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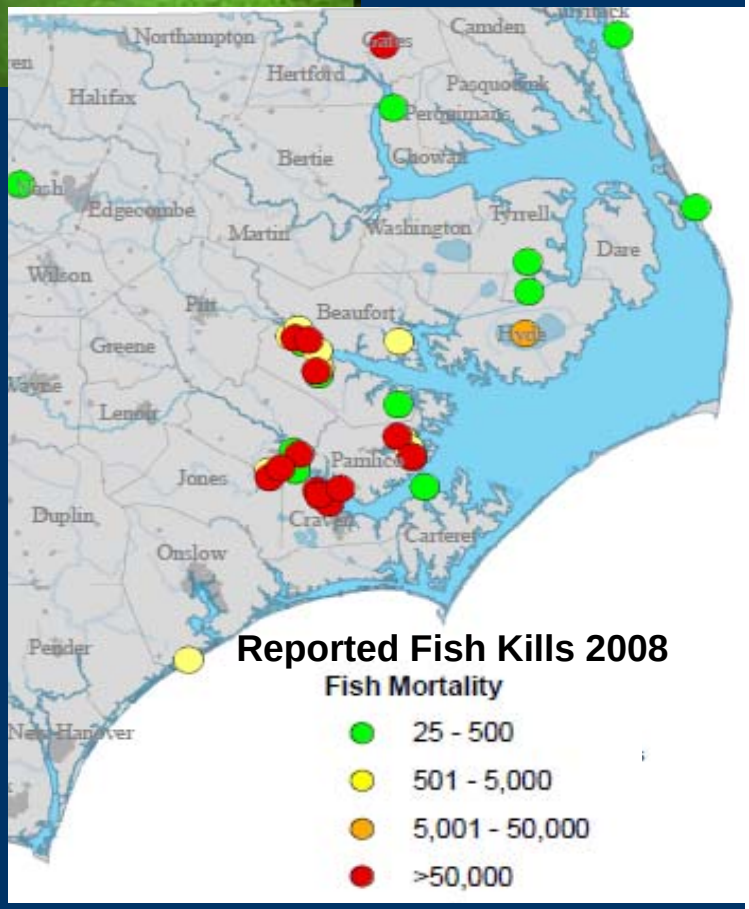
Using GIS Models to Identify Relative Nitrogen Attenuation by Riparian Buffers in the Coastal Plain of North Carolina

Jay Christensen & Anne Neale

Office of Research and Development
National Exposure Research Lab, Environmental Science Division, Landscape Ecology Branch

Impacts of Nutrients

- Freshwaters and Estuaries
  - Harmful algal blooms
  - Hypoxic events
  - Fish kills



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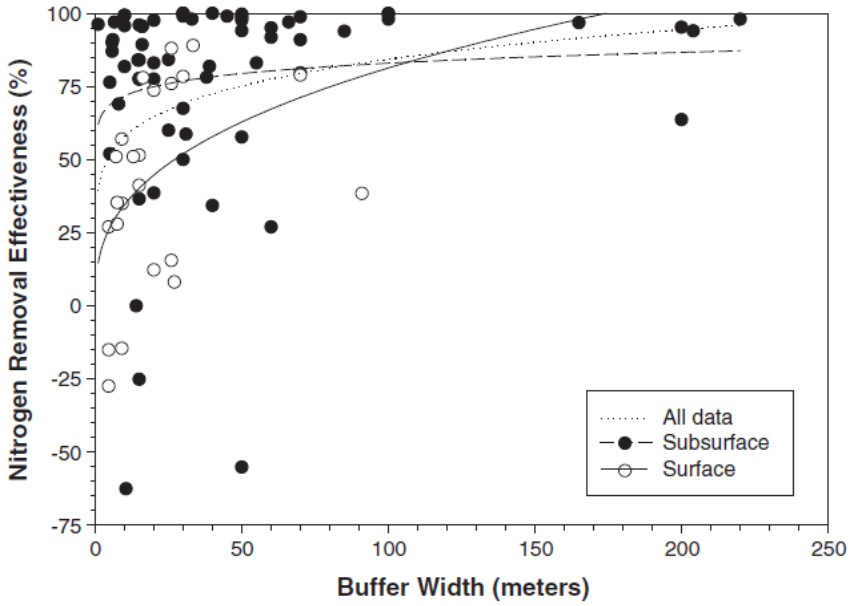
Impacts of Nutrients

- Freshwaters and Estuaries
- Focus on Watershed

- Riparian Buffers shown to reduce nitrogen load
- Promotion of riparian buffers
  - Goal of 100,000 additional acres in NC



Mayer et al. 2006

Peterjohn and Correll 1984

soil.ncsu.edu

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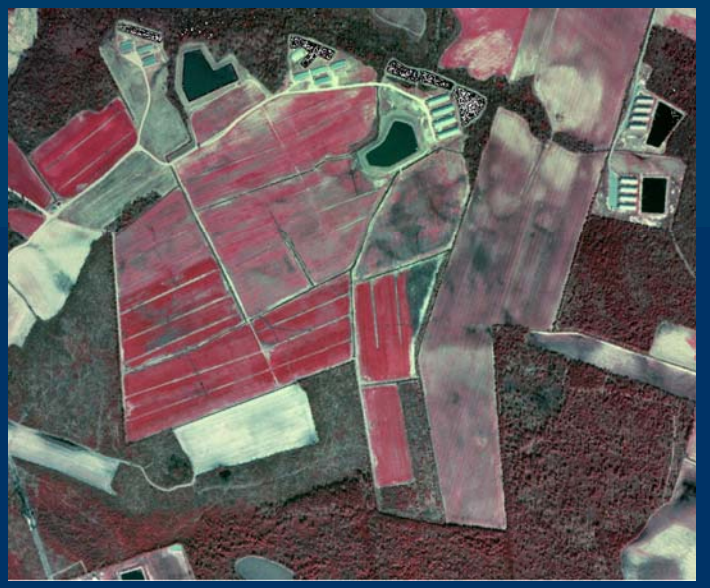
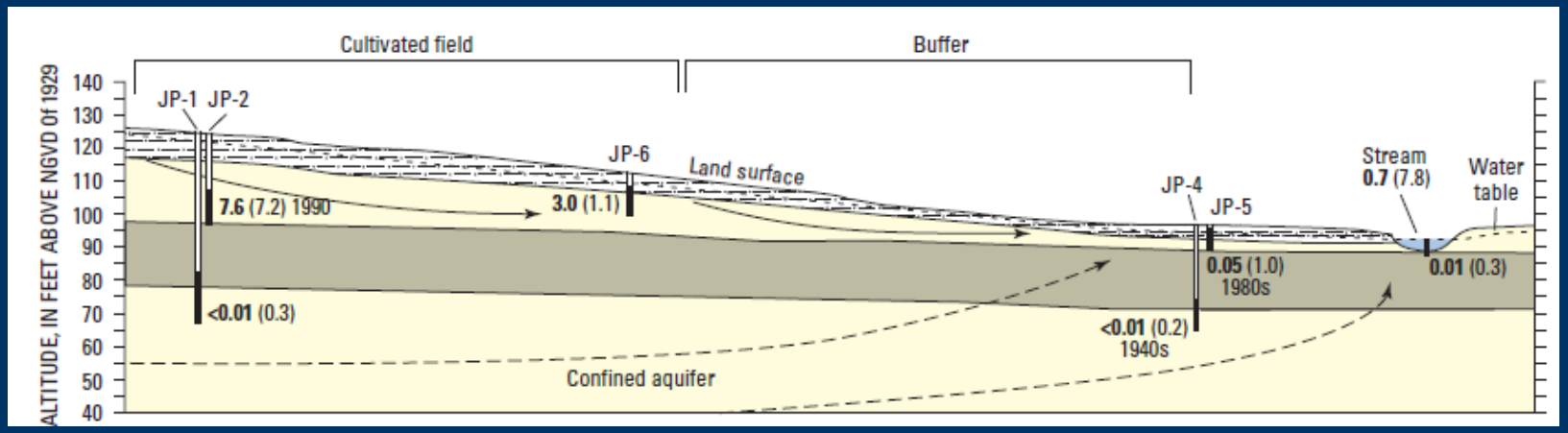
Coastal Plain of Carolinas

