Low elevation old channel features of the Willamette River floodplain support high subsurface denitrification rates.

Kenneth J. Forshay[1], Barton R. Faulkner[1], Ashley McElmurry [1], Renee J. Brooks[2], Paul Mayer[1] and Steven P. Cline[2], **R. Adeuya[1]

Photo courtesy of McKenzie River Trust and Raptor Views

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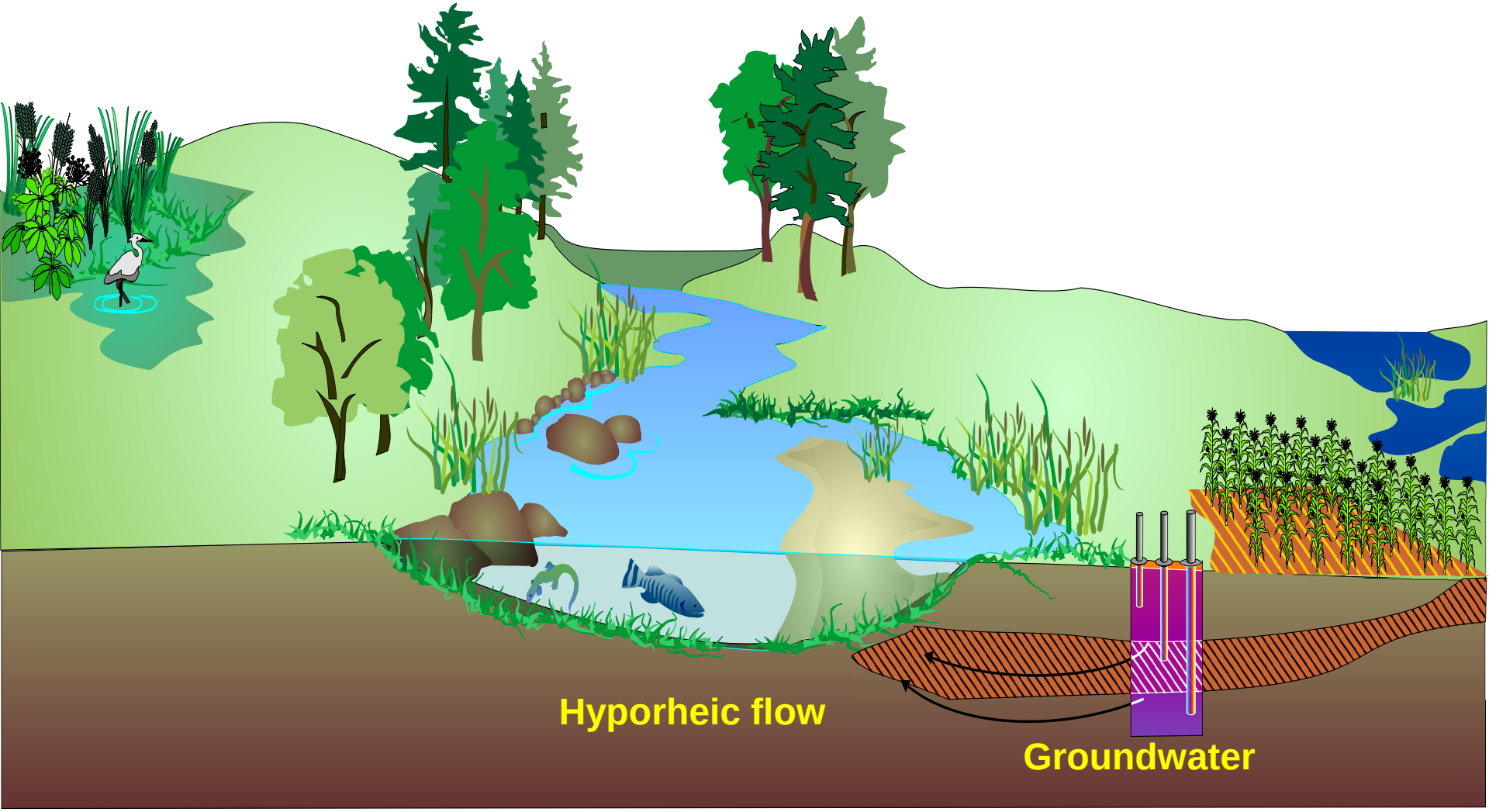
Office of Research and Development
1. NRMRL, Groundwater and Ecosystem Restoration Division, Ecosystem and Subsurface Protection Branch
2. NHEERL, Western Ecology Division

Floodplains are good sinks for nitrate.



Groundwater Surface water interactions are important because nitrate moves with water.

Q_1: What are the spatial and temporal patterns of nitrate in shallow ground water of the floodplain?

Q_2: Are there predictable indicators of subsurface DeN like geomorphic structure or GW depth?

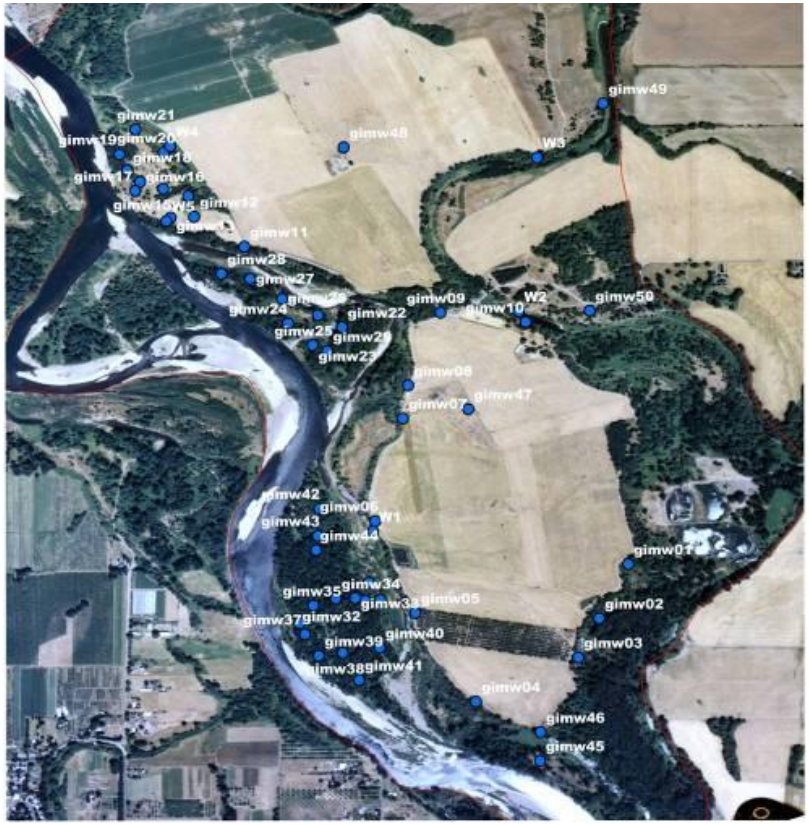
Q_3: What are the drivers and controls of N distribution and processing in the subsurface?

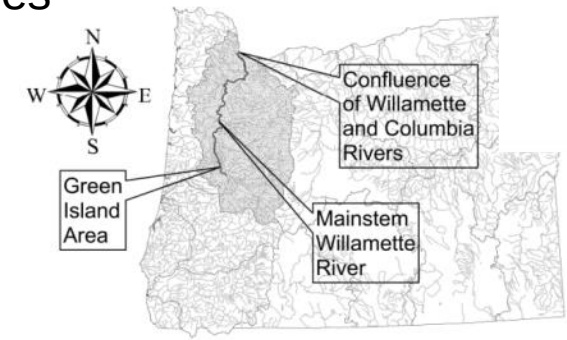
The Willamette is undergoing extensive restoration.

50 monitoring wells 2008.
(3-8m deep- 1.5m screen)
(Sampled quarterly 2008-11)

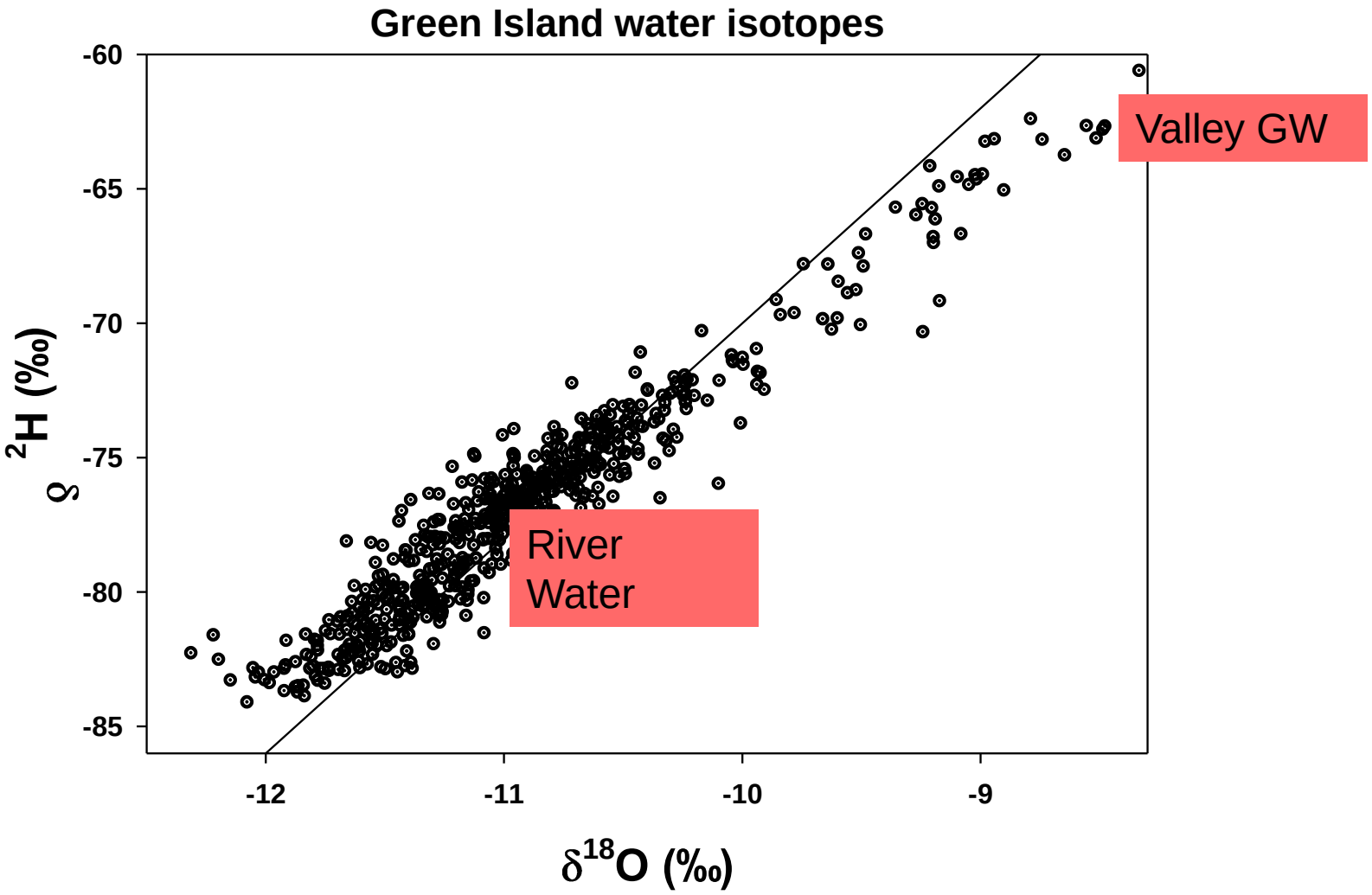
10-16 piezos
(0.5-3m below surface)
(3x's per yr 2008-10)

