



Irrigation as a Conservation Practice to Reduce Nitrate Concentrations in Coastal Plain Groundwater of Eastern Shore Chesapeake Bay

Judy Denver (Mark Nardi)

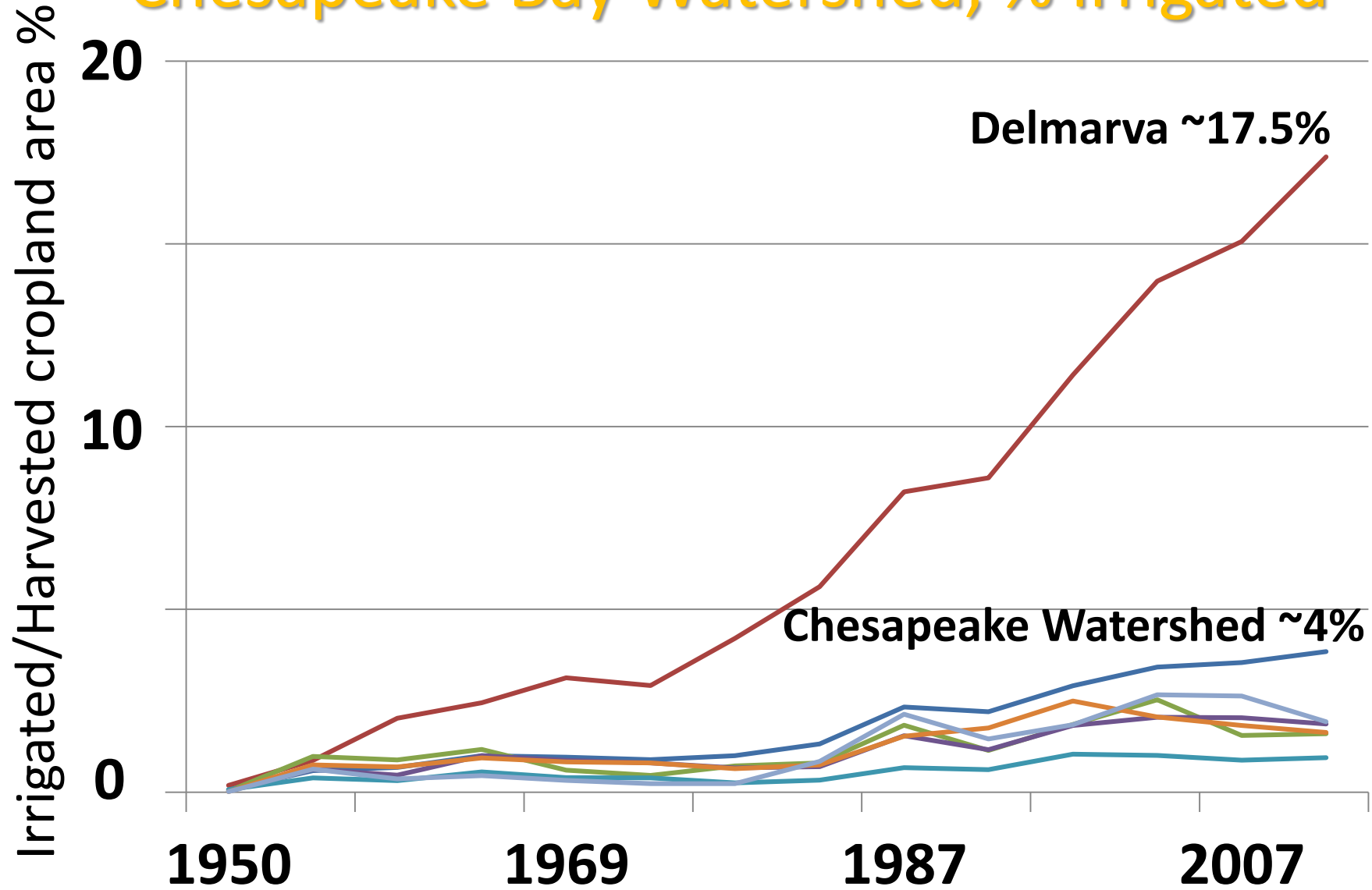
Cropland Irrigation Meeting

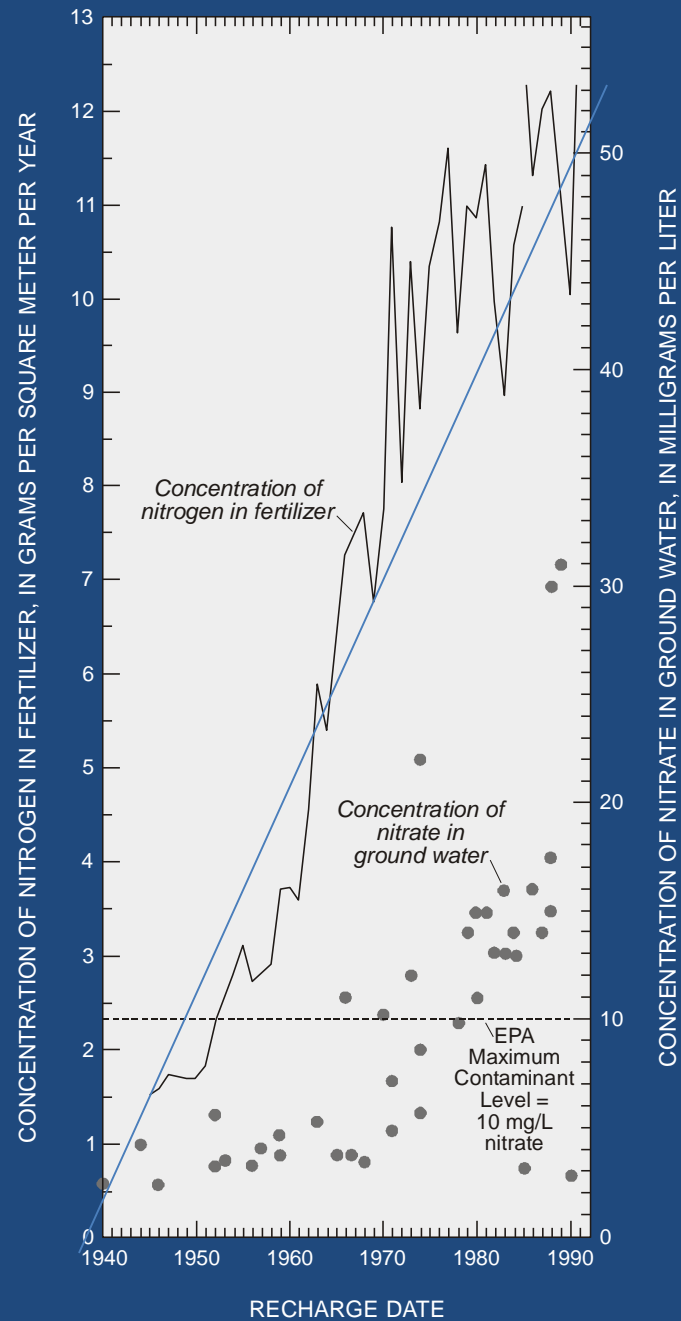
February 26, 2019 – Georgetown Delaware

Outline

- Regional nitrogen concerns
 - Water quality trends
- On Farm Studies
 - Soil water
 - Groundwater

