Restoring stream-floodplain connection with legacy sediment removal increases denitrification and nitrate retention, Big Spring Run, PA USA.

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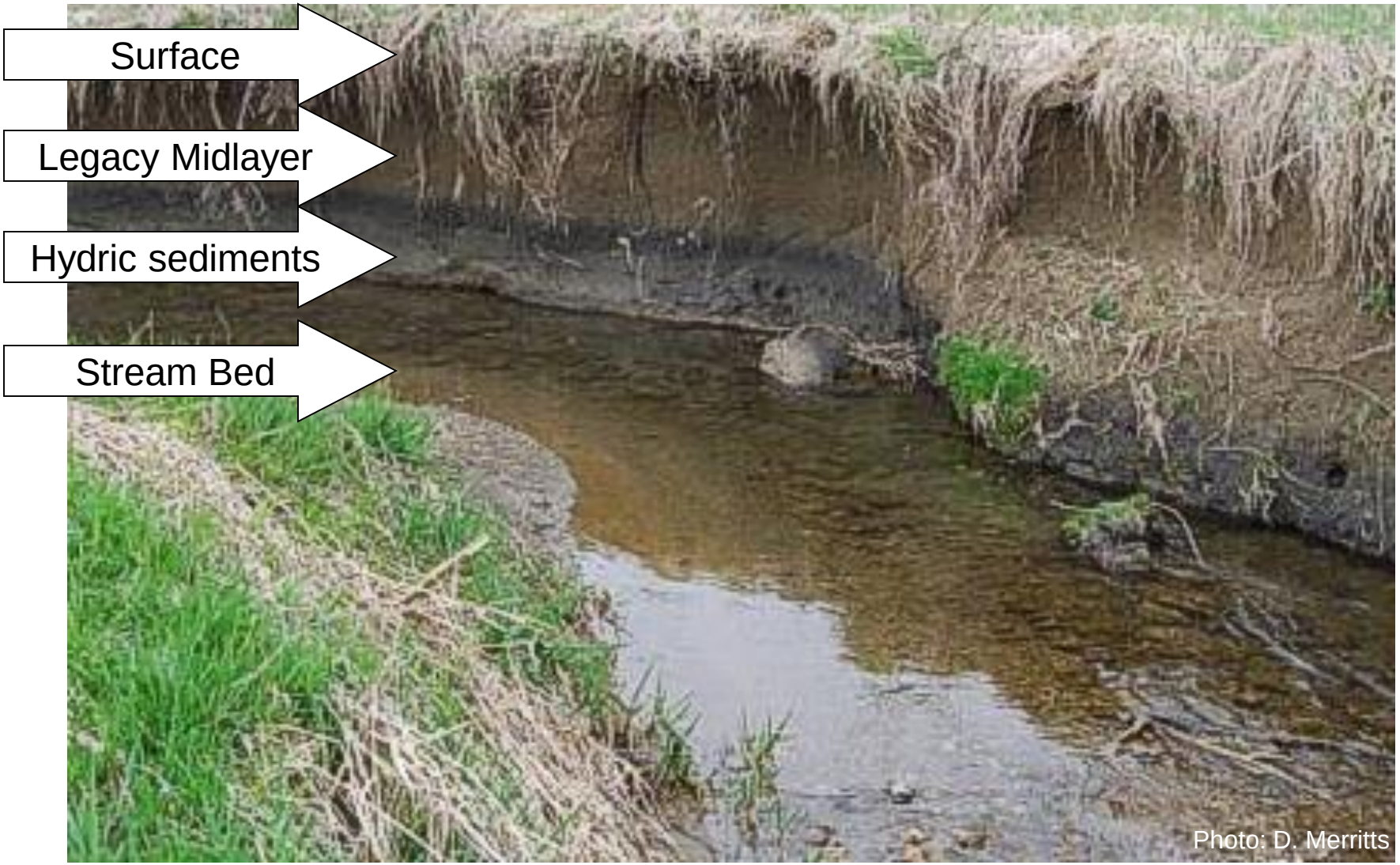
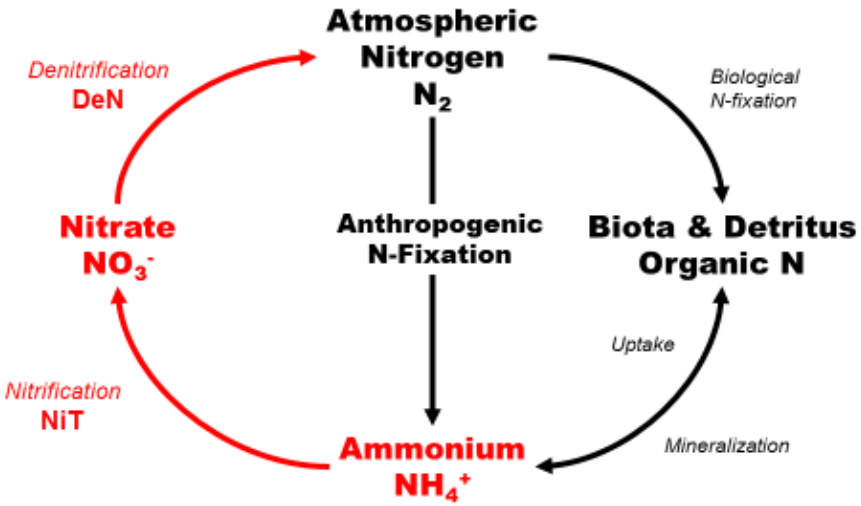
Excess legacy sediments deposited in previously impounded streams bury Holocene valley bottoms.

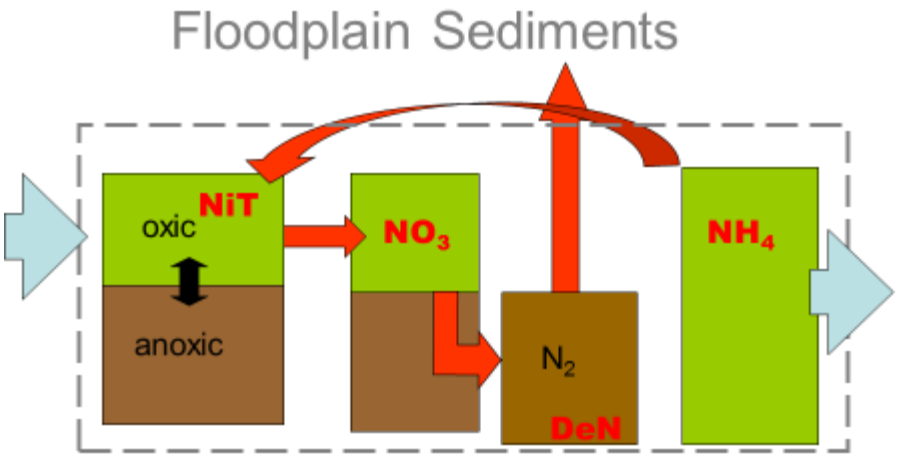


Biogeochemistry and hydrology can provide some insight and prediction of function.

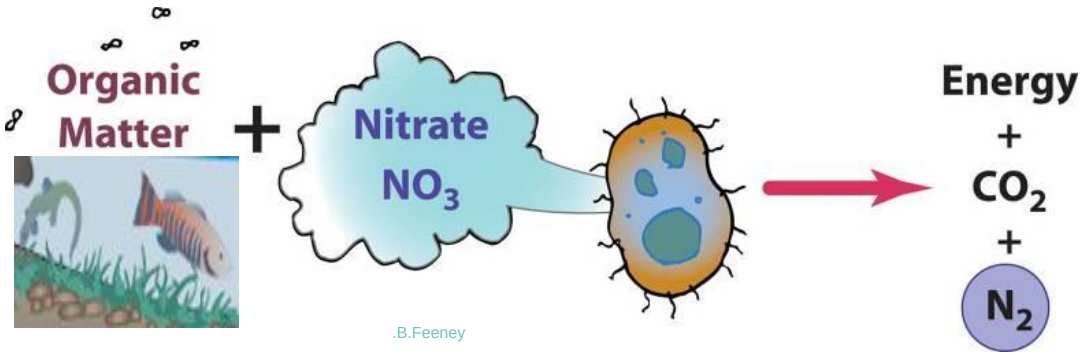
The nitrogen cycle



Where is inorganic N being processed?

