Riparian Buffers for Water Resource Protection

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Riparian Areas

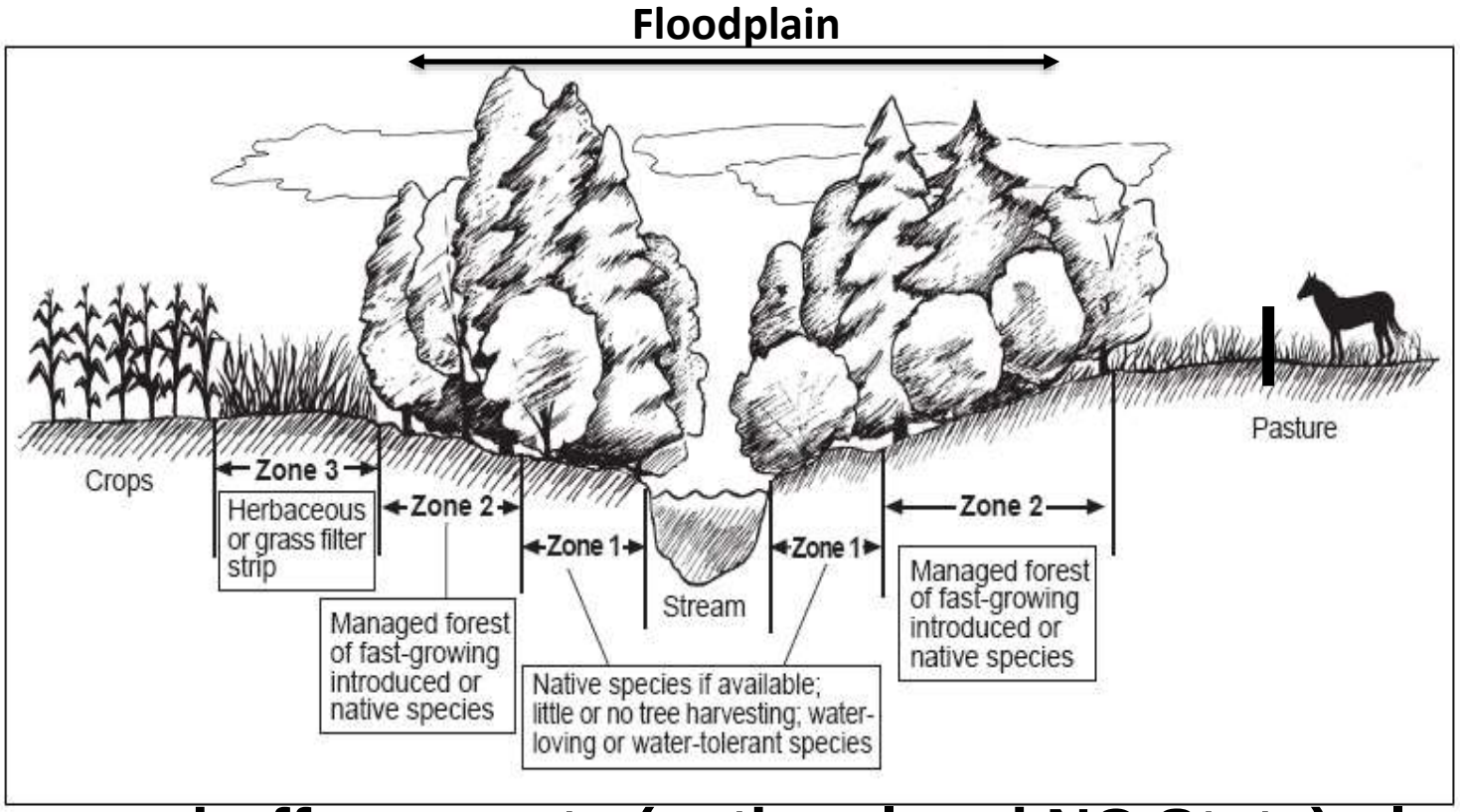
- From Latin *ripa* - area adjacent to a watercourse
- In NC most of the floodplains were well vegetated – mostly forested
- Considered an *ecotone*
  - transitional area from upland to aquatic
  - like a cell membrane, controlling how materials enter the stream

Riparian Buffers

- Vegetated streamside corridors (either protected or restored) meant to protect stream ecological functions and downstream water quality

www.ifgene.org

NRCS ideal buffer design to achieve multiple functions



20 yrs ago, buffer experts (national and NC State) plus state officials joined to determine realistic buffer width to minimize land to put into buffers

Result = 50 feet, two zone buffer

Research has shown buffers can provide 4 functions

http://www.mda.state.mn.us/protecting/conservation/practices/bufferforested.aspx

1. Protect stream structure

- Vegetation within the buffer slows surface water down
- Roots near stream stabilize banks (particularly in bends)
- Slower runoff+ reinforced streambanks = less erosion
- Less streambank erosion = less sediment loss downstream