Chesapeake Bay Watershed, % Irrigated



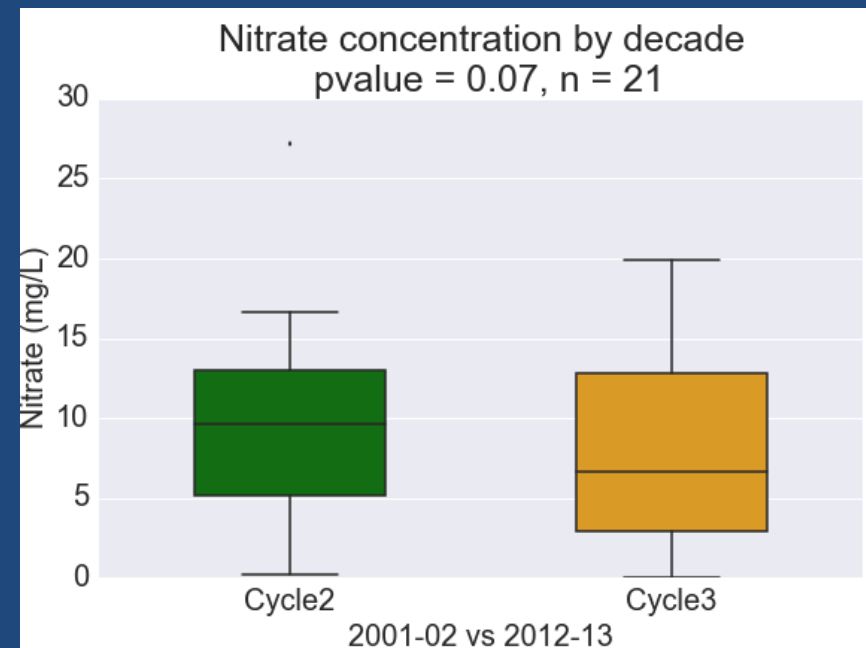
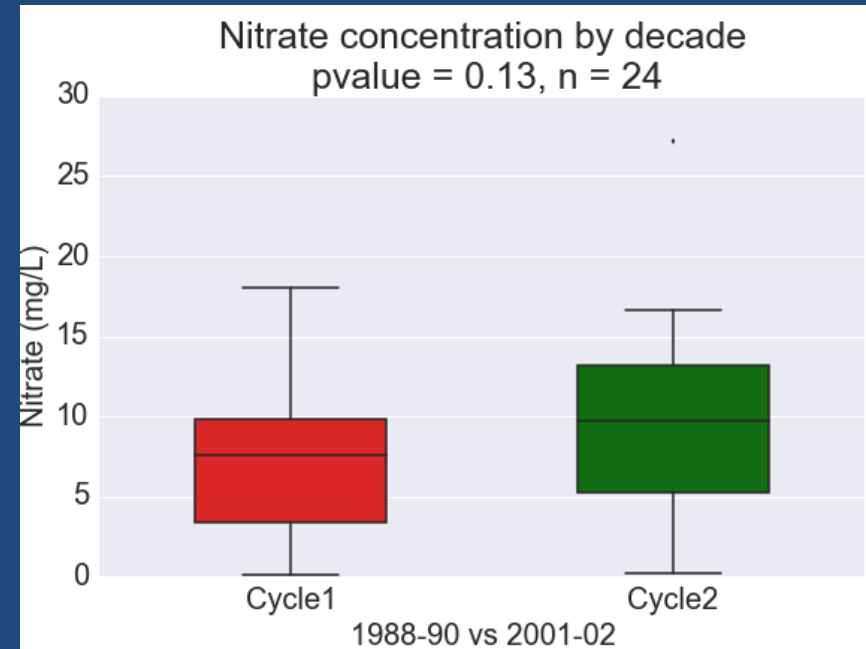
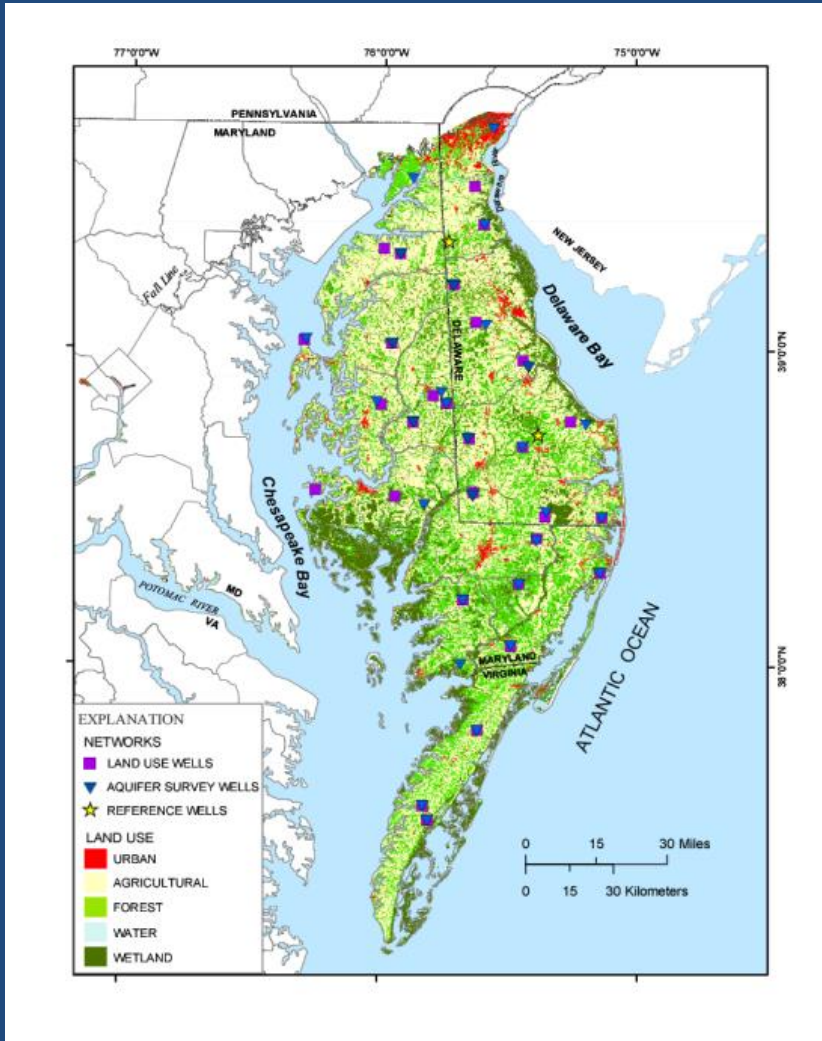


Comparison of rates of nitrogen fertilizer application in Kent County, MD to nitrate concentrations in groundwater, Locust Grove Study Area, Kent County, MD
(Böhlke and Denver, 1993)

