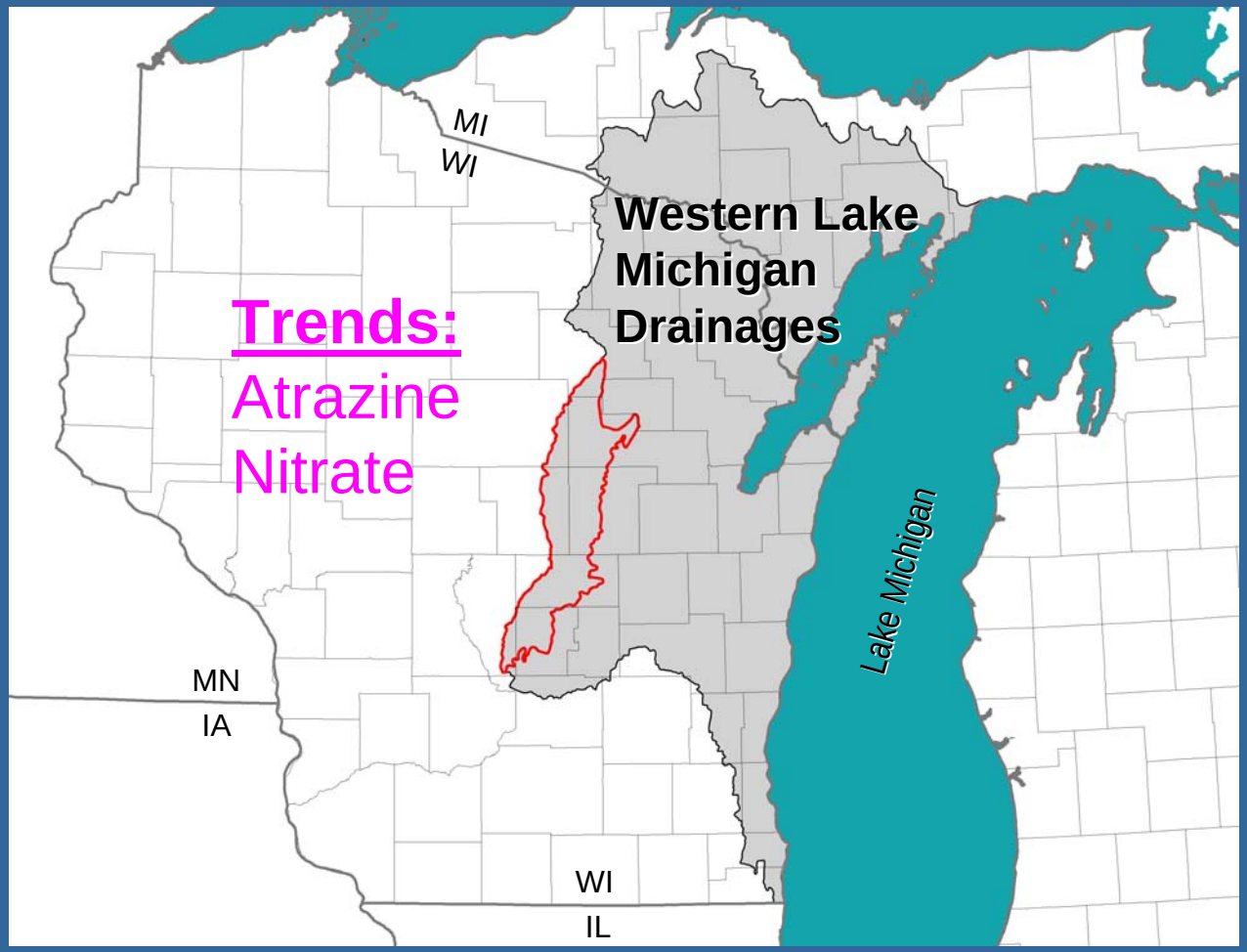
Understanding Agriculture-Related Trends in Ground-Water Quality, Western Lake Michigan Drainages, Wisconsin



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USGS National Water-Quality Assessment Program (NAWQA)

NAWQA Objectives: Describe water-quality status and trends and improve our understanding of natural and anthropogenic factors affecting water-quality conditions in many of the Nation's rivers and aquifers

NAWQA Ground-water Land-Use Studies

Land-use study objective: Status, trends and understanding of factors that affect shallow ground-water quality in an area of specified land use

Presentation focus: Describe trends and factors that affect trends of atrazine and nitrate in shallow ground water in the glacial deposits aquifer in an area of corn/alfalfa rotation