2. Enhance aquatic environment

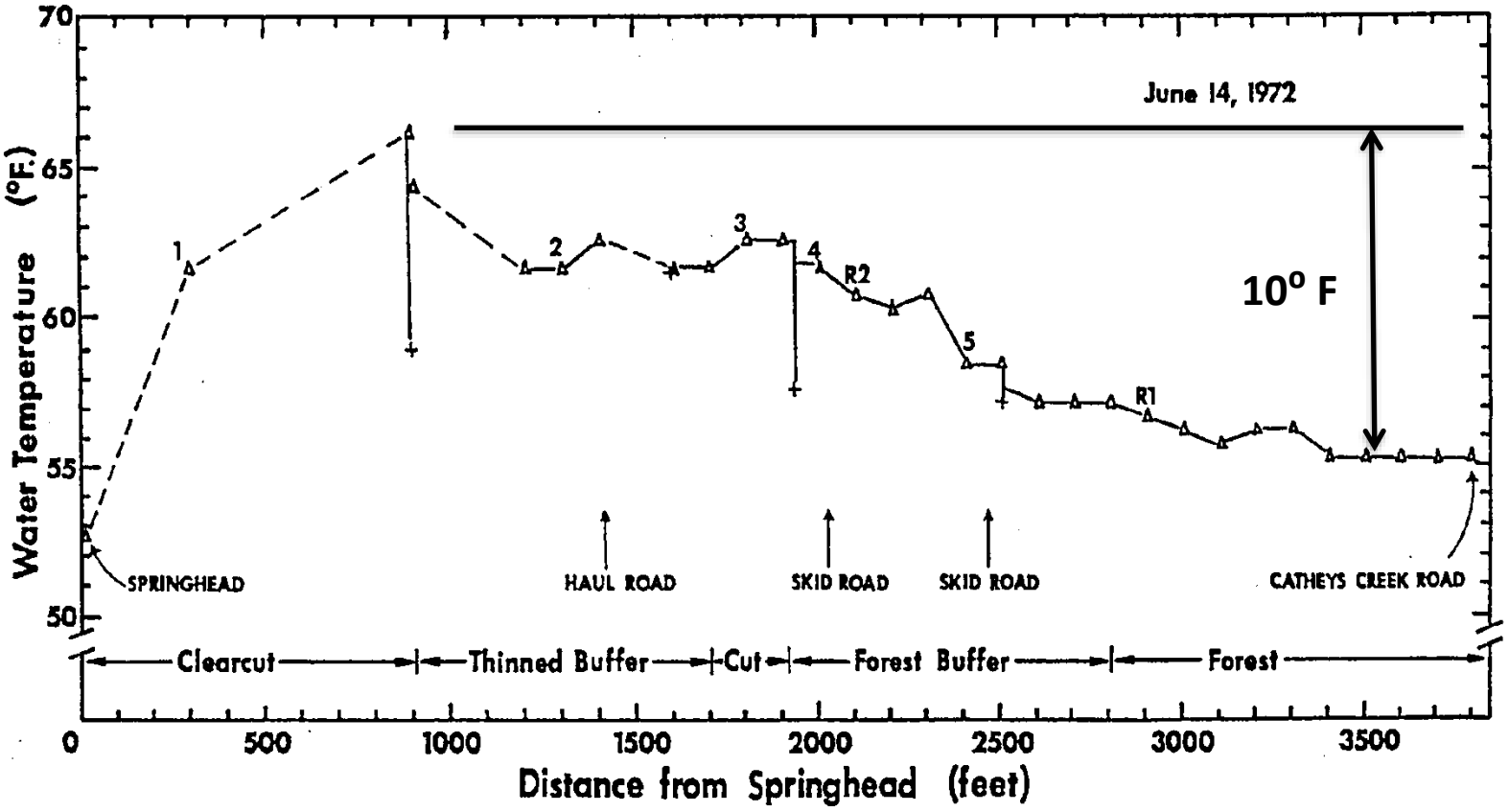
- Tree canopy provides shade
  - Temp control
  - Higher oxygen
  - Controls algae

- Leaf litter
  - Carbon and organic nutrients (energy for food web)
  - Habitat

- Coarse woody debris
  - Habitat

Temperature - Forested Riparian Areas

Effects of Clearcut Timber Harvesting on stream temperature

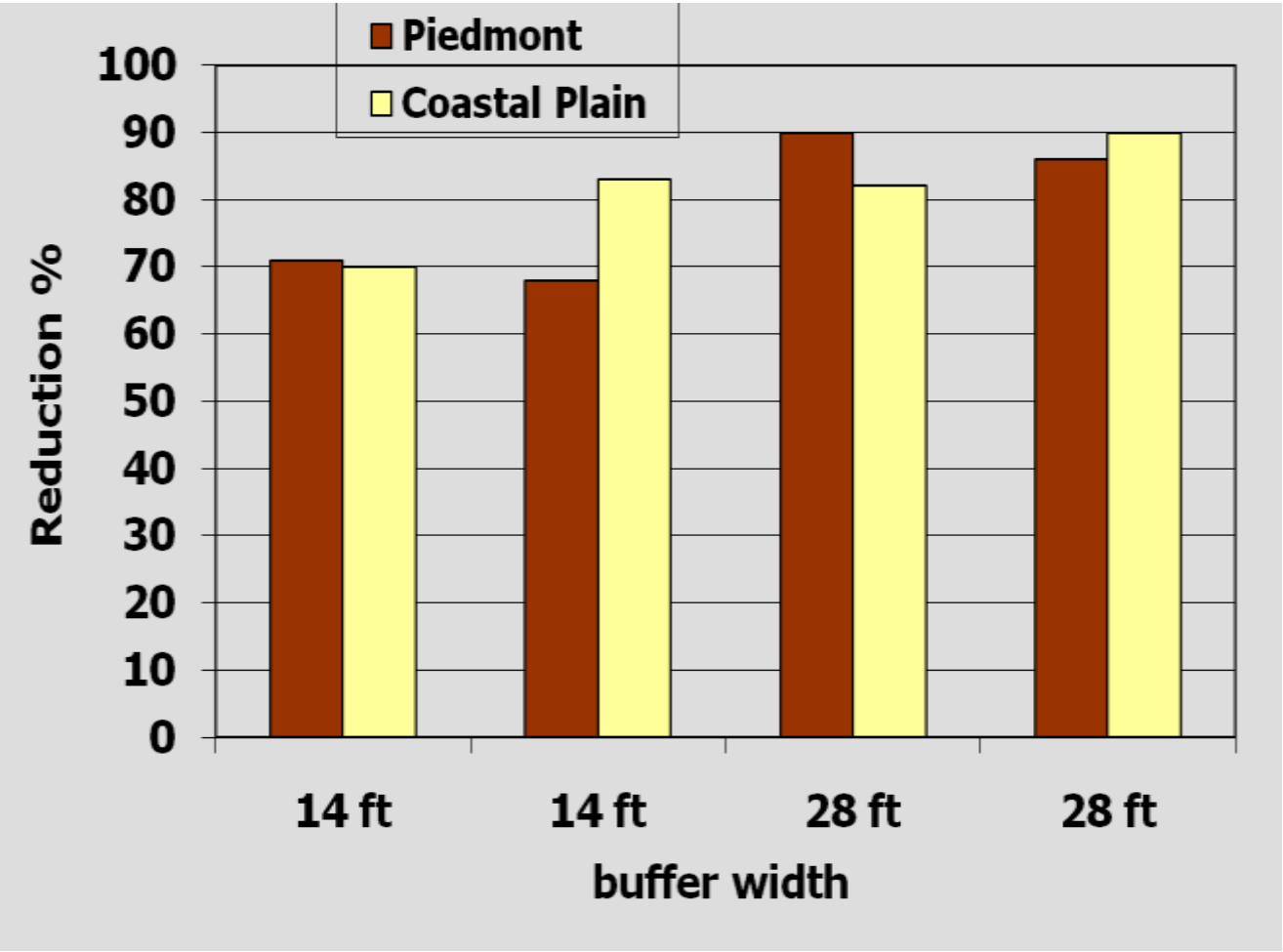


Lloyd Swift, US Forest Service Coweeta Hydrologic Laboratory – 135 ac clearcut in mixed hardwood forest, 40 ft wide riparian buffer, N-S oriented first order stream, Pisgah National Forest near Brevard, NC

3. Reduce sediment and phosphorus from surface runoff

- Grass filter slows water
- Encourages diffuse flow (critical component)
- Sediment and sediment –bound P is deposited
- Sediment can be trapped, P uptake by vegetation possible

Sediment Reduction Can Be High



From: NCSU Technical Bulletin 318 - Riparian Buffers and Controlled Drainage to Reduce Agricultural NPS Pollution.

