Water Table and Nutrient Fluctuations within the Floodplain of the Upper Cape Fear River

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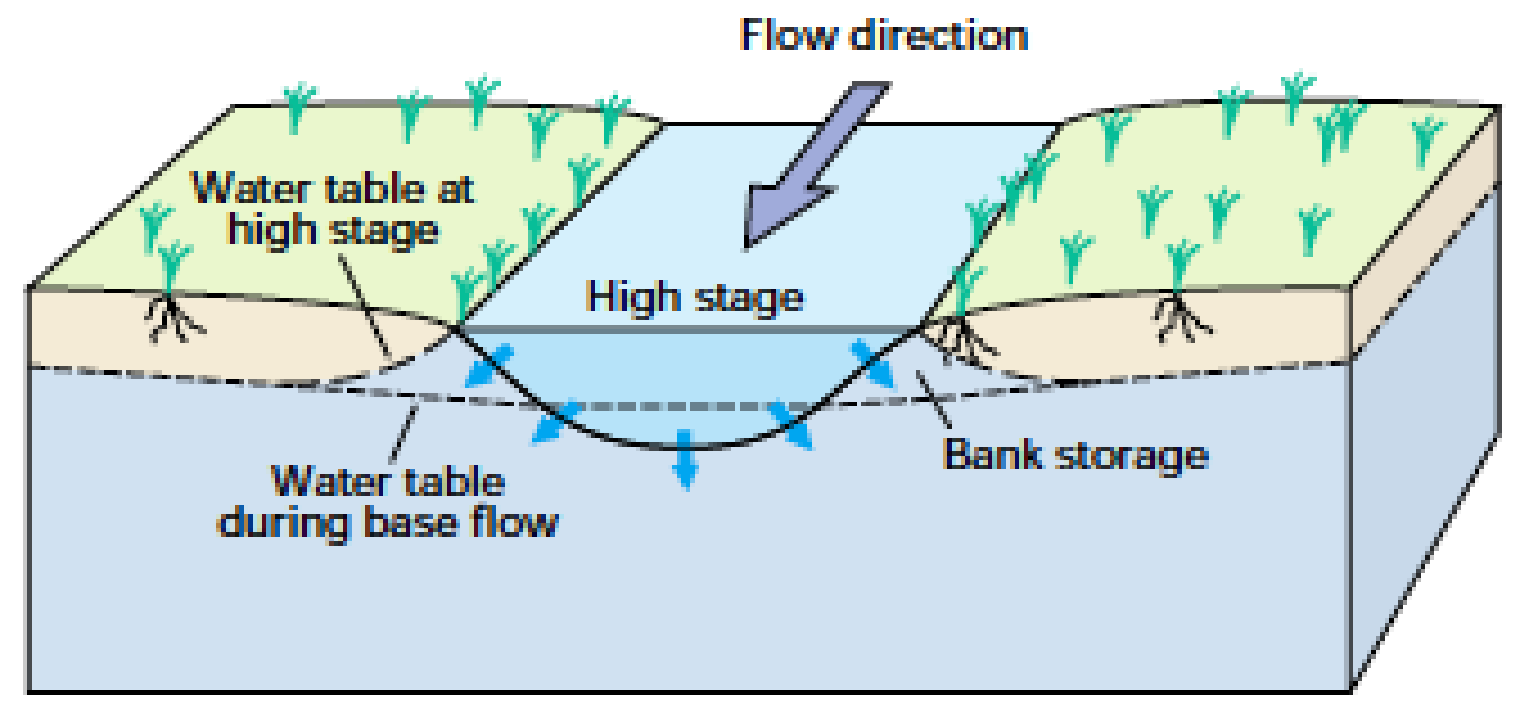
Floodplain Functions
• Floodwater storage

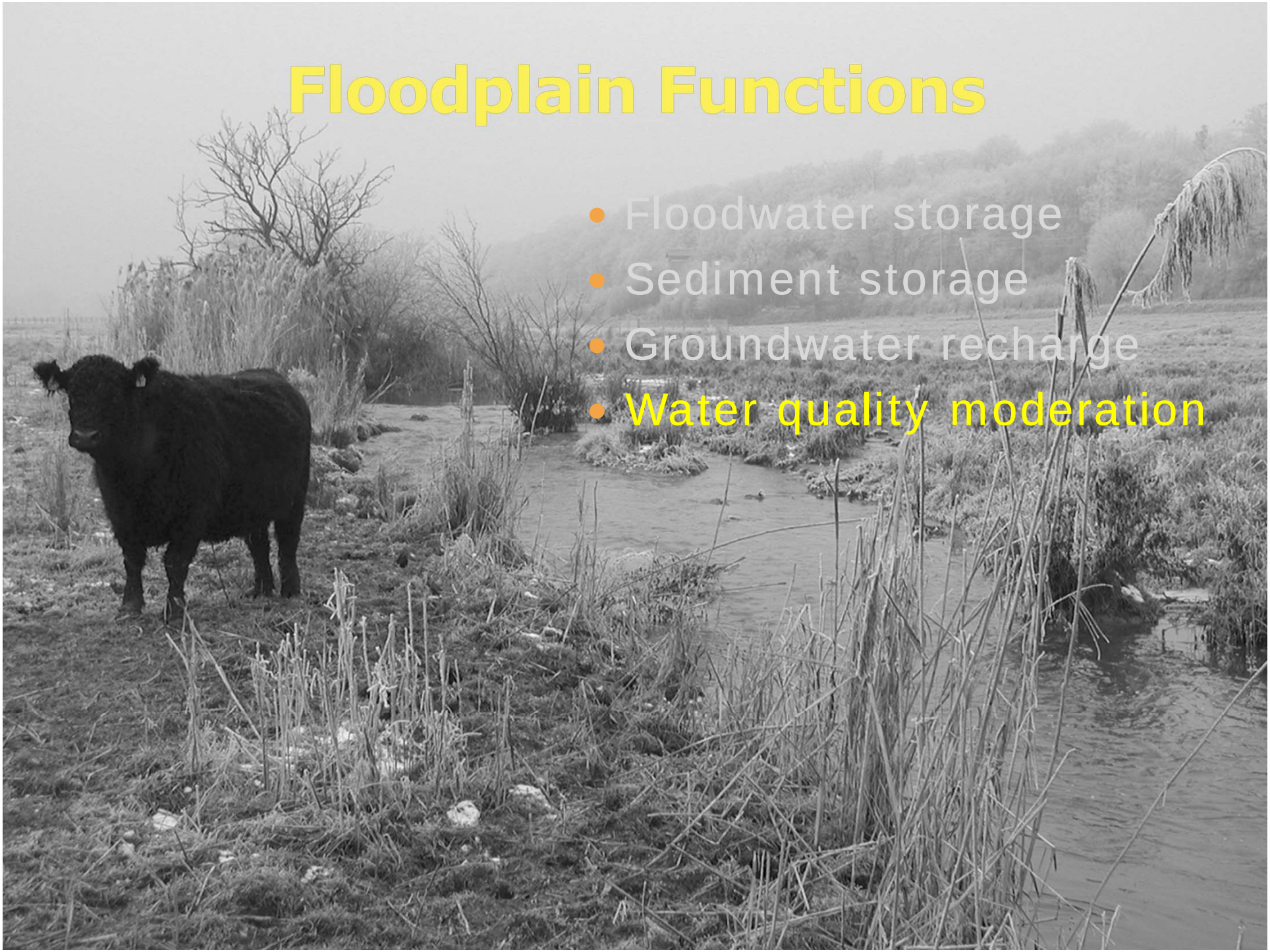

Floodplain Functions
Floodwater storage
Sediment storage

Floodplain Functions

- Floodwater storage
- Sediment storage
- Groundwater recharge



Modified from: Winter, TC and others (1998) USGS Circular 1139


Floodplain Functions
Floodwater storage
Sediment storage
Groundwater recharge
Water quality moderation


Floodplain Functions
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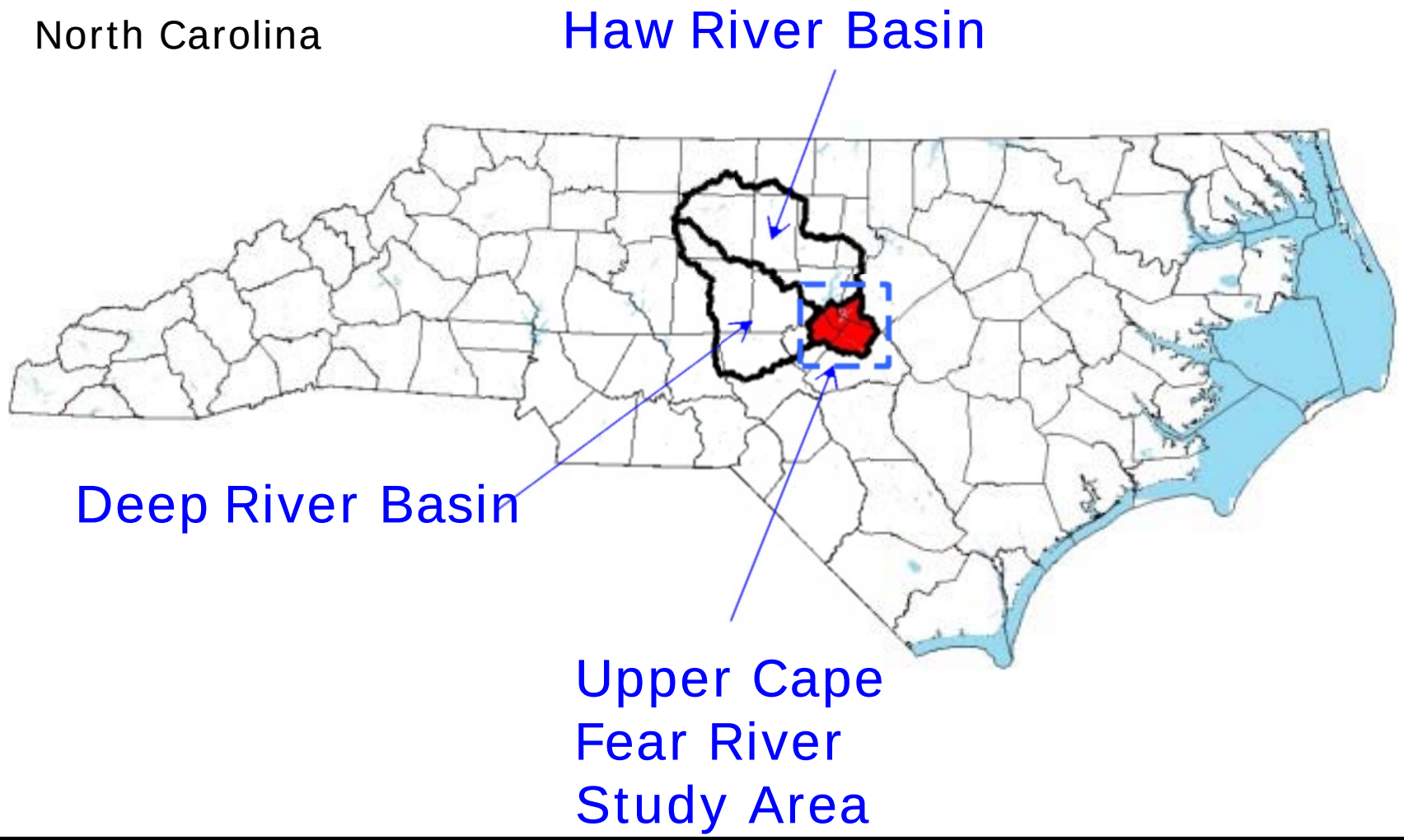
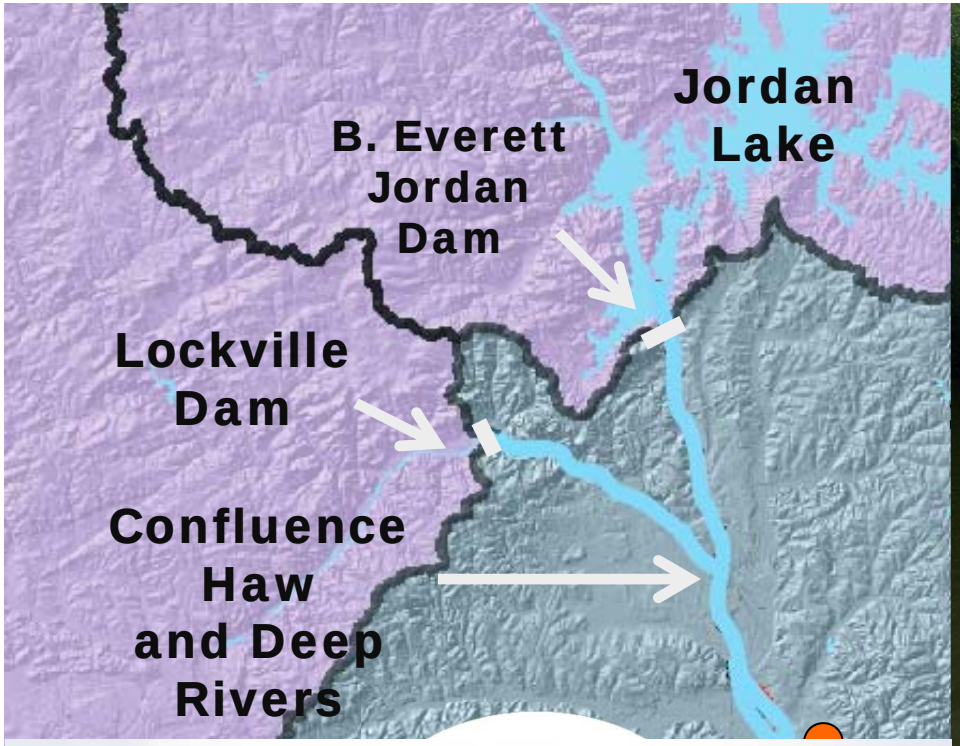
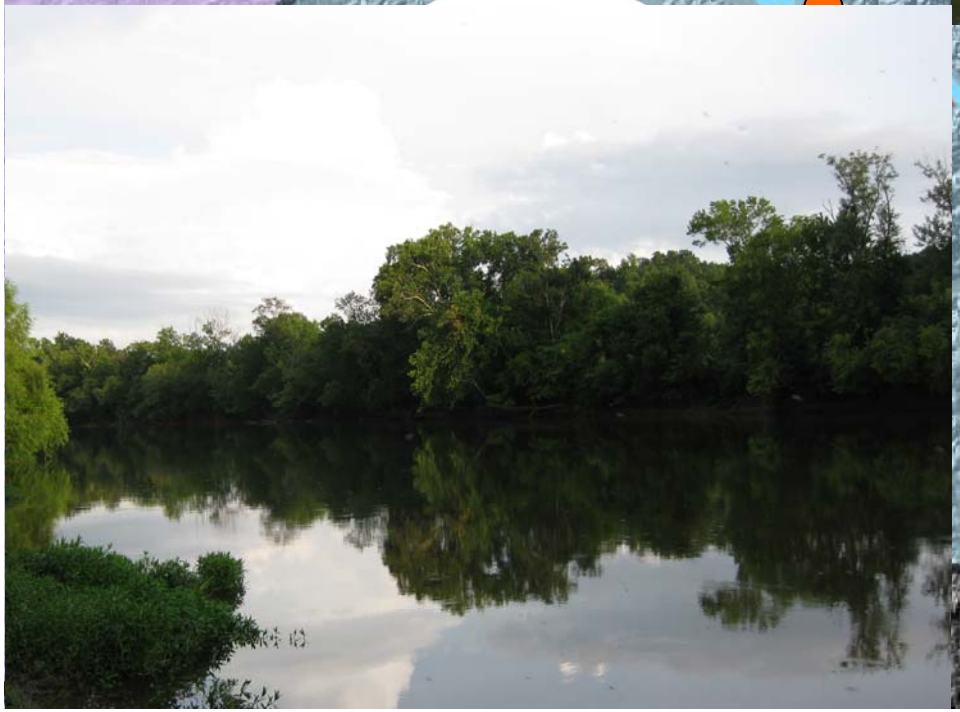
Water quality moderation
Habitat

