Canopy complexity and chronic nitrogen amendments constrain the primary production of a Mid-Atlantic forest: A long-term study at the nexus of environmental and ecological change

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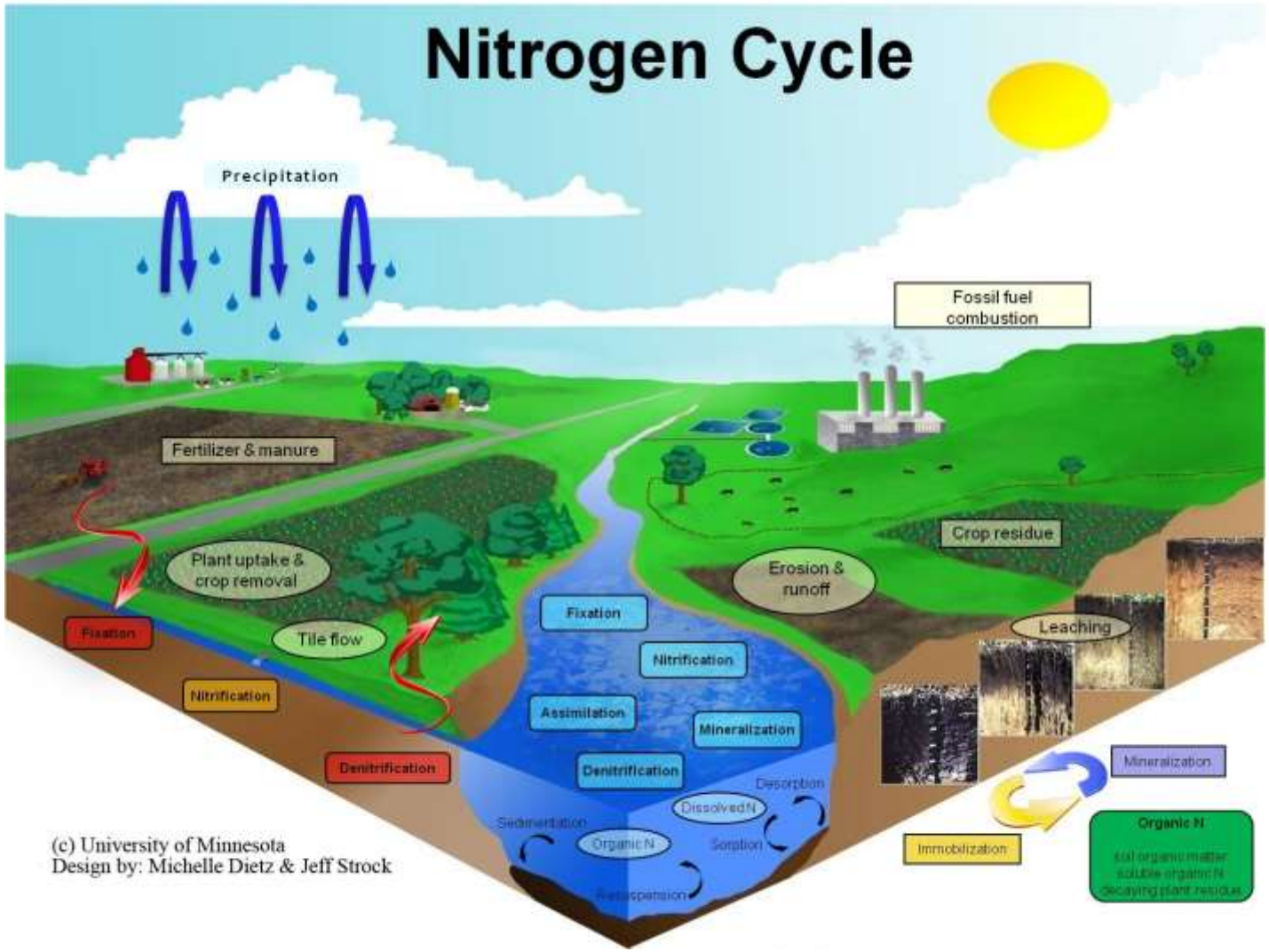
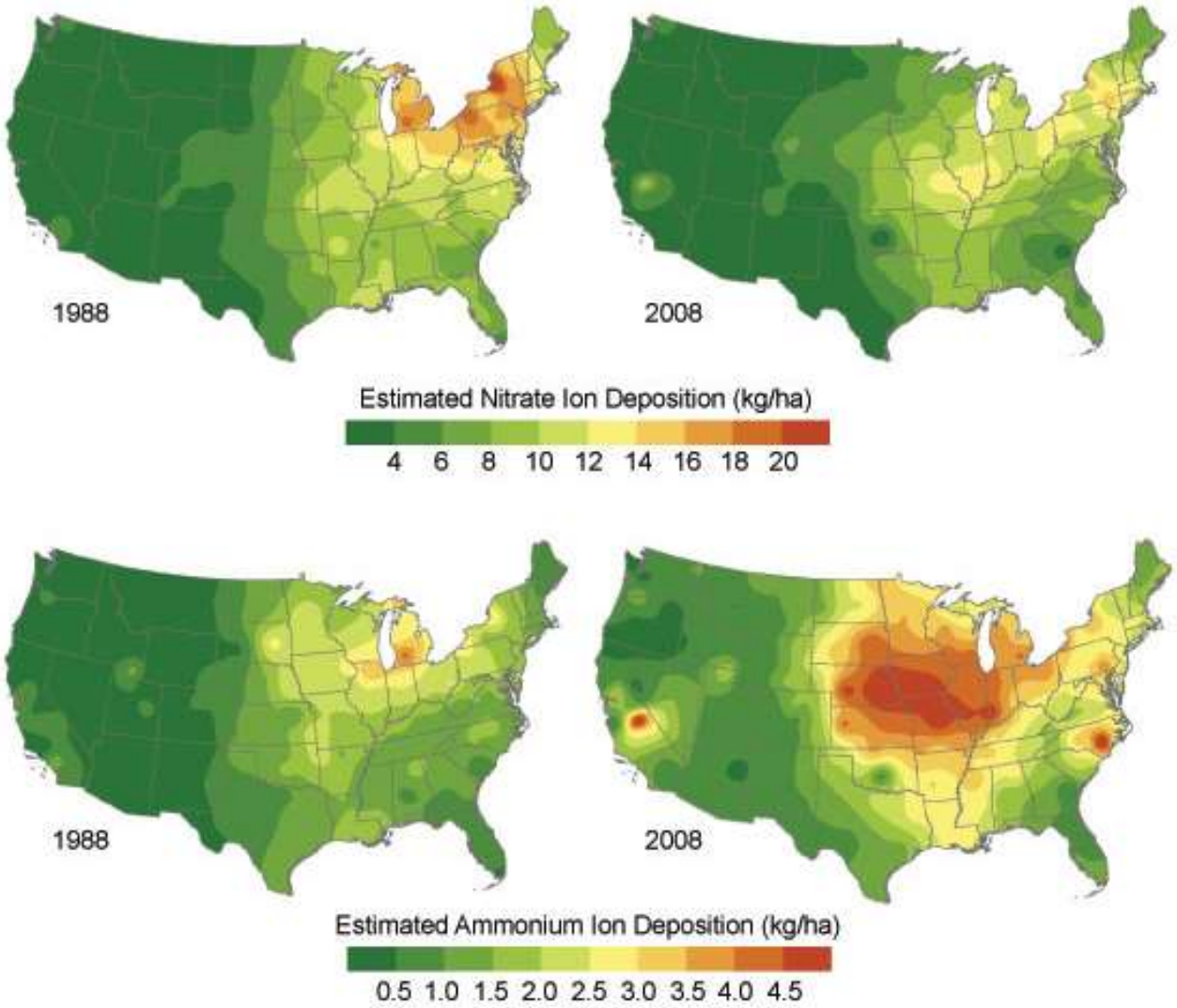