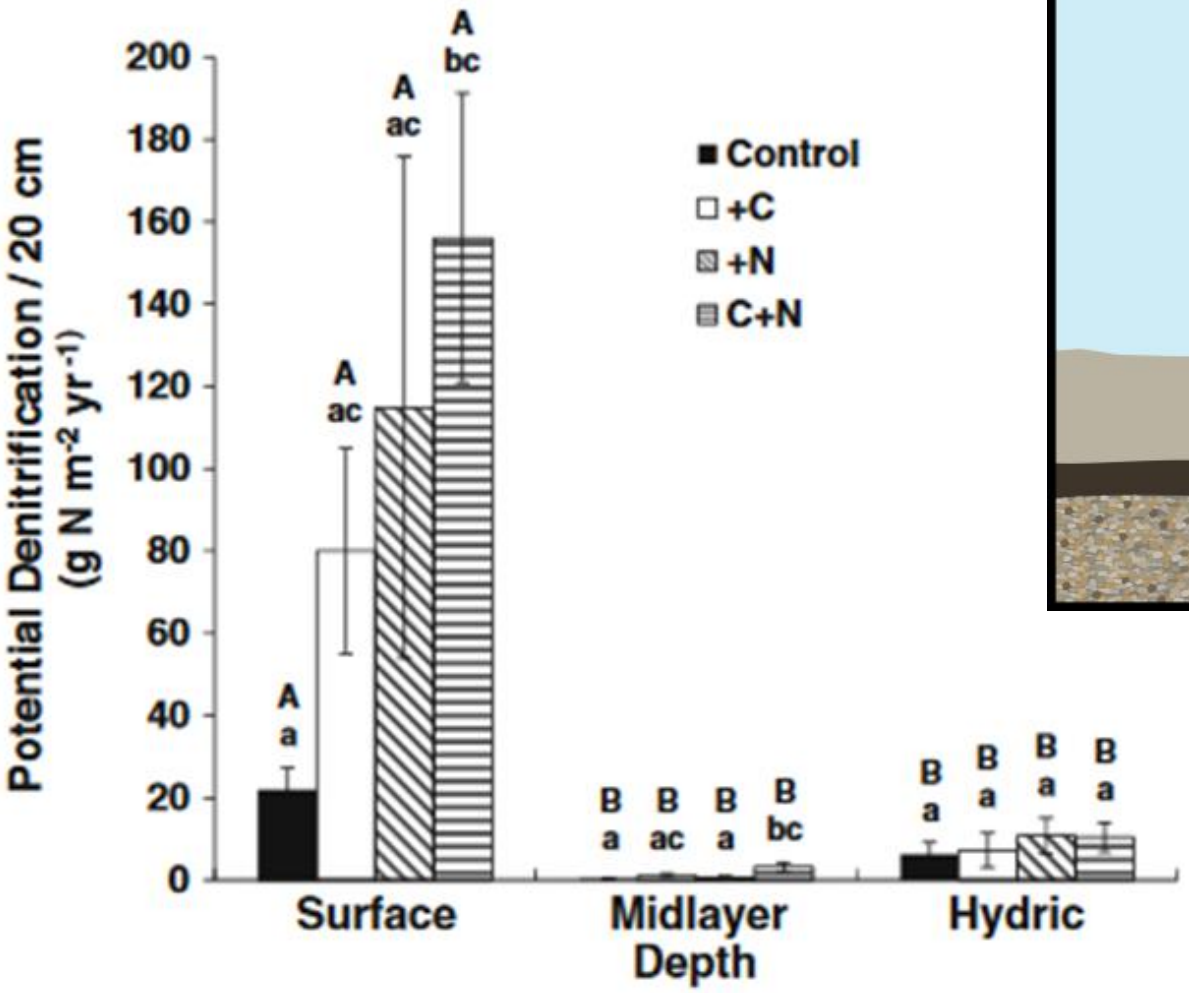


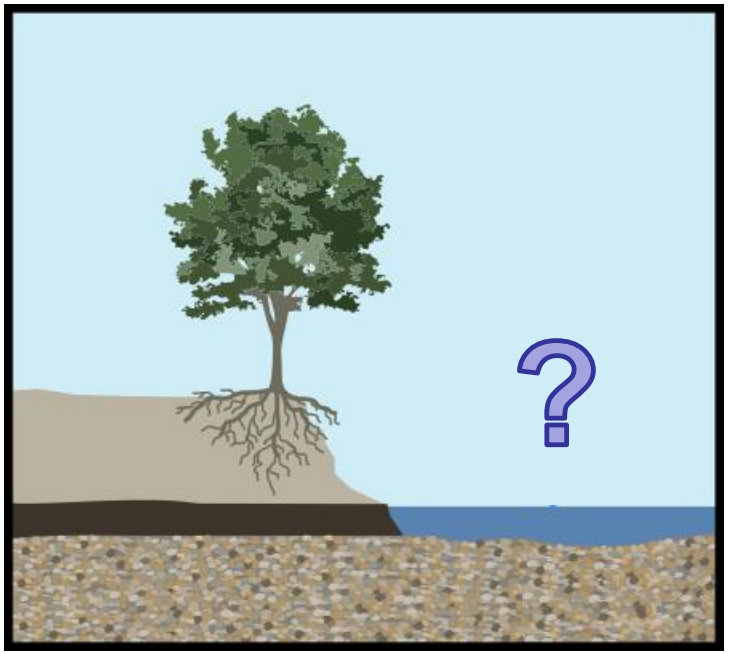
Sediments provide the oxic-anoxic matrix.



.B.Feeney

Disconnected floodplains are bad at denitrification because active sediments do not contact nitrate rich water.





Biogeochemistry
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Potential nitrogen and carbon processing in a landscape rich in milldam legacy sediments

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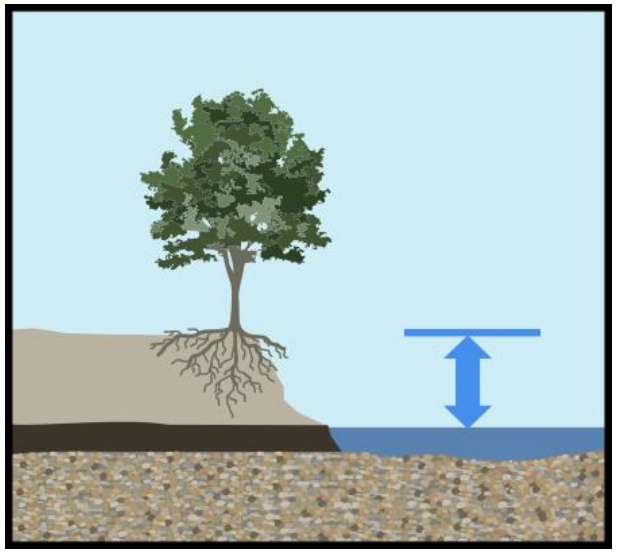
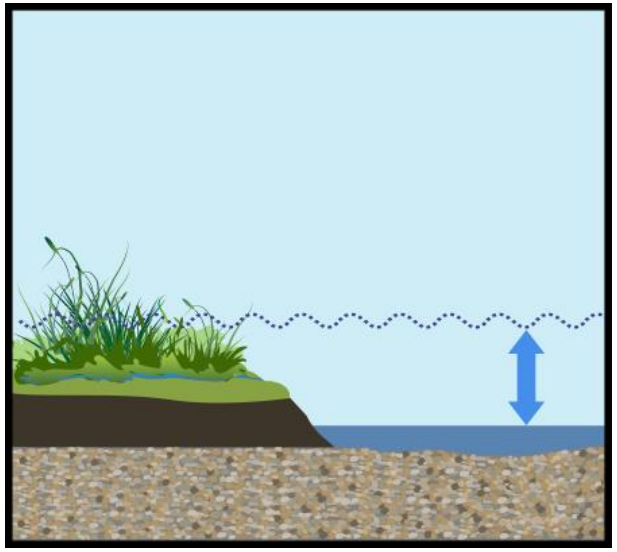
Does legacy sediment removal actually improve watershed, floodplain, and river nitrogen loads?





Hypothesis: Floodplain restoration with legacy sediment removal can increase N retention and decrease N loads.

Q1: Do we see evidence in the surface or groundwater of decreased N?

Q2: Do we see evidence in the sediments of high denitrification or other indicators?

Q3: Is there a decrease in downstream loads?

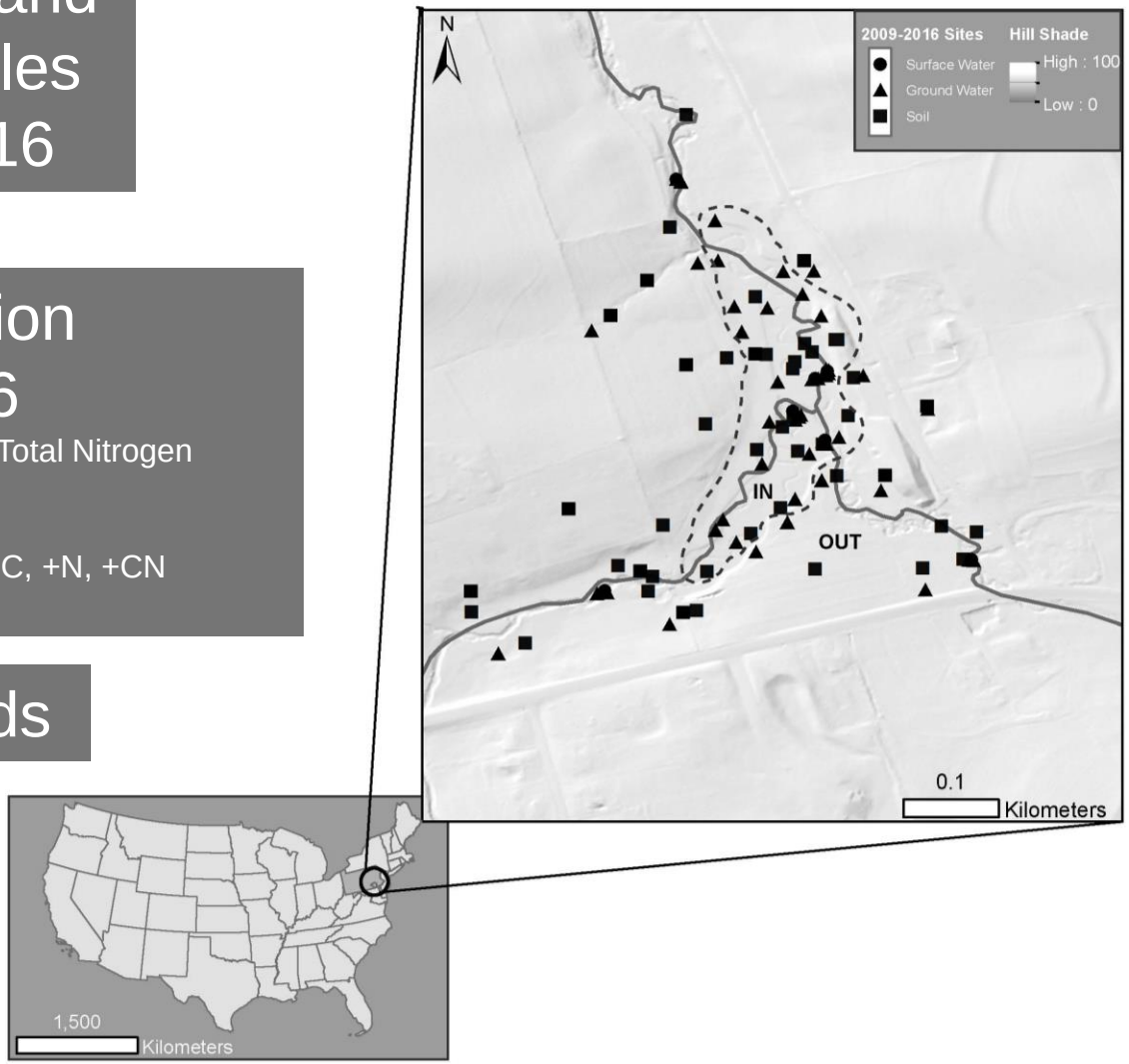
We collected surface soil, groundwater, and surface water Pre and Post.

