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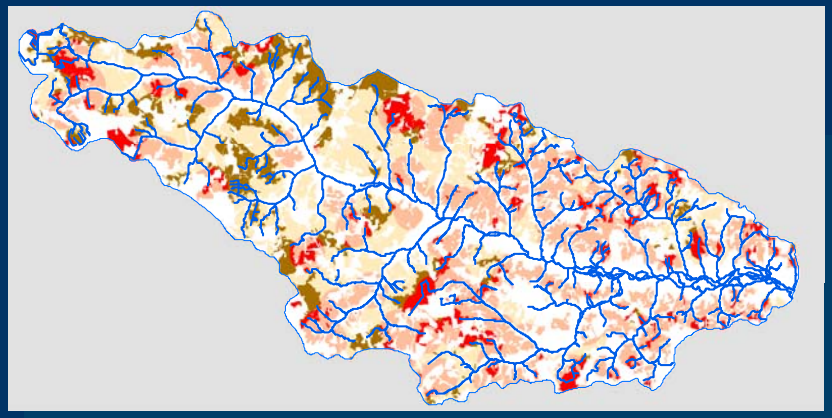
Effects of Stream and Elevation Resolution on Riparian Metrics and Restoration Identification



Jay Christensen & Donald Ebert

Landscape Ecology Branch

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

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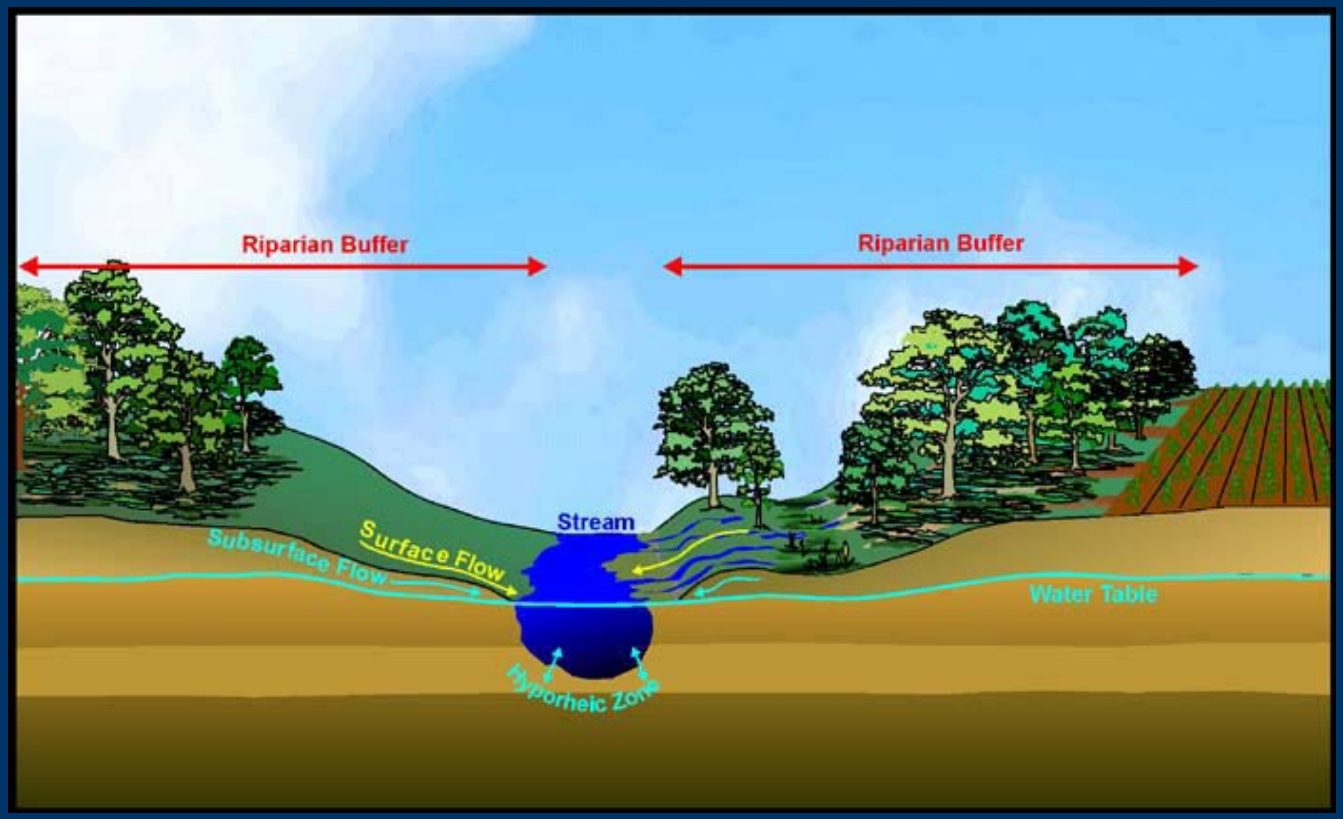
Influence of Riparian Buffers on Water Quality



Mayer et al. 2006

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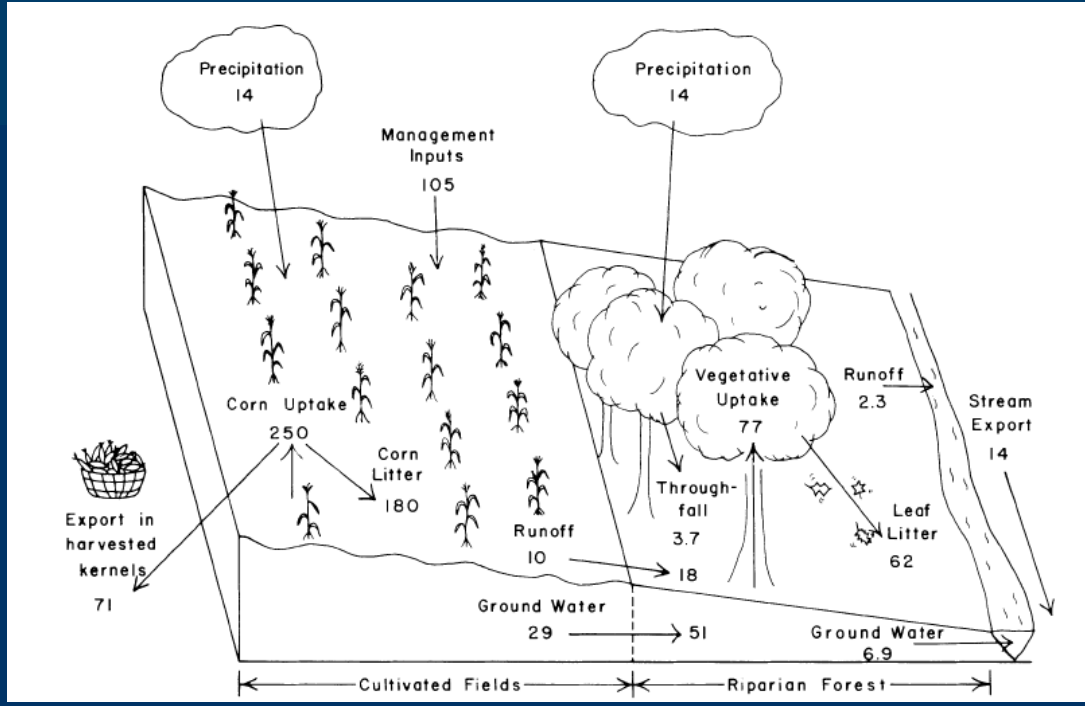
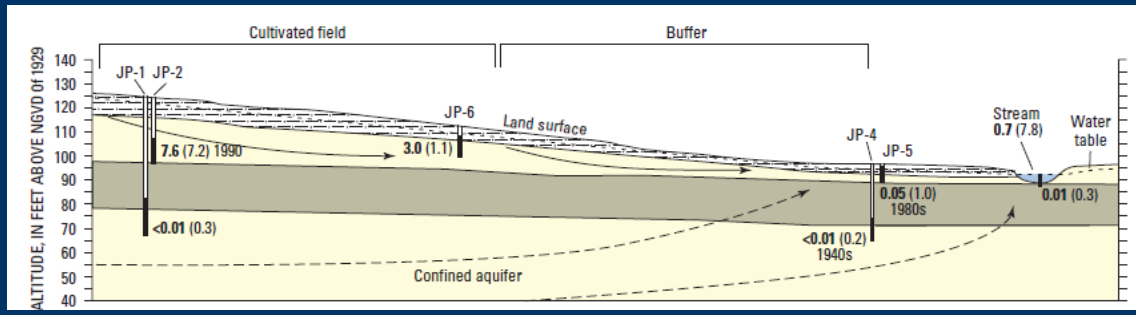
Influence of Riparian Buffers on Water Quality

- Field Scale
  - Transect studies showing nutrient and sediment losses
  - Reviews: Dosskey 2001, Mayer et al 2007



