



DENITRIFICATION AND NITROGEN DYNAMICS IN SEDIMENTS OF A MID-ATLANTIC INCISED STREAM DEPOSITED WITH DEEP LEGACY SEDIMENTS.

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Excess legacy sediments deposited in former impounded streams often bury Holocene pre-settlement wetlands.

Surface

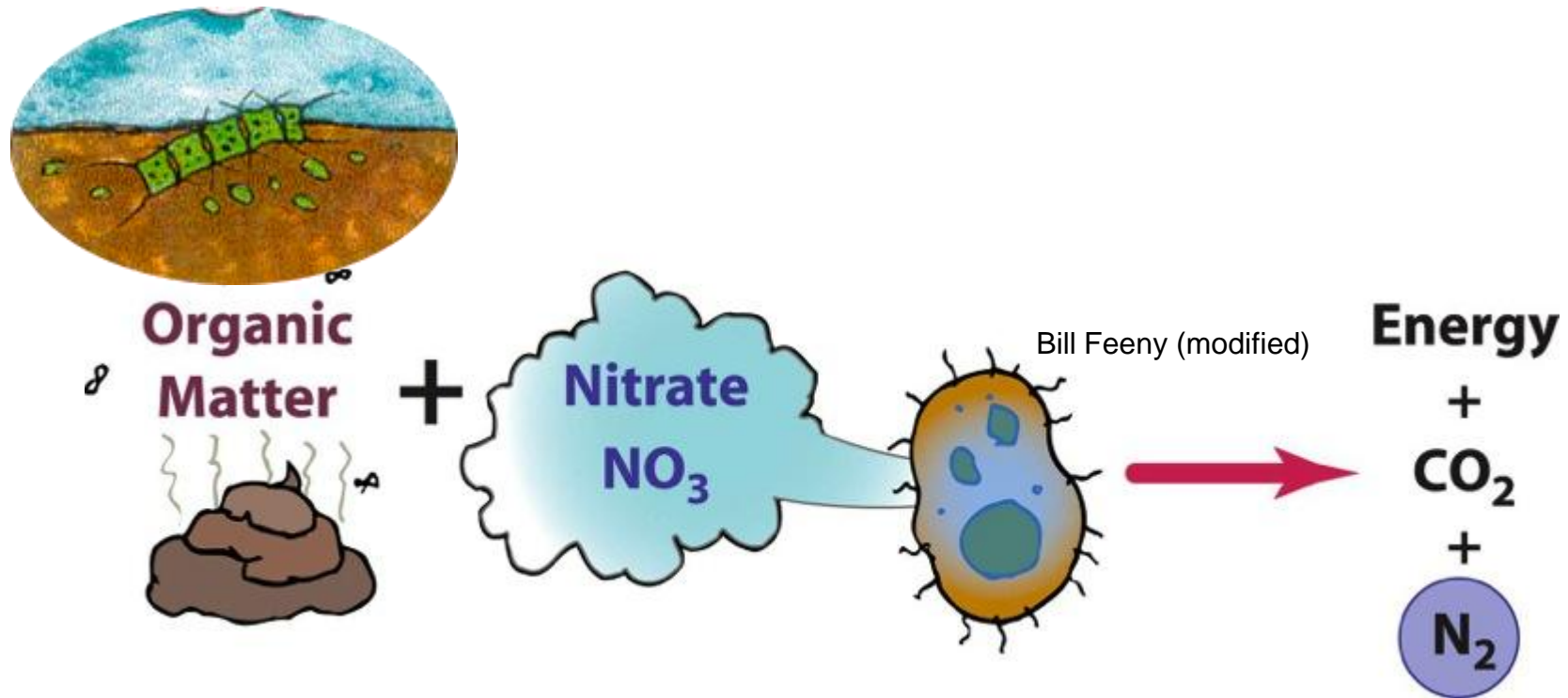
Legacy

Hydric sediments

Stream Bed



Denitrification is a sink for NO_3^- -N.



What are the relative rates and drivers of DeN in near stream and surrounding sediments?

Does DeN vary within the sediment profile? e.g. Hill et al. 2004

What controls DeN in the sediments of an incised stream near channel and within region around the stream?

Will legacy sediment removal improve DeN and N retention?

Big Spring Run is part of the Conestoga River watershed, leads into the Susquehanna River, and flows into the Chesapeake Bay.



Six sites were selected for bank coring along Big Spring Run with incised channels.



