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Insights into Efficacy of BMPs in Surficial Aquifers of Delaware

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Photograph courtesy of the Chesapeake Bay Program

Outline

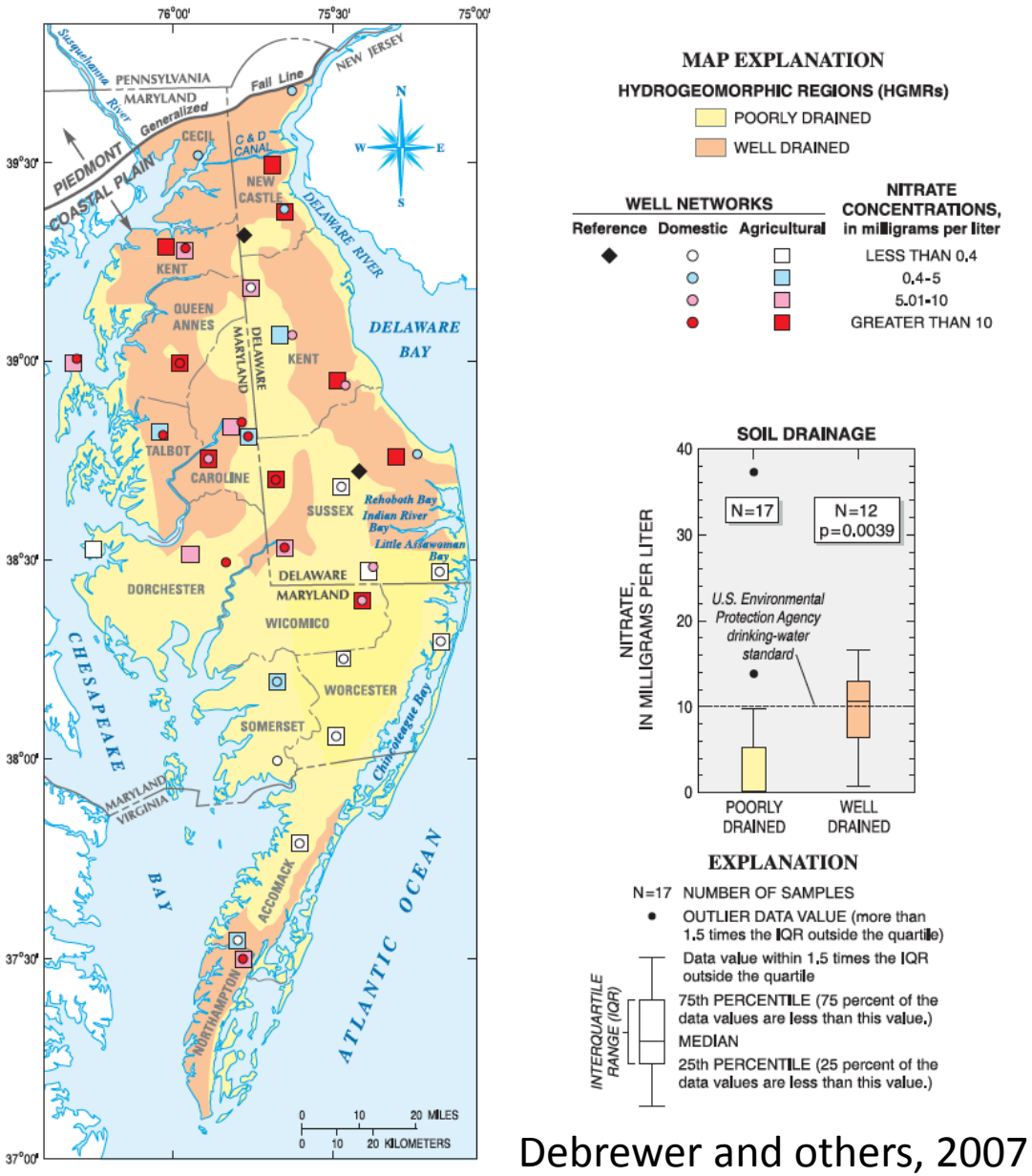
Area
Larger

Smaller

Sampling
Less Frequent

More Frequent

- Delmarva NAWQA Studies
- Delaware Agricultural Groundwater Study
- Small Watershed Studies
- Insights on short-term Nitrate variability from daily groundwater quality



Debrewer and others, 2007

Delmarva NAWQA Studies

Started monitoring nutrients from groundwater wells in 1988

Synoptic water quality sampling every 10 years

Purpose is to make resource-wide assessments of water quality.

Well drained soils have higher Nitrate than poorly drained soils.

Delmarva NAWQA Studies

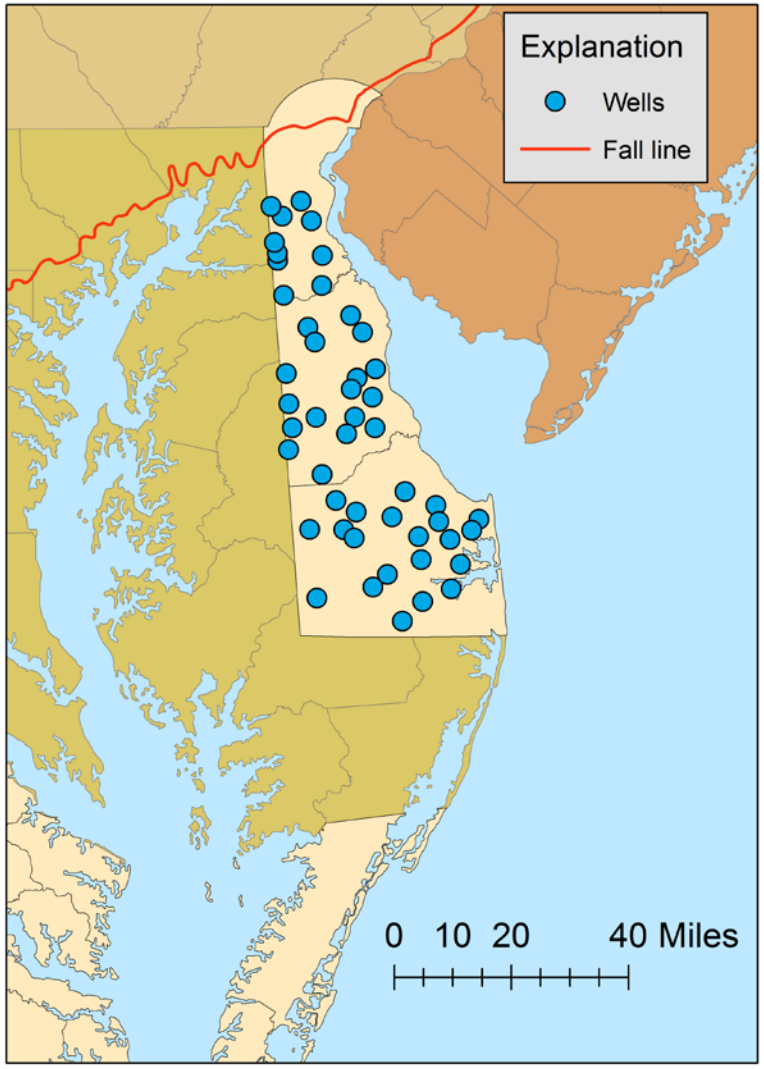
- Nitrate more prevalent in well drained soils and oxic groundwater.
- Redox conditions tend not to change in these groundwater settings.
- The best places to monitor for change in Nitrate are in well drained, oxic groundwater.
  - Key design factor in next study.

Delaware Agricultural Study

- Can we measure changes in groundwater quality and attribute them to changes in agricultural practices at the aquifer scale?
- Where are you going to see change first? Water table not stream.
- 2014 baseline sampling of 48 shallow wells in oxic groundwater. Get a large sample size for future trend analysis.