Upper Cape Fear River Basin




Jordan
Lake
B. Everett
Jordan
Dam
Lockville
Dam
Confluence
Haw
and Deep
Rivers




Bradley
Road
Reach
City of
Lillington

Research Questions

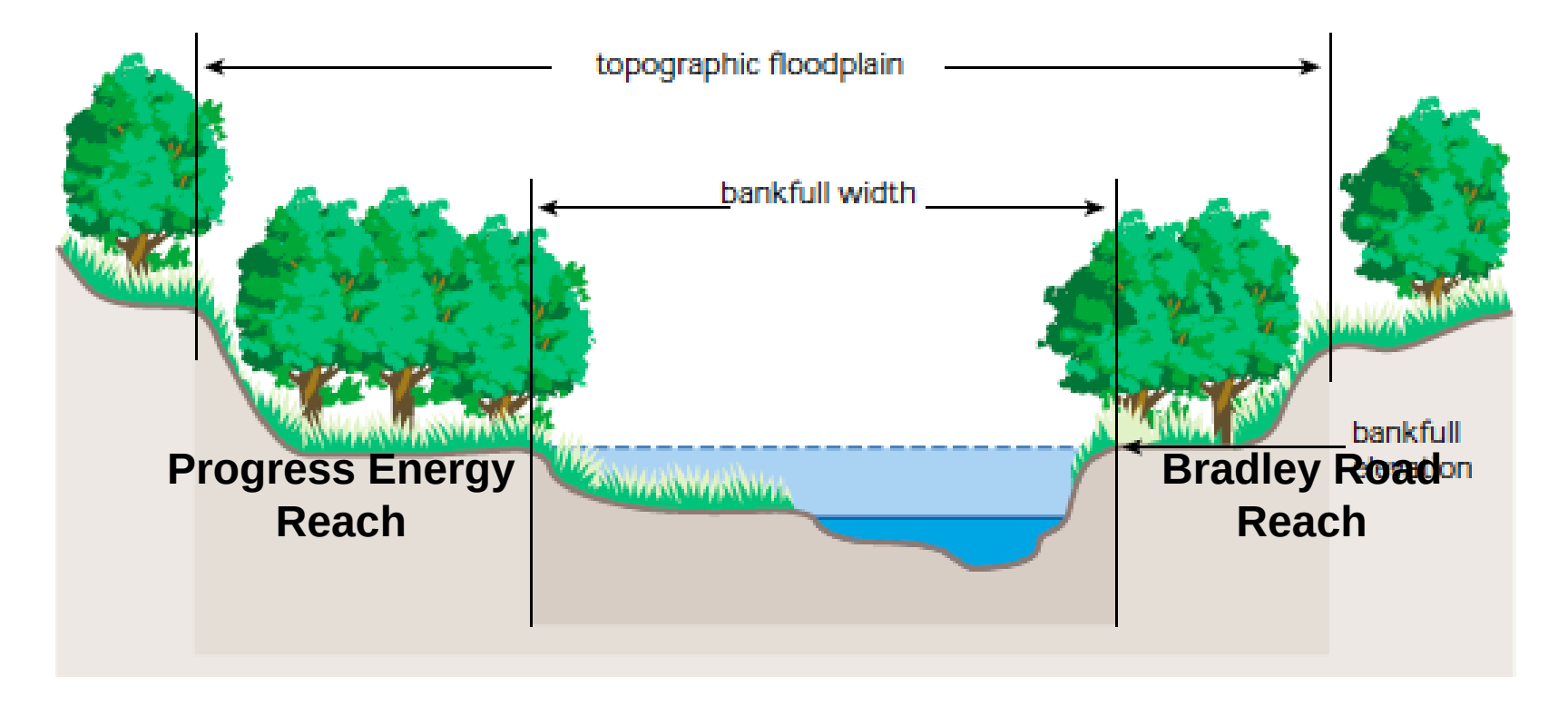
- Is the upper Cape Fear River a “gaining stream” for the majority of the year?
- Are there spatial and seasonal differences in floodplain water quality?
- Does nutrient processing within the floodplains function as expected?

Discussion Topics

- Floodplains of two reaches investigated
- Measuring interaction
- Differences between groundwater and surface water
  - Hydrology
  - Water quality
- Answers to research questions