Nitrate, DOC, field measures
Isotopes of Water and Nitrate

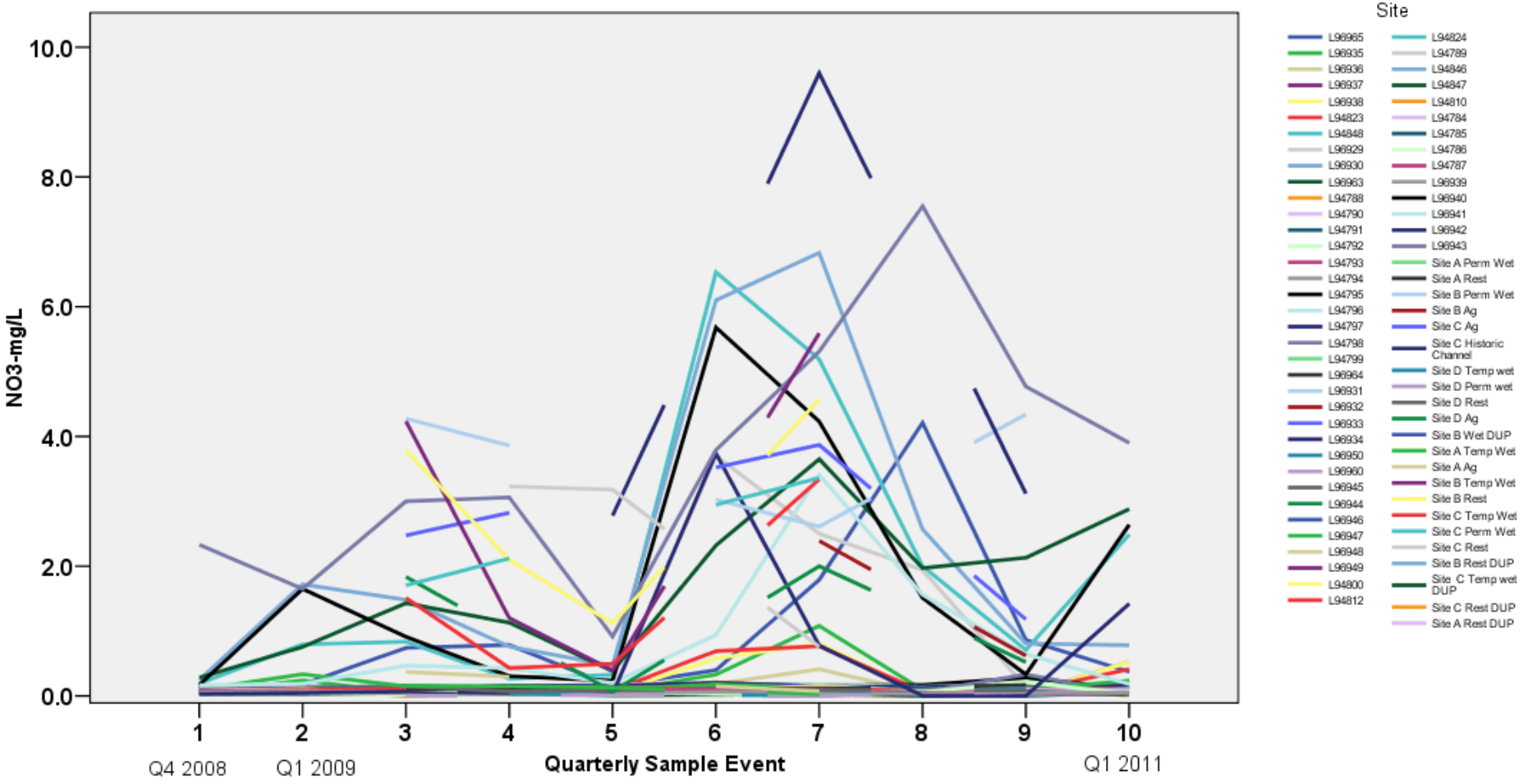


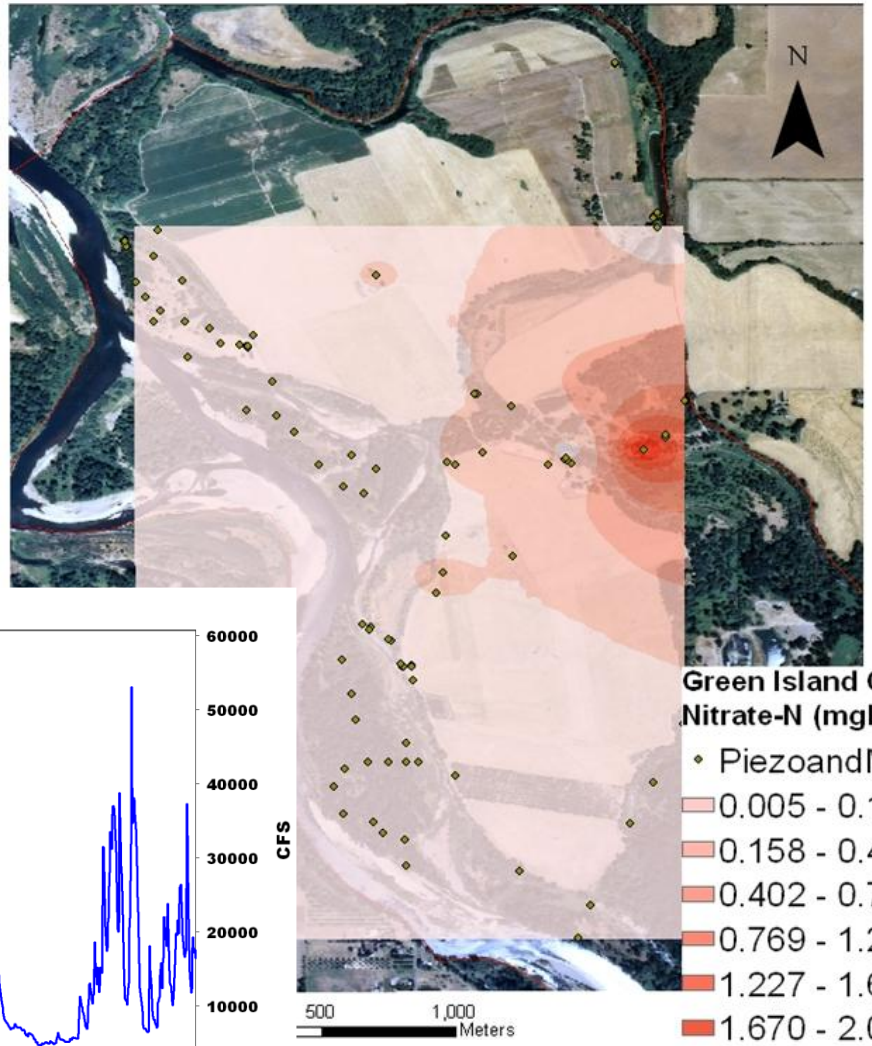


The floodplain is an interface of river and groundwater.



Shallow groundwater nitrate is high and extremely variable.




N
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Meters
Green Island Coburg, OR
Nitrate-N (mgL-1)
PiezoandMonWells
0.005 - 0.158
0.158 - 0.402
0.402 - 0.769
0.769 - 1.227
1.227 - 1.670
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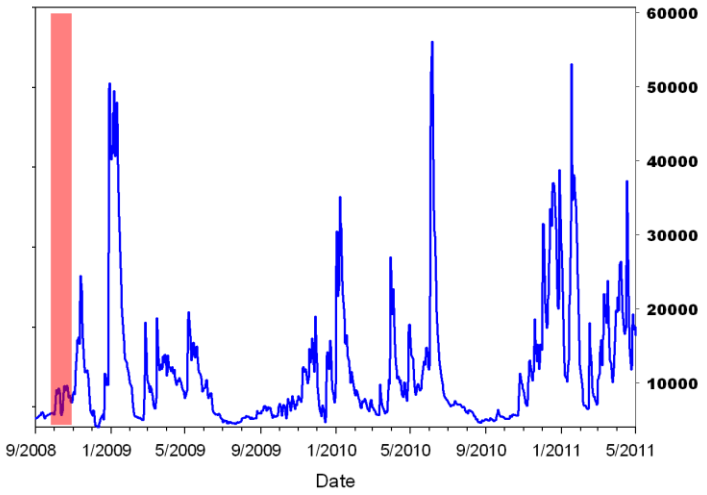
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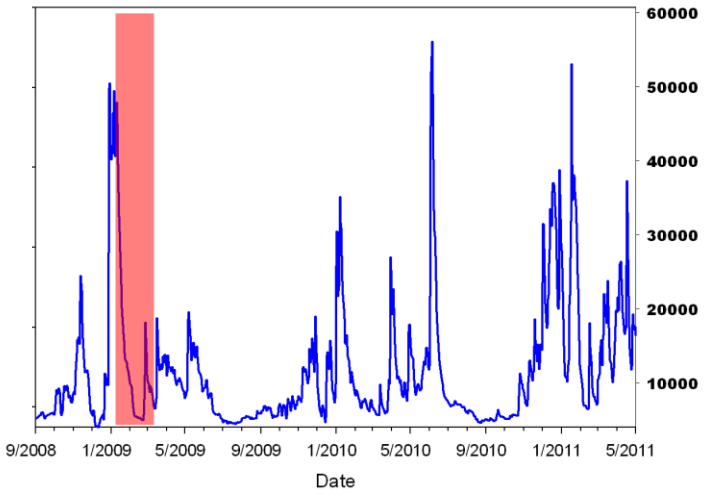

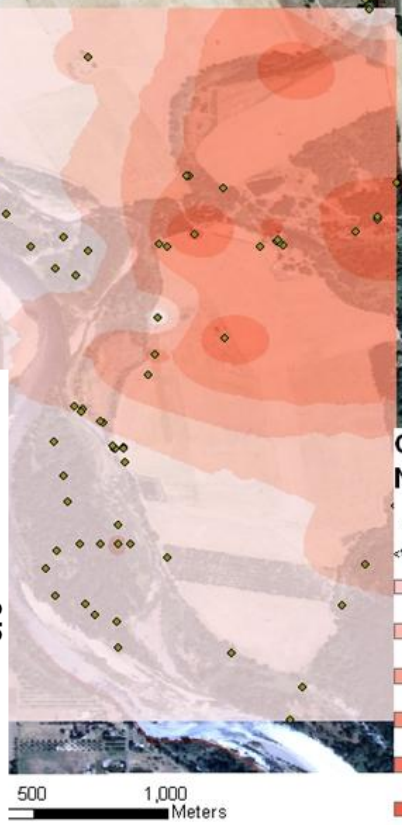

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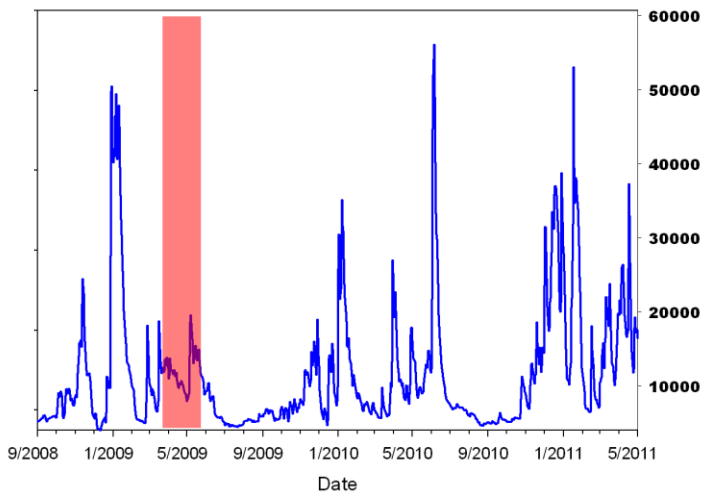