Nitrogen Cycle
Precipitation
Fossil fuel combustion
Fertilizer & manure
Plant uptake & crop removal
Crop residue
Erosion & runoff
Fixation
Tile flow
Nitrification
Denitrification
Fixation
Nitrification
Assimilation
Mineralization
Denitrification
Desorption
Dissolved N
Sedimentation
Organic N
Sorption
Resuspension
Leaching
Mineralization
Immobilization
Organic N
(c) University of Minnesota
Design by: Michelle Dietz & Jeff Strock


1988
2008
Estimated Nitrate Ion Deposition (kg/ha)
4 6 8 10 12 14 16 18 20
1988
2008
Estimated Ammonium Ion Deposition (kg/ha)
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

Nitrogen deposition makes a minor contribution to carbon sequestration in temperate forests

Knute J. Nadelhoffer*, Bridget A. Emmett†, Per Gundersen‡, O. Janne Kjønaas§, Chris J. Koopmans‖, Patrick Schleppi¶, Albert Tietema‖ & Richard F. Wright#

nature Vol 447|14 June 2007|doi:10.1038/nature05847

LETTERS

The human footprint in the carbon cycle of temperate and boreal forests

Federico Magnani[1], Maurizio Mencuccini[2], Marco Borghetti[3], Paul Berbigier[4], Frank Berninger[5], Sylvain Delzon[4], Achim Grelle[6], Pertti Hari[7], Paul G. Jarvis[2], Pasi Kolari[7], Andrew S. Kowalski[4], Harry Lankreijer[8], Beverly E. Law[9], Anders Lindroth[8], Denis Loustau[4], Giovanni Manca[10]†, John B. Moncrieff[2], Mark Rayment[2], Vanessa Tedeschi[3], Riccardo Valentini[10] & John Grace[2]

Controls on Annual Forest Carbon Storage: Lessons from the Past and Predictions for the Future

CHRISTOPHER M. GOUGH, CHRISTOPH S. VOGEL, HANS PETER SCHMID, AND PETER S. CURTIS

Is Nitrogen Deposition Altering the Nitrogen Status of Northeastern Forests?

JOHN D. ABER, CHRISTINE L. GOODALE, SCOTT V. OLLINGER, MARIE-LOUISE SMITH, ALISON H. MAGILL, MARY E. MARTIN, RICHARD A. HALLETT, AND JOHN L. STODDARD

Ecological Applications, 6(3), 1996, pp. 806–814

SPATIAL AND TEMPORAL PATTERNS IN TERRESTRIAL CARBON STORAGE DUE TO DEPOSITION OF FOSSIL FUEL NITROGEN[1]

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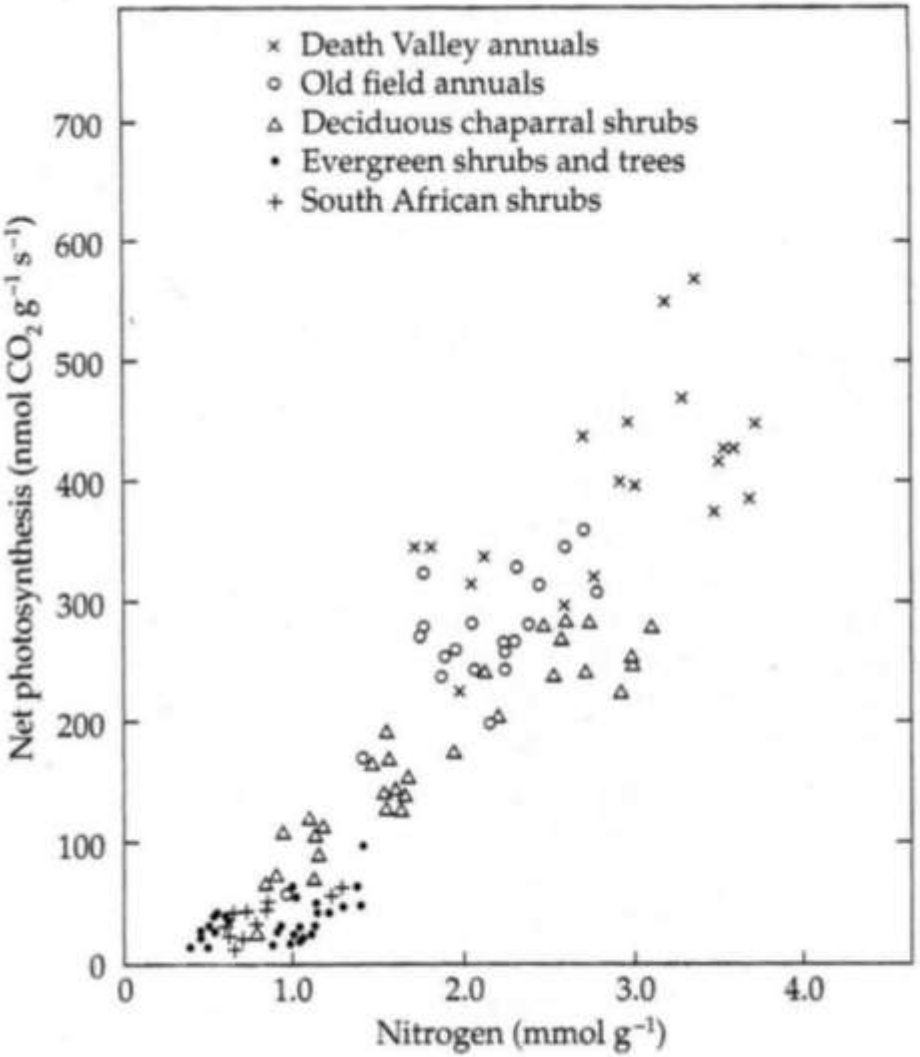


Figure 15-11 Maximum photosynthesis and nitrogen per unit leaf weight for 21 species grown under natural conditions. From Field and Mooney (1986).

↑Nitrogen = ↑NPP

Right?