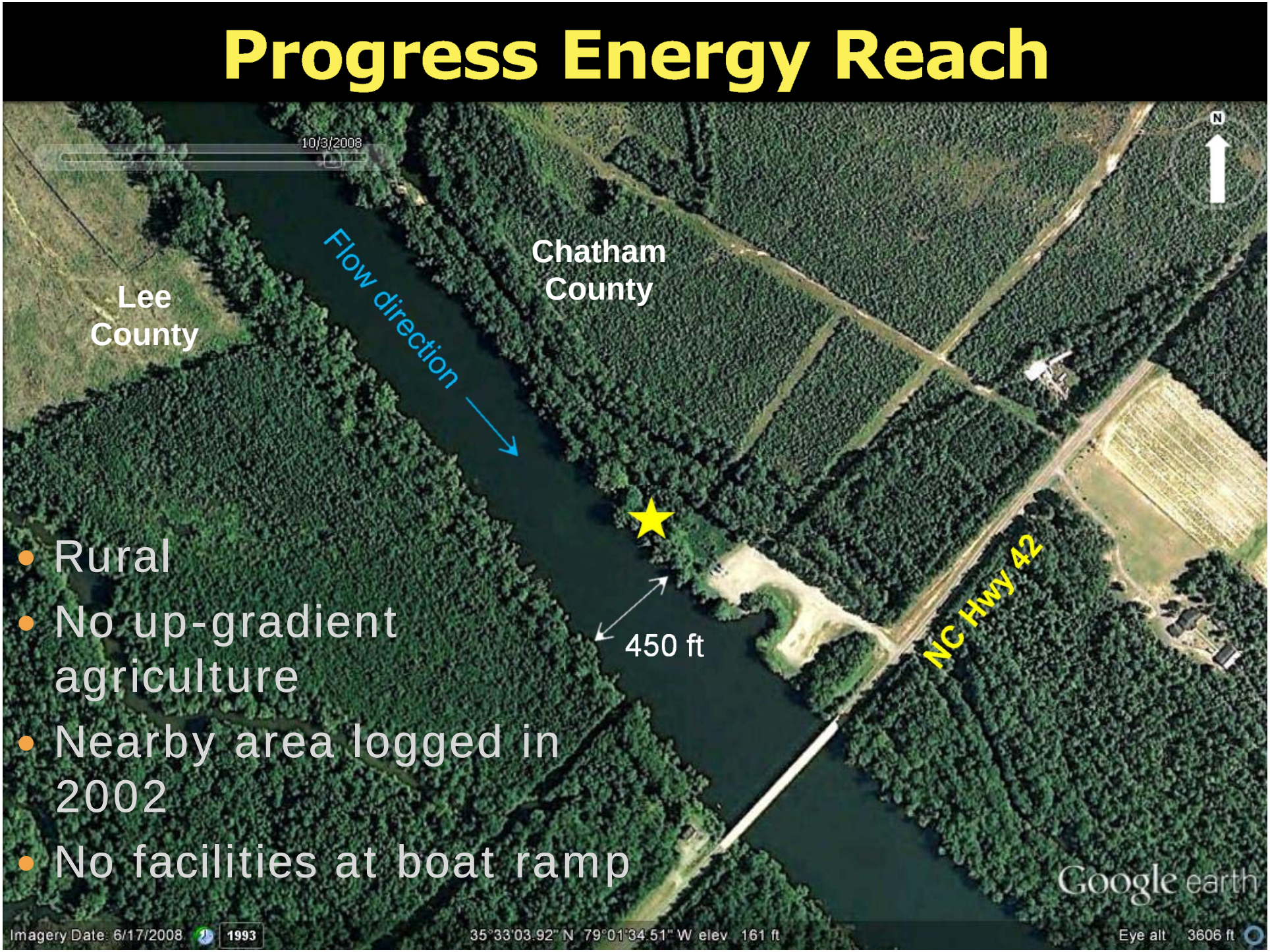
Floodplains of Two Reaches

- Morphology slightly different



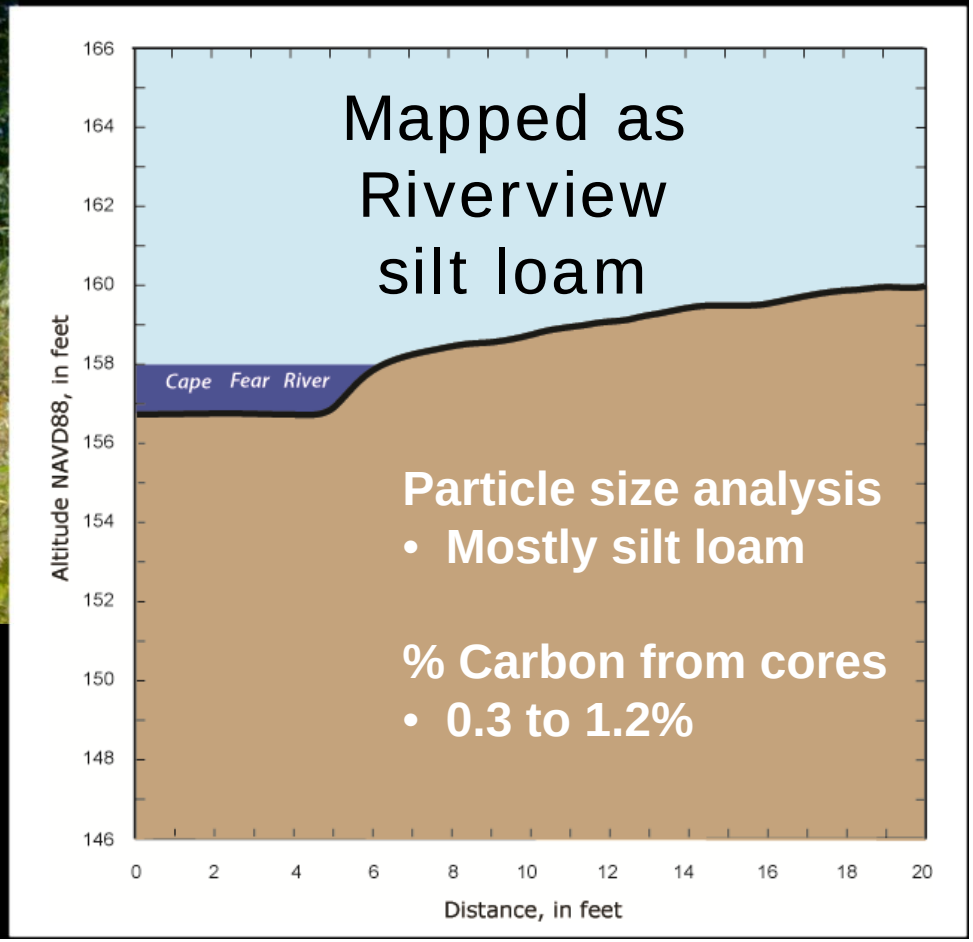
Source: Winter, TC et al (1998) USGS Circular 1139

Progress Energy Reach



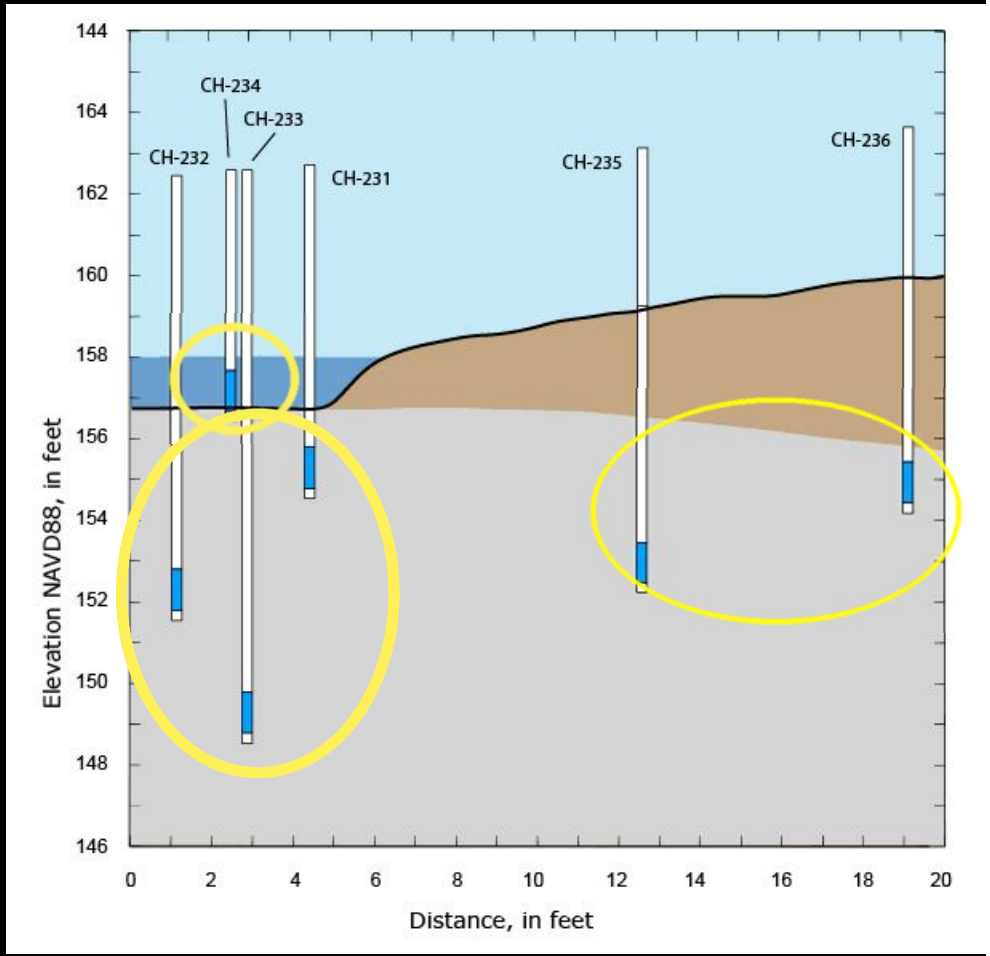
- Rural
- No up-gradient agriculture
- Nearby area logged in 2002
- No facilities at boat ramp

Progress Energy Reach Soils

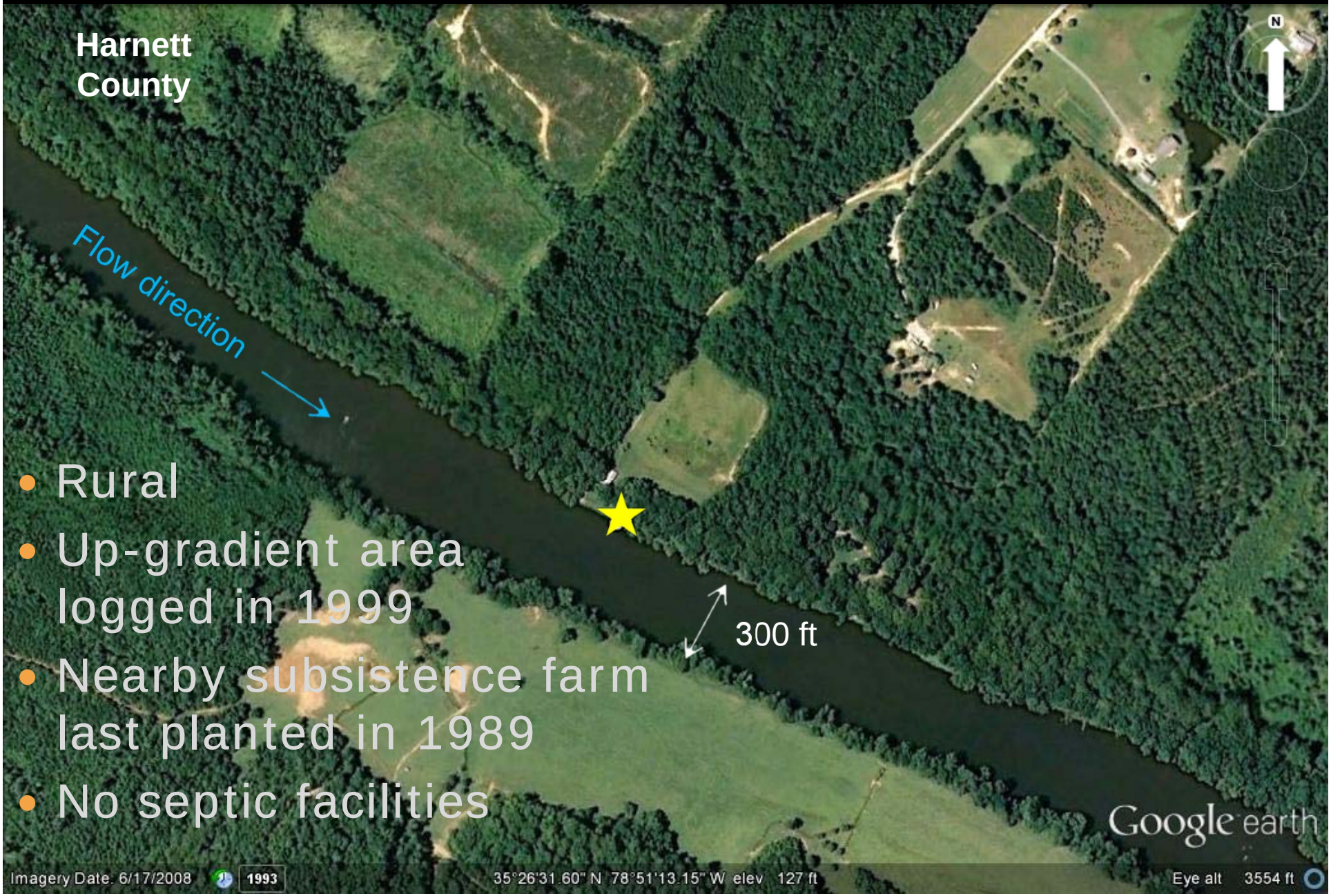


Progress Energy Piezometer Transect

- 6 piezometers
  - 2 on the bank
  - 3 beneath river bed
  - 1 river stage

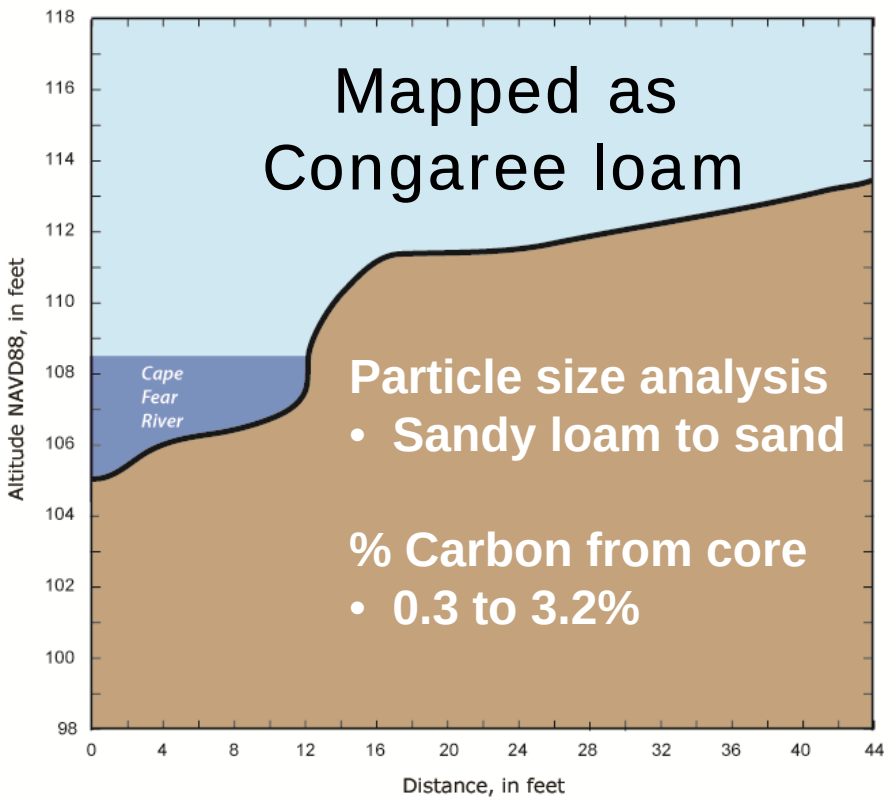


Bradley Road Reach



- Rural
- Up-gradient area logged in 1999
- Nearby subsistence farm last planted in 1989
- No septic facilities