Monitored groundwater and surface water ~50 samples bimonthly Late 2008-2016

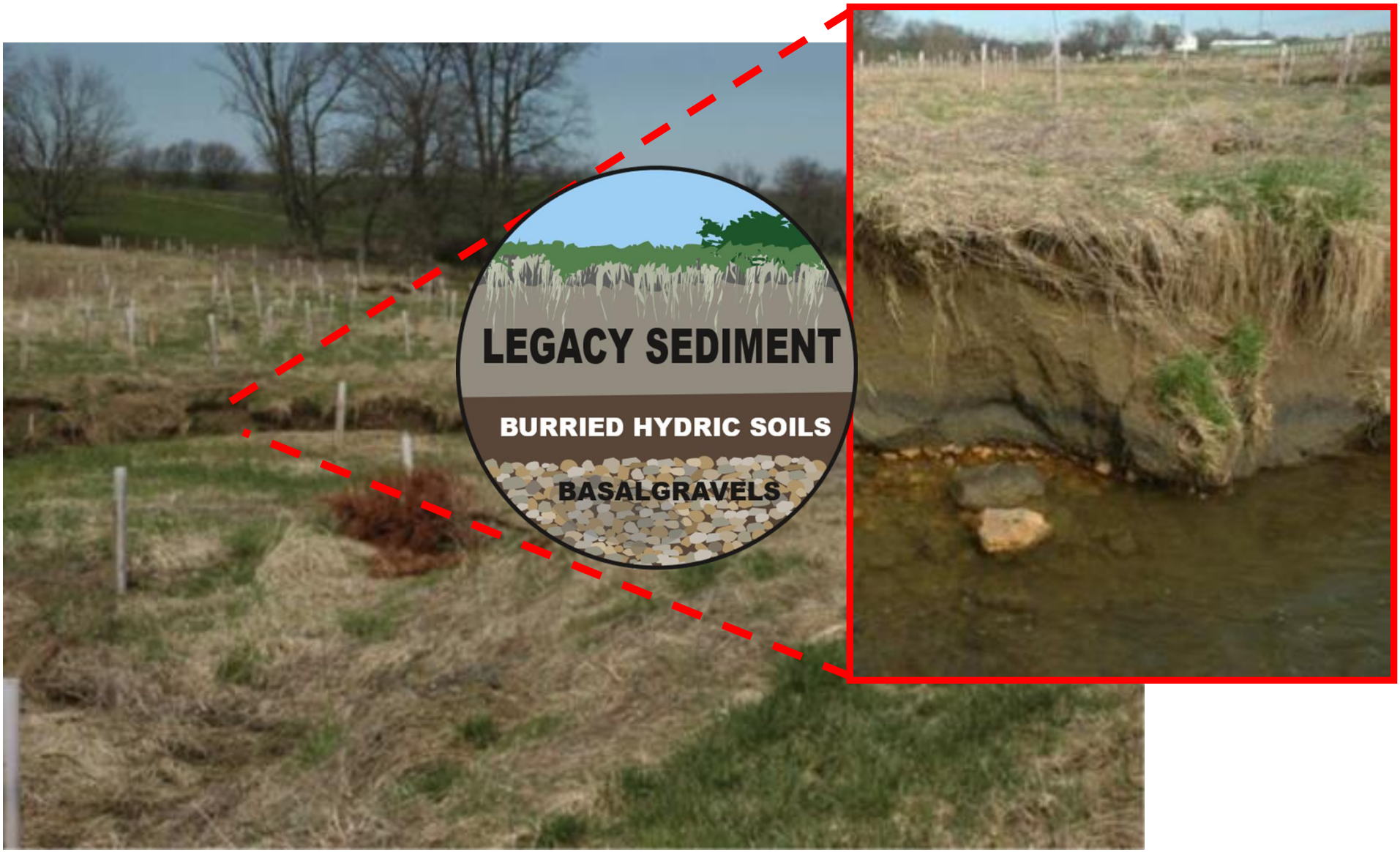
Annual sediment collection
35-40 per yer 2010-2016
Measurements of Total Carbon, Organic Matter, Total Nitrogen

Process Measurements
DEA in a Factorial design 4 treatments control, +C, +N, +CN
Nitrification

Estimated Nitrogen Loads



Big Spring Run pre-restoration in 2010.

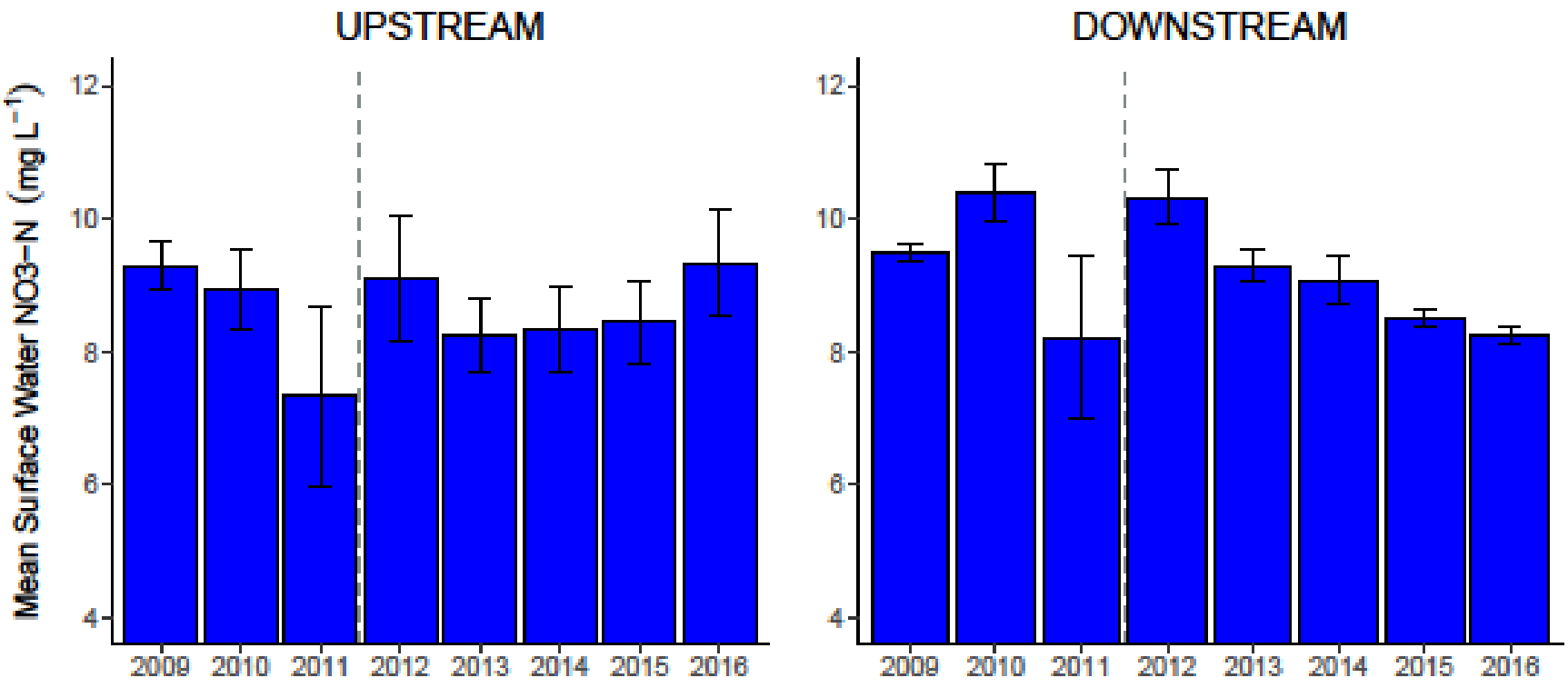


Sediment removal and stream reconstruction in 2011.

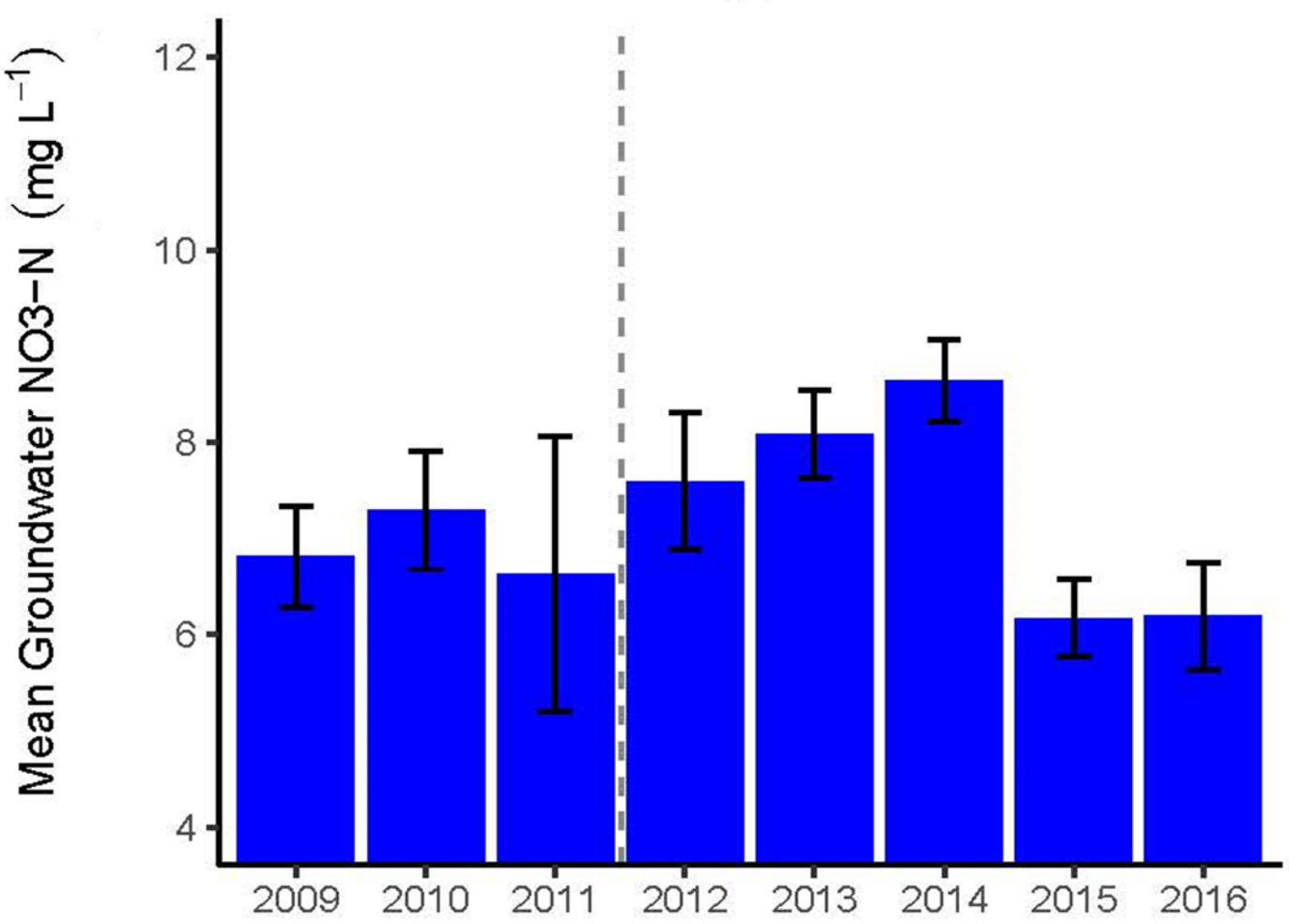
Vegetation was established by planting based on seed bank 2011- 2012.