DEA in a Factorial design

4 strata

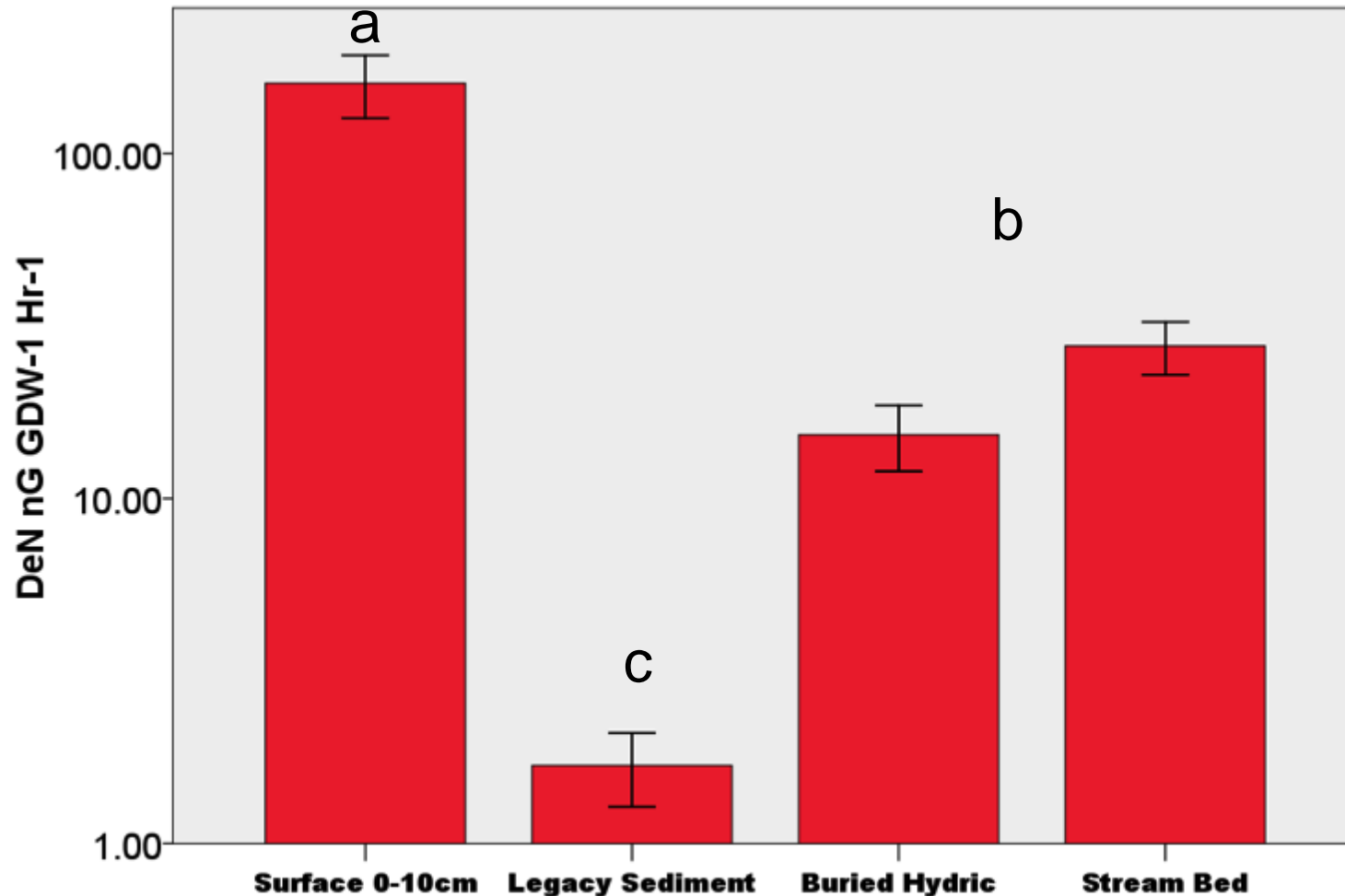
4 treatments control, +C, +N, +CN

3 dates spring, summer and fall

Total n=288

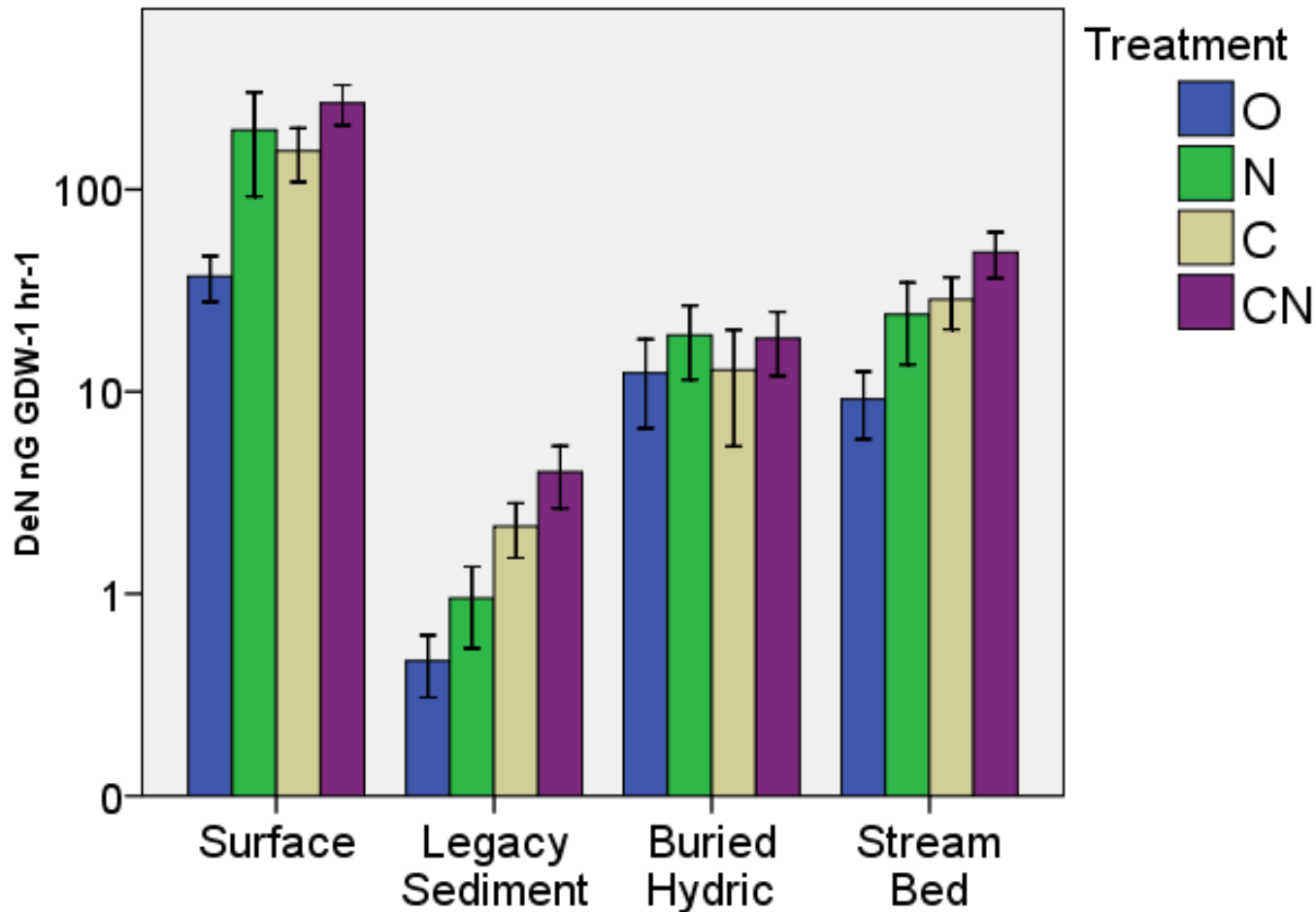


Buried hydric soils support greater DeN rates and DeN potential than Legacy Sediments.