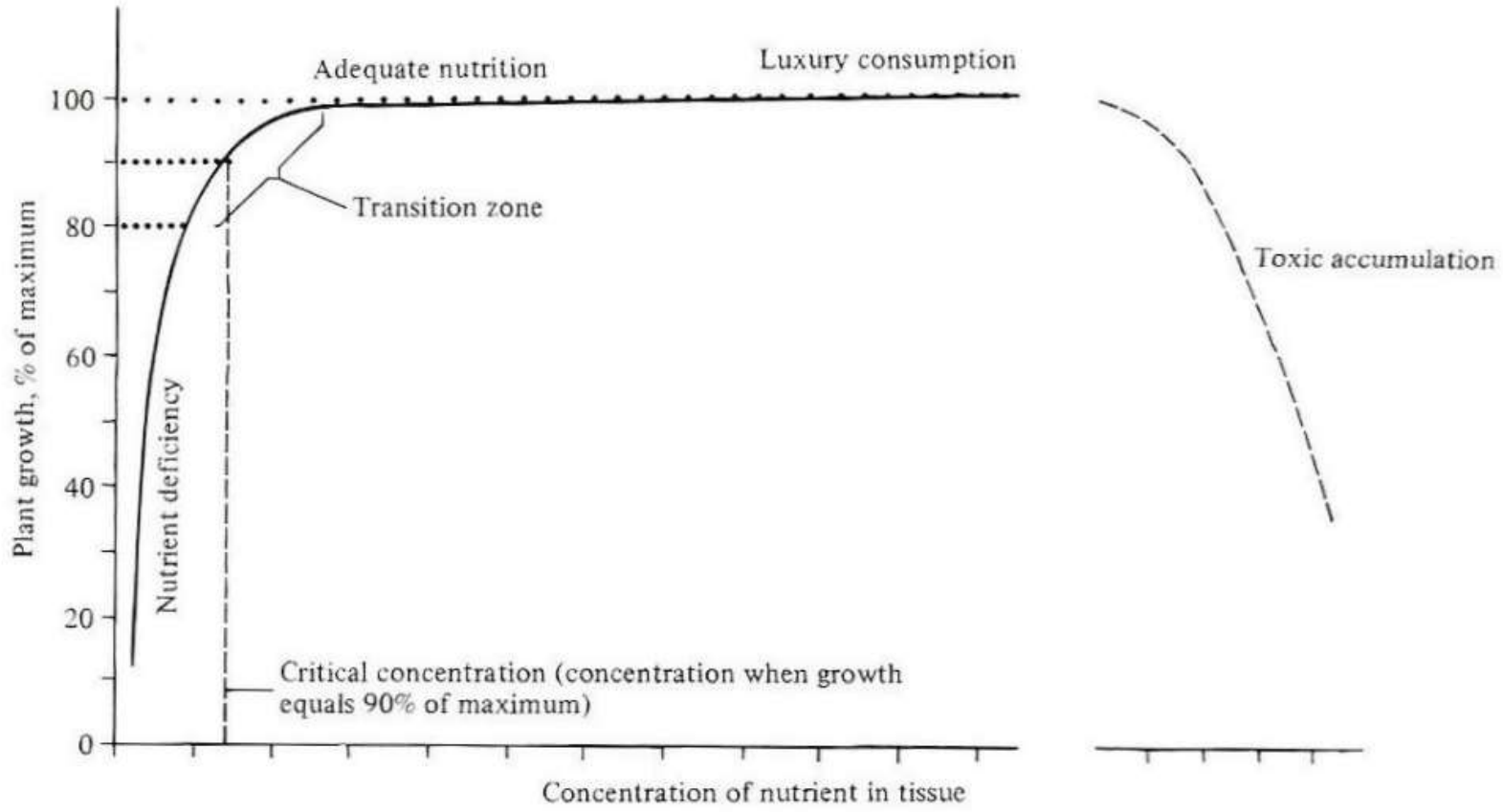
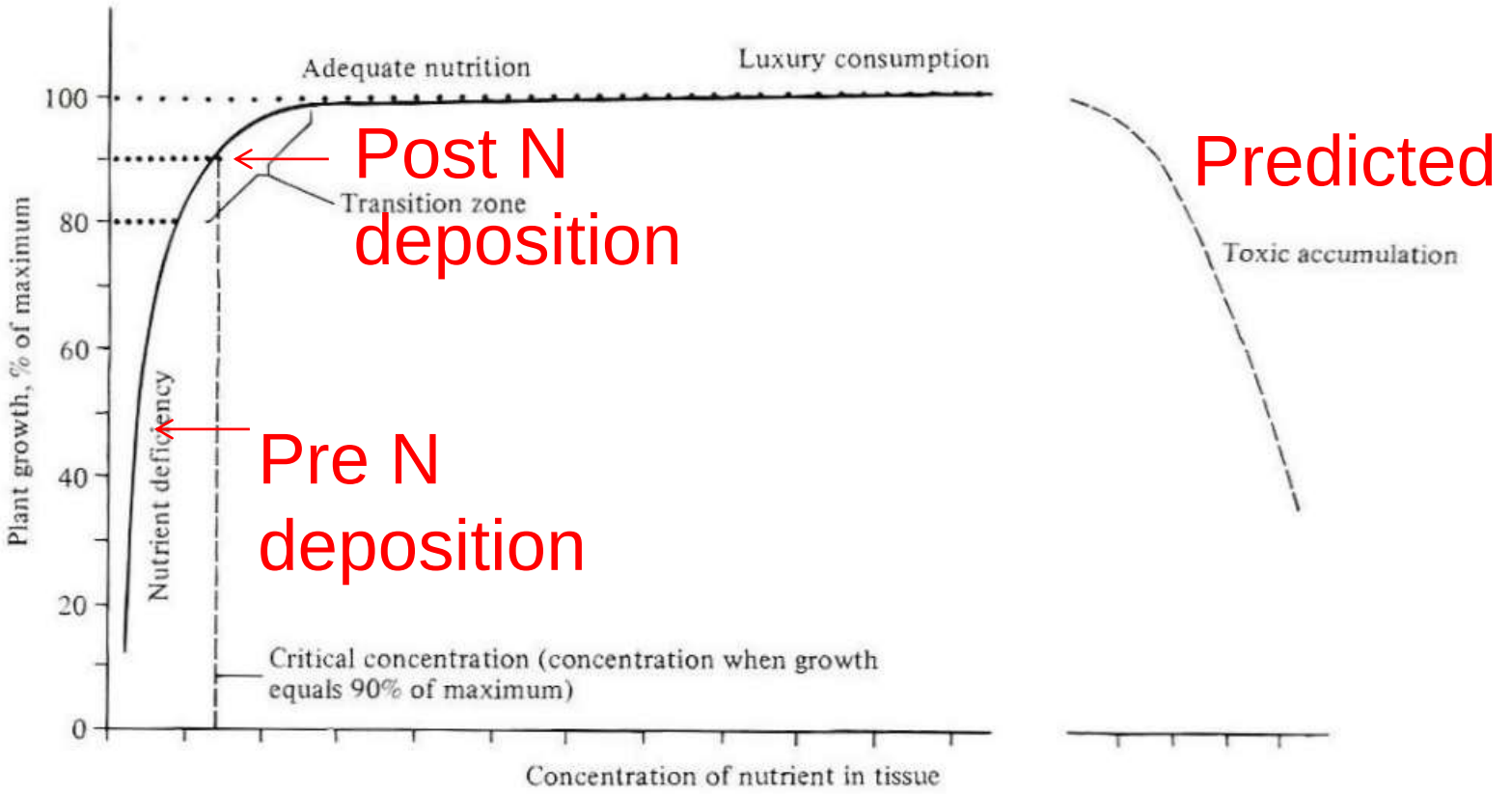


Figure 5.2 Relationship between the growth of a plant and the concentration of a nutrient in its tissue. (Modified after Ulrich and Hill, 1967.) If n addition of the nutrient increases plant growth but has little effect on the concentration of the nutrient in the plant, the plant is nutrient deficient. uch an addition results in little change in growth but an increase in concentration, the plant is adequately nourished. For an alternative method of ssessing plant nutrition, see Figure 10.13. (Reproduced by permission of Soil Science of America and A. Ulrich.)