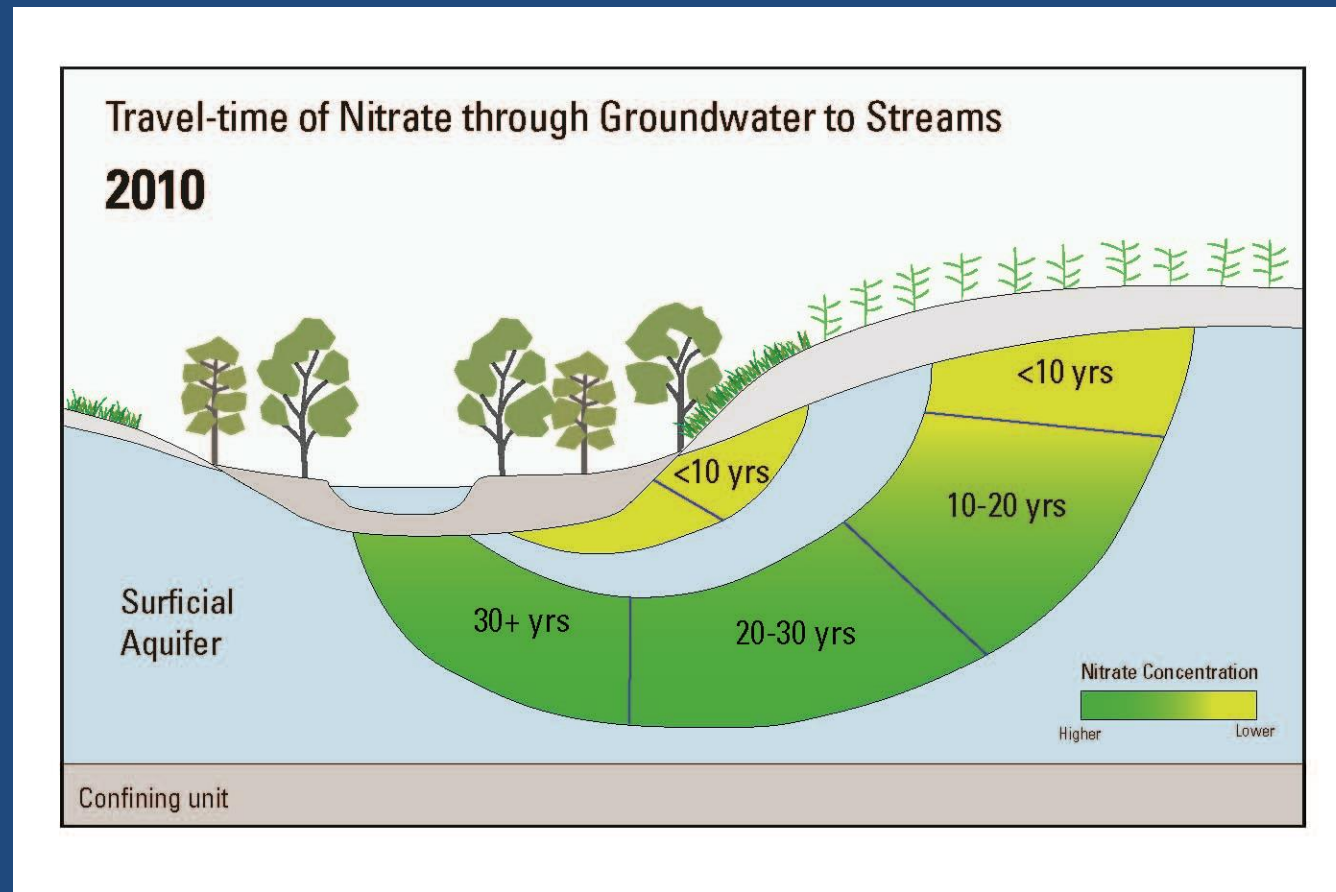
NAWQA Program

Decadal Groundwater Trends

Sampling (DO > 0.5 mg/L)

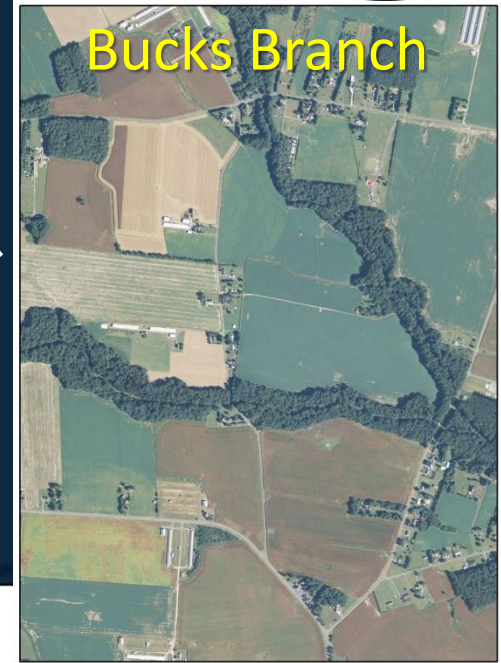
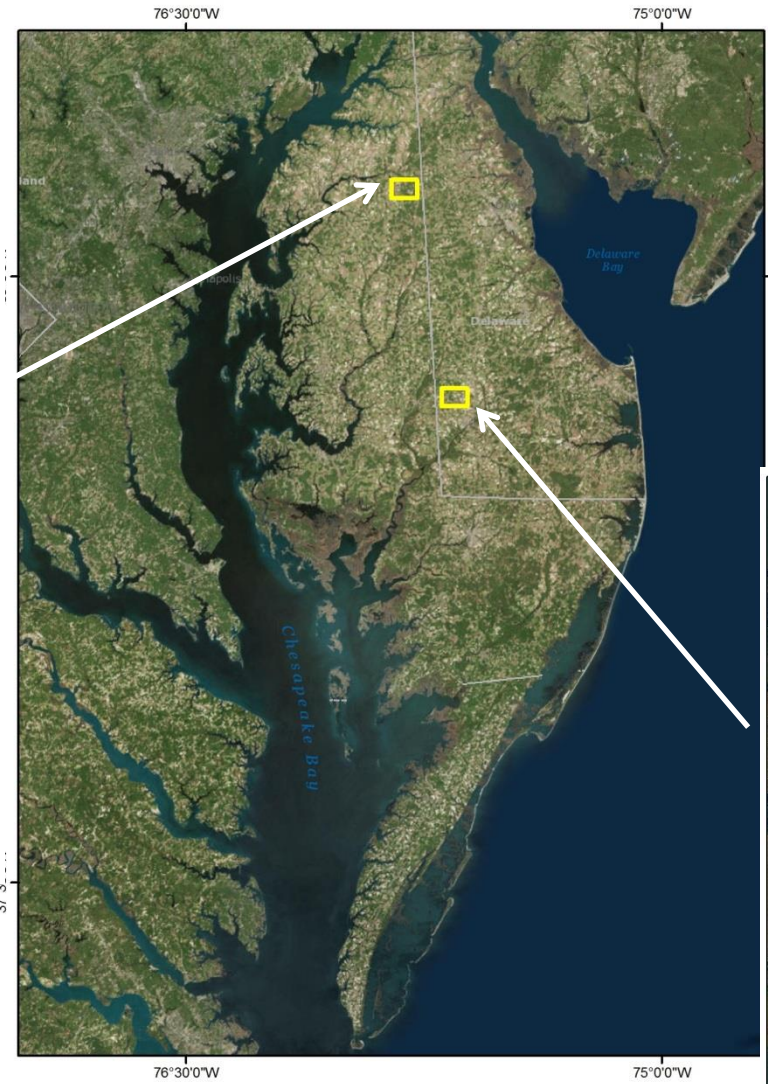
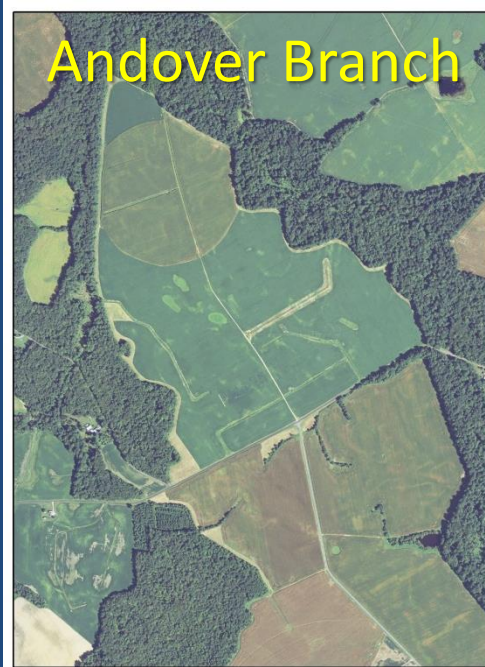


