

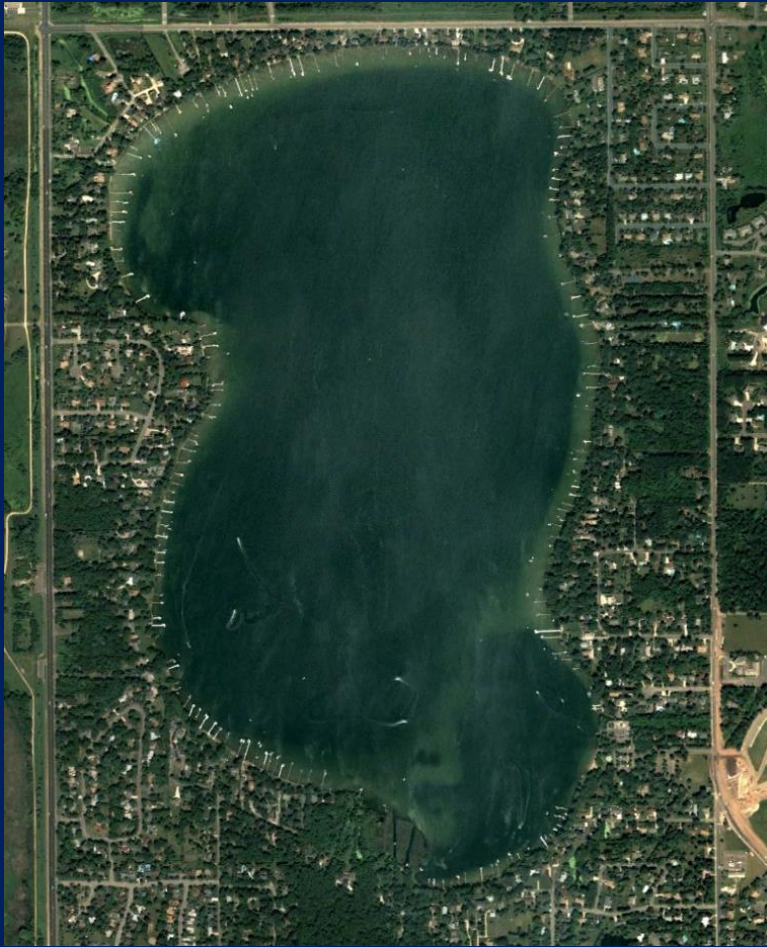


# Water-Level Changes in Lakes in the Northeast Metro: Why do they differ?

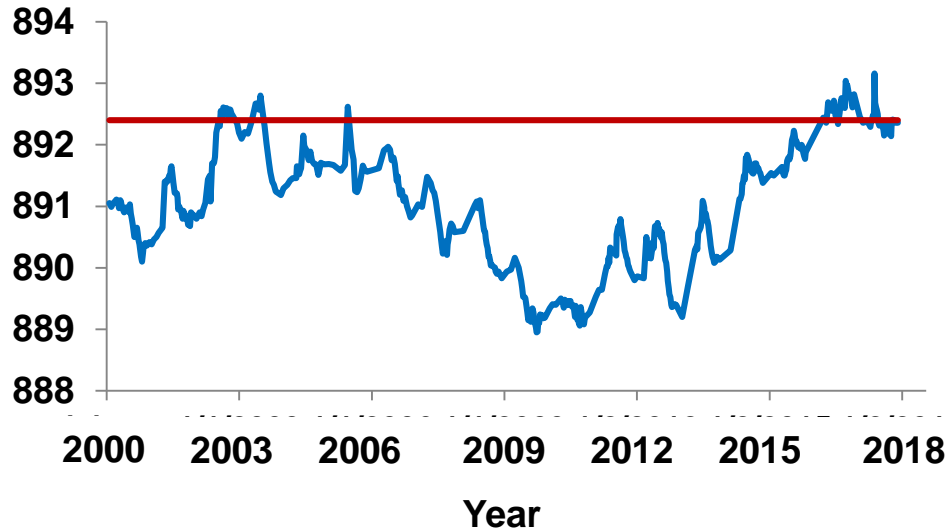
Perry M. Jones, Jared J. Trost, Aliessa Diekoff, and Melinda L. Erickson