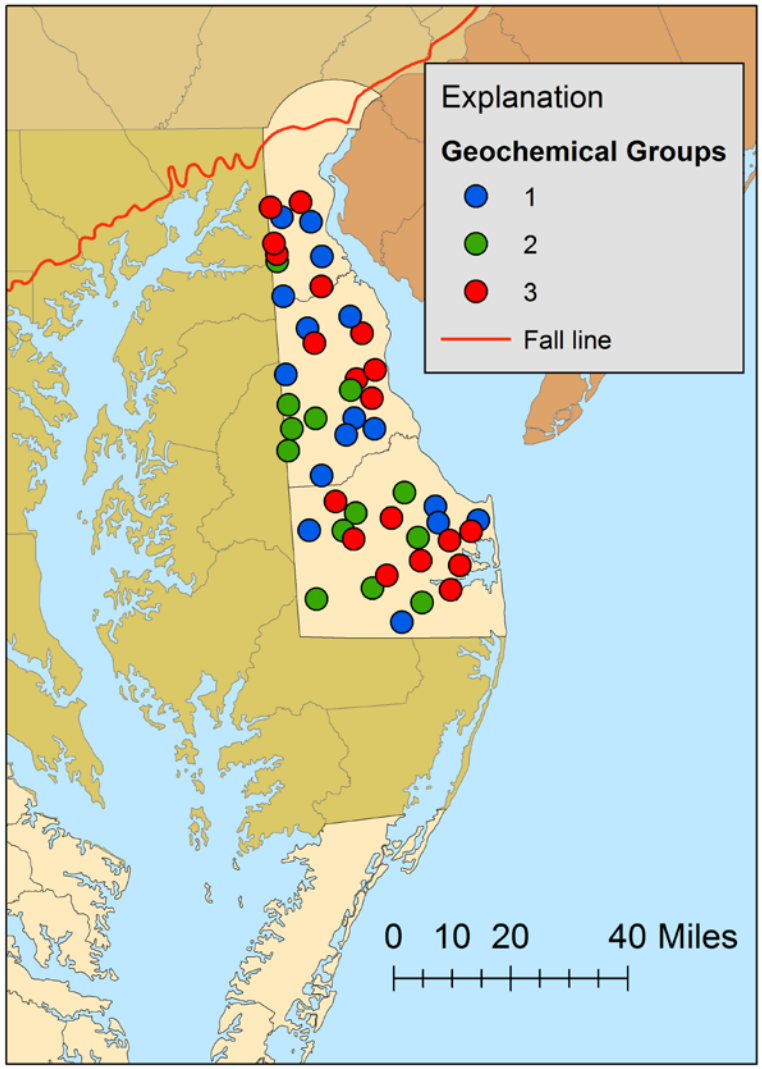
Delaware Agricultural Study

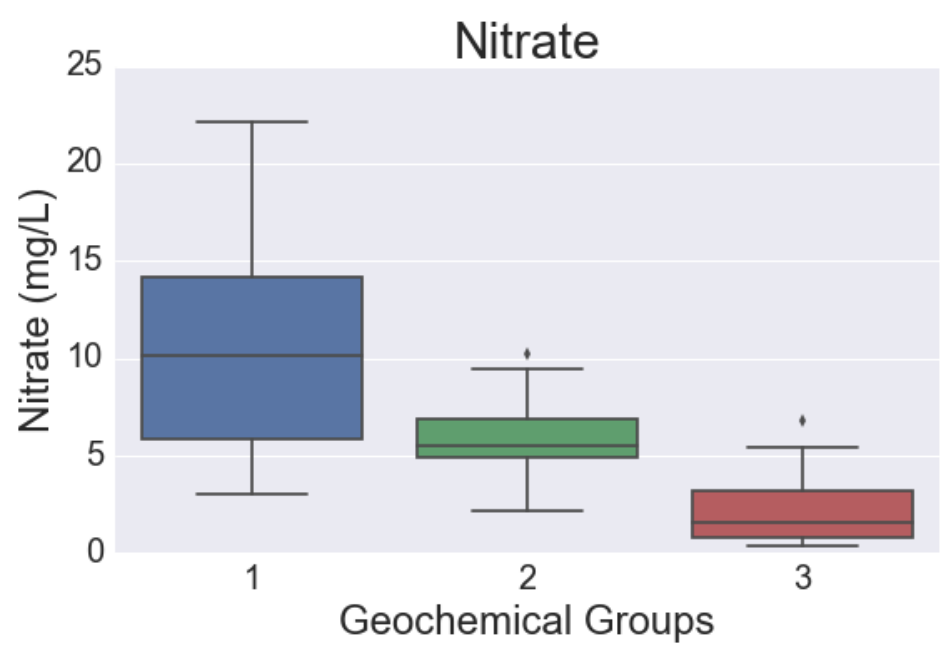
- 48 wells from existing USGS and Delaware Dept. of Agriculture well networks.
- All wells less than 40 feet below land surface.
- Dissolved Oxygen greater than 1 mg/L.
- Major ions, nutrients, GW age tracers

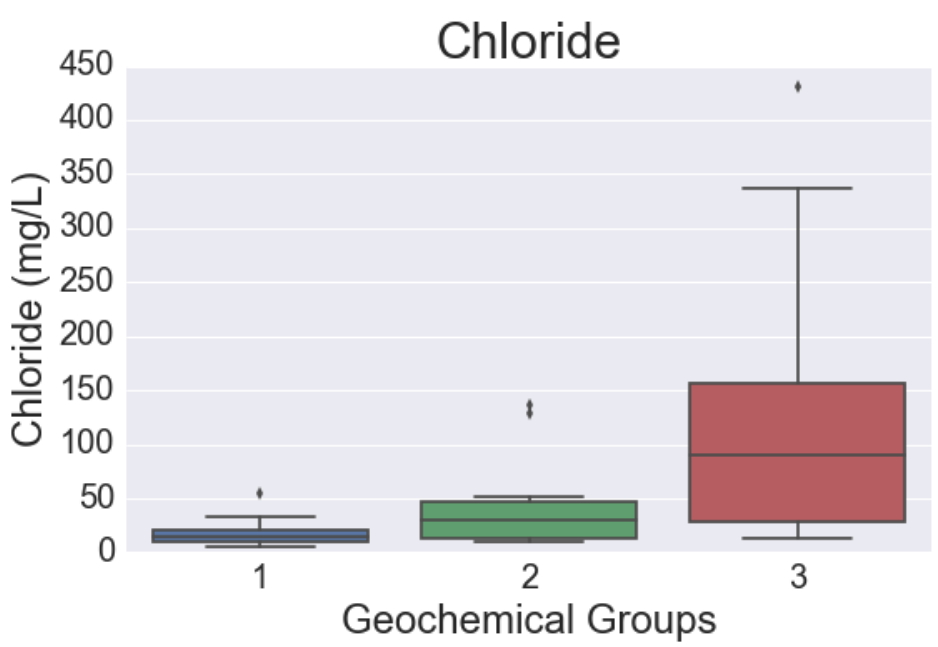


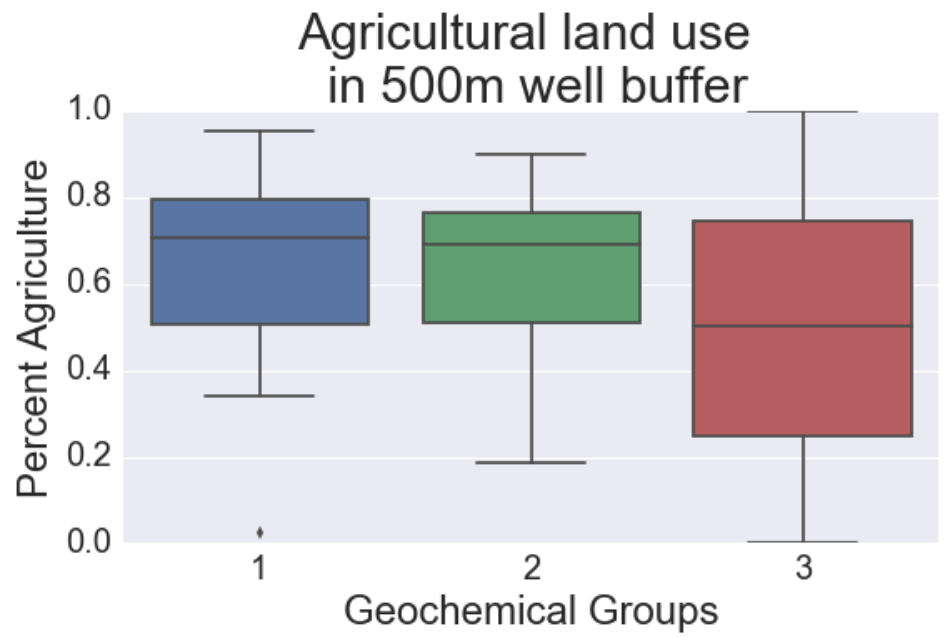
Delaware Agricultural Study

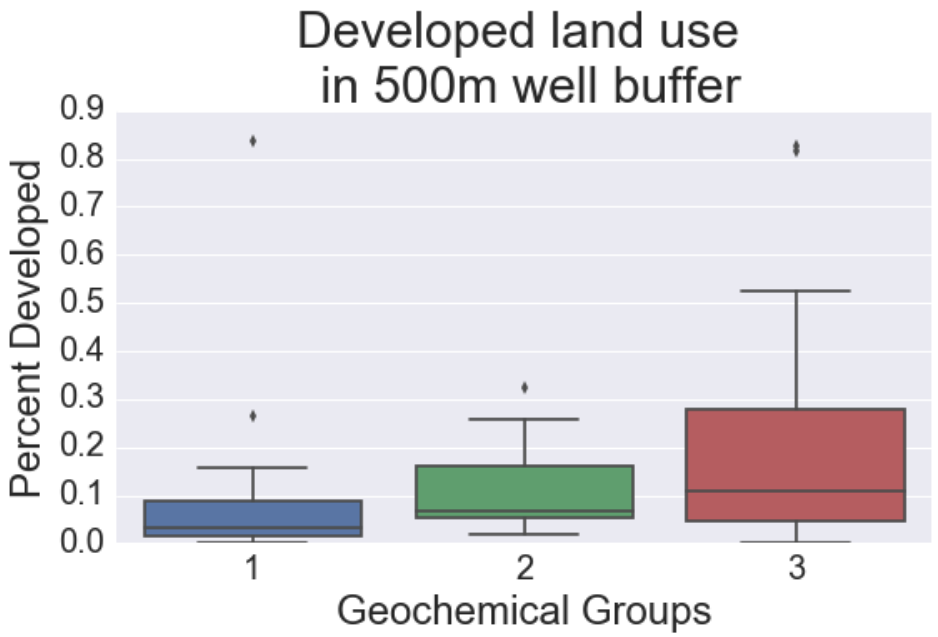
- Use geochemistry define the groups
  - Correlation analysis on major ions and nutrients results
  - Cluster analysis using correlation matrix of 48 wells