June 2015

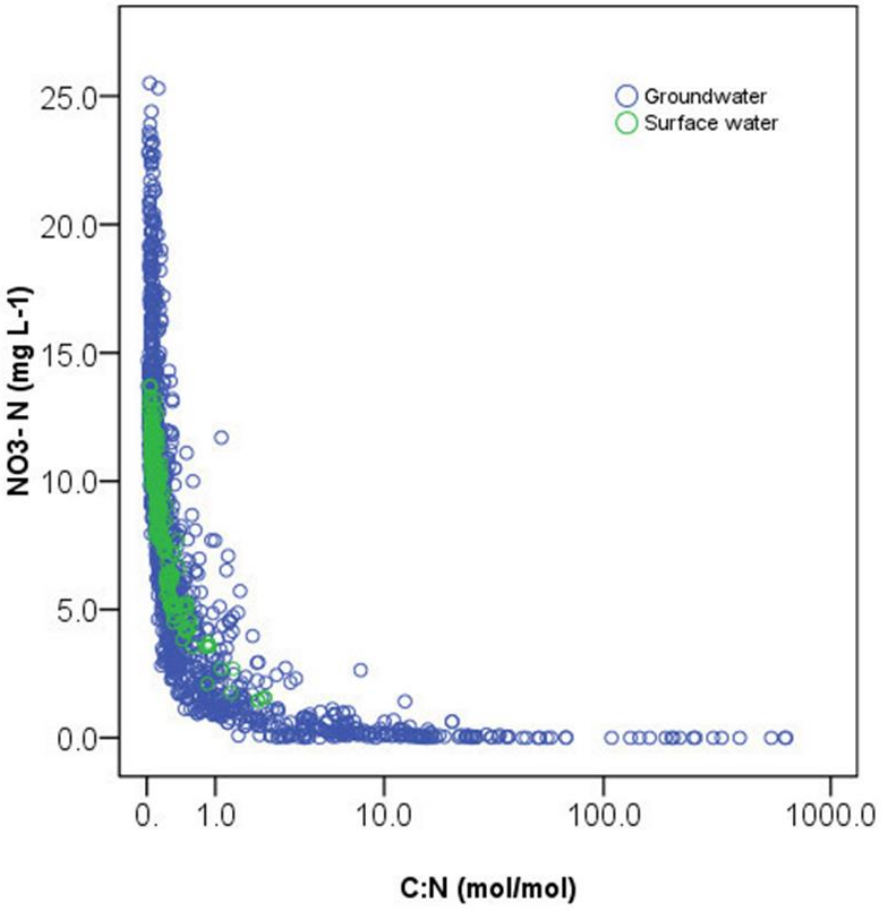
Surface water nitrate decreased gradually.

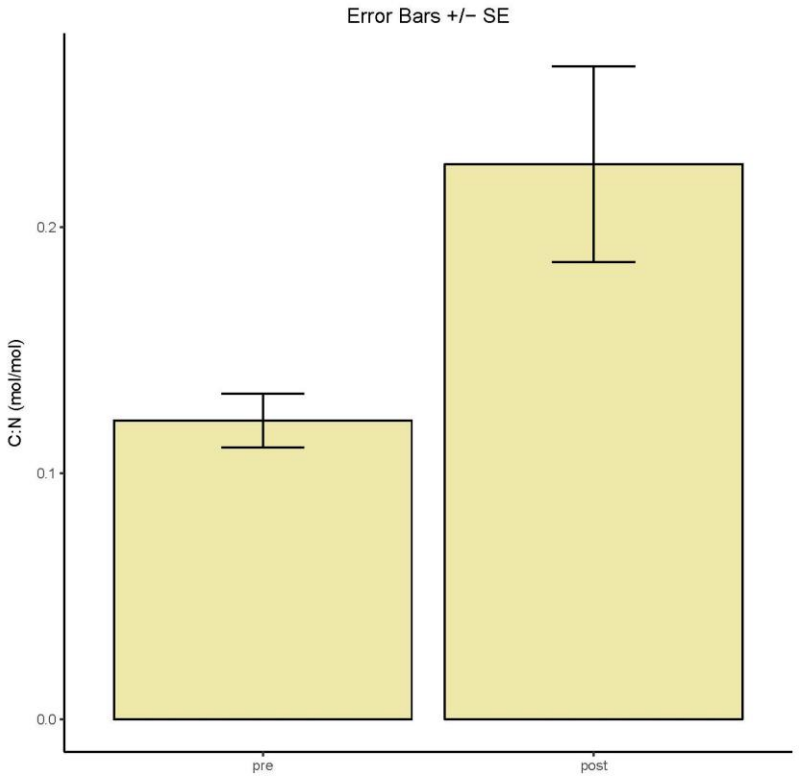


Groundwater nitrate decreased but it took four years after restoration.

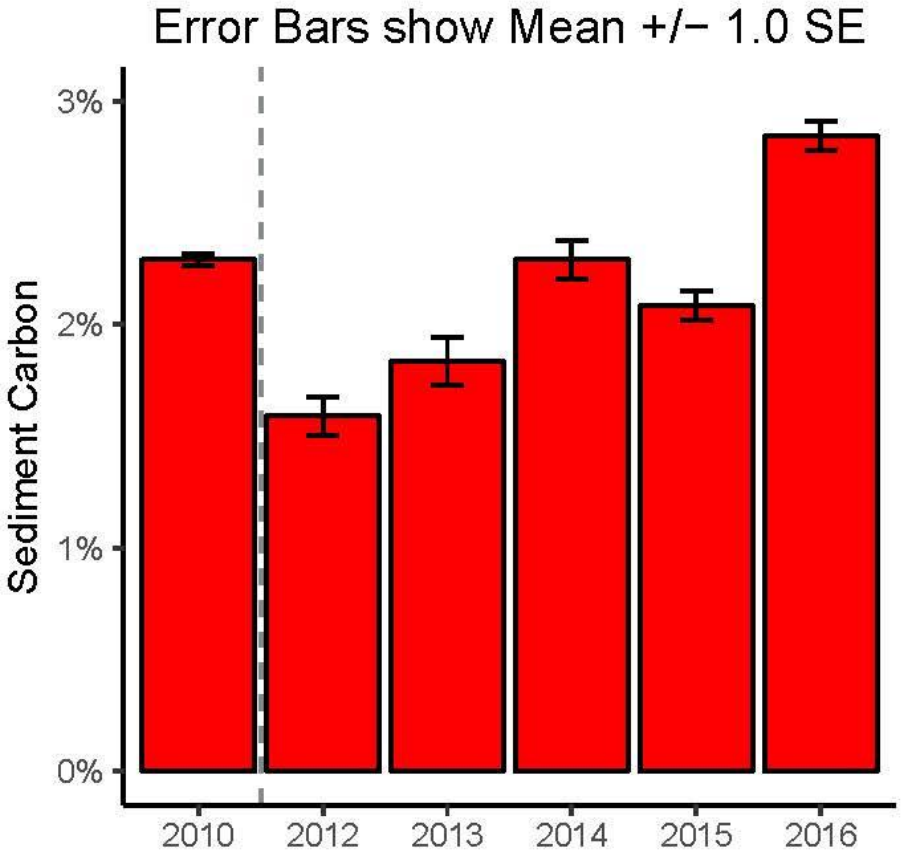


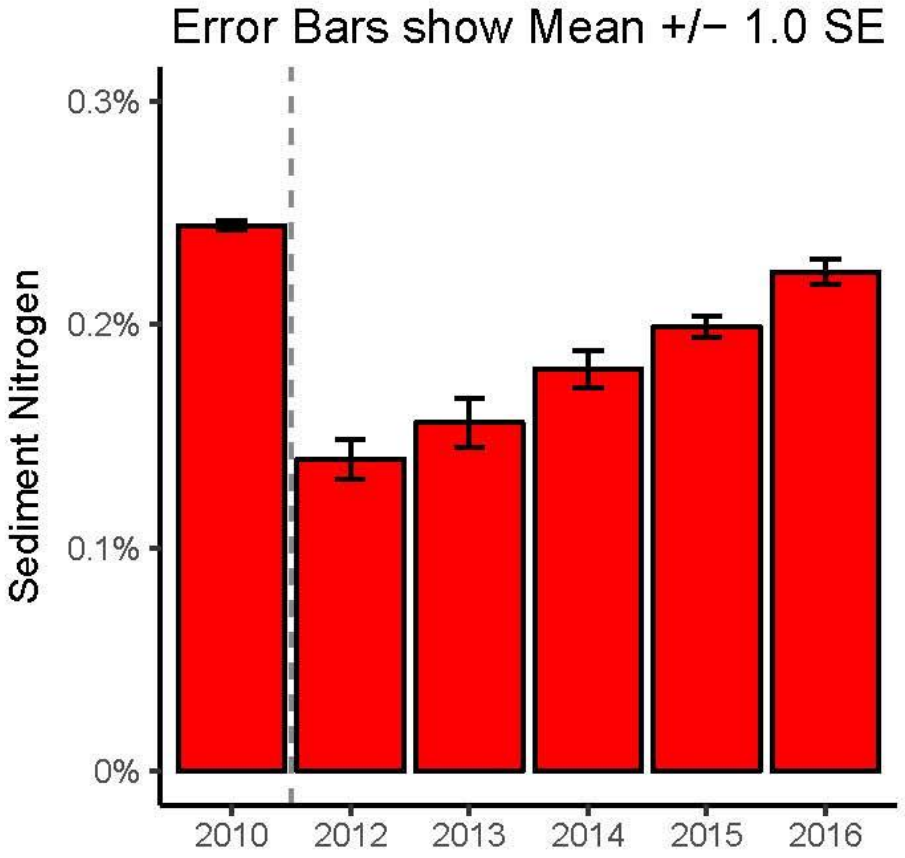
High C:N is a good indicator of nitrate reduction and GW connectivity.