Peterjohn and Correll 1984



Harden and Spruill 2008

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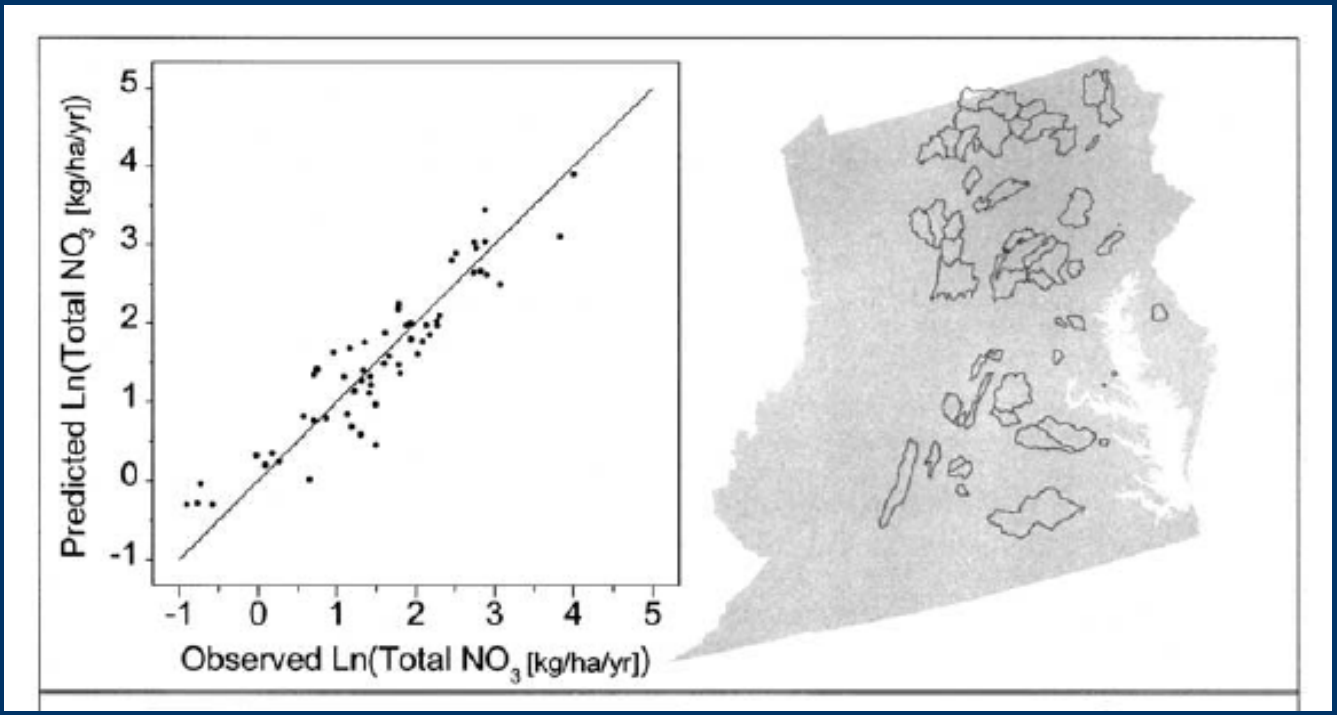
Influence of Riparian Buffers on Water Quality

- Watershed scale
  - Relationships of Landscape characteristics to WQ
    - Weller et al. 1996, Johnson et al. 1997, Baker et al 2001, Jones et al. 2001



Jones et al. 2001

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- Fixed width analysis within watershed studies
- Spatial location matters

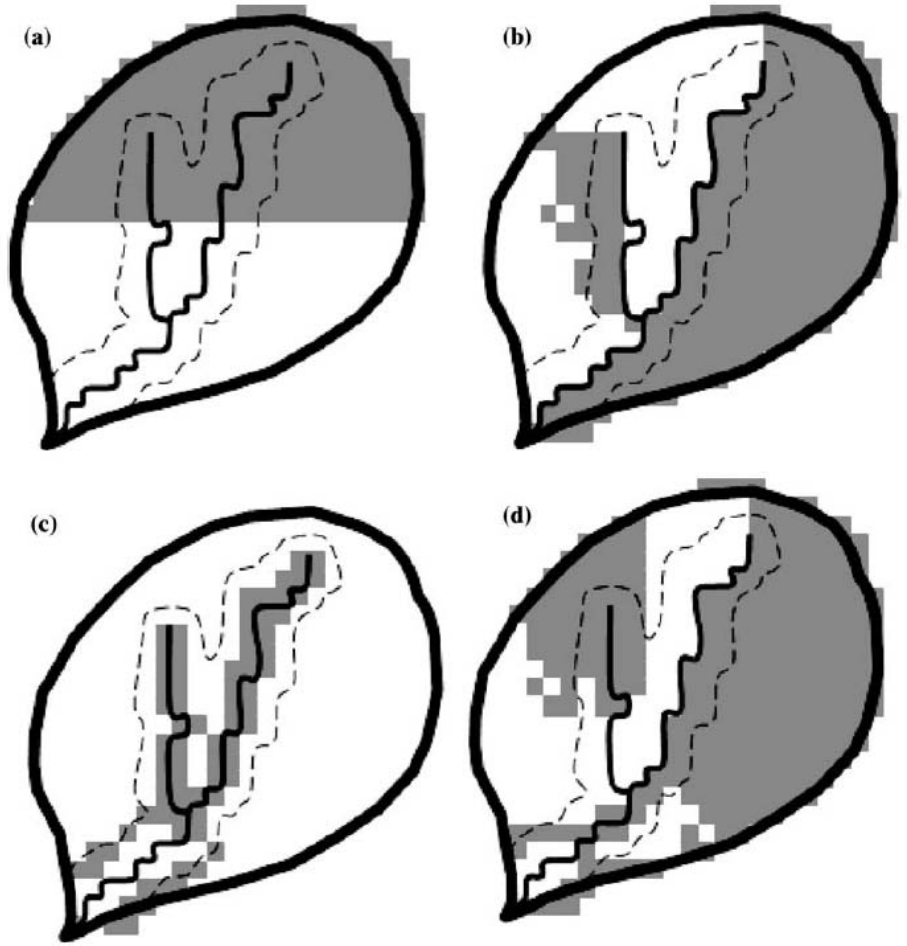

Fig. 2 Set of hypothetical watersheds with the same proportion of forests and wetlands (for-wet) within a fixed distance of the stream, but with different nutrient filtering potentials. The fixed-distance metric fails to account for a longitudinal patterns of land cover, **b** different buffer patterns on two stream banks, **c** contiguous versus disjunct near-stream for-wet, and **d** combinations of different patterns

Baker et al. 2006

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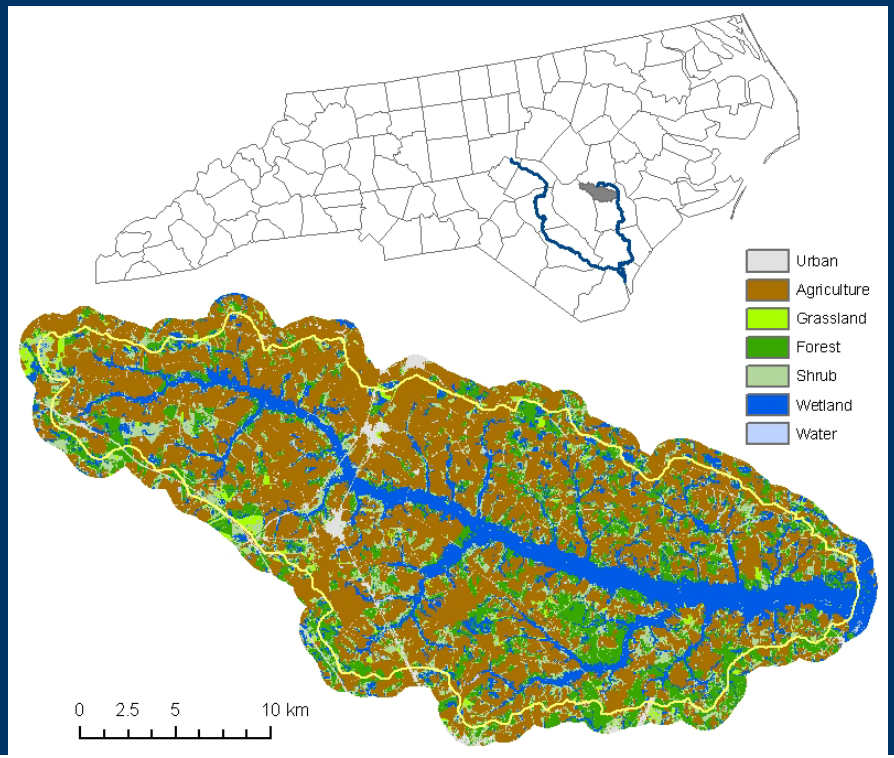
GIS Riparian tool

Baker et al. 2006

- Goal: “We focus on describing the connectivity of cropland to streams through riparian buffers”
- Goshen Swamp Catchment



- Tributary of NE Cape Fear River
- Catchment Area - 479 km2
- Ag – 52%,
- For/wet - 46%,
- Urban – 2%

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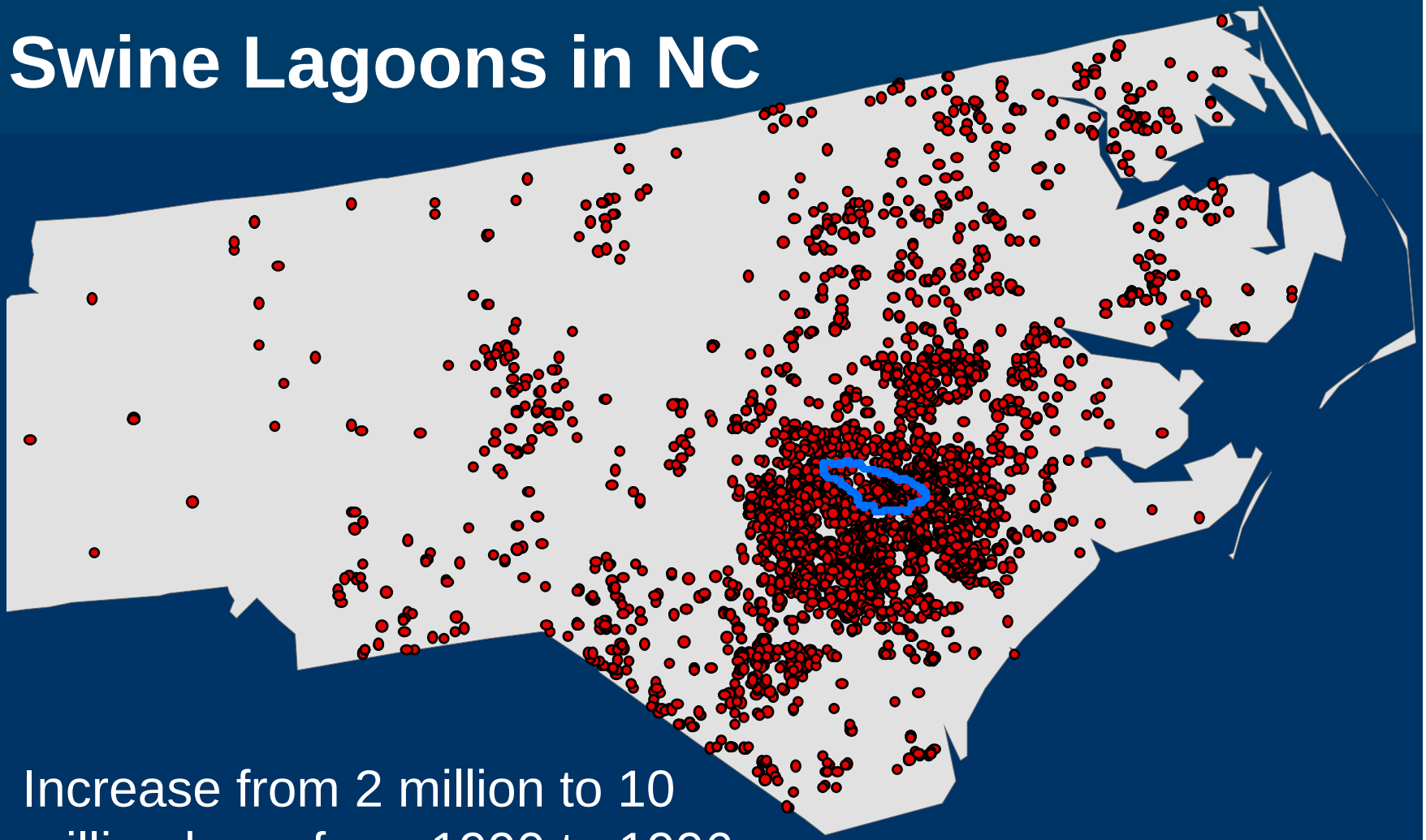
Swine Lagoons in NC