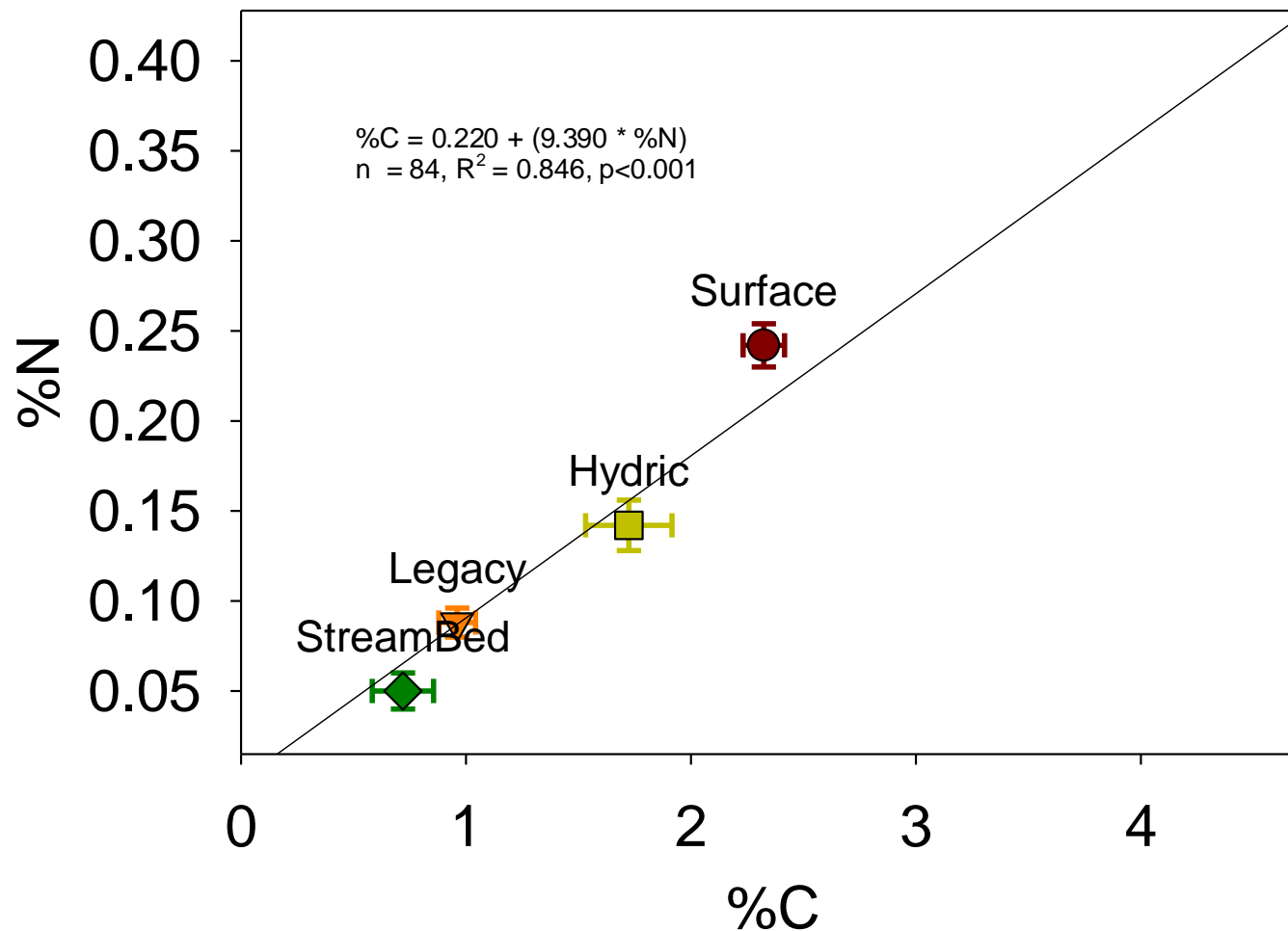
Error bars ± 1 s.e.
n = 72 p < 0.05

Organic carbon limits DeN in legacy sediments of banks while other sediments are co-limited.



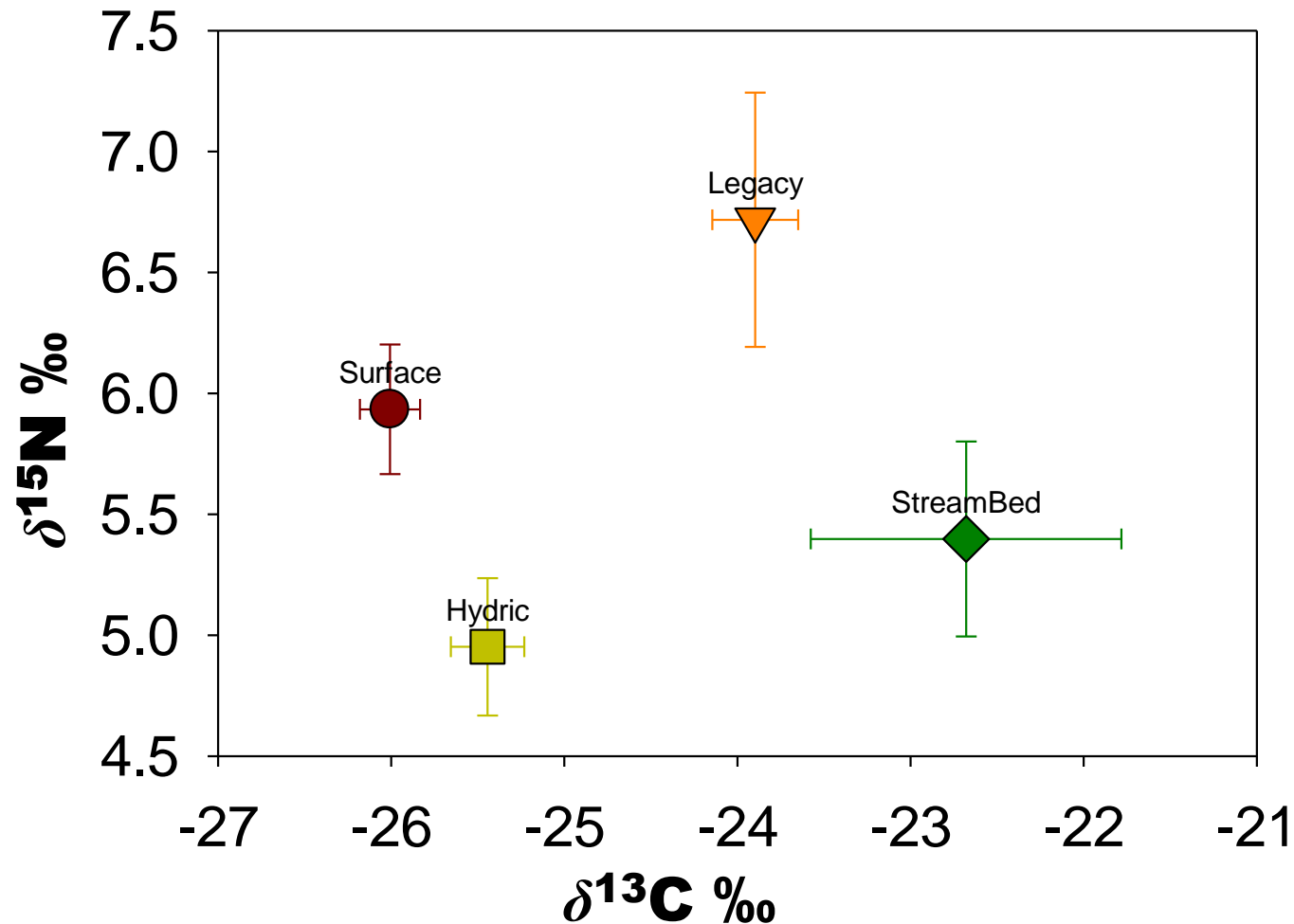
Sediment C and N ratios are highly correlated across all strata, but different from one another.

Bulk % Carbon and Nitrogen



The carbon and nitrogen in the strata are isotopically different.

