Spatial and Temporal Variability of Nitrate and Selected Pesticides in Ground Water from the Great Valley Carbonate Region

Linda Debrewer
U.S. Geological Survey

Outline

- Purpose and Scope
- PODL Study Area
- Great Valley Carbonate Region
  - Description of Study Area
  - Agricultural land use well network
  - Water Quality (nitrate and pesticides)
- Next steps

Purpose and Scope

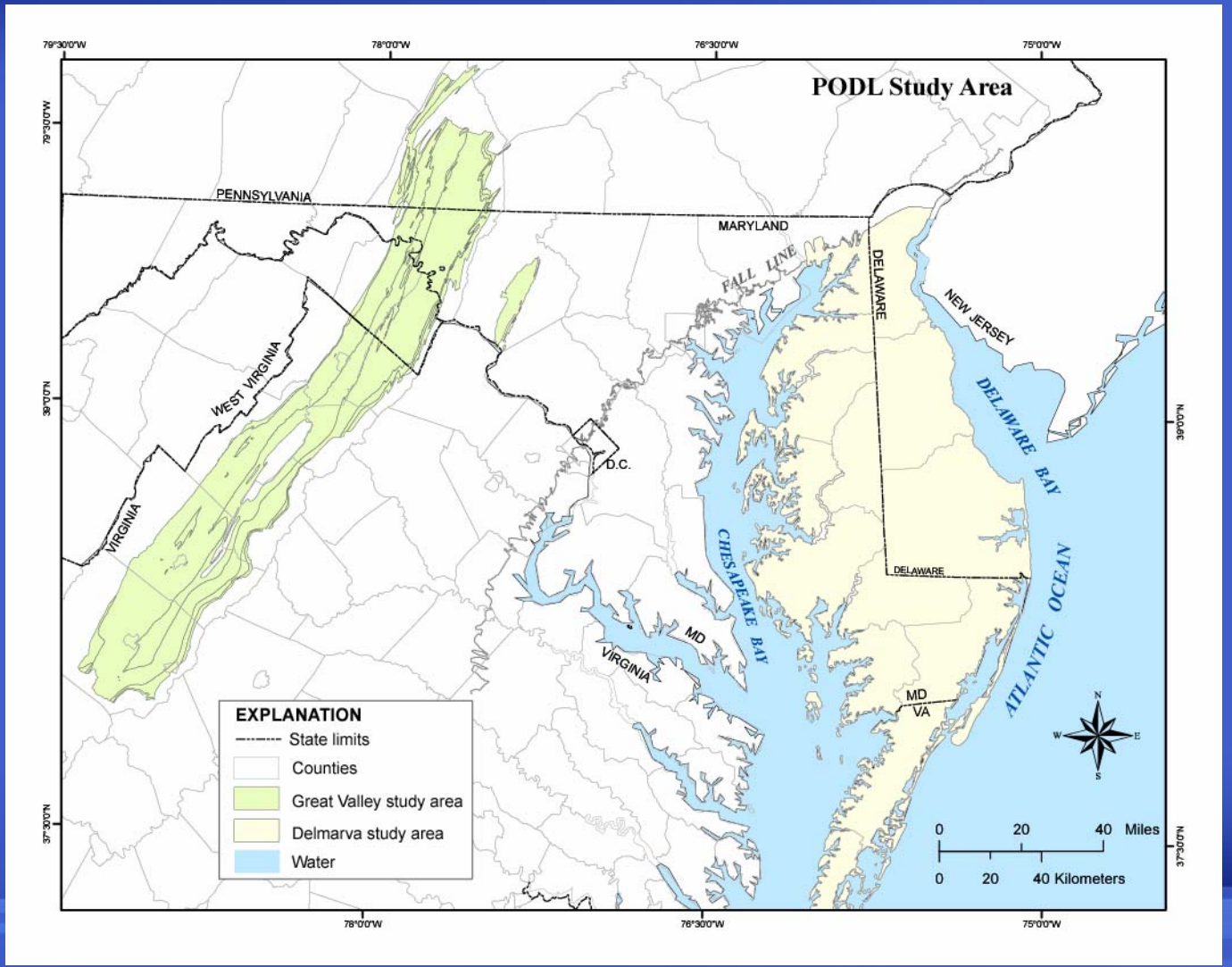
- Purpose

  Evaluate spatial and temporal variability in nitrate and selected pesticides in the Great Valley Carbonate region of the Potomac River Basin

- Scope

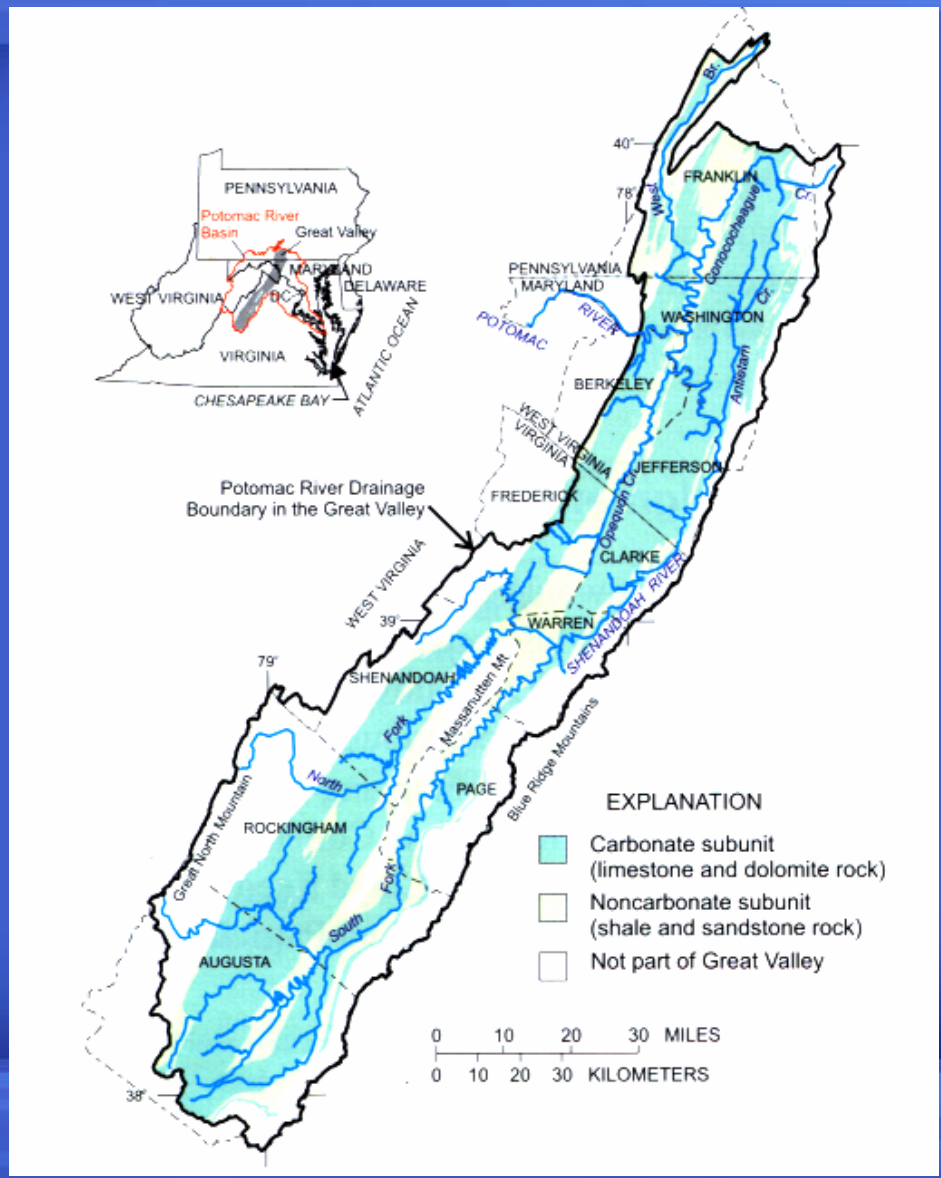
  Analysis of ground-water samples from domestic wells on three temporal scales: decadal (24), annual (5), and quarterly (5)

Study Area


PODL Study Area
PENNSYLVANIA
MARYLAND
DELAWARE
NEW JERSEY
WEST VIRGINIA
VIRGINIA
D.C.
FALL LINE
DELAWARE BAY
CHESAPEAKE BAY
ATLANTIC OCEAN
MD
VIRGINIA
MD
VA
DELAWARE
EXPLANATION
State limits
Counties
Great Valley study area
Delmarva study area
Water
0 20 40 Miles
0 20 40 Kilometers
79°30'0"W
78°0'0"W
76°30'0"W
75°0'0"W
39°0'0"N
38°0'0"N
37°30'0"N