Increase from 2 million to 10 million hogs from 1990 to 1996

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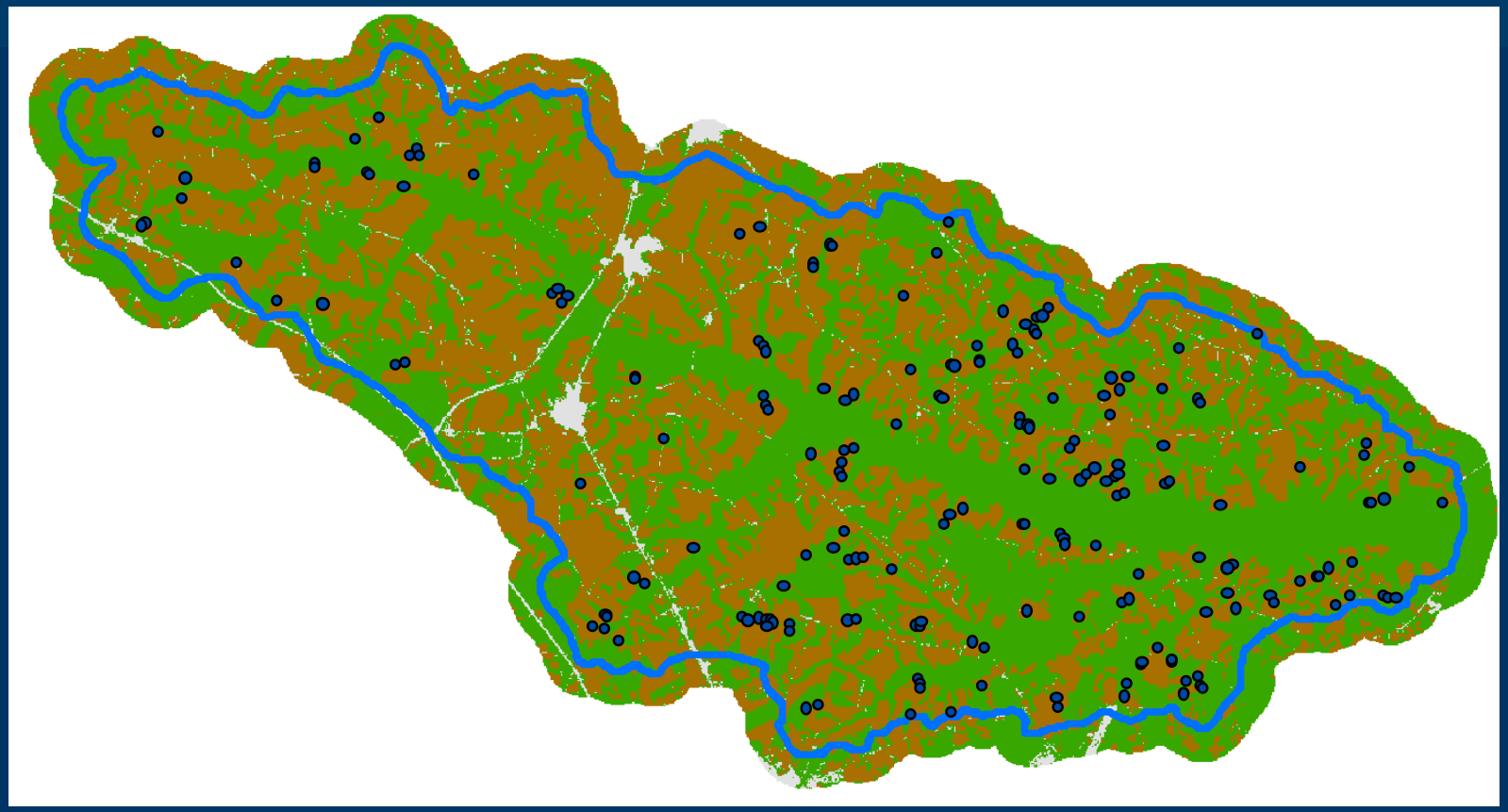
Swine Lagoons in Goshen Swamp



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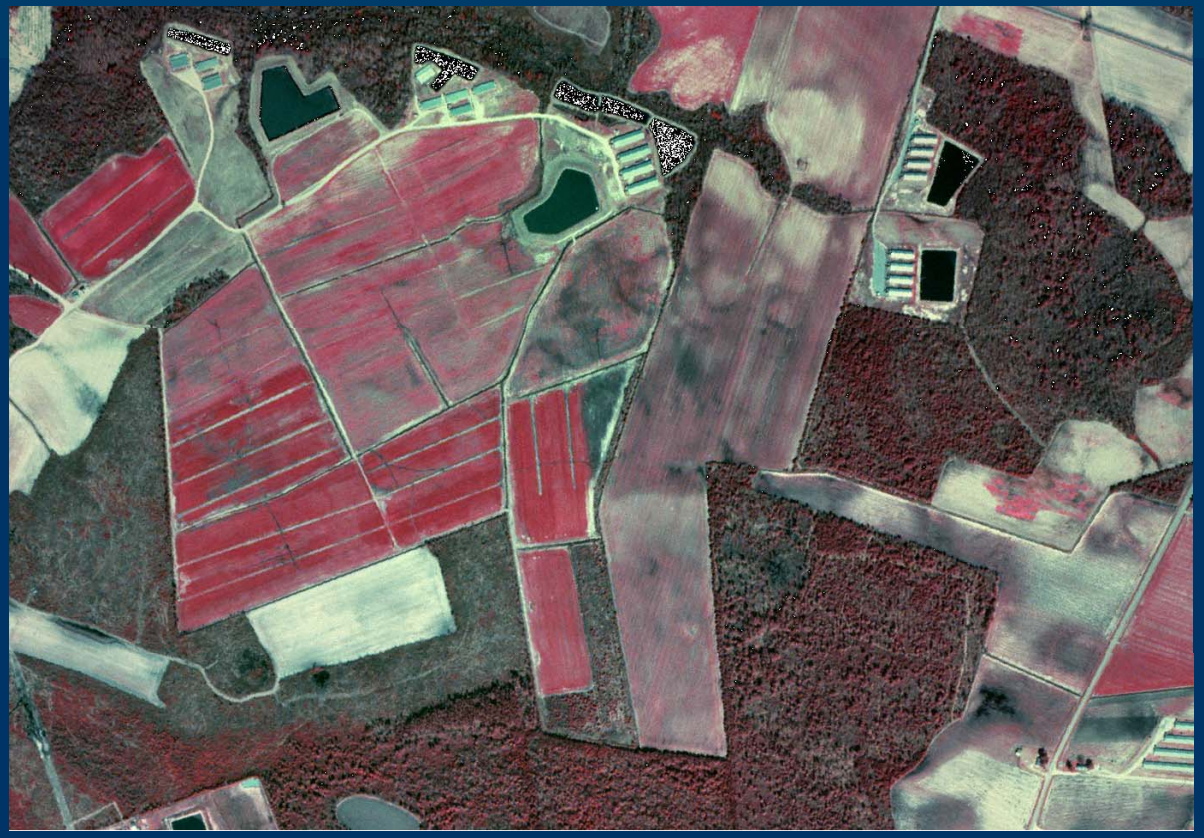
Swine lagoons surrounded by sprayfields



- Associated with increased concentrations of nutrients
- (Stone et al. 2004, Weldon & Hornbuckle 2004, Burkholder et al. 2007, Harden & Spruill 2008)