Theoretical Nutrient Response Curve



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Theoretical Nutrient Response Curve


VIRGINIA
1 Richmond
2 Norfolk
3 Roanoke
4 Portsmouth
Natural Bridge
Luray Cave
POTATOES
POTATOES
SHENANDOAH
MTS
BLUE RIDGE
JAMES R.
POTOMAC R.
CHESAPEAKE BAY
WASHINGTON
COAL
WEST VIRGINIA
MARYLAND
NORTH CAROLINA
KENTUCKY
OHIO
1
2
3
4

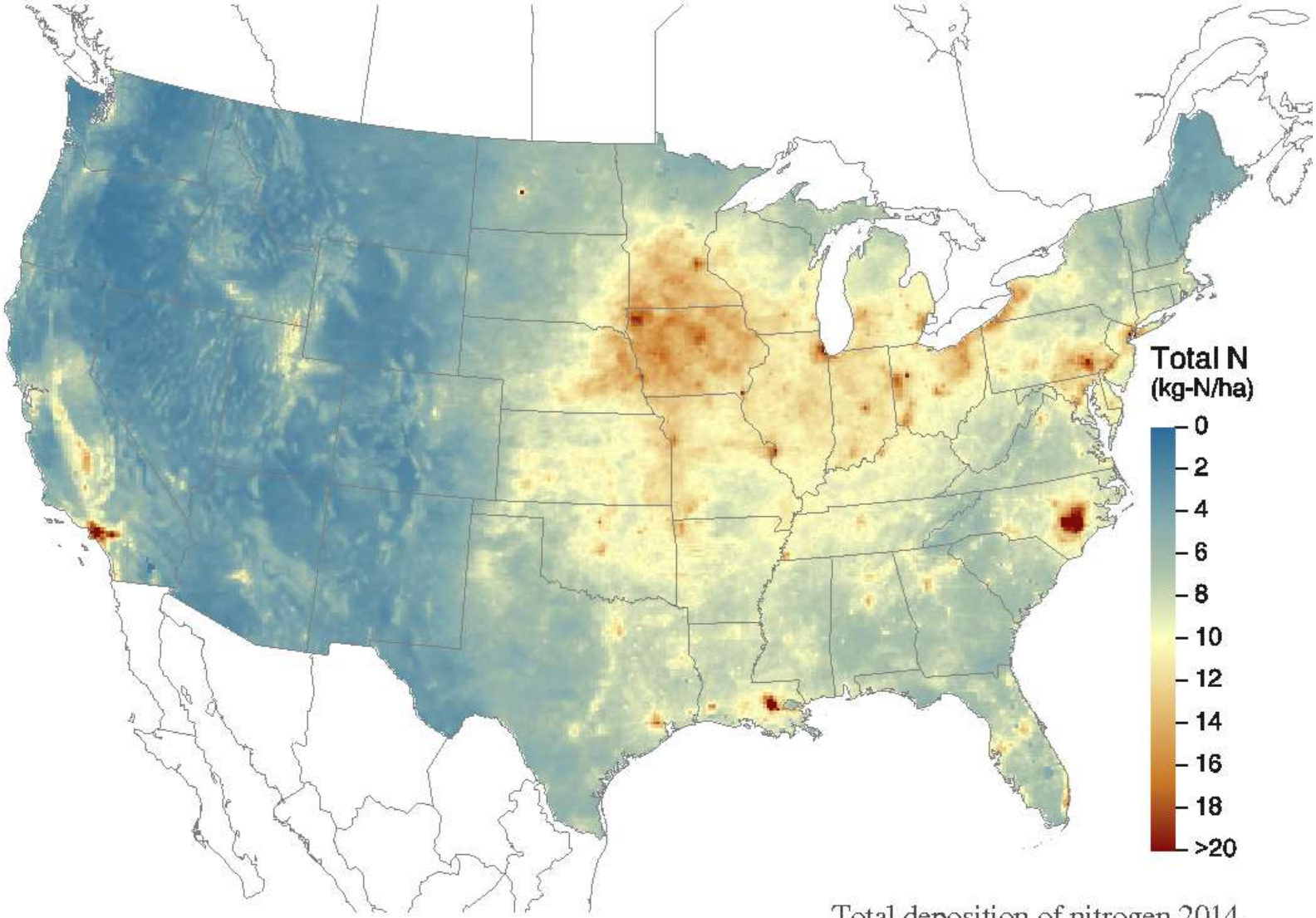

DGIF
RICE
A
VCU Rice Center

A multi-year study

- 10 total plots (4 at Rice, 6 at DGIF)
- Calculated change in biomass from 2010-2012, 2012-2014, and 2014-2015
- Data set includes DBH and species data for each tree in 2010, 2012, and 2014