From D. Osmond with permission

Other analysis on sediment

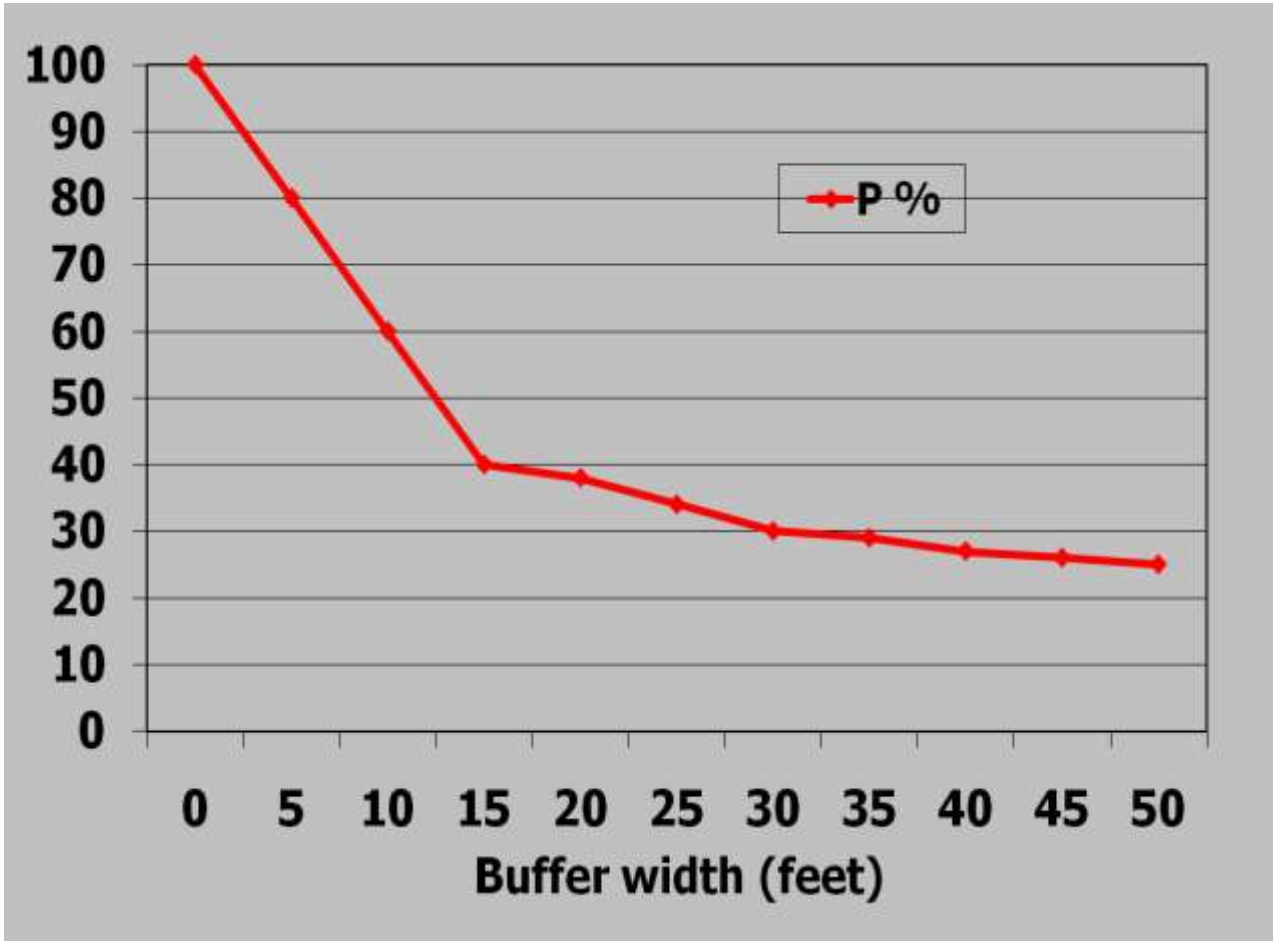
Predictive models

- Liu et al. (2008) at 85 sites
  - 30 ft buffer – 85% removal
  - 50 ft buffer – 94% removal
  - 100 ft buffer – 100% removal
  - Possible over-prediction due to experimental setup?

- Sweeny and Newbold (2014) at 22 sites
  - 30 ft buffer – 64% removal
  - 50 ft buffer – 74% removal
  - 100 ft buffer – 80% removal

- Note – sediment that is lost has more fine particles and will be more easily to transported downstream

Sediment-attached Phosphorus removal can follow similar trends



From: NCSU Technical Bulletin 323 – North Carolina Phosphorus Loss Assessment.