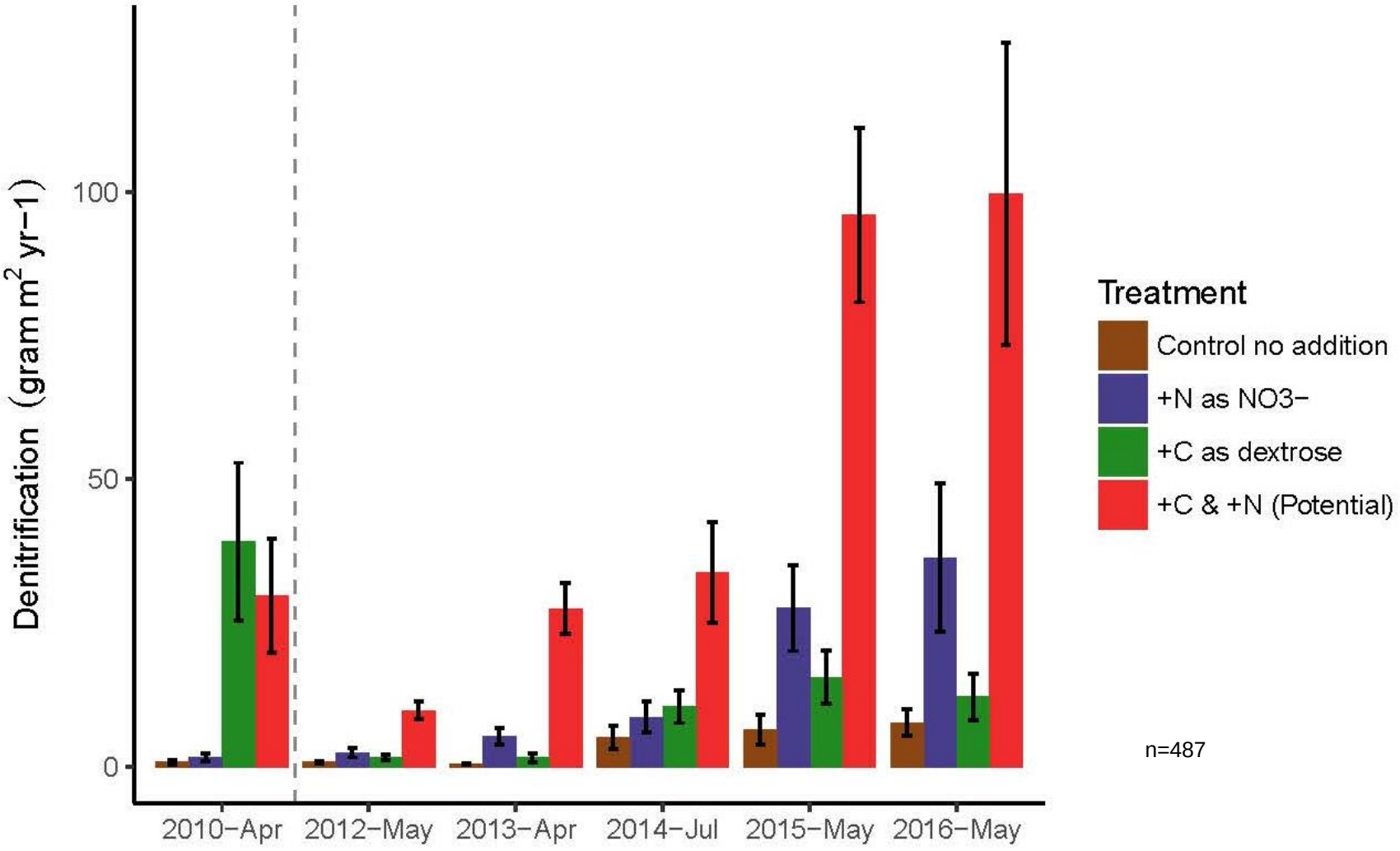


Sediment C and N recovered.

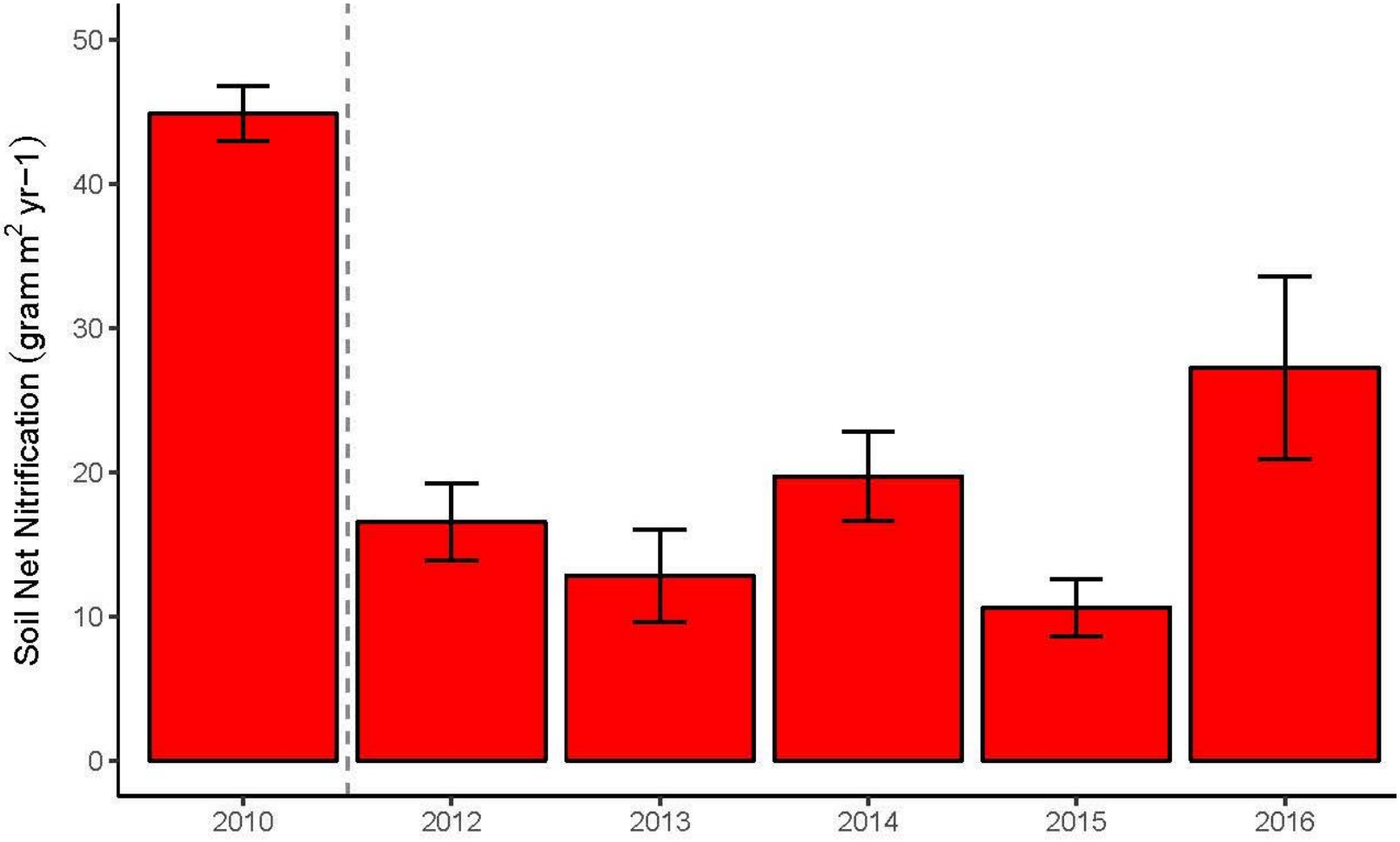




Sediment processing rates changed dramatically and DeN switched from C to N limited.