Litter collection baskets


Waste water discharge as experimental
chronic nitrogen deposition treatments



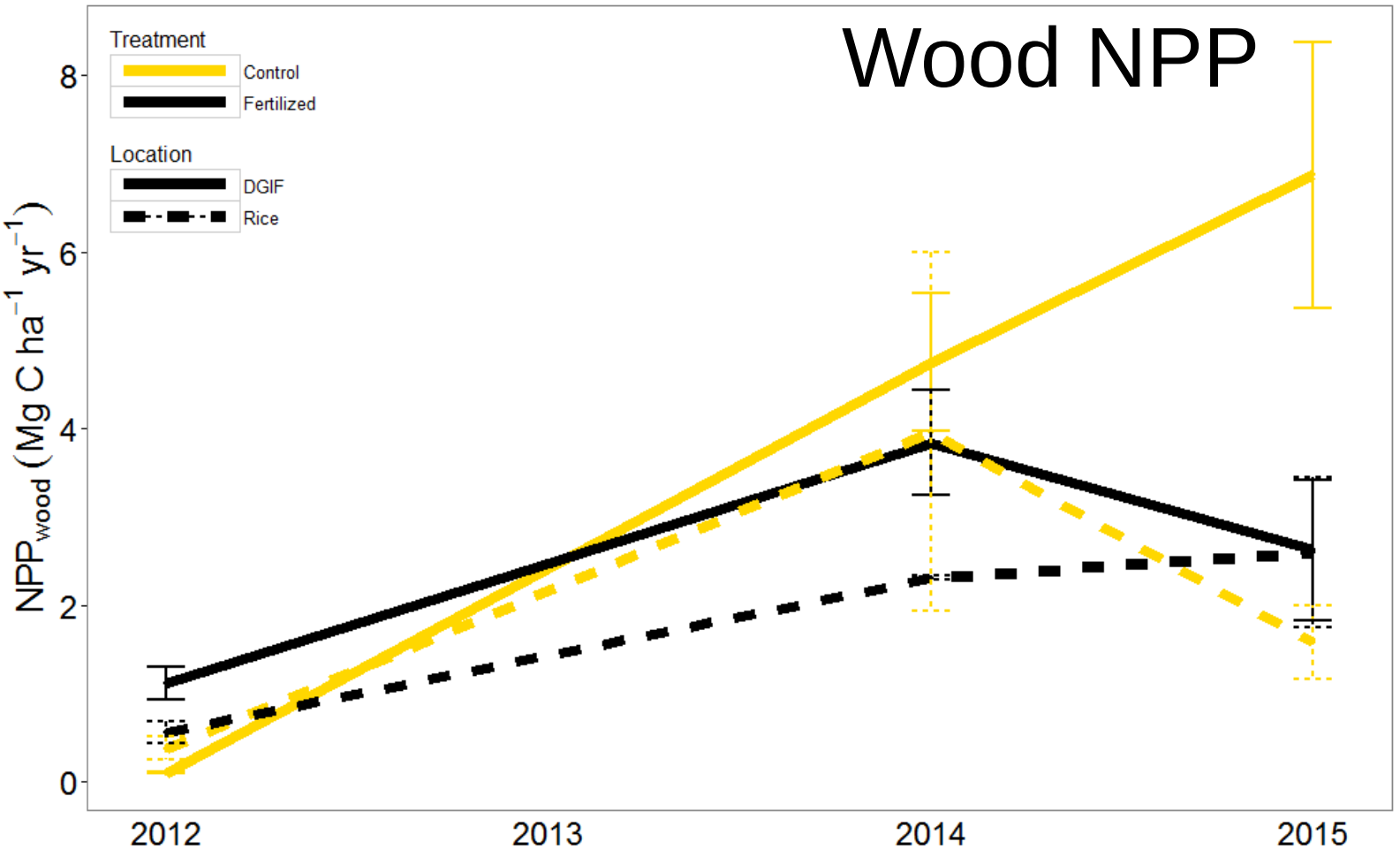
Total deposition of nitrogen 2014

Source: CASTNET/CMAQ/NTN/AMON/SEARCH

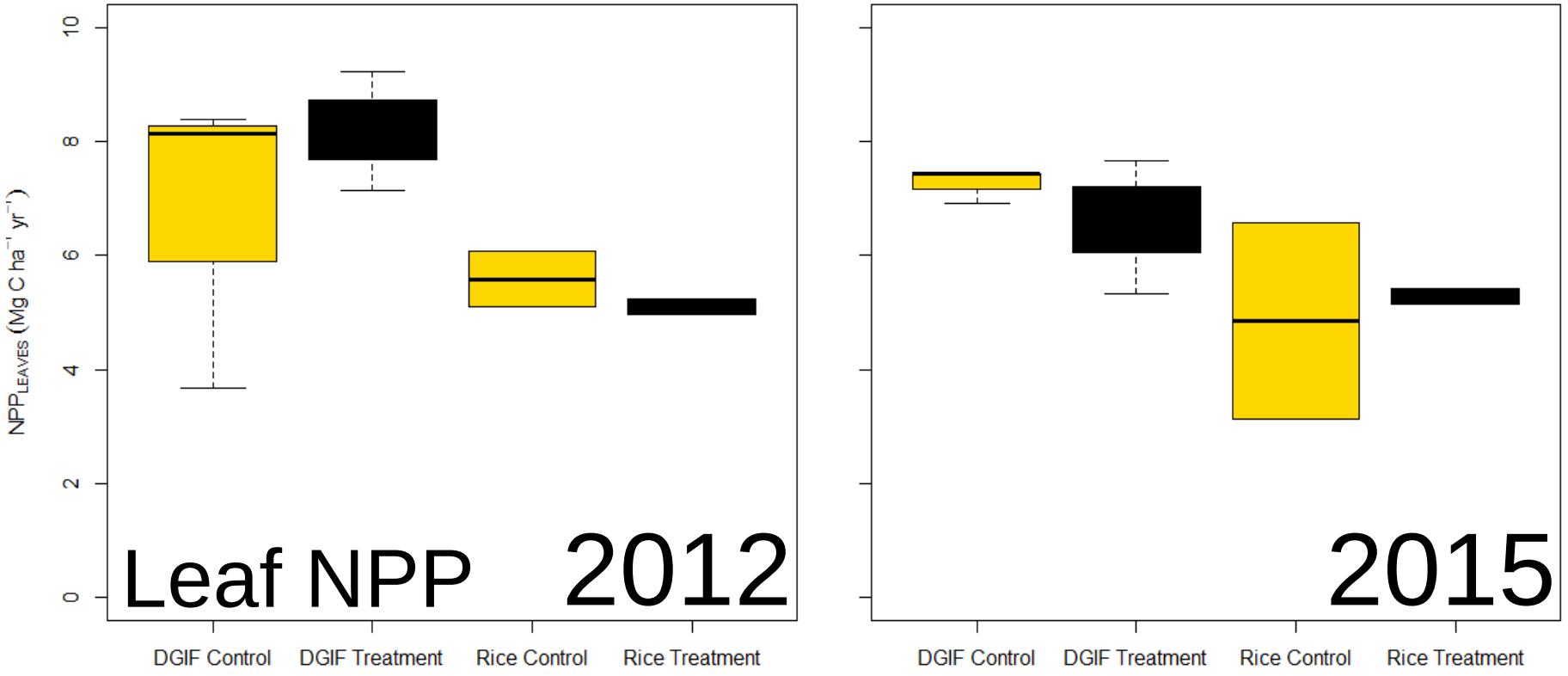
USEPA 06/27/16

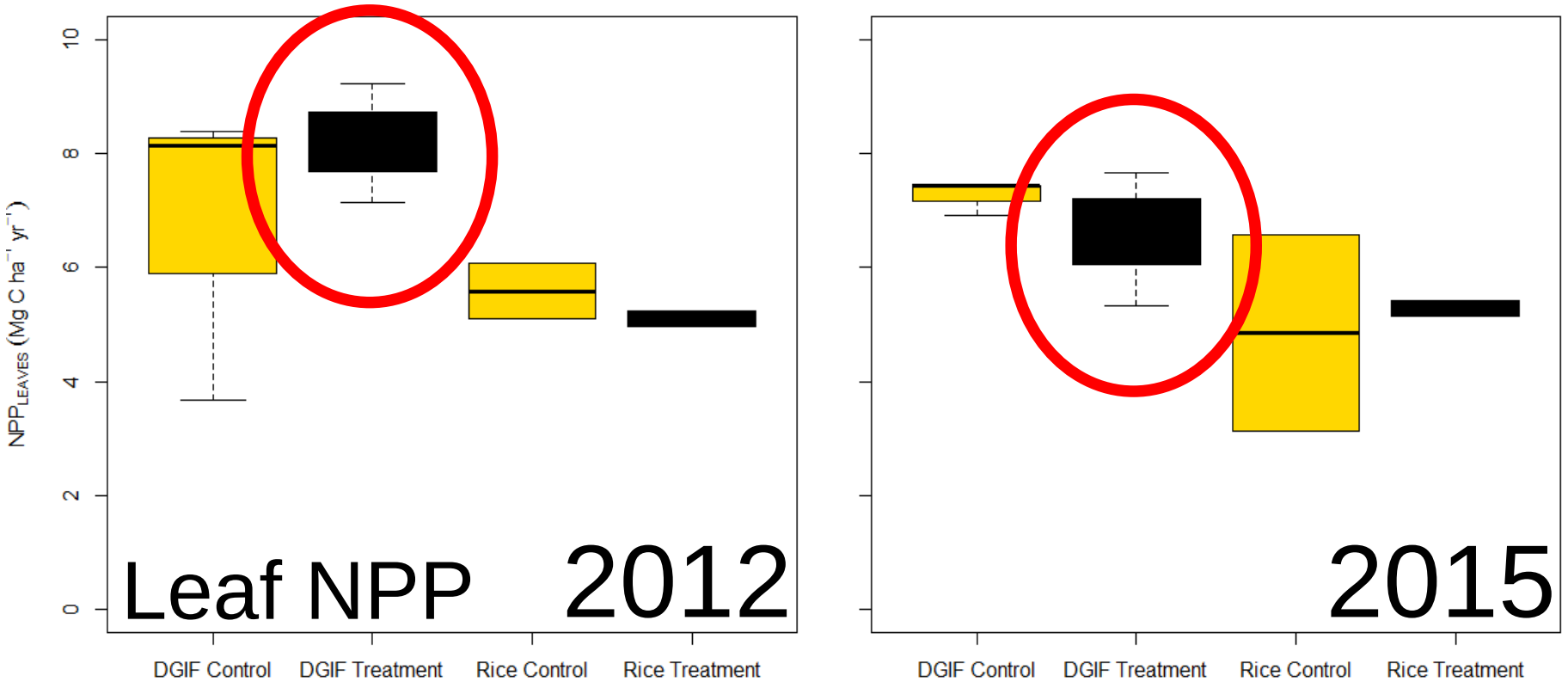

Lysimeters at 20 cm depth


Canopy structural complexity with portable canopy LiDAR (PCL)



*error bars denote standard error