Sediment C and N Isotope Ratios



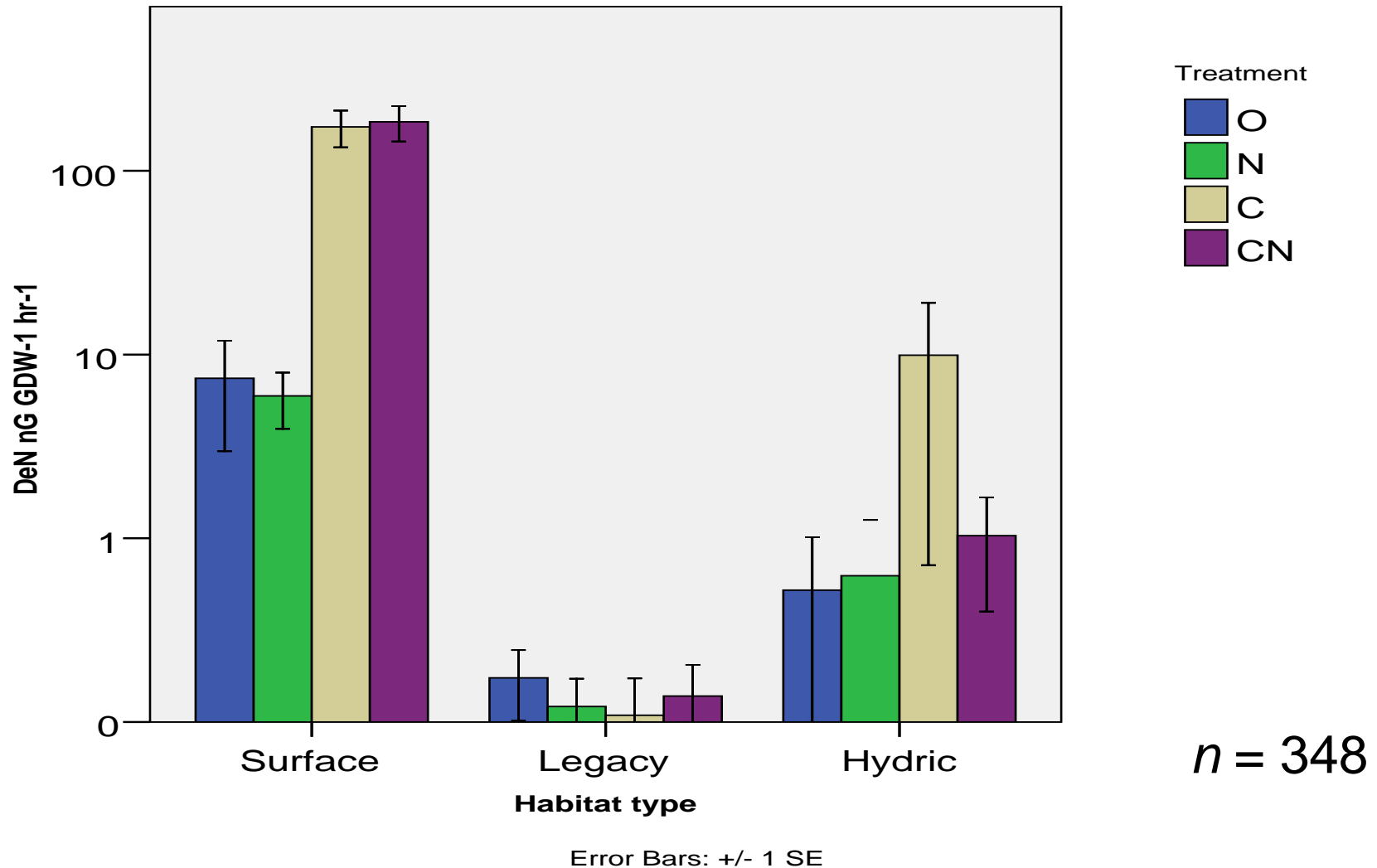
We collected 30 soil cores surrounding the stream channel to a depth greater than 1 meter for surface, legacy, and deep



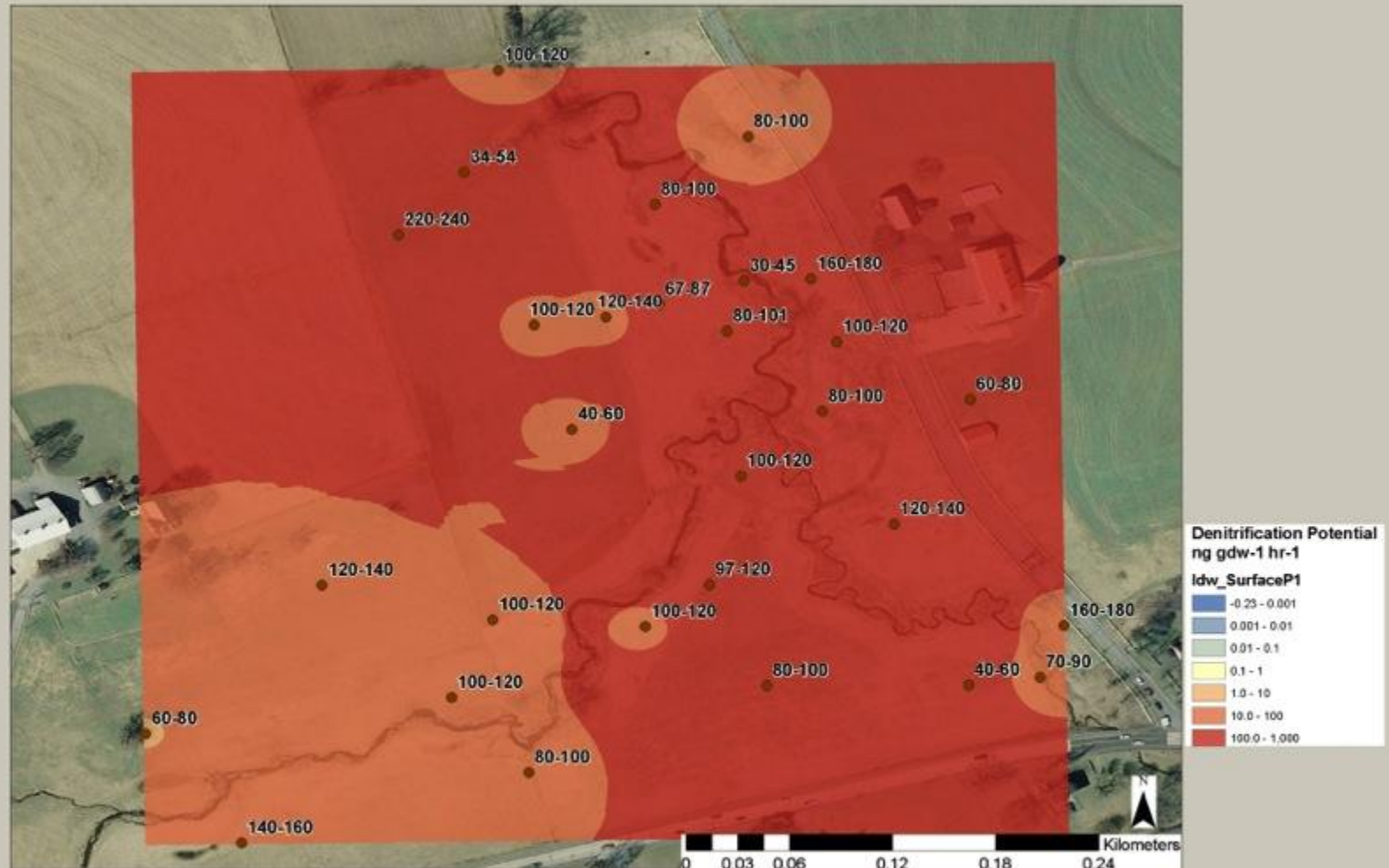
Cores were sectioned between surface (0-20cm), legacy sediments, and deep darker sediments.