Nitrate
Nitrate (mg/L)
25
20
15
10
5
0
1
2
3
Geochemical Groups

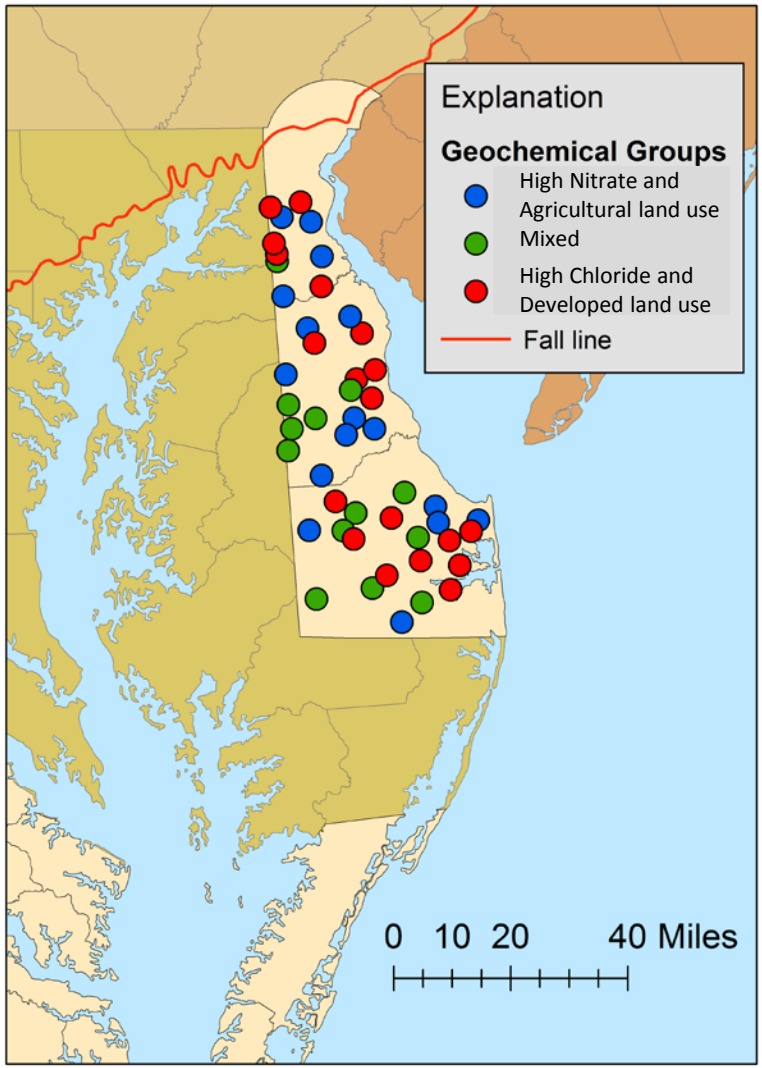

Chloride
Chloride (mg/L)
450
400
350
300
250
200
150
100
50
0
1
2
3
Geochemical Groups


Agricultural land use
in 500m well buffer
Percent Agriculture
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
Geochemical Groups


Developed land use
in 500m well buffer
Percent Developed
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
2
3
Geochemical Groups

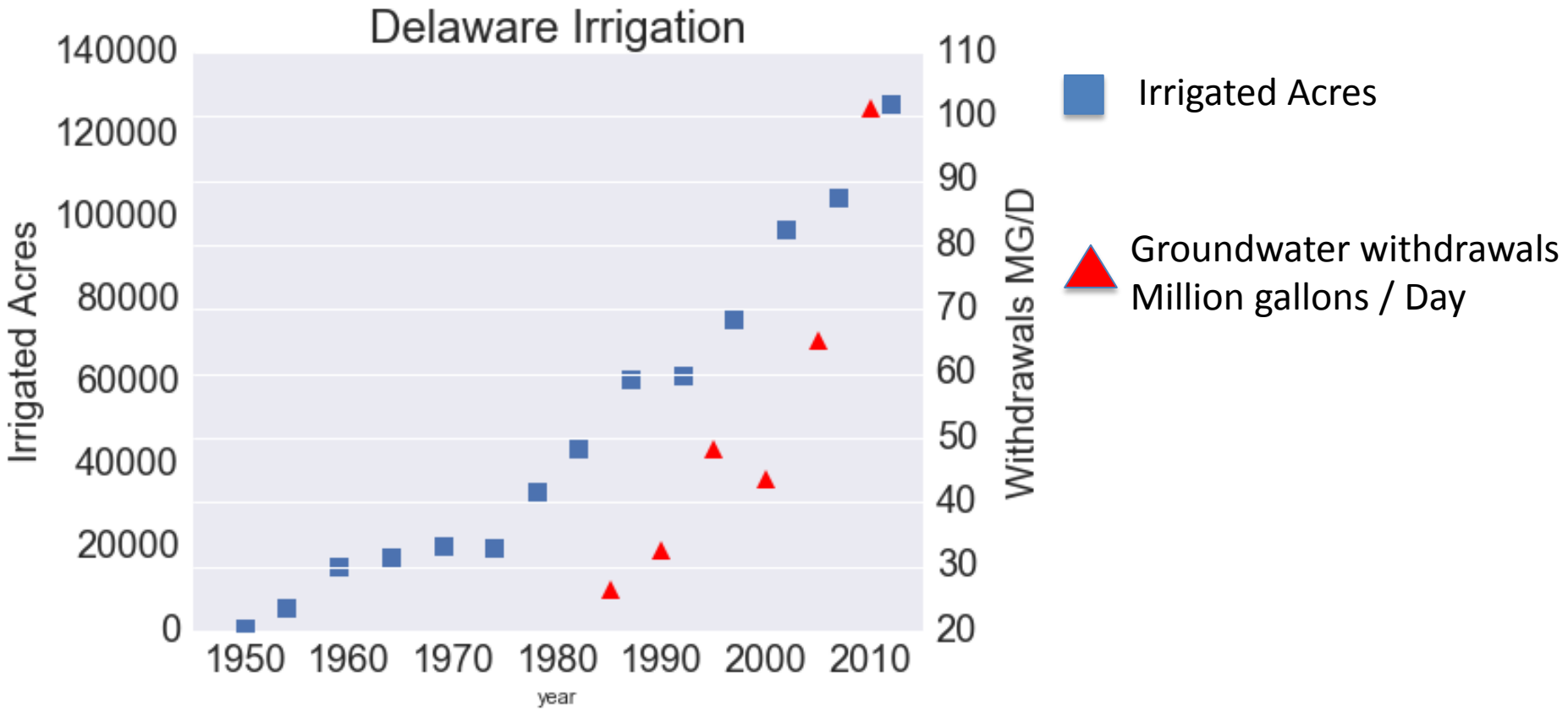
Delaware Agricultural Study

- Use geochemistry define the groups
  - Correlation and cluster analysis on major ions and nutrients
- Baseline dataset now exists to compare future results, next sampling is planned for 2019
- Caution: Sc is often a good surrogate for nitrate in agricultural settings, but not if there are road salt, septic, or other interferences.

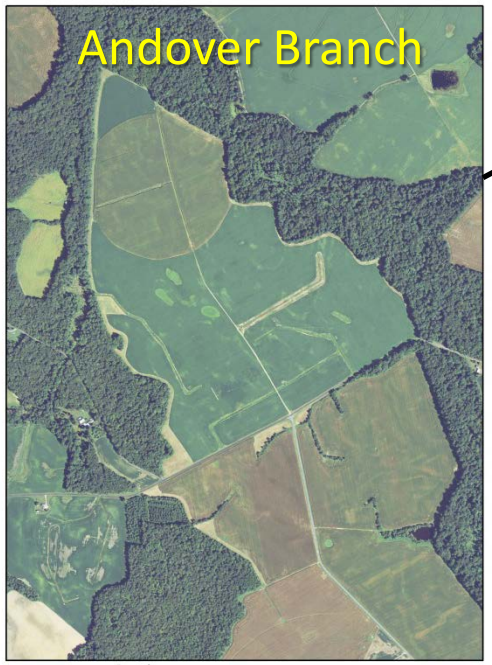


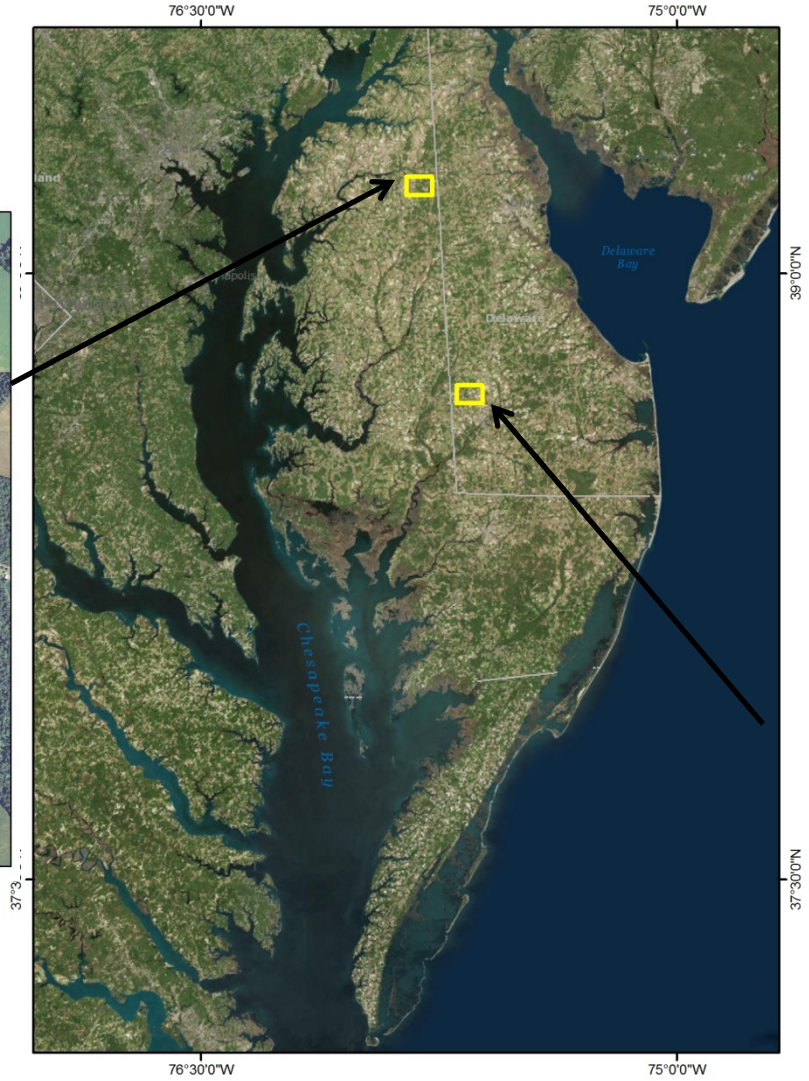
Small Watershed Studies

- Question: Is irrigation effective in reducing the amount of nutrients that reach the water table?