- Effectiveness of buffers reduced
  - Artificial drainage
  - Subsurface flows





Harden and Spruill 2008

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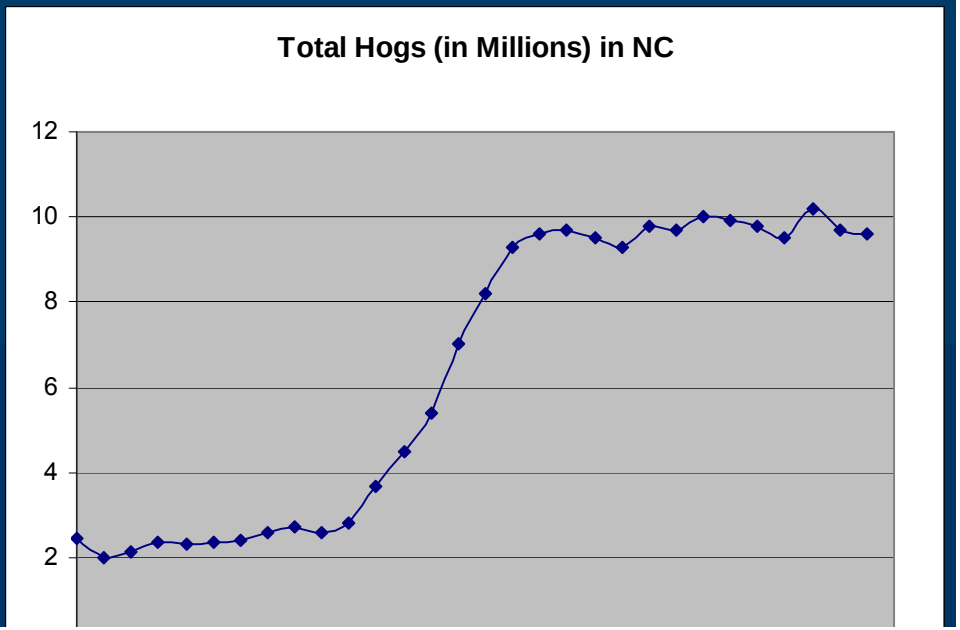
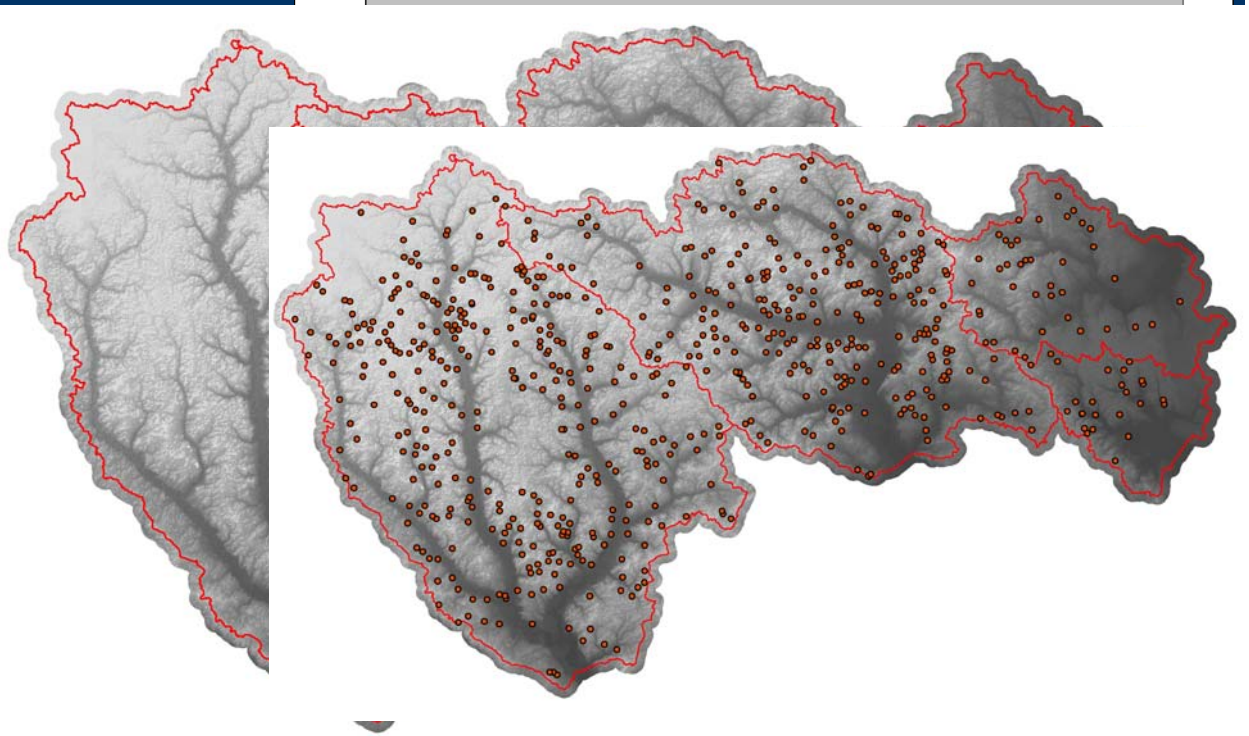
Coastal Plain of Carolinas

- Gauged watersheds in Cape Fear and New Rivers
  - High N loads – (Ho McMahon 2009)
  - Rise of CAFOs
    - Duplin Co.- high population of sw
  - Benefit from ripari placement?





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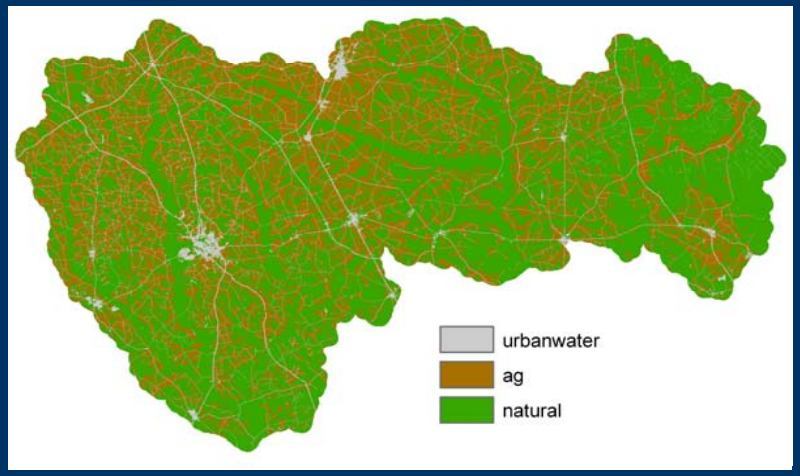
GIS Riparian tool
Baker et al. 2006

Goal: Describing the connectivity of cropland to streams through riparian buffers



- Method requires
- 3 data inputs:
  - Elevation - 10m DEM
  - Stream Network – NHD High Resolution 1:24,000 – includes river/stream/pond lines
  - Landcover – NLCD 2001 and Cropland Data Layer 2008

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GIS Riparian tool
Baker et al. 2006

Methodology of Tool: GIS analysis

- A) Flow path determined
- B) Isolate source cell flow paths
- C) Length of sink cells calculated
- D) Buffer width assigned

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Nitrogen Removal in Riparian Zones

Riparian Zones:

- Can run GIS tool with NLCD, elevation and stream database (NHD) to see where agriculture passes or does not pass through natural vegetation before entering the stream

- Does natural vegetation = biogeochemically active riparian zone?

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Nitrogen Removal in Riparian Zones

Riparian Zones:

- Removal efficiency also influenced by location of:
  - Anaerobic conditions – Hydric Soils
  - Hydrologic flows – Landform