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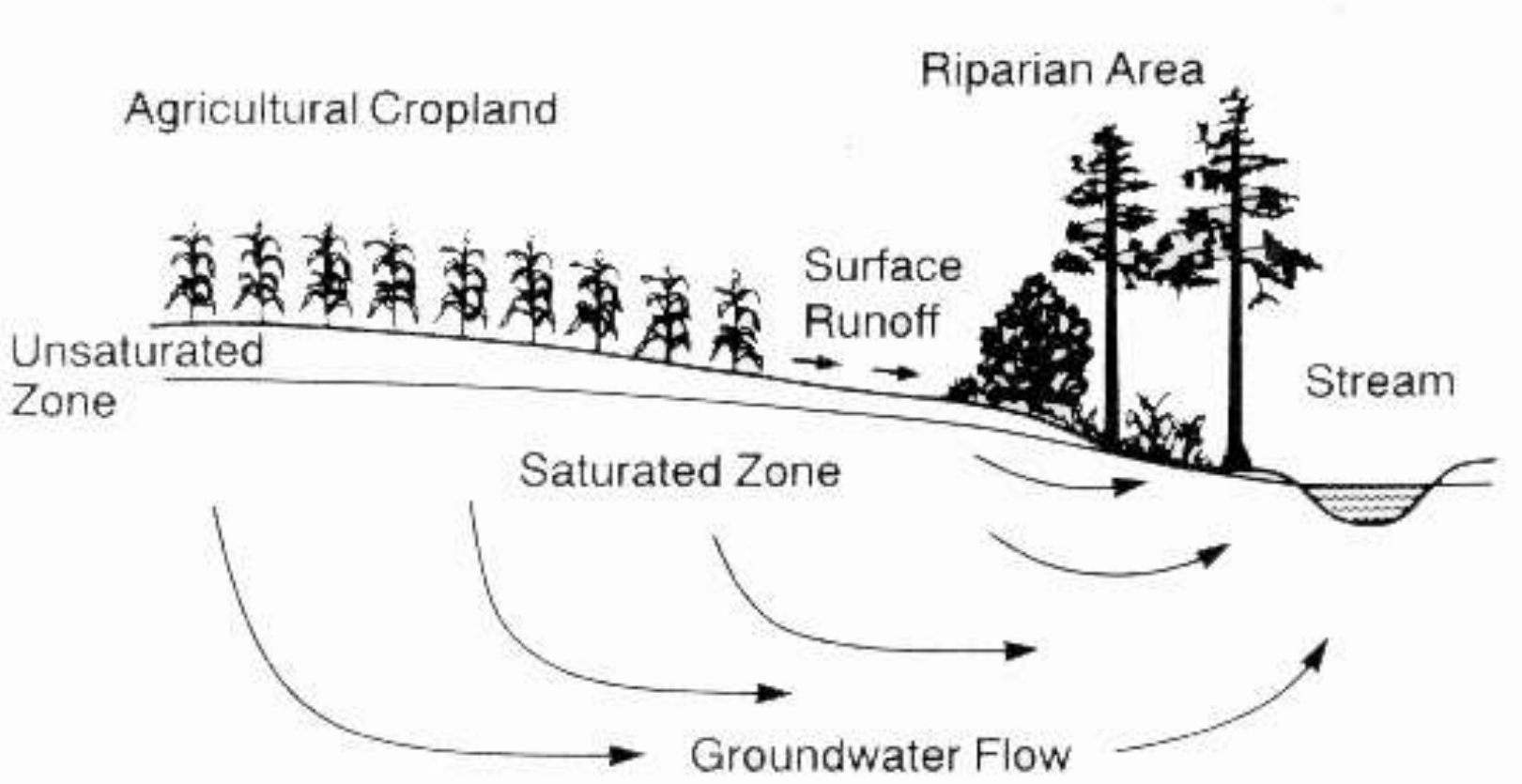
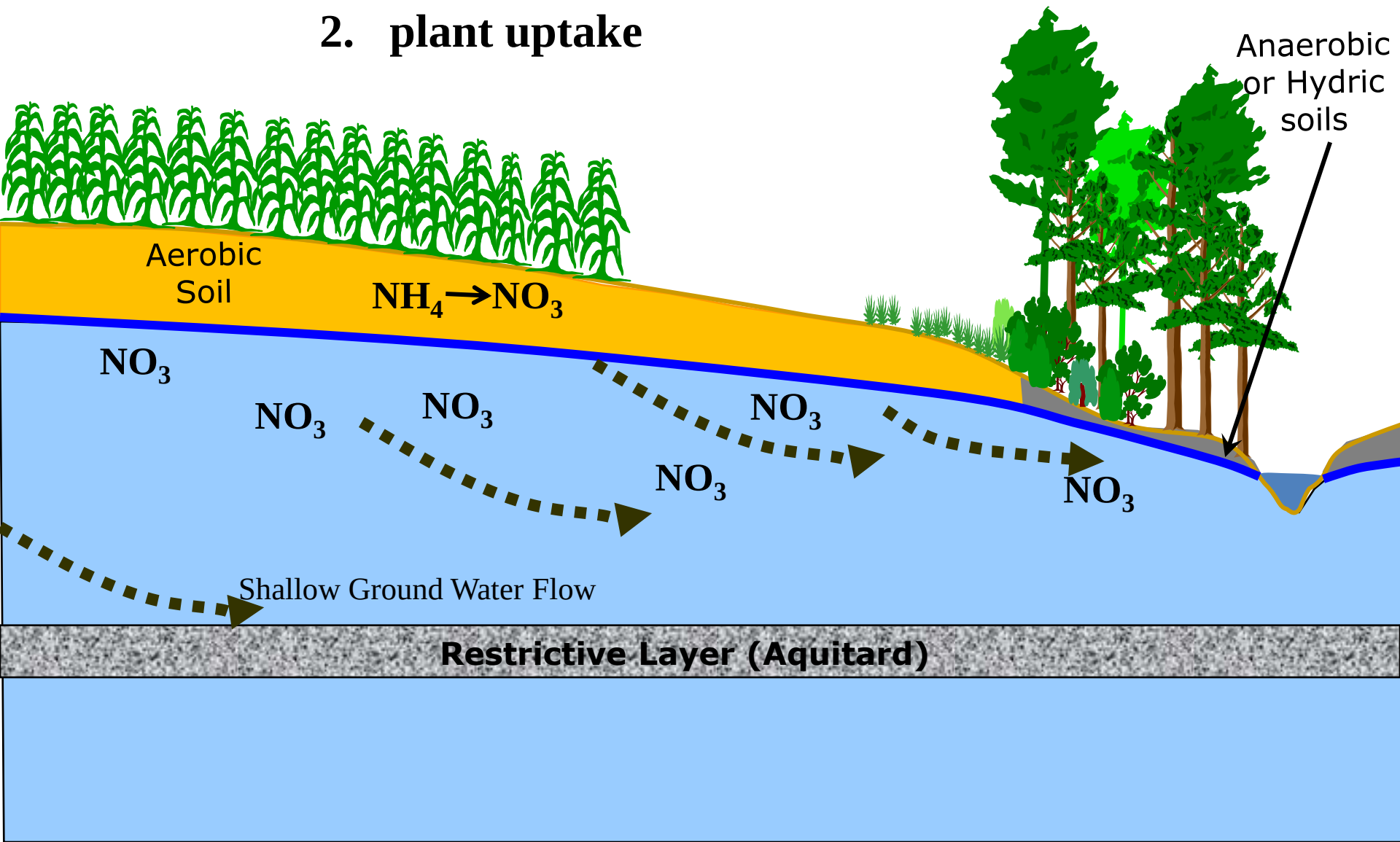
4. Reduce nitrate-nitrogen from groundwater before it discharges to the stream