# Water-Level Changes in Northeast Metro Lakes

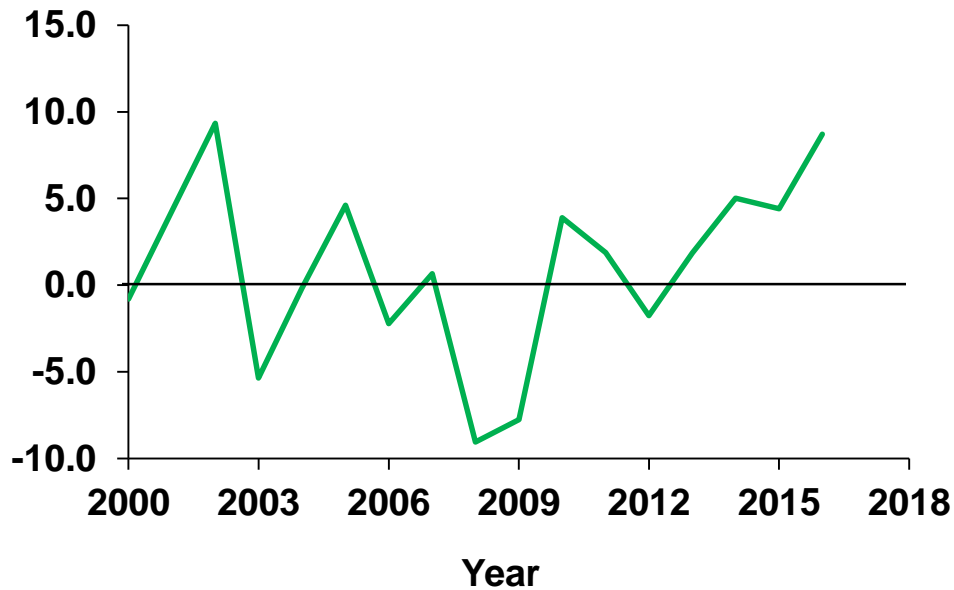
## Example: Turtle Lake



# Water-Level Changes in Turtle Lake, 2000-2017

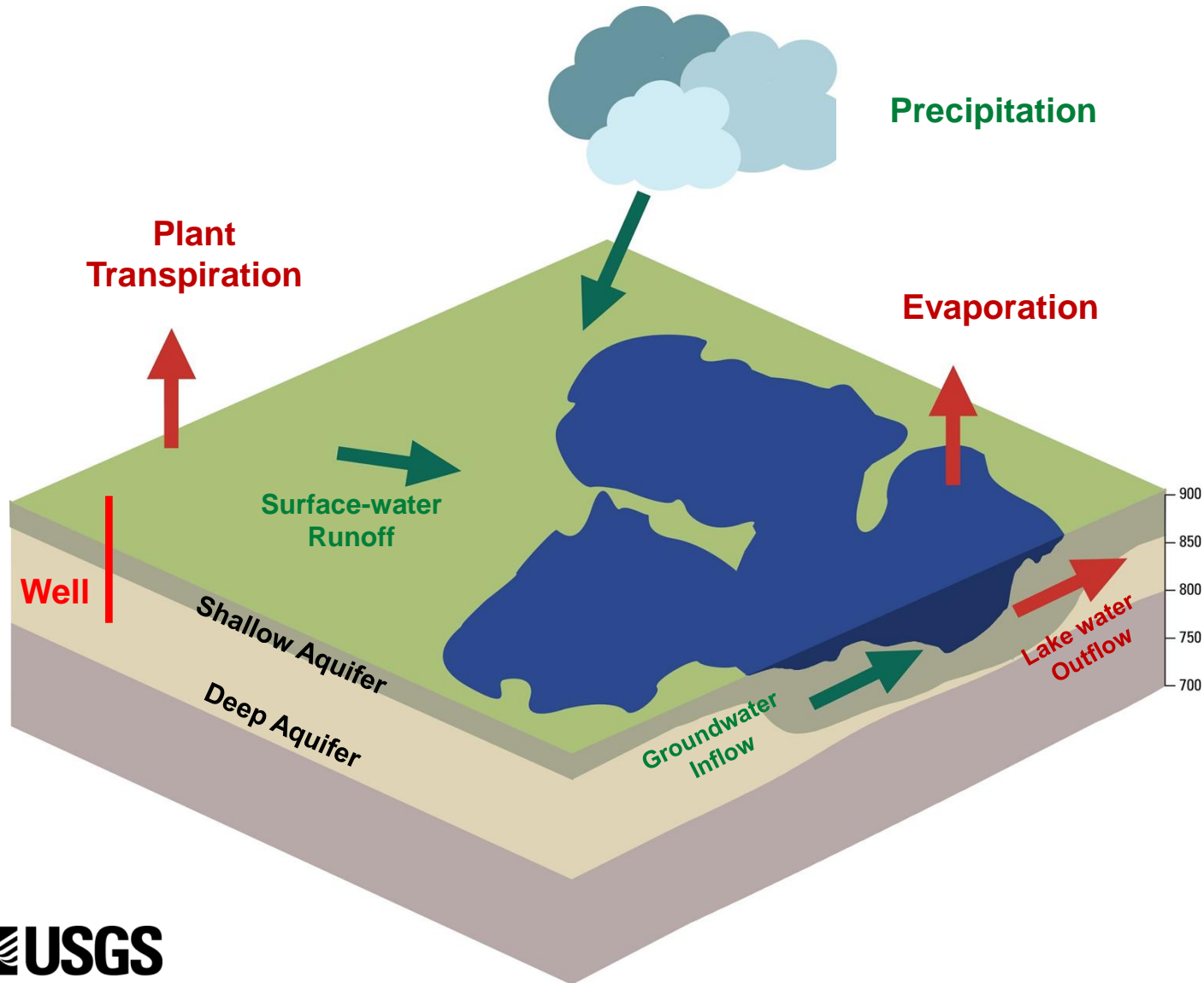


Water levels  
Ordinary High Water Level



Annual Precipitation Relative to Normal (inches)