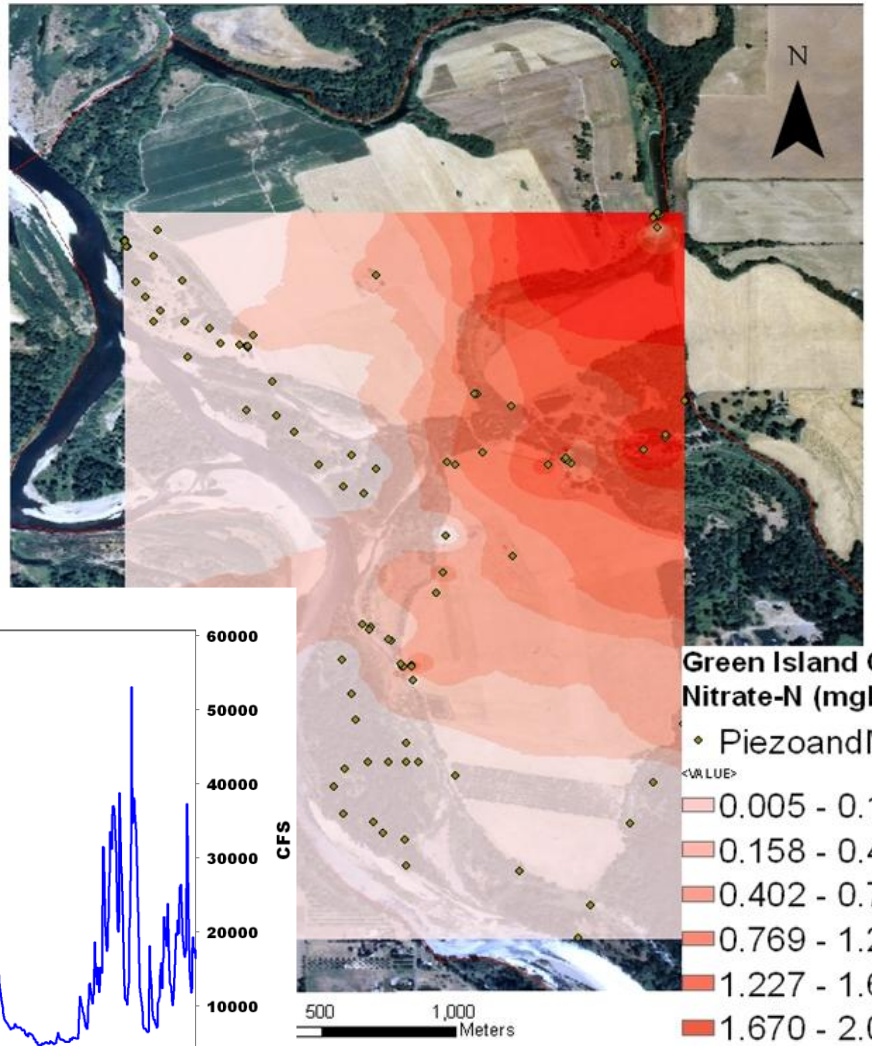

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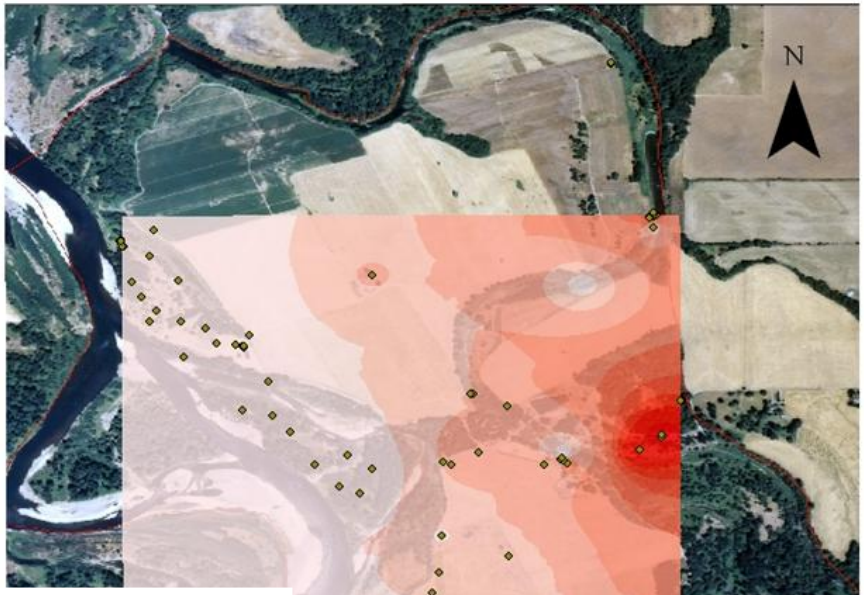

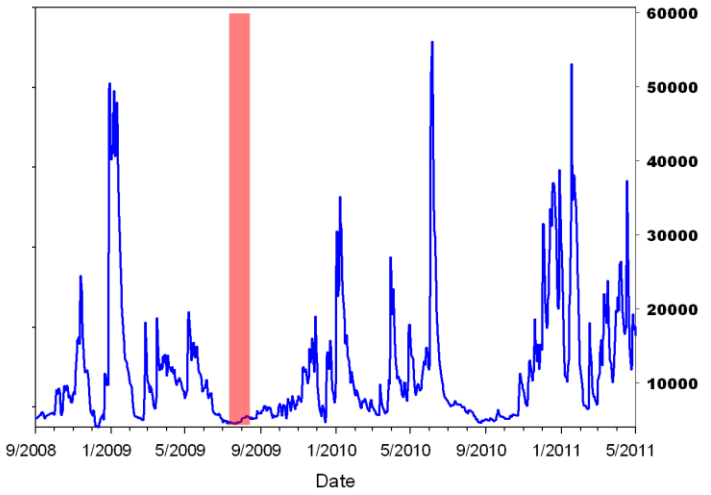

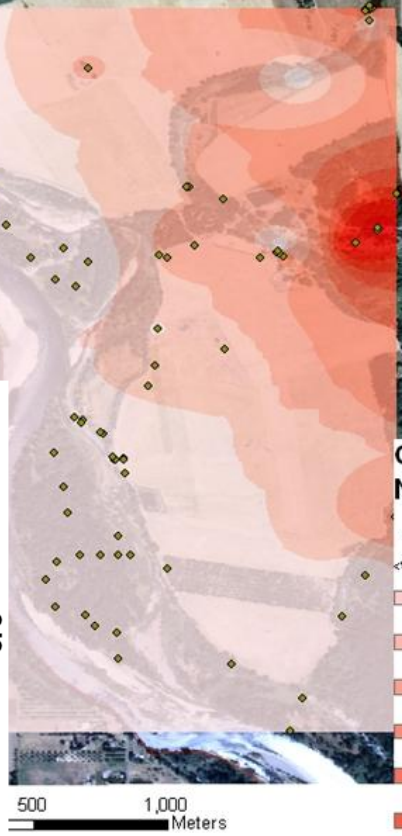

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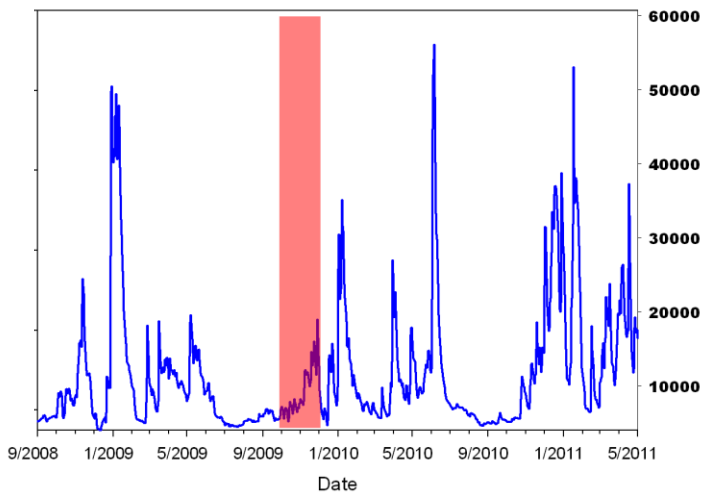

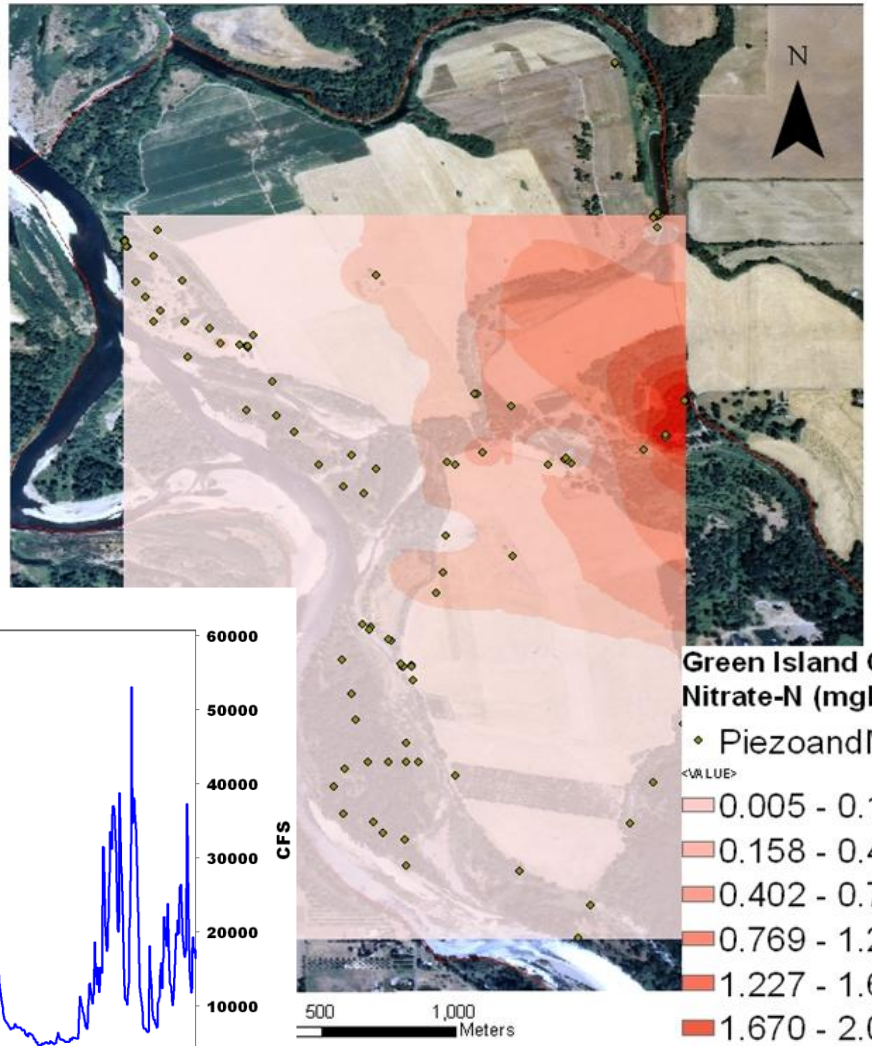

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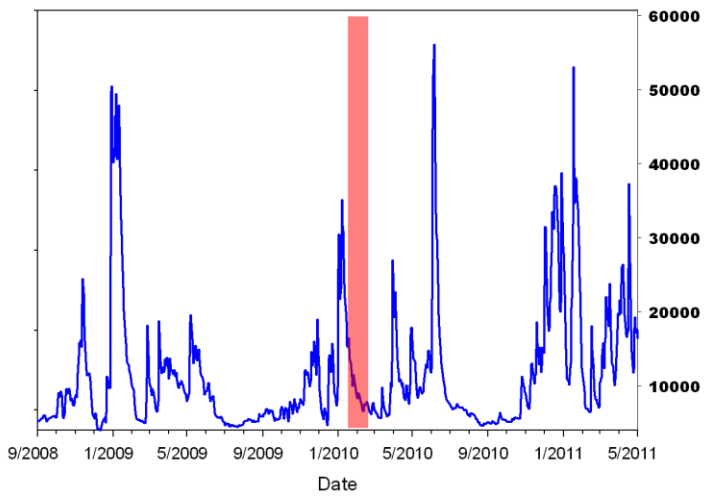