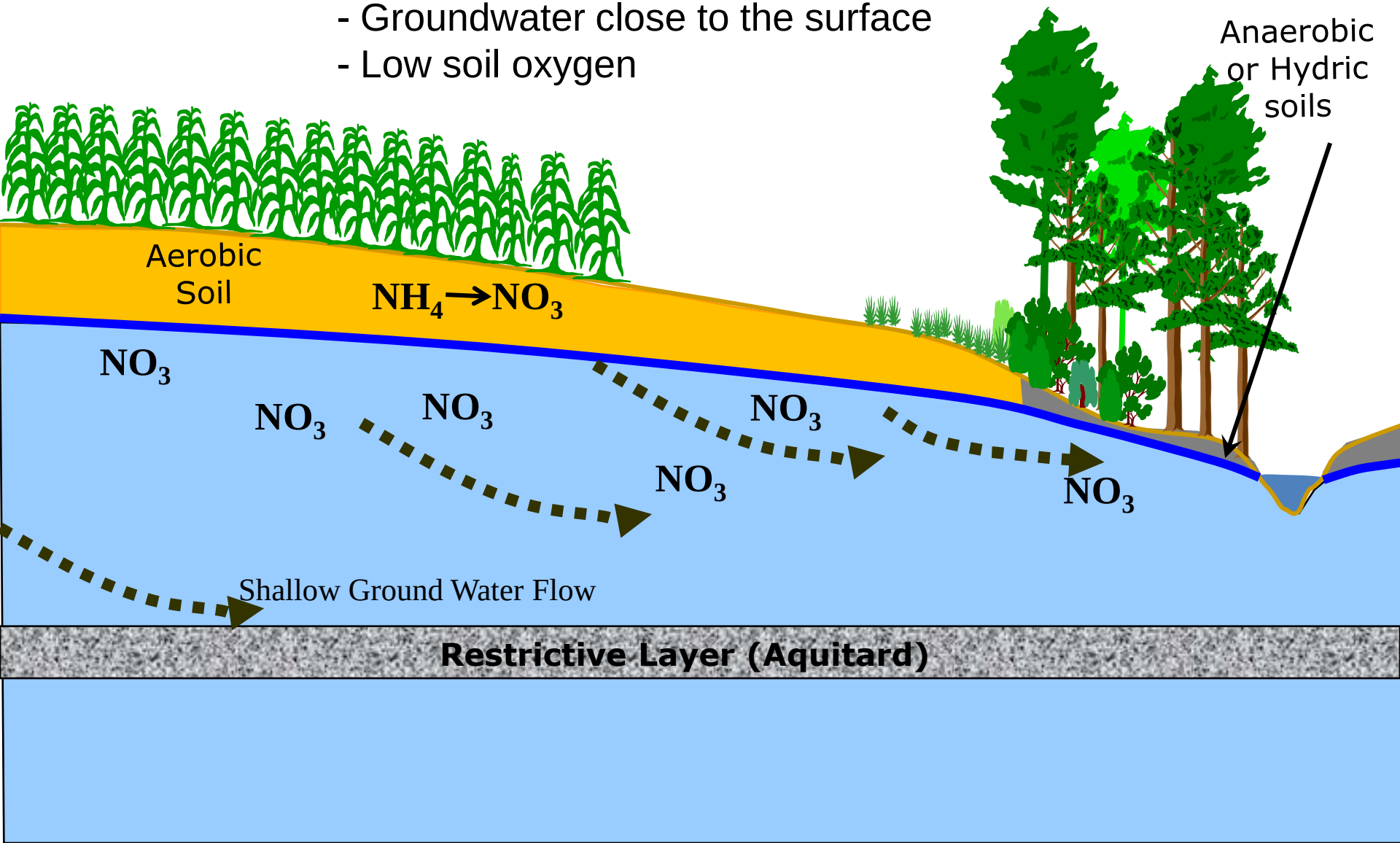
Buffers **can** be effective sinks of NO_3 through

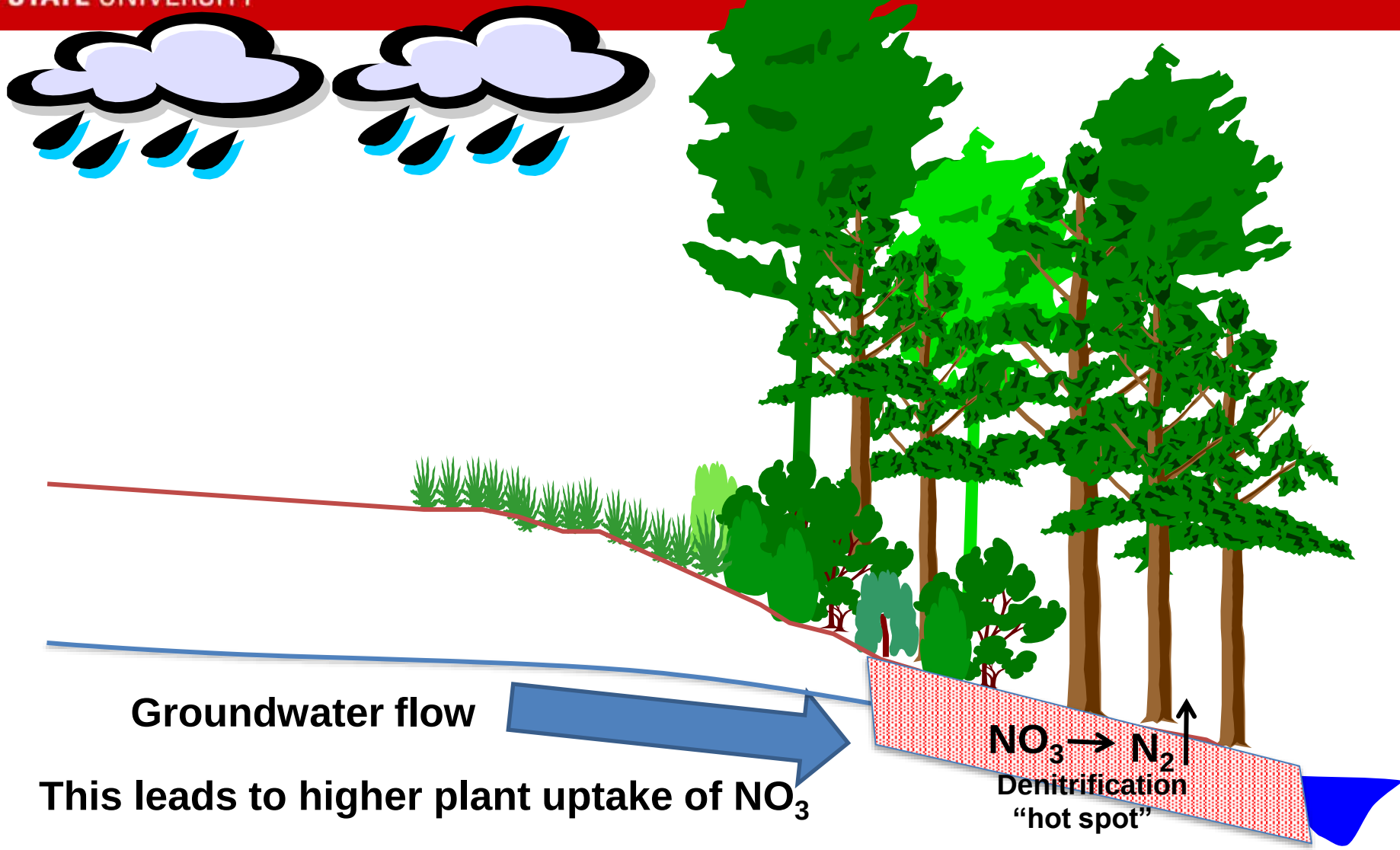
1. **microbial denitrification**
2. **plant uptake**