# General Closed Lake Water Budget



# **Statistical Analysis of Lake Levels - Objectives**

## **Short-term (1999-2014) analysis**

- Assess lake-level fluctuations across region**
- Determine if climatic, landscape, or geologic characteristics (40 variables) can explain lake-level variations**

## **Long-term (1925-2014) analysis**

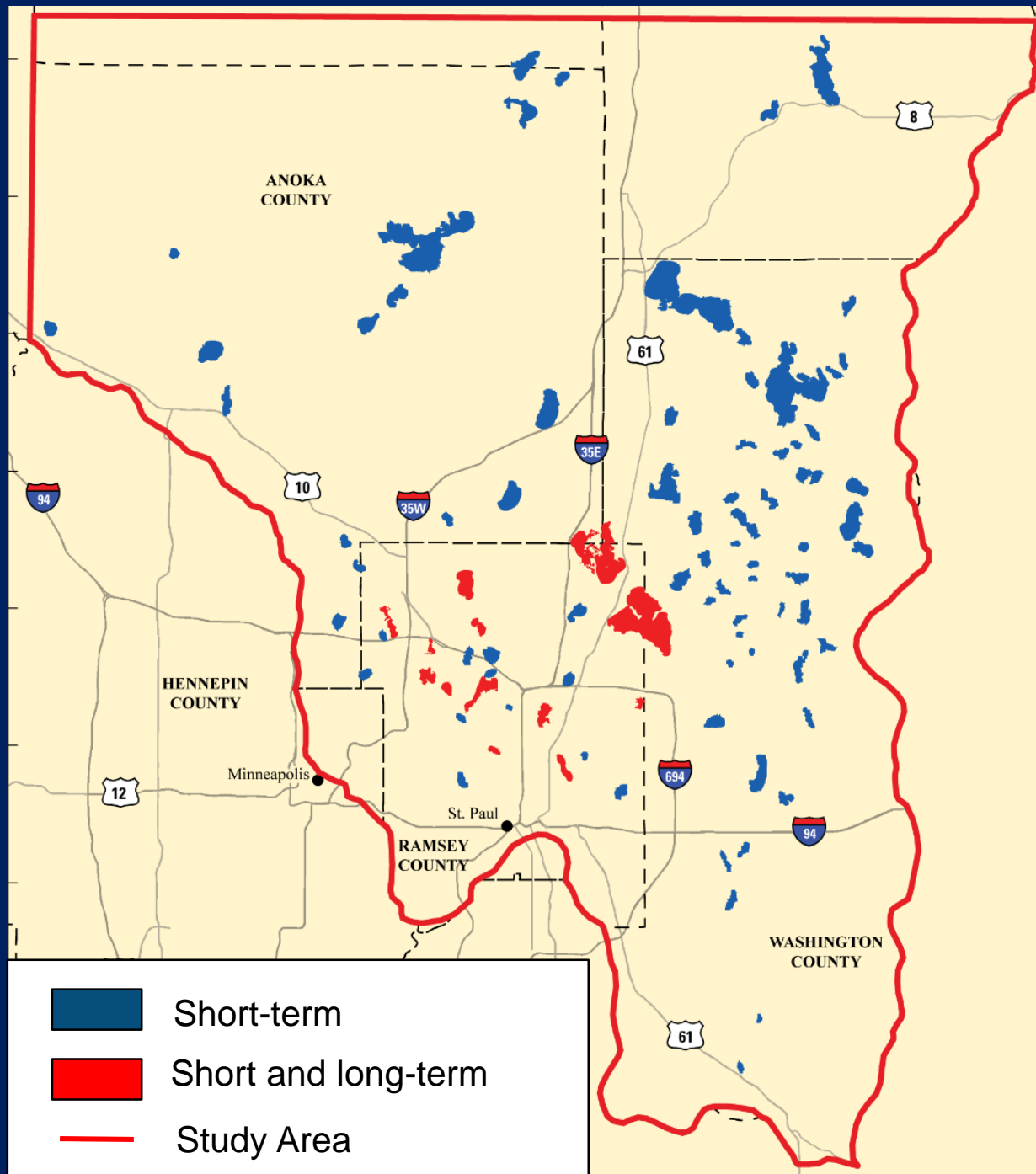
**Evaluate temporal relations between precipitation and lake levels**