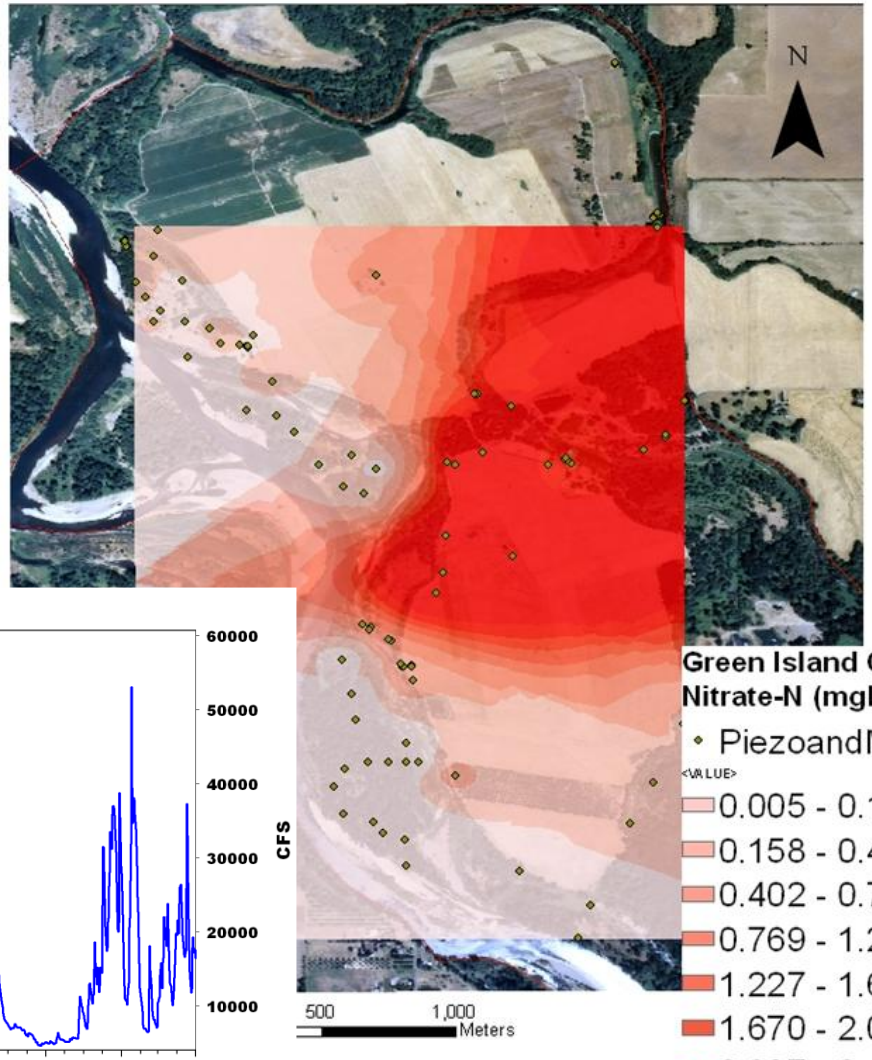

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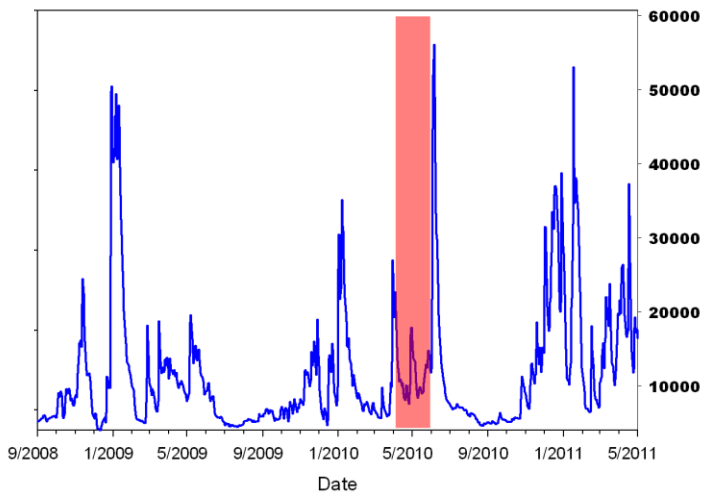

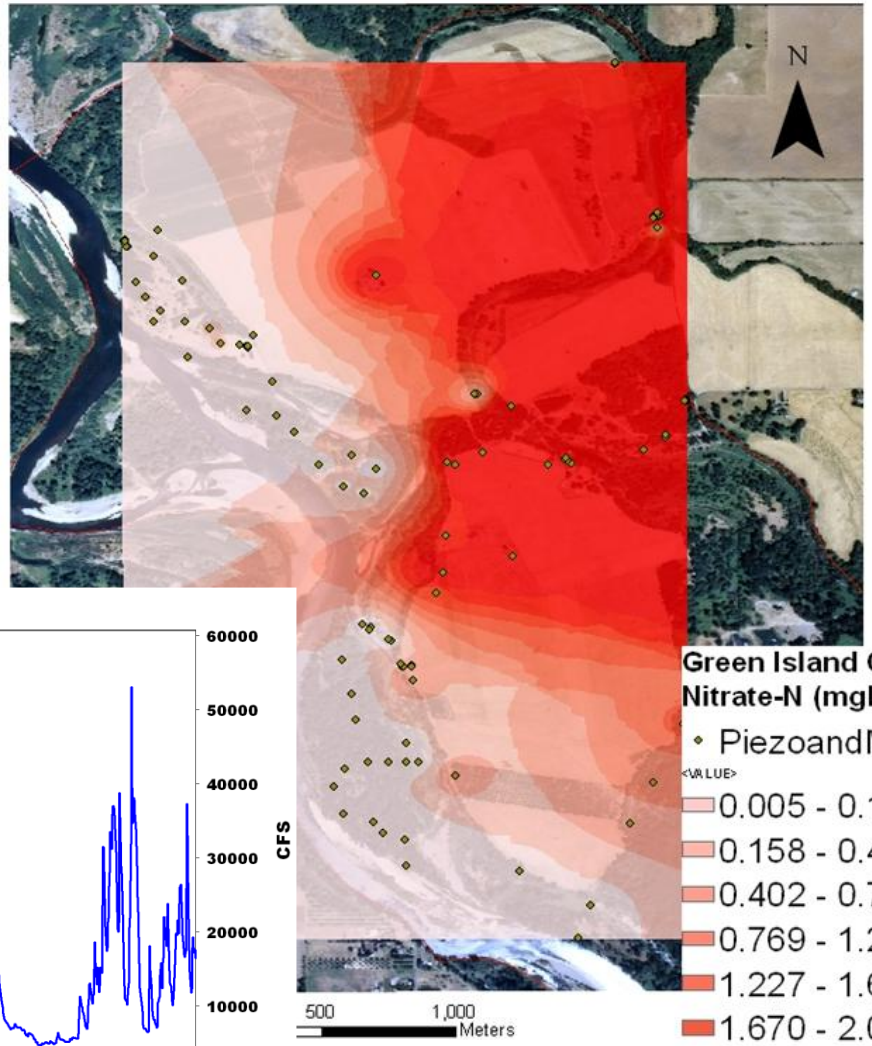

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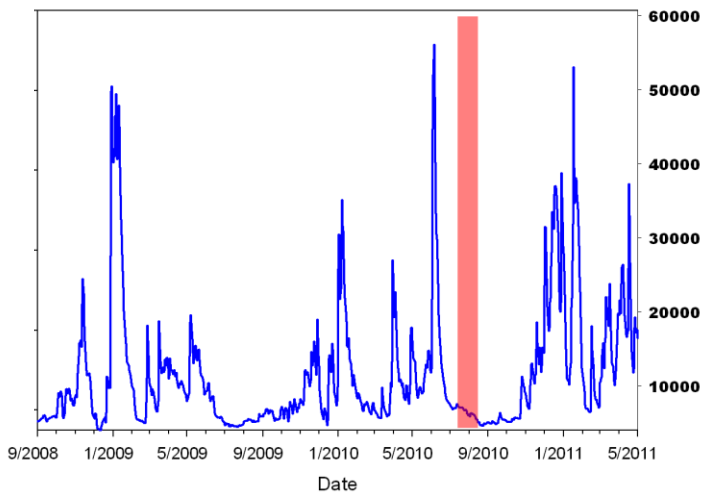