Changes in stream nitrate concentrations lag behind those in groundwater

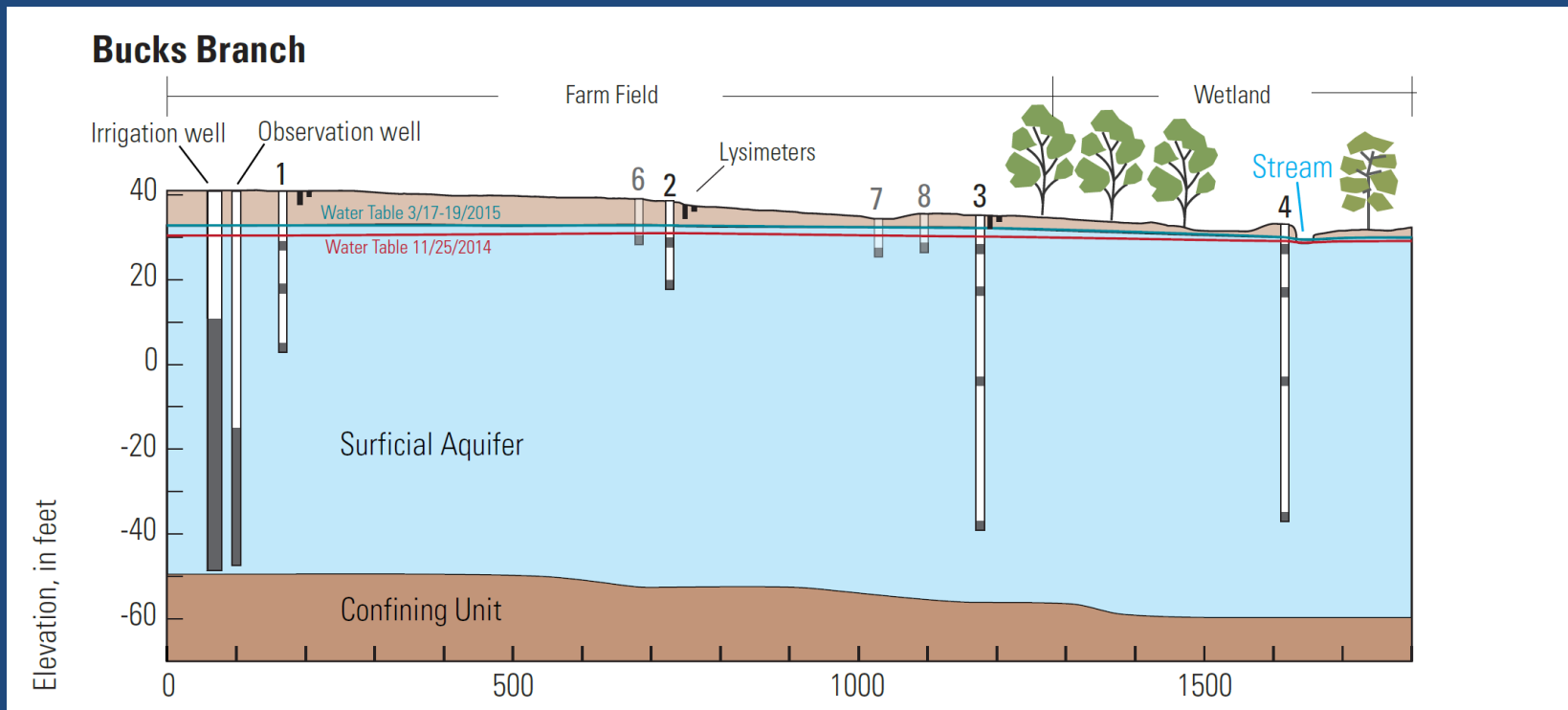
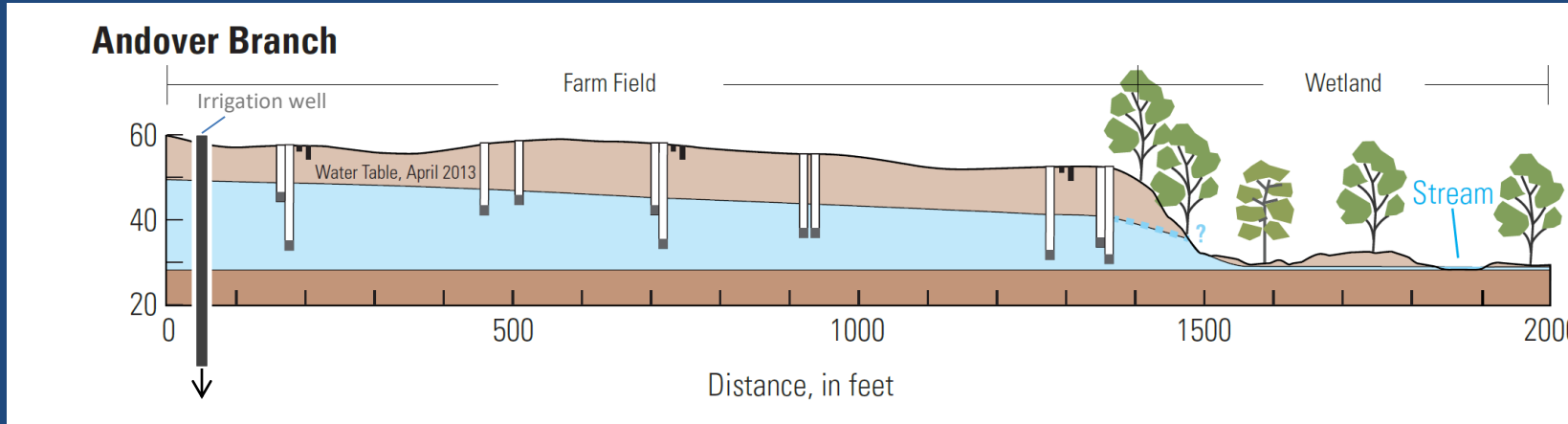


Most nitrogen in Delmarva streams is nitrate from groundwater.