NPP$_{LEAVES}$ (Mg C ha^{-1} yr^{-1})
0
2
4
6
8
10
Leaf NPP
2012
2015
DGIF Control
DGIF Treatment
Rice Control
Rice Treatment
DGIF Control
DGIF Treatment
Rice Control
Rice Treatment

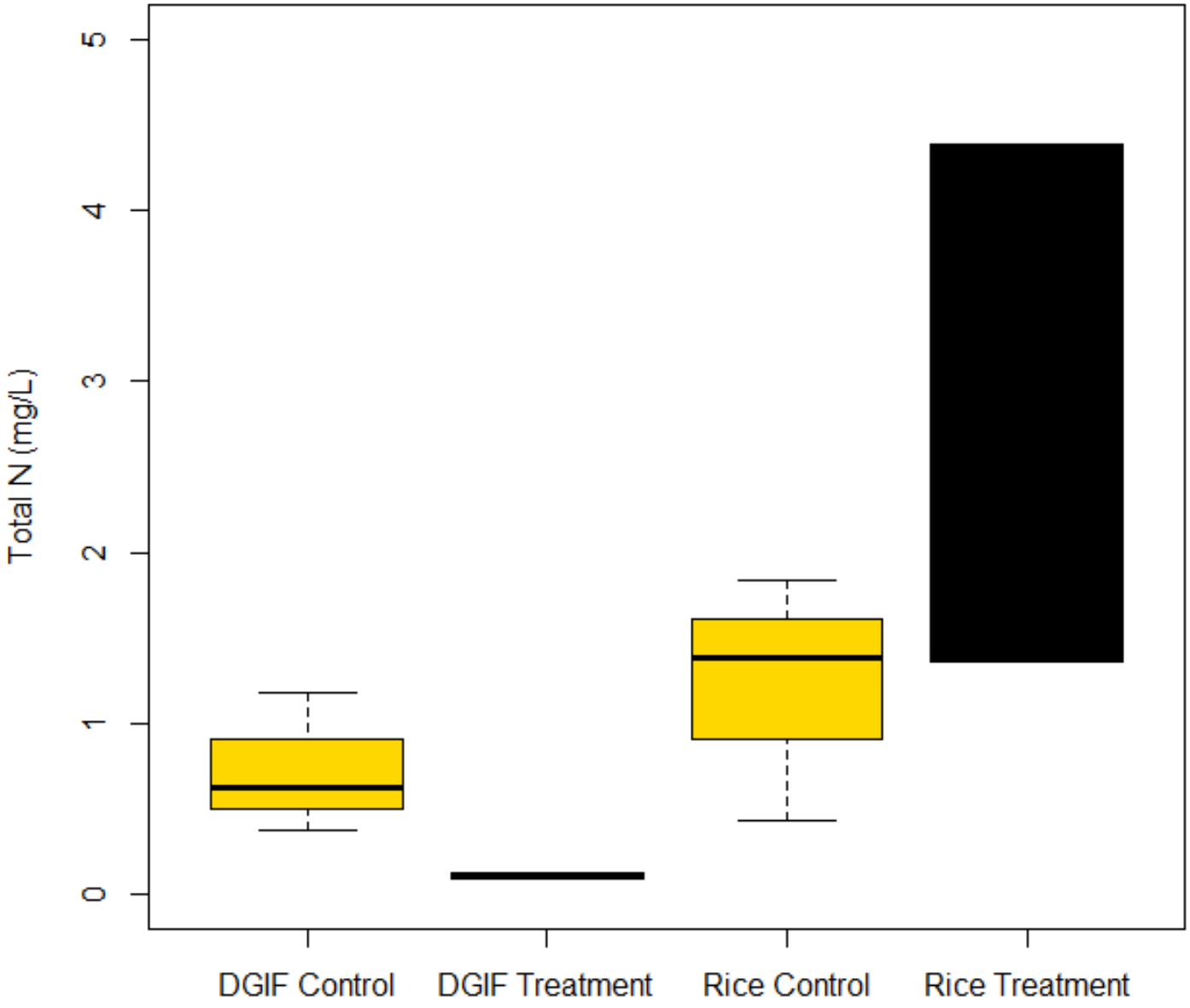


DGIF Treatment ↓

Species effects

Hickory, Poplar ↓

Oak, Pine ↑



Lysimeter data

- No differences in LAI or fPAR
- Light use efficiency (LUE) in treatments more than double that of control