- Relative nitrogen removal
  - Crop specific nitrogen exports – Crop Data Layer

  - Inform placement and protection of buffers

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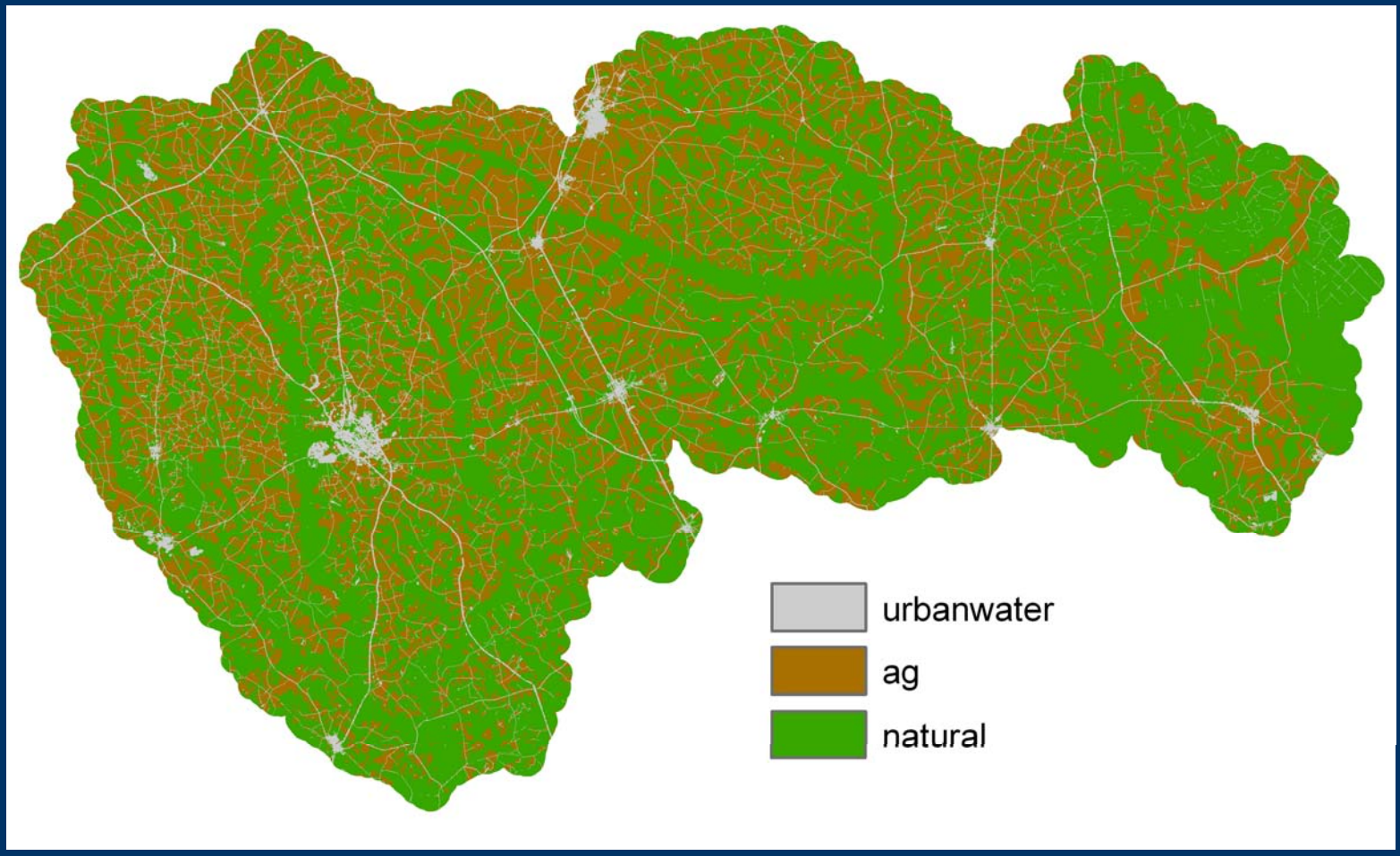
Landcover



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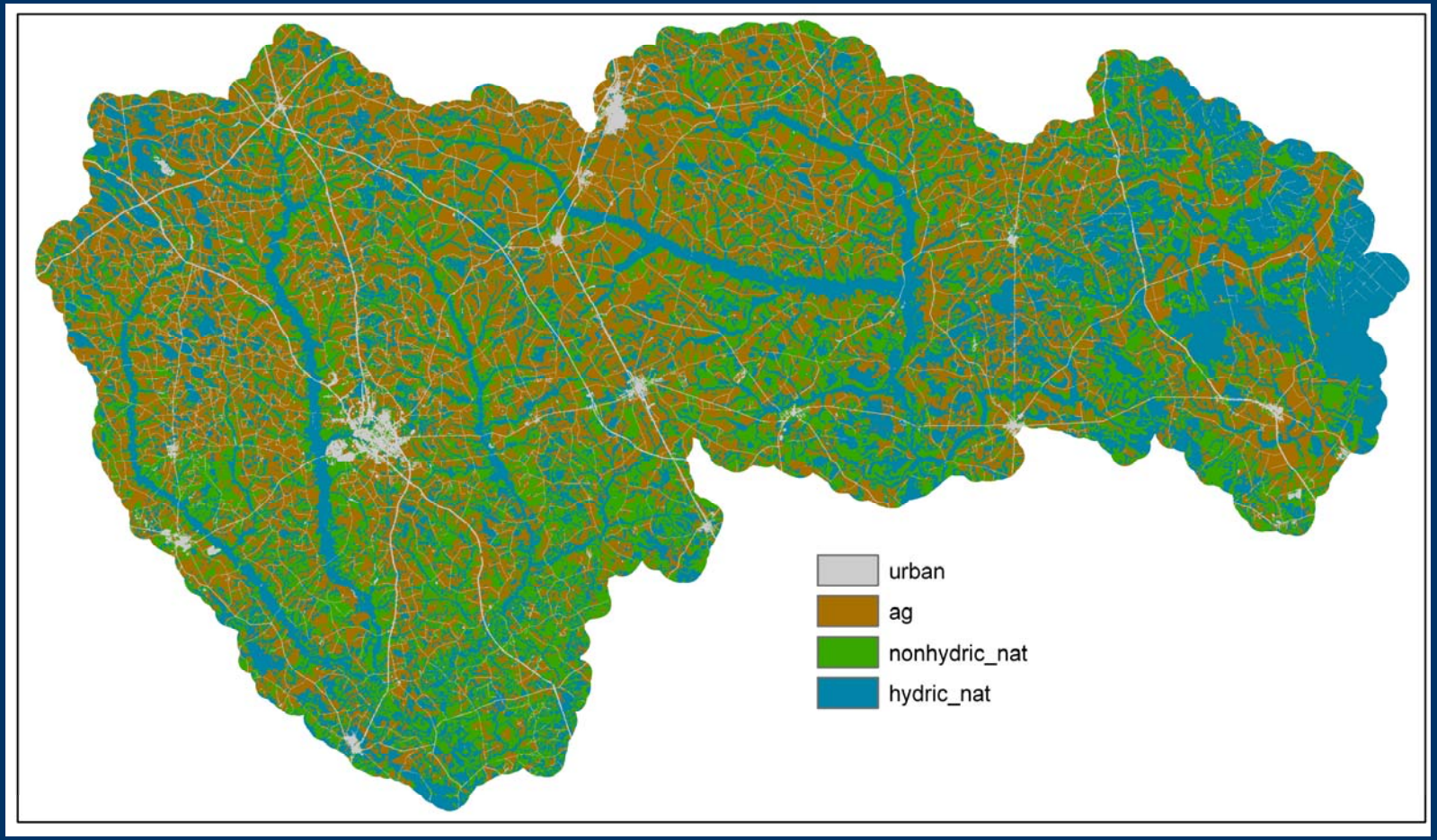
Add hydric soils in natural areas



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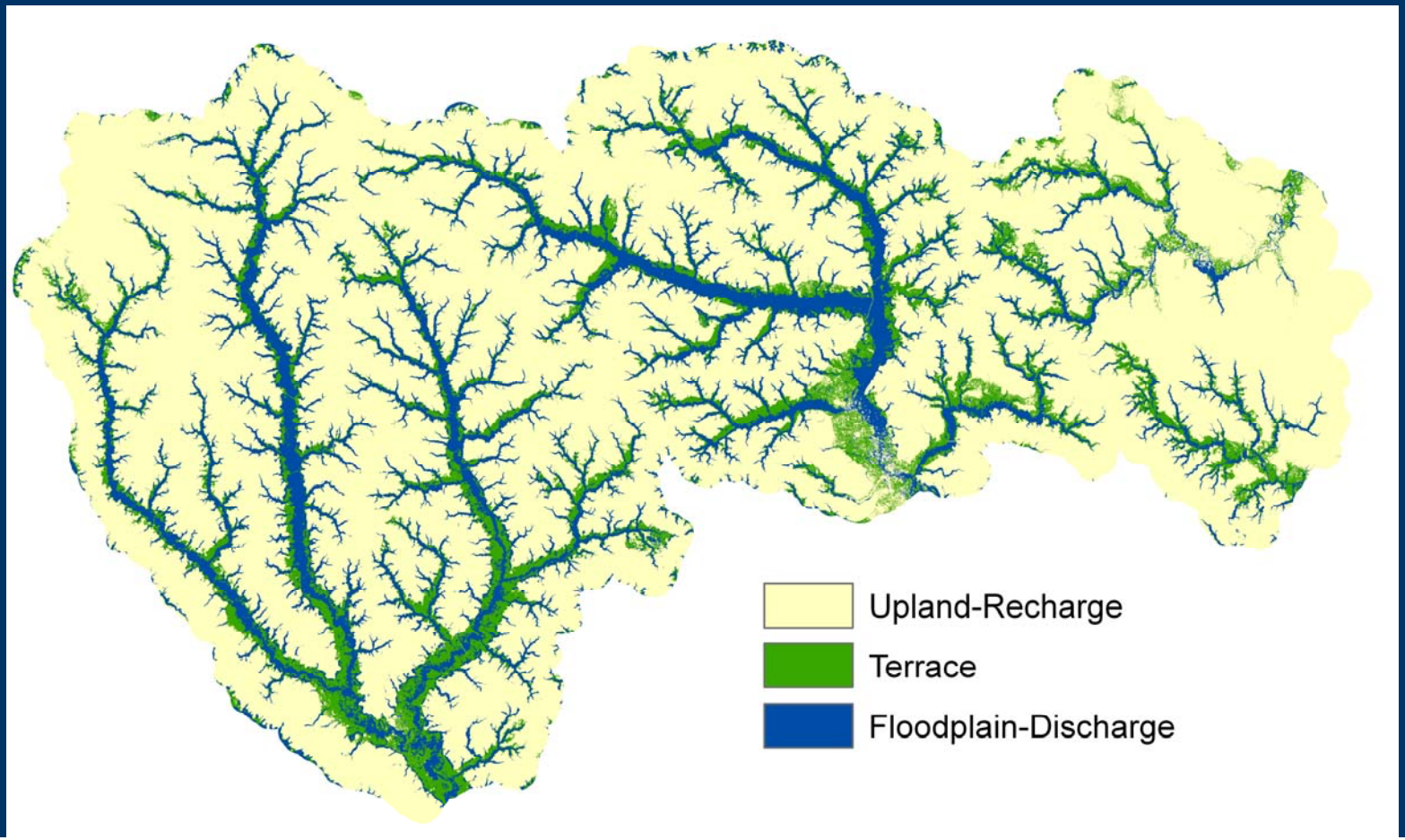
Landform from multiple Topographic Position Indices through PCA analysis - matched to SSURGO recharge maps (Mew et al 2002)