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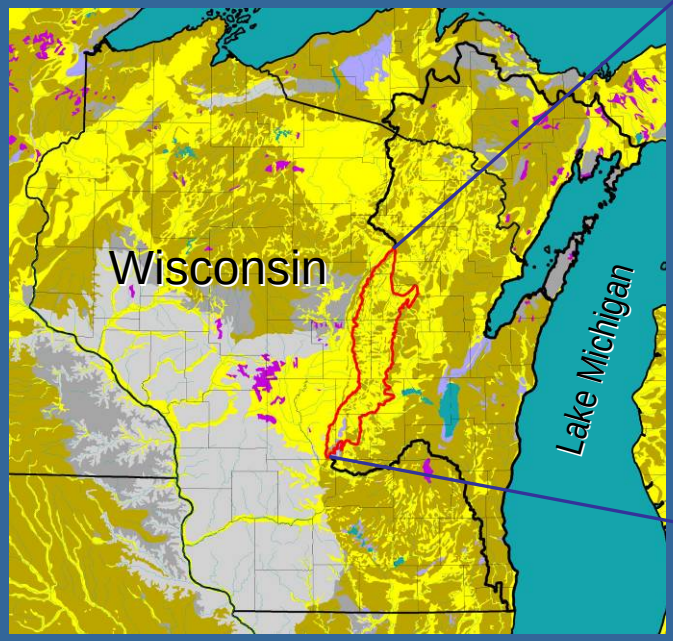
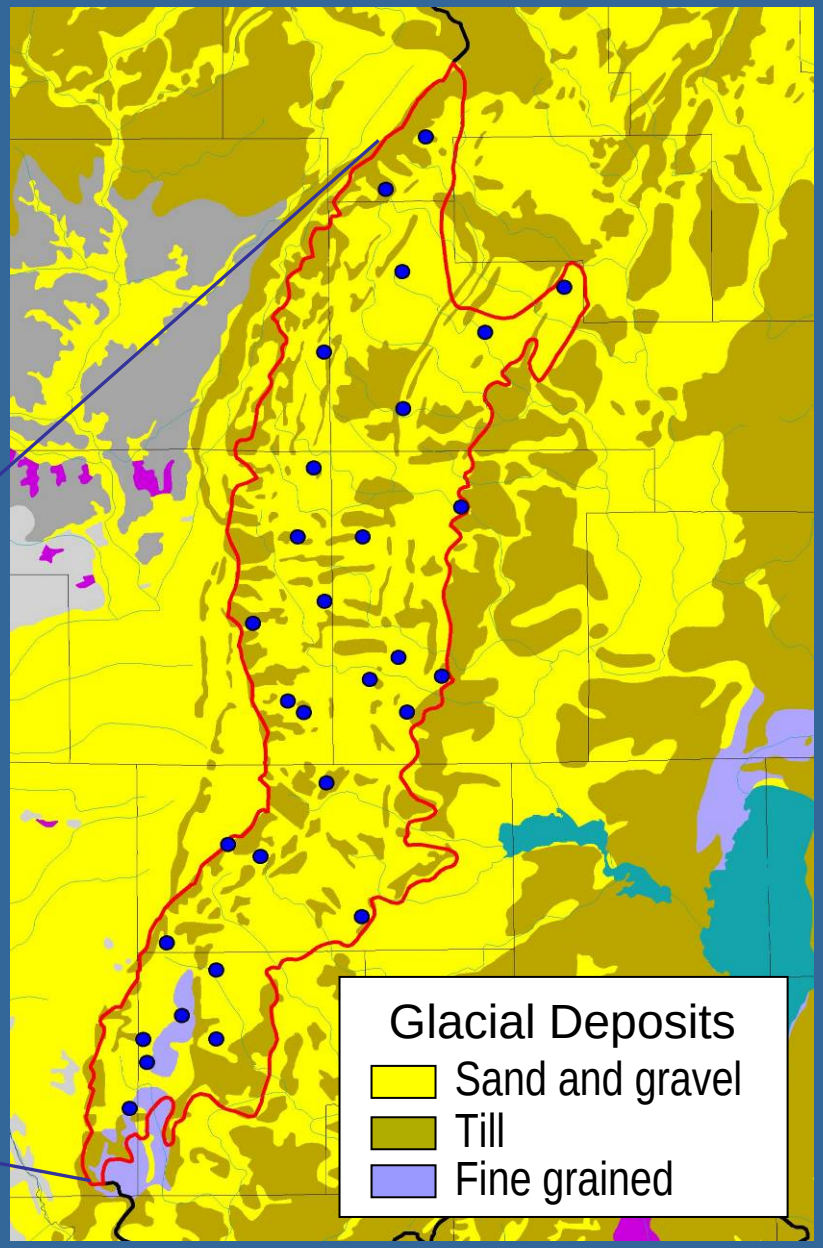
GW Land-use study area:

30 well network (2” pvc)
Glacial Deposits aquifer
LU=Corn/alfalfa rotation (dairy)
Sampled 1994 and 2002

<u>Water Quality</u>
Atrazine or deethyl: 28 of 30 wells
Nitrate: 28 of 30 wells





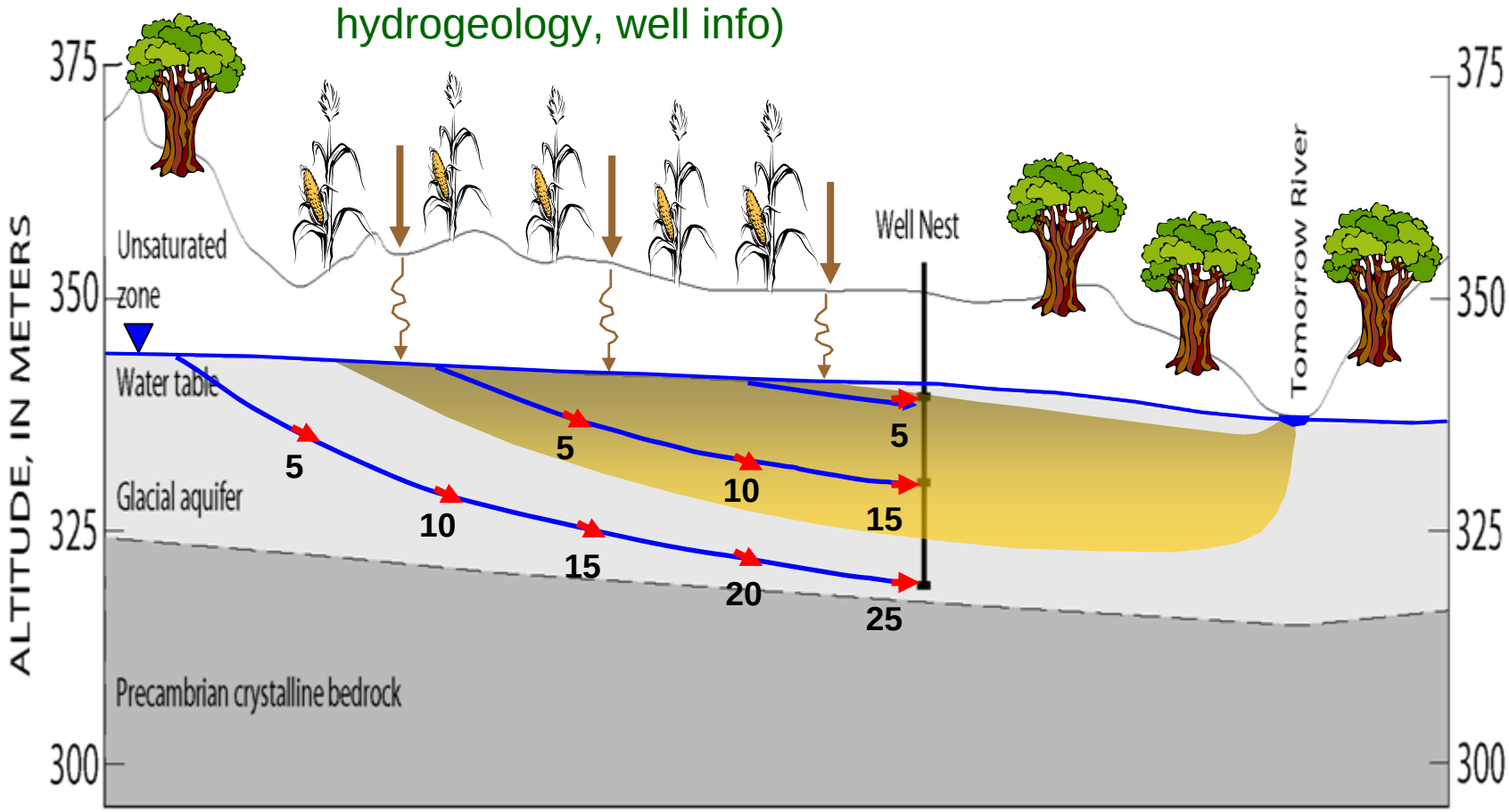
To <u>understand</u> ag related trends in gw quality need to know:

-Input history (ag chem use)

-Source of gw

-Age of gw

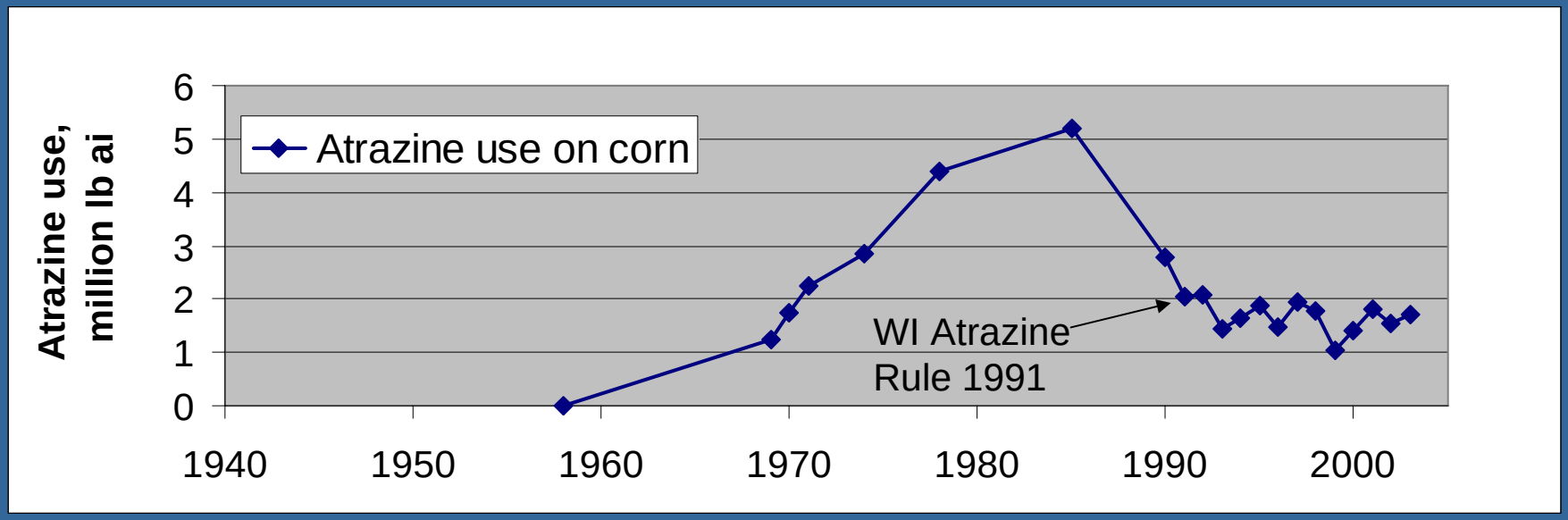
-Other factors (climate, chemistry, soils, hydrogeology, well info)