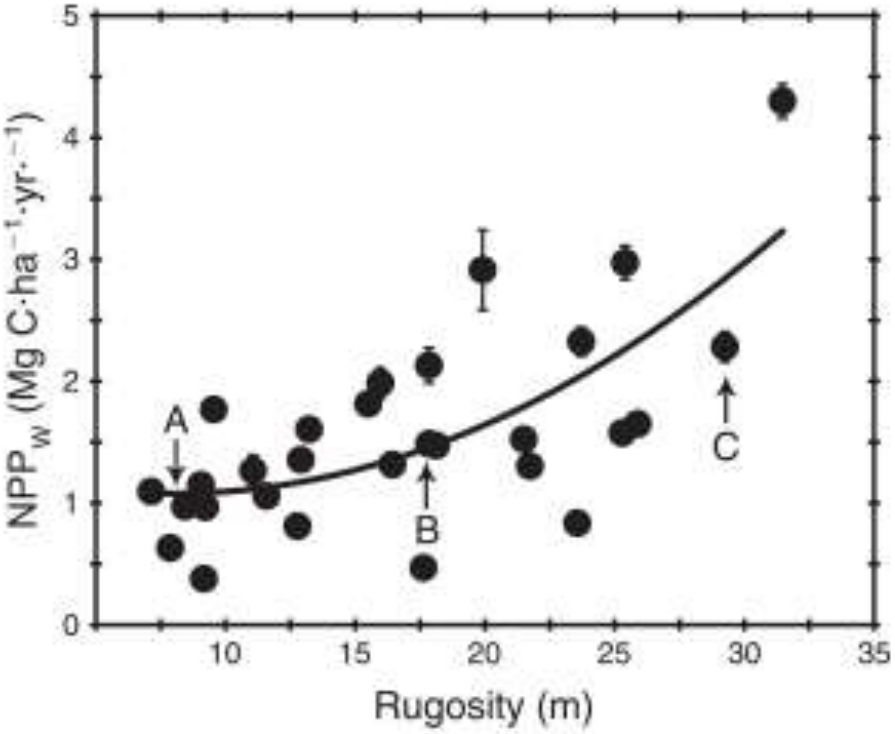
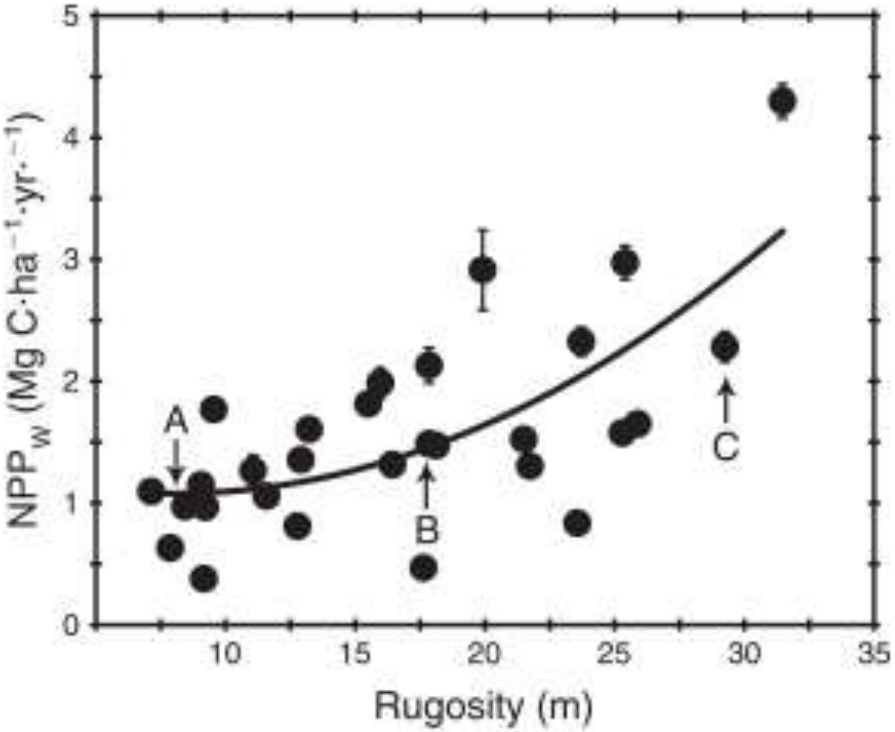


FIG. 3. The relationship between canopy rugosity and decadal wood net primary production (NPP_W, 1999–2008). Lettered arrows correspond to plots illustrated in Fig. 1A–C. Values are mean ± SE. $NPP_W = 0.004 \times (\text{Rugosity})^2 - 0.062 \times (\text{Rugosity}) + 1.324$ ($R^2 = 0.48$, $P < 0.01$).

Hardiman et al. 2011

Canopy complexity



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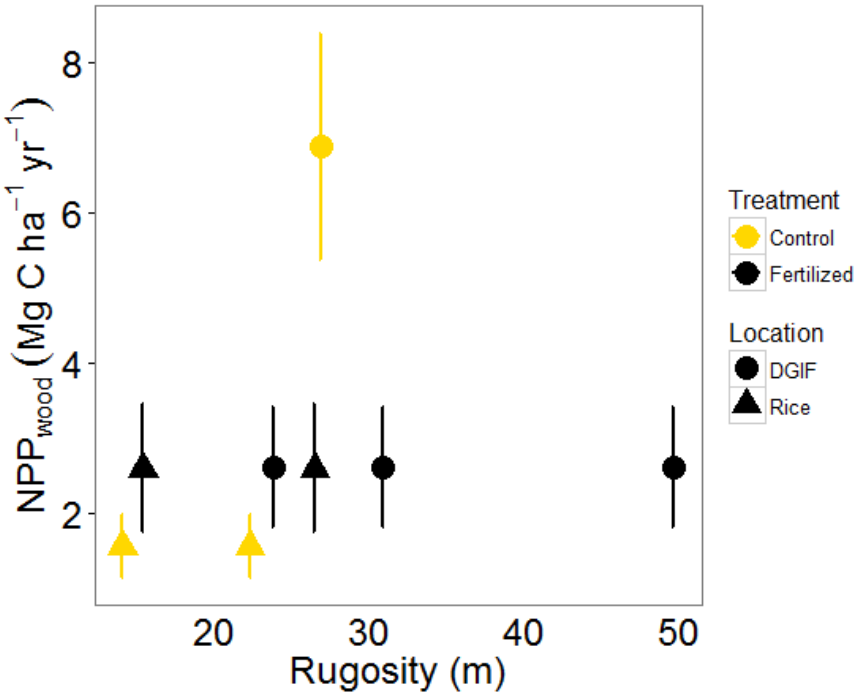
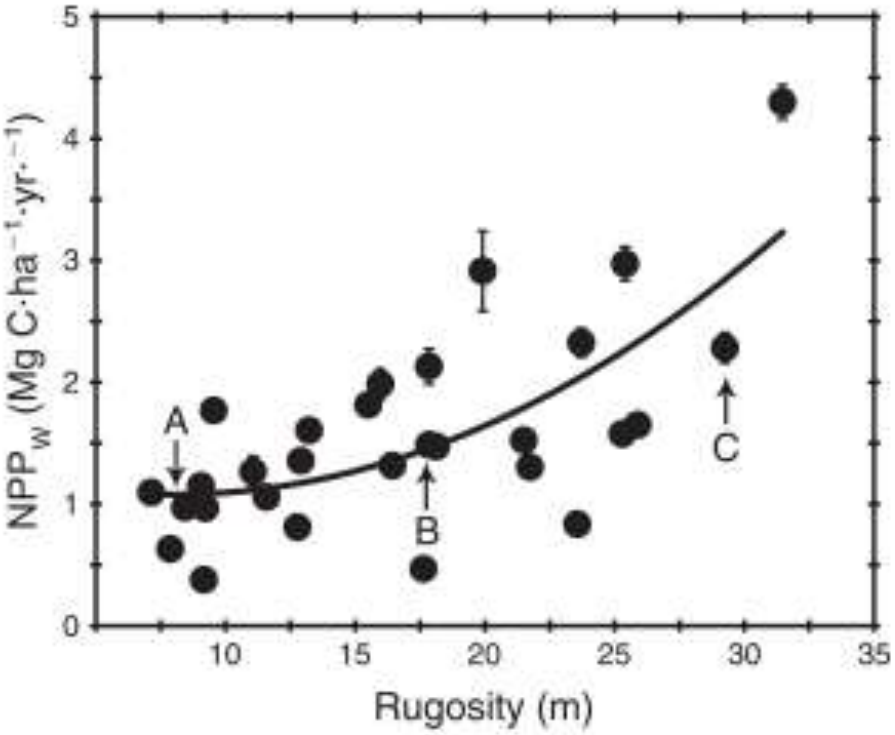