# Statistical Lake-Level Analysis

Short-term  
96 lakes

Long-term  
14 lakes

Selected based  
on lake-level data

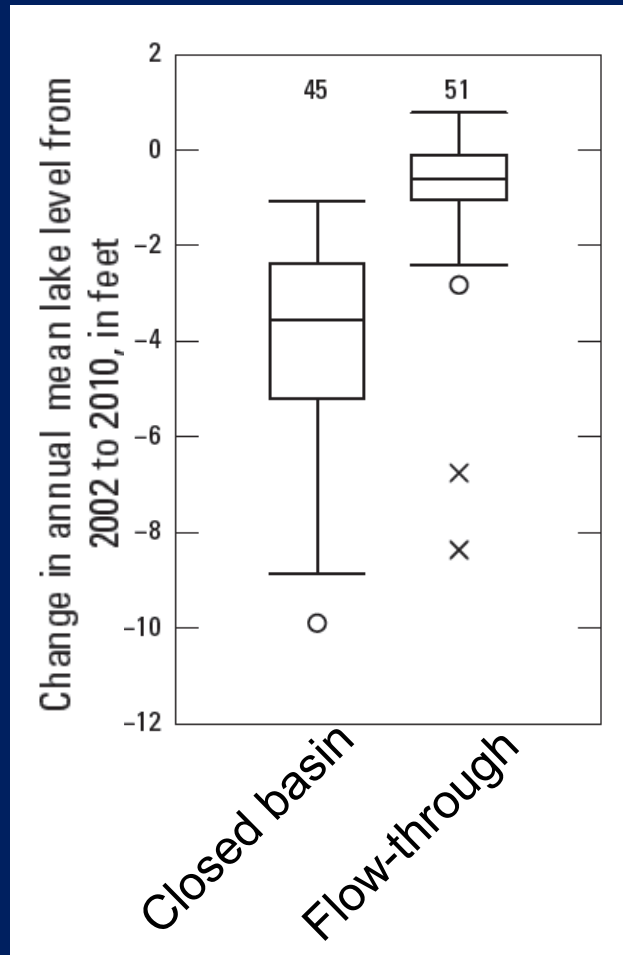


# Lake-level variability – based on lake type

## Closed-basin Lake

no active surface-water outlet