Study Sites





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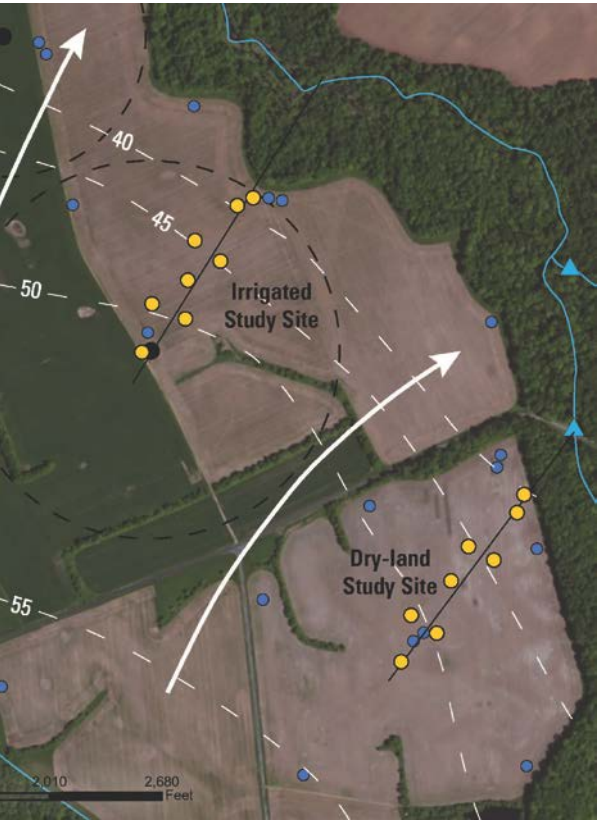
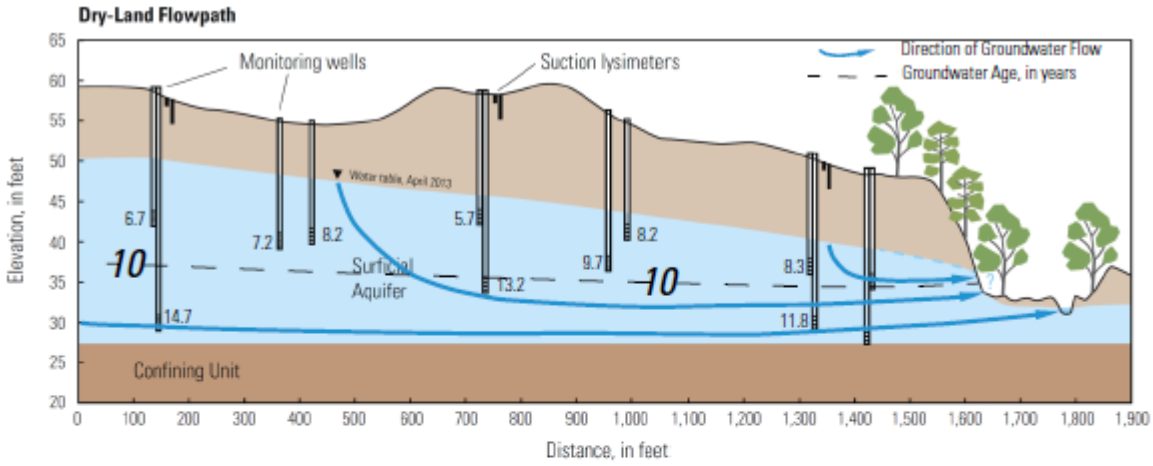
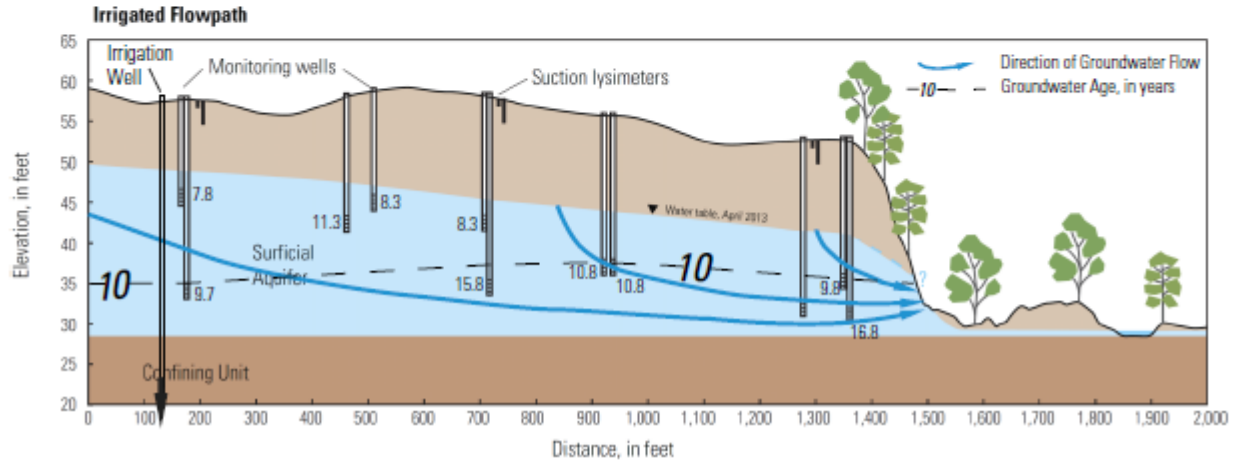
Andover Branch

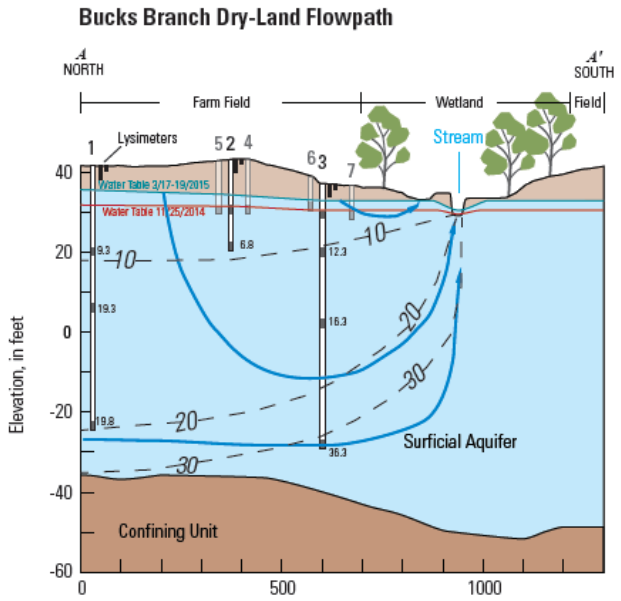


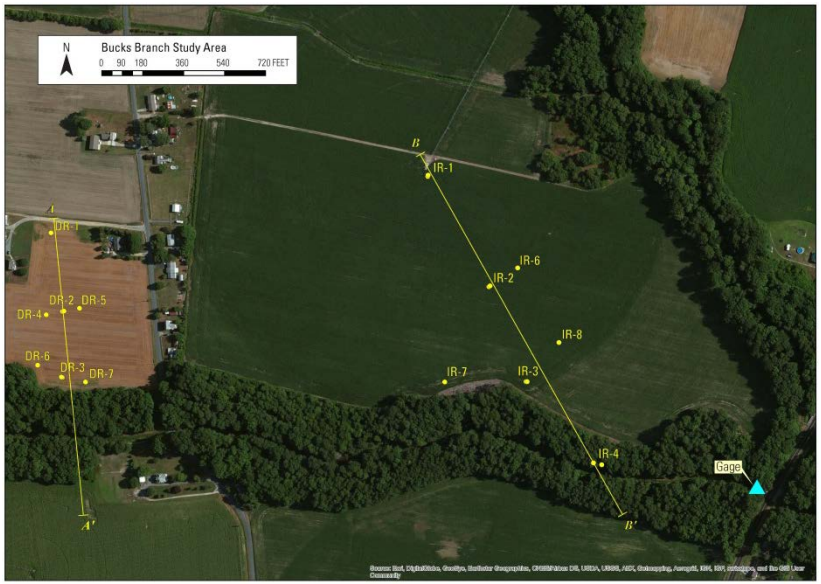




- Surficial aquifer is about 30 ft thick (land surface to underlying fine-grained sediments)
- Groundwater flows from uplands towards stream—discharge is mostly to seeps
  - High potential for loss or uptake of nitrate before it reaches the stream