Canopy complexity

Hardiman et al. 2011



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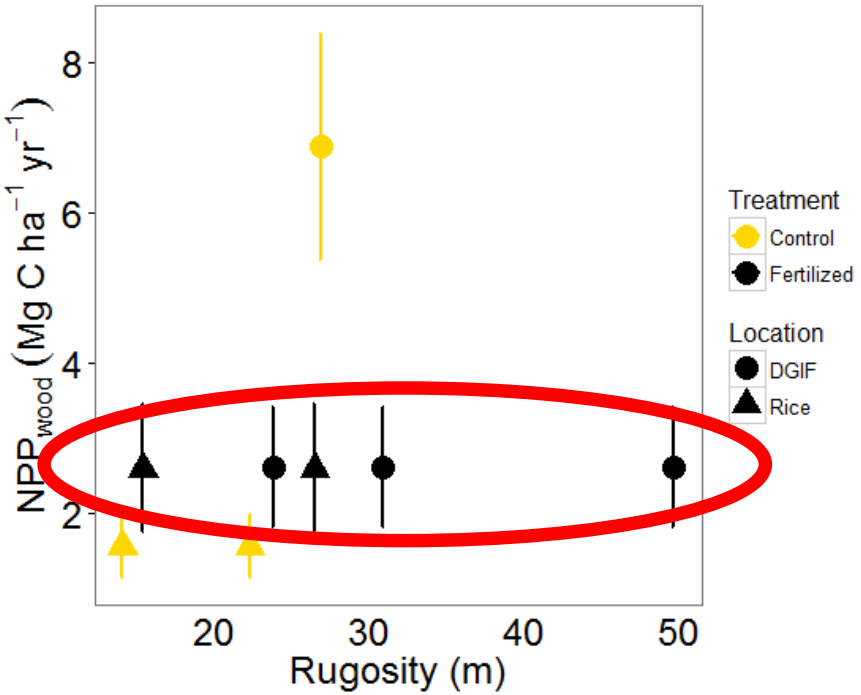

Canopy complexity

Hardiman et al. 2011


Community change
Control
Fertilized

Future directions

- Leaf canopy analysis
- Soil respiration
- Soil chemistry and physics

Rice Rivers Center

ACKNOWLEDGMENTS

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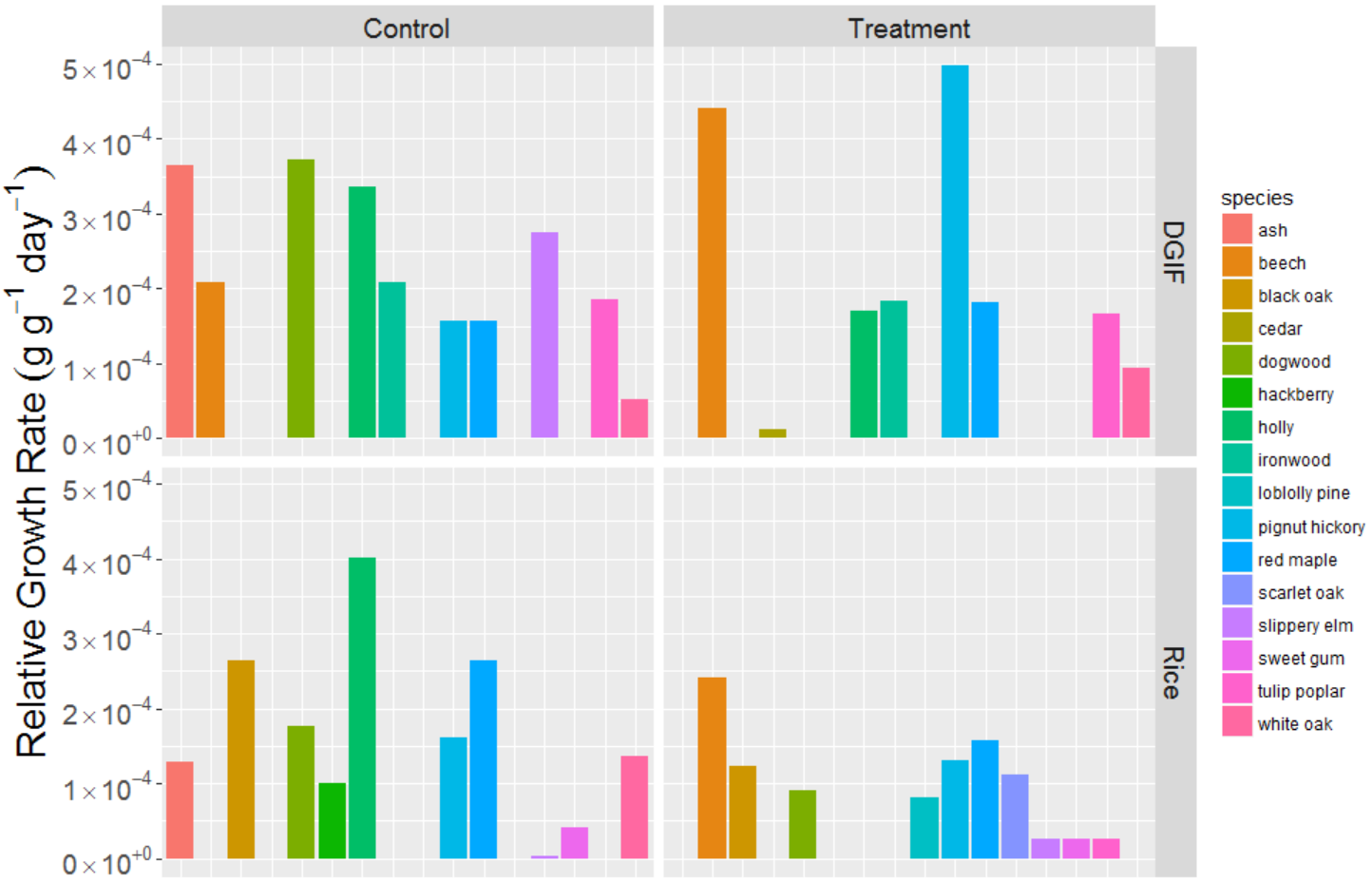

*Significant differences by location and treatment ($p < 0.5$) based on ANOVA

And Michael’s stuff maybe…

Future directions…

Let’s look at rugosity stuff

Add species specific and use relative growth rate

And add error bar notation to bars in boxplot
Adjust litter traps by area to

Add error bars to NPP wood
Add leaf NPP graph
If you want to highlight Look at 2012 and 2015 moving window
Look at LEAF NPP and biomass change.

Treatment response changes voer time. Three-interaction

Funders: NSF, Rice Rivers Center, NSF No. Award 1550657

Only a couple of thoughts, really:
1.Intersting to see the relative growth rate stuff, but I wonder if it’s too much (27 slides for 15 minute talk!); plus, trends are difficult to pick out. Will definitely be useful later.
2.Rugosity v NPP — Would be interesting and maybe revealing to first adjust NPP values for N trt/site to see if they then correlate with rugosity. You could model Ndep v NPP (since we don’t have Ndep yet from Mike (?), some numeric categorical ranking) and then plot residuals against rugosity. Or, you could run a stepwise analysis and see what is retained in the model: NPP (2016 only) = rugosity + site + N (categorical low = 0; high = 1) + rugosity*site + rugosity*N + N*site + rugosity*site*N. This would be a way to statistically test our hypothesis that there’s an N x structure interaction affecting NPP.
Love the VA map, and other stylistic liberties.

Chris