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Combine hydric soils and landform to create 4 buffer types

- Hydric Floodplain – high effectiveness - reducing conditions and **more** interaction with subsurface inputs
- Hydric Uplands – moderate effectiveness - reducing conditions and **varied** interaction with subsurface inputs
- Non-hydric Floodplains – low effectiveness - **non**-reducing conditions and **more** interaction with subsurface inputs
- Non-hydric Uplands – low effectiveness - **non**-reducing conditions and **less** interaction with subsurface inputs

- (Spruill 2000, Rosenblatt et al 2001, Gold et al 2001, Vidon and Hill 2004, Tesoriero et al 2005, Baker et al 2007, Harden & Spruill 2008)

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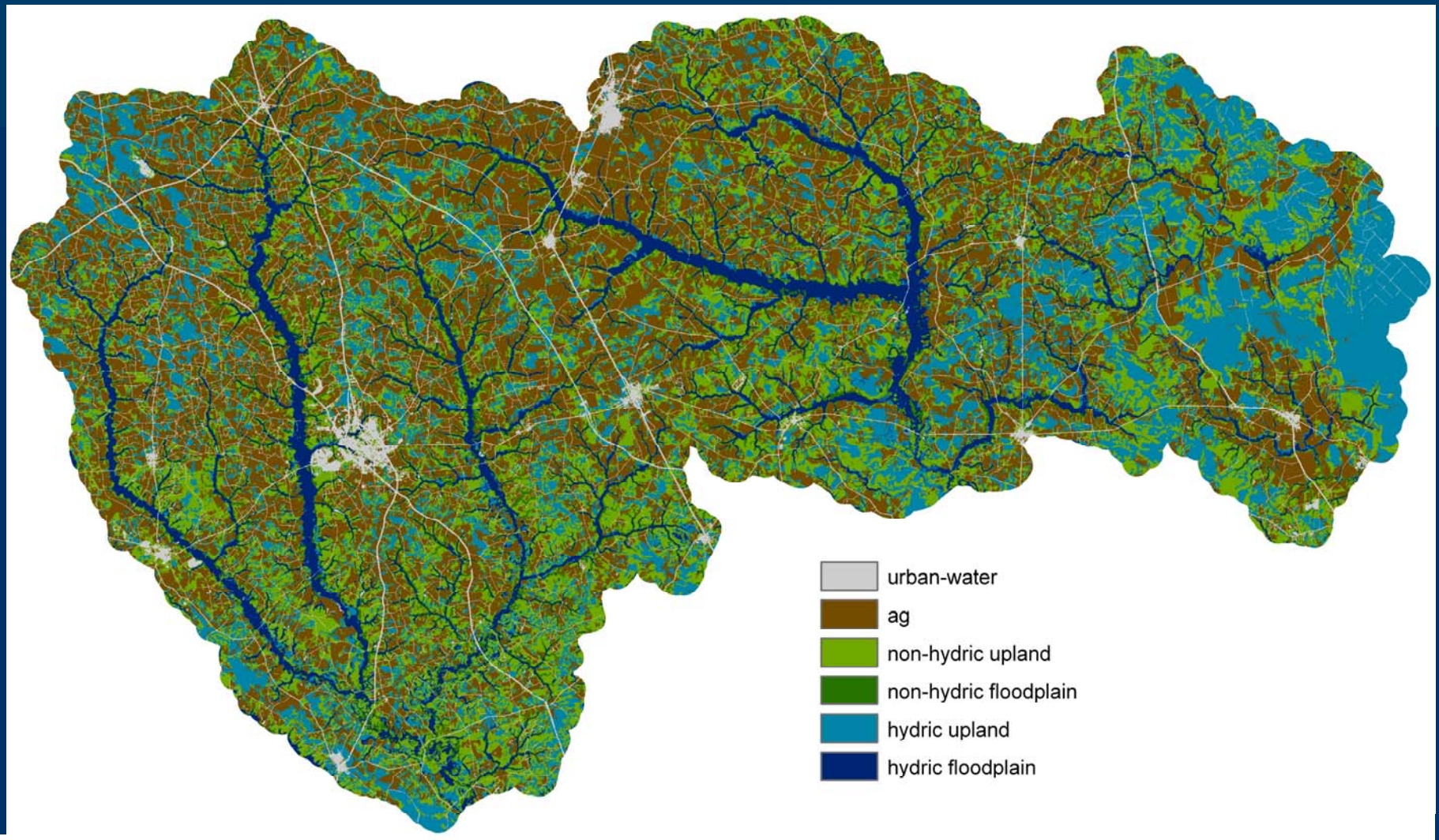

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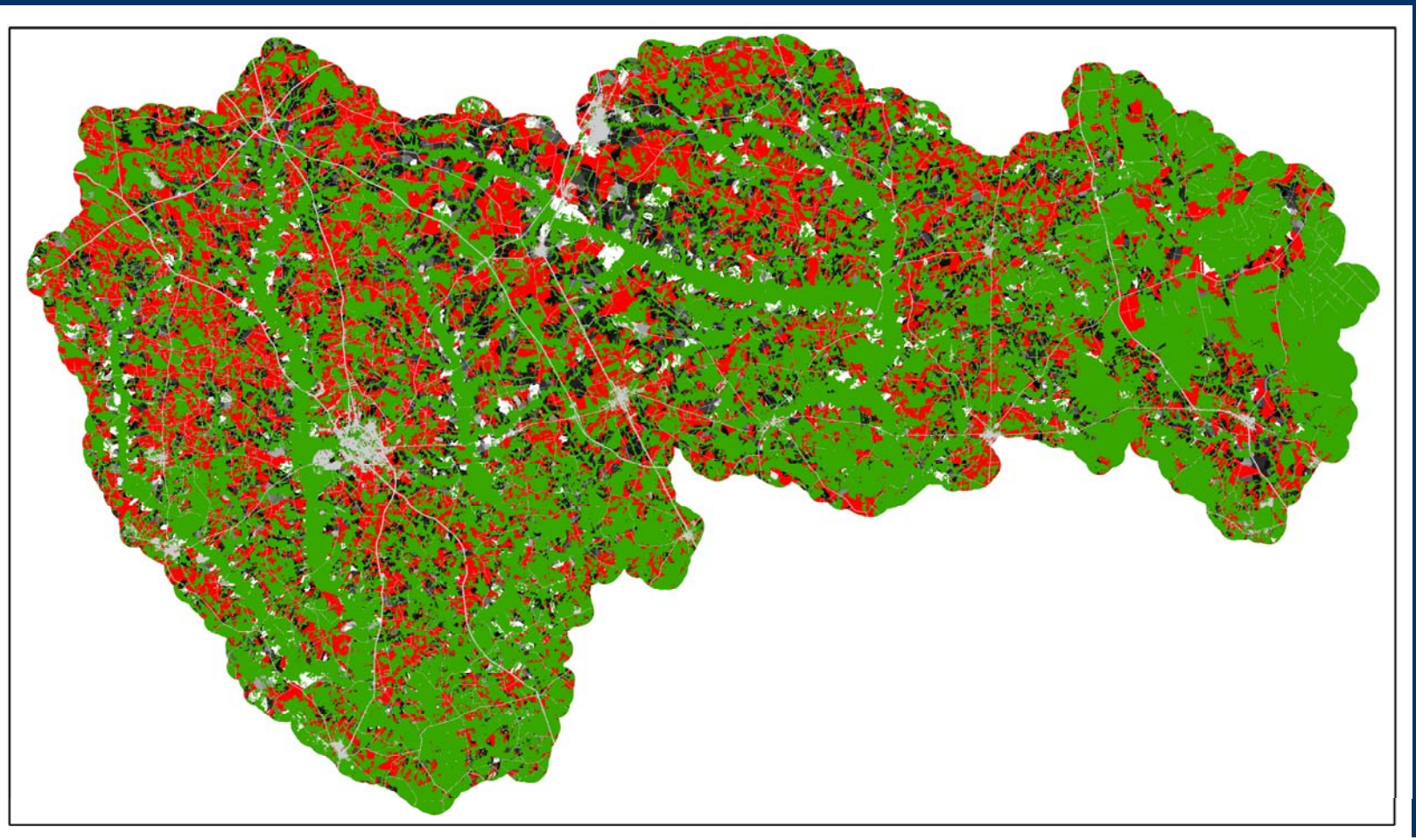
Run riparian tool for each buffer type