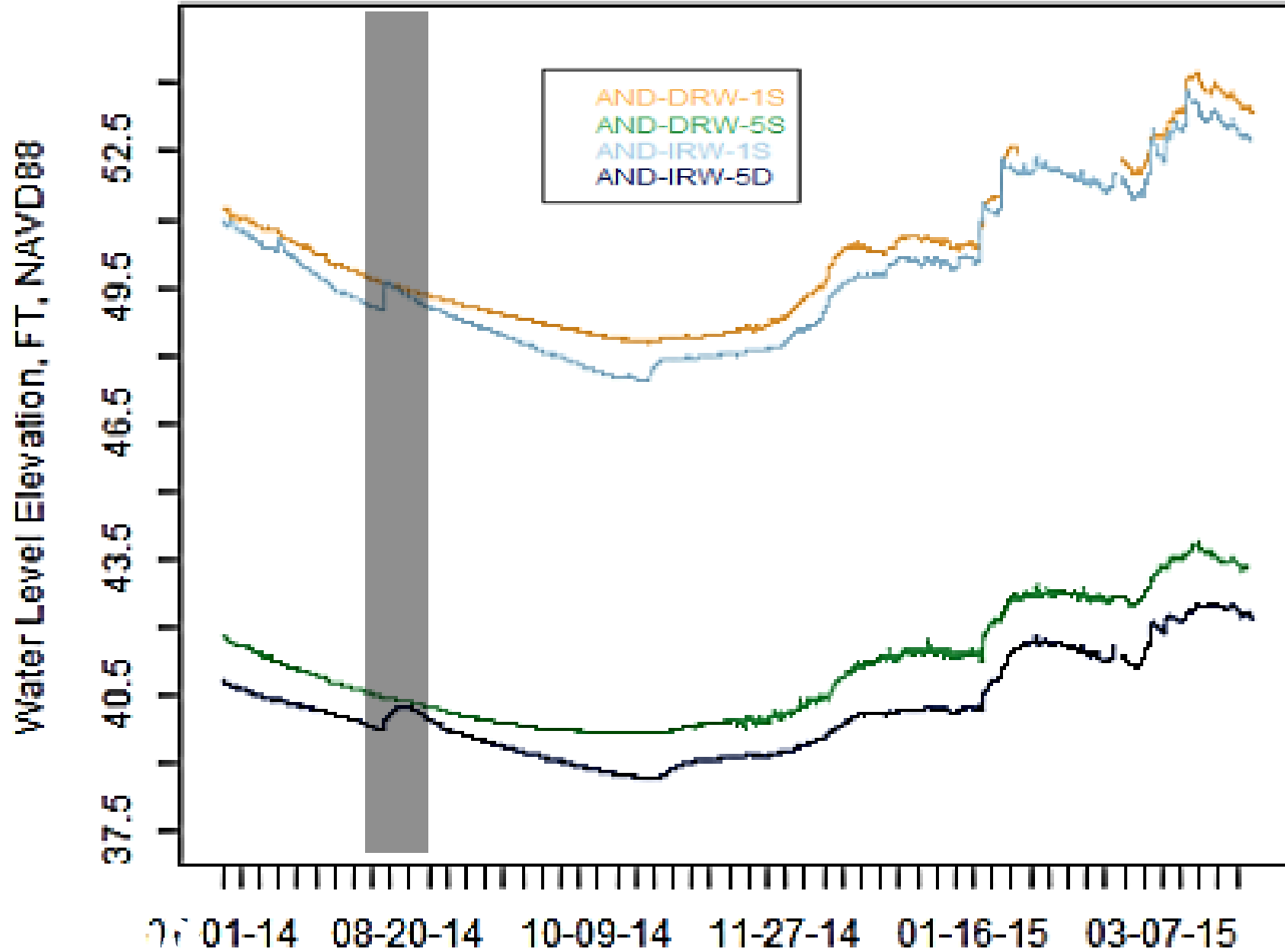
Study Sites



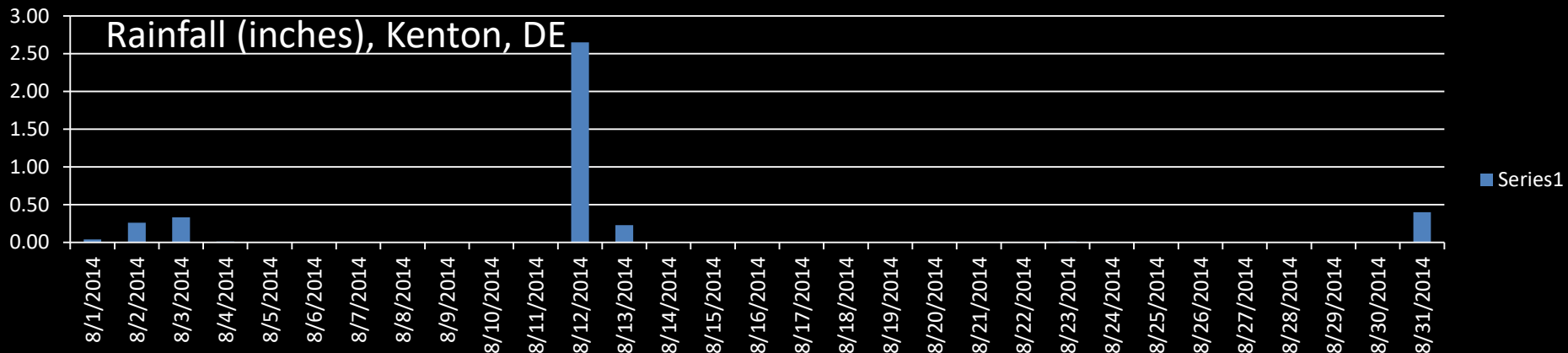
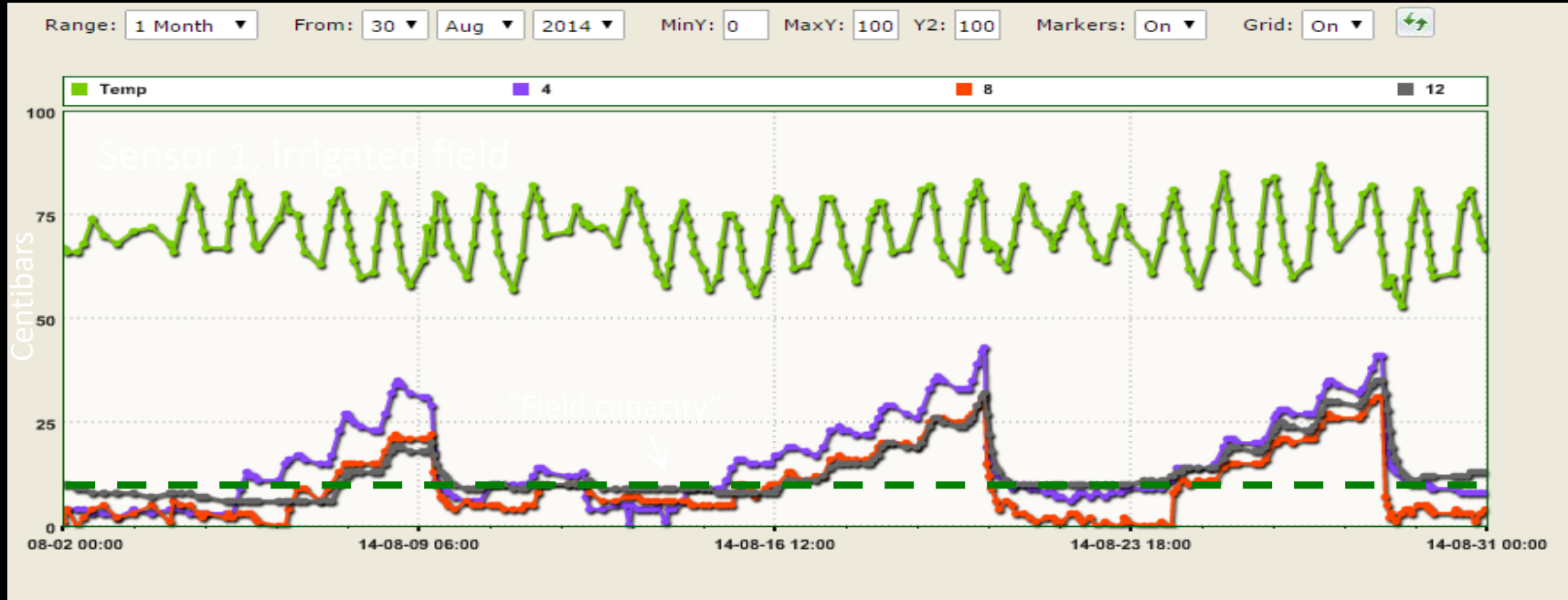
Study Networks-- Irrigated Fields



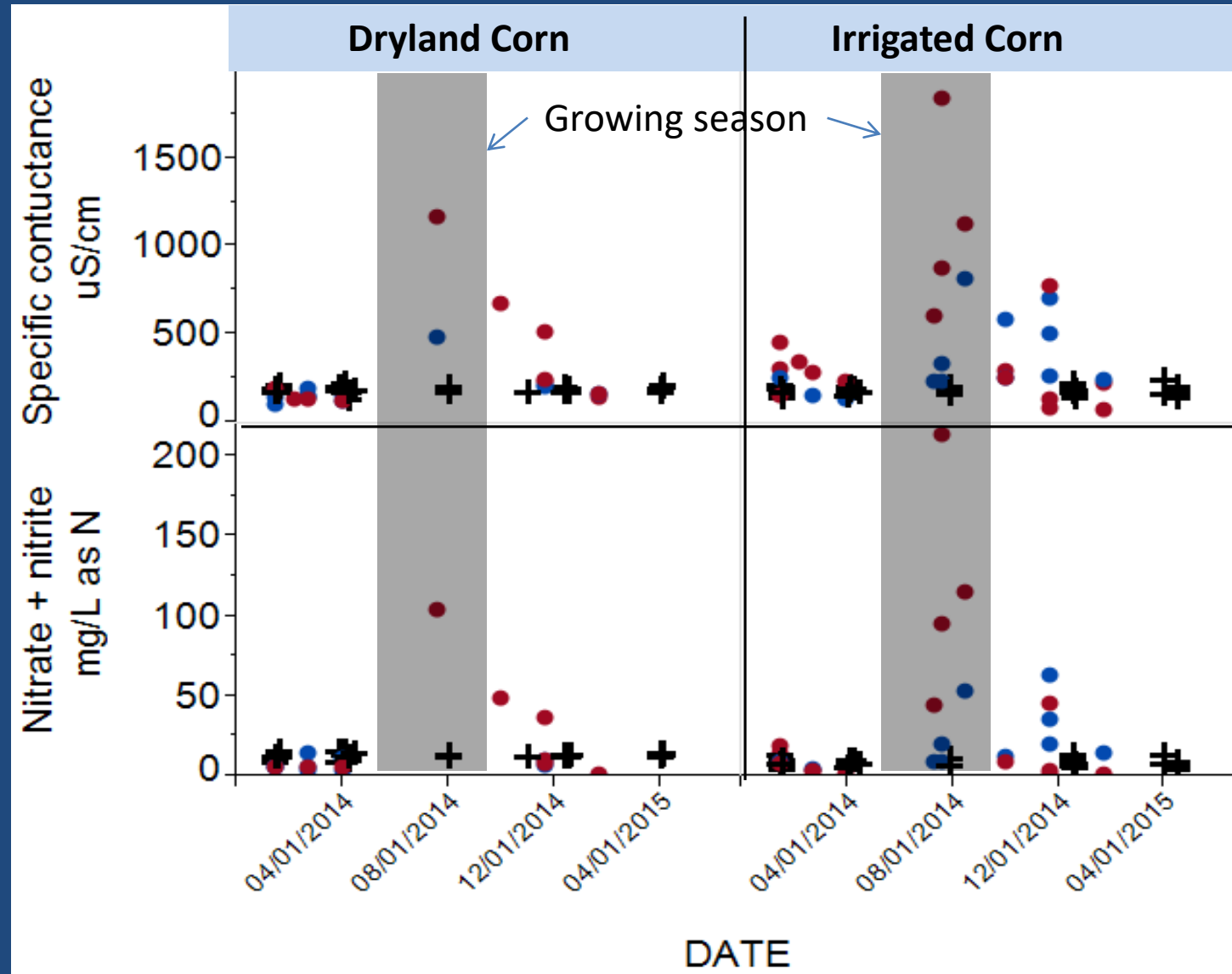
Andover Branch, Continuous Water Levels 2014-07-01 Through 2015-03-31