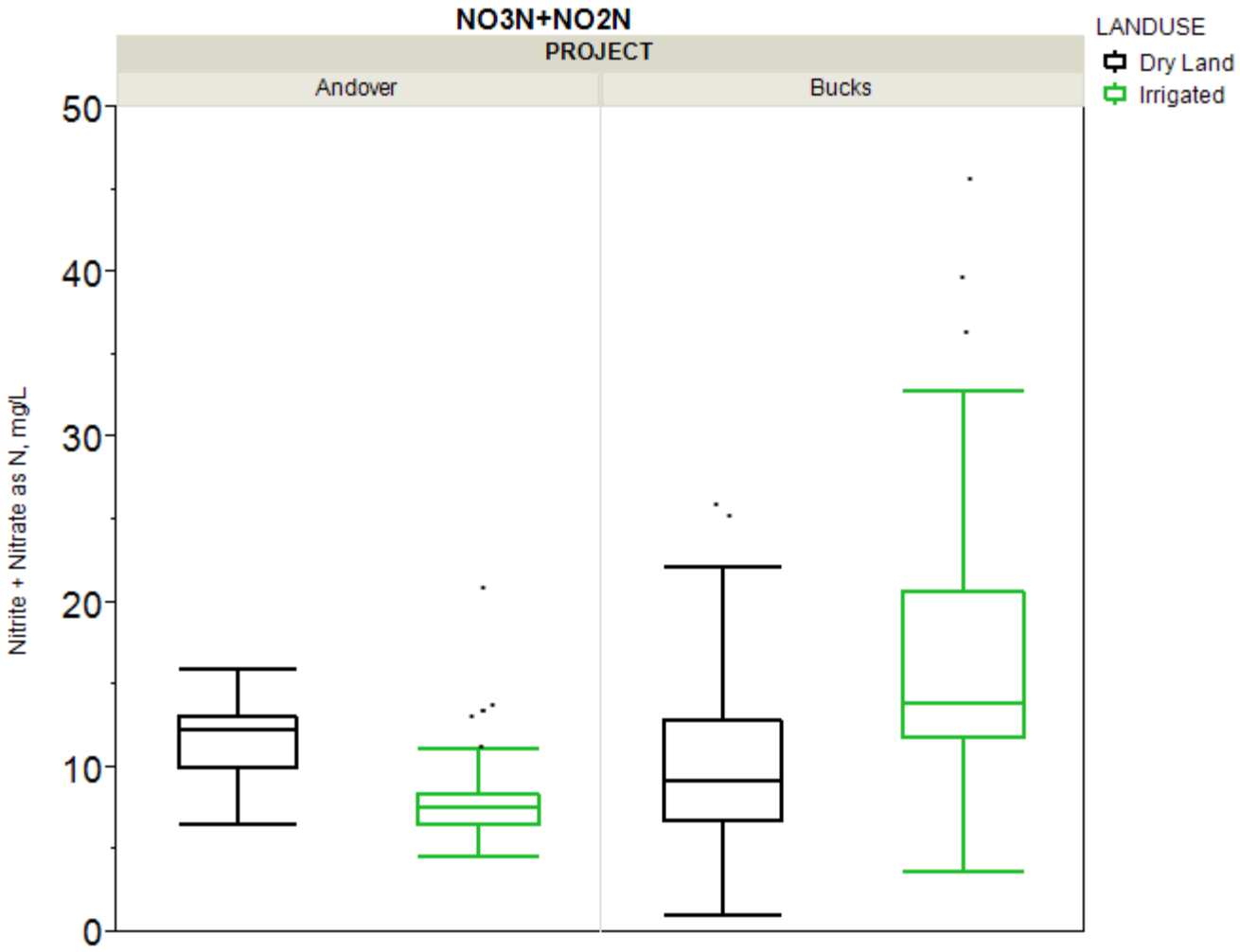
Bucks Branch

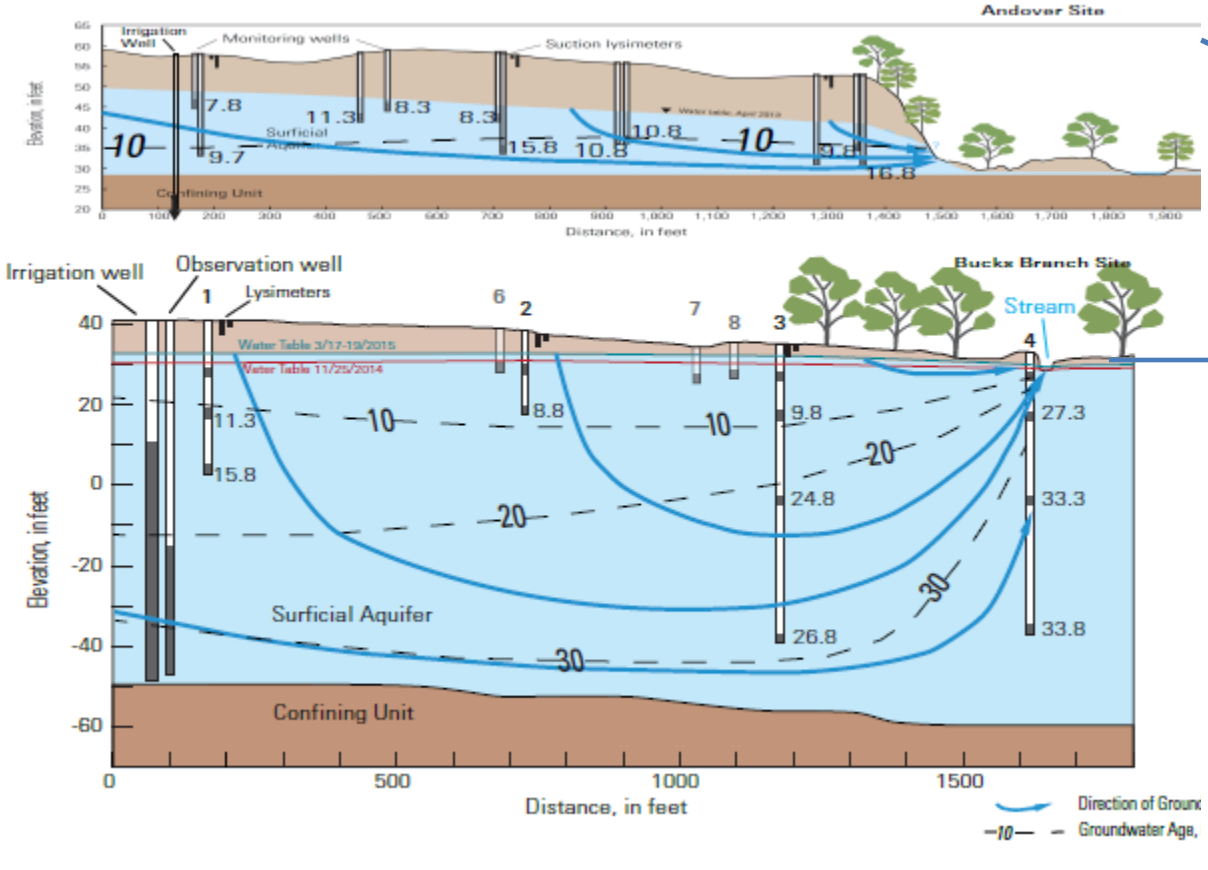


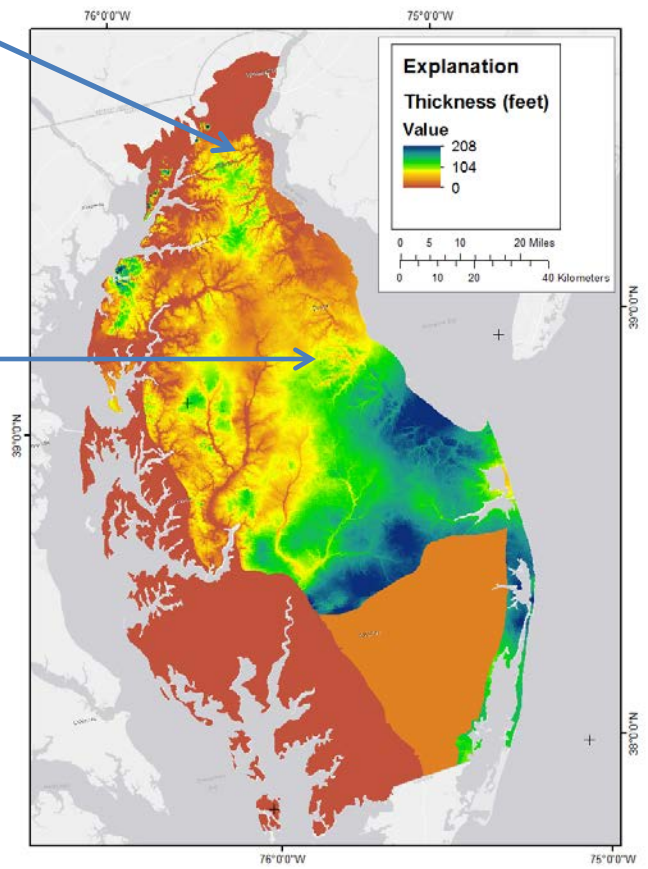


- Surficial aquifer 80-90 ft thick
- Groundwater discharges through the stream bed, with some shallow flow to wetlands; nitrate loss is minimal in discharge through streambed
- Groundwater age exceeds 30 years along the deepest longest flowpath