**Turtle Lake**



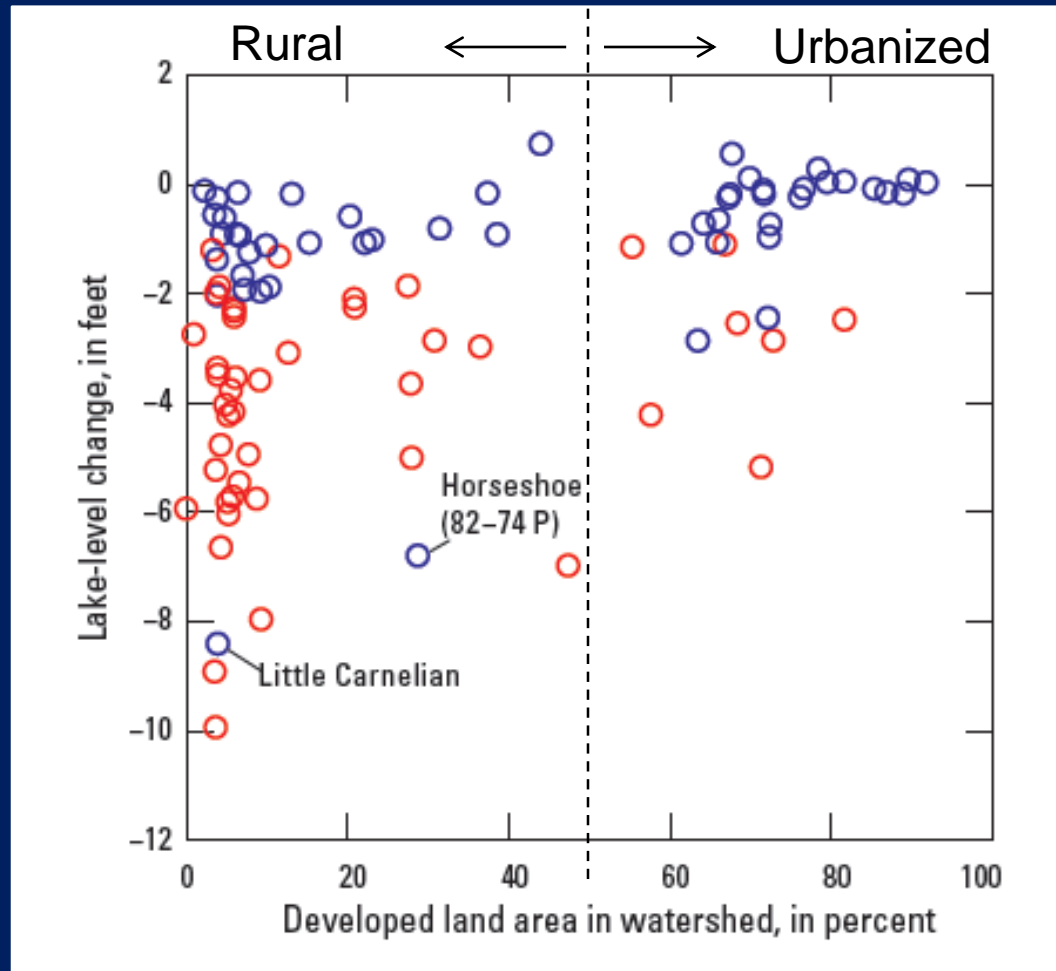
## Flow-through Lake

active surface-water outlet

**Pleasant Lake**



# Lake levels more stable in urbanized areas

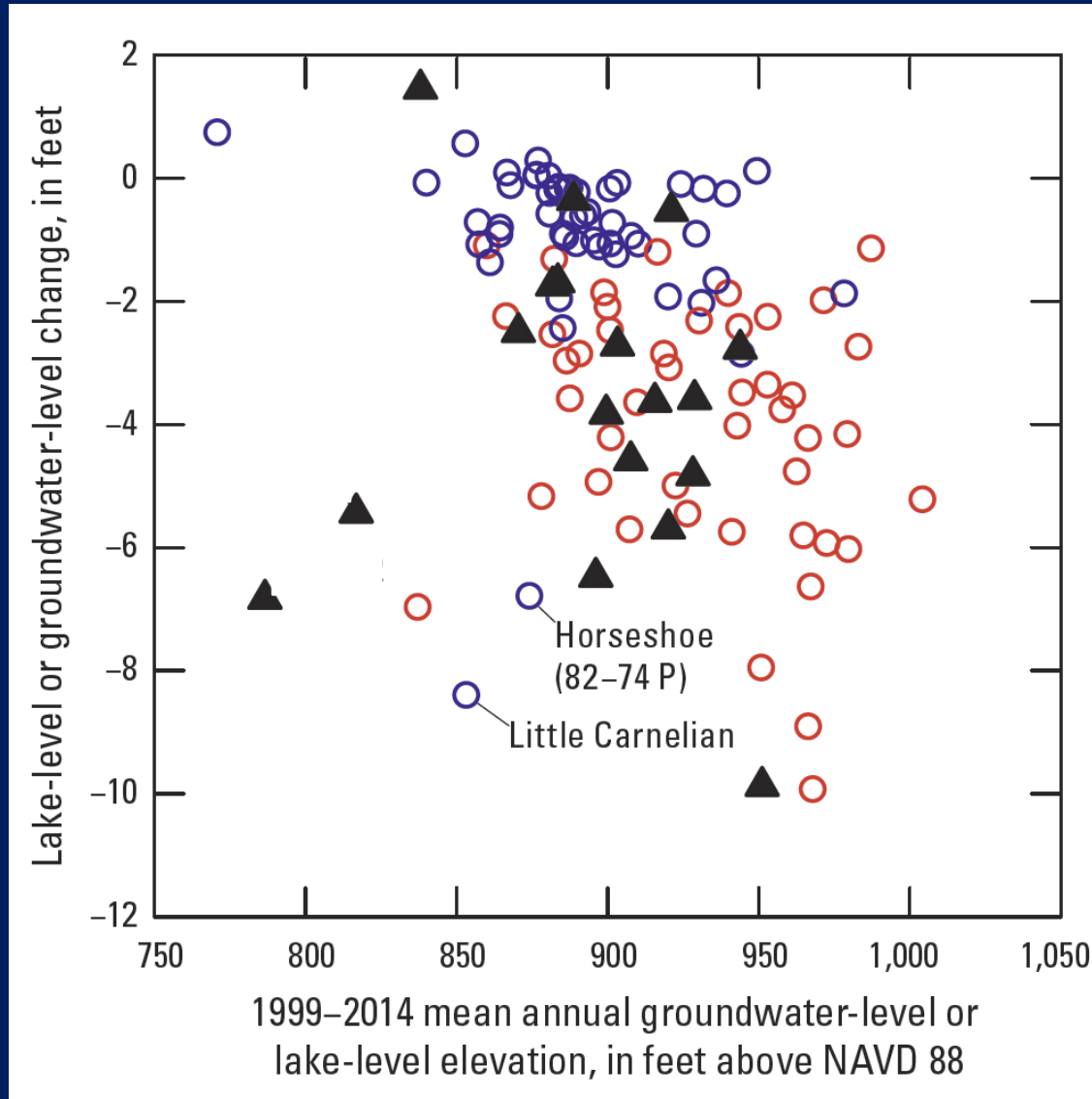


- most urban lakes are flow-through