- Example of hydric floodplain buffer widths assigned to agricultural cells



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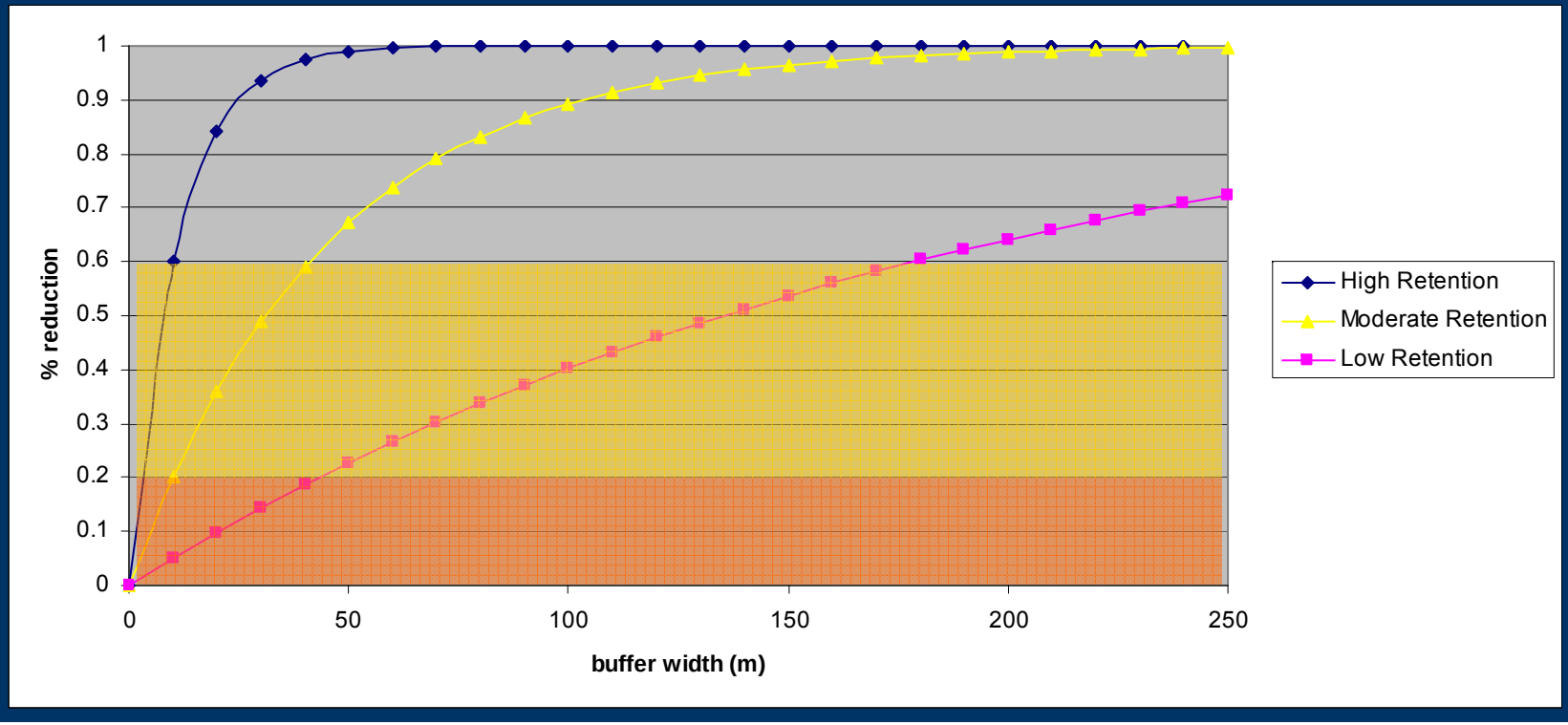
Create combined raster on effectiveness

- Combined High retention ≥ 60% reduction for total buffer width
- Combined Mod retention = 20-60% reduction for total buffer width
- Combined Low retention = 1-20% reduction for total buffer width



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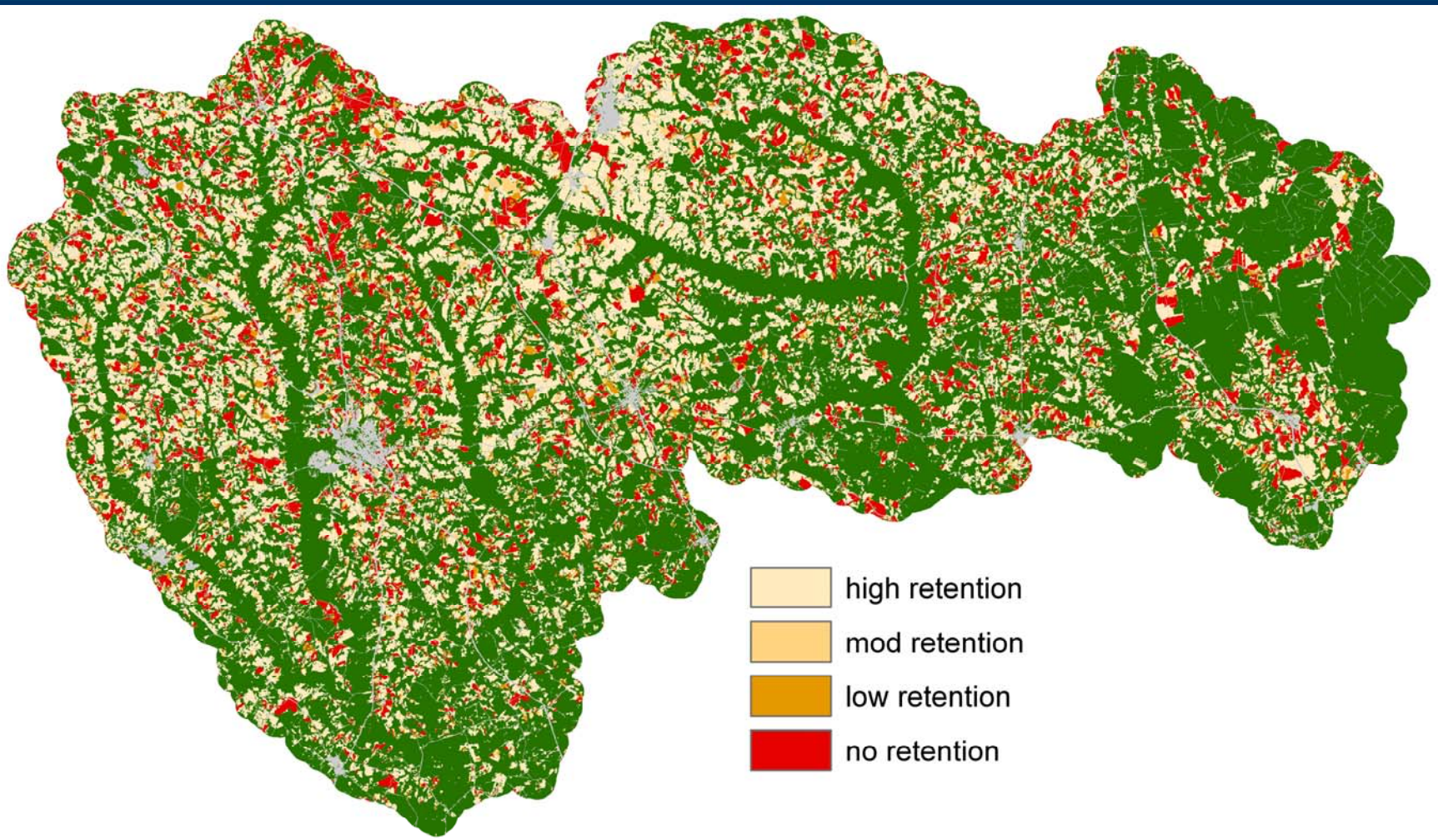
Combined Raster