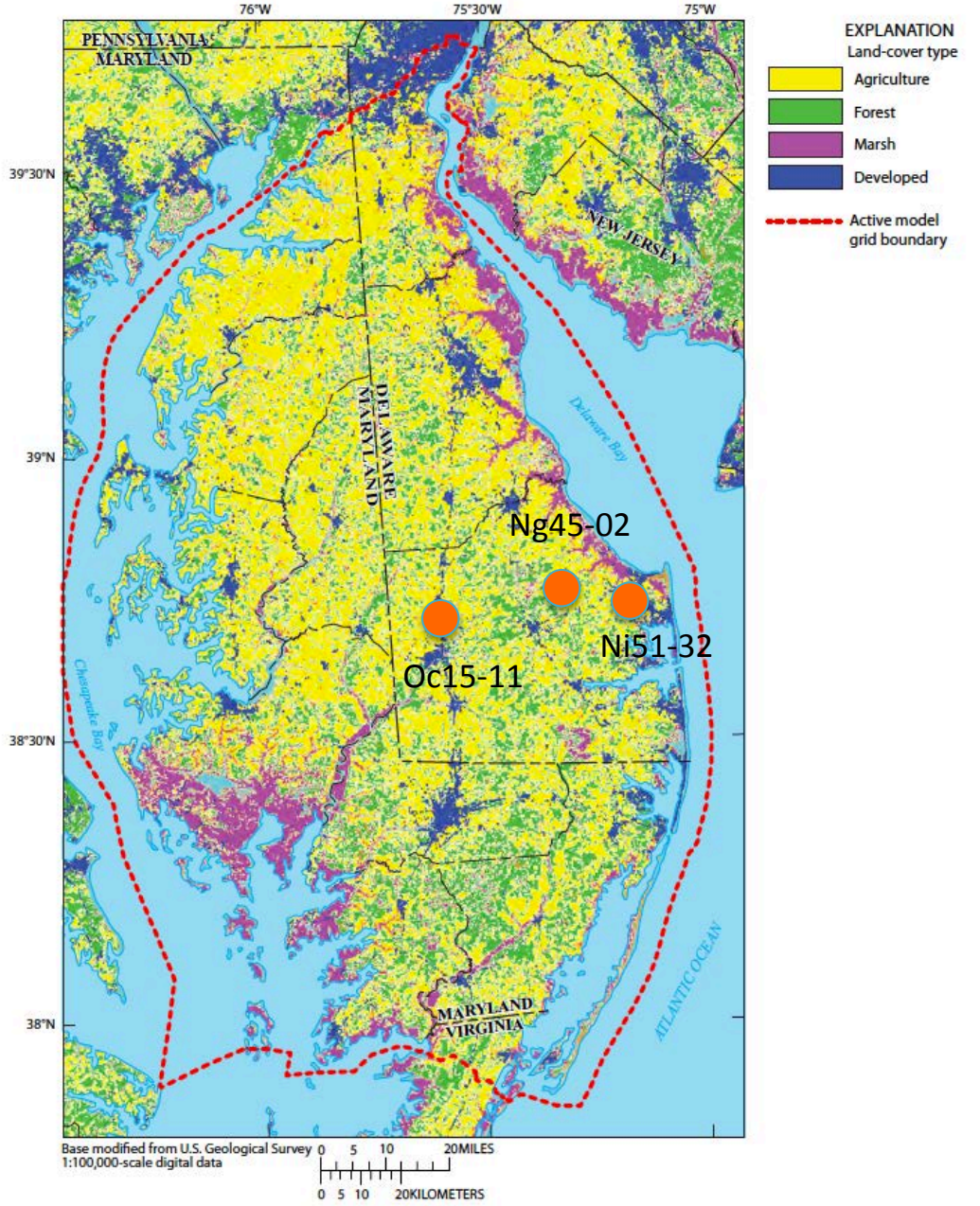
Dry land vs Irrigated fields







- Hydrogeologic setting is variable across the Coastal Plain of the Delmarva Peninsula
  - Affects natural processes that may mitigate nutrient transport
- Understanding local setting can help producers and other resource managers optimize BMP implementation.

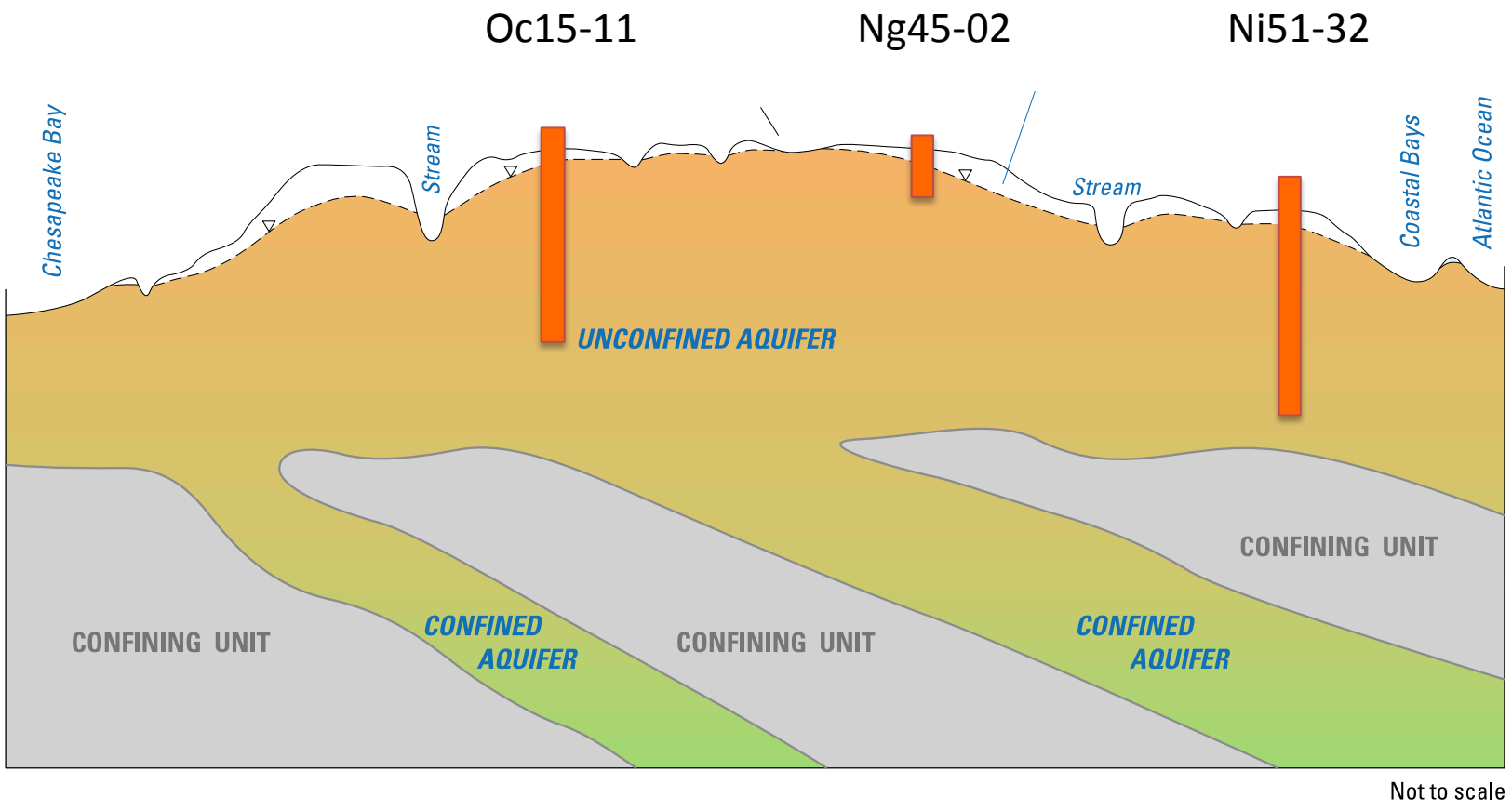


Modified from Sanford and others, 2012

Daily Groundwater Quality

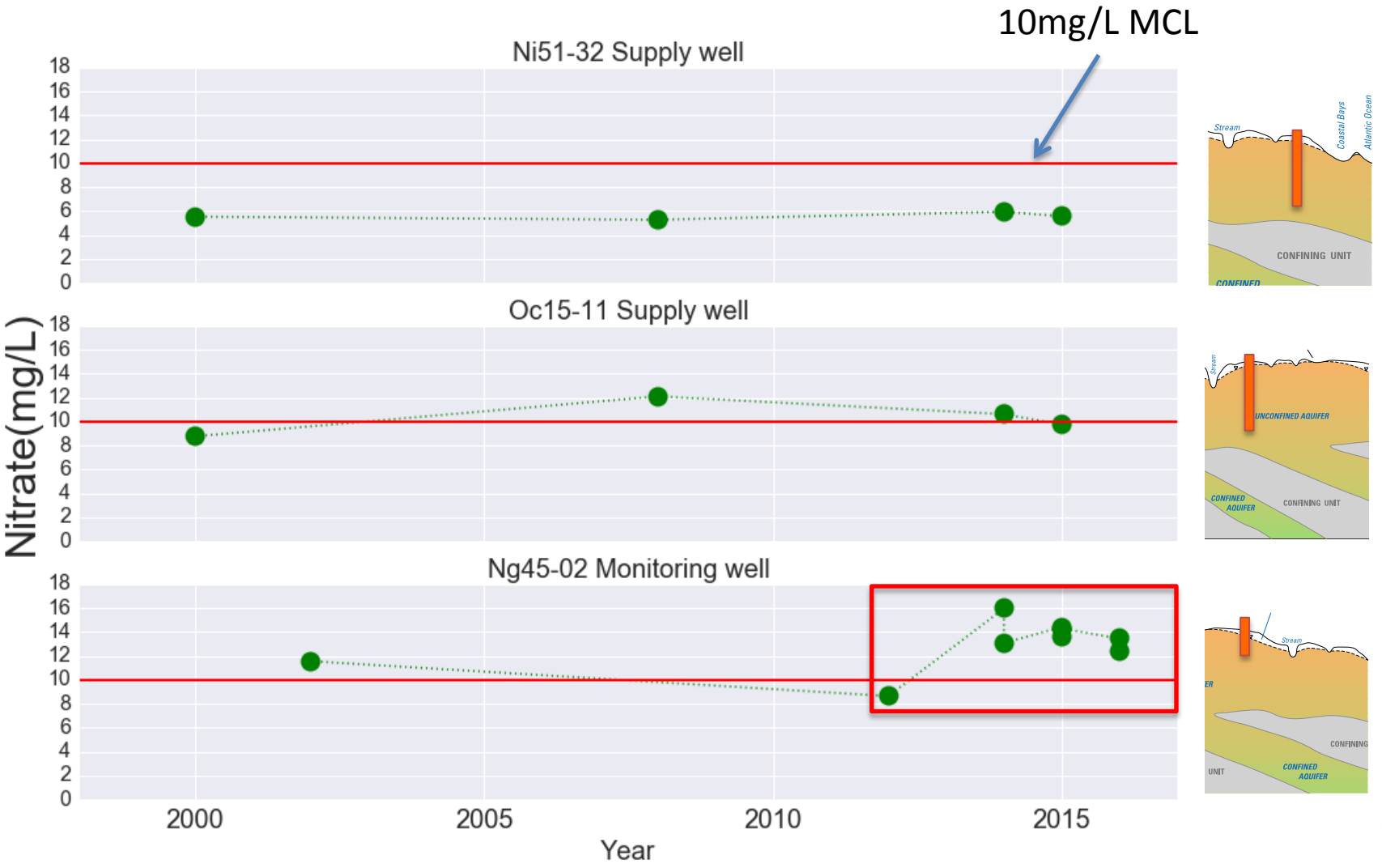
- Daily water quality data is being collected at 3 wells in Delaware.
- Wells are in different hydrogeologic settings
- Wells are pumped at different rates