Bradley Road Reach (BR) Soils

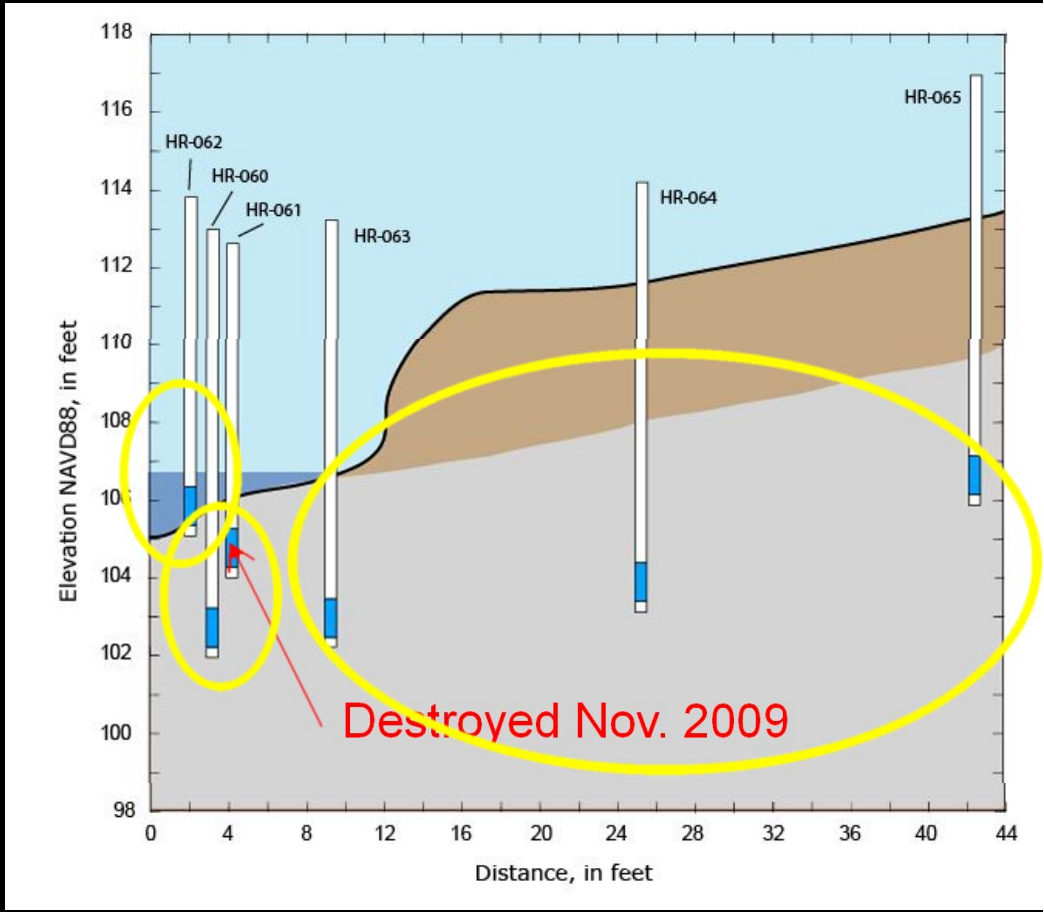


Particle size analysis
- **Sandy loam to sand**

% Carbon from core
- **0.3 to 3.2%**

Bradley Road Piezometer Transect

- 6 piezometers
  - 3 on the bank
  - 2 beneath river bed
  - 1 river stage
- BR-1U destroyed



Piezometers

- Jet pump installation
- 1.5 in diameter PVC
- 1 ft screen length
- Capped bottom
- Filter sand
- Bentonite seal
- Casing elevations surveyed to closest 0.01 ft

Measuring GW/SW Interaction

- 15-min hydraulic data
  - Water level
  - Dec 2009 to Nov 2010

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  - Water level
  - Dec 2009 to Nov 2010
- QA 2X a month
- Precipitation data from State Climate Office of NC
- Discharge from USGS Lillington, NC gage

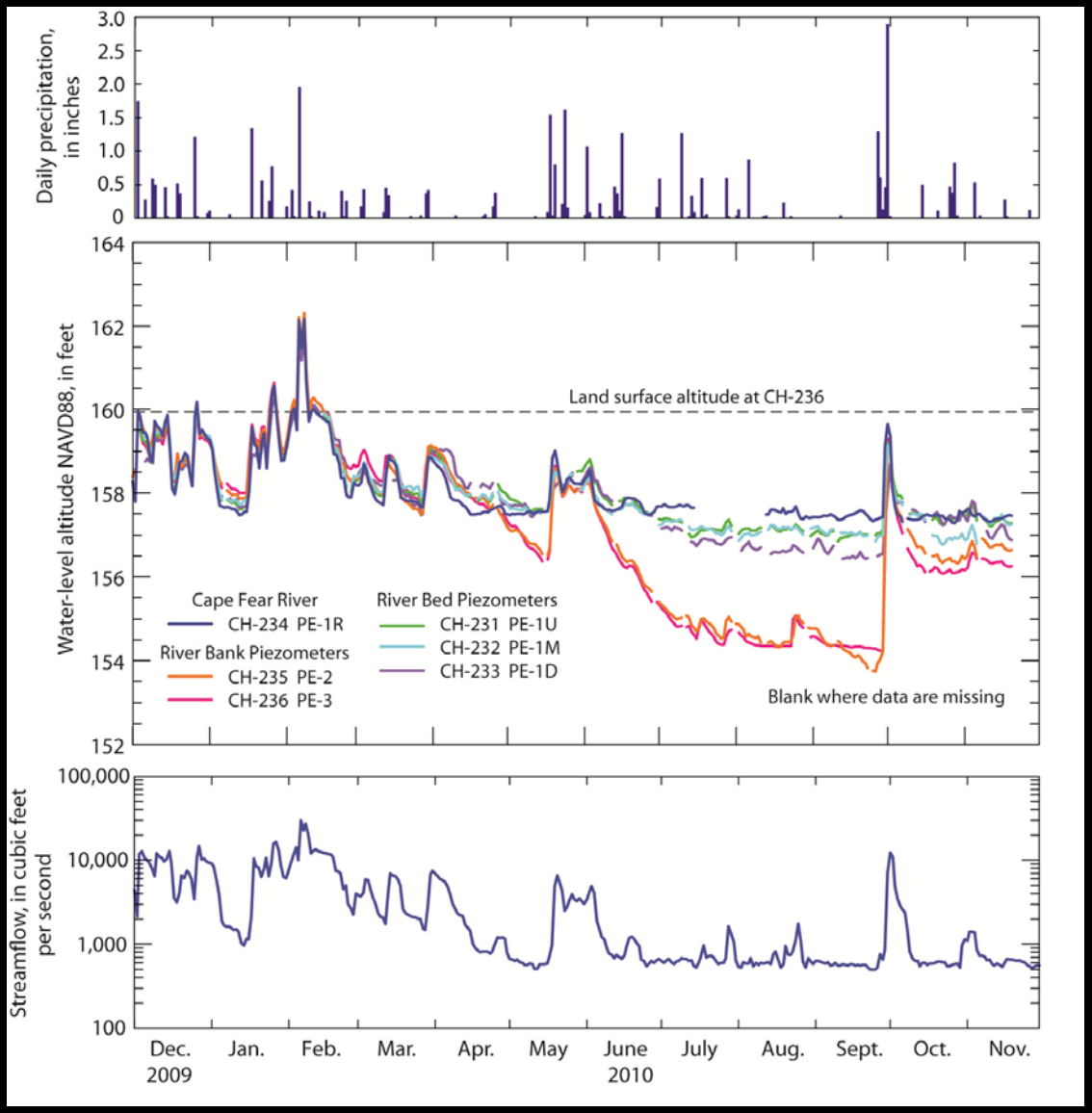
Water Quality Samples

- Attempted collection 2X a month from Dec. 2009 to Nov. 2010
- All 11 piezometers
- River grab sample at both sites
- Pumped 3 well volumes or until dry

Water Quality Samples

- Total N
- NO_3 - N
- NH_4 - N
- Organic N
- PO_4 - P
- DOC
- Cl
- Field Parameters

