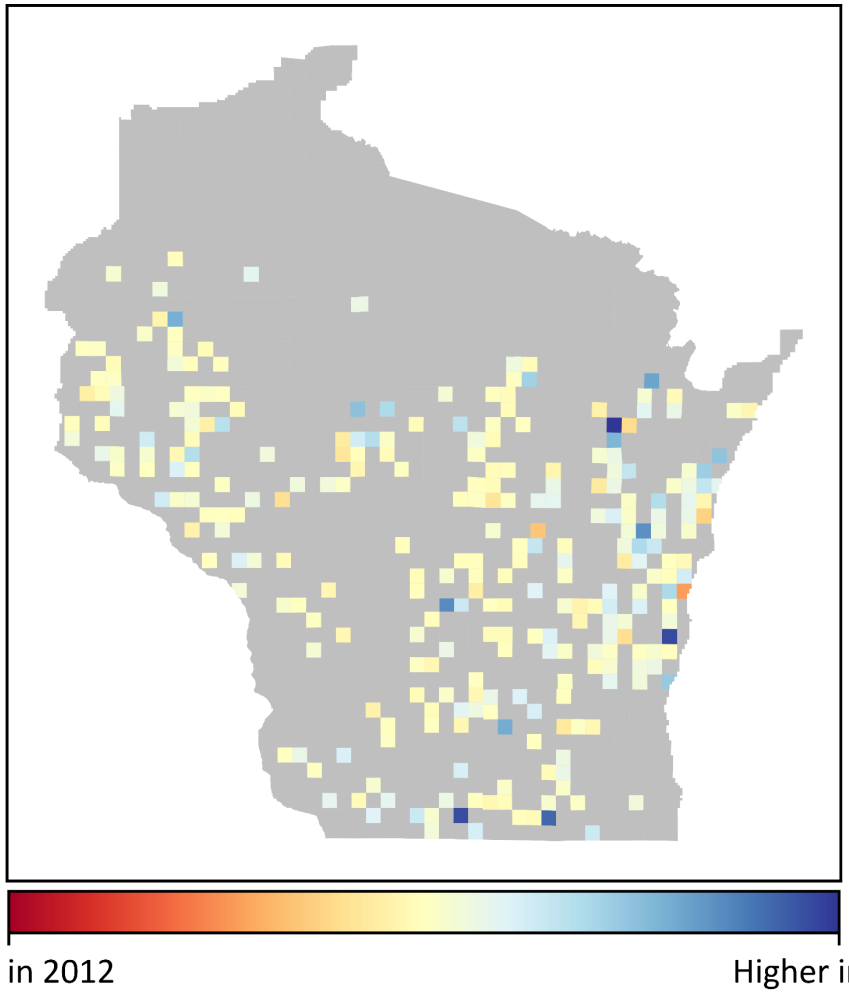


2023 Groundwater Use: Dairy

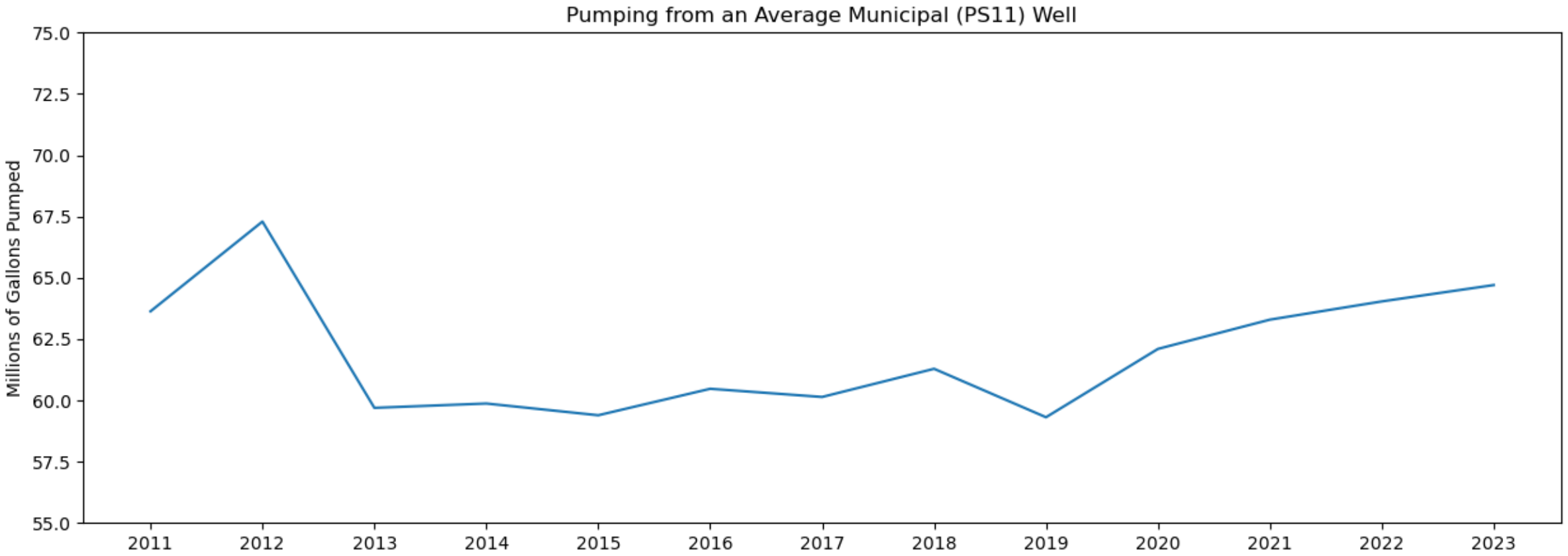


2023 Groundwater Use: Dairy

Groundwater - Change in Annual Pumping at Township Level
Dairy Farming

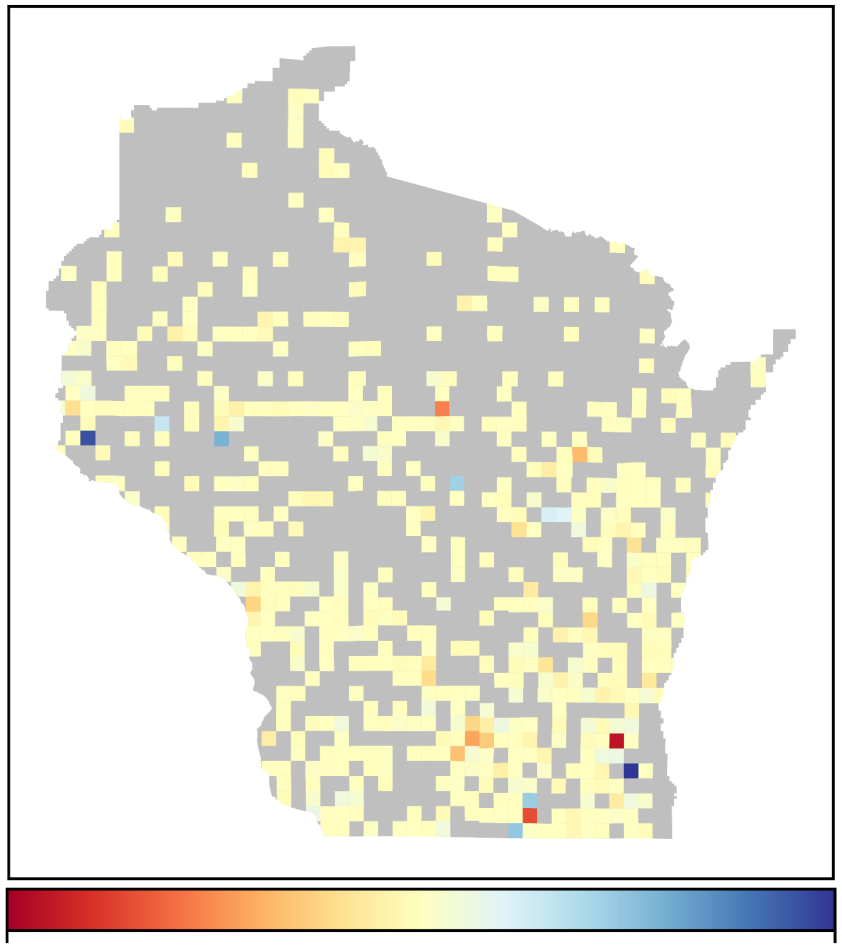


2023 Groundwater Use: Municipal



2023 Groundwater Use: Municipal

Groundwater - Change in Annual Pumping at Township Level
Municipal Public Water Supply



Higher in 2012 Higher in 2023

2023 Flash Drought: Take Aways

Agricultural Drought

- Yields were still relatively good due to higher soil moisture at the start of the season,
- Lands most susceptible (sandy soils) had supplemental irrigation
- Temps and wet winter / spring leading up to drought, buffered impact

Hydrologic Response

- Surface water resources saw level / flow decline
- Following record setting water levels (2017 – 2020) most groundwater dependent resources didn't experience the lows of early 2000s
- Smaller headwater streams, particularly those surrounded by groundwater withdrawals, saw greatest impact

Water Use

- 2023 agricultural water use saw lower seasonal peak demand, but great total water use in many areas
- Both dairy and municipal water use did not see impact from 2023 drought

The hydrologic response and water use can be confounded by other variables over time

Acknowledgements

Questions