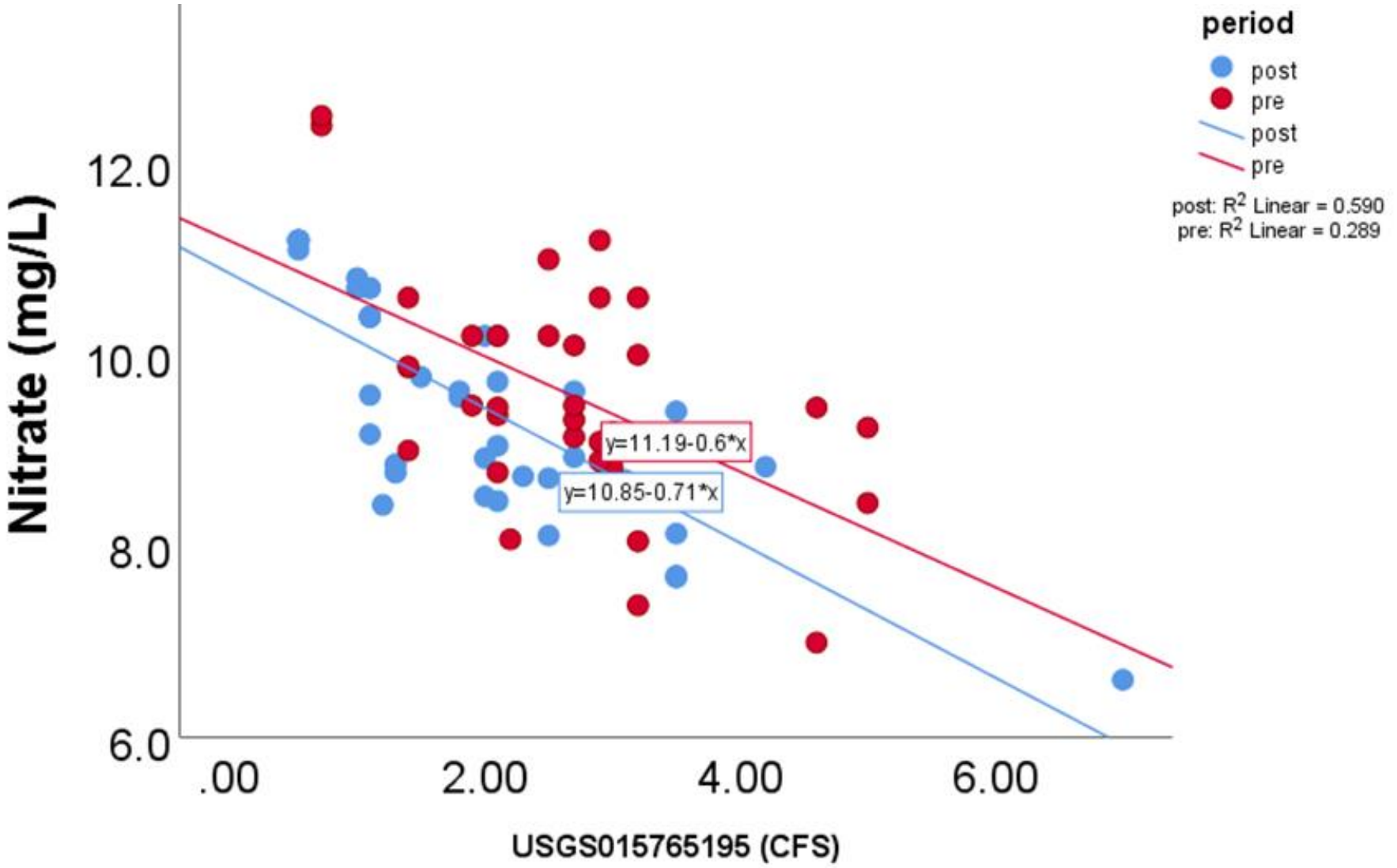


Nitrification decreased.



n=471

How much load reduction do we expect Downstream?



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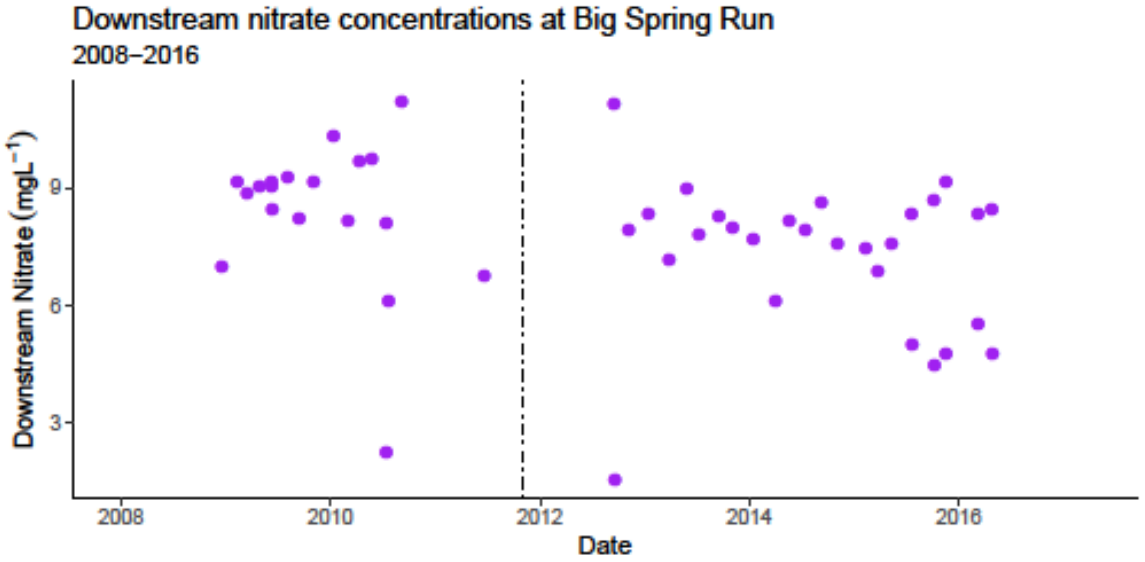
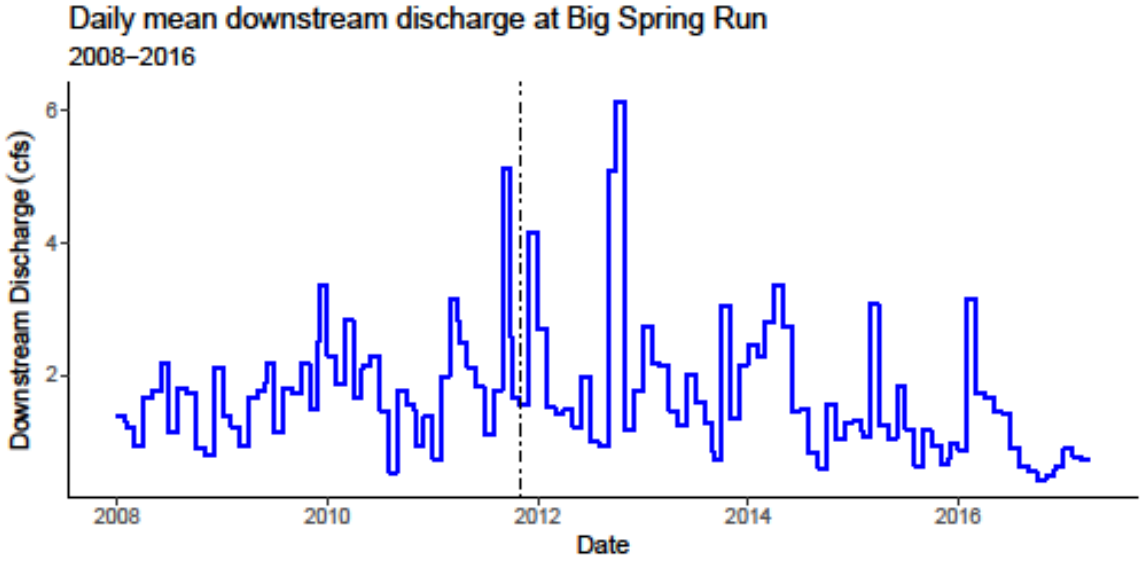


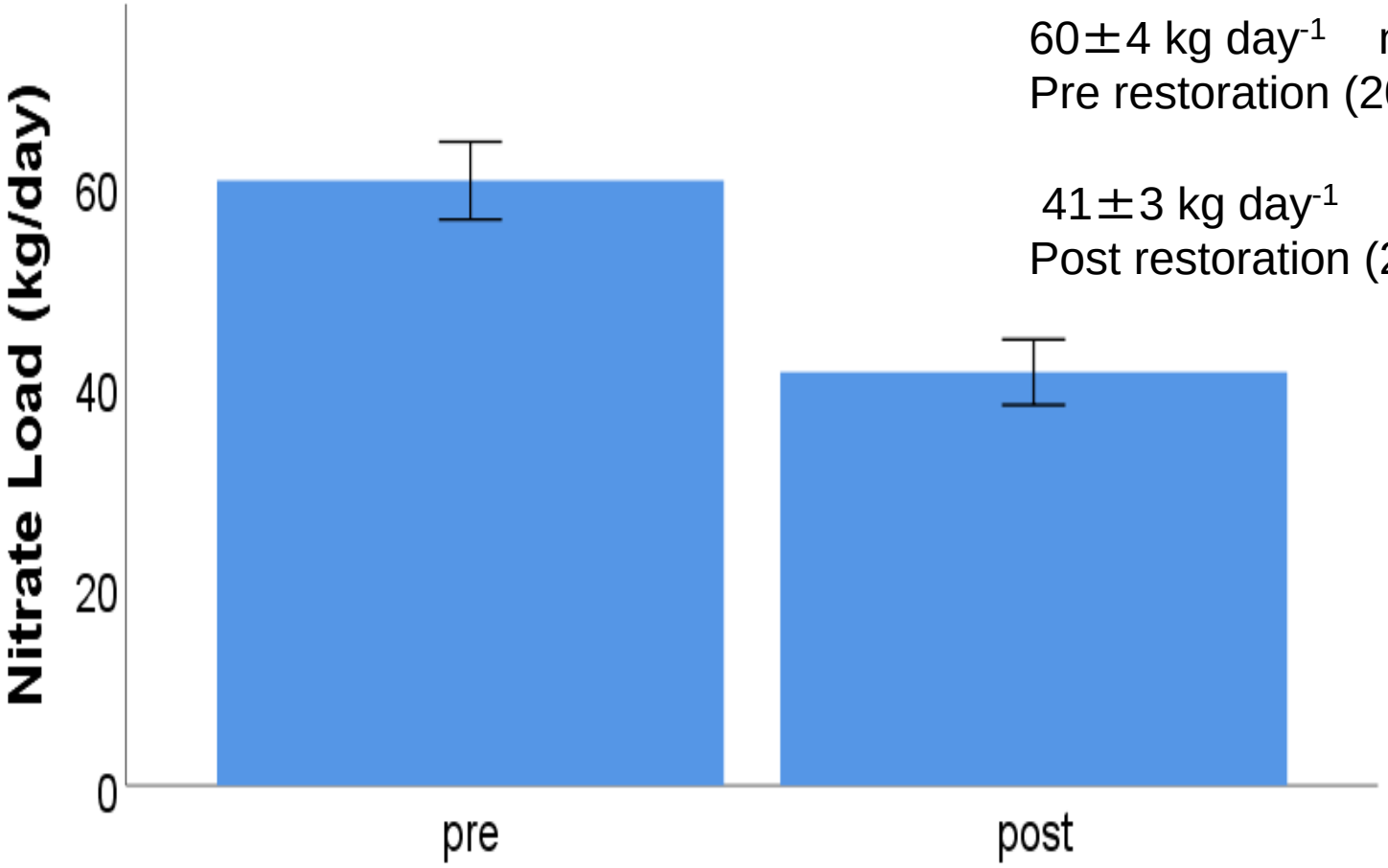


Surface Water Downstream
9.3 mg L^{-1} Pre
7.7 mg L^{-1} Post

USGS# 015765195

Post restoration loads are smaller.