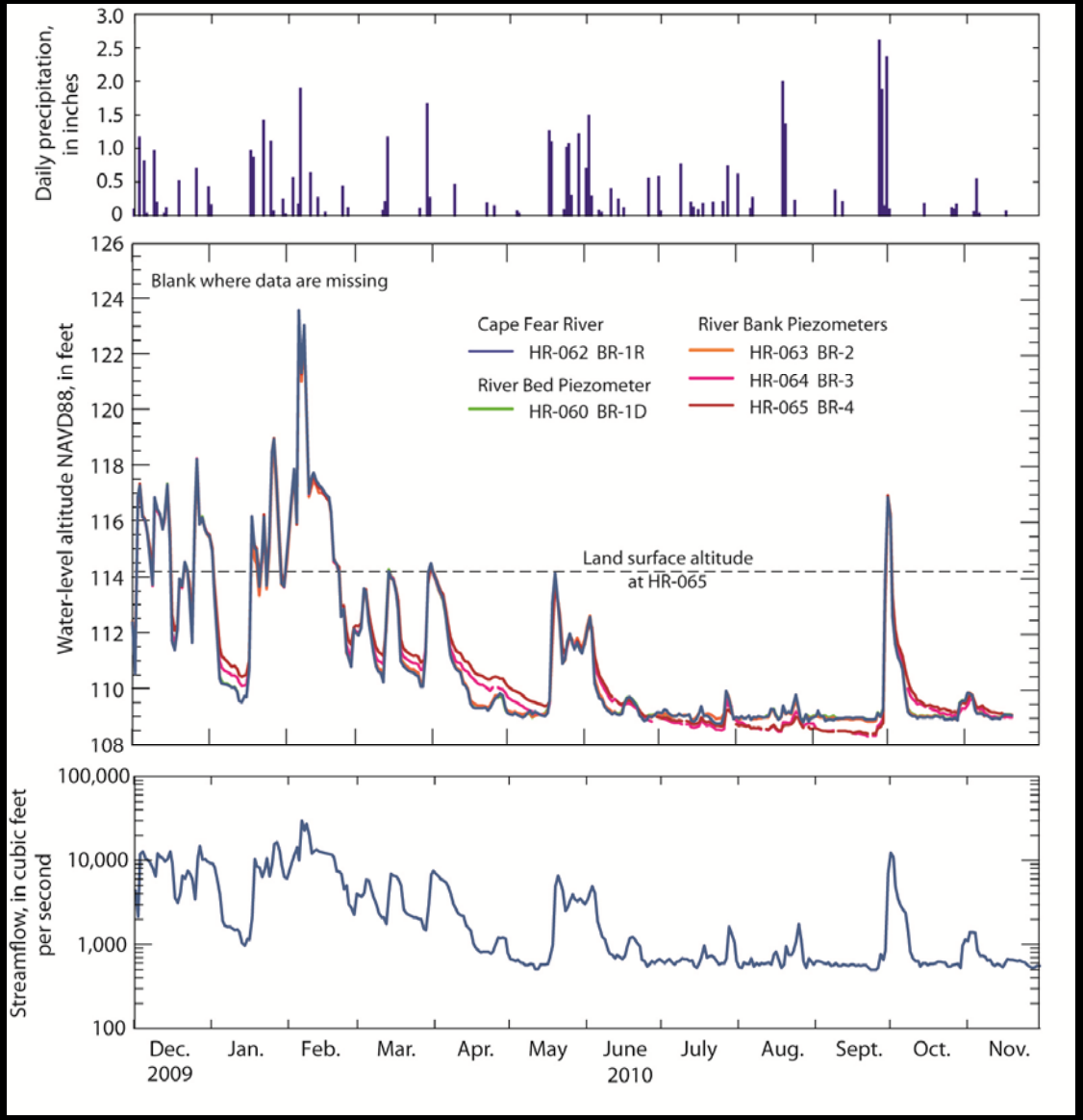
PE Reach Hydrology

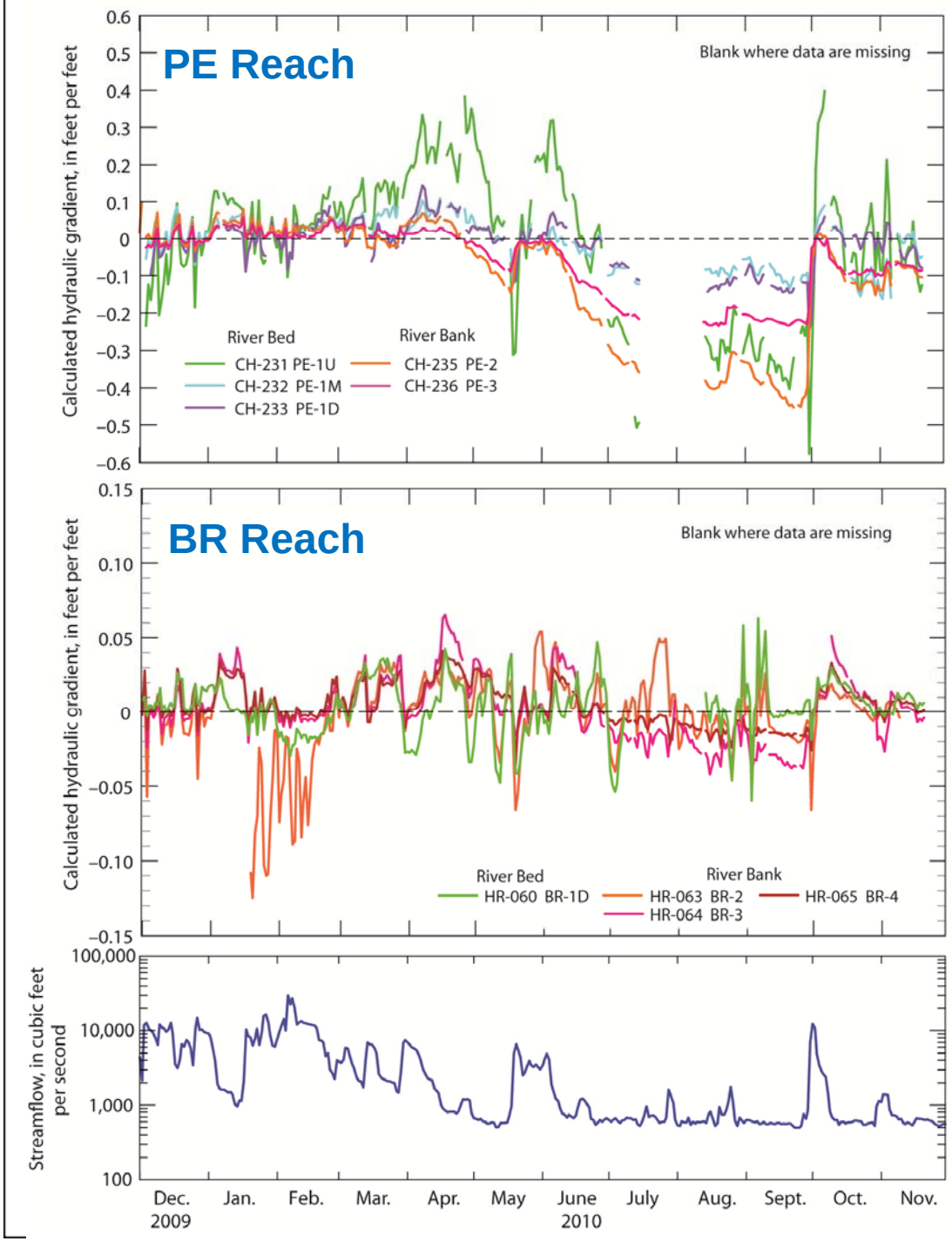


- River stage range about 6 ft
- Floodplain is well connected to river
- A few days when all piezometers were submerged
- Extended dry period during the summer

BR Reach Hydrology

- River stage range about 16 ft
- Floodplain well connected to river
- Several weeks when all piezometers were submerged
- Extended dry period during the summer





Hydraulic Gradients

PE Reach

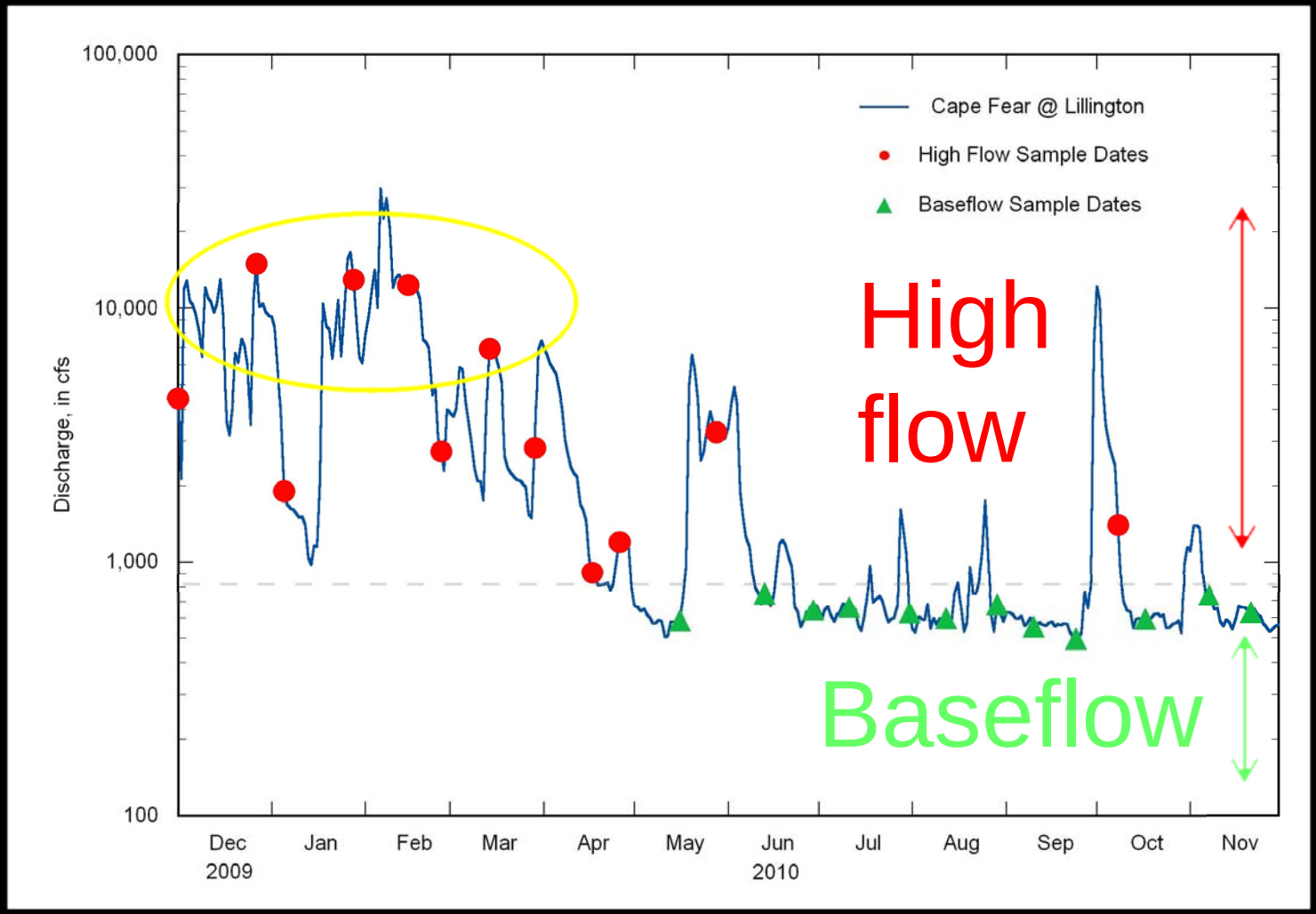
- Gaining ~ 25%
- Losing ~ 45%
- Mixed ~ 30%
- Range 0.4 to -0.5 ft/ft

BR Reach

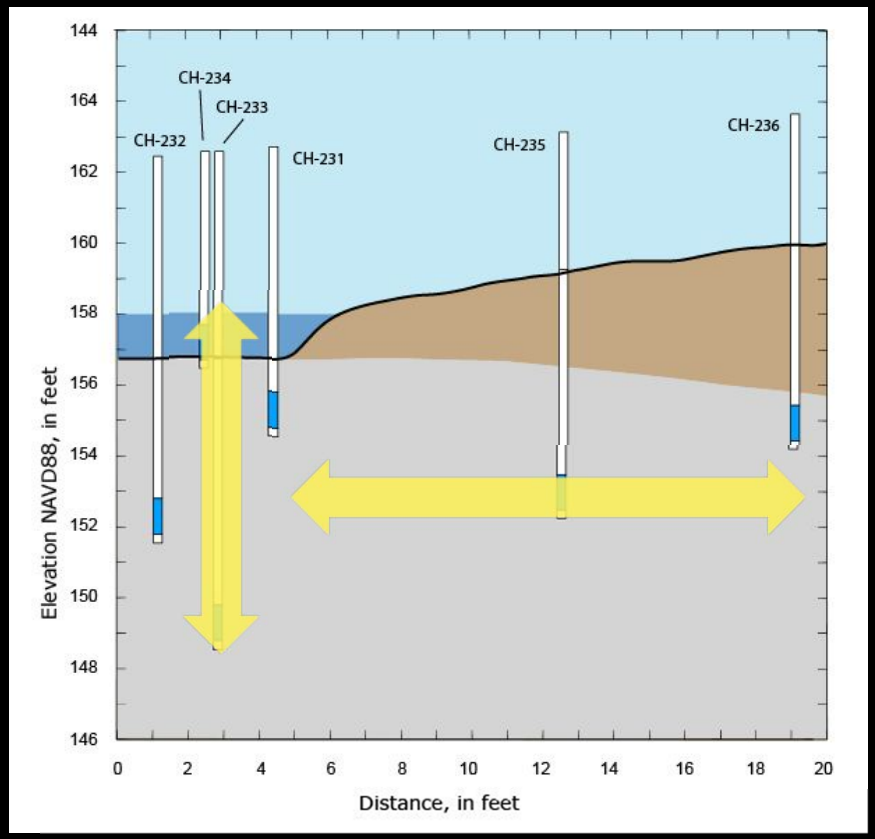
- Gaining ~ 30%
- Losing ~ 20%
- Mixed ~ 50%
- Range 0.07 to -0.13 ft/ft

Water Quality Comparisons

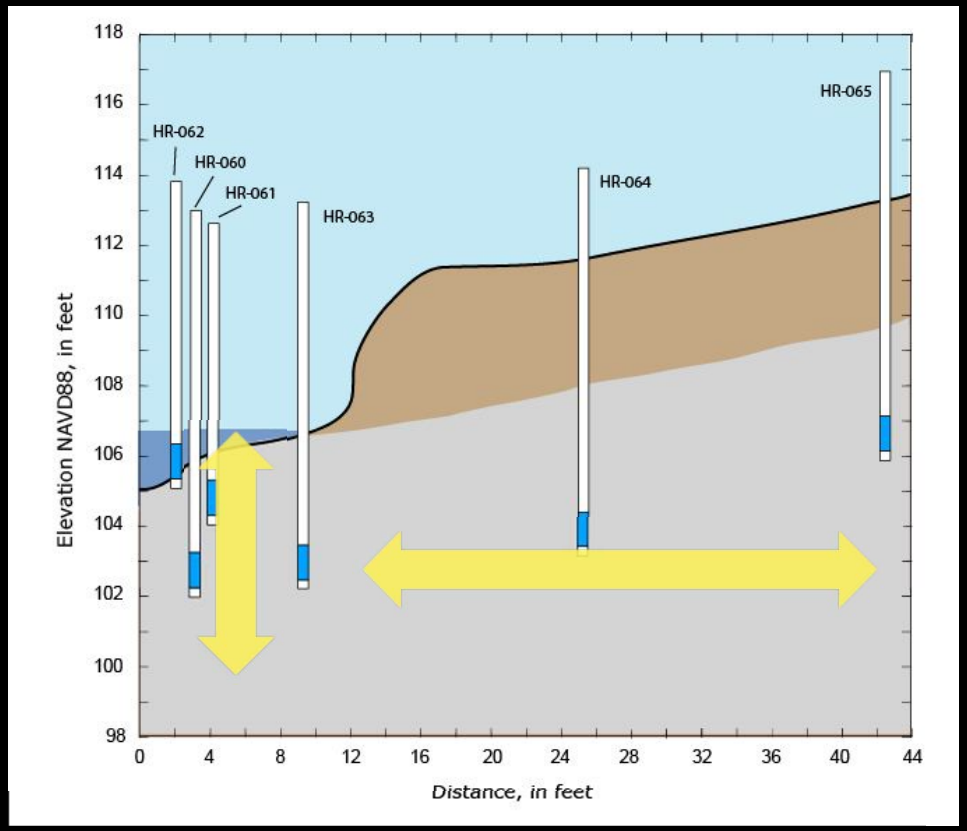
- Periods of high flow to baseflow (2 seasons)
- Biased to lower river stages at BR transect