- most rural lakes are closed-basin

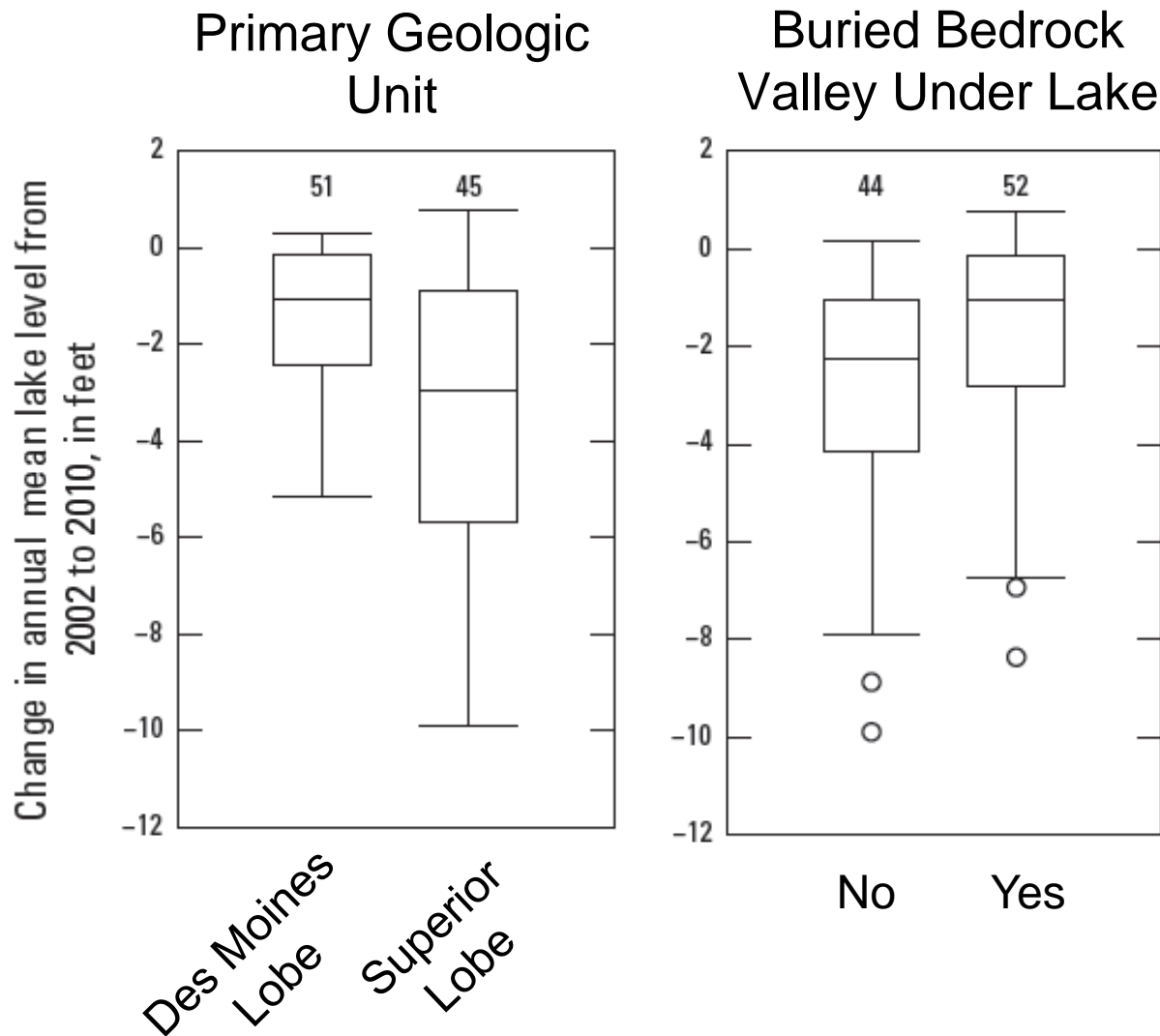
EXPLANATION	
○ (Red)	Closed basin lake
○ (Blue)	Flow-through lake



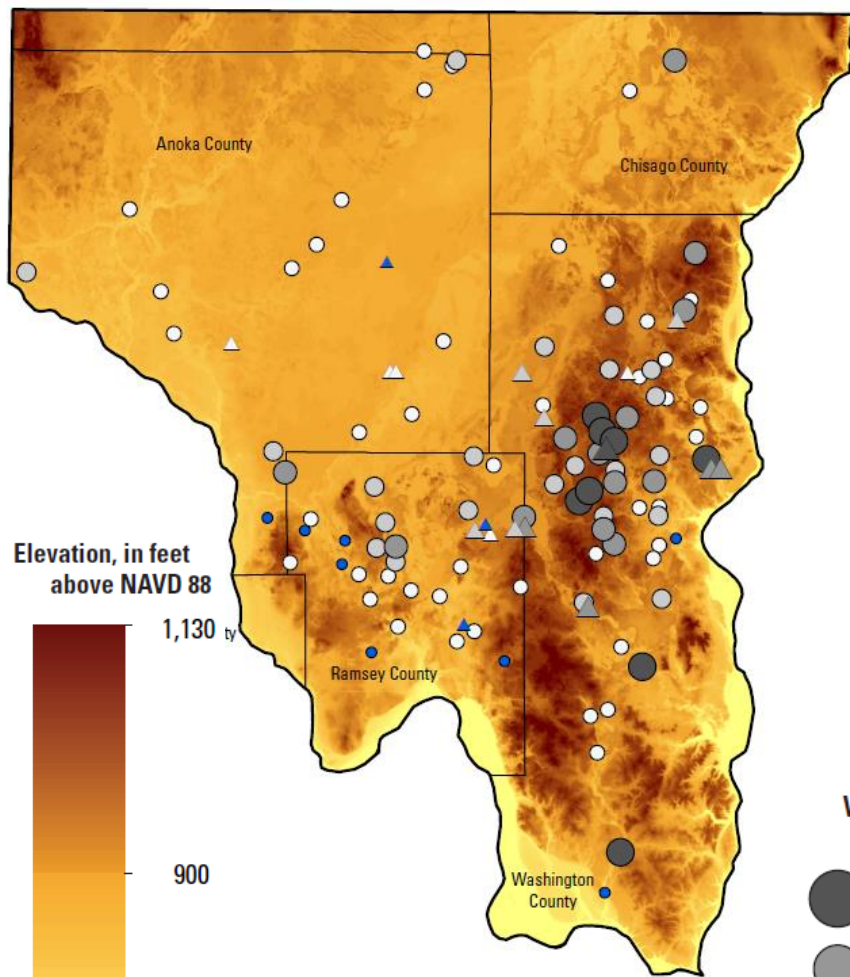
# Closed-basin lake levels declined more at higher elevations similar to groundwater levels