Load = [NO3] x Mean Daily Discharge



60±4 kg day^{-1} n=33
Pre restoration (2008-2011)

41±3 kg day^{-1} n=44
Post restoration (2012-2016)

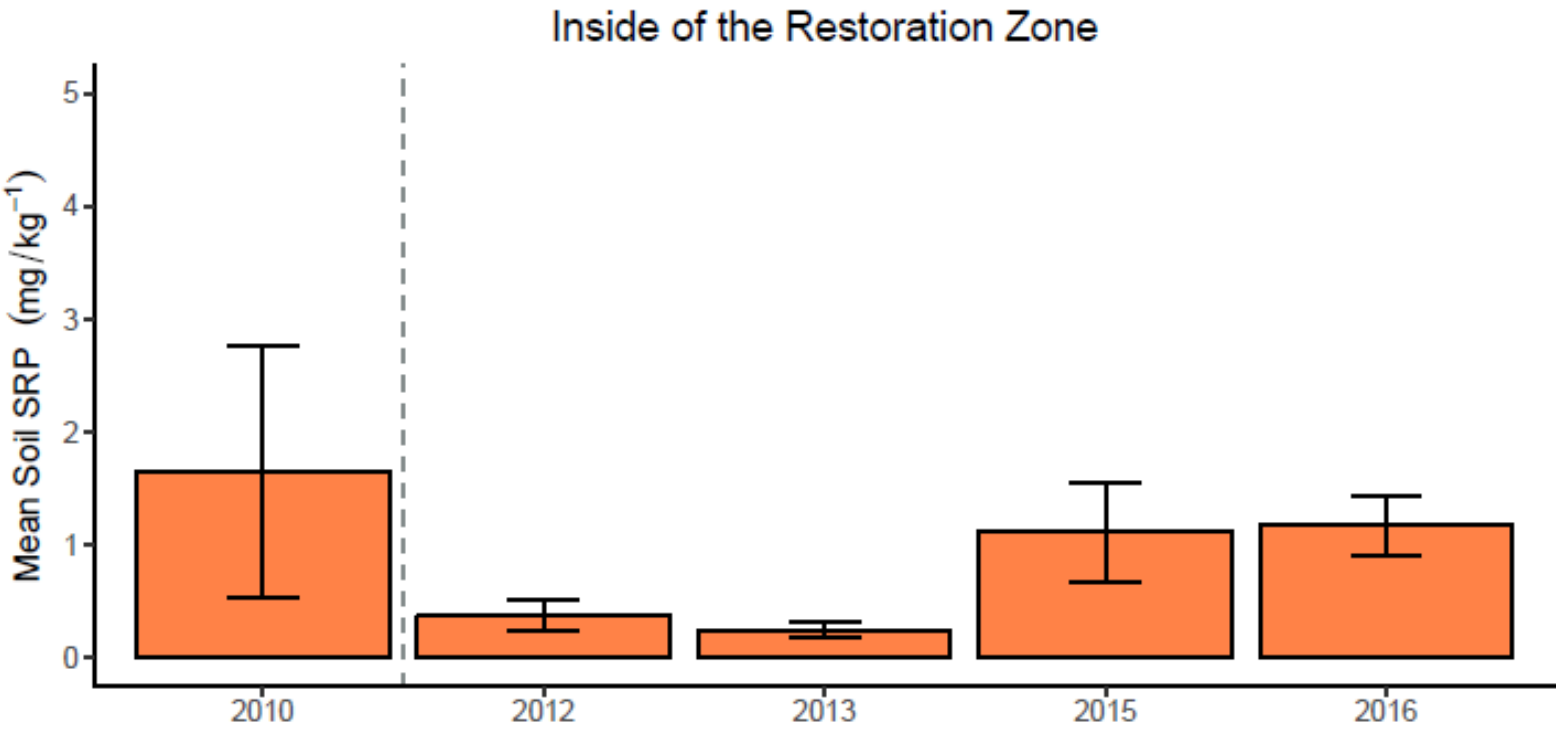
$p<0.001$ df = 76

What about P?

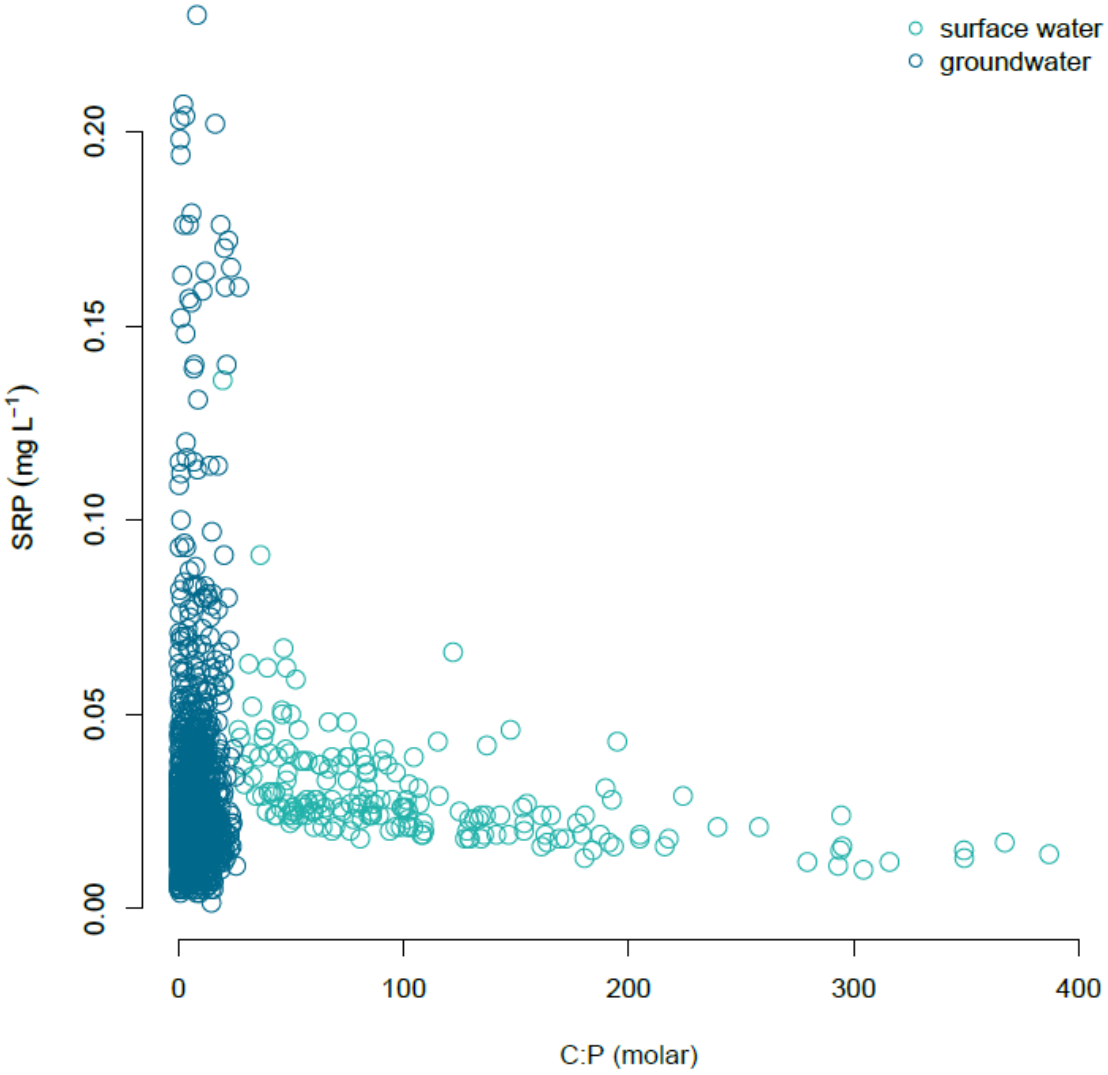
- We expect soluble reactive P to be retained quickly.

- Potential release of P due to increased org C.