Andover Branch, Irrigated Field Soil Moisture and Rainfall 8/2/2014-8/31/2014

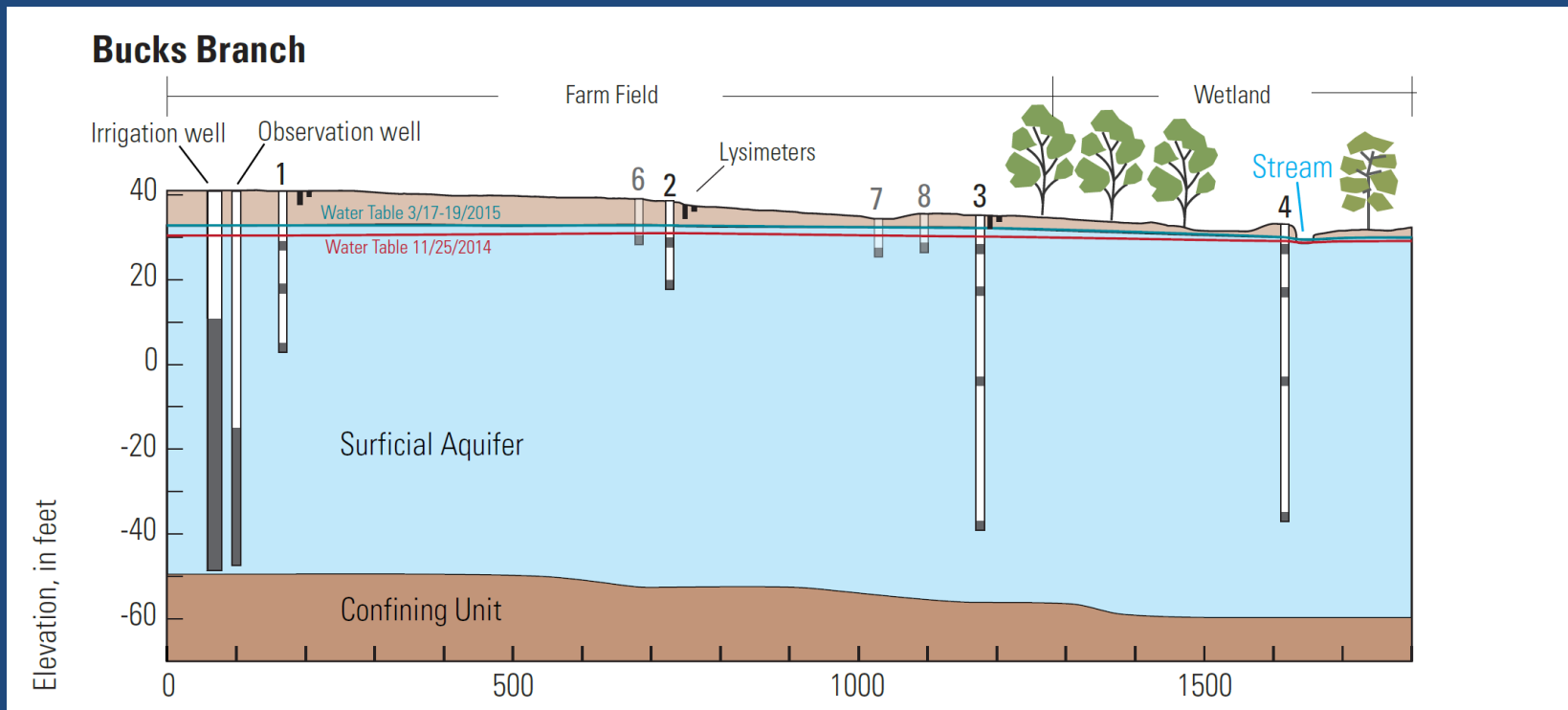
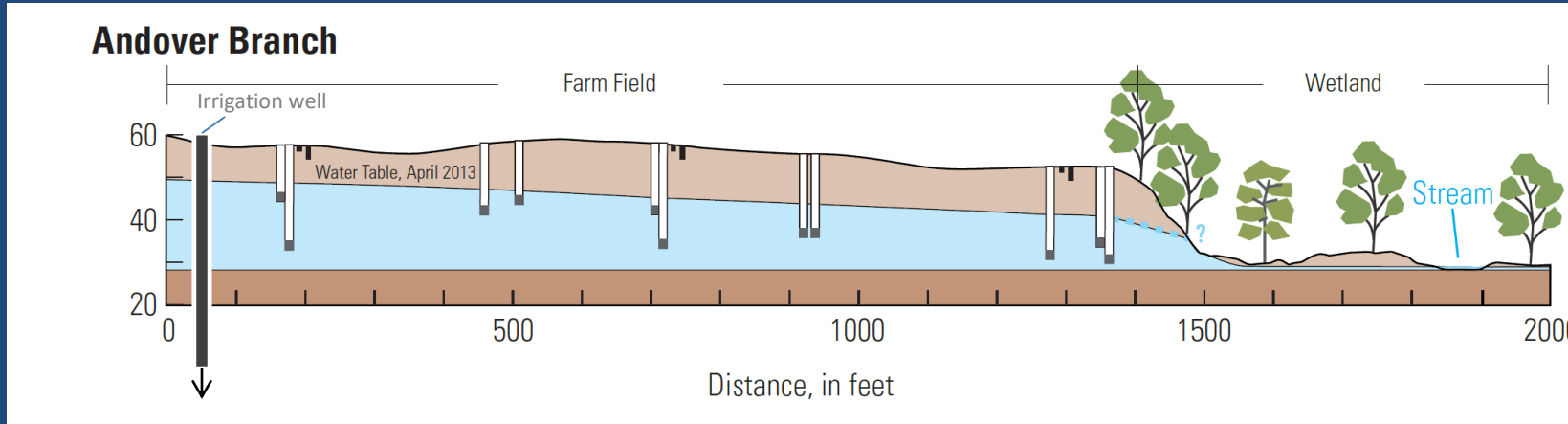