Hydrogeologic Setting

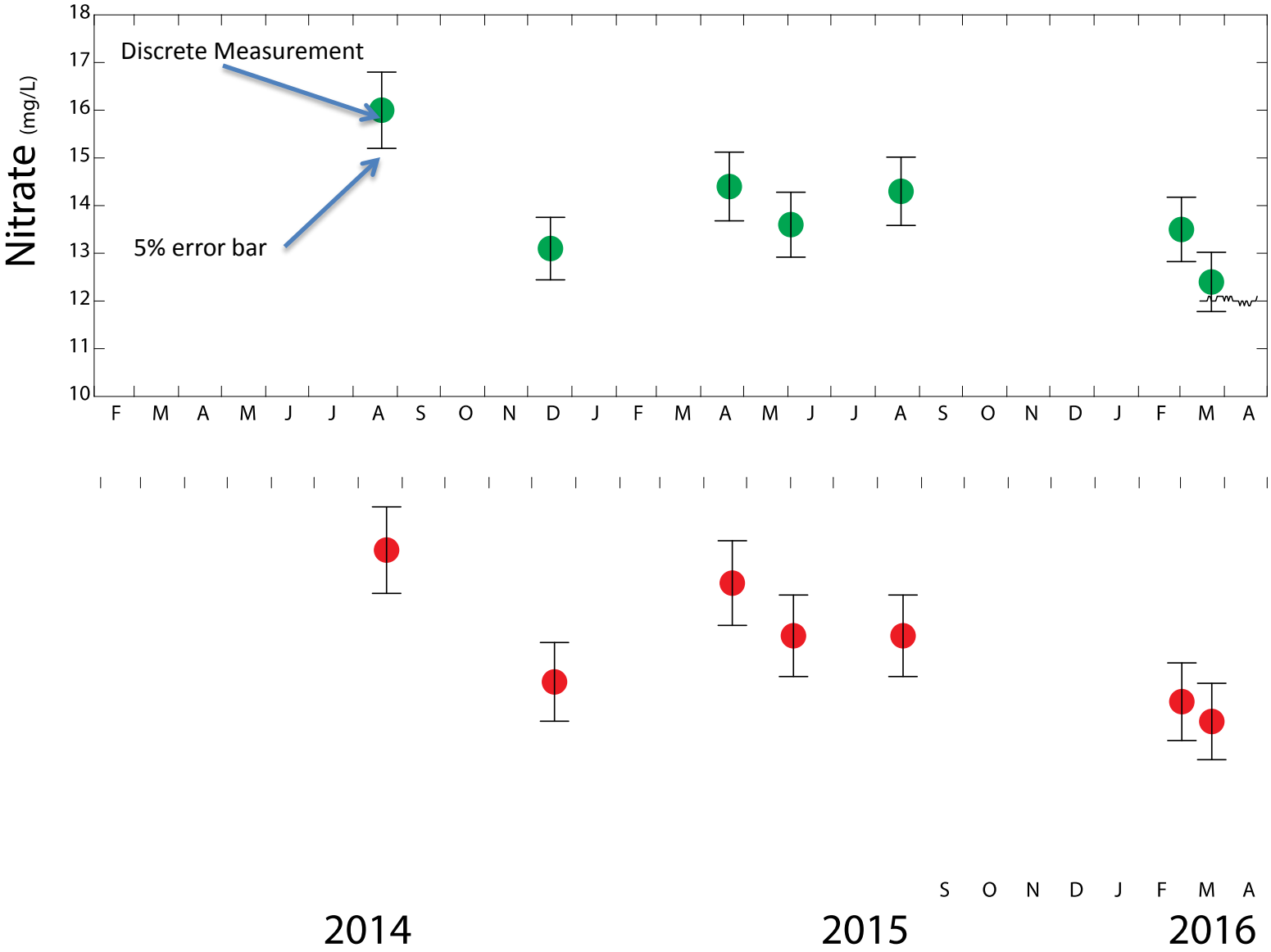


s section modified from Shedlock and others, 2007.