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To remove nitrogen the buffer must receive nitrogen

- Use of NLCD and Cropland Data Layer
  - Higher N Exports from MANAGE v3 database

crop	avg Ds N export (kg/ha)	min	max
Coastal Bermudagrass	9.9	6.6	13.1
Corn	6.0	3.0	13.8
Soybeans	3.8	2.4	6.0
Cotton	3.5	1.7	5.6
Wheat	2.3	0.6	4.7
Peanut	0.7	0.5	0.9

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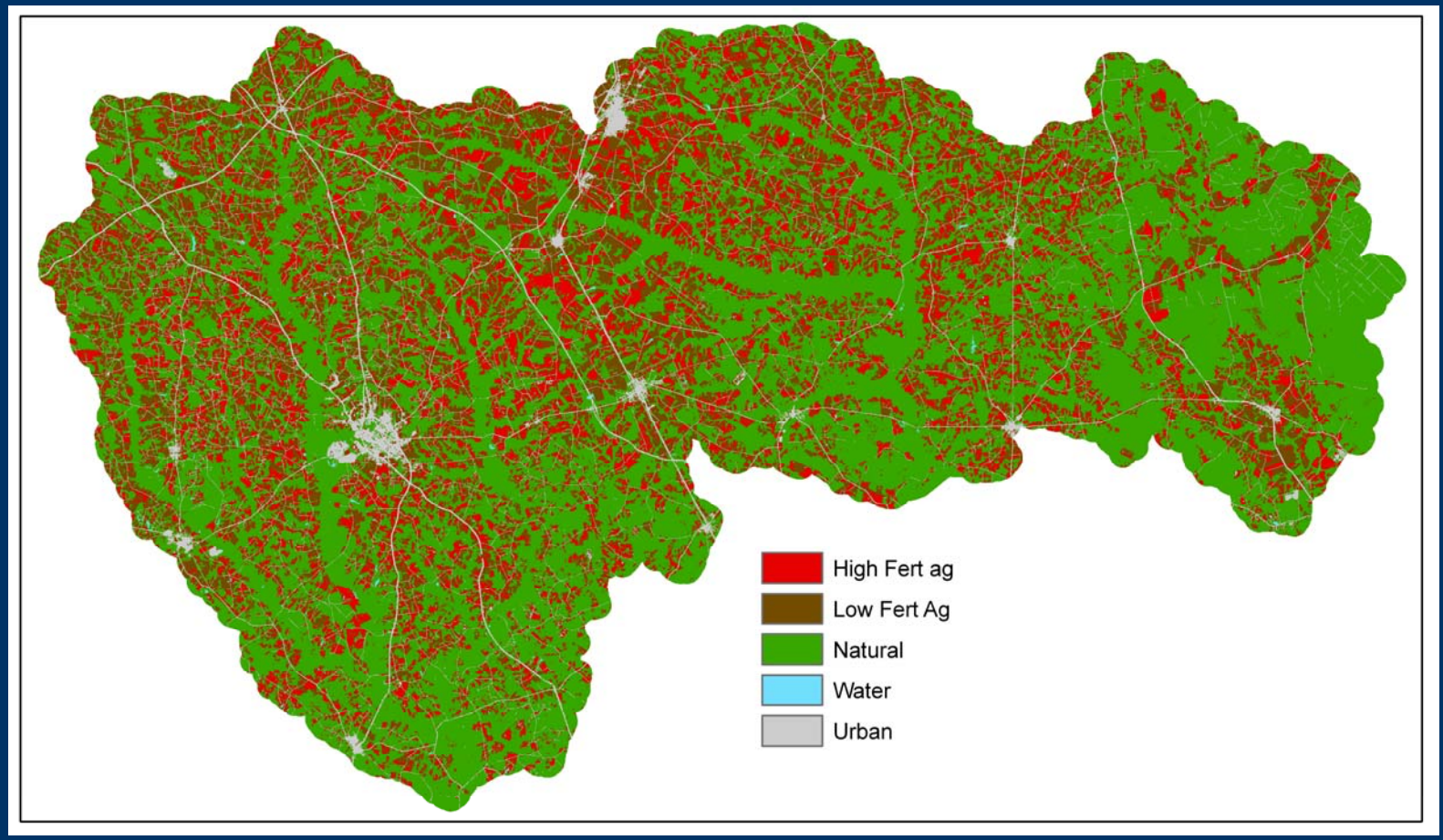
To remove nitrogen the buffer must receive nitrogen



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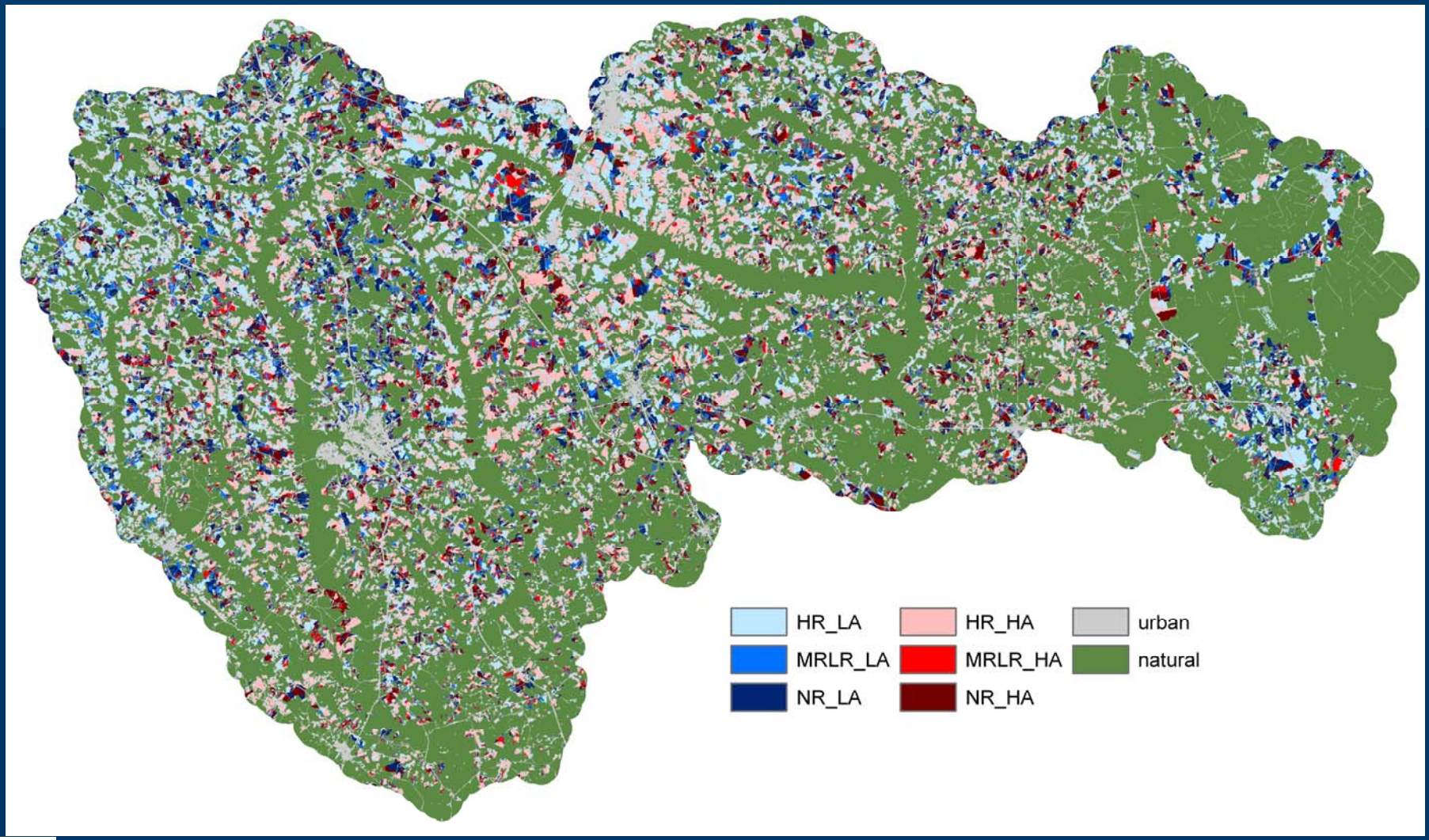
Nitrogen Removal in Riparian Zones