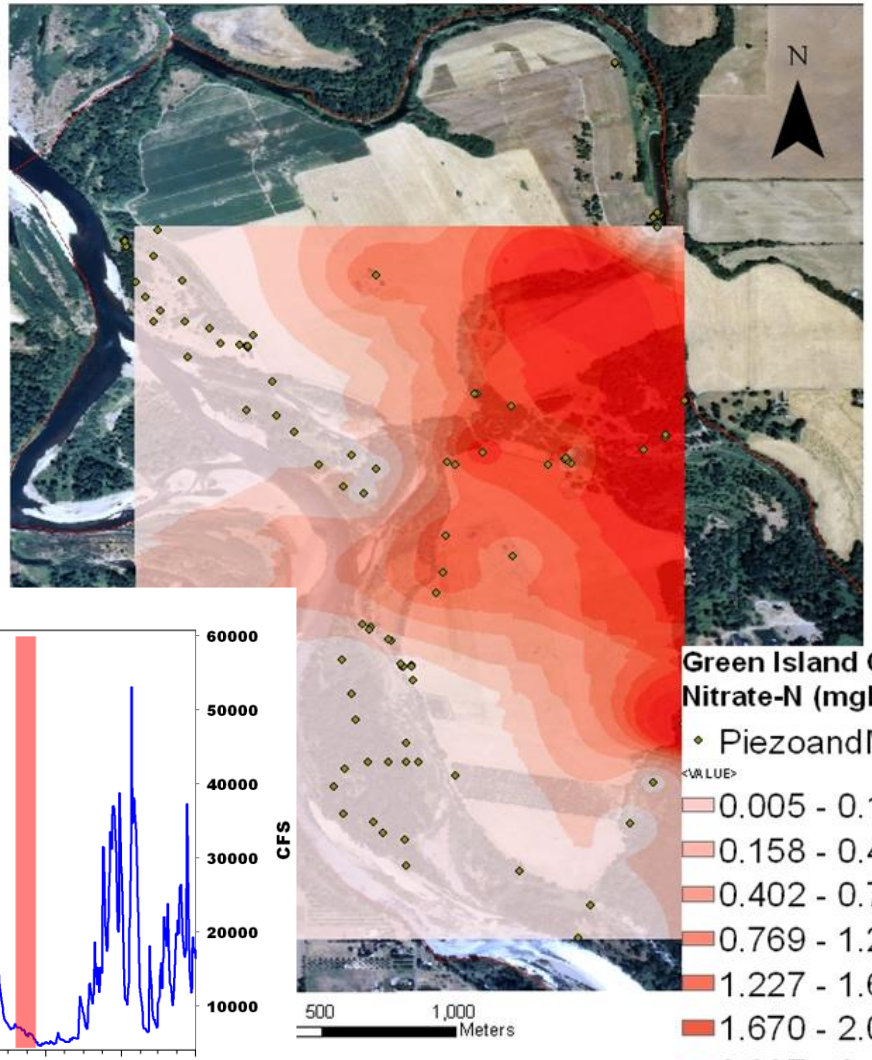

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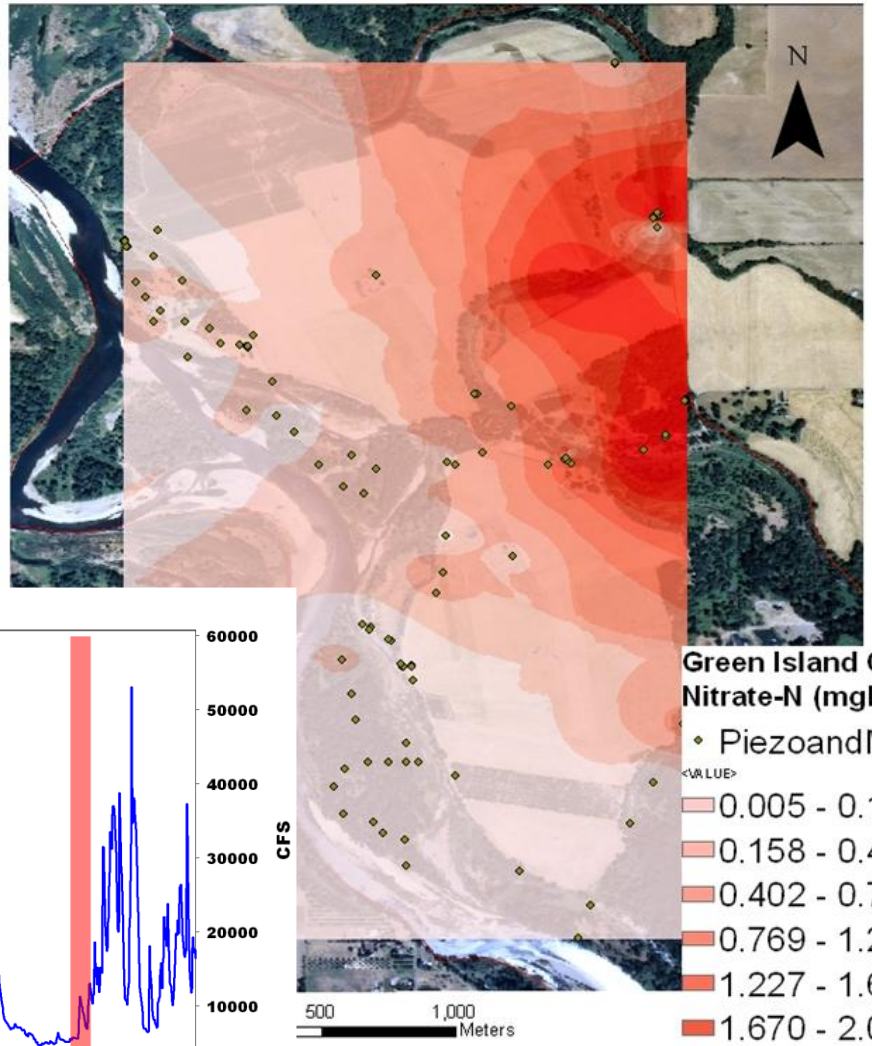
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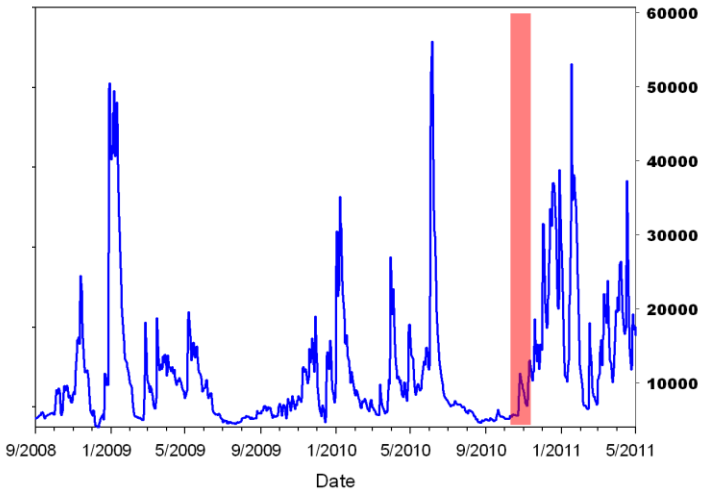
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1/2011
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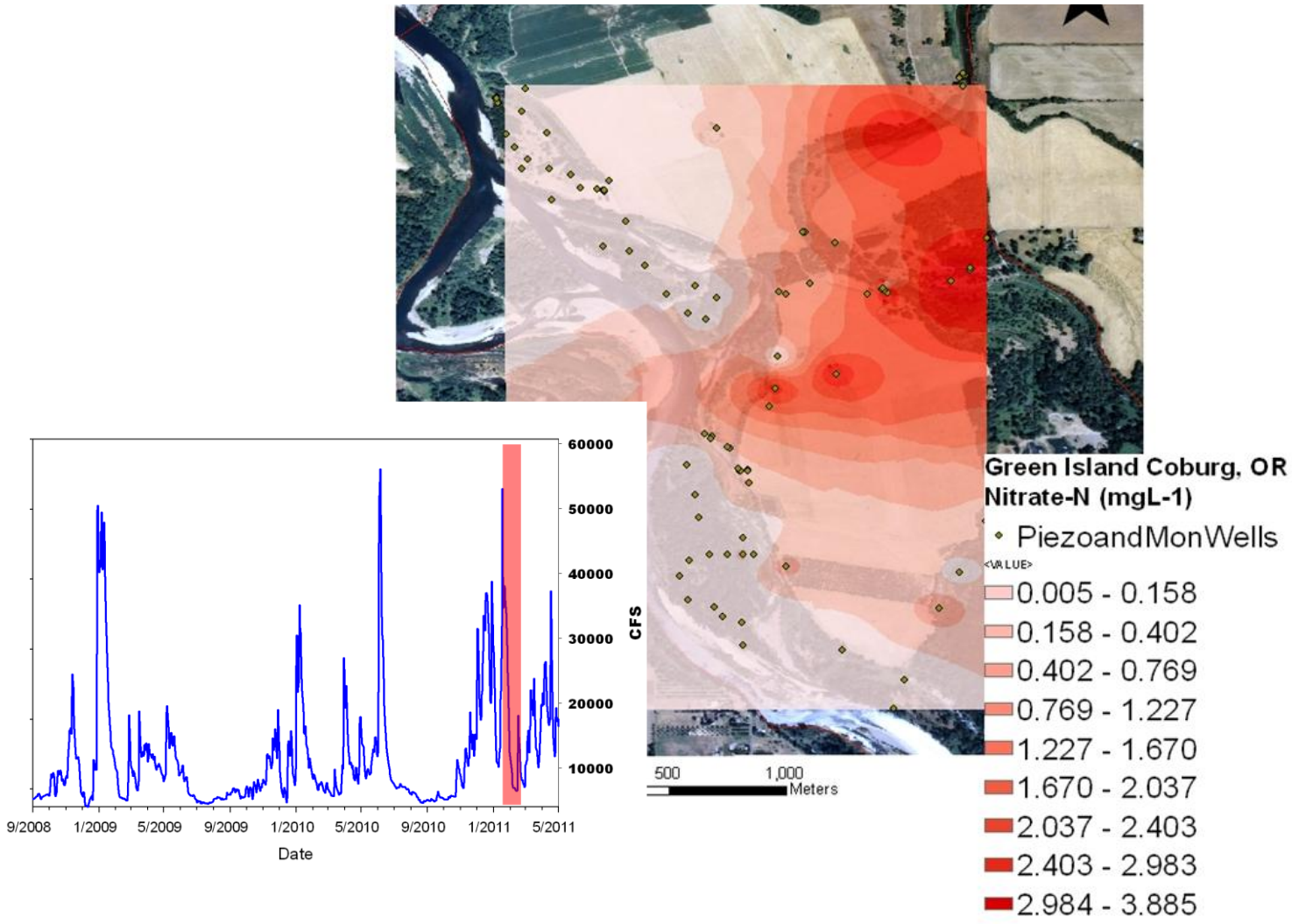
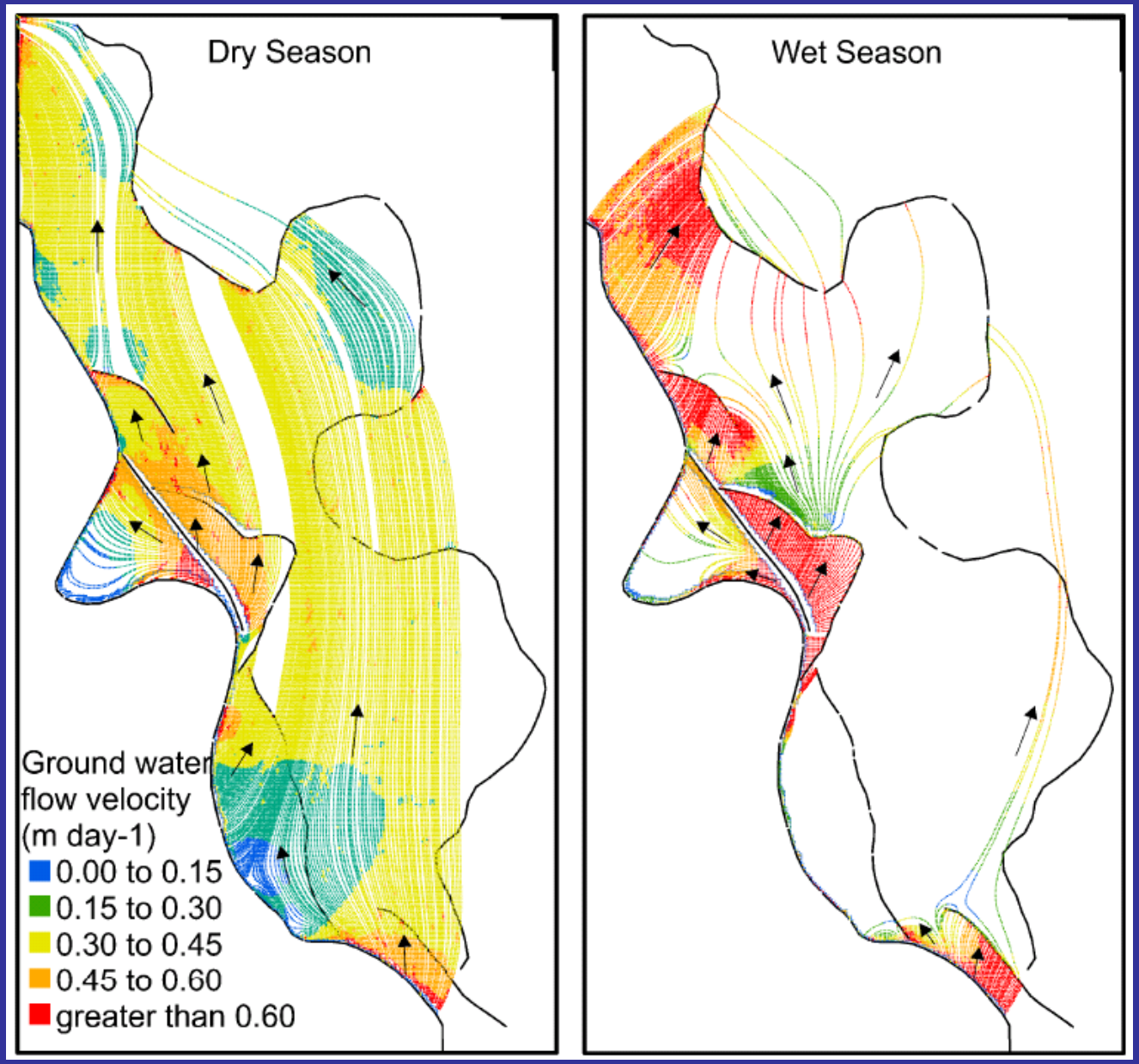
Date

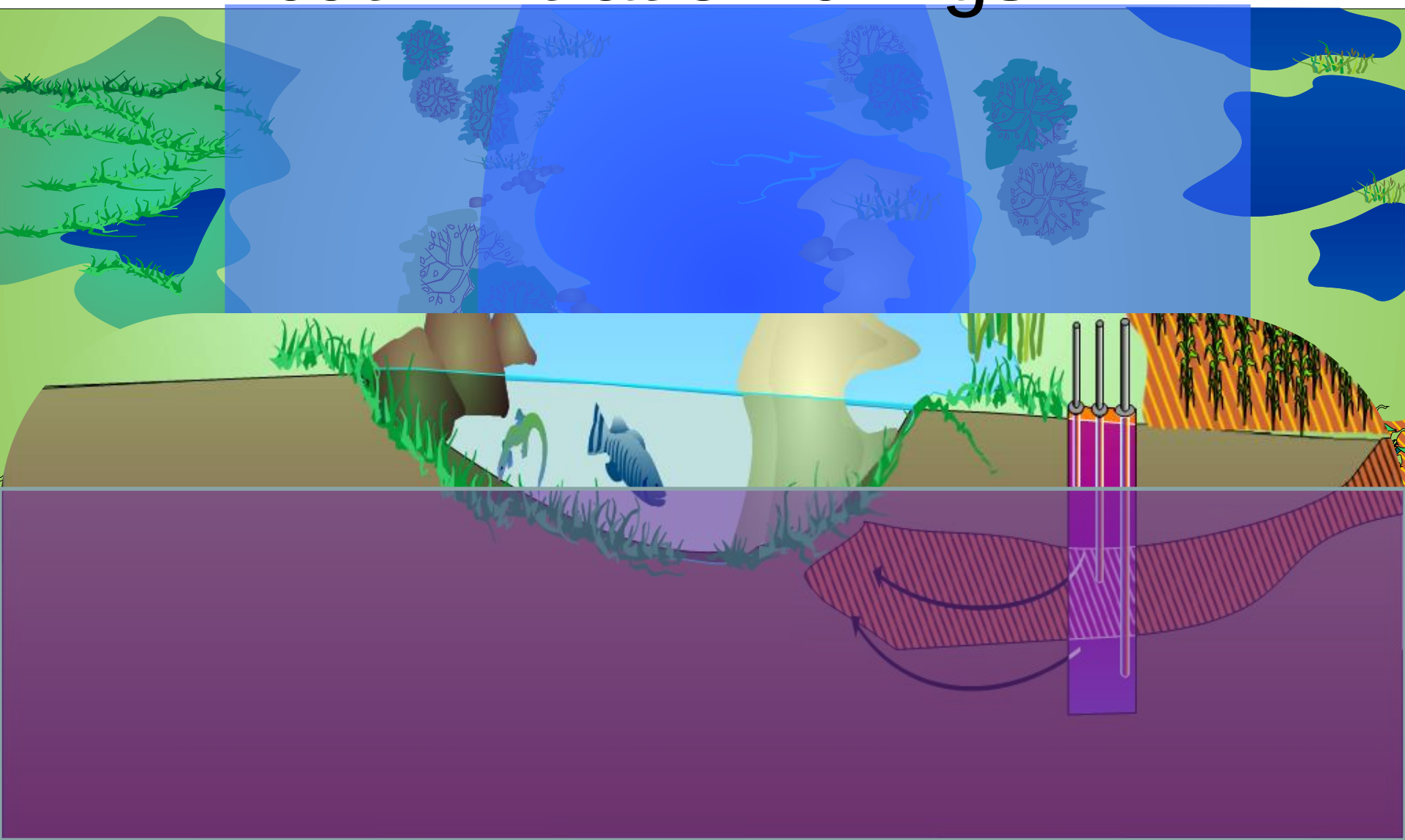
What is driving this pattern?