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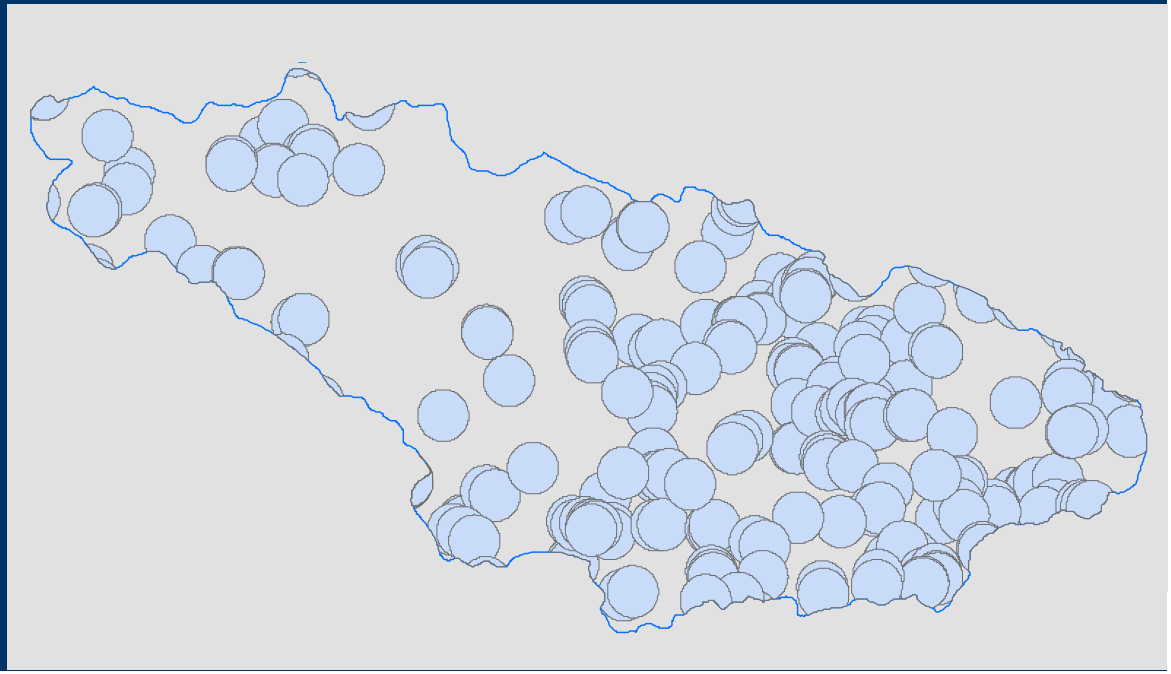
GIS Riparian tool

Goal: Describe the connectivity of cropland likely to be influenced by CAFOs to streams through riparian buffers and determine effect of input resolution

- Goshen Swamp Catchment

  - Method requires:
  - Elevation
  - Stream Network
  - Landcover
  - Estimation of spray fields



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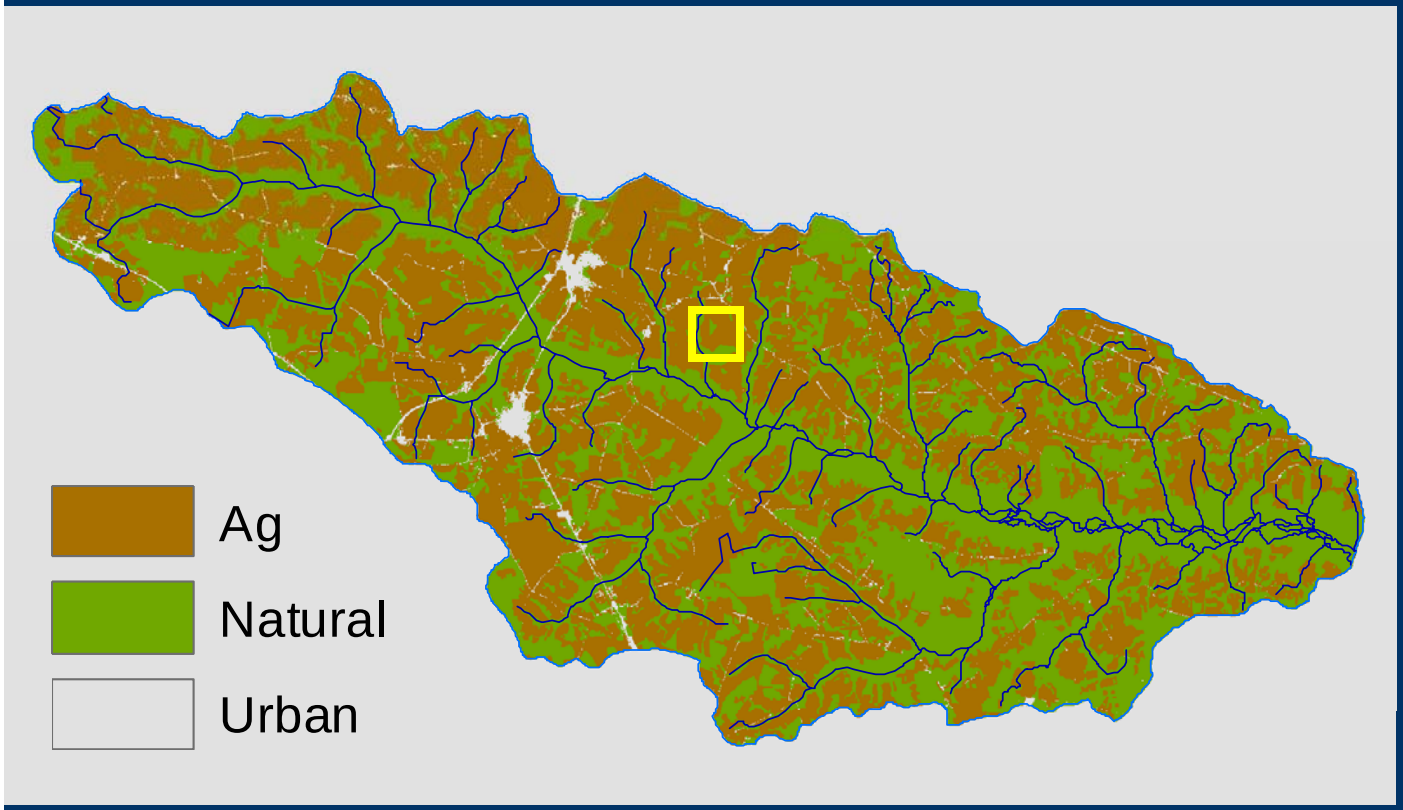
GIS Riparian tool

Methodology of Tool: GIS analysis



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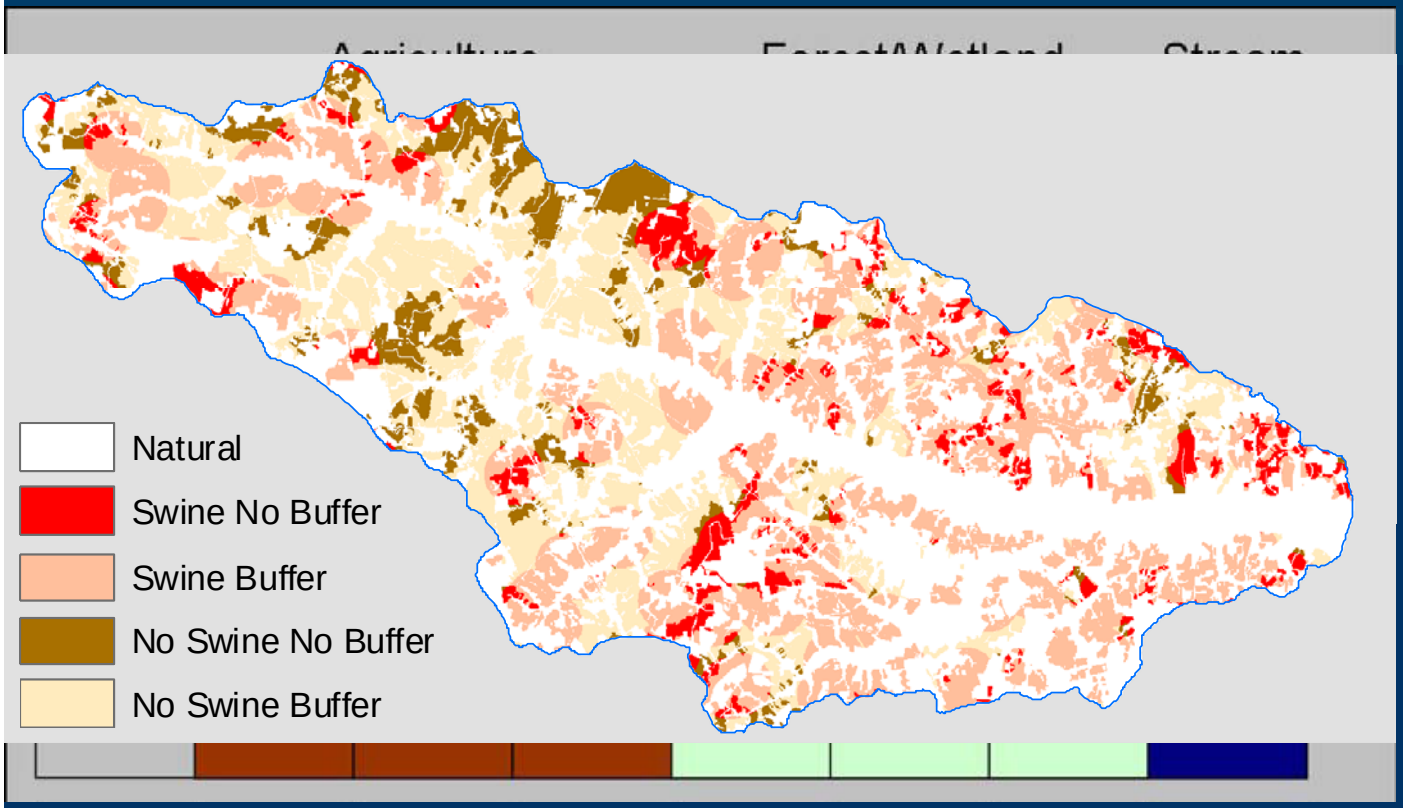
GIS Riparian tool