HR = high retention, MRLR = mod to low retention, NR = No retention, LA = low ag, HA = high ag

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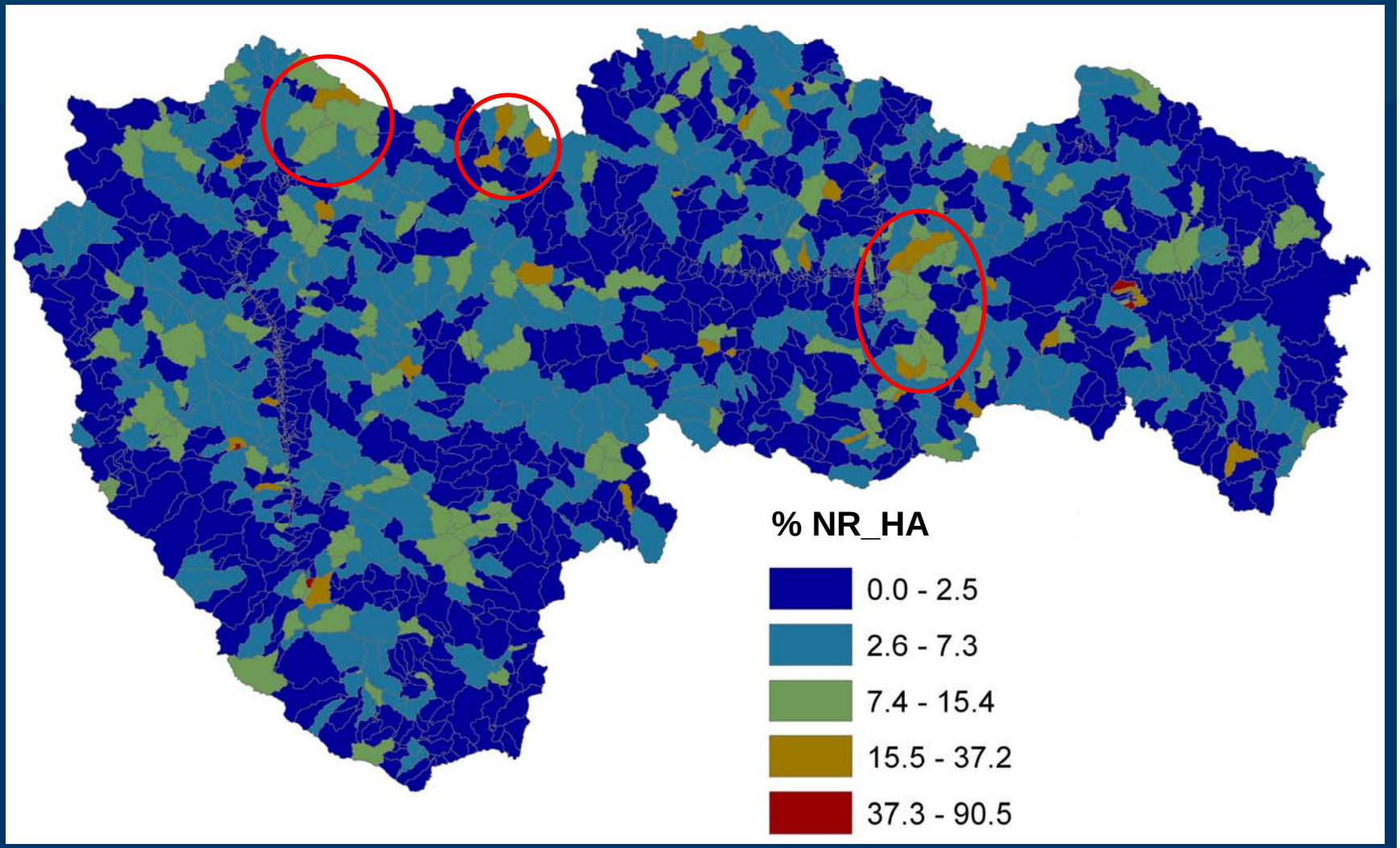
Nitrogen Removal in Riparian Zones



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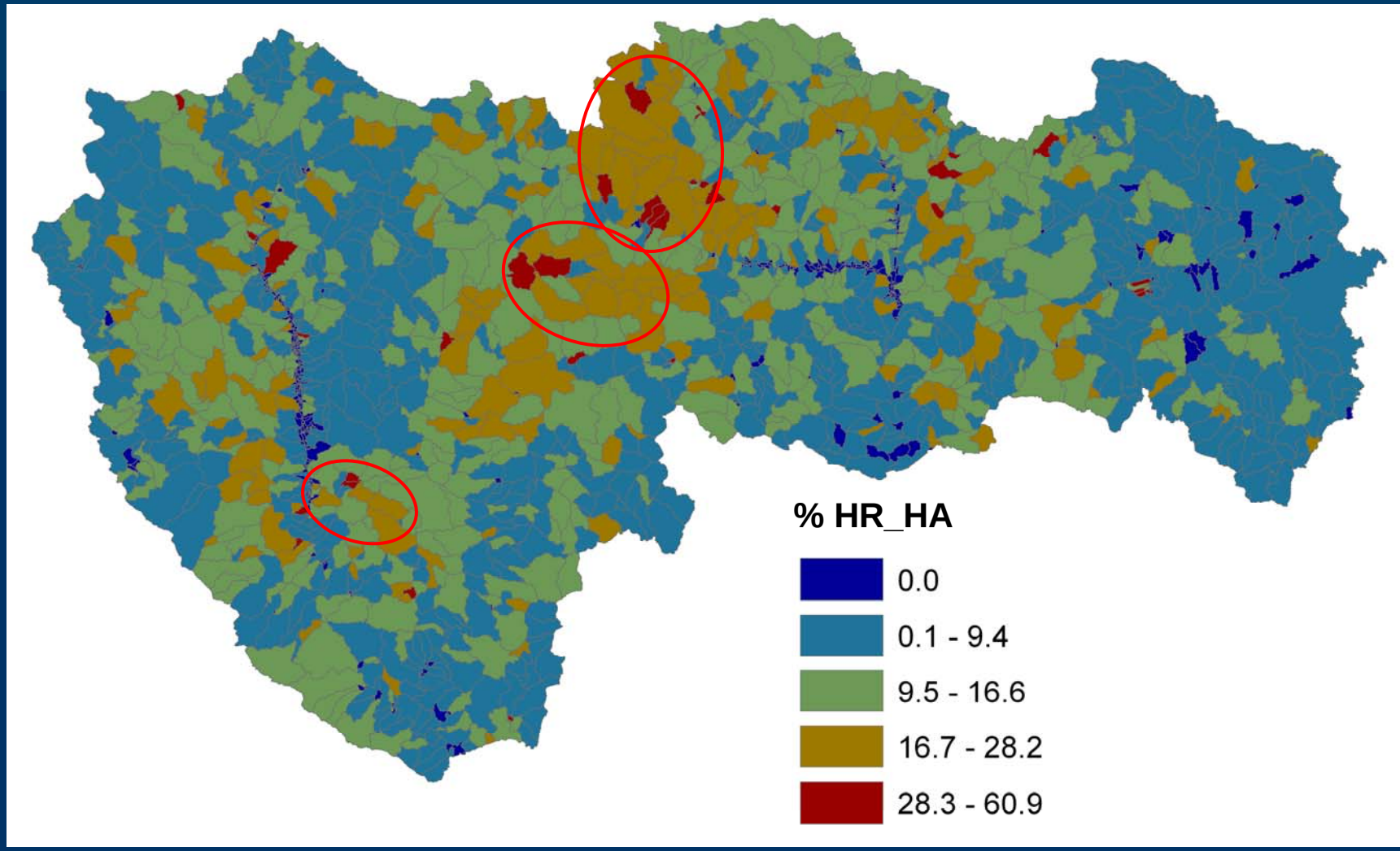
Nitrogen Removal in Riparian Zones