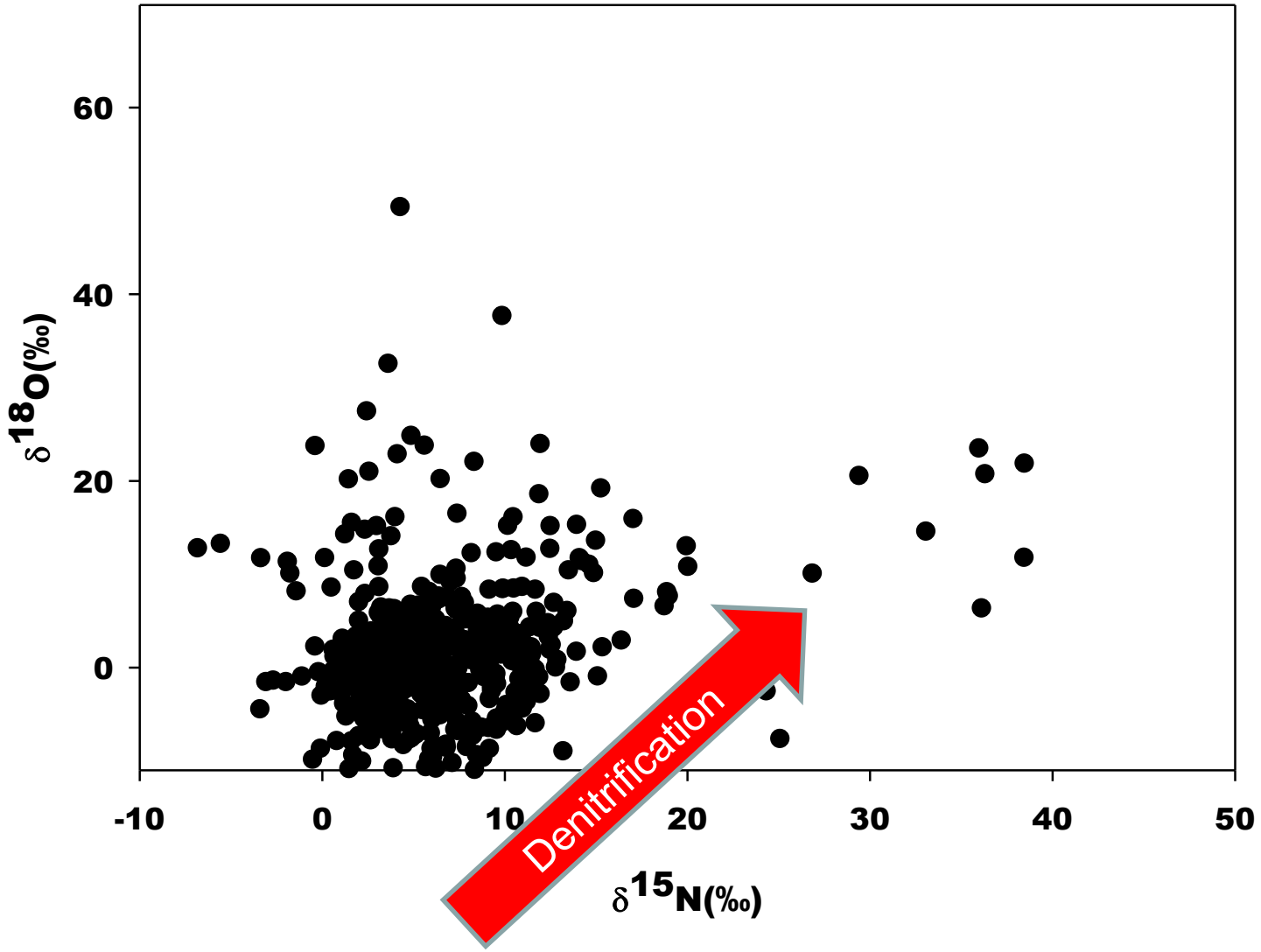


Faulkner, B. R., J. Renée Brooks, K. J. Forshay, and S. P. Cline. 2012. Hyporheic flow patterns in relation to large river floodplain attributes. Journal of Hydrology.

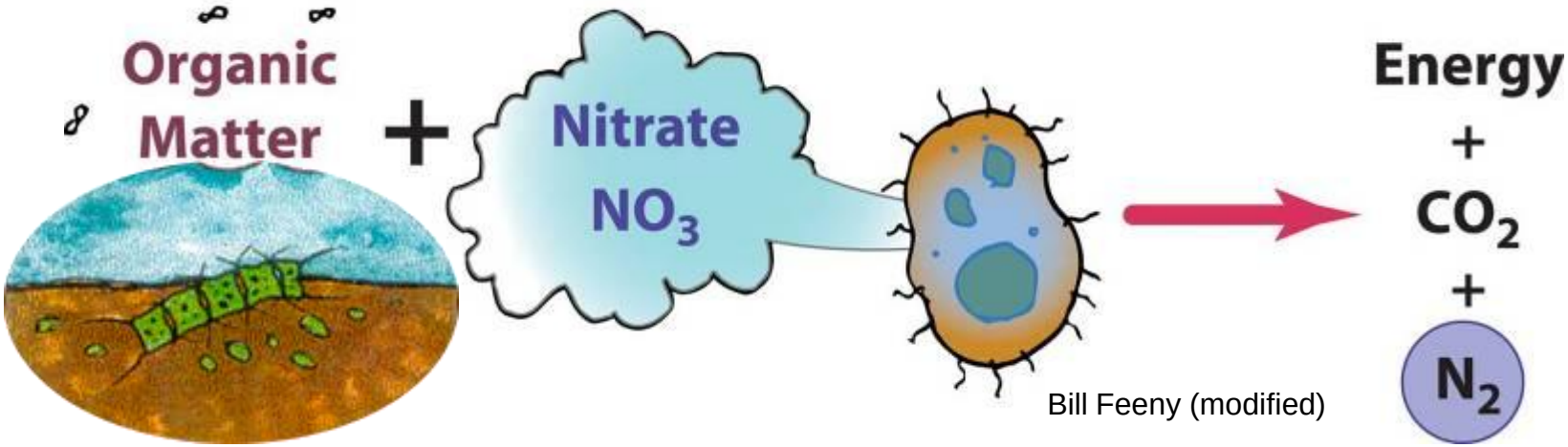
Subsurface water moves slowly, but infiltration brings N.



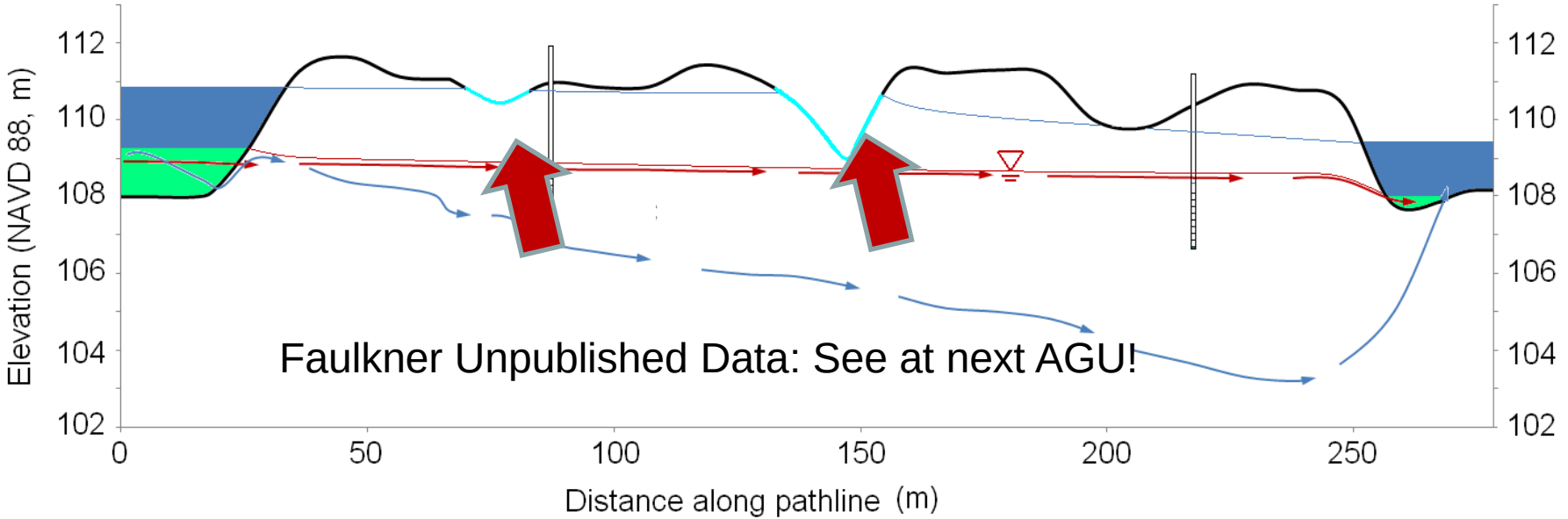
Nitrate is mostly from fertilizers with some evidence of DeN at GI.



Areas of GW-SW interaction support higher denitrification.



Bill Feeny (modified)



Denitrification measured with push-pull tracer technique. (Istok et. al 1997,Addy et. al 2002…)

10L 30ppm KNO3-N 30% 15N with SF6 and KBr as conservative tracer

ANOVA n= 31

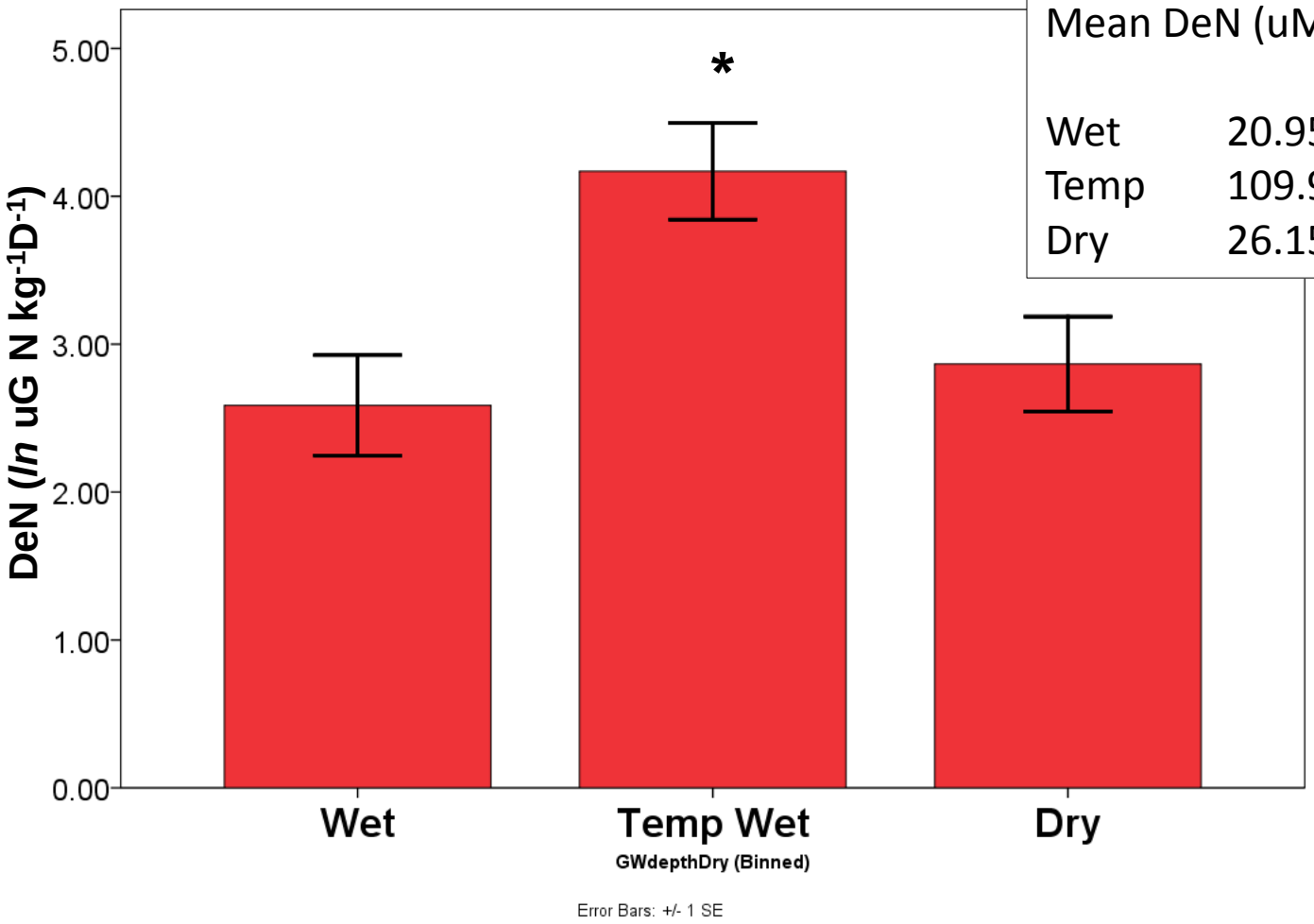
Excluded ~32 no tracer recovery sites

Dry (GWD > 1.5m)

Temp wet (0.5<GWD<1.5m) GW-SW interaction Zone!!