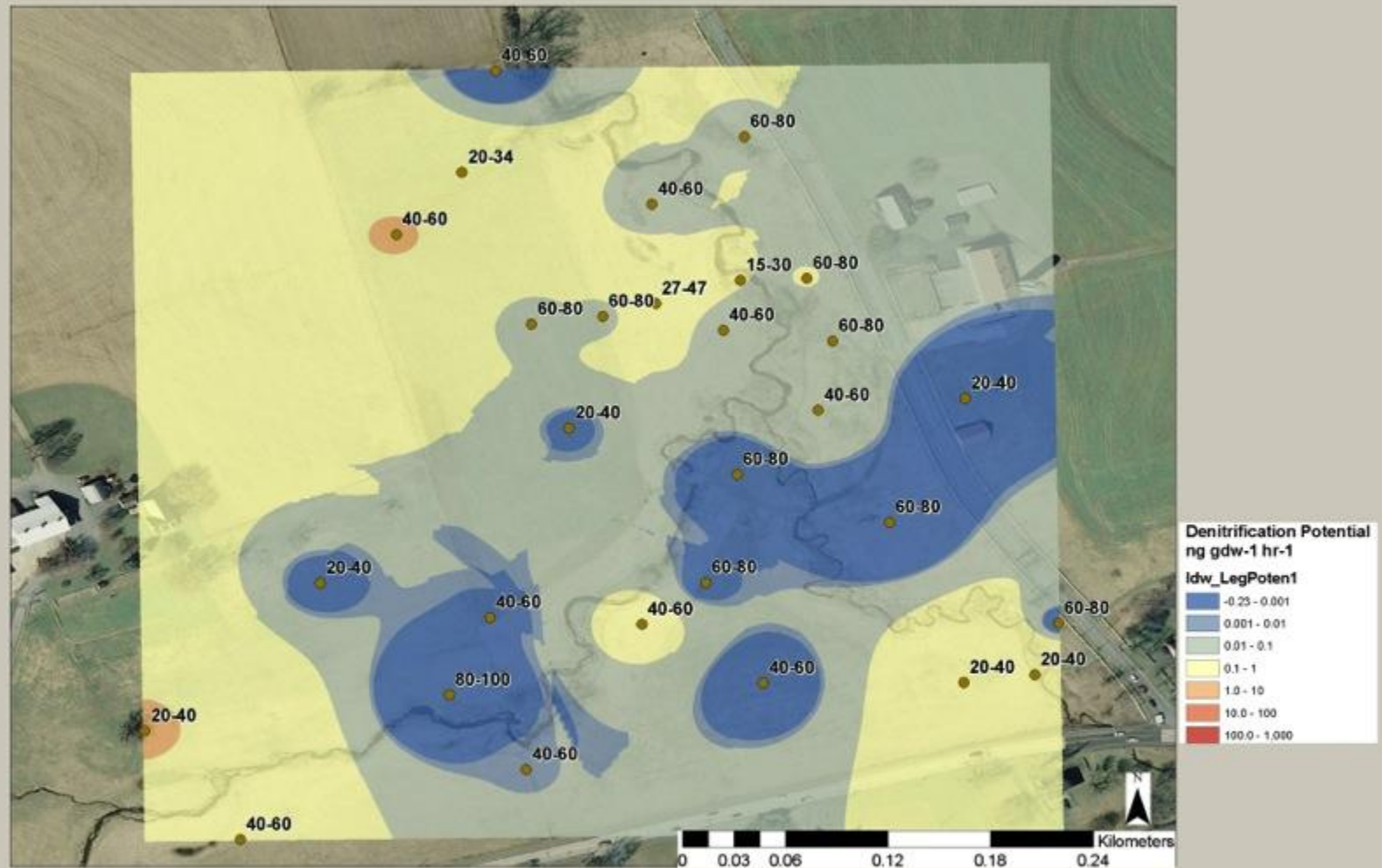
DeN in legacy sediments is very low, while the deeper strata below legacy sediments are higher and variable.



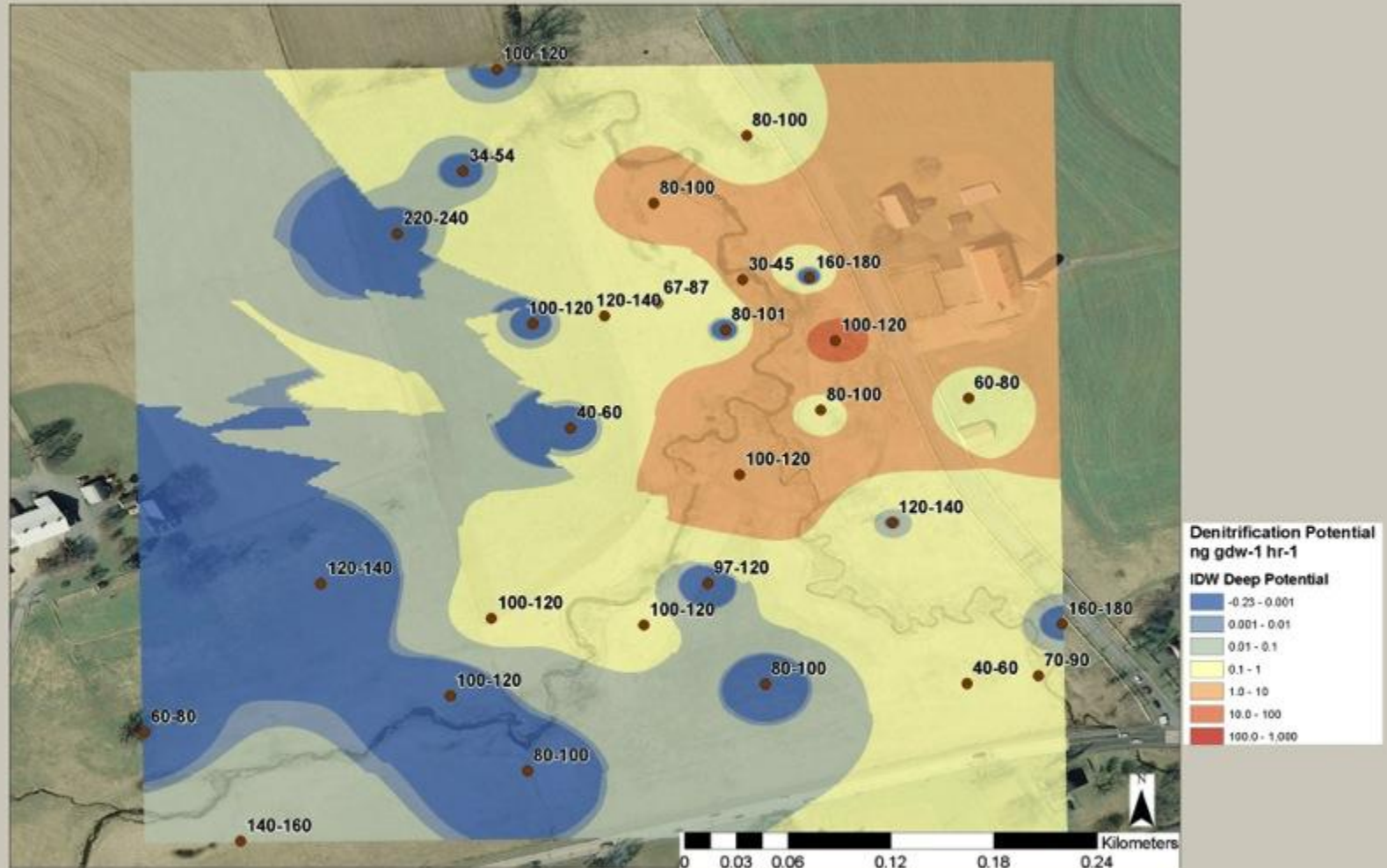
Surface DeN potential high but does not interact with high nitrate ground or surface waters.