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

E) Binary selection: buffer or no buffer

F) Overlay with CAFO datalayer

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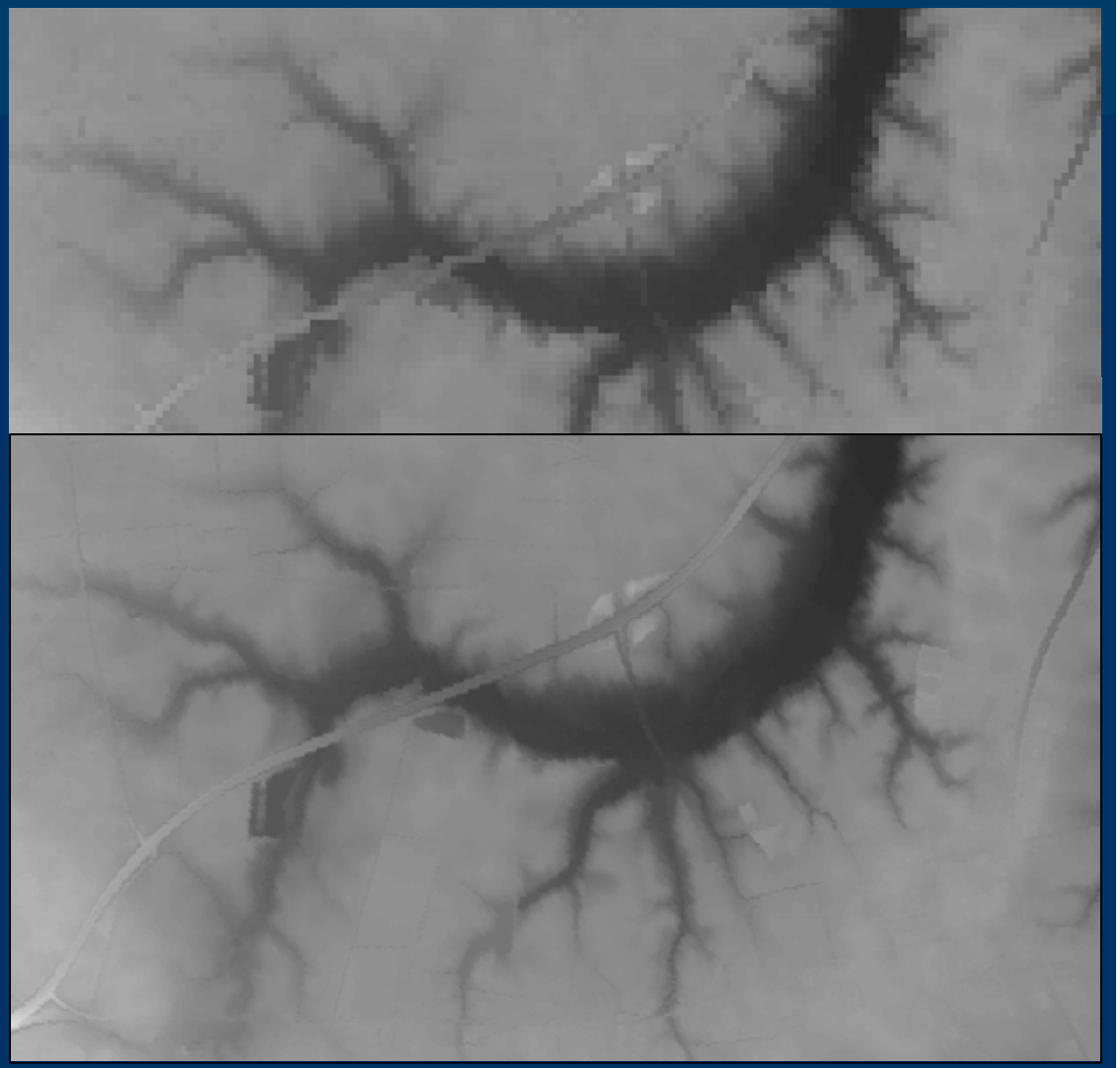
GIS Riparian tool DEM Resolution

- Metrics and interpretation are influenced by the resolution of the inputs
- (Baker et al. 2007)

  - Data availability & Computational capacity
  - versus
  - Representation of reality



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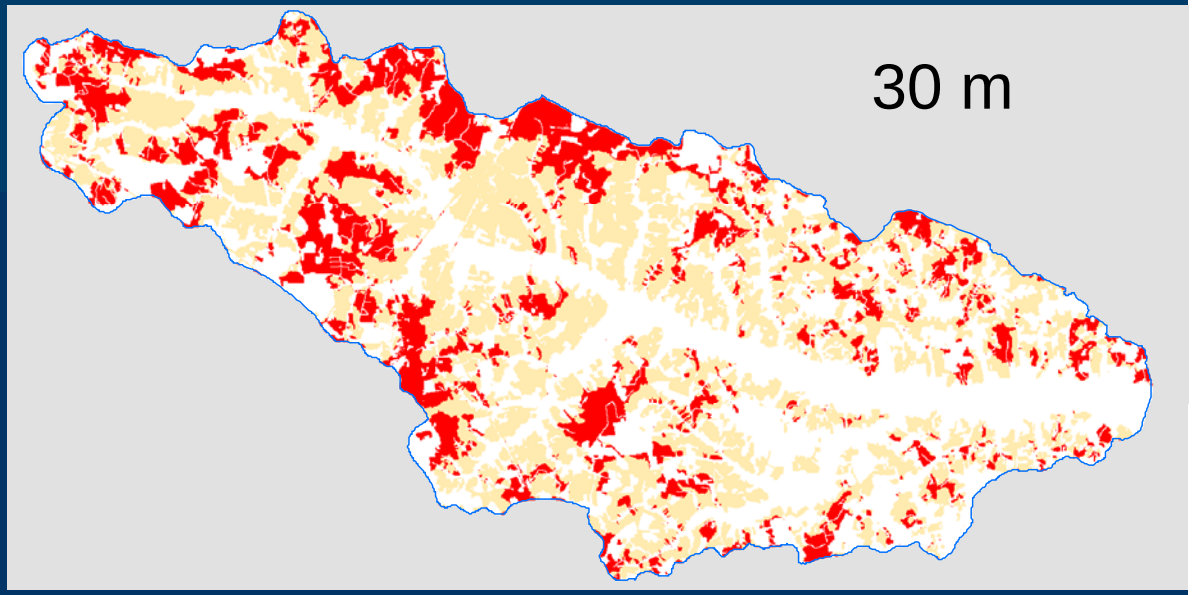
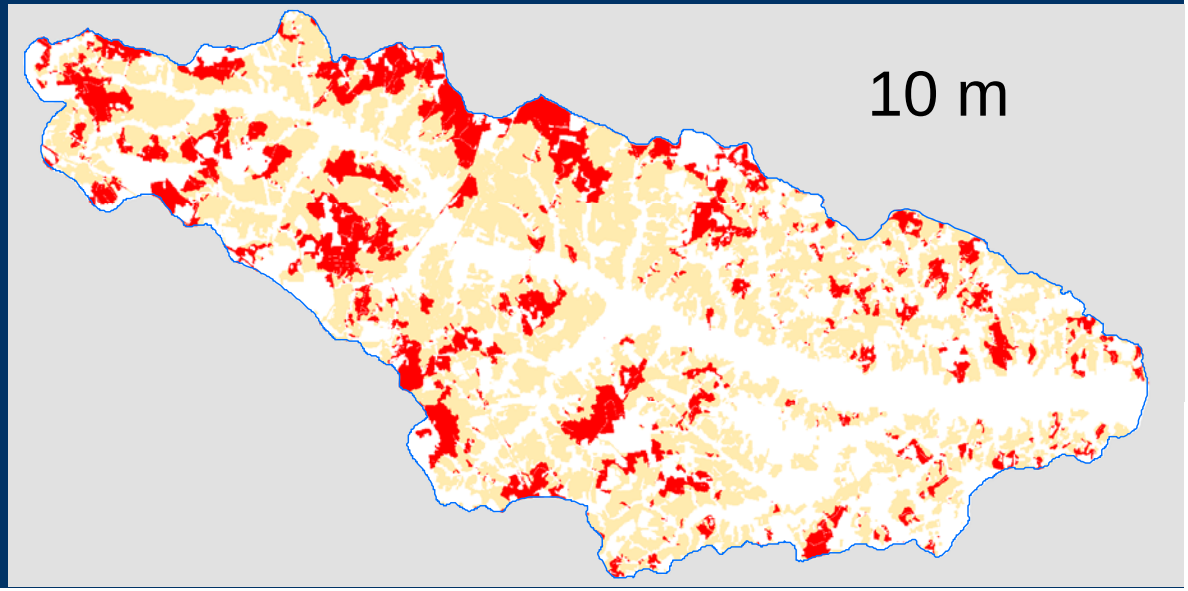
Results: DEM