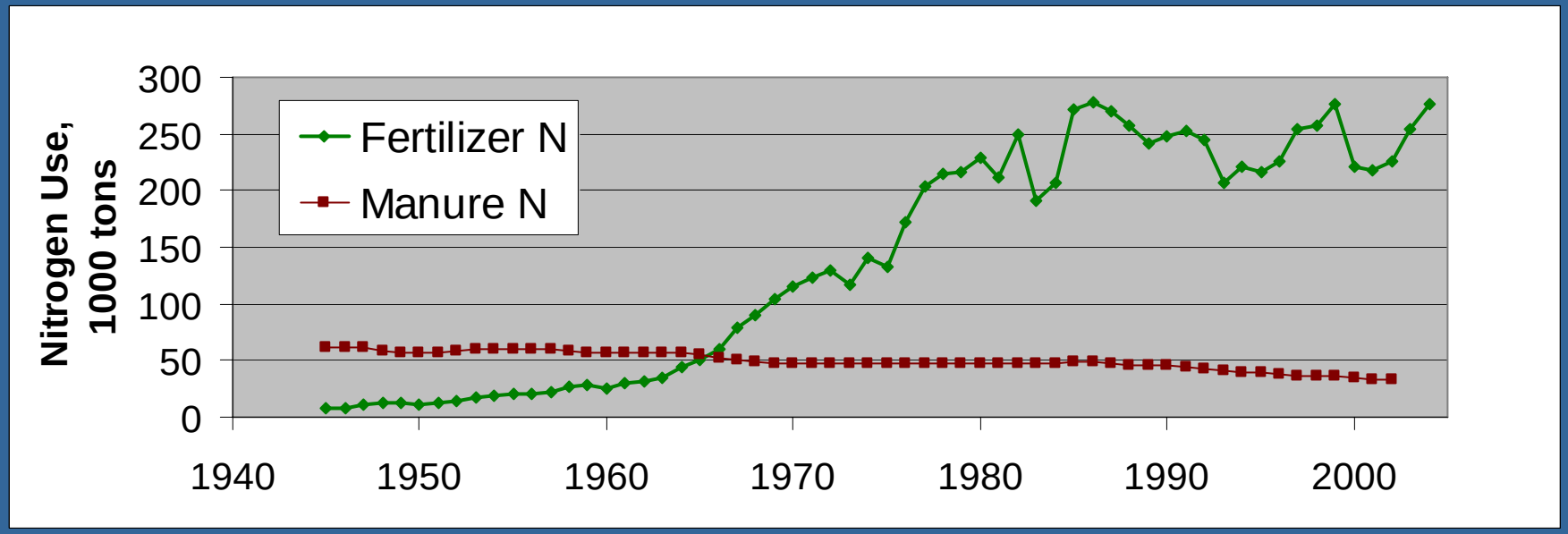


EXPLANATION

→ **5 year Time of Travel**

Input history-Wisconsin Atrazine and Nitrogen Use

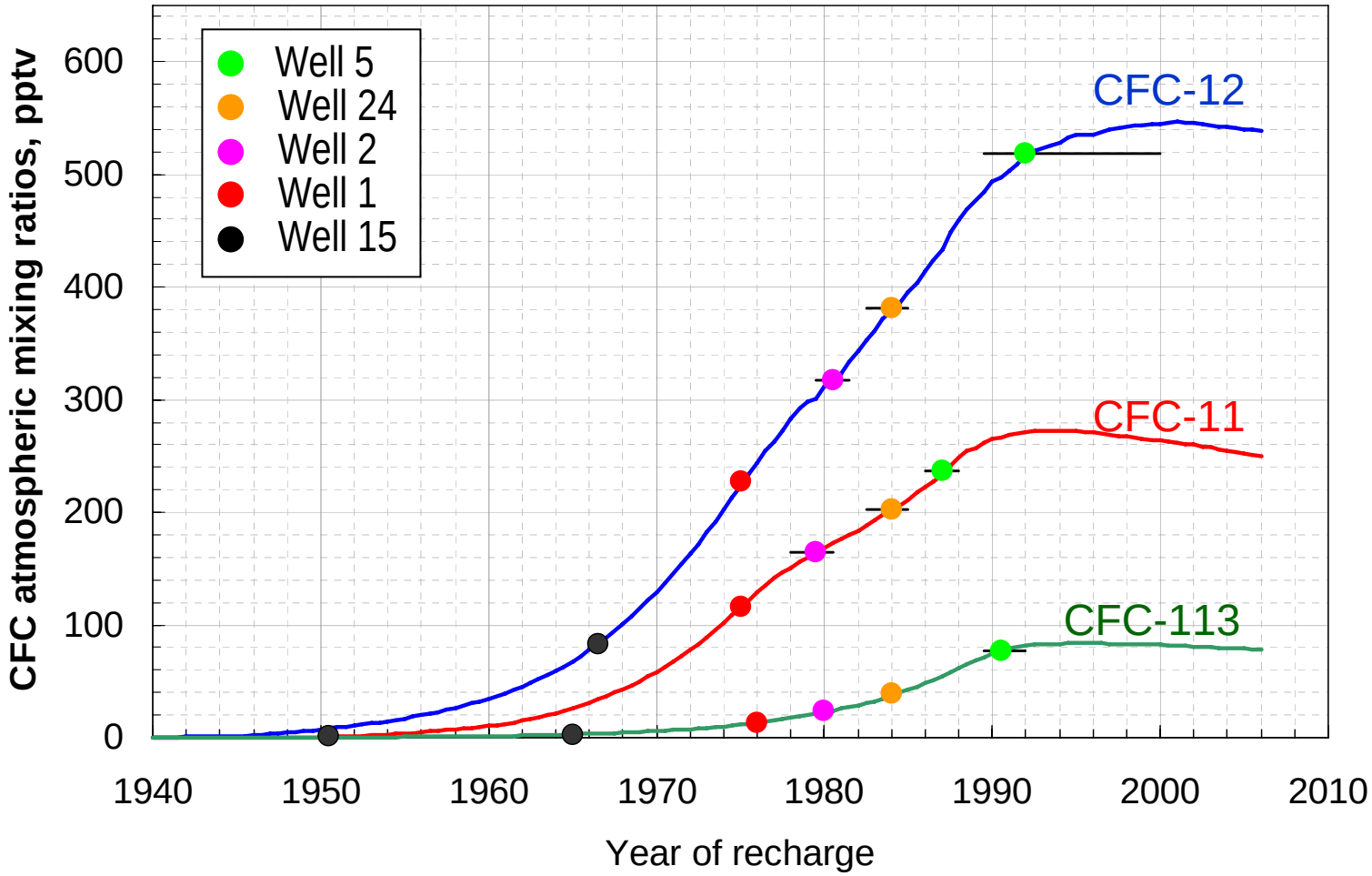




To understand trends in ground-water quality need to know:

- Input history
- Source of ground-water ←Nearby, upgradient
- Age of ground-water ←Chlorofluorocarbons (CFCs)
- Other factors

CFC-based ground-water recharge dates



(Uncertainty based on +/- 1 deg C)

To understand trends in ground-water quality need to know:

- Input history
- Source of ground-water
- Age of ground-water
- Other factors ←Climate (annual precip), Chemistry (DO), Soils (STATSGO), Hydrogeology (Kh), Well Info (depth, WL)

Land-use Study
Trends Analysis:

→Near-decadal changes (using samples collected in 1994 and 2002)

→Trends using ground-water age data

→Correlations to inputs and other factors

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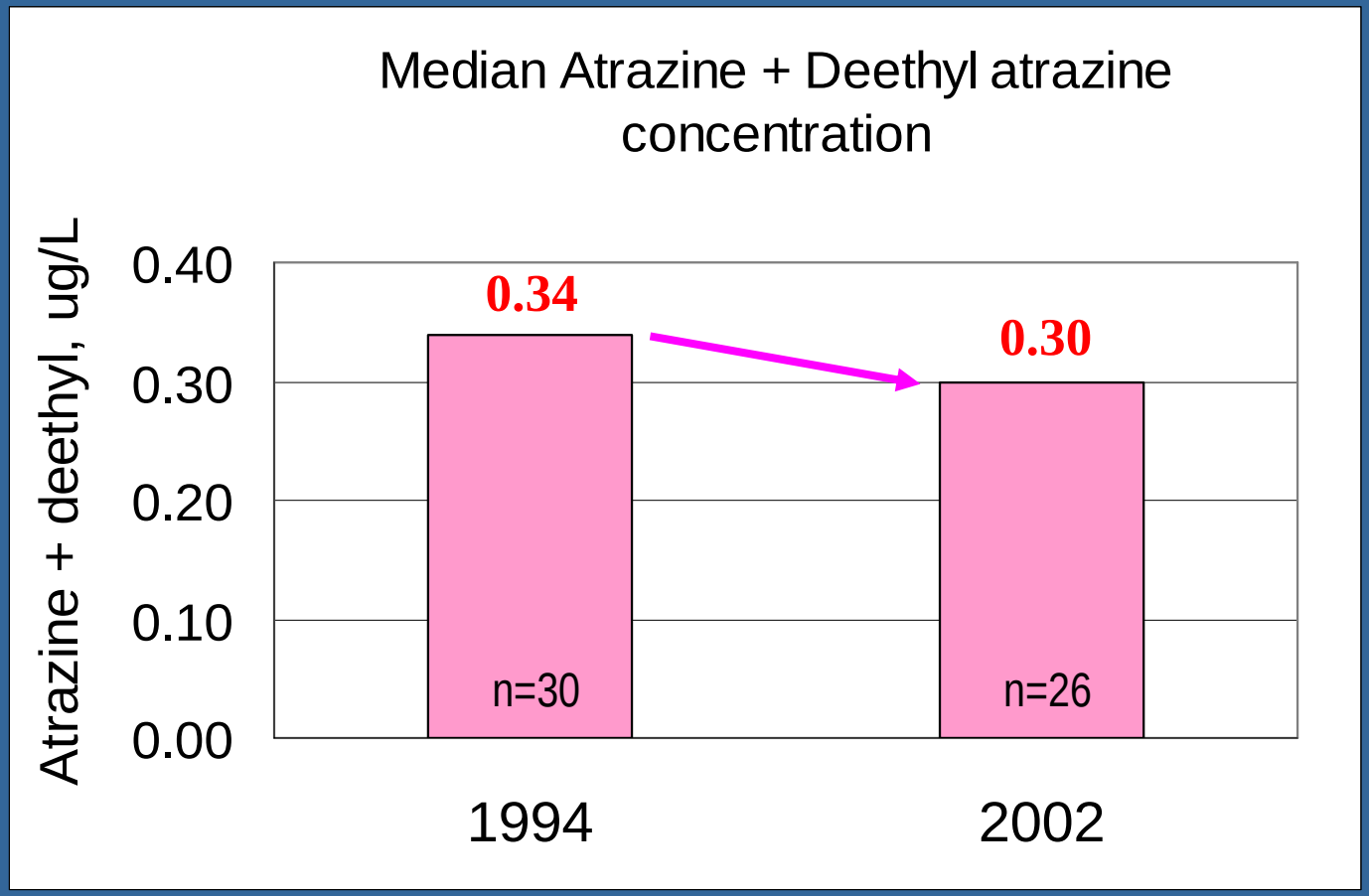
Data adjustments to consider when determining trends in water quality:

Detection limits→ If detection limit changes over time, recensor data to a uniform detection limit.