Flow Paths Comparisons

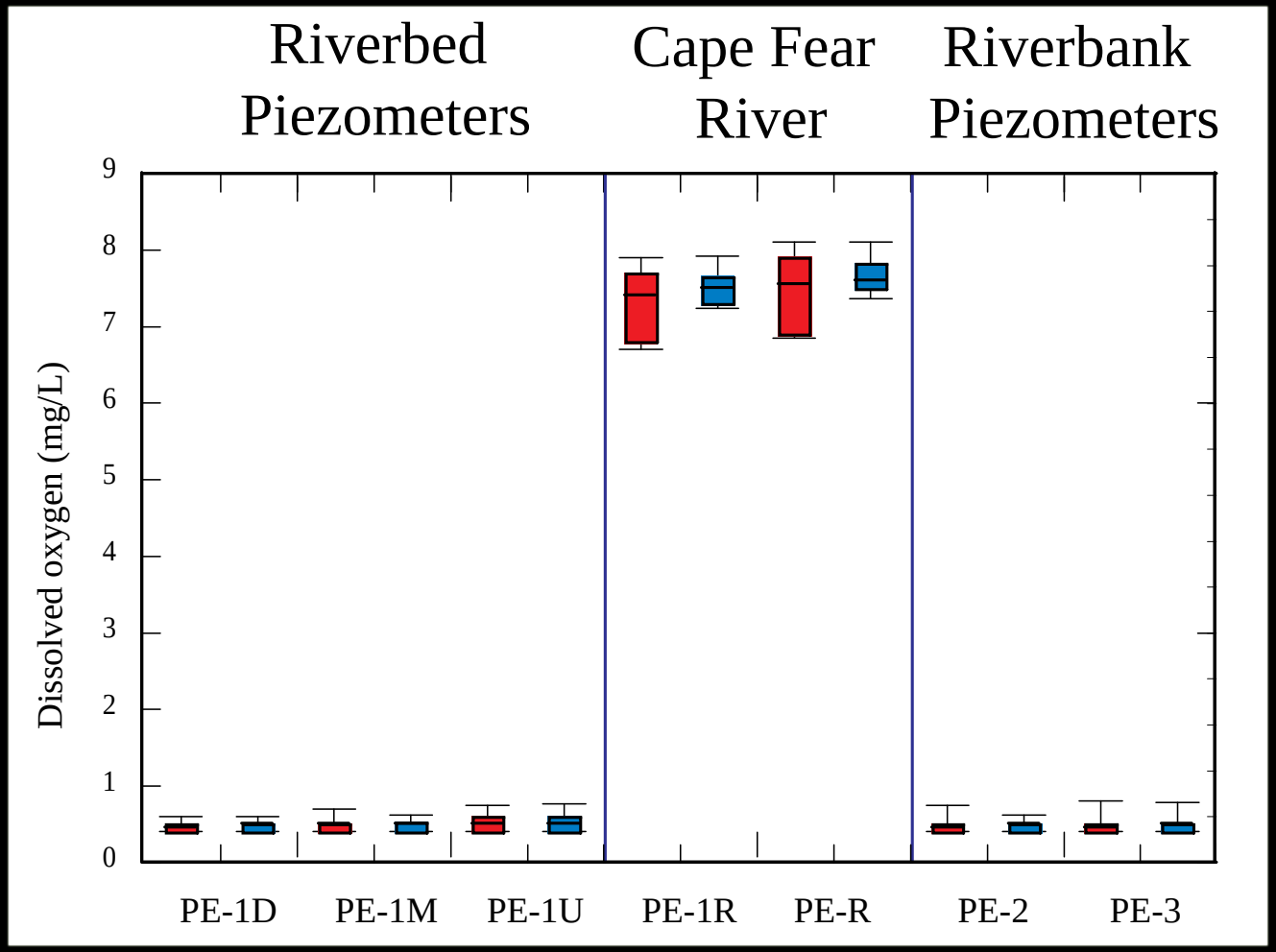


PE samples



BR samples

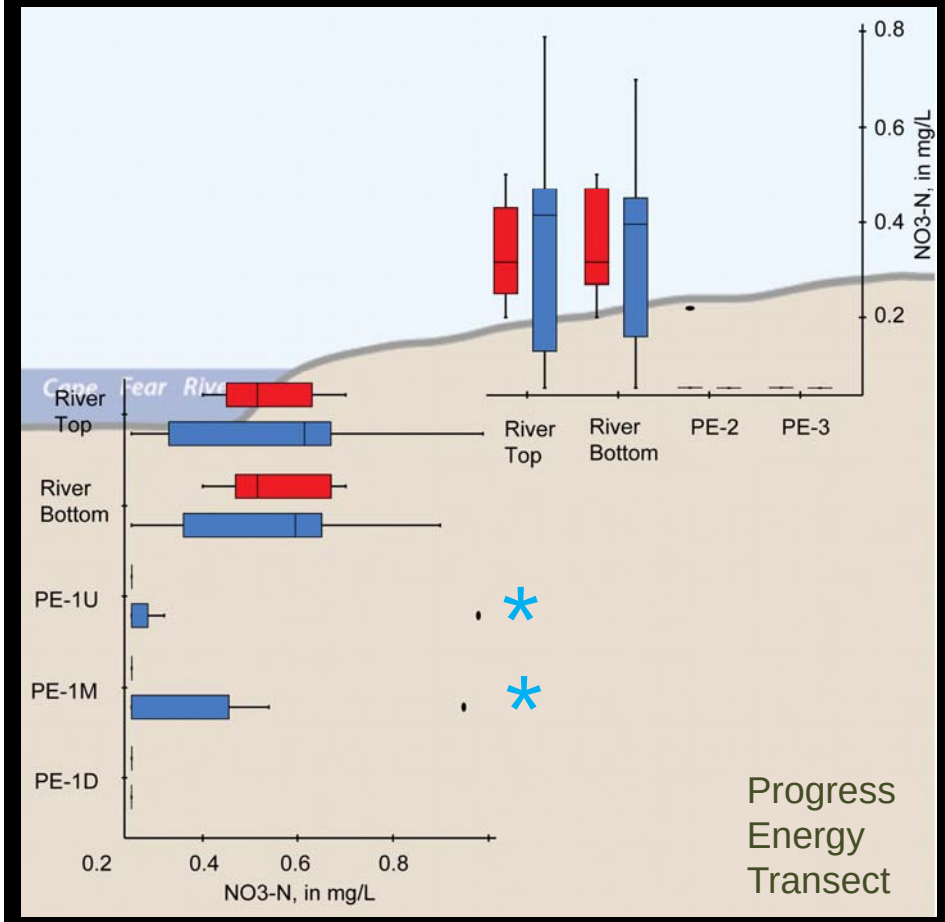
Floodplain DO Concentrations

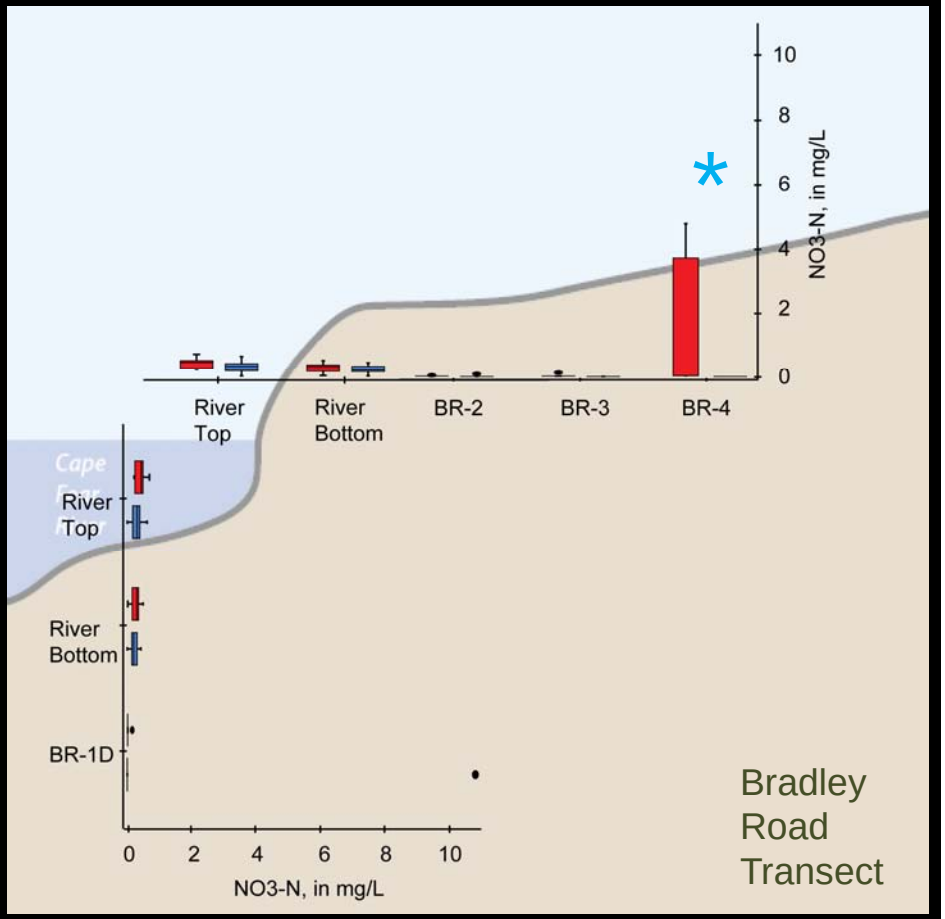


Red = High flow samples Blue = Baseflow samples

Nitrate as N Distribution

- Generally little, with river more than floodplain
- PE baseflow and BR high flow statistically different





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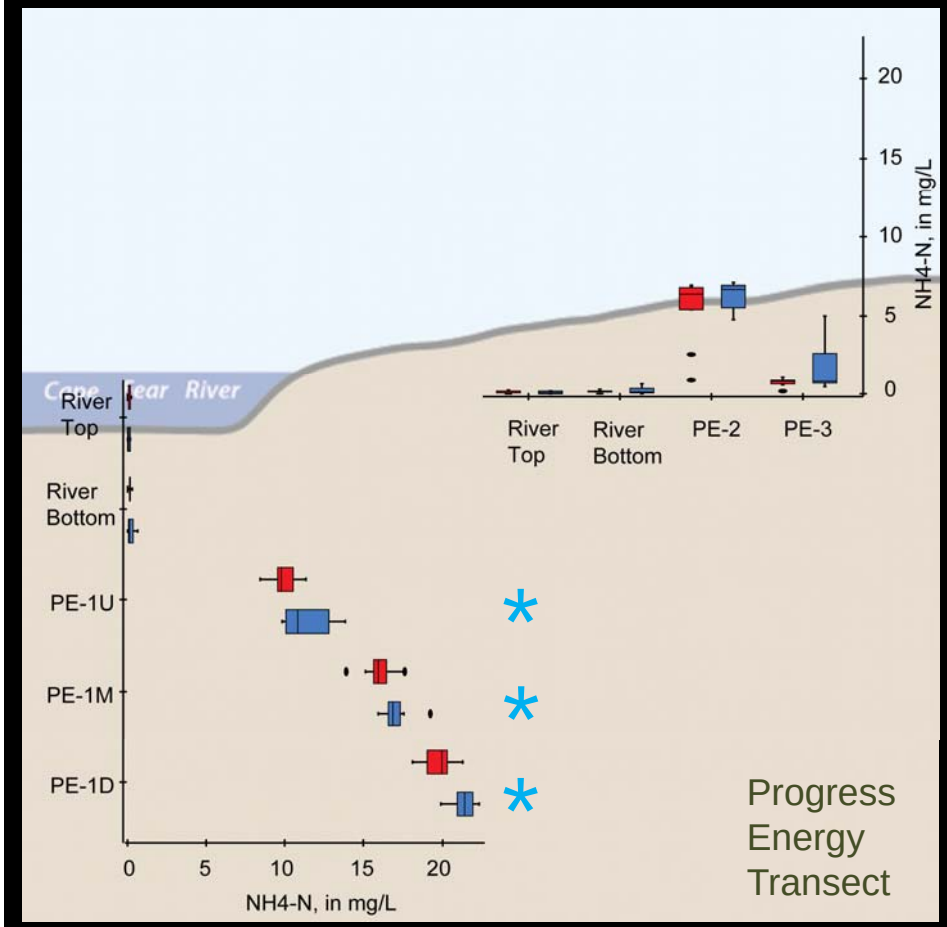
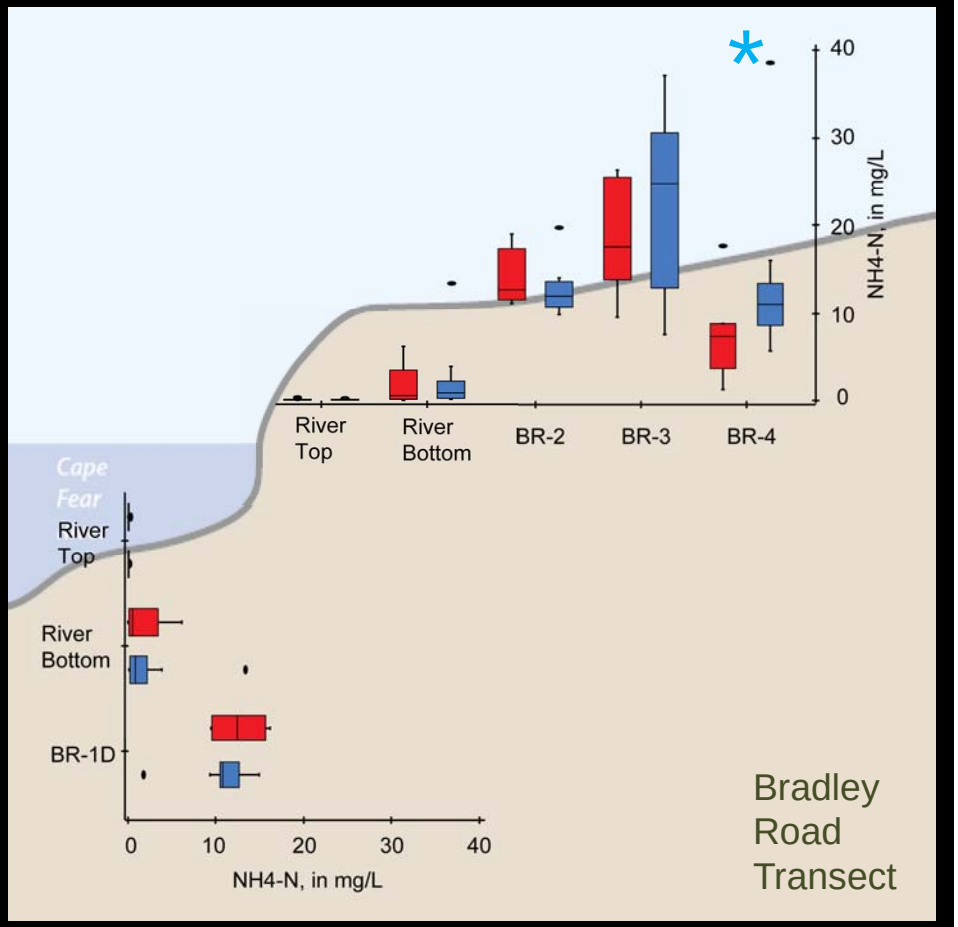
Ammonium as N Distribution