- 42.1% of Goshen Buffered
- 11.3% of Goshen Non-Buffered



- 45.0% of Goshen Buffered
- 8.8% of Goshen Non-Buffered



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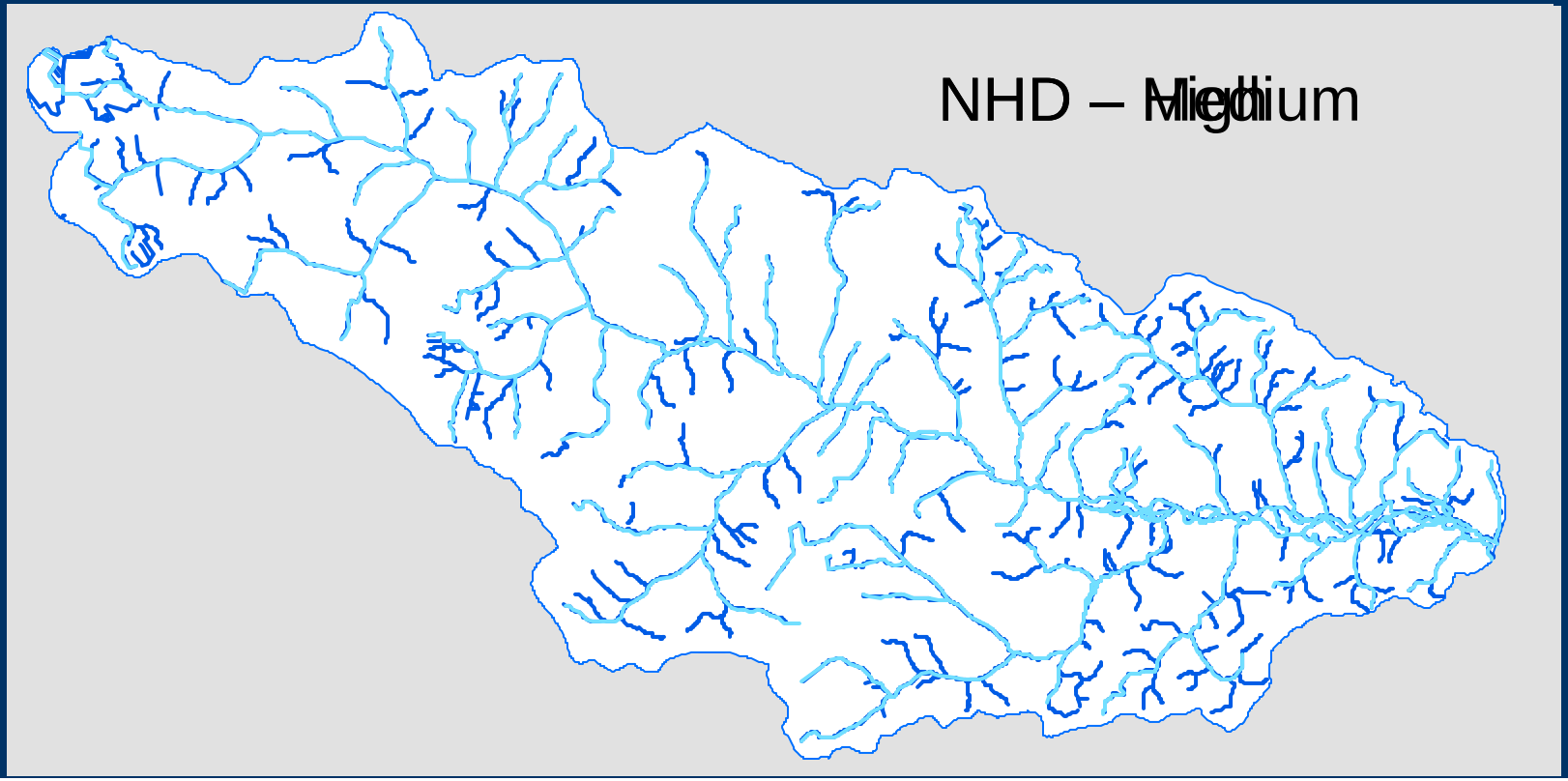
GIS Riparian tool Stream Resolution

- Metrics and interpretation are influenced by the resolution of the inputs
- (Baker et al. 2007)



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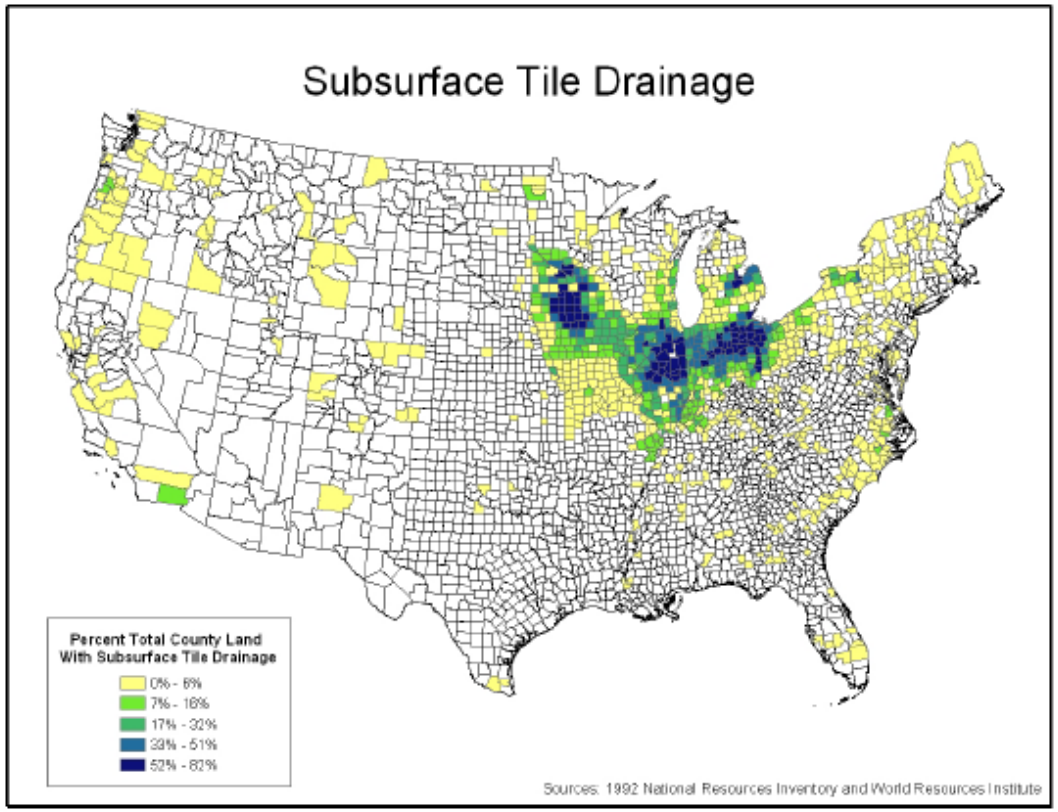
GIS Riparian tool Stream Resolution

Artificial Drainage

- Duplin County:
- Estimates of 7-10% tile drainage
- Estimates of 10-25% total artificial drainage
- No maps of connection to stream network



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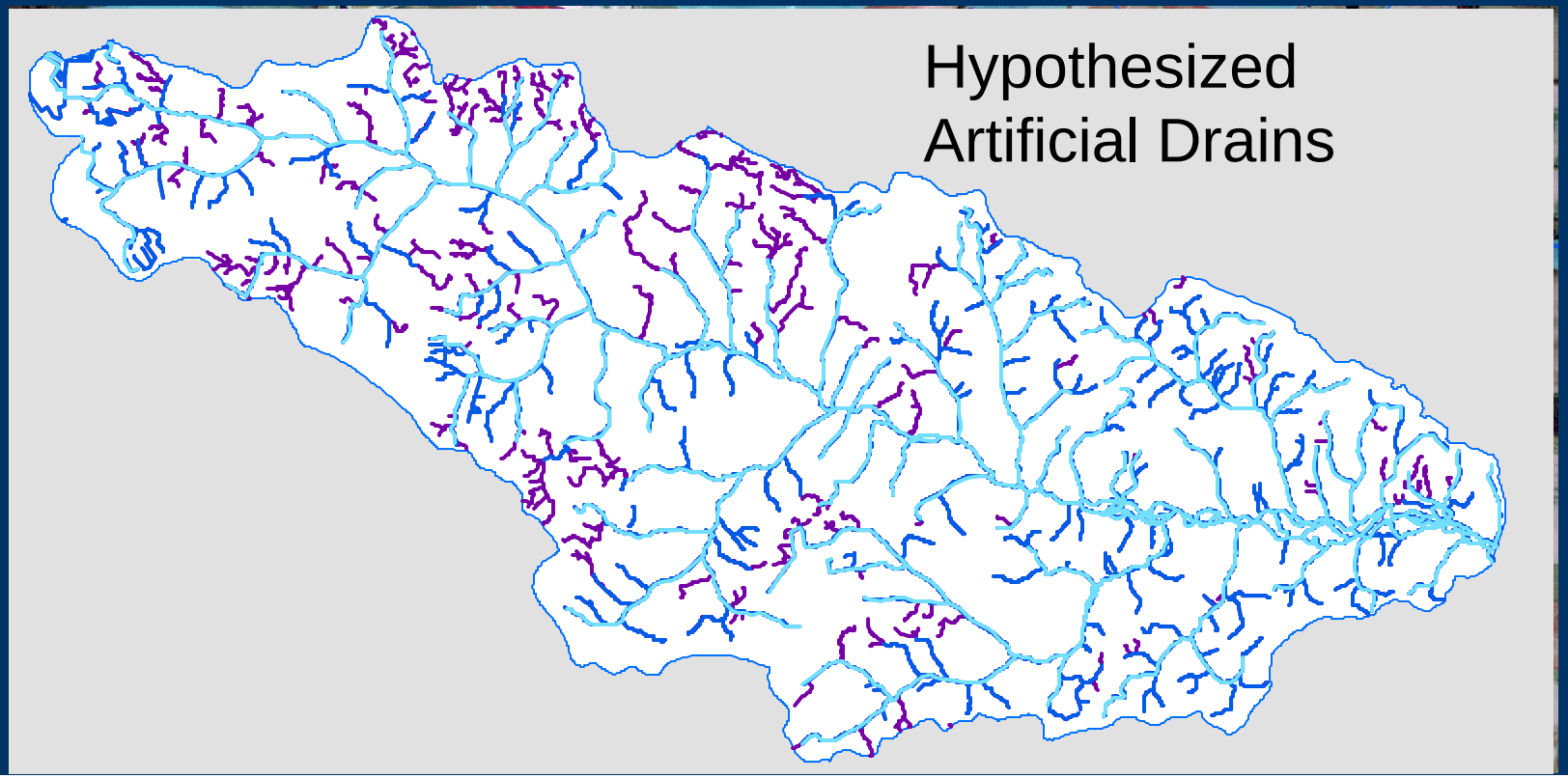
GIS Riparian tool Stream Resolution

- Artificial Drainage: 1) found average flow accumulation threshold of drains included in NHD High
- 2) Applied threshold to flowpaths on 7m DEM
- 3) Selected those reaches on agriculture with hydric soils