# Geologic Characteristics vs. Lake-level Change (2002-2010)



# Closed-basin lakes – water levels more variable at high elevations, in Superior Lobe deposits

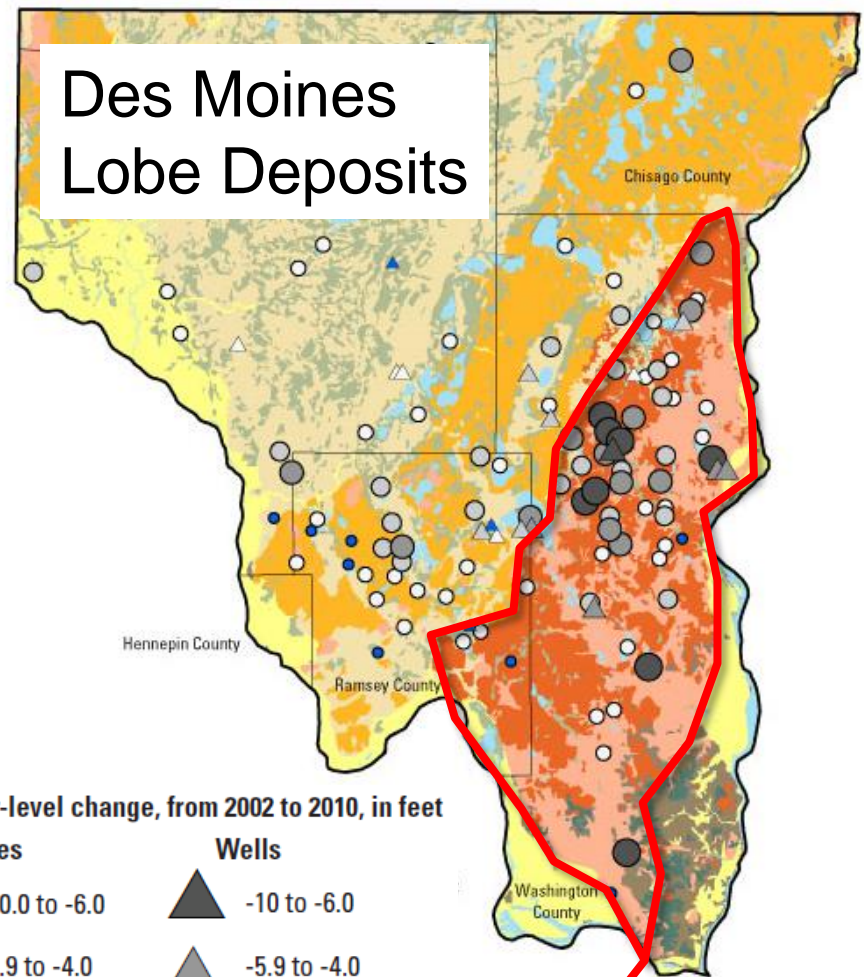


Elevation, in feet above NAVD 88

1,130

900

665



Des Moines Lobe Deposits

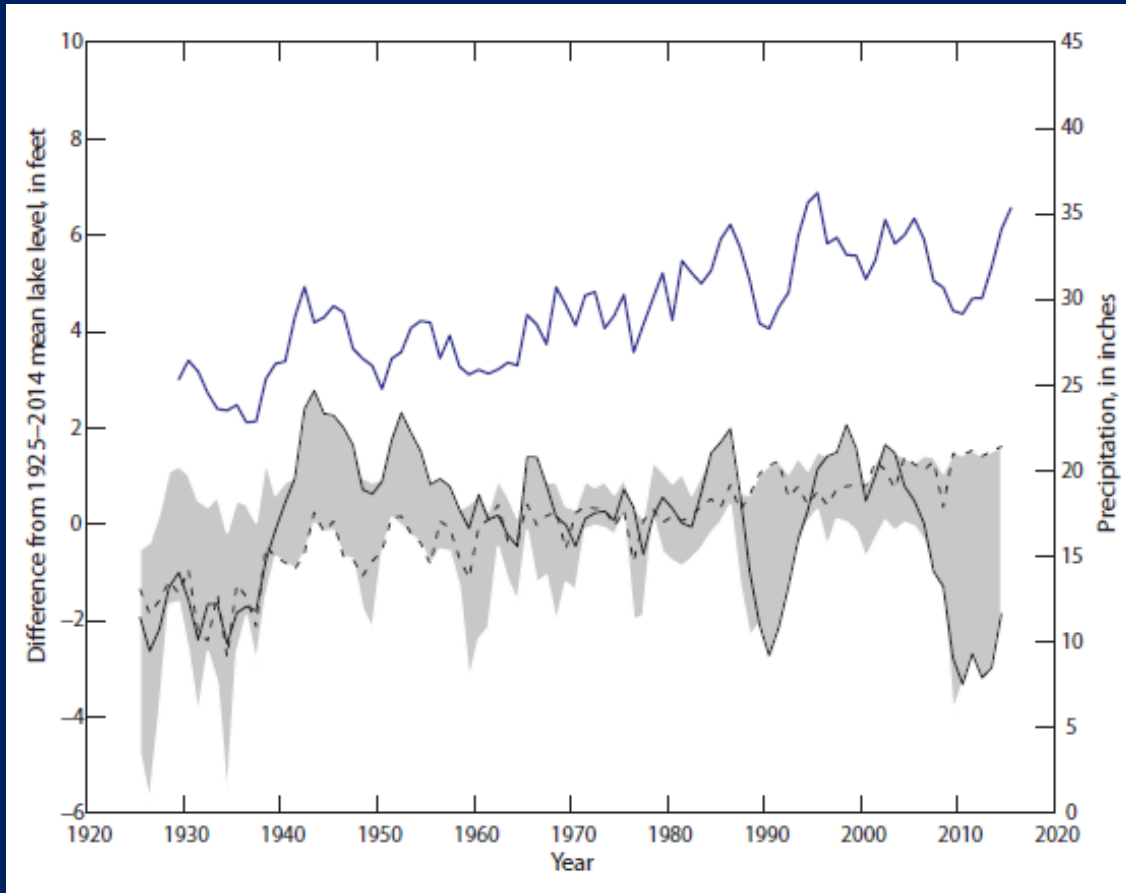
Water-level change, from 2002 to 2010, in feet