Permanently wet

DeN is greatest in zones of GW and SW interaction.

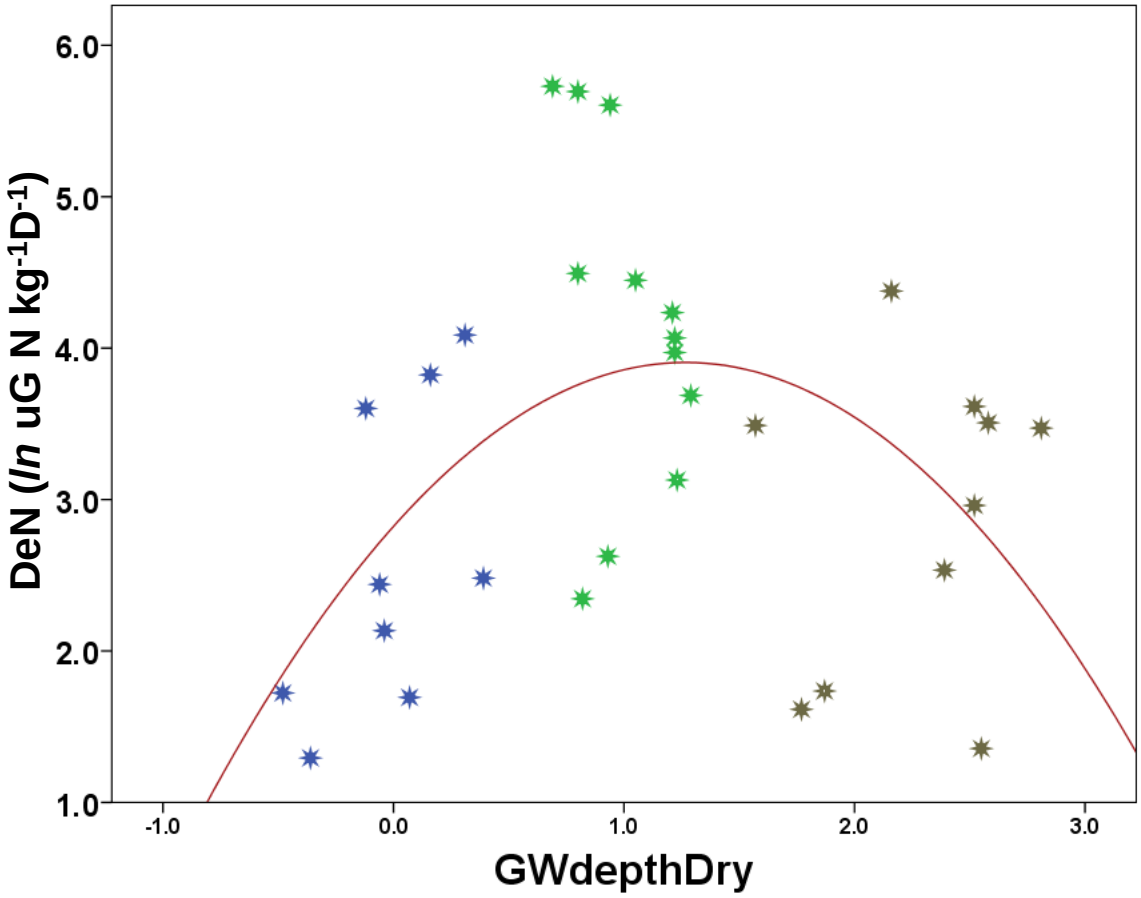


Mean DeN (uMol Kg^{-1} D^{-1})±s.e.

Wet	20.95 ± 6.9
Temp	109.92 ± 32.6
Dry	26.15 ± 7.2

ANOVA p = 0.04, R^2=0.33,df =31, PostHoc ($p<0.05$)

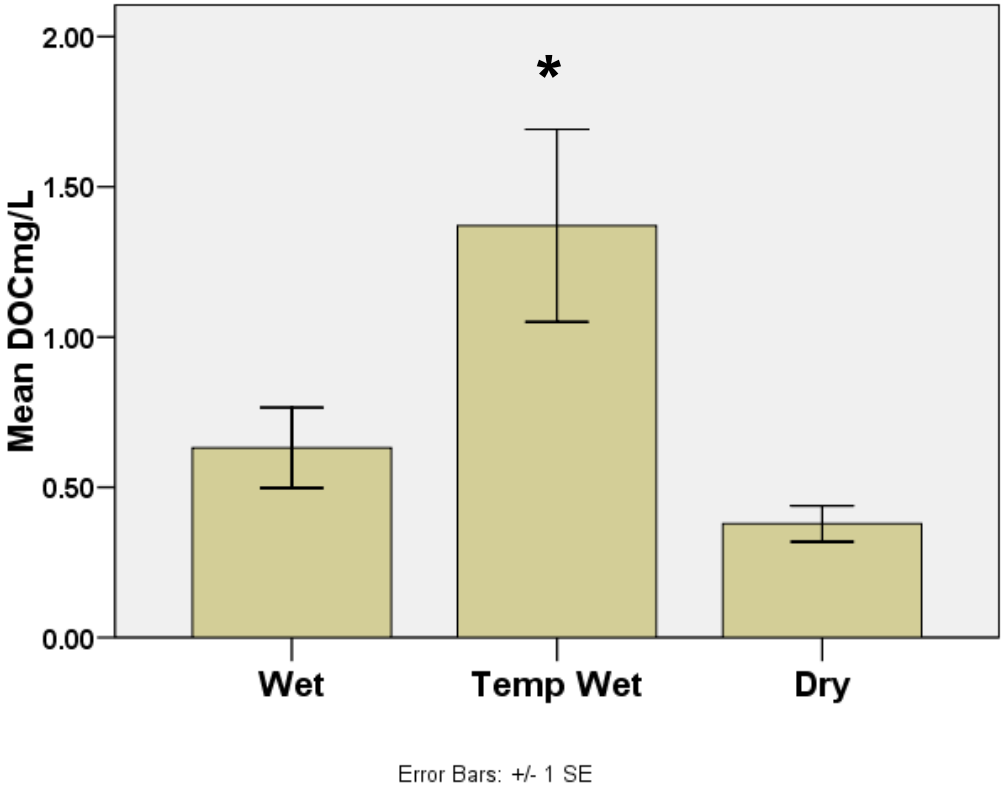
There is a significant relationship with GW depth.



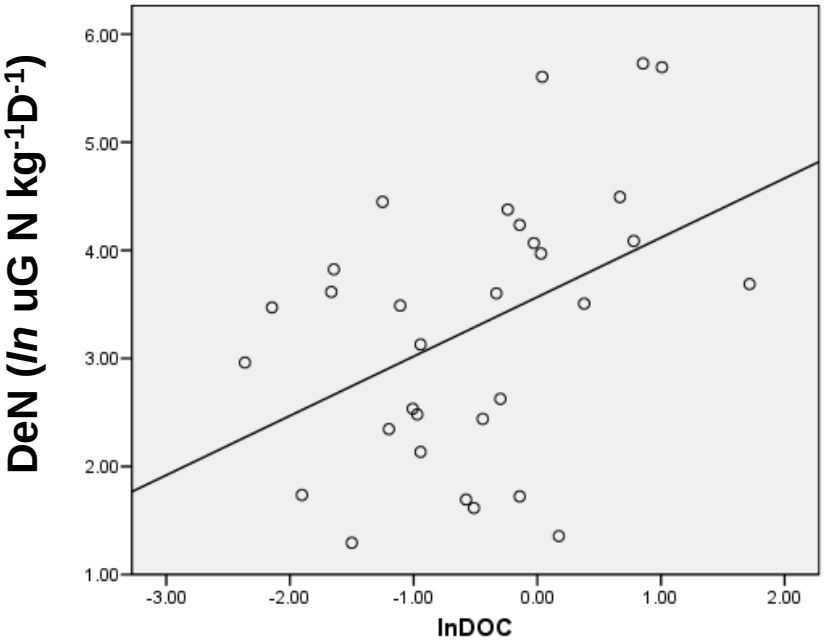
$lnDeN=-0.674\ (GWD)^2 + 1.7(GWD) + 2.823$

$R^2 = 0.23$, $df=30$, $p=0.025$

DOC is highest in GW/SW interaction zone and correlates with DeN, DO, Redox indicators.