Legacy sediment DeN potential is nearly zero.

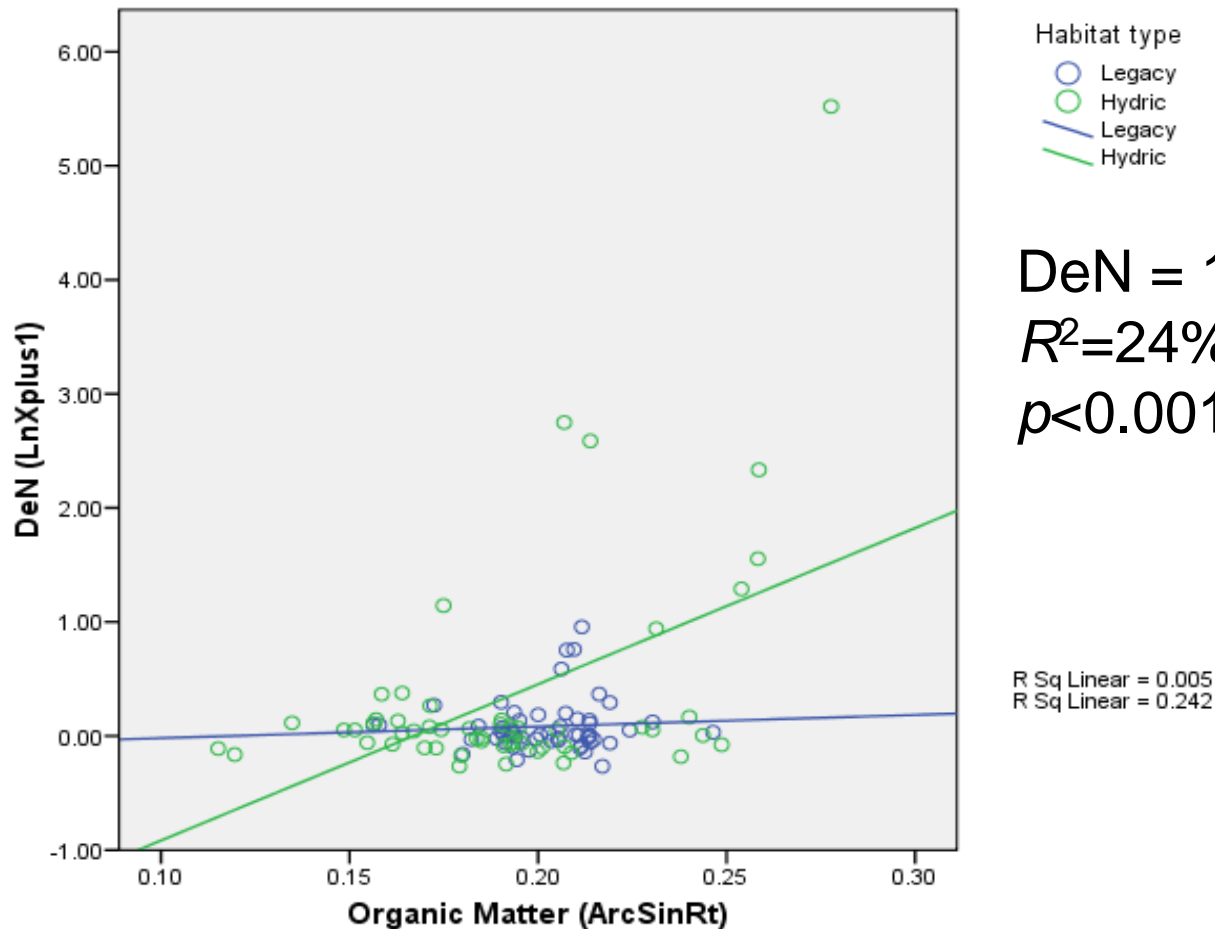


Deeper strata DeN rates are highly variable and range from BDL to nearly that of surface sediments.



Organic matter has a positive relationship with denitrification in non-legacy sediments.