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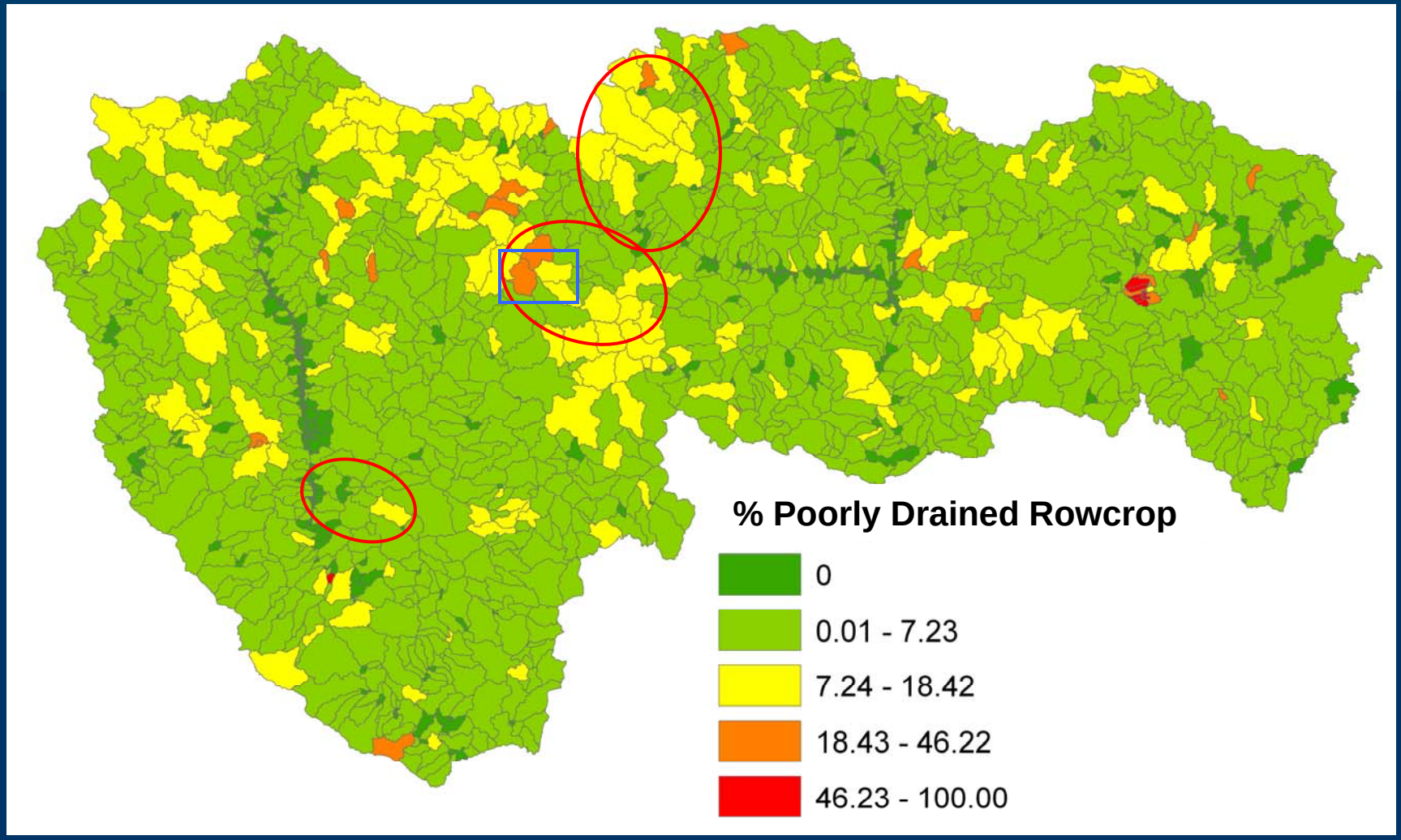
Influence of Agricultural Drainage



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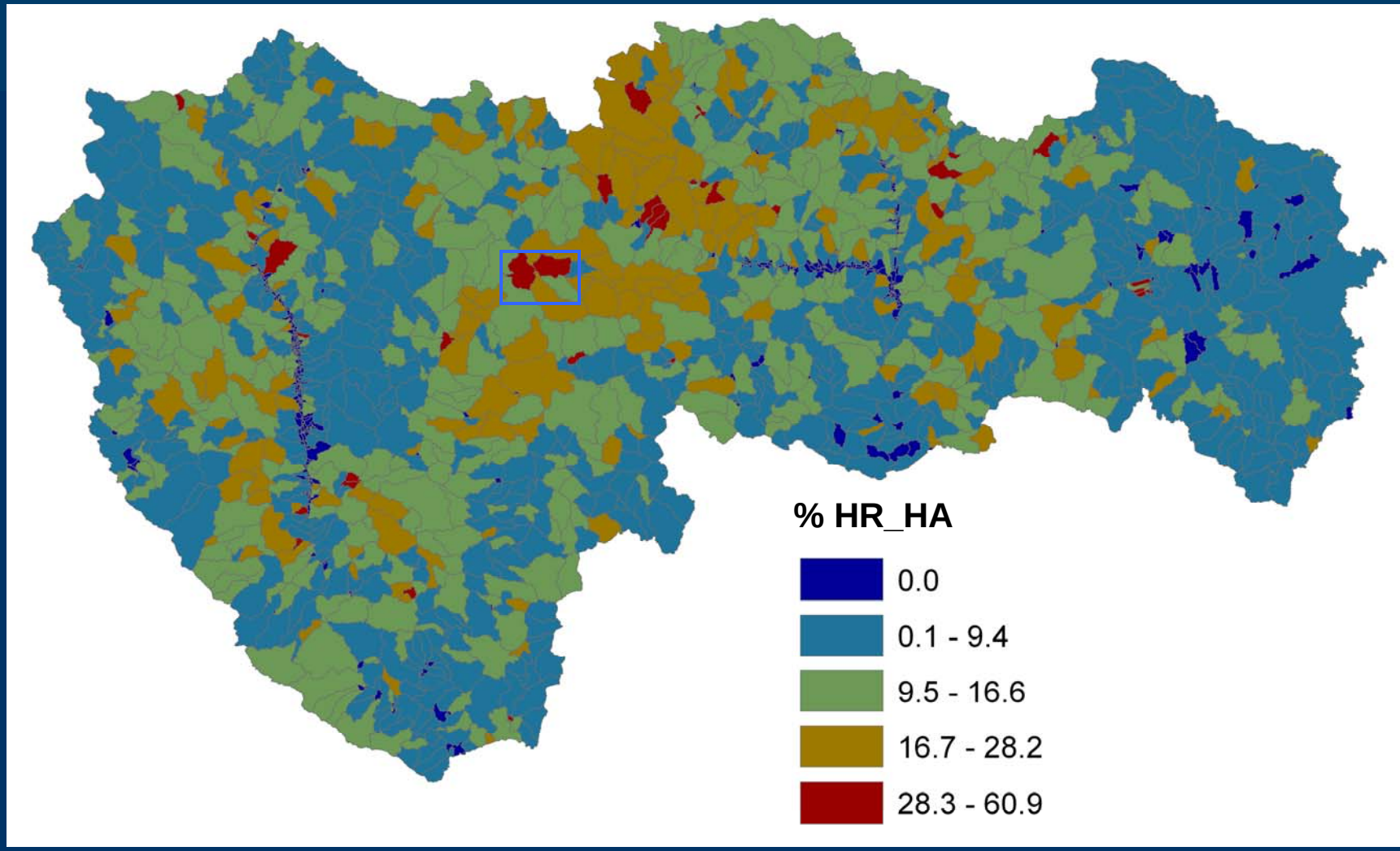
Nitrogen Removal in Riparian Zones



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Influence of agricultural drainage

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In Summary

- Riparian tool combined with hydric soils and landform
  - Creates map of relative retention
- Combined with crop N estimates to high, low, or no nitrogen removal
- Allows for targeting approach:
  - NHD catchments with no buffer (restoration of buffer)
  - NHD catchments that provide varying degrees of nitrogen removal (preservation of buffer)

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In Summary

- Agricultural Drainage is important but poorly mapped
  - Coarse method to identify buffers influenced by ag drainage
  - Efforts underway to include agricultural drainage
- Next Steps:
  - Approach applied to Albemarle-Pamlico Watershed
  - Test watersheds in APW to validate model
  - Inform placement of BMPs in APW as NCDENR attempts to meet TMDLs

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Questions?

- Jay Christensen: christensen.jay@epa.gov


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Combining effectiveness with buffer width

- **Must combine level of effectiveness with buffer width to determine overall effectiveness of a buffer**
- **Example:**
  - **10 m of highly effective buffer removes 60% of N load = 180m of low effective buffer (5% every 10m) also removes 60% of N**

- (Spruill 2000, Rosenblatt et al 2001, Gold et al 2001, Vidon and Hill 2004, Tesoriero et al 2005, Baker et al 2007, Harden & Spruill 2008)

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Assign general measure of effectiveness

- Hydric Flooplain (HF) – high effectiveness
  - **60% / 10m buffer**
- Hydric Uplands (HU)– moderate effectiveness
  - **20% / 10m buffer**
- Non-Hydric Uplands and Floodplains (NH) – low effectiveness
  - **5% / 10m buffer**

- (Spruill 2000, Rosenblatt et al 2001, Gold et al 2001, Vidon and Hill 2004, Tesoriero et al 2005, Baker et al 2007, Harden & Spruill 2008)