This is because areas in the floodplain have:

- High plant productivity
- High soil carbon
- Groundwater close to the surface
- Low soil oxygen



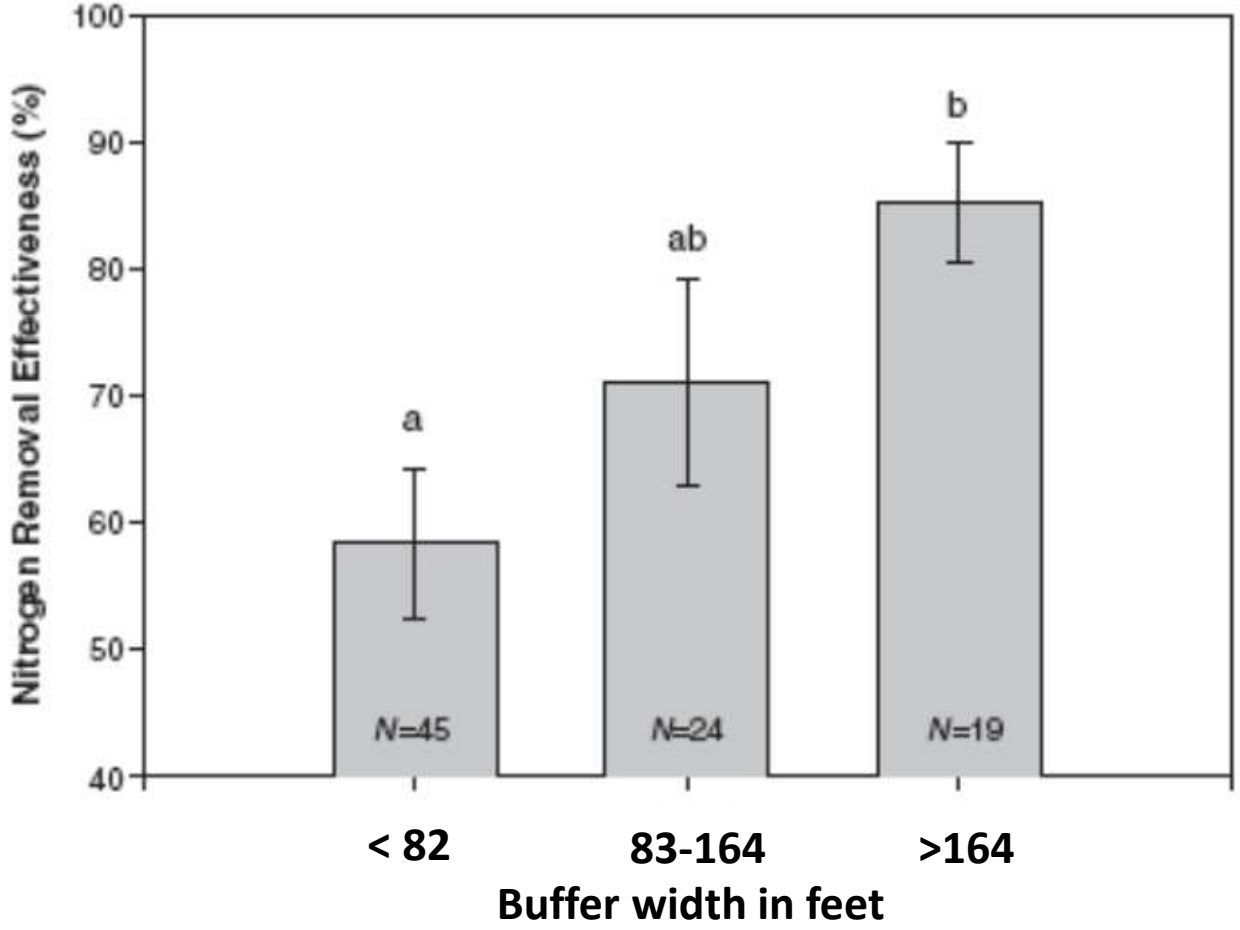


- This leads to higher plant uptake of NO_3
- In the absence of oxygen, soil microbes use NO_3 instead (denitrification) and release N_2 to the atmosphere
- Both processes combine for significant potential removal of N