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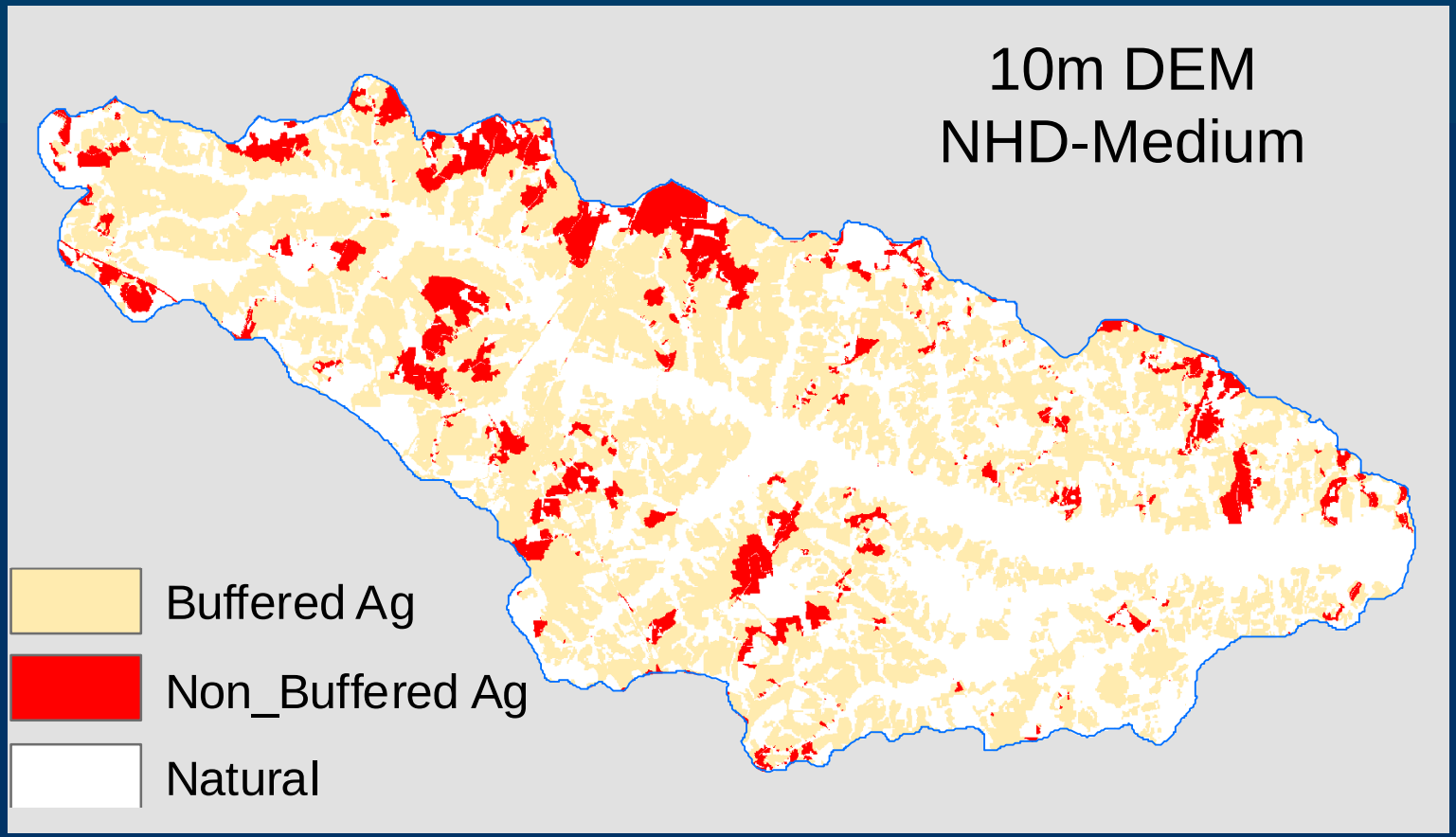
Results: Stream



- 45.0% of Goshen Buffered
- 8.8% of Goshen Non-Buffered

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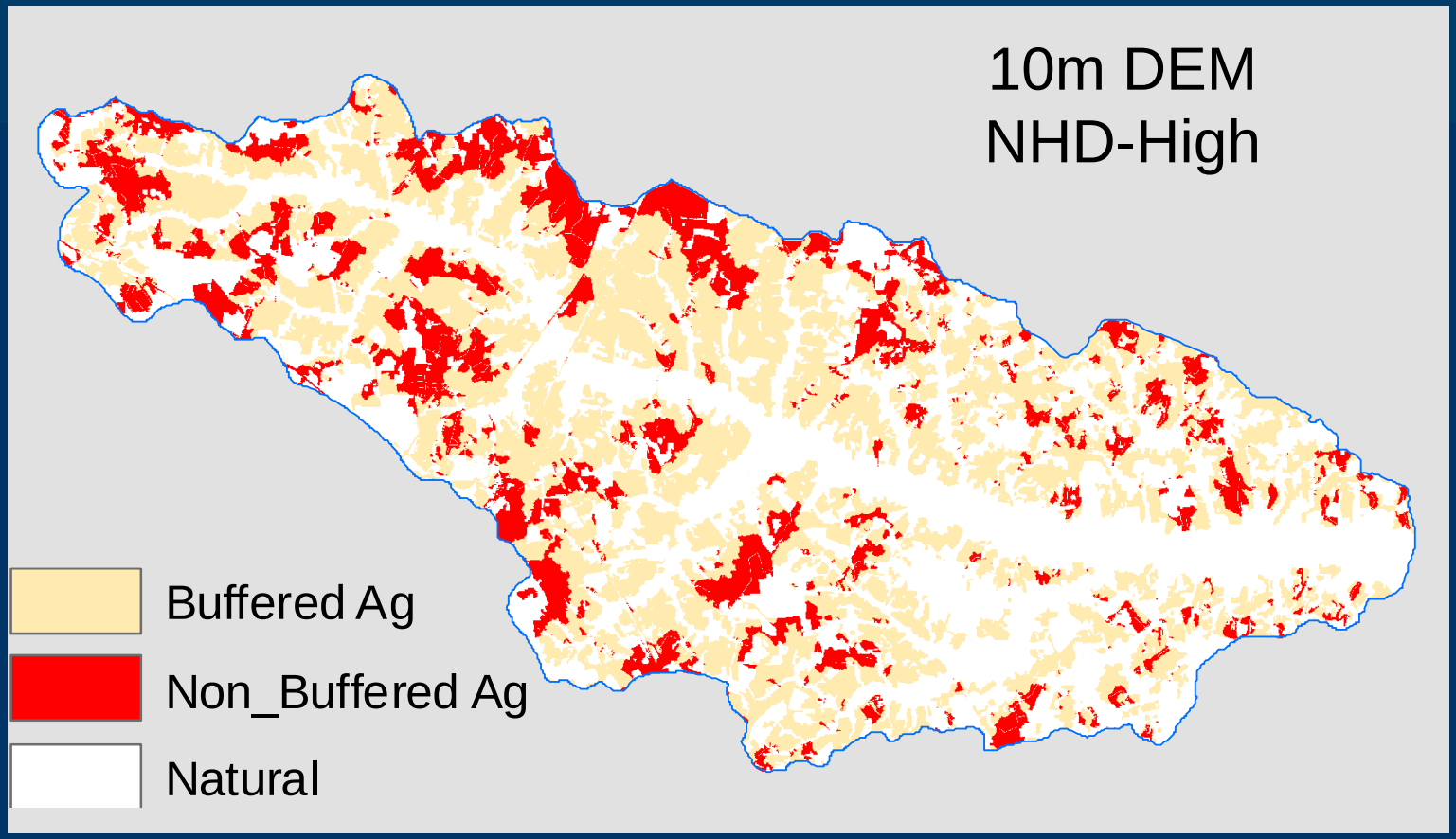
Results : Stream



- 38.9% of Goshen Buffered
- 14.7% of Goshen Non-Buffered

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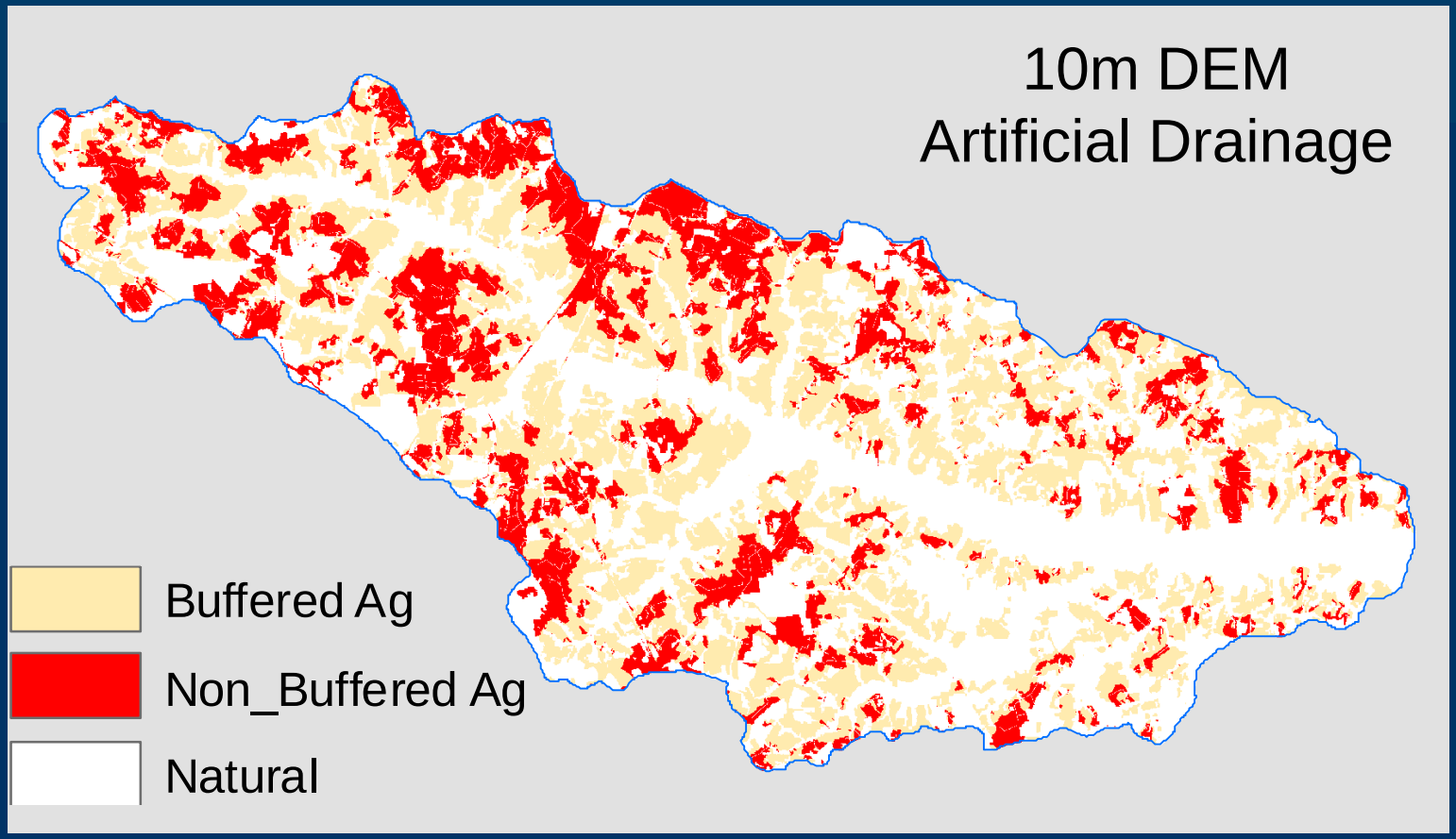
Results: Stream