Denitrification plus Org C. vs. Organic Matter in core samples April 2010

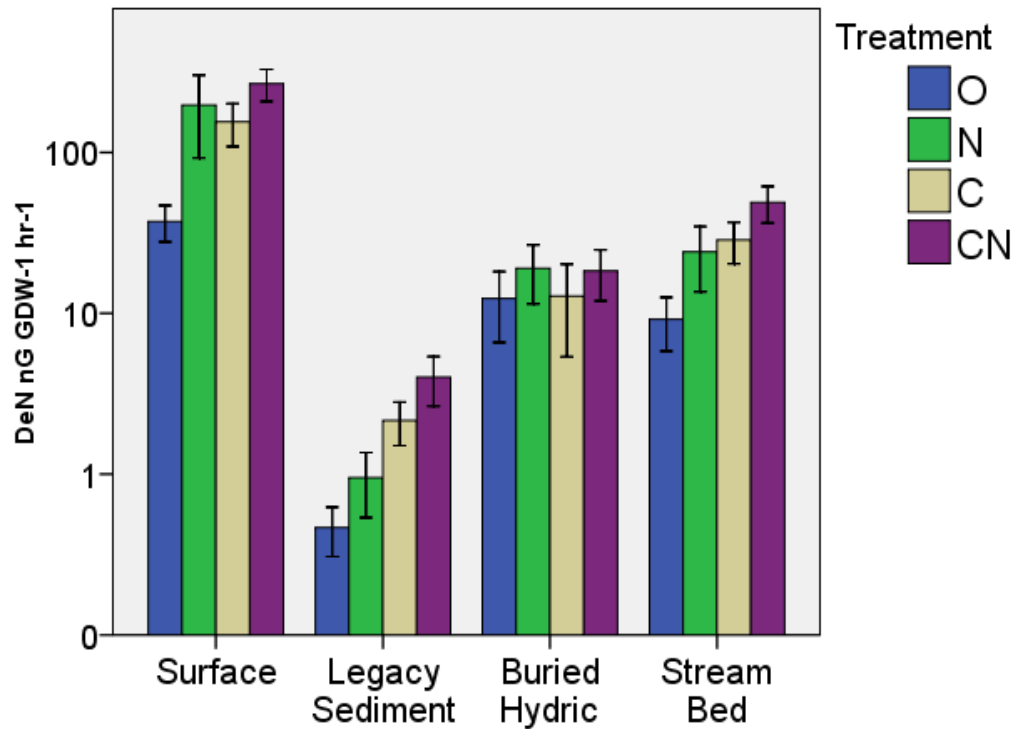


DeN = 13.7 * OM - 2.3 + error
 $R^2=24\%$,
 $p<0.001$, $df=53$, $F=16.6$

R Sq Linear = 0.005
R Sq Linear = 0.242

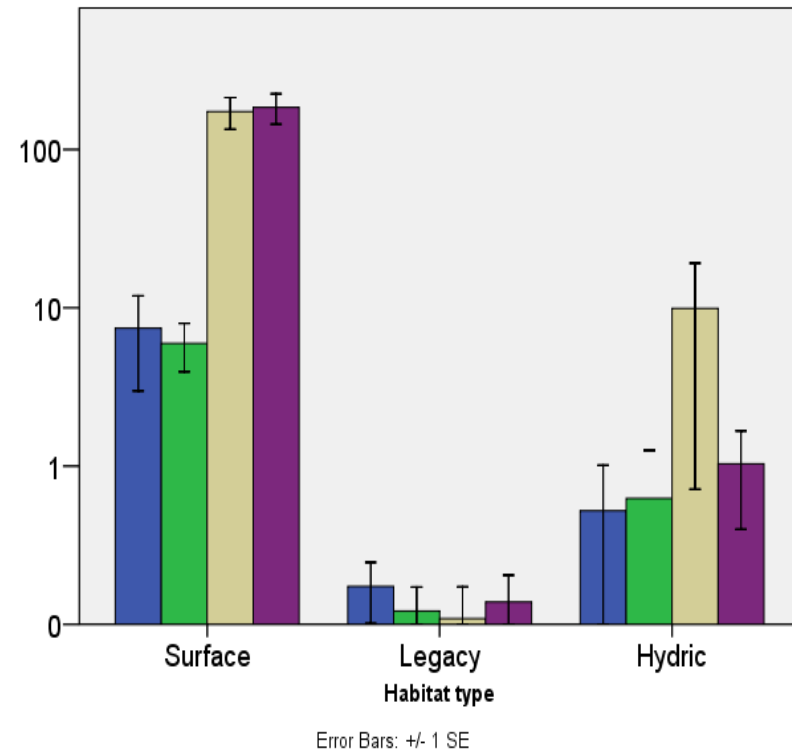
Comparisons between banks and outlying areas may indicate future outcomes.

Stream Bank



Error bars ± 1 s.e.

Soil Cores



Microbial community and nitrification are critical controls of the N processing in stream systems with legacy sediment.



Legacy sediment and DeN Take Home Message

Buried legacy sediments do not support high DeN,
surface sediments are not interacting with nitrate.

There is potentially high denitrifying strata that is buried.

DeN is highly variable and controlled by OM content.

Legacy sediment may improve DeN and N removal?

Depends on:

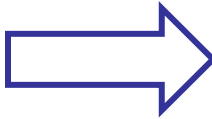
- OM accumulation

- Nitrate surface interaction

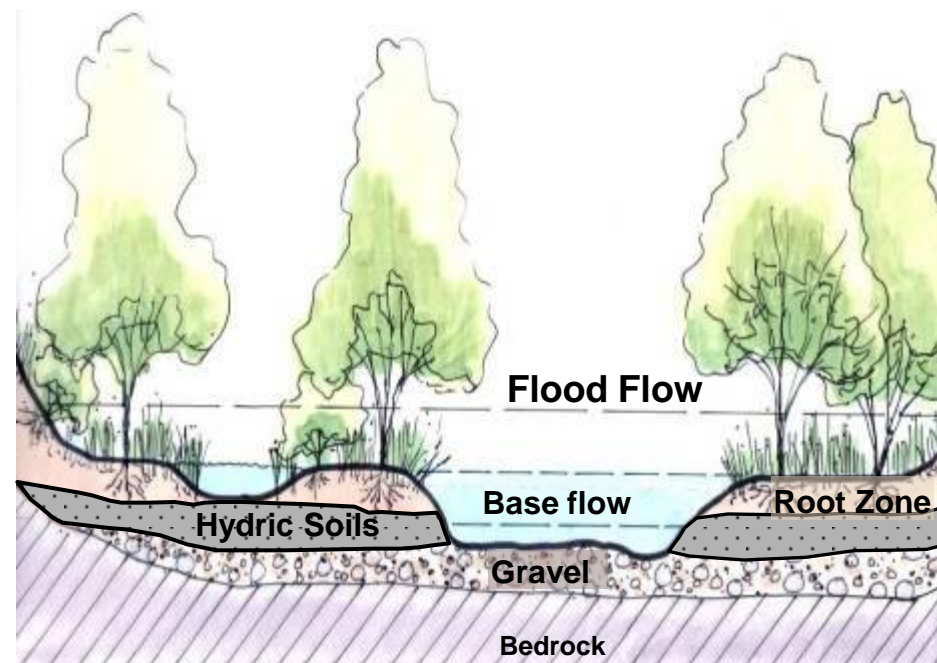
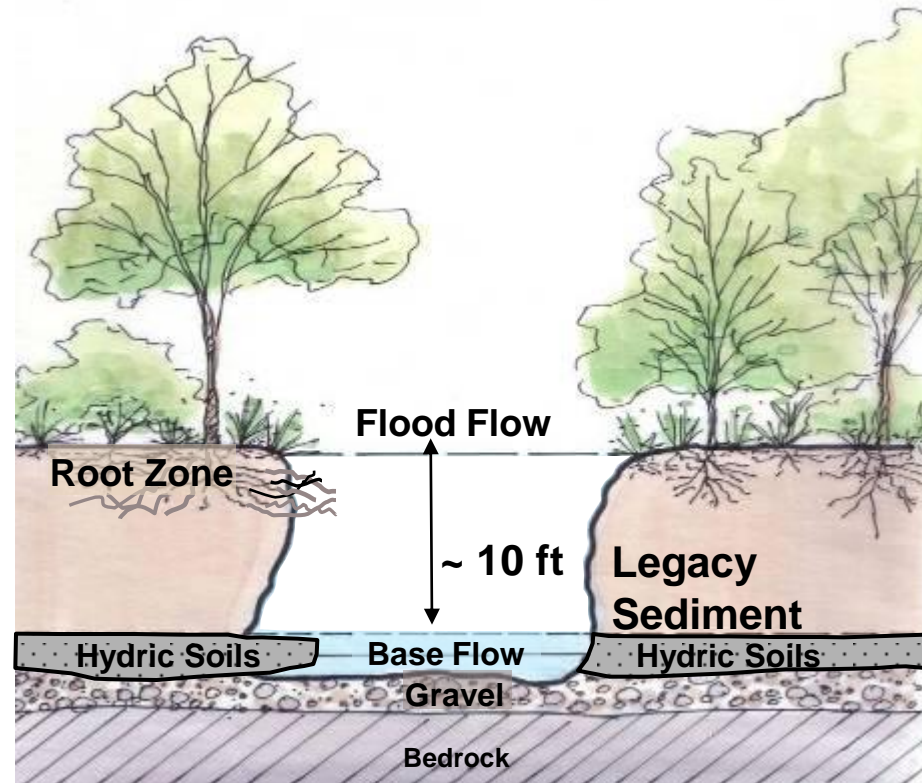
- Development of microbe activity