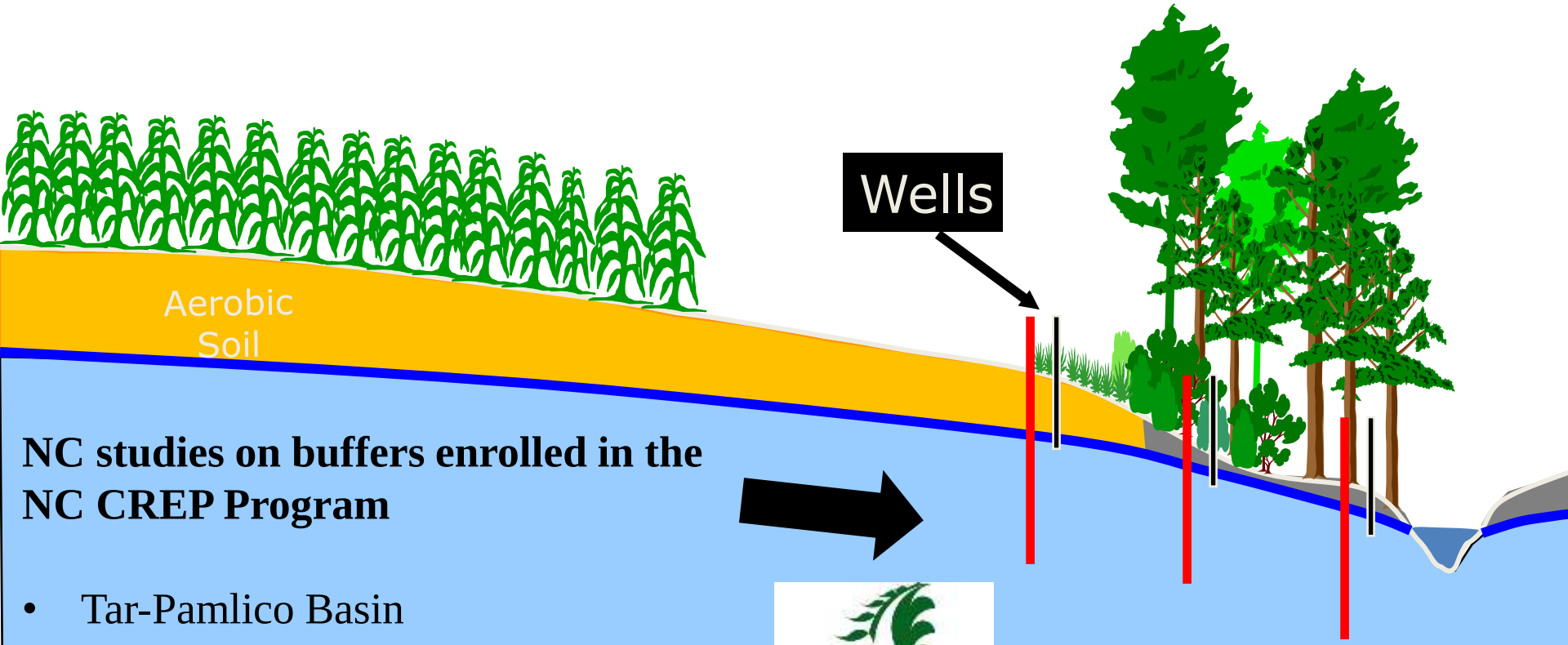
Other analysis on nitrogen removal

Note: Surface+subsurface contributions

- Mayer et al. 2007 at 88 sites



Grass Pines Hardwoods

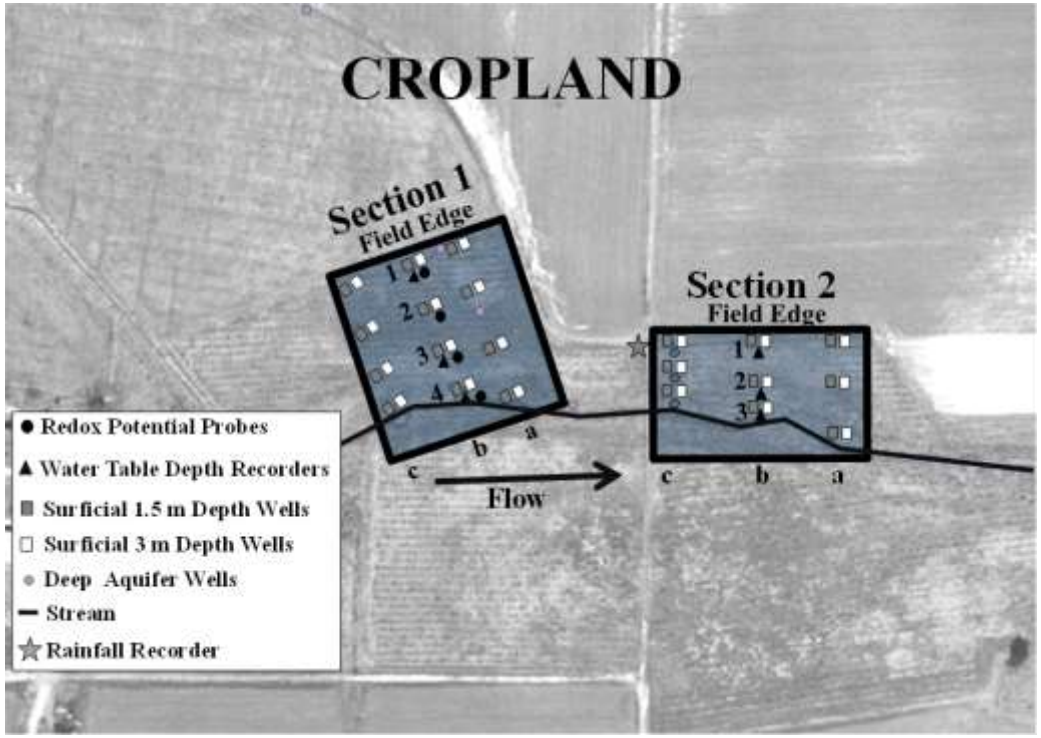


NC studies on buffers enrolled in the NC CREP Program

- Tar-Pamlico Basin
- 2-5 years data
- 54-72 groundwater wells per site across experimental blocks
- Typical experimental setup

CREP
Conservation Reserve Enhancement Program

Site 1



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Groundwater nitrate reductions within upstream and downstream sections of a riparian buffer

Tiffany L. Messer[a], Michael R. Burchell II[a], Garry L. Grabow[a], Deanna L. Osmond[b]

NO_3-N Source - Cropland

Section 1 (200 ft width)

- Groundwater at Field Edge
  4 mg/L NO_3-N
- Higher Elevation

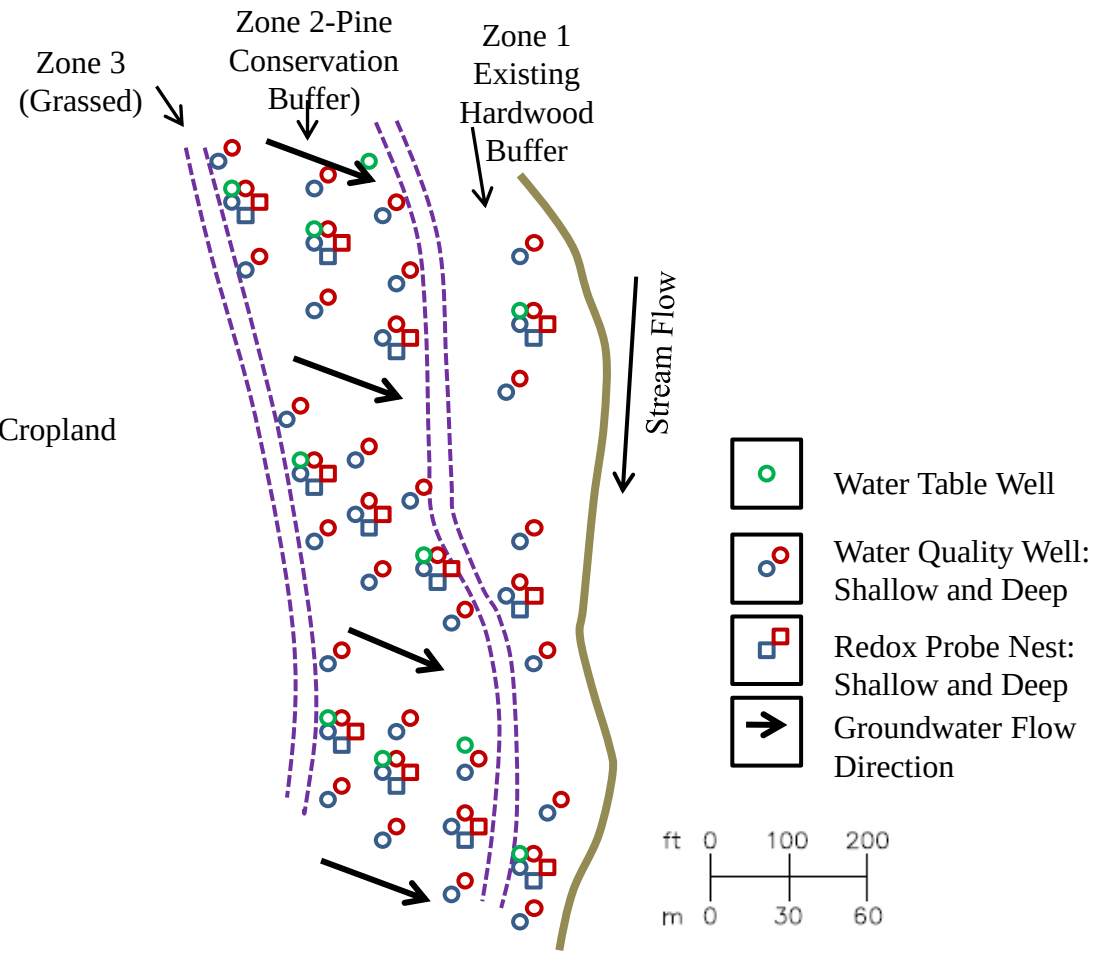
Shallow– 63% reduction
Deep – 15% reduction