Andover Branch, Lysimeter and Shallow Groundwater Data

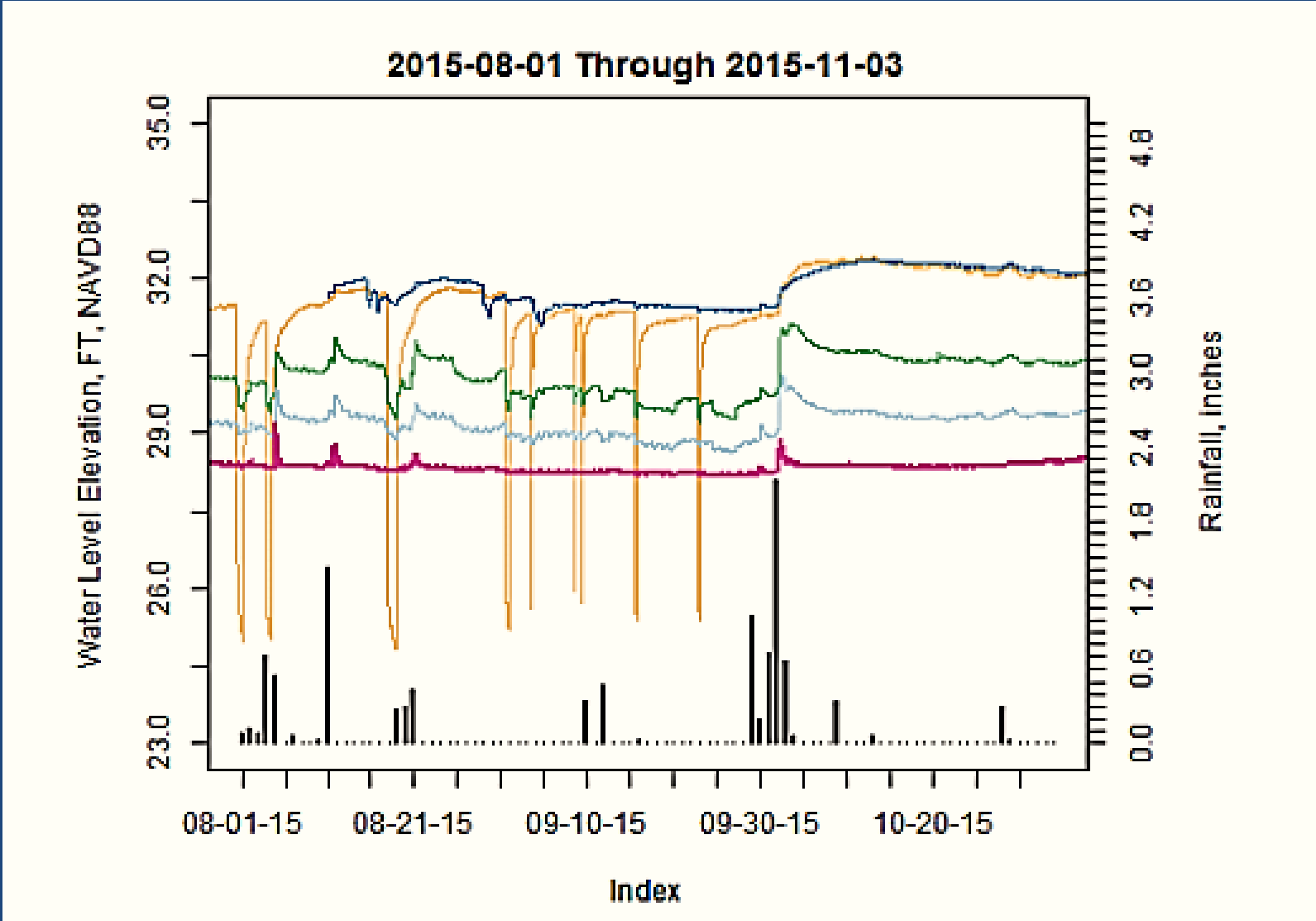


(Lysimeters: circles, red = 1 ft, blue = 3 ft; Shallow well samples: +)