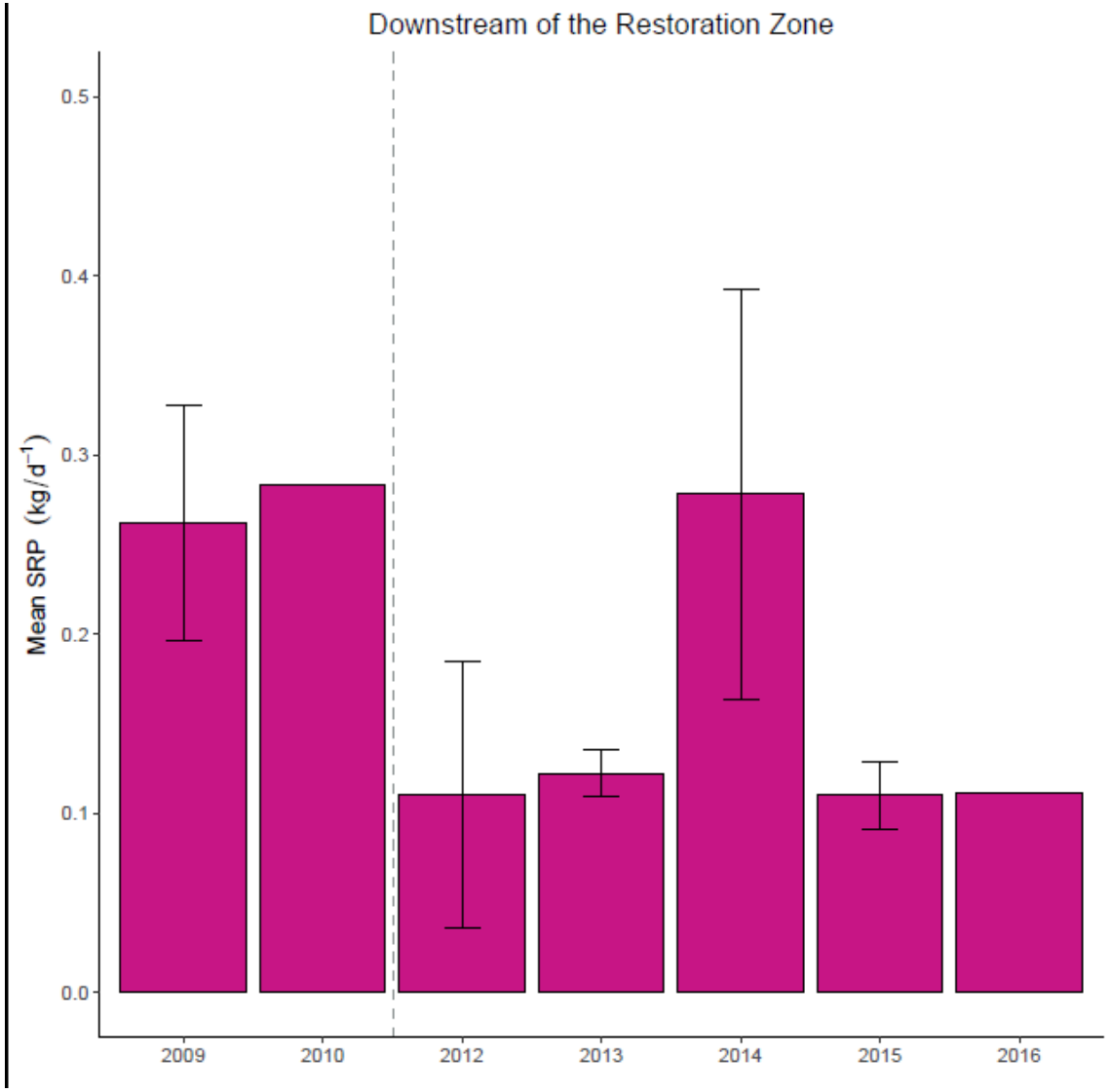
Soil extractable P is lower.



Dissolved P is related to Org. C in surface water.



Downstream dissolved P is lower post restoration.

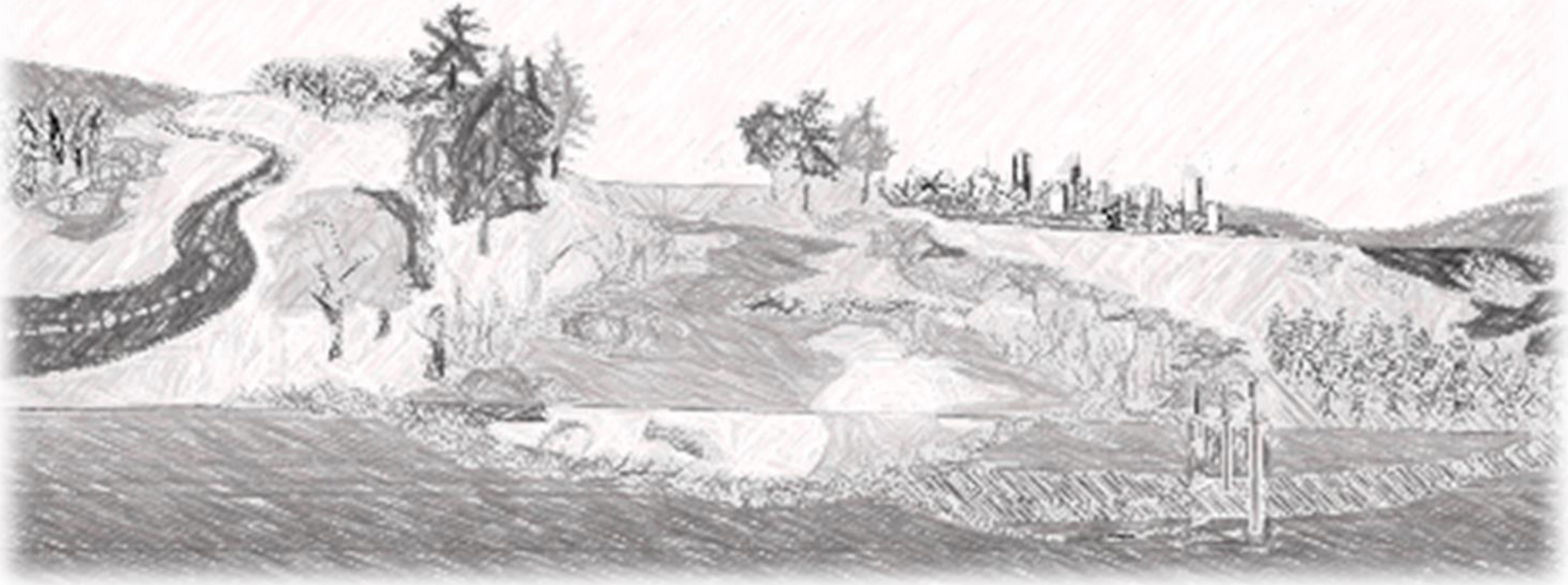


Conclusions

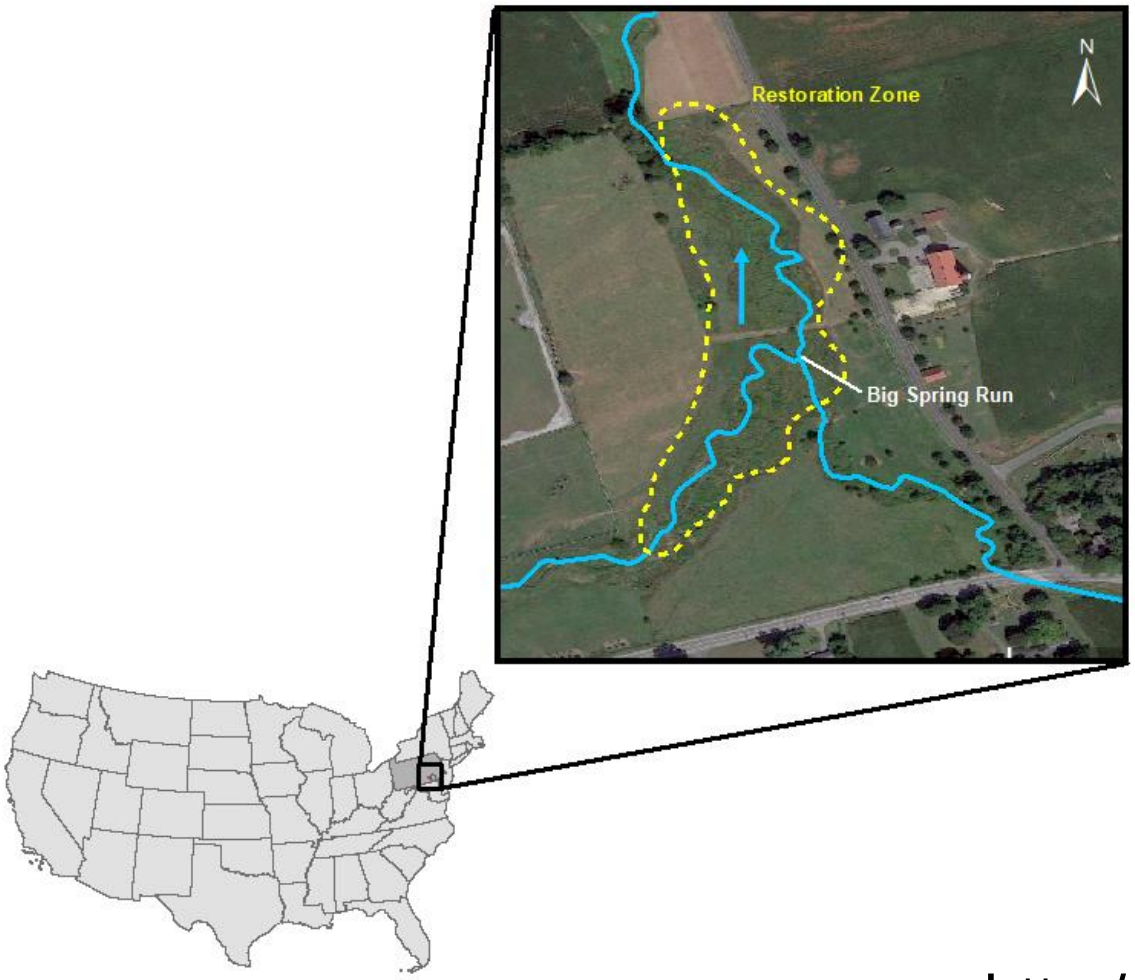
- Legacy Sediment Removal Improves N Retention BUT it takes a few years.
- Nitrate retention is driven primarily by enhancement of organic carbon and subsequent biogeochemistry.
- It works for N and P… at Big Spring Run

Thank you.

R. Neil, M. White, L. Callaway, K. Jewell, K. Hargrove, ERAP students, D. Burden,, R3, Land Studies, Marja Copeland, PA DEP, J. Hartranft, USGS, Dan Galeone, Stacey Sosenko, M.Rahnis, GWERD Staff, J.Koval, and many others.



Big Spring Run is a restored tributary to the Conestoga that eventually flows into the Chesapeake Bay.



http://www.bsr-project.org/


Big Spring Run 2016
Google earth
N
60 m

2013.

Jun 2014

Sediment organic matter increased.