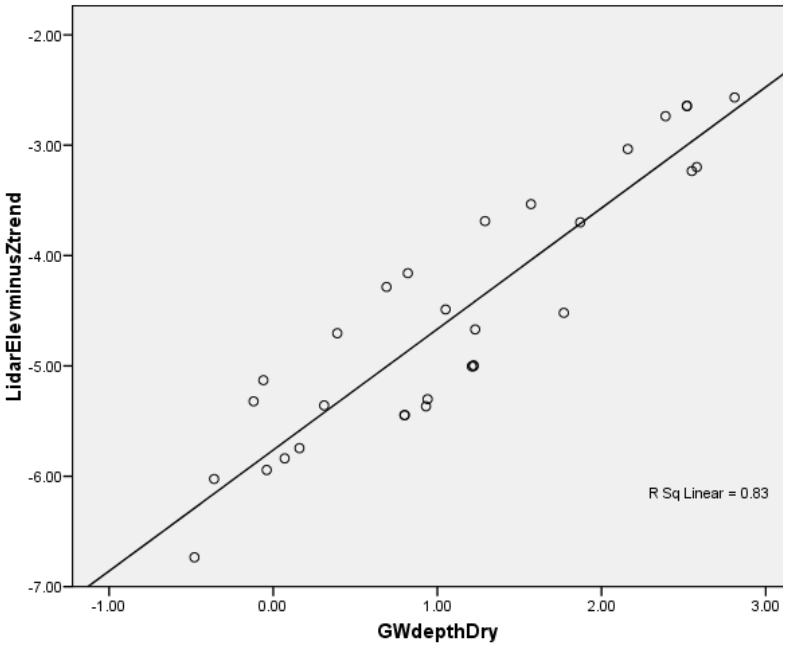


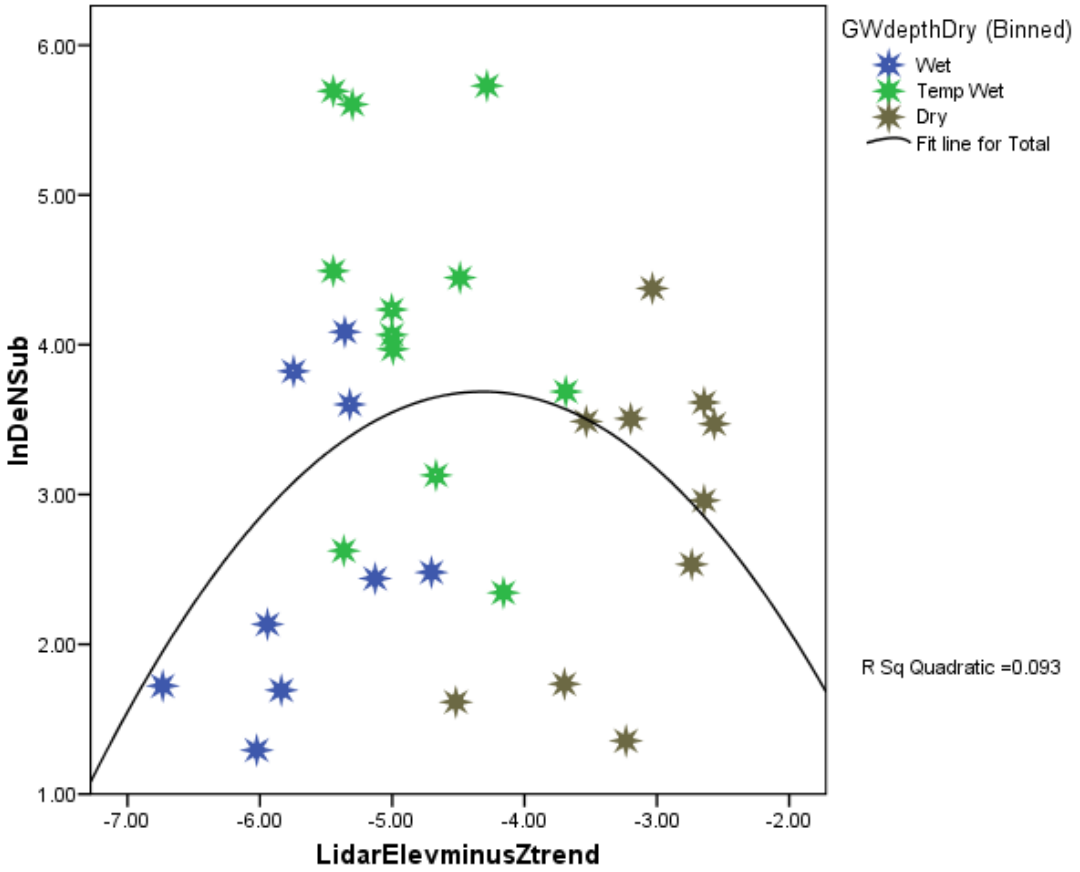
ANOVA $p < 0.001$, R^2=0.30,df =63



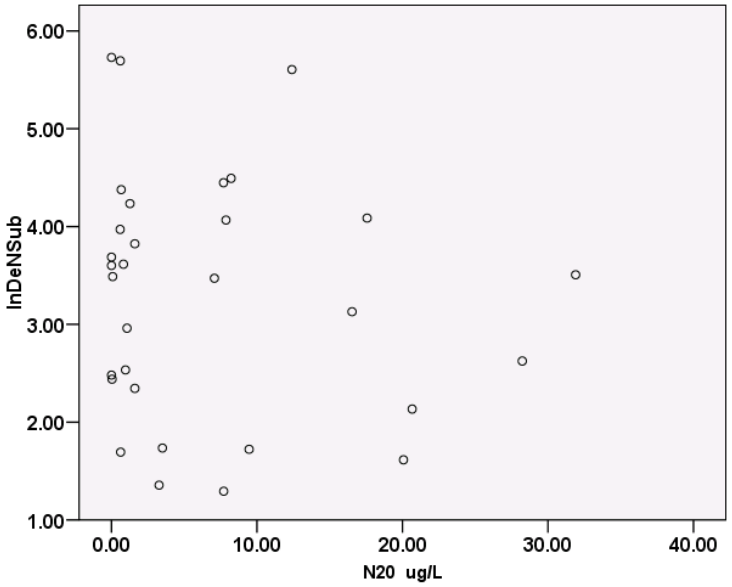
R^2=18%,
p=0.02,
df=30

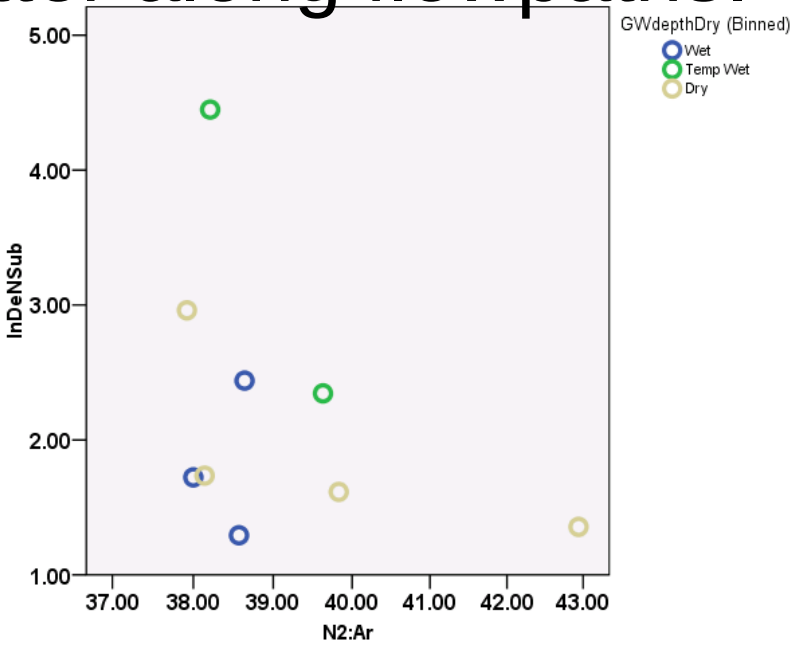
GW depth is highly correlated with elevation, but not with DeN?

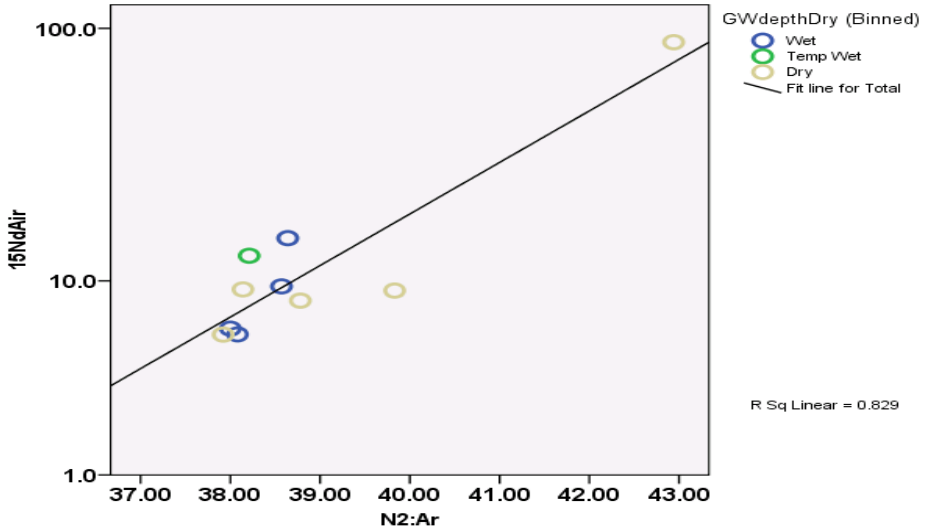


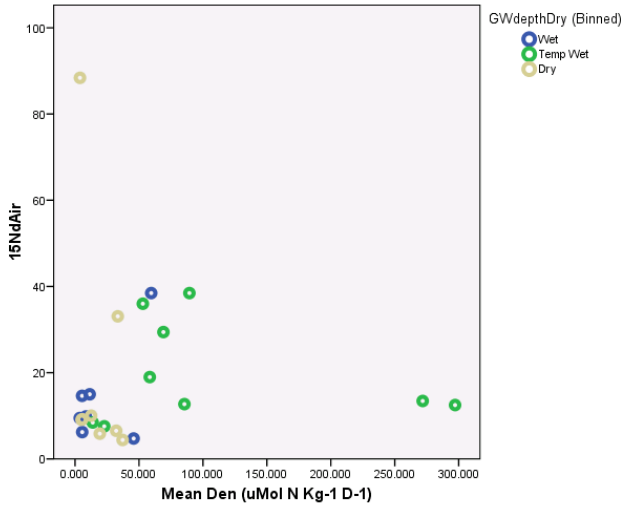


Some indicators are not useful for habitat ID, but probably much better along flowpaths.







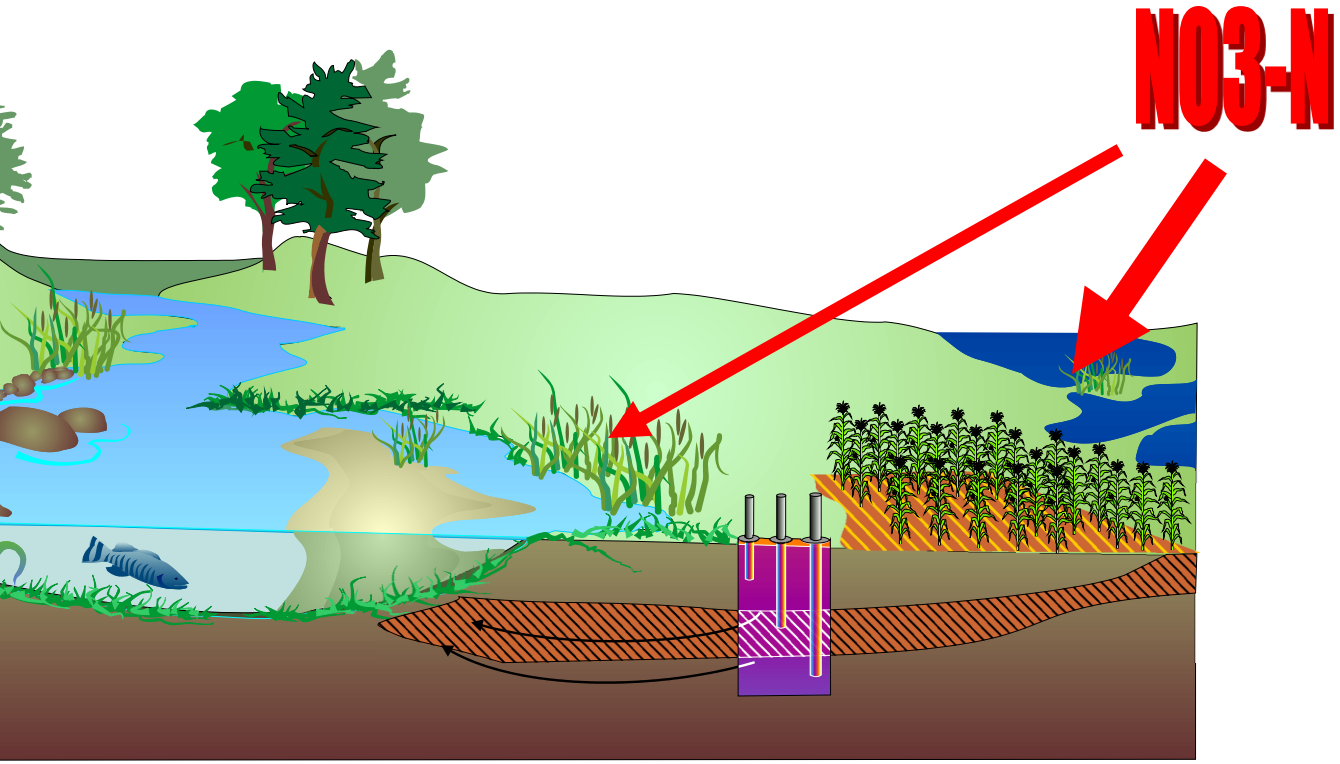


Wet habitats are good indicators of Groundwater Nitrate sinks.

Hydrology determines how upland nitrate rich waters move through the floodplain.

Denitrification is dep. GW and topography, but may account for much of the attenuation in the subsurface.

Floodplain GW – SW interaction does enhance nitrogen removal.



Isolated waterbodies
(Forshay and Stanley 2005),

Wet fringe
(Forshay and Dodson 2011),

and

Historic channels
(Forshay et al *in prep*),

are

regions of organic carbon accumulation that intercept nitrate.

Thank you! Questions?

- McKenzie River Trust
  - Chris Vogel
  - Joe Moll
- EPA's Western Ecology Division
  - Bill Rugh, Kent Rodecap
  - M. Erway and crew
- EPA's GWERD
  - J. Groves, M. Baxter, M. Wood, D. Riley, K. White, T. Canfield, L. Callaway, K. Hargrove,
- Amy Burgin for N2:Ar
- K. Addy, Q. Kellogg, A. Gold, S. Kaushal, and T. Newcomer
- J.Compton