- High, with floodplain containing more than river
- Several samples seasonally statistically differ





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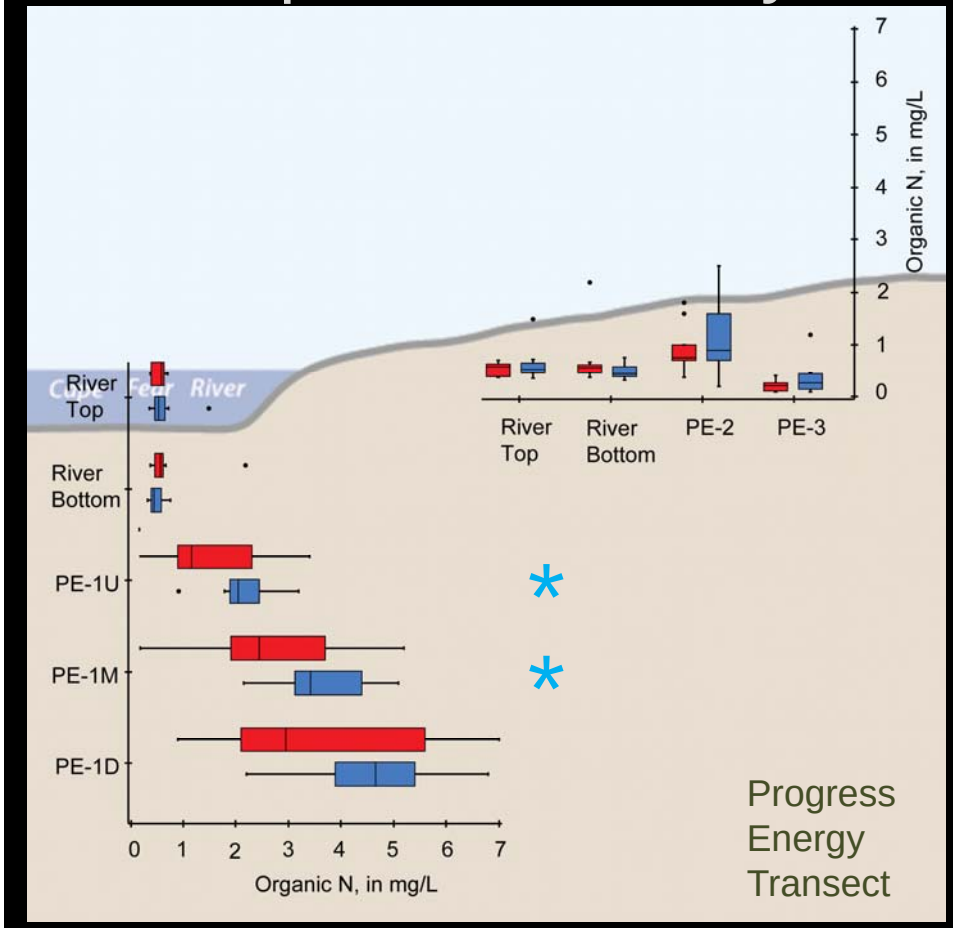
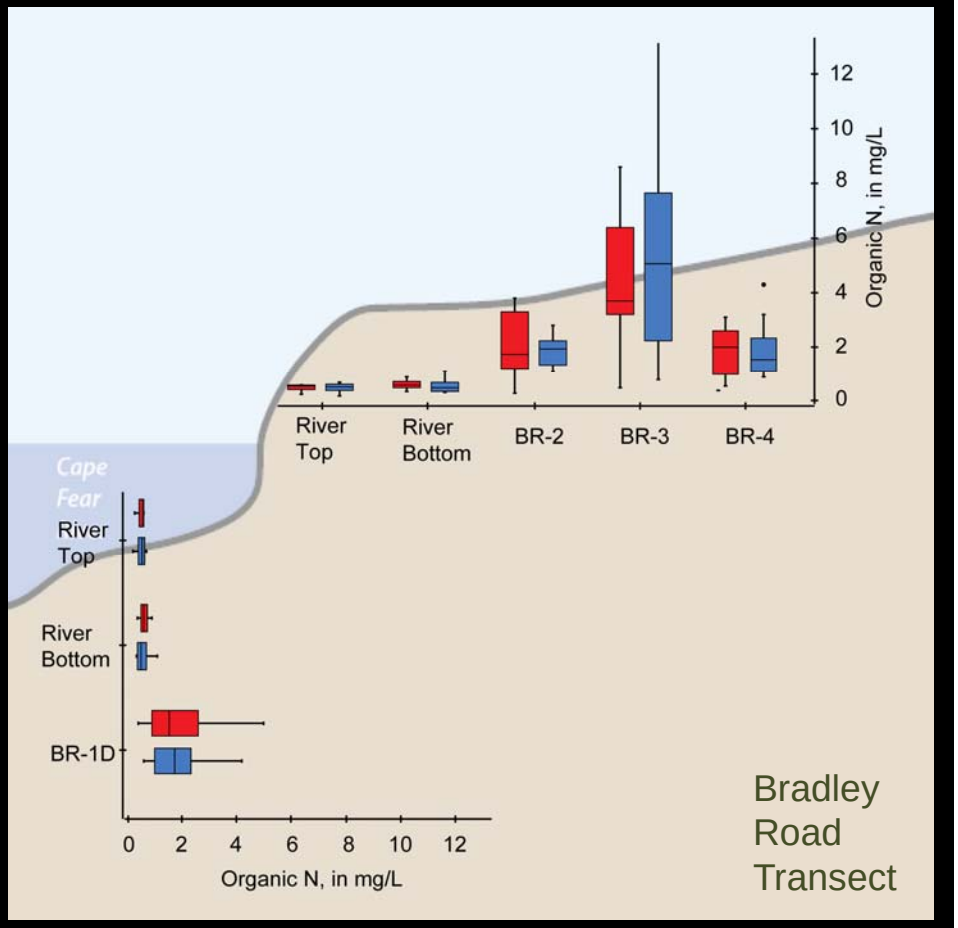
Dissolved Organic Nitrogen Distribution

- Distribution differences between sites
- Samples statistically different at PE in riverbed





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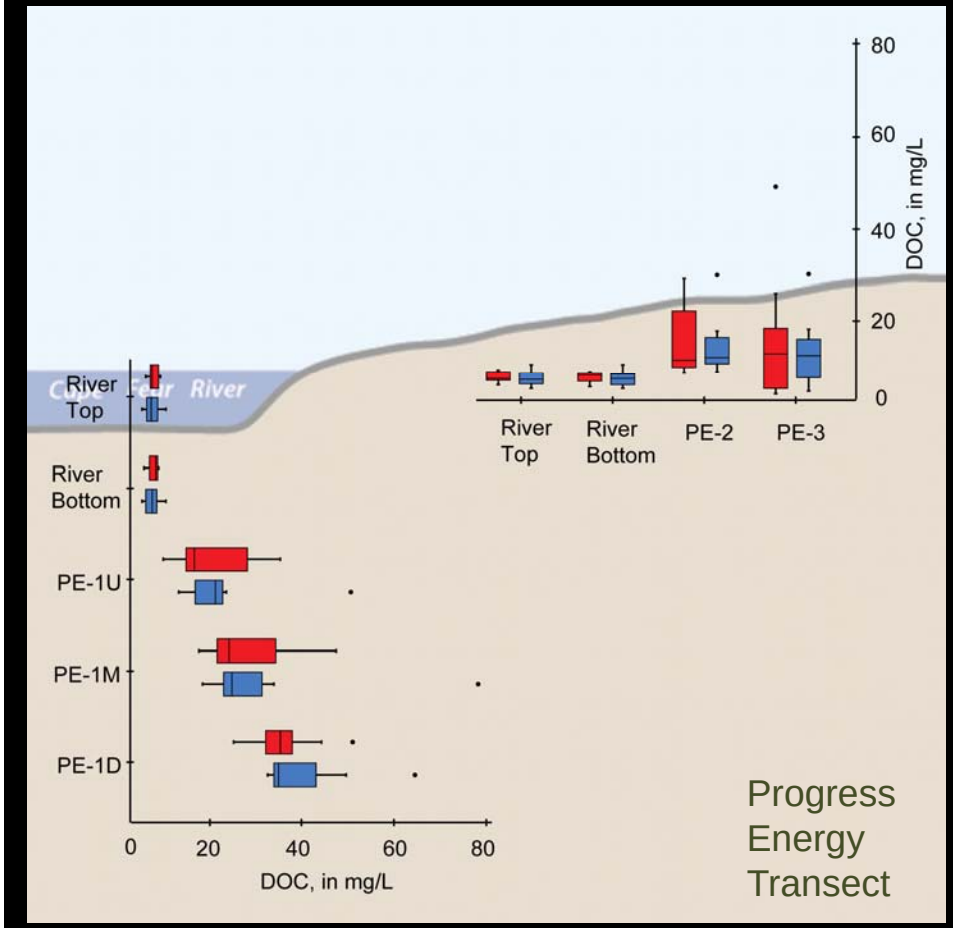
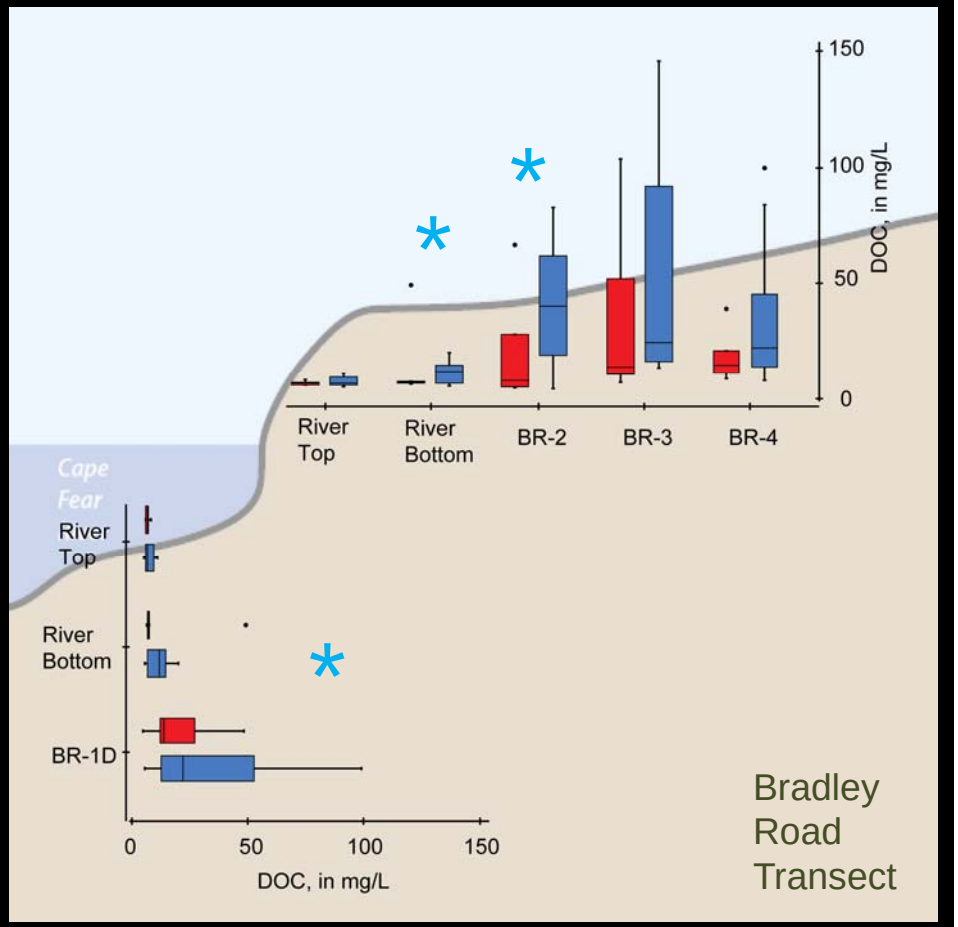
Dissolved Organic Carbon Distribution

- Concentrations about 2X greater at BR than PE
- Samples statistically different at BR





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Is the upper Cape Fear River a "gaining stream" for the majority of the year?