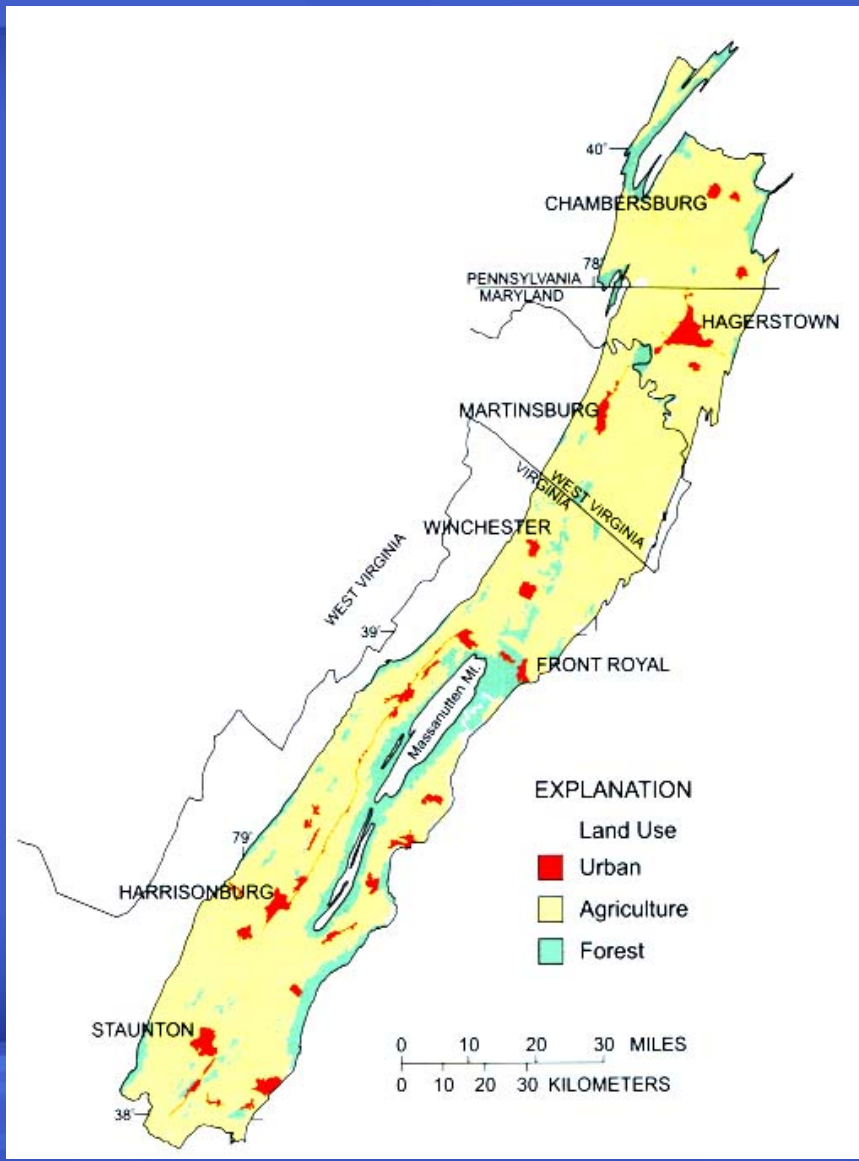
Great Valley Carbonate Region

- Potomac River basin (14,670 mi^2) contributes about 15% of inflow to Chesapeake Bay
- Great Valley carbonate subunit (3,070 mi^2) of Valley and Ridge physiographic province
- Bounded by Great North Mountain and Blue Ridge Mountains and contains Massanutten Mountain
- Limestone and dolomite carbonate rock
  - Susceptible to dissolution (karstic features)

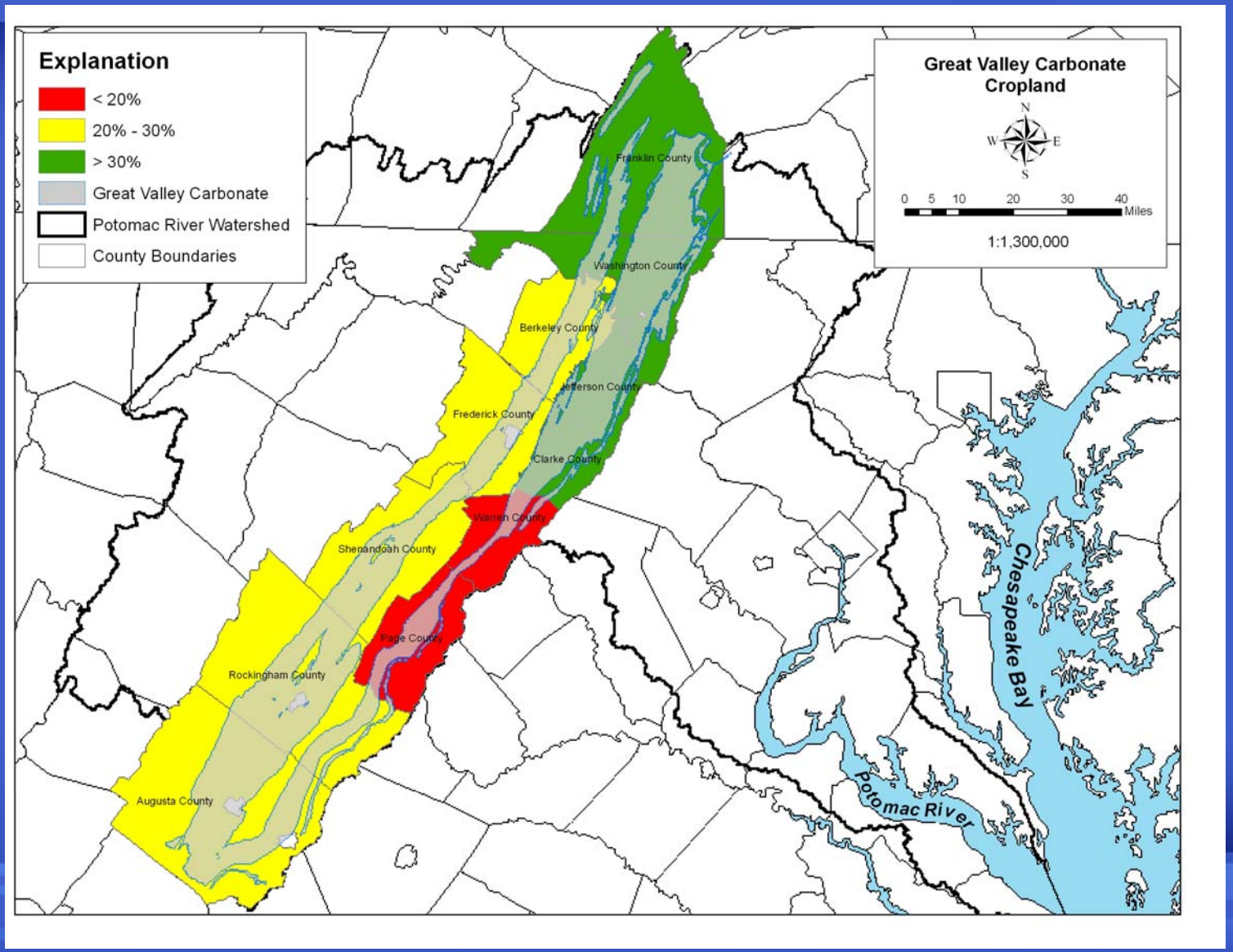


Great Valley Carbonate Region

- 75% of land use is agriculture
- Row crop: corn, wheat, barley, soybeans, oats
- Pasture: includes hay and alfalfa
- Orchards: apples and peaches
- Dairy operations
- Poultry operations



Great Valley Carbonate Region



Great Valley Carbonate Region

- Water primarily stored in and moves through fractures in the bedrock
- Secondary openings may be enlarged due to dissolution of carbonate rock
- Water tends to flow horizontally, discharging into surface-water bodies
- Over 80% of total streamflow is from ground water (baseflow) in carbonate rocks, although locally may encounter losing streams

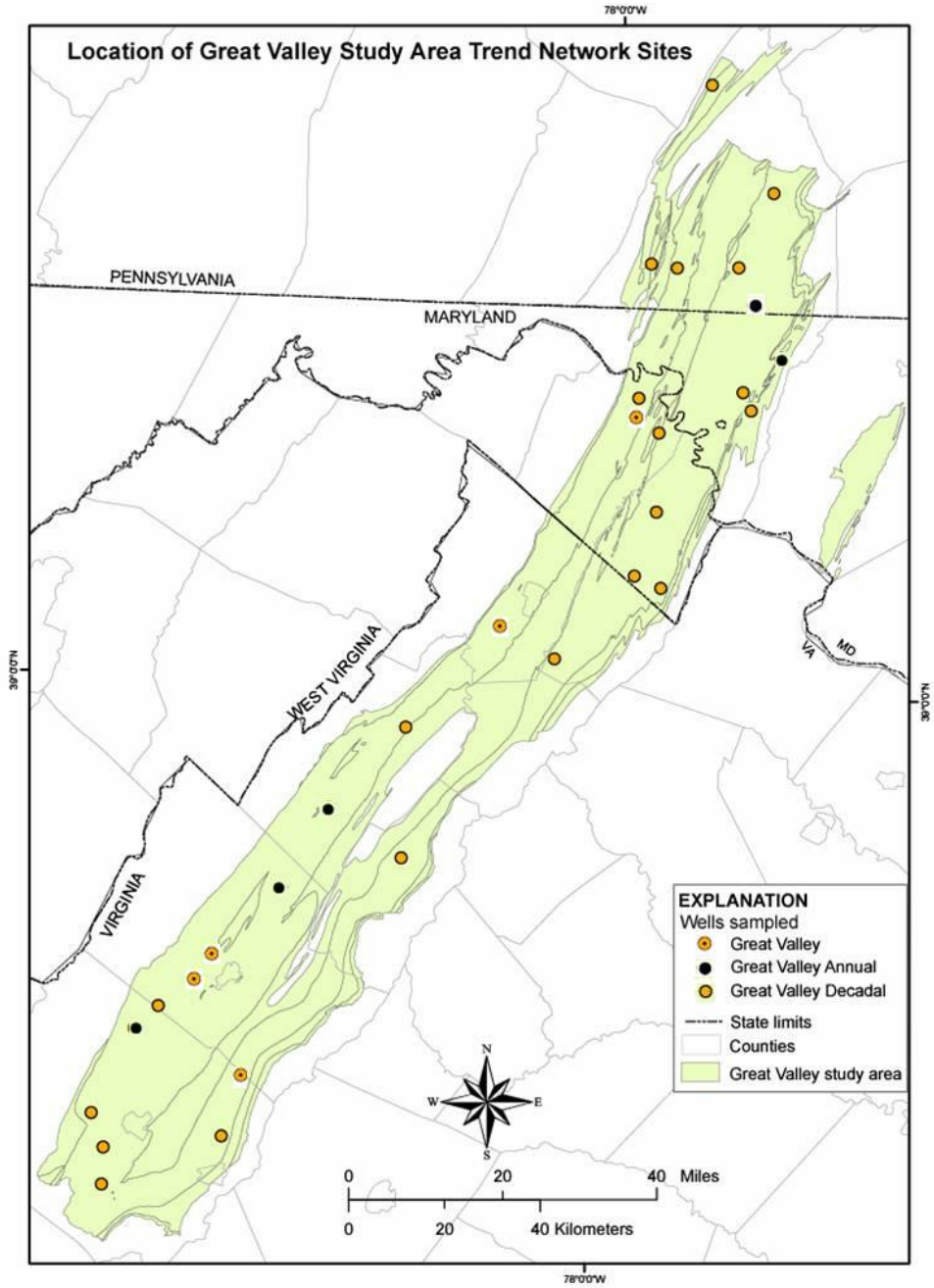
Well Networks

Network	Sample Dates	Well Depth	Purpose
Great Valley (29)	2002	75-360, med 155	Spatial trends
Great Valley (24)	1993 and 2002	75-290, med 148	Decadal trends
Great Valley (5)	1993, 1999, 2000, 2001, 2002, 2004	65-235, med 166	Annual trends
Great Valley (5)	WY2005	100-235, med 150	Quarterly trends

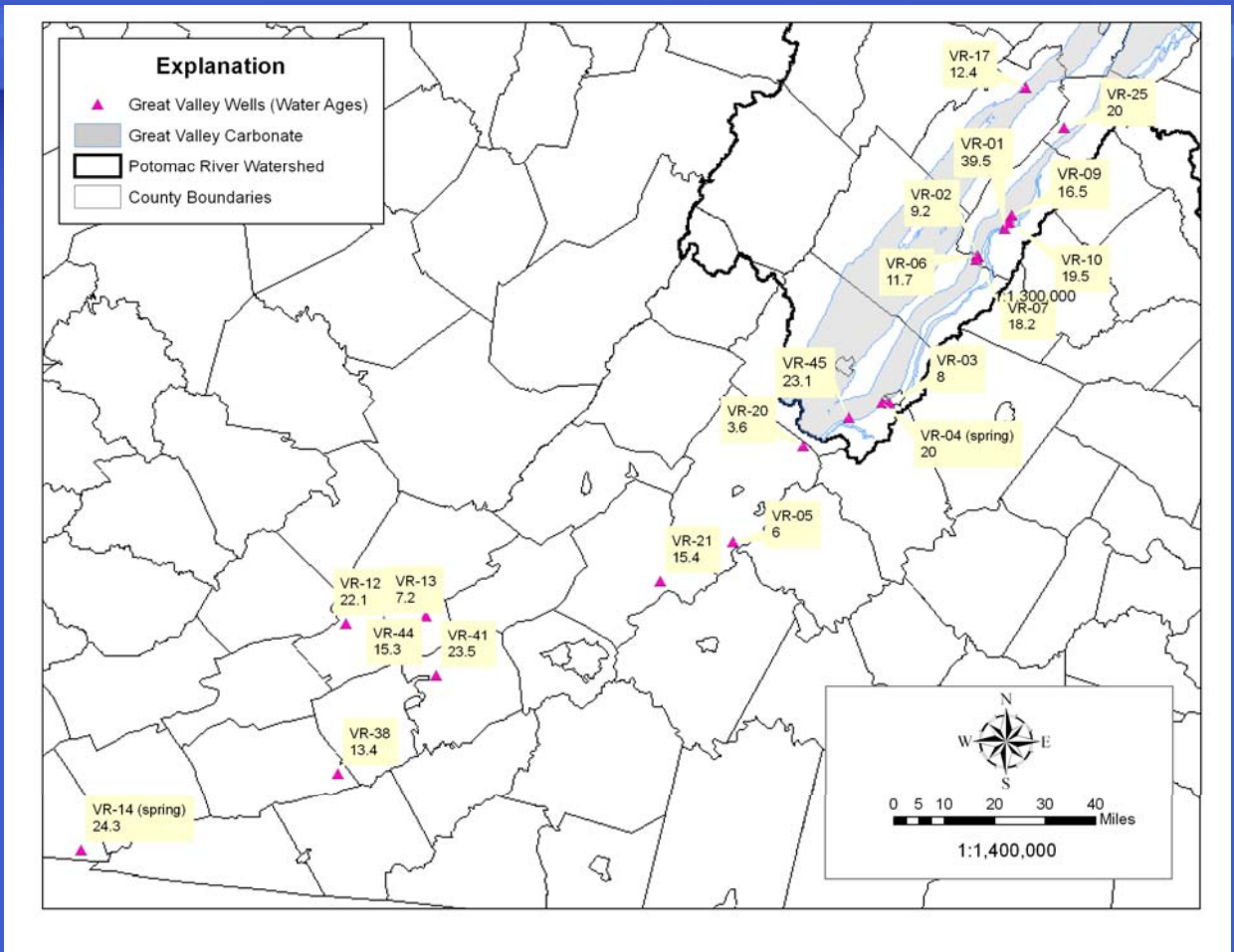
Well Networks

Randomly selected domestic wells

Network extends from Franklin County, Pennsylvania to the north to Augusta County, Virginia to the south



Ground Water Age Dates

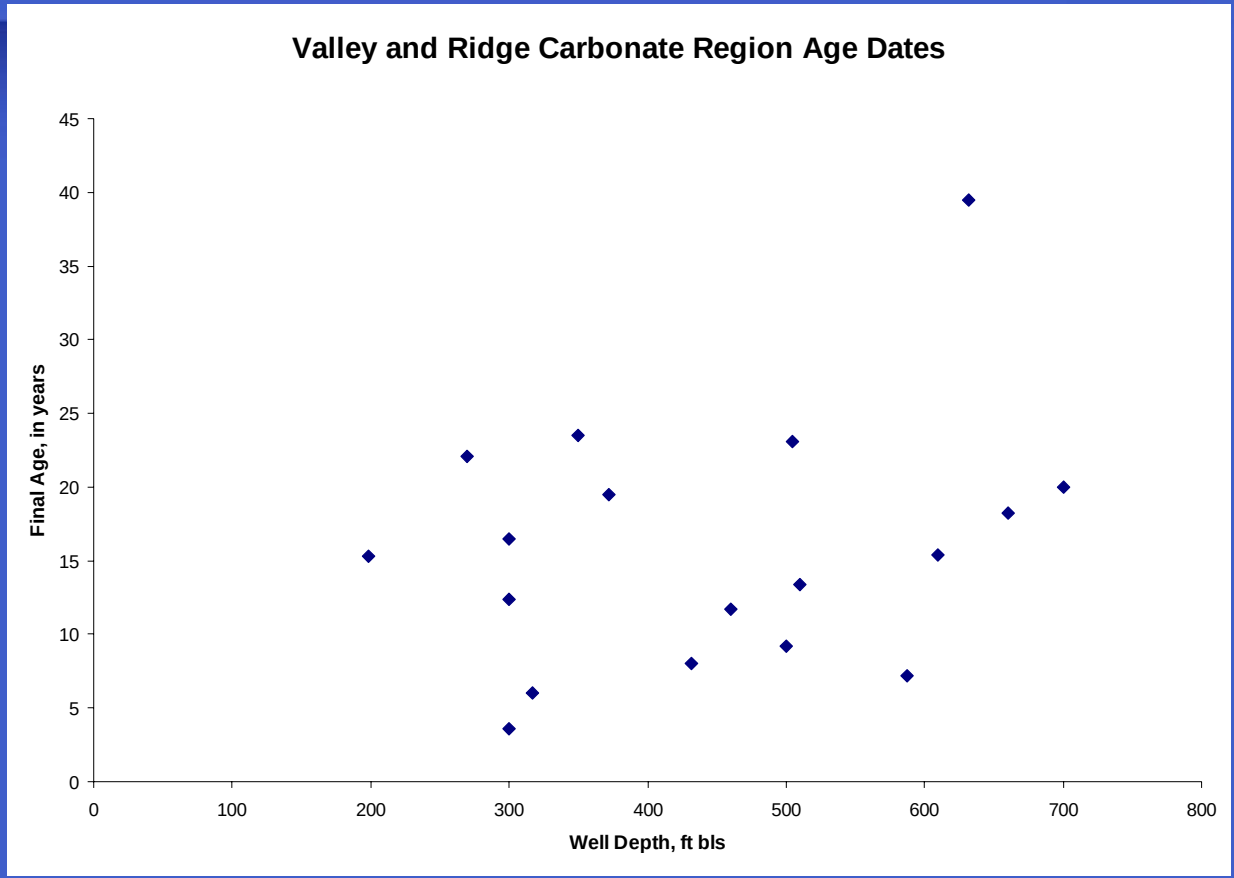


From Nelms and others, 2003

18 wells and 2 springs in VR Carbonate (well depths: 198 to 700 feet)

Apparent age range 3.6 to 39.5 years (median 16 years)

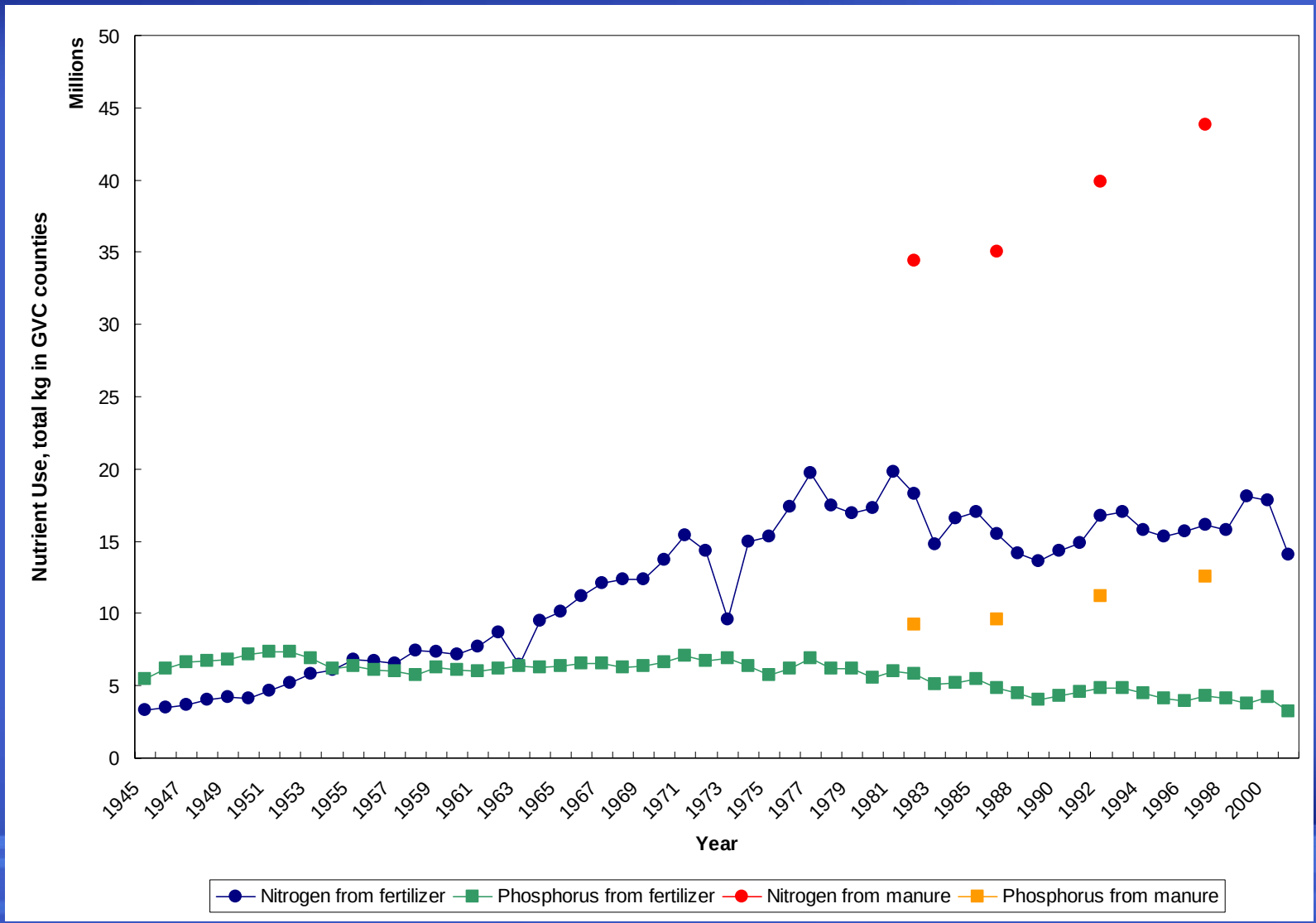
Ground Water Age Dates



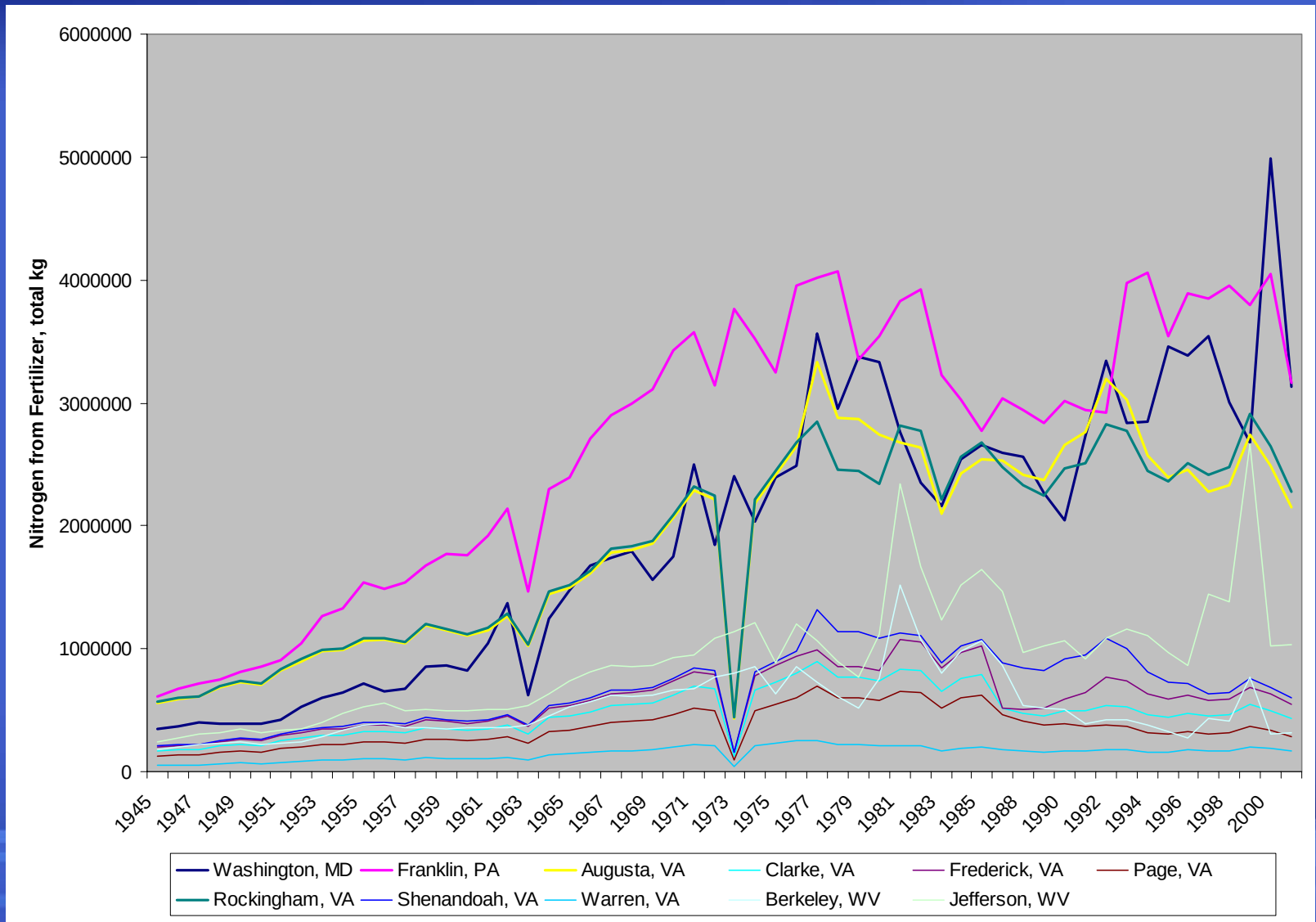
No significant correlation between well depth and apparent age

Assume ground water in Great Valley Carbonate Region less than 25 years old

Great Valley Carbonate Region Nutrient Use



Great Valley Carbonate Region Nutrient Use



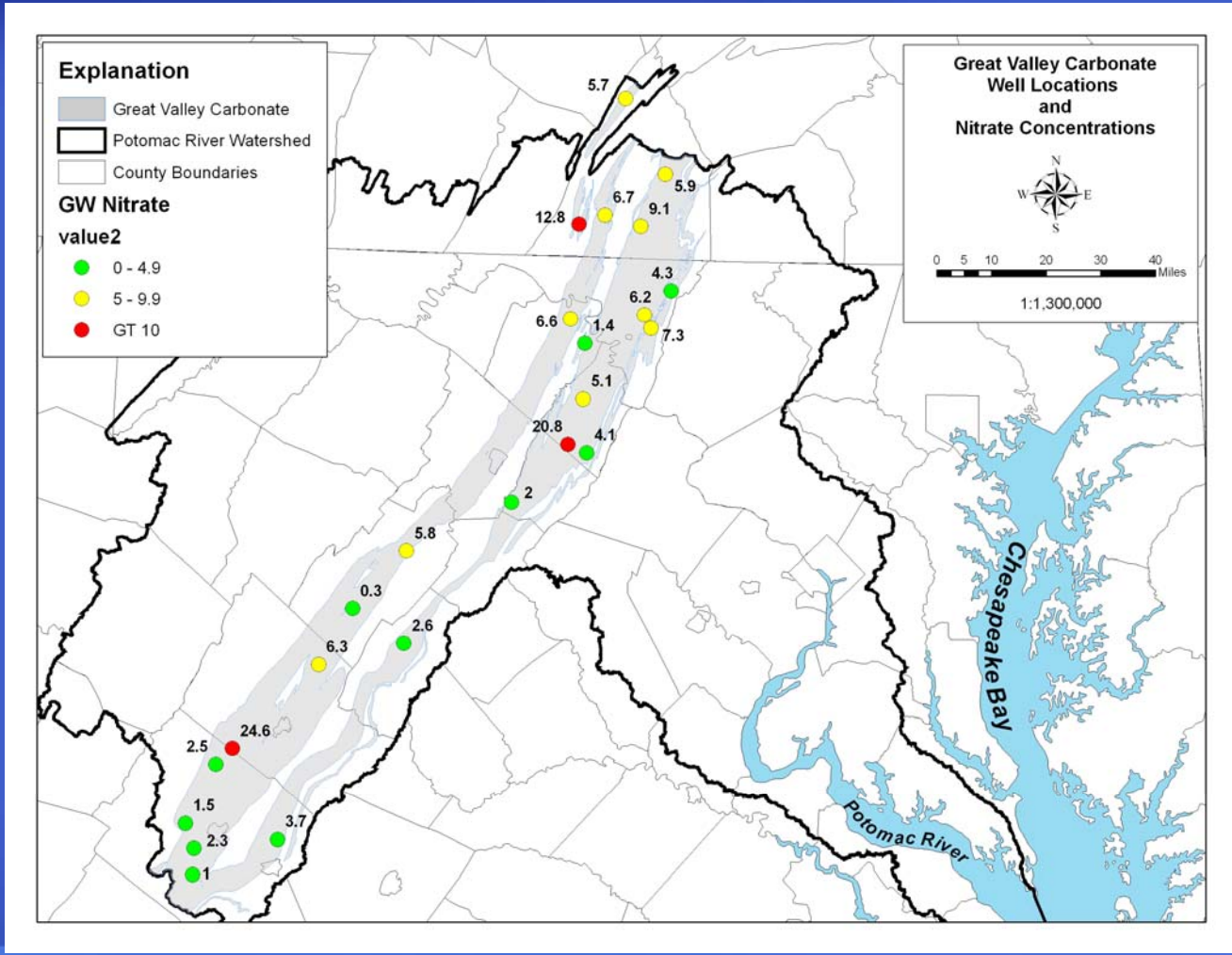
Spatial Trends in Nitrate

Above reporting level (0.06 mg/L) in all 29 wells in 2002

Distribution throughout aquifer (depth 75-360 feet)

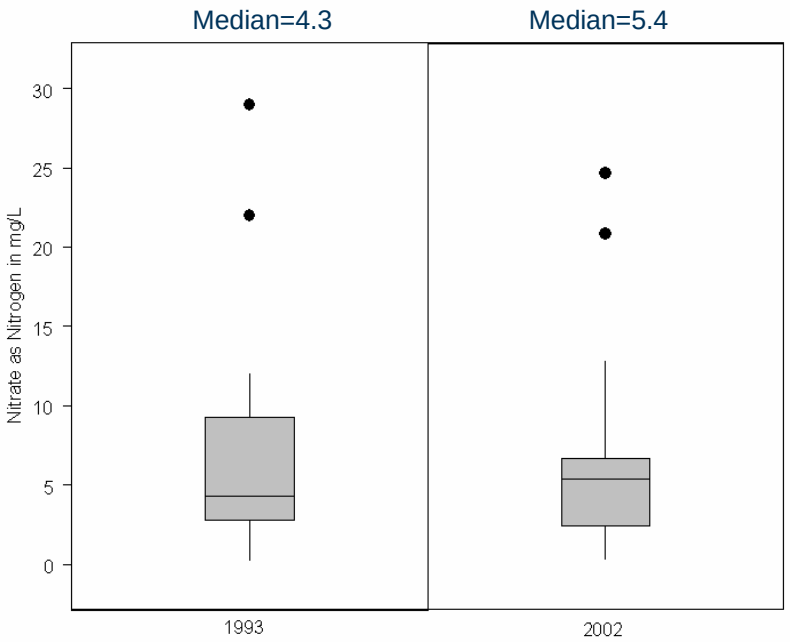
- Median 5.10 mg/L as N
- Range 0.33 to 24.64 mg/L as N
- 4 of 29 samples were above MCL (10 mg/L)

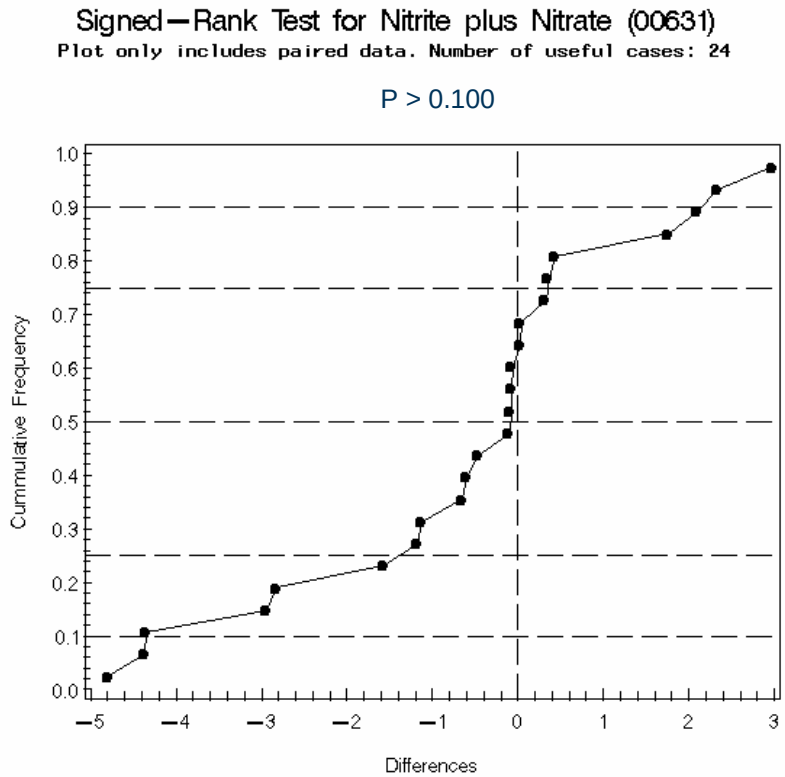
Spatial Trends in Nitrate



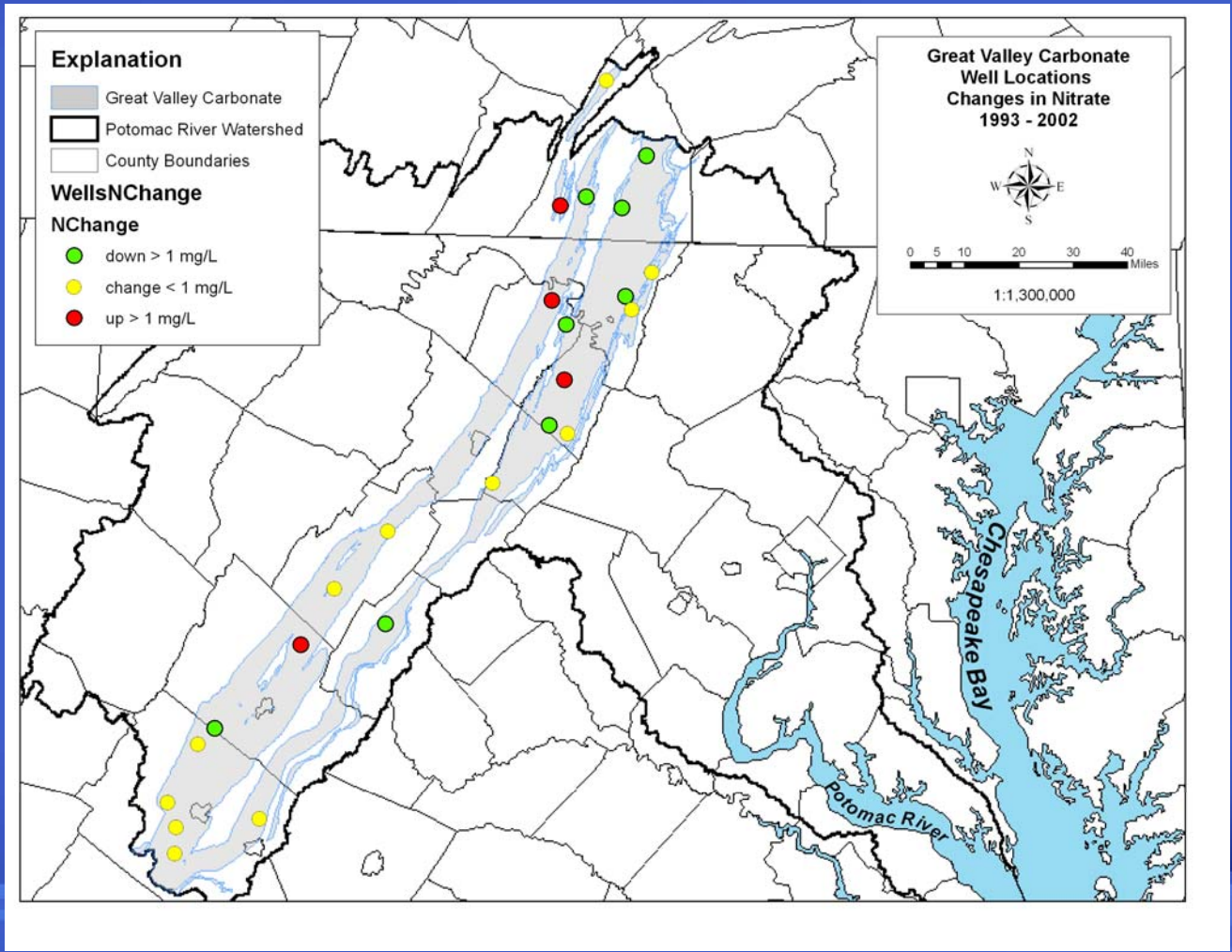
Temporal Trends
Decadal Change in Nitrate

No significant change in nitrate concentrations from 1993 to 2002

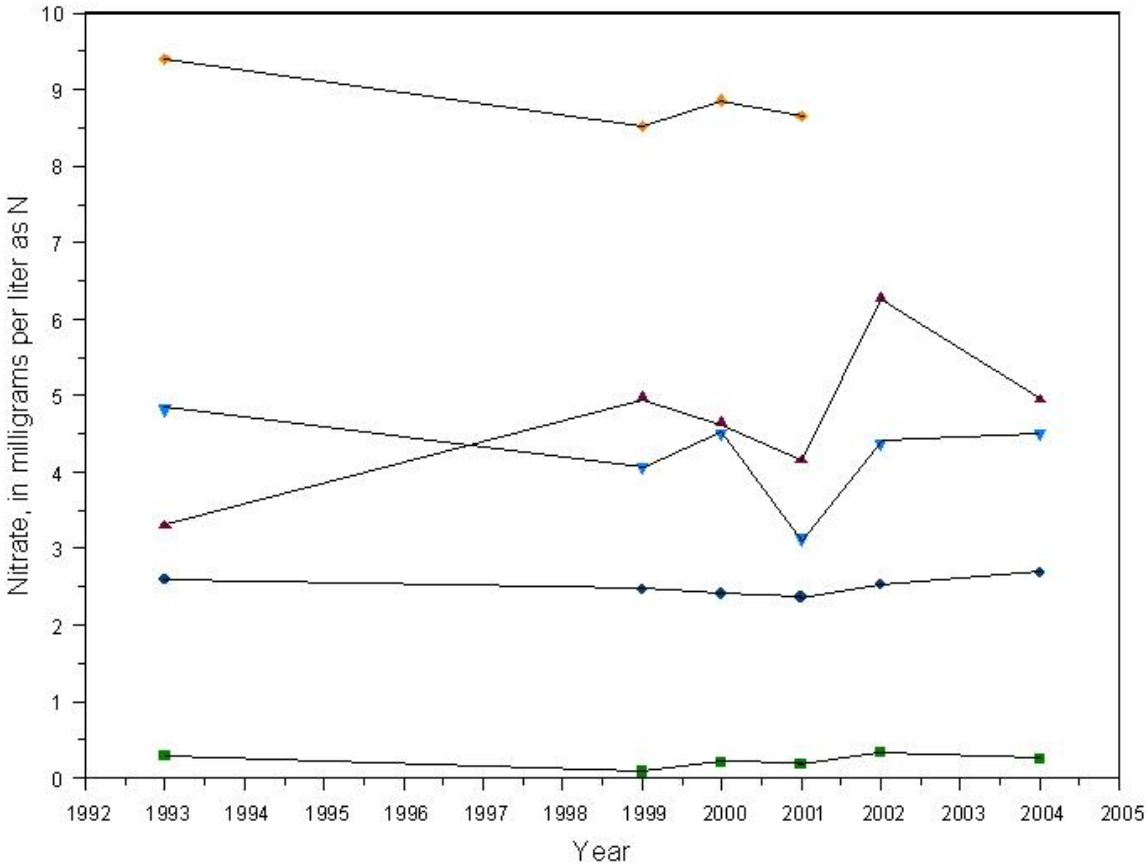




Temporal Trends
Decadal Change in Nitrate



Temporal Trends
Annual Change in Nitrate



Franklin, PA

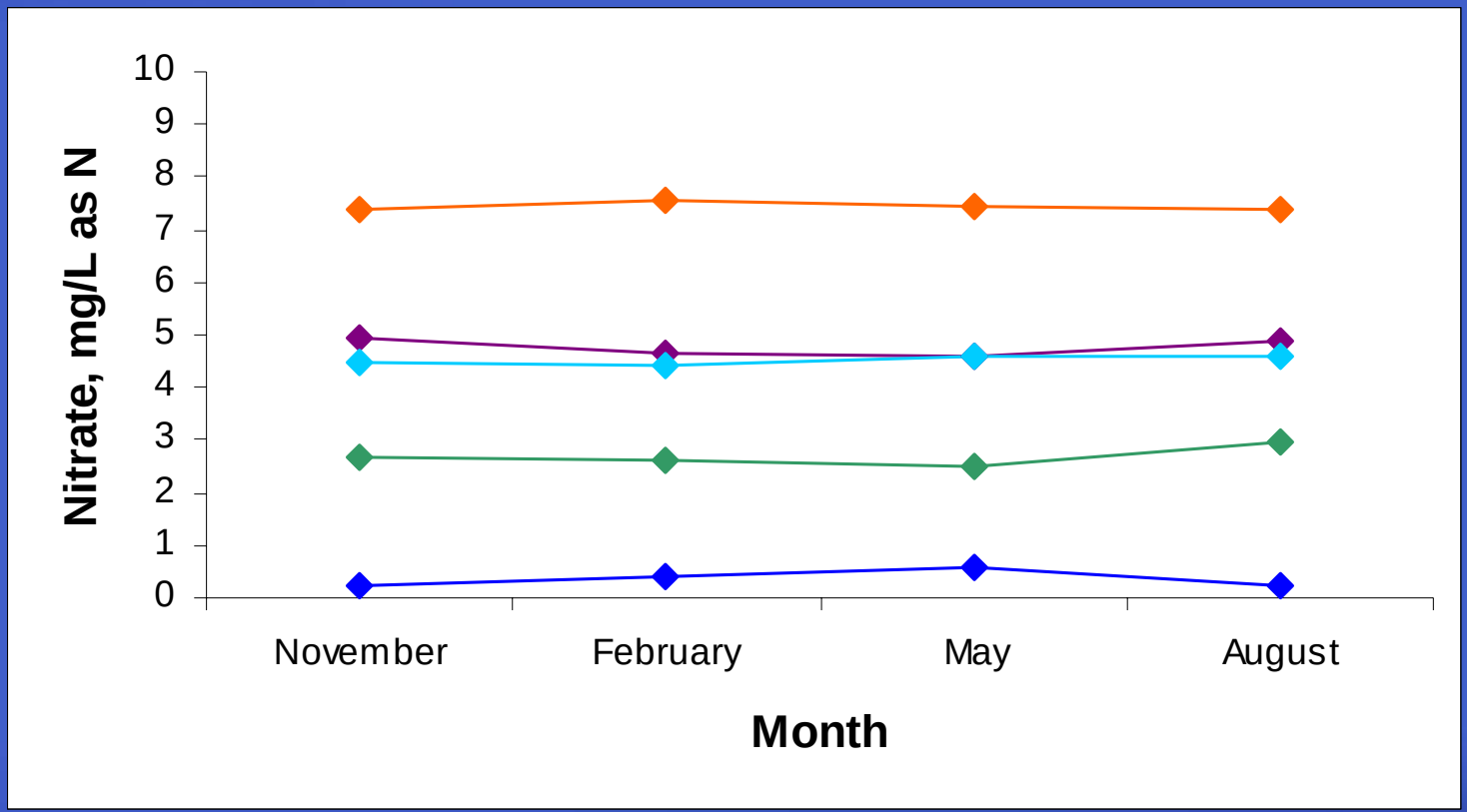
Rockingham, VA

Washington, MD

Augusta, VA

Shenandoah, VA

Temporal Trends
Quarterly Change in Nitrate

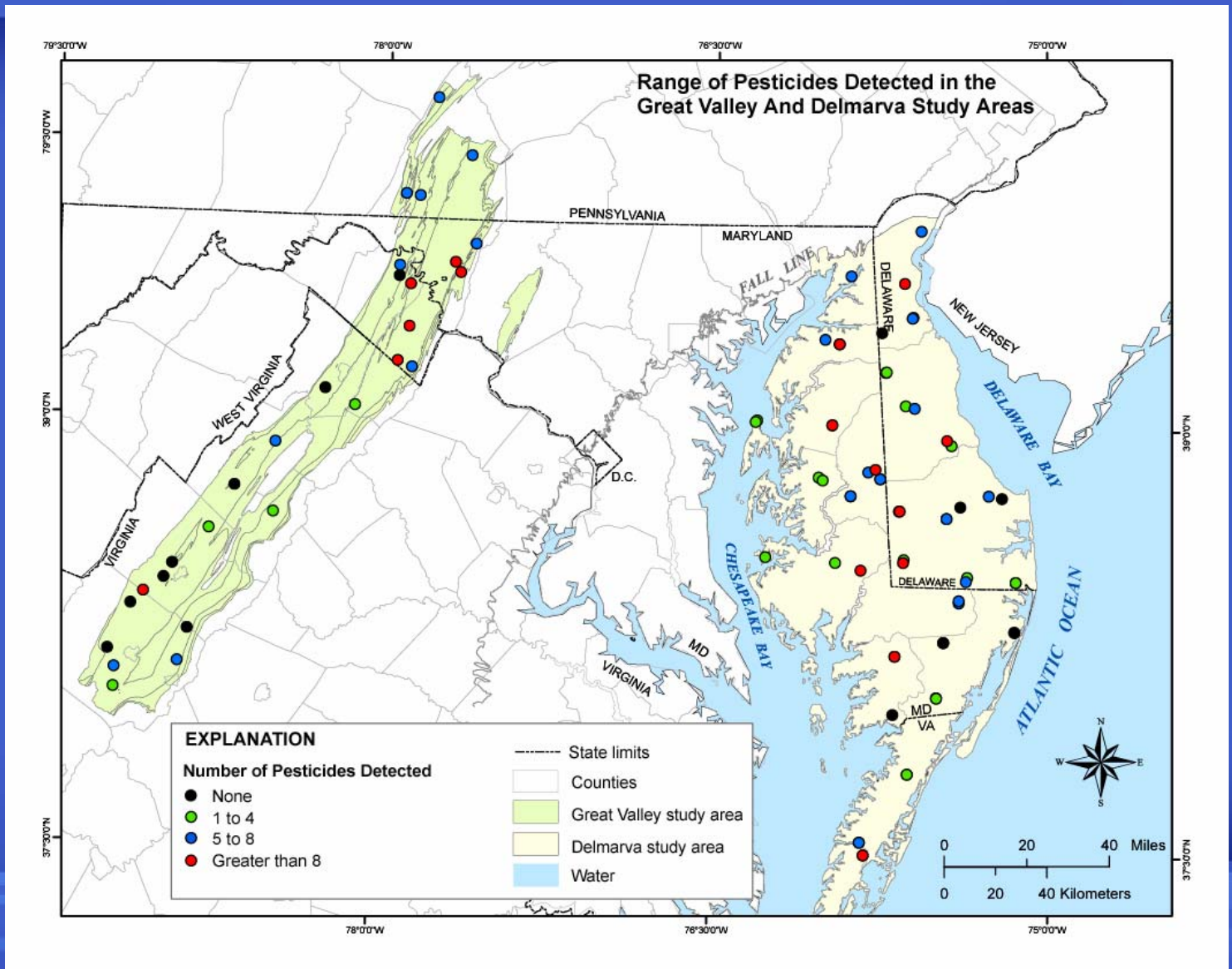


Spatial Trends in Pesticides

Widespread detection reflects abundant use, chemical properties, and aquifer characteristics

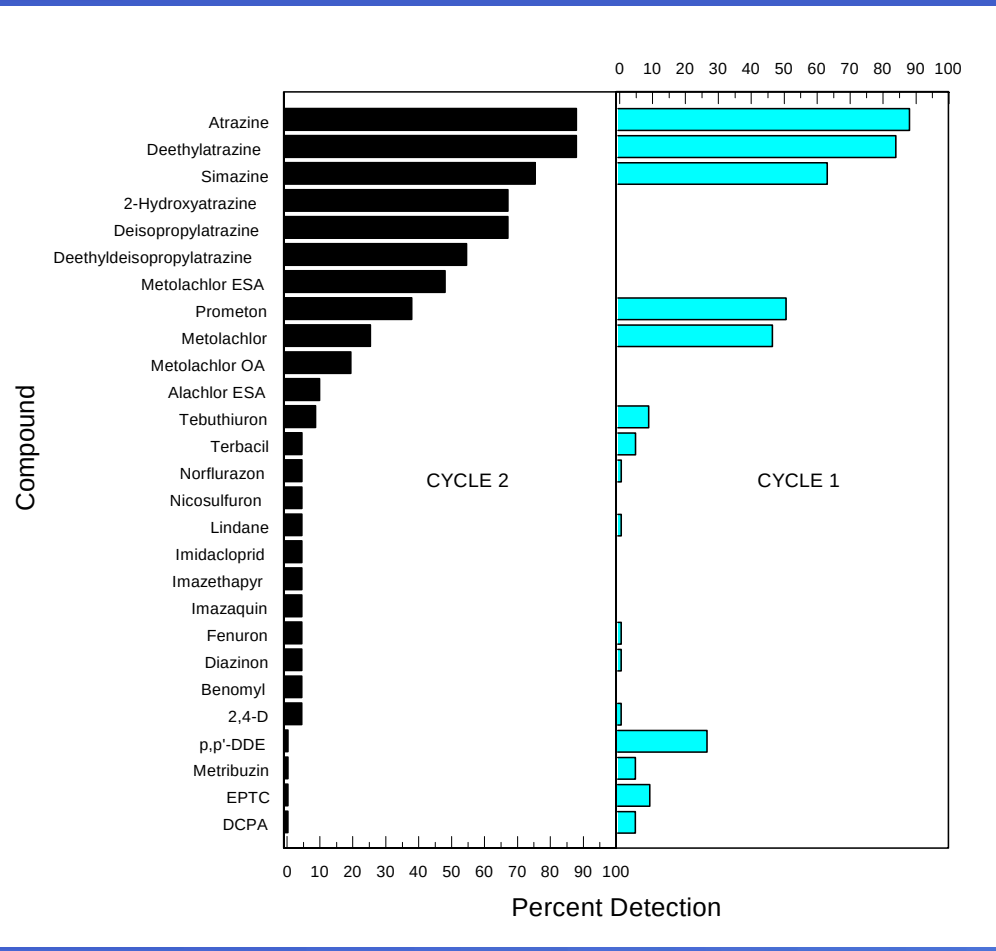
- Most commonly used are frequently detected
- Moderate to high solubility and relatively high persistence
- Karst environment creates favorable conditions for ground-water exposure

Spatial Trends in Pesticides

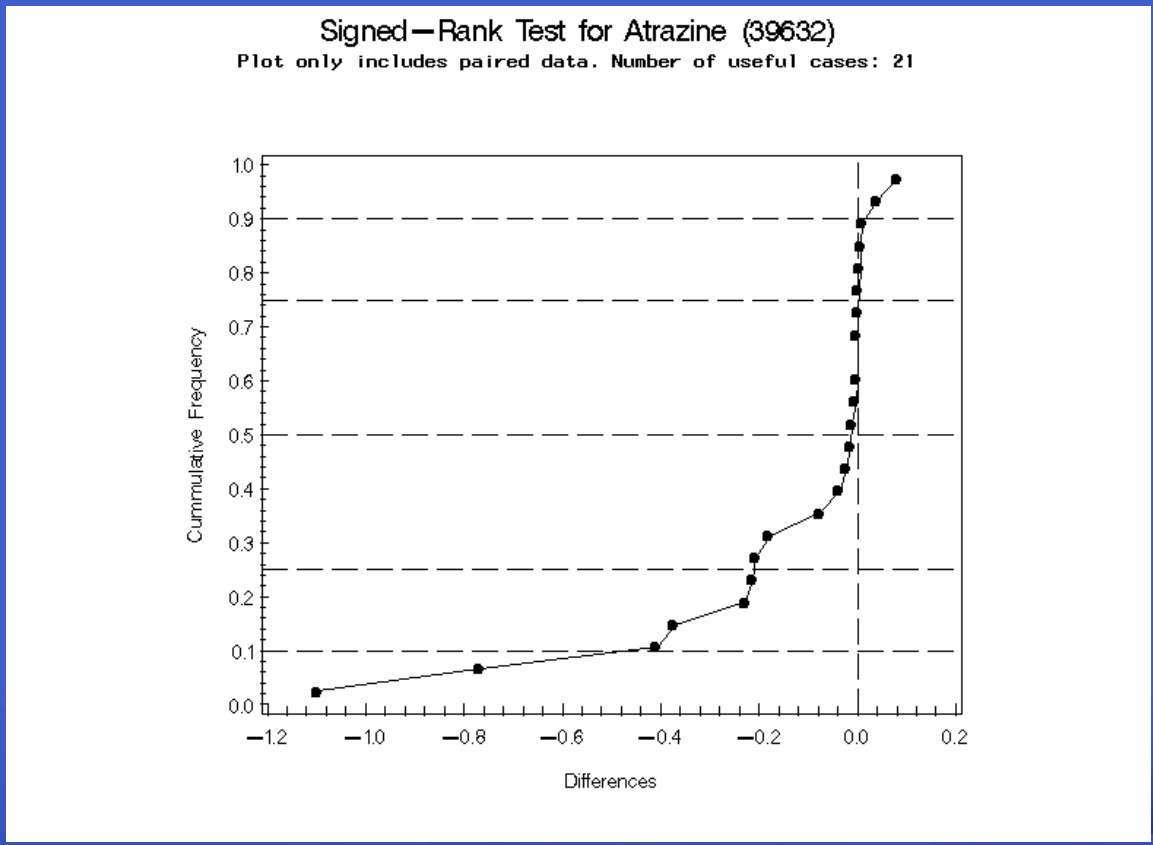


Temporal Trends
Decadal Change in Pesticides

- Atrazine, deethyl atrazine, and simazine most commonly detected
- Additional degradation products of atrazine (although not analyzed in Cycle I)
- Prometon and metolachlor also common
- Parents and degradates detected in 88% of trend wells
- Detected at low levels



Temporal Trends
Decadal Change in Pesticides

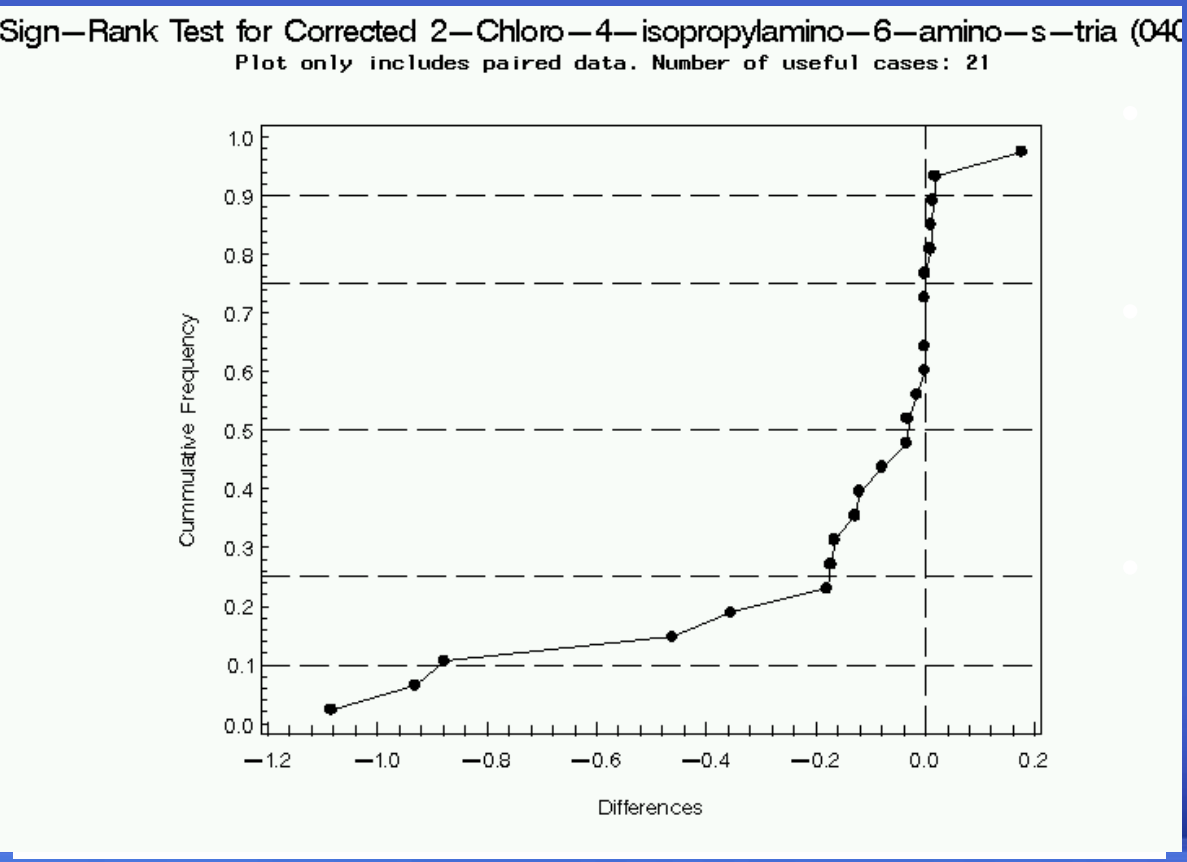


Median difference is not significantly difference from 0

N=21; 3 wells had nondetects in both sampling rounds

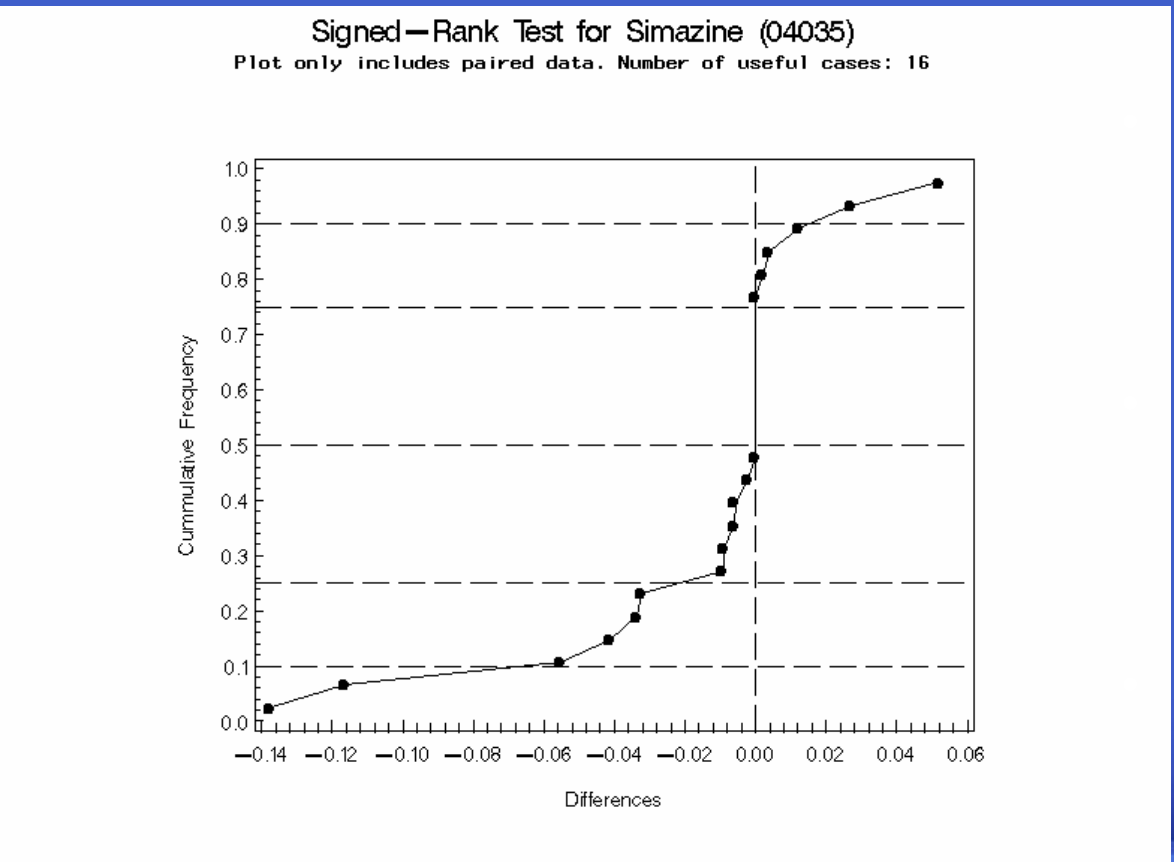
p-value is >0.1

Temporal Trends
Decadal Change in Pesticides



- Median difference is 0.0139 mg/L
- This compound has historically poor laboratory spike recovery.
- Sign-rank of corrected data show no significant change in between 1993 and 2002 (p-value >0.1)

Temporal Trends
Decadal Change in Pesticides

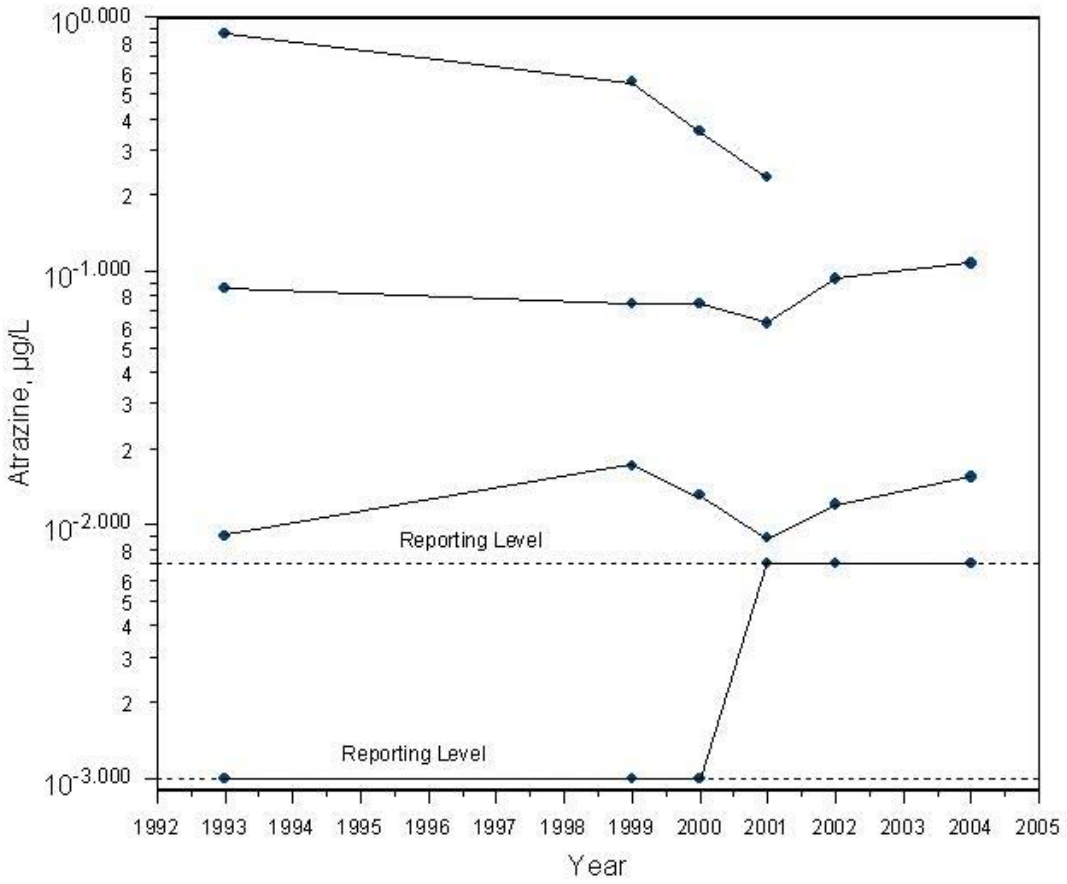


Median difference is not significantly difference from 0

N=16; 8 wells had nondetects in both sampling rounds

p-value is >0.1

Temporal Trends
Annual Change in Atrazine



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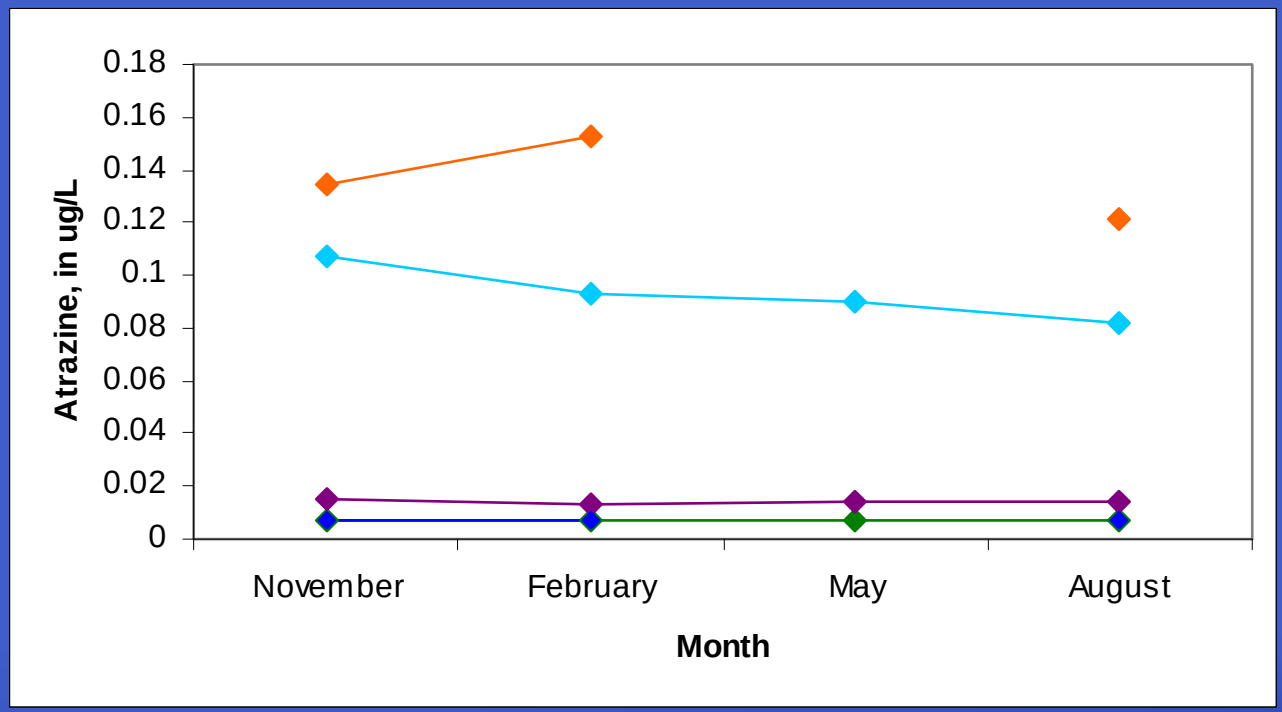
Temporal Trends
Quarterly Change in Atrazine



Washington, MD

Washington, MD

Next Steps

- Combine these findings with similar work done in the surficial aquifer on the Delmarva Peninsula
- Publish chapter in larger National ground-water trends report
- Decadal trends in ground water on the Delmarva Peninsula available early in the new year