- | Lakes           | Wells          |
|-----------------|----------------|
| ● -10.0 to -6.0 | ▲ -10 to -6.0  |
| ● -5.9 to -4.0  | ▲ -5.9 to -4.0 |
| ● -3.9 to -2.0  | ▲ -3.9 to -2.0 |
| ○ -1.9 to 0     | △ -1.9 to 0    |
| ● 0.1 to 2.0    | ▲ 0.1 to 2.0   |

Superior Lobe Deposits

# Long-term analysis (1925-2014)

## White Bear Lake – most variable level



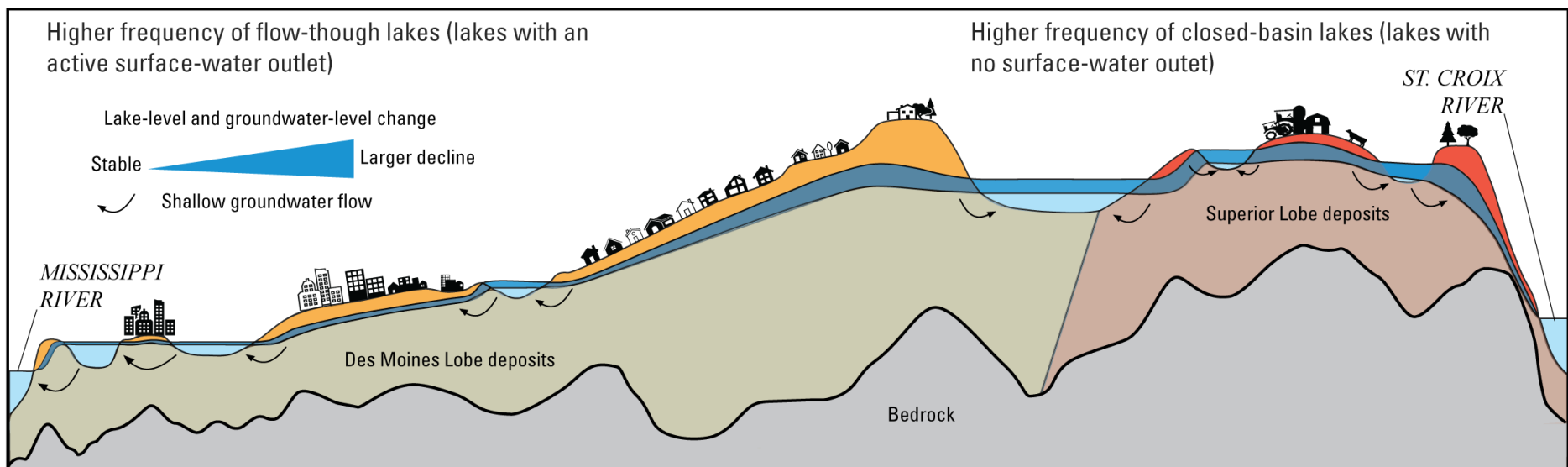
- Range in annual lake-level anomalies- 14 lakes
- White Bear Lake
- - Valentine Lake
- Precip, 5-yr moving average



Annual lake-level anomaly =  
mean annual lake level – long-term mean

# Statistical Analyses of Lake Levels - Results

Lake type (flow-through/closed-basin), elevation, development, and glacial geology were variables affecting lake-level variability



# USGS Reports

Available online

<http://dx.doi.org/10.3133/sir20165139>



Prepared in cooperation with the Metropolitan Council and Minnesota Department of Health

## Statistical Analysis of Lake Levels and Field Study of Groundwater and Surface-Water Exchanges in the Northeast Twin Cities Metropolitan Area, Minnesota, 2002 through 2015

Chapter A of  
**Water Levels and Groundwater and Surface-Water Exchanges in Lakes of the Northeast Twin Cities Metropolitan Area, Minnesota, 2002 through 2015**



Scientific Investigations Report 2016–5139–A

U.S. Department of the Interior  
U.S. Geological Survey

Questions?