- The two Cape Fear River floodplains investigated are hydraulically different
  - Floodplains are well connected
  - PE reach area has
    - small river stage range,
    - large groundwater level range, and
    - more frequently "losing" than "gaining"
  - BR reach area has
    - large river stage range,
    - smaller groundwater level range, and
    - more frequently "gaining" than "losing"

Are there spatial and seasonal differences in floodplain water quality?

- Yes there are spatial and seasonal differences in floodplain water quality
  - Ammonium and DOC increase with depth beneath river and distance up the floodplain
  - DON increases beneath the river at PE reach and into the floodplain at BR reach
  - Nitrate during baseflow at PE reach and high flow at BR reach statistically different

Does nutrient processing within the floodplains function as expected?

- Not exactly…
  - There is very little nitrate, which was expected.
  - But, there are very high concentrations of NH_4^+ beneath the river and within the floodplain.
  - DON and DOC concentrations are also elevated, suggesting that the source of nitrogen for the ammonium is organic rather than anthropogenic.
  - The lack of nitrate coupled with high NH_4^+, DON, and DOC under anoxic conditions suggest that N mineralization is occurring.
  - The floodplain is flushing NH_4^+ to the Cape Fear River during high flow events


Questions?
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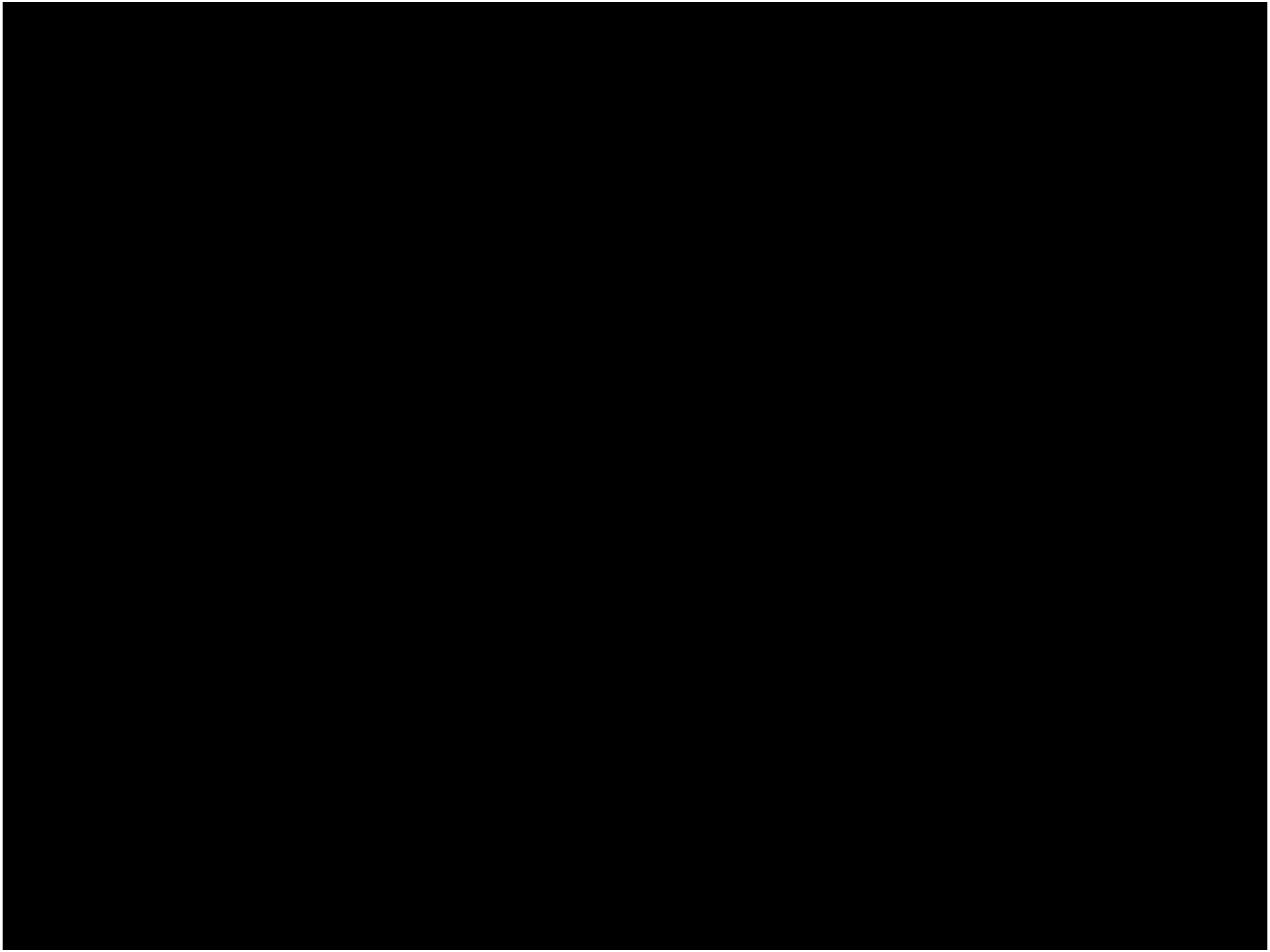

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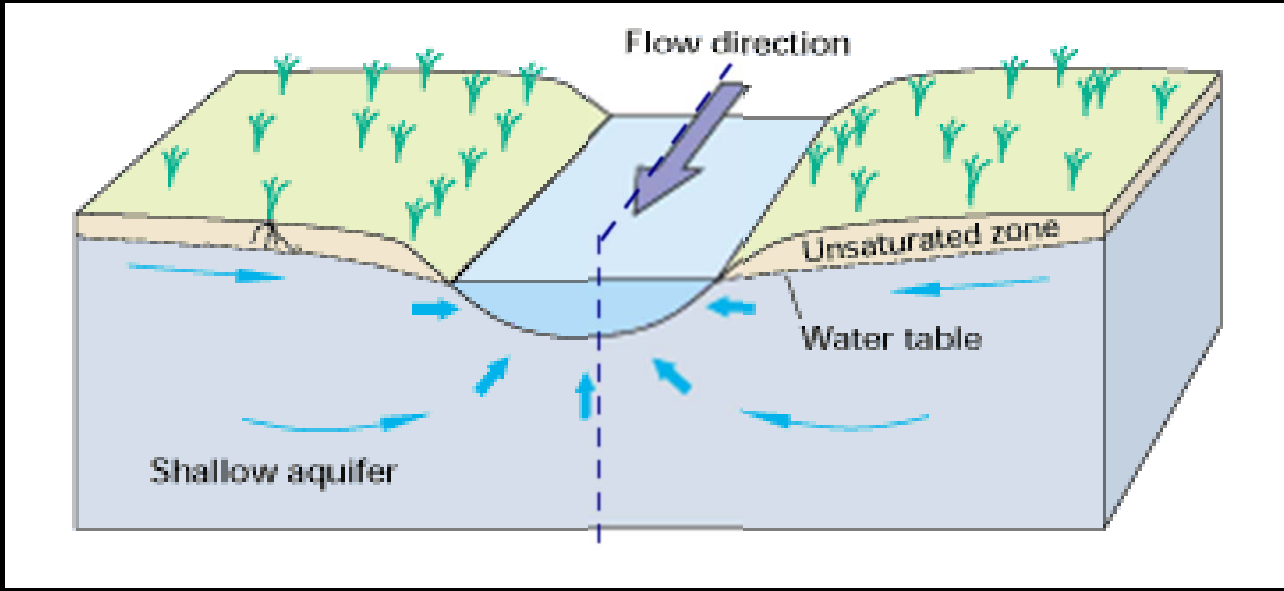
  - Doug Harned
- Ethan McSwain
- Joe Bukowski

Interaction Between Groundwater and Surface Water



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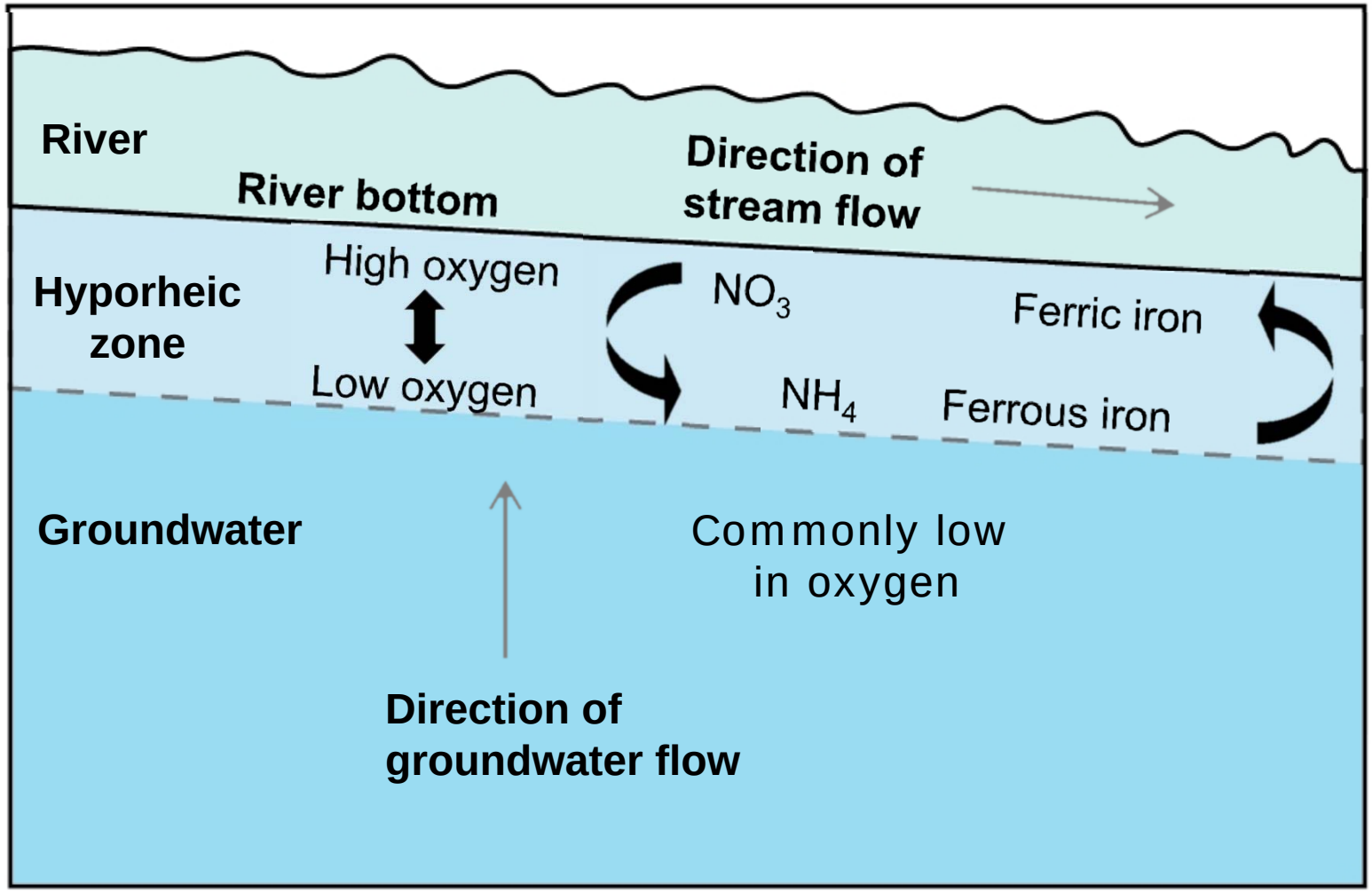

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Water Quality Samples

Field Parameters

- Temperature
- Specific conductance
- pH
- Dissolved oxygen