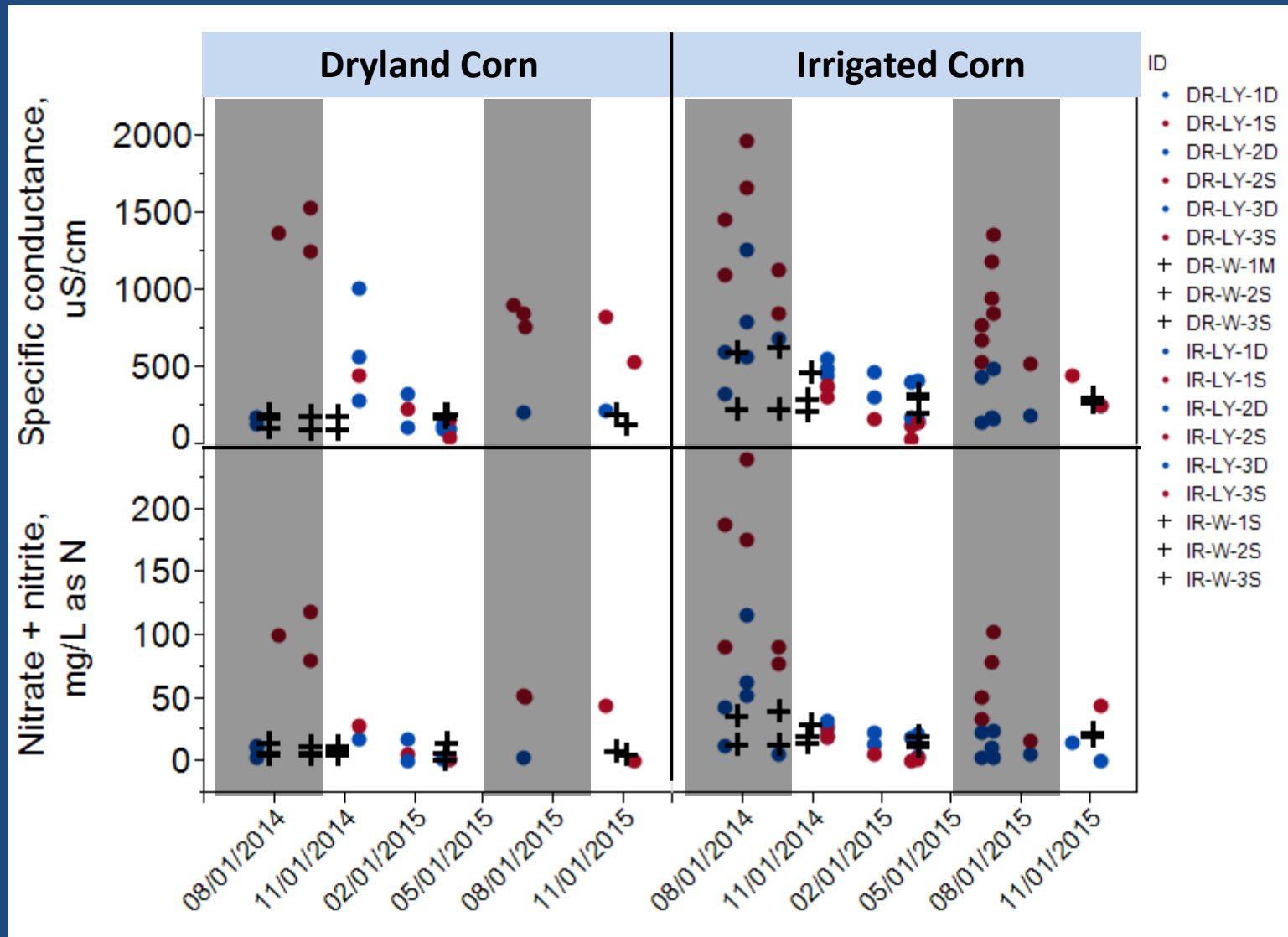
Study Networks-- Irrigated Fields



Bucks Branch, Continuous Water Levels

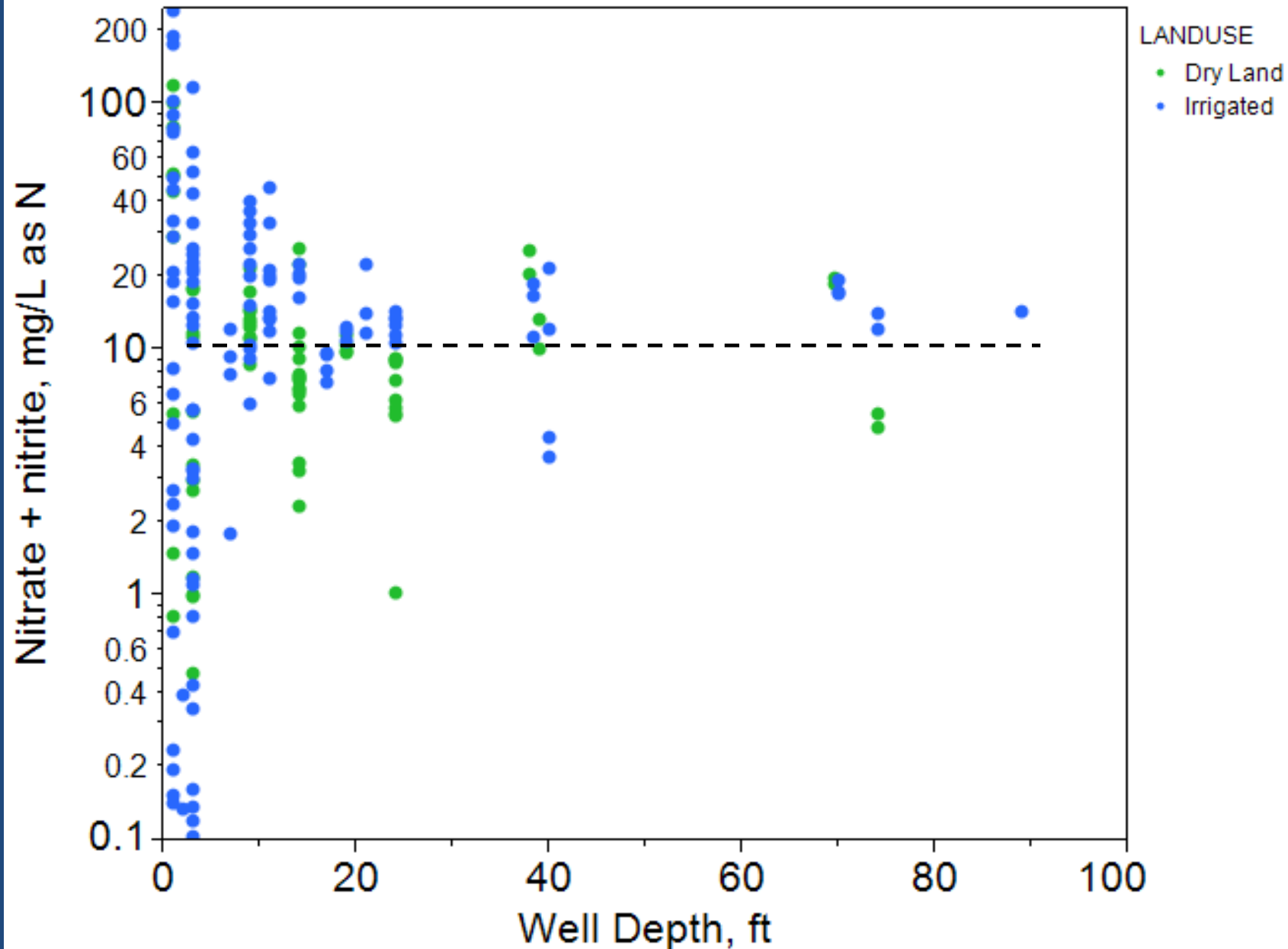


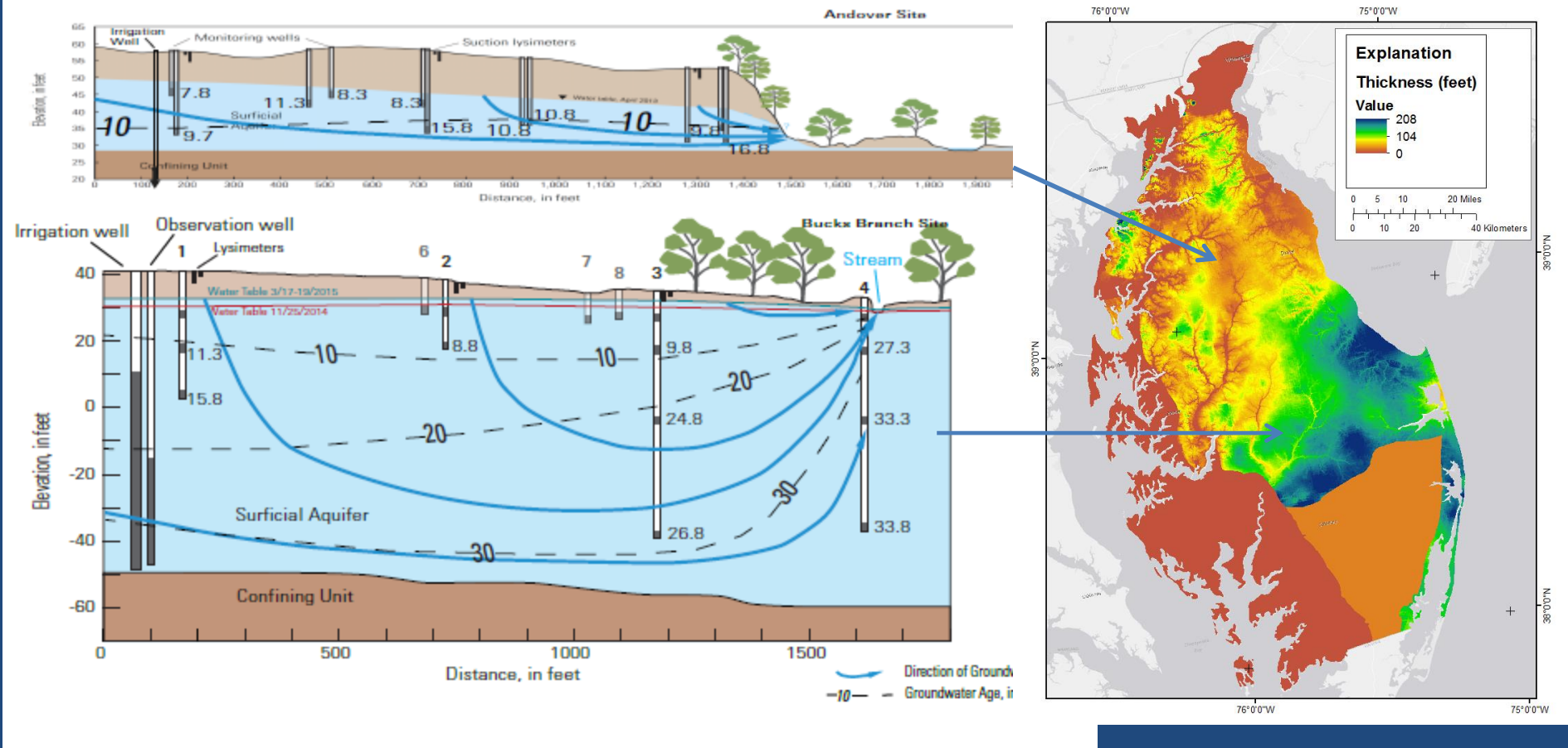
Bucks Branch, Lysimeter and Shallow Groundwater Data



(Lysimeters: circles, red = 1 ft, blue = 3 ft; Shallow well samples: +)

Bucks Branch, Nitrate in Lysimeters and Groundwater





- Hydrogeologic setting is variable across the Coastal Plain of the Delmarva Peninsula
 - Effects the response time of streams to changes in land management
 - Effects natural processes that may mitigate nutrient transport
- Understanding local setting can help producers and other resource managers optimize BMP implementation.

Conclusions



- **Nitrogen use efficiency** is generally greater with irrigation than dryland farming
- **Annual recharge to the water table** is greatest in winter (ET lowest), but also occurs with heavy rainfall in the summer
- **Highest nitrate** in groundwater:
 - Where water-table is very shallow and unsaturated zone is thin, or absent
 - Where soil and aquifer sediments are most permeable

Conclusions



- **Leaching of nitrate** beyond zone of plant uptake occurs during growing season
 - Nitrate concentrations in soil water are higher than during other times of the year
 - Higher nitrate concentrations in leachate with irrigation because of greater amount available from recent nitrogen application and greater soil saturation
- *Question is: What is the significance of the increased amount of nitrate leached through the soil zone during the growing season to the total nitrate load to groundwater?*

Mass Balance Modeling with RZWQM2 (Root Zone Water Quality Model)

- One-dimensional model that integrates agricultural management practices and flow and transport processes, including both preferential and matrix flow, N-cycling processes, and plant uptake of water and solutes.
- The model yields a detailed mass balance summarizing additions, losses, and transformations of N from various sources.
- Predicts average nitrate concentrations at the bottom of the simulation profile—which can be as deep as 30 m.
- Previous models agreed reasonably well with measured nitrate concentrations in monitoring wells.

– Reference: Nolan, B.T., Puckett, L.J., Ma, Liwang, Green C.T., Bayless, E.R., and Malone, R.W. 2010. Predicting unsaturated zone nitrogen balances in agricultural settings of the United States. *J. Environ. Qual.* 39:1051-1065 (2010)

Thank you