Restoration can remove legacy sediments and support hydric soils

Existing Condition



Restoration

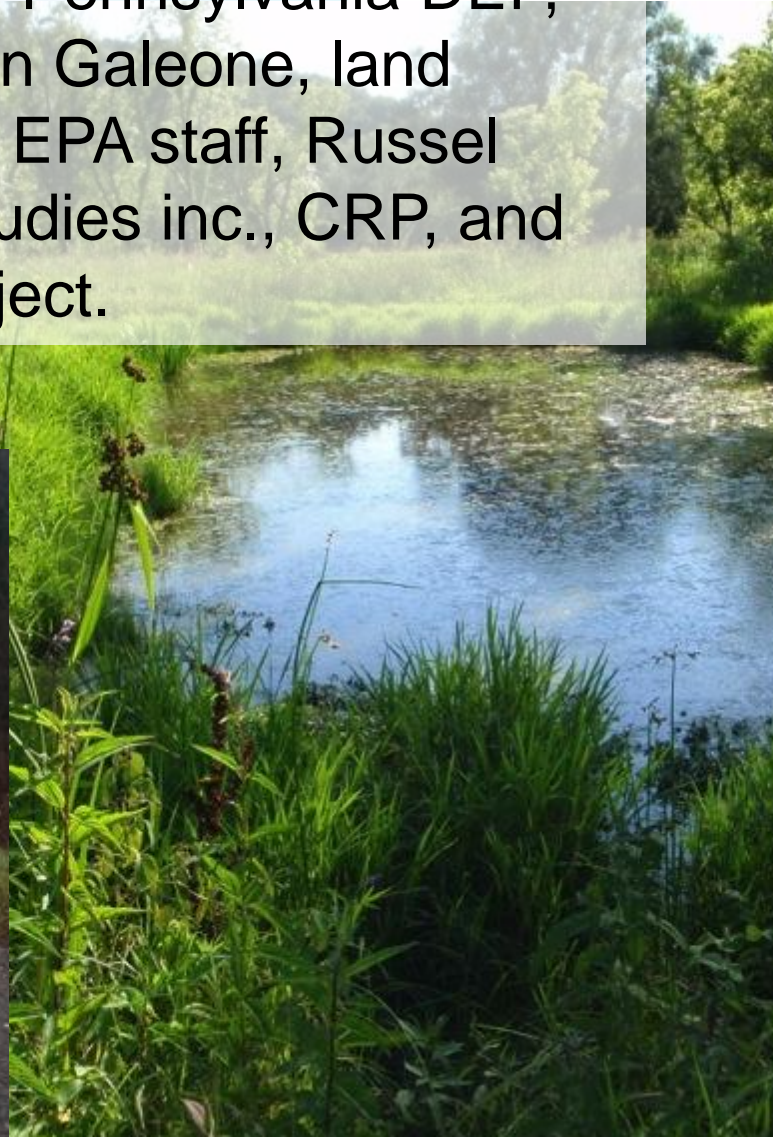


How much denitrification?

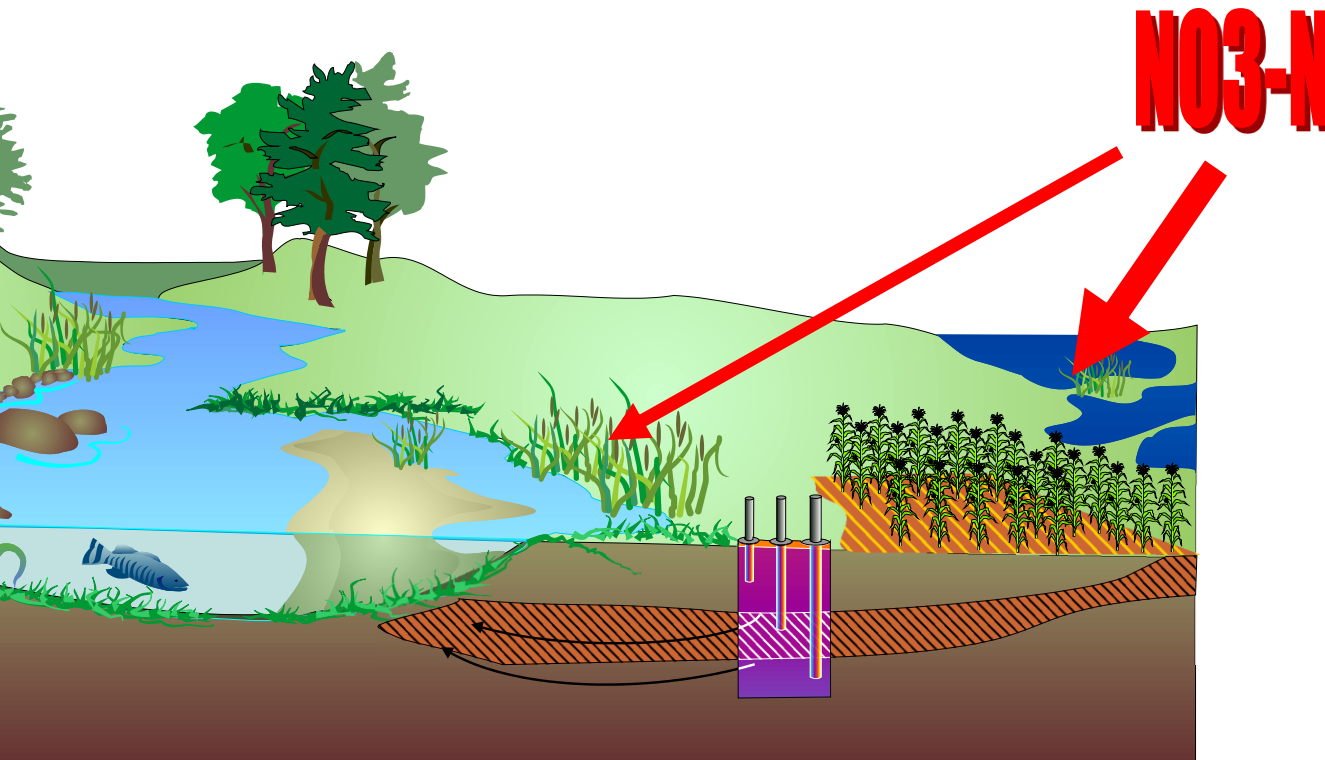
Increased denitrification?

Thank you

US EPA, Franklin and Marshall College, Pennsylvania DEP, Jason Kaye and Penn State, USGS, Dan Galeone, land owner, Mr. Sweeney, Lancaster County, EPA staff, Russel Neil, Ken Jewell, Tim Lankford, Land Studies inc., CRP, and everyone who has assisted with the project.



Floodplains provide important ecosystem services that enhance nitrogen removal.



Isolated waterbodies
(Forshay and Stanley 2005),

Wet fringe
(Forshay and Dodson 2011),

and

Historic channels
(Forshay et al 2011 *in prep*),

are

regions of organic
carbon accumulation
that intercept nitrate.

Denitrification away from the stream is carbon limited in surface, low in legacy, and variable in deeper sediments.