- 34.0% of Goshen Buffered
- 19.3% of Goshen Non-Buffered

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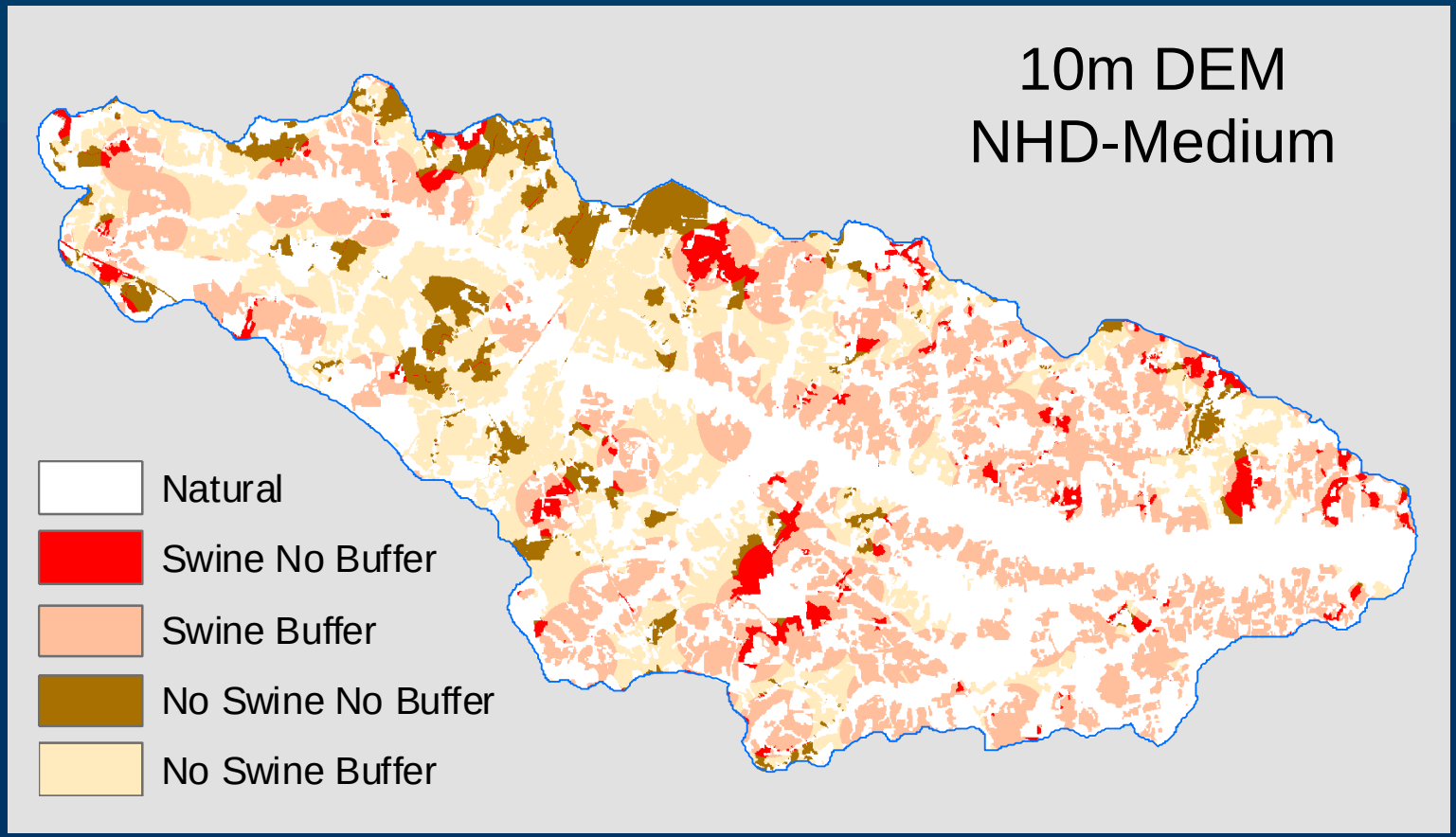
Buffer Output and Swine Lagoon Interaction



- 3.4% of Goshen – Swine and No Buffer (Red)
- 24.4% of Goshen – Swine and Buffer (Pink)
- 5.5% of Goshen – Non-swine Ag and No Buffer (Brown)

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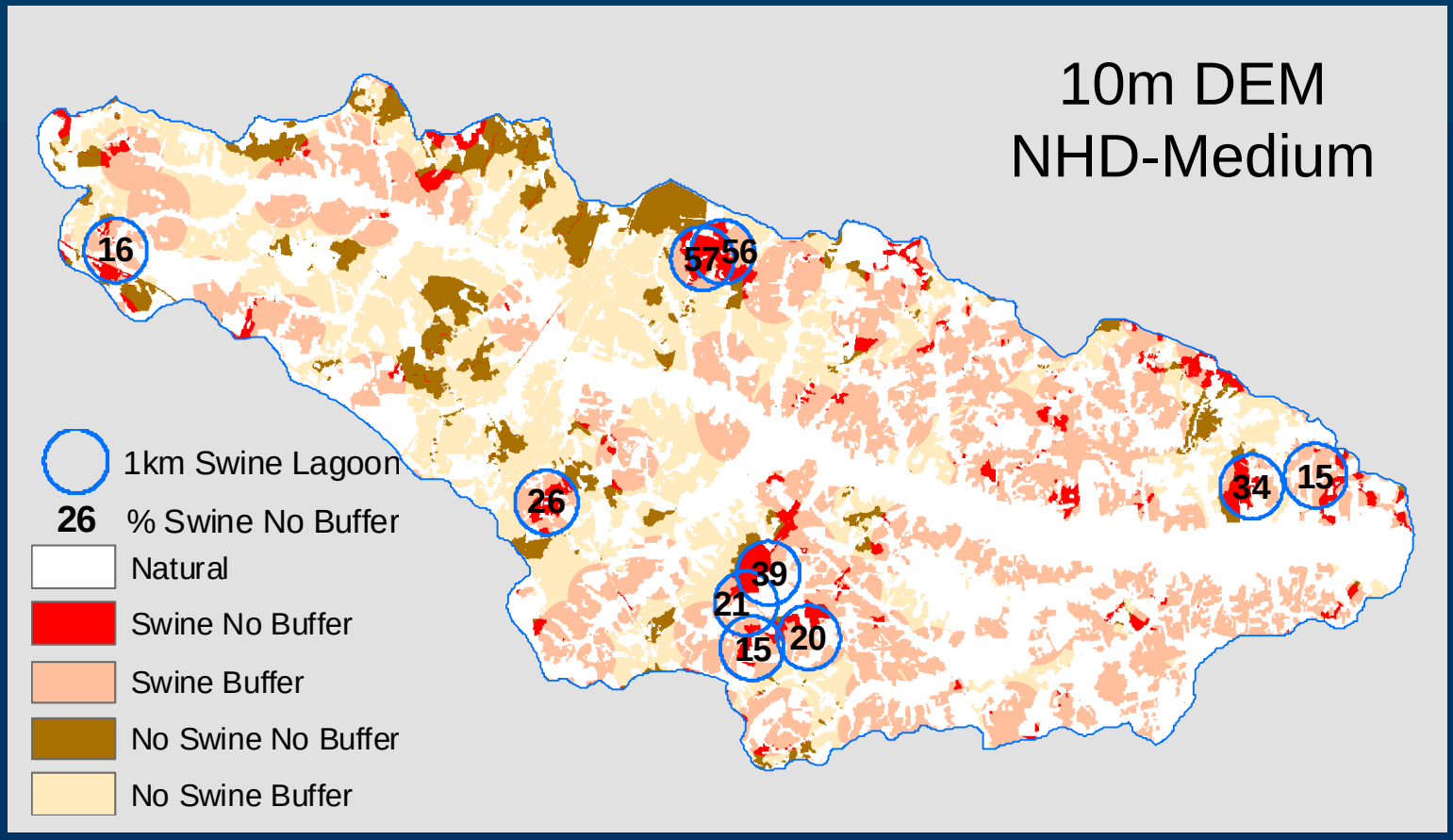
Selection of riparian restoration around CAFOs



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- 5.5% of Goshen – Non-swine Ag and No Buffer (Brown)

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