Sample variability→ Are measured differences greater than known sample variability? If not, difference = 0

Analytical recovery→ Does lab reported conc equal environmental conc? Adjust data for poor recovery.

Near-decadal changes: Atrazine + Deethyl atrazine

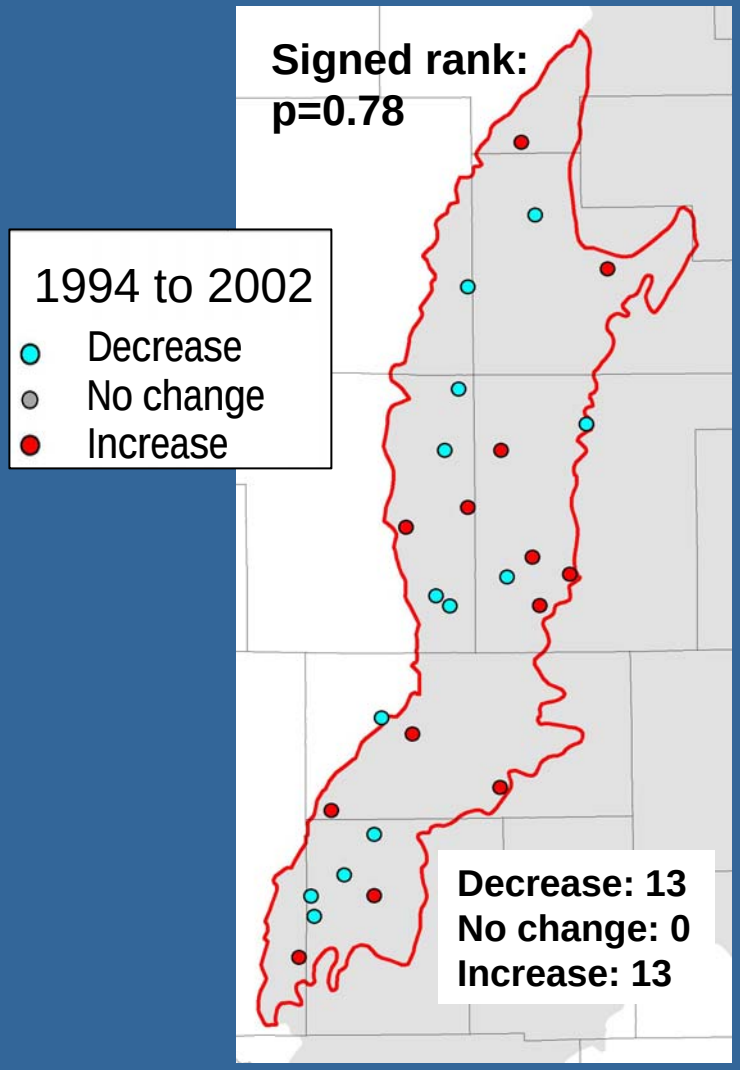


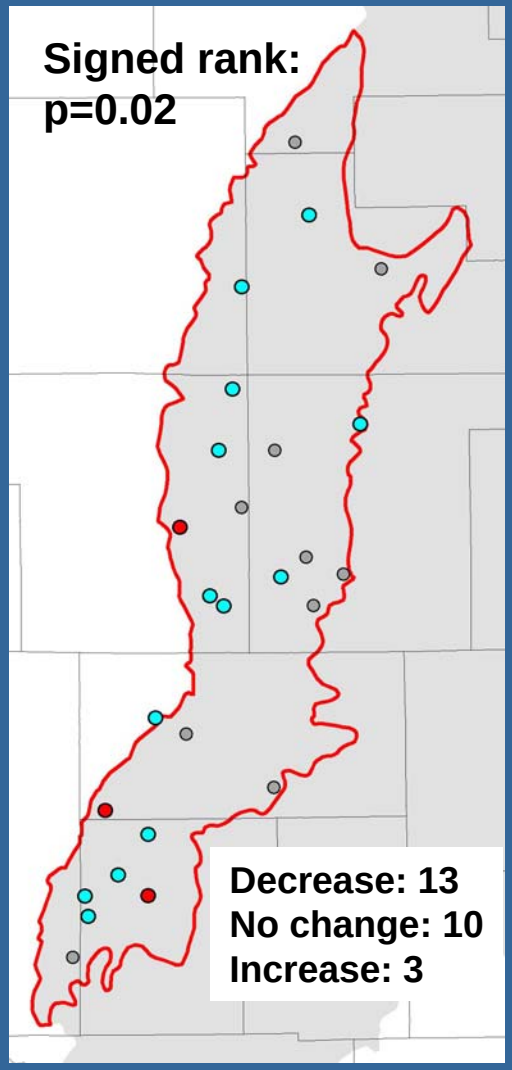
Signed-Rank Test: p=0.02

Data adjustments:

-uniform detect limit
-sample variability
-analytical recovery

Near-decadal changes: Atrazine + Deethyl atrazine

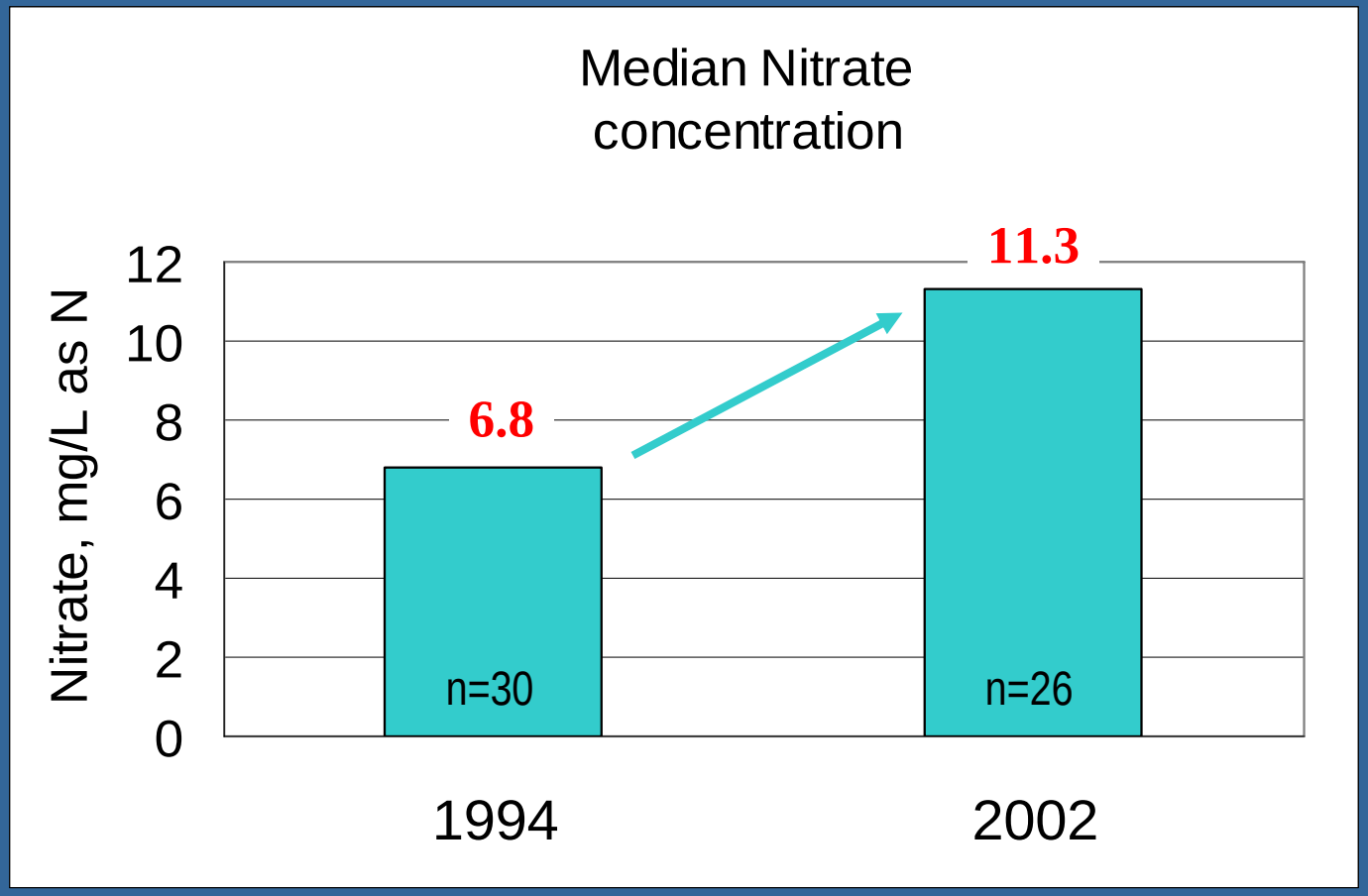




Data adjustments:
-uniform detect limit

-uniform detect limit
-sample variability
-analytical recovery

Near-decadal changes: Nitrate

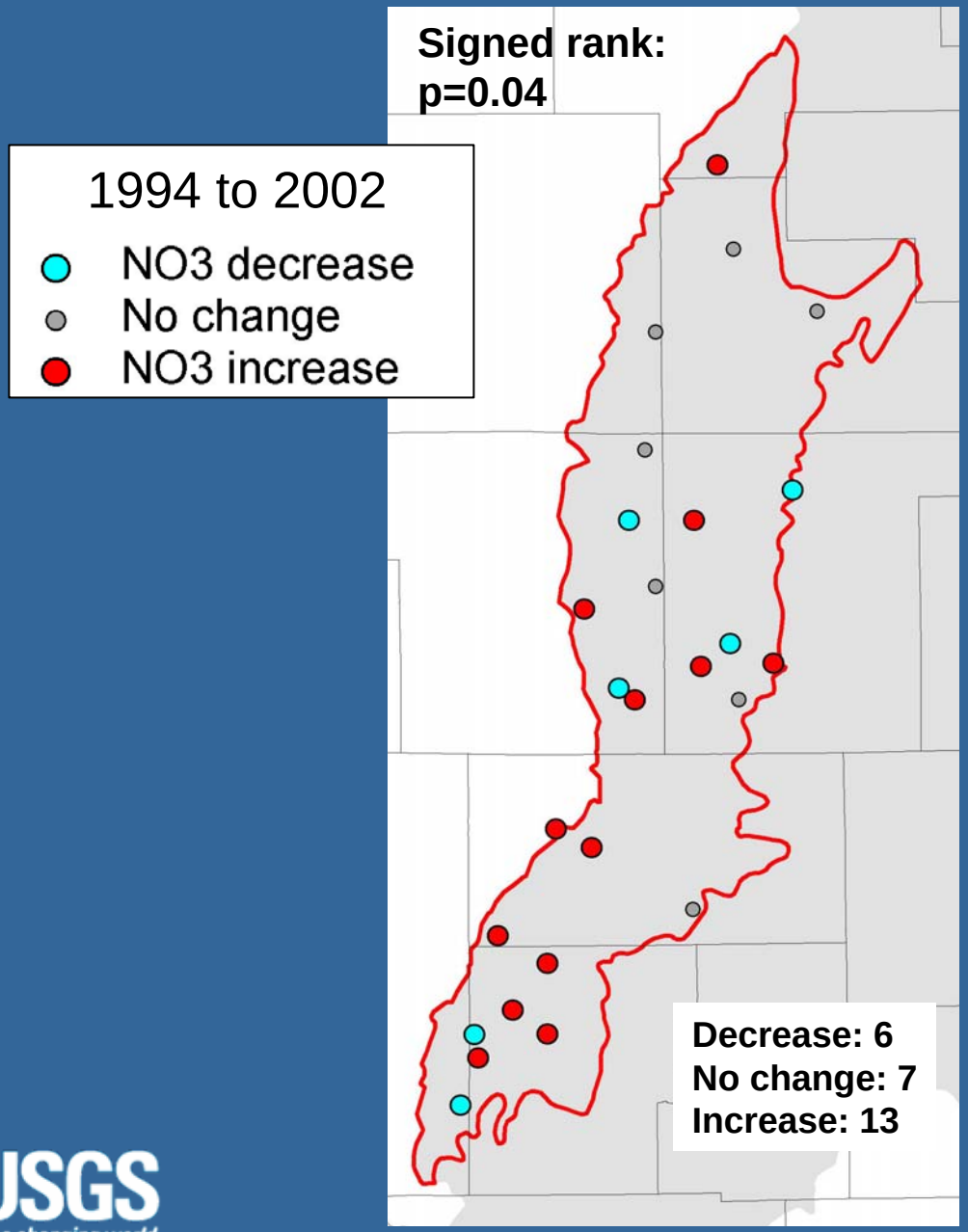


Signed-Rank Test: p=0.04

Data adjustments:

-uniform detect limit
-sample variability

Near-decadal changes: Nitrate

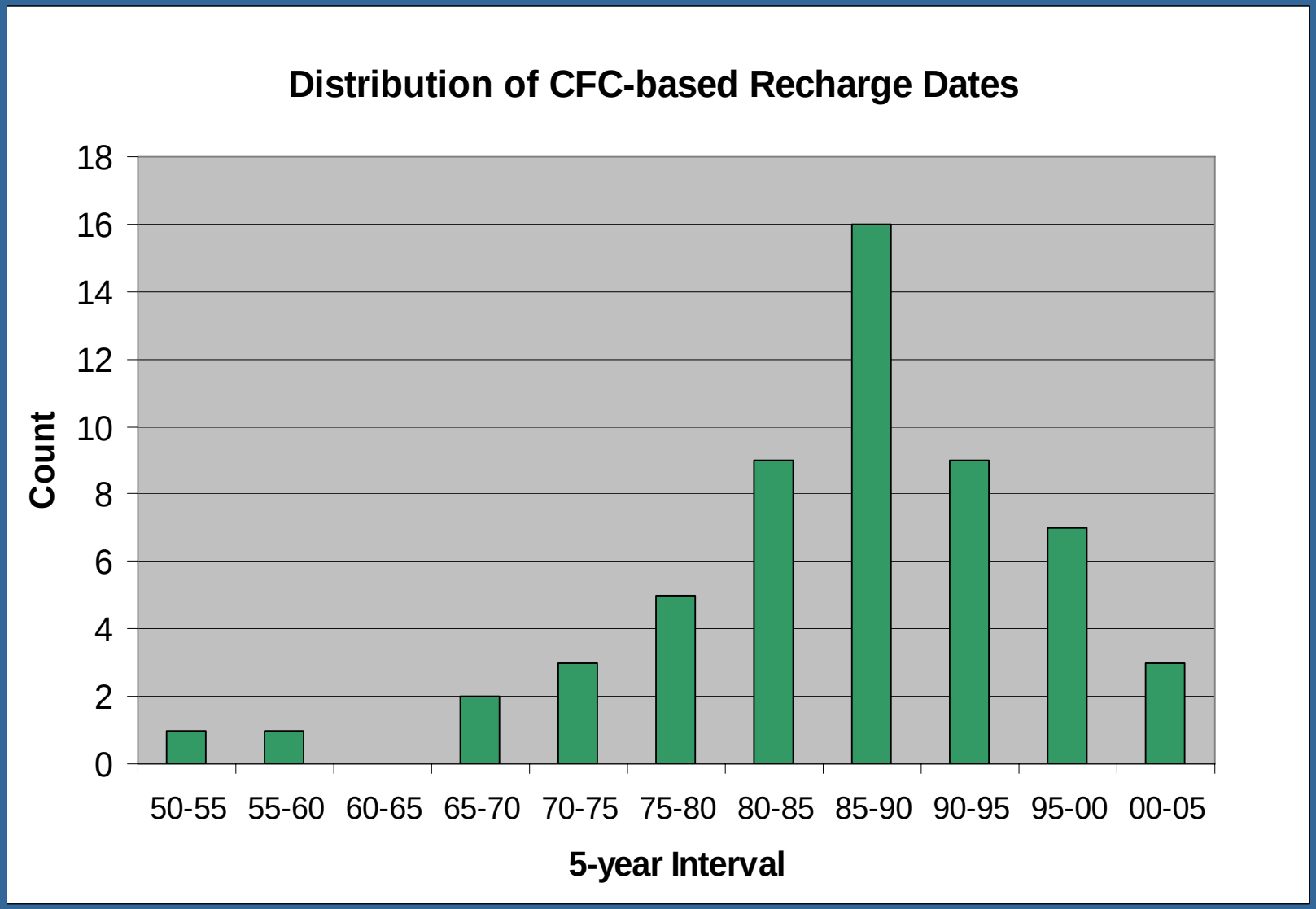


Data adjustments:

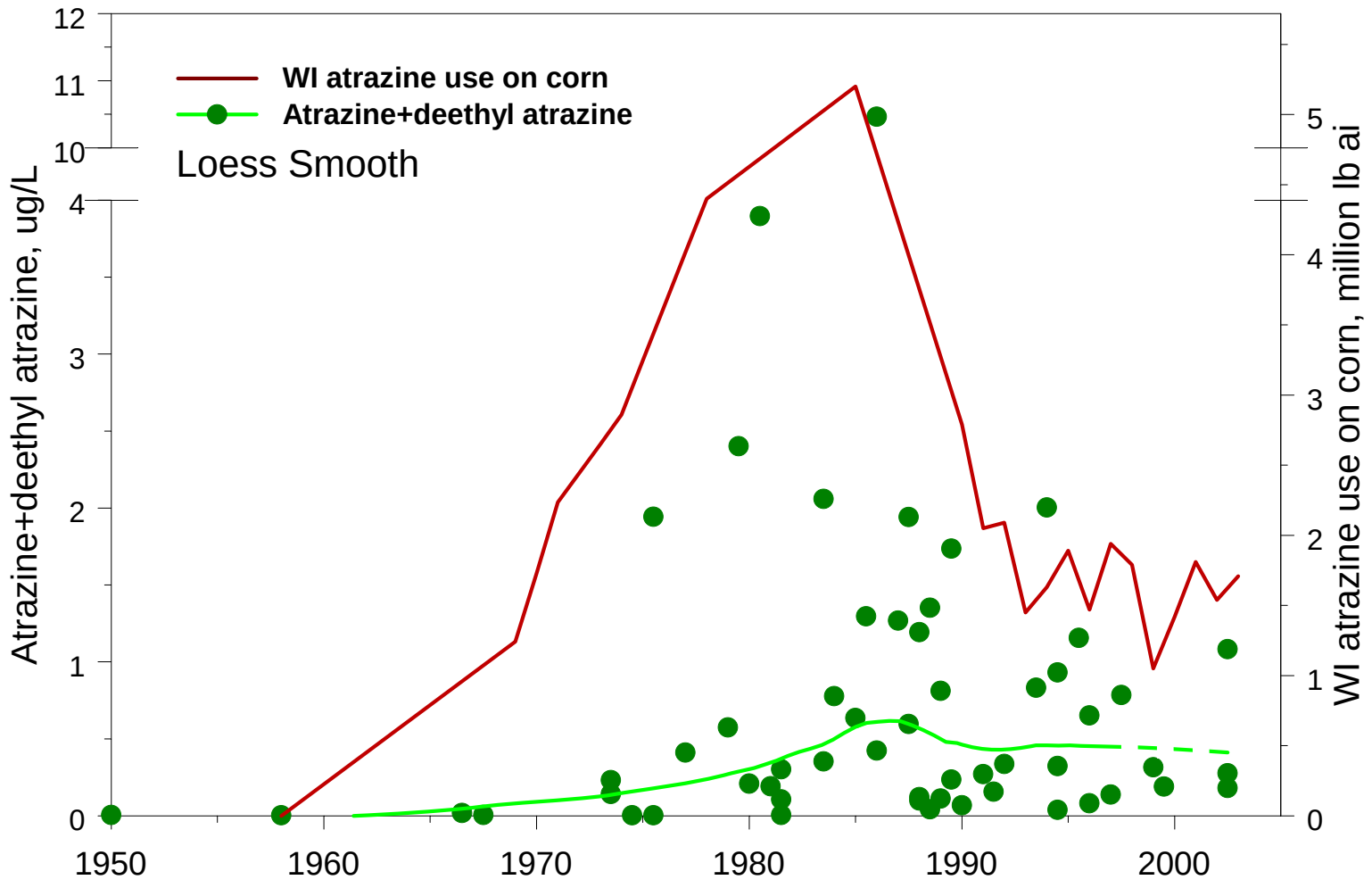
-uniform detect limit

-sample variability

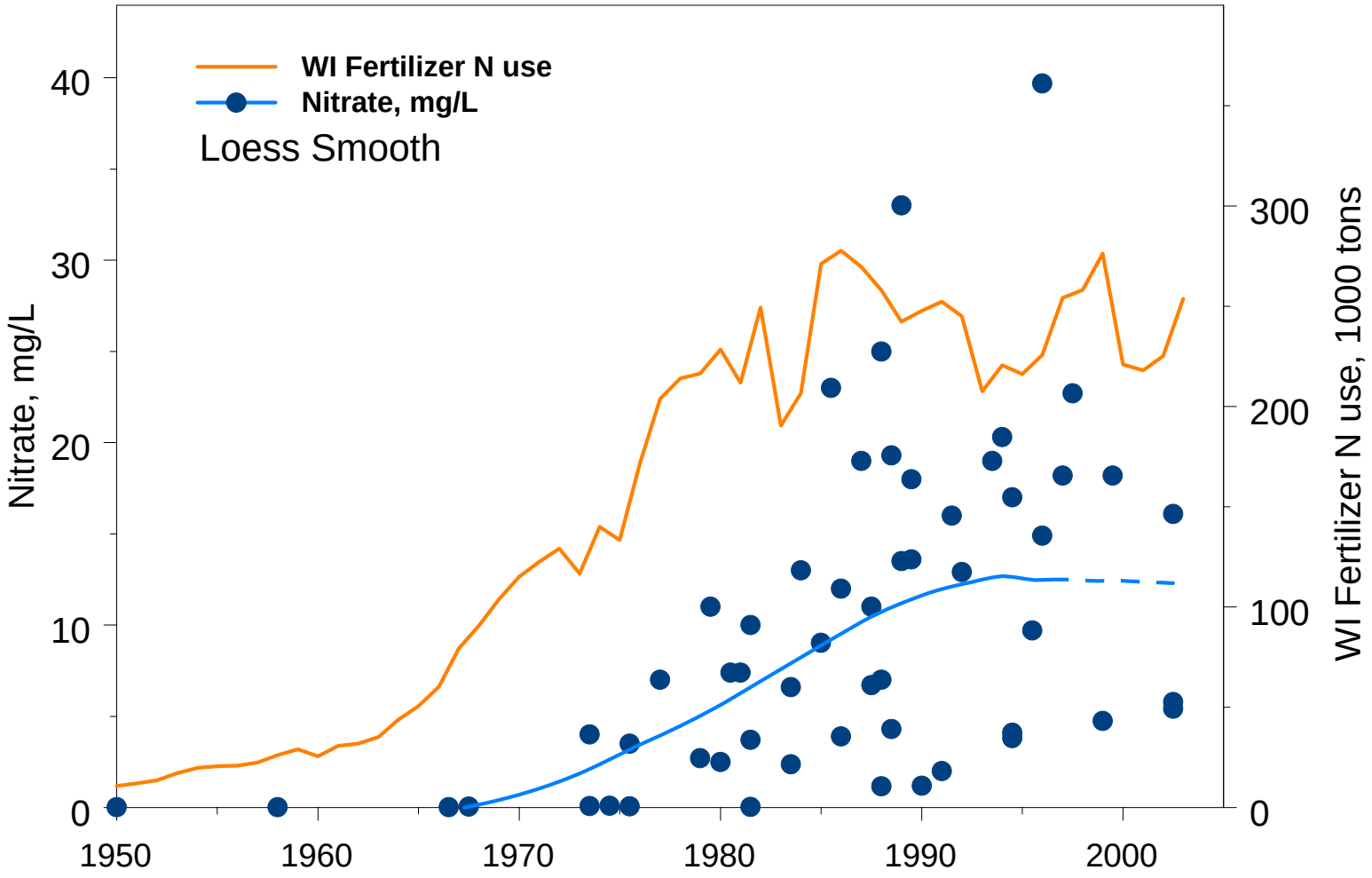
Trends using ground-water age data



Trends using ground-water age data-Atrazine



Trends using ground-water age data-Nitrate



Correlation of ground-water concentrations to inputs and other factors:

Expected Causal Relationships

- Inputs (atrazine/fertilizer use)
- Well info (well depth, water level)
- Hydrogeology, soil characteristics
- Climate (annual precipitation)
- Water chemistry (DO→NO3)

Spearman's Rho correlations

Atrazine + deethyl atrazine:

	rho	p-value	N
Soil perm	.47	.0003	56
Atrazine use	.34	.01	56
Annual precip	.30	.02	56

Spearman's Rho correlations

Nitrate:

	rho	p-value	N
Fertilizer N use	.49	.0001	56
DO	.40	.002	56

Summary and Conclusions

- Atrazine+deethyl→ Significant decrease in ground-water concentrations 1994 to 2002
- Nitrate→ Significant increase in ground-water concentrations 1994 to 2002
- Temporal trends in ground-water concentrations correlated to historical inputs
- Atrazine also correlated to precipitation and soil; Nitrate also correlated to DO

Summary and Conclusions

- Ground-water age data provides valuable information
- Data adjustments are important to consider when determining trends in water quality
- To understand trends in ground-water quality need to know more than just changes in concentration.