Section 2 (150 ft width)

- Groundwater at Field Edge
  12 mg/L NO_3-N
- Lower Elevation
- Wetland indicators

Shallow– 89% reduction
Deep – 54% reduction

Site 2



NO_3 -N Source – Cropland

3 Blocks (390 ft width)

Zone 1 Existing Hardwood Buffer

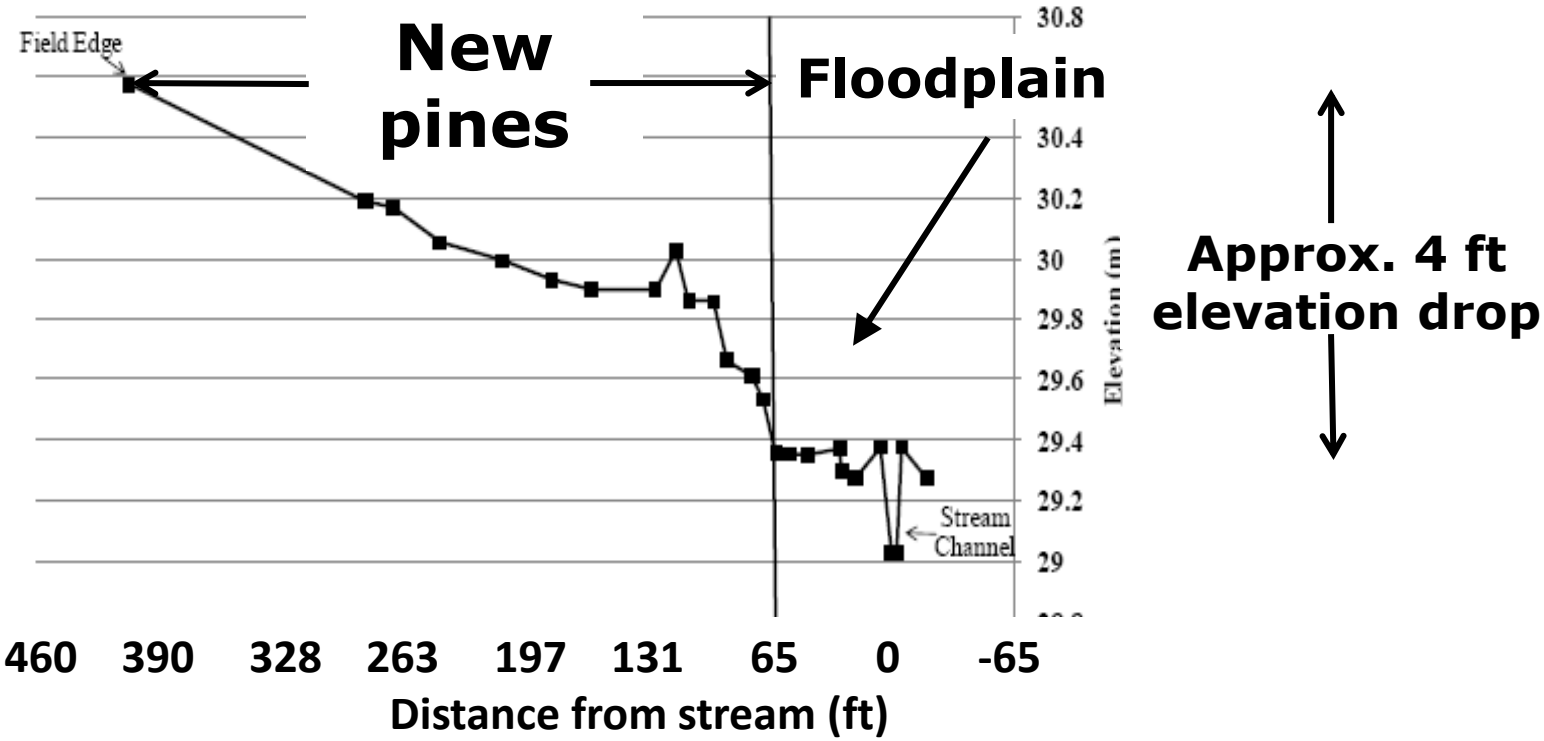
Ecological Engineering

Riparian buffer located in an upland landscape position does not enhance nitrate-nitrogen removal

Sara R. Johnson, Michael R. Burchell II, Robert O. Evans, Deanna L. Osmond, J. Wendell Gilliam

– "A misunderstood paper"

Site 2 – Elevation cross section



Limited Nitrate removal

20-80% removal in floodplain

Treatment DID OCCUR in the existing hardwood forest within the **floodplain** within the last **65-75 feet** to the stream

Conclusions

- Riparian Buffers can:
  1. **Protect stream structure**
  2. **Enhance the aquatic environment**
  3. **Reduce sediment and phosphorus from surface runoff**
  4. **Reduce nitrate-nitrogen from groundwater before it discharges to the stream**

- Often, riparian buffers will provide most of these important functions at all sites

- Research strongly supports the fact that buffers are a critical component of successful water quality protection strategy in NC watersheds

Conclusions

- Overall, research indicates most buffer functions approach a maximum at or above 100 feet and start to diminish at different rates as buffers widths get more narrow

- Reduction in the 50 ft width requirement could significantly reduce the effectiveness in N removal (less treatment area) and sediment removal (particularly on lands with higher slopes).

Questions?

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