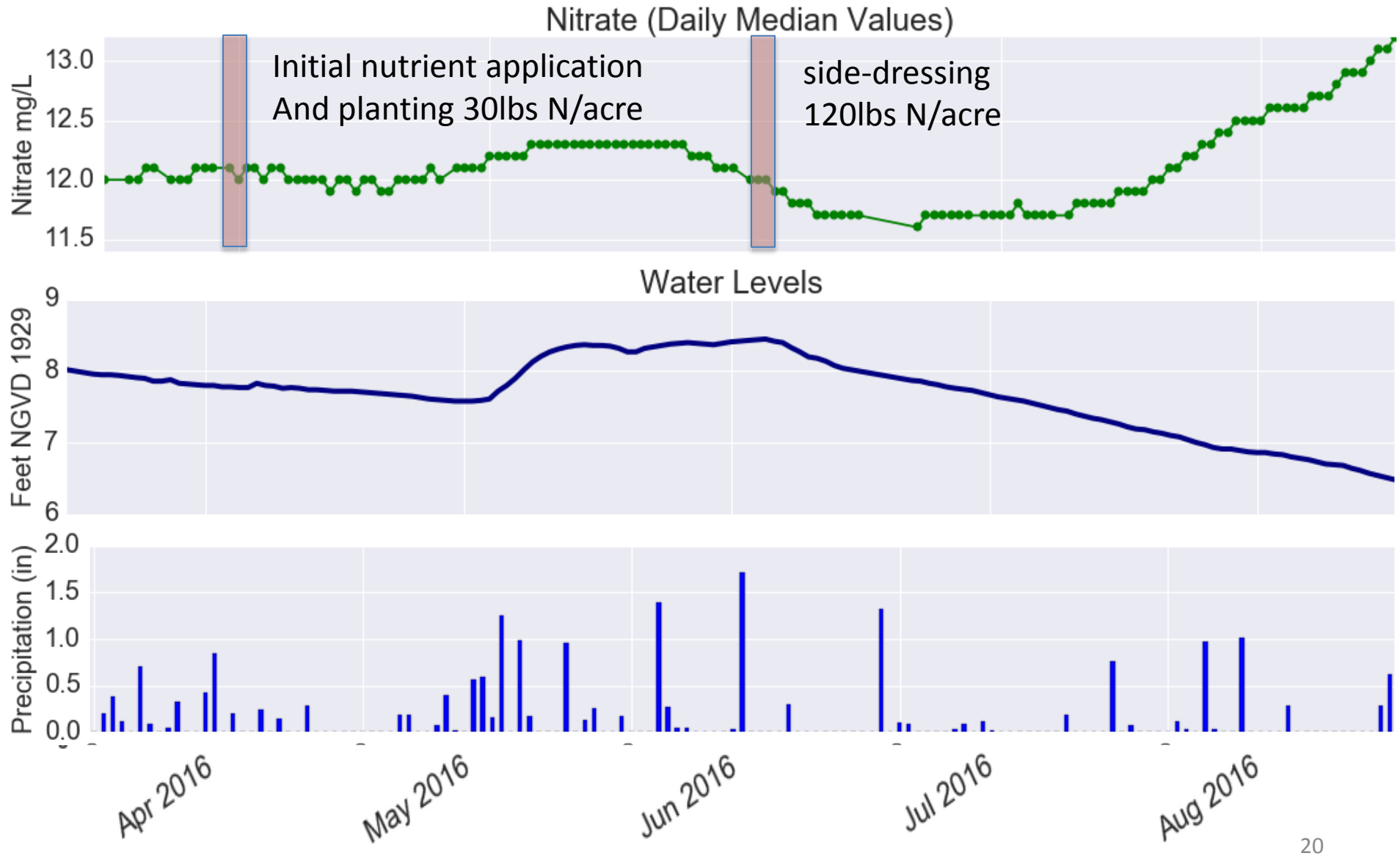
Long-term Nitrate Variability

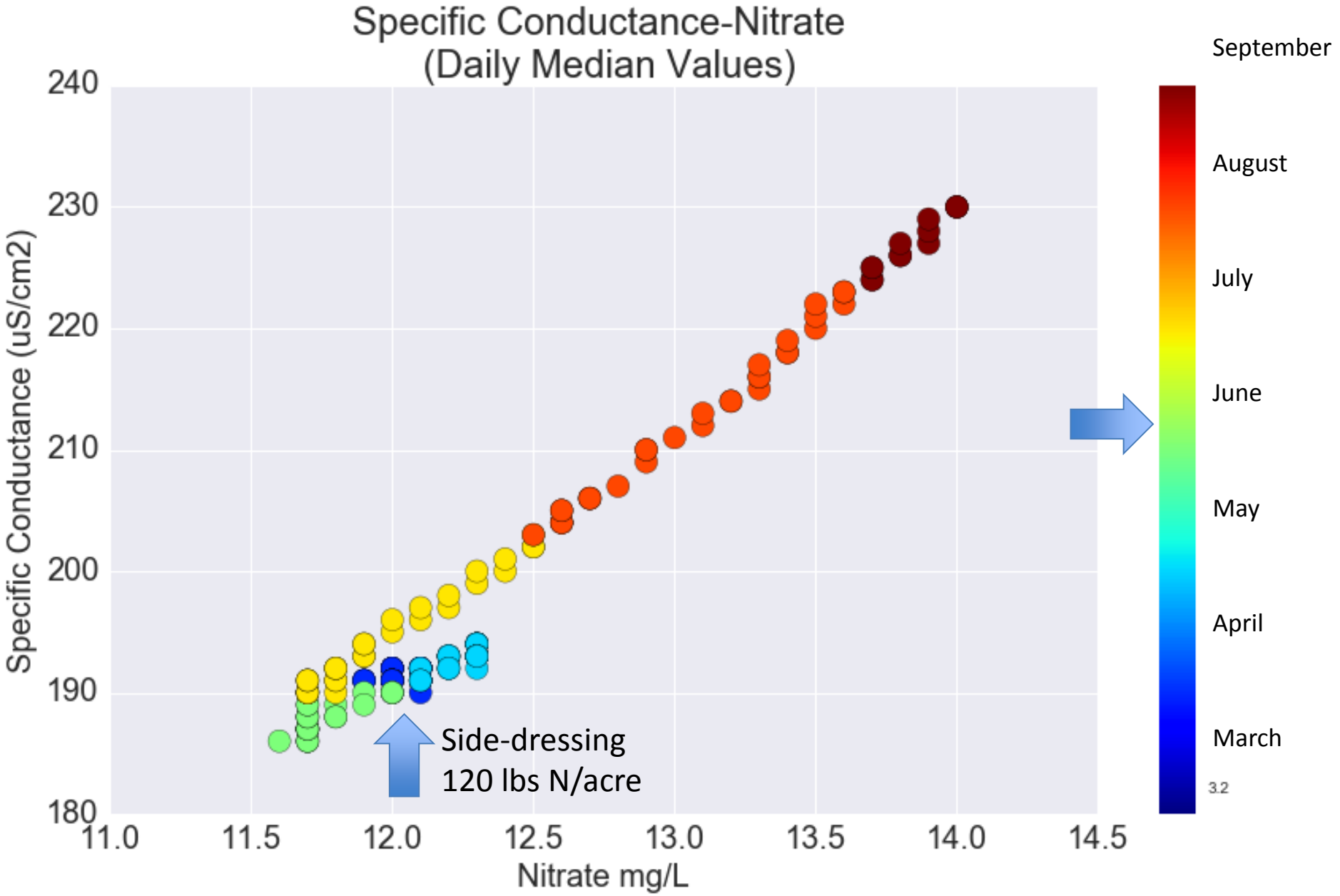


Short-term Nitrate variability Ng 45 02

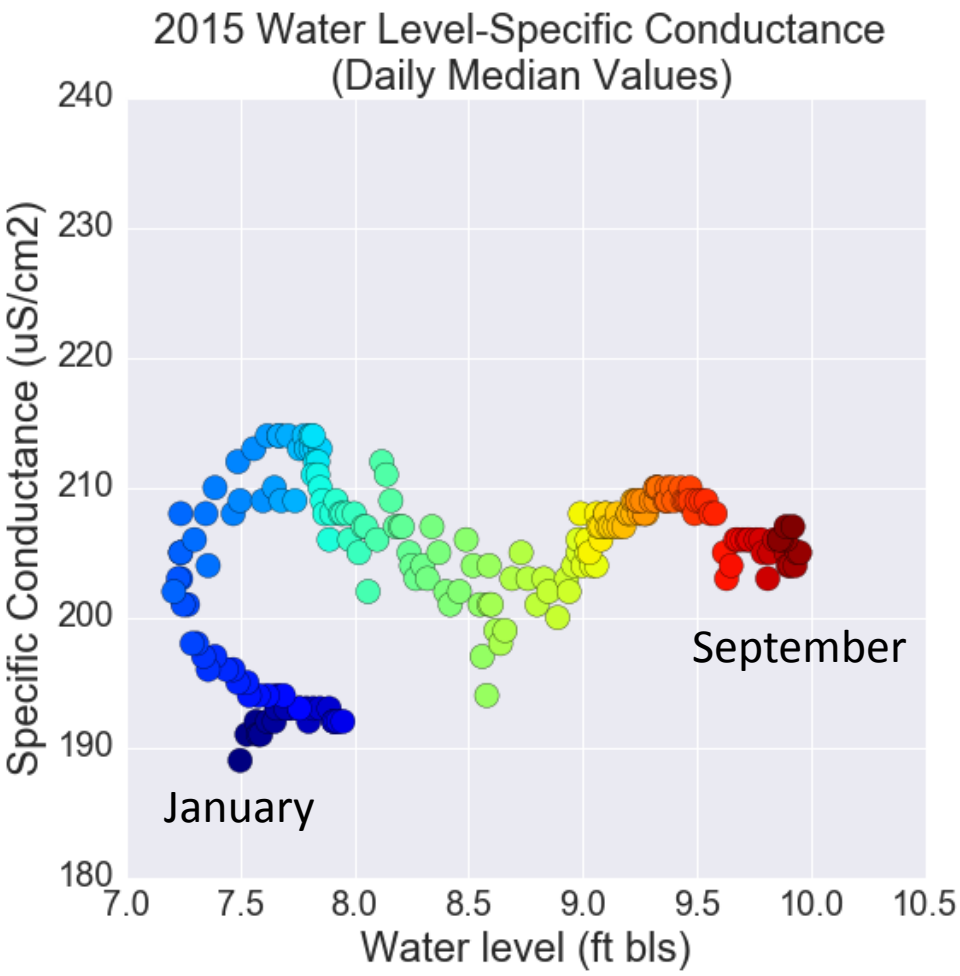


Shorter-term Nitrate variability

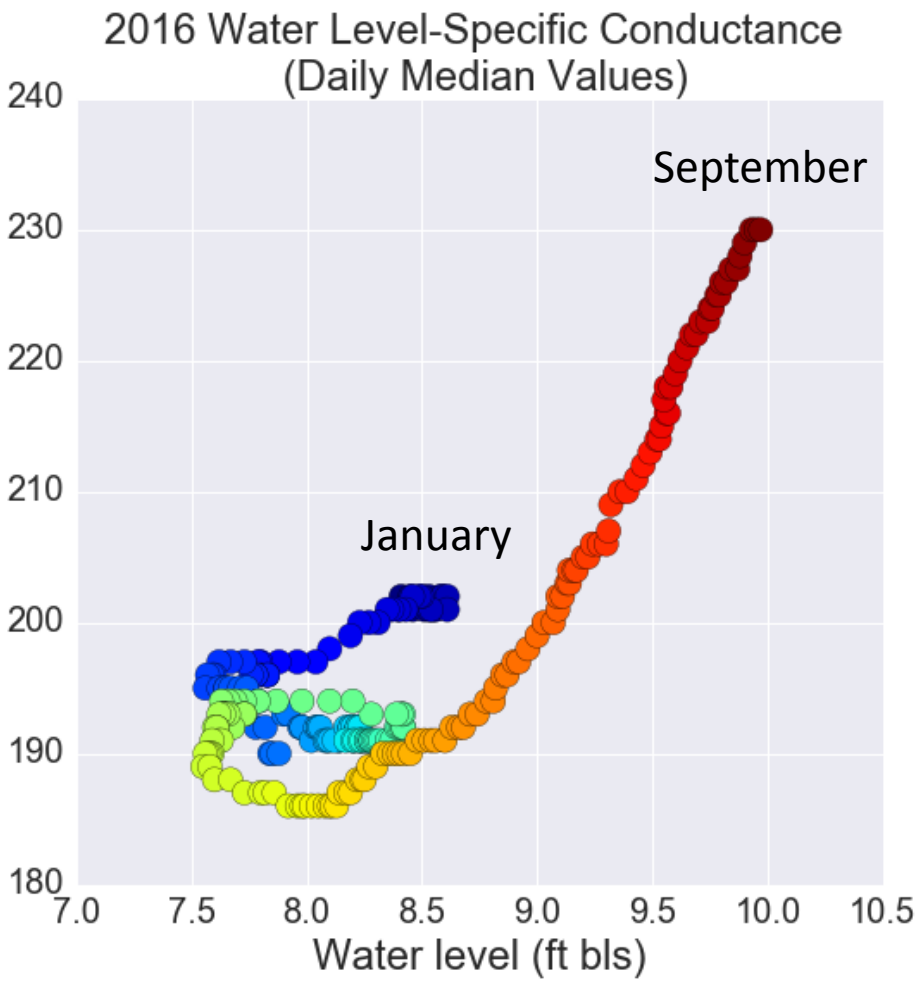



Specific Conductance-Nitrate
(Daily Median Values)
Specific Conductance (uS/cm2)
240
230
220
210
200
190
180
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
Nitrate mg/L
Side-dressing
120 lbs N/acre
September
August
July
June
May
April
March
3.2

2015



2016



Soybeans

Corn

Considerations when monitoring BMP effectiveness

- Soils and Redox conditions matter
- Hydrogeology matters
- When you sample matters
- BMP's may be effective in one setting and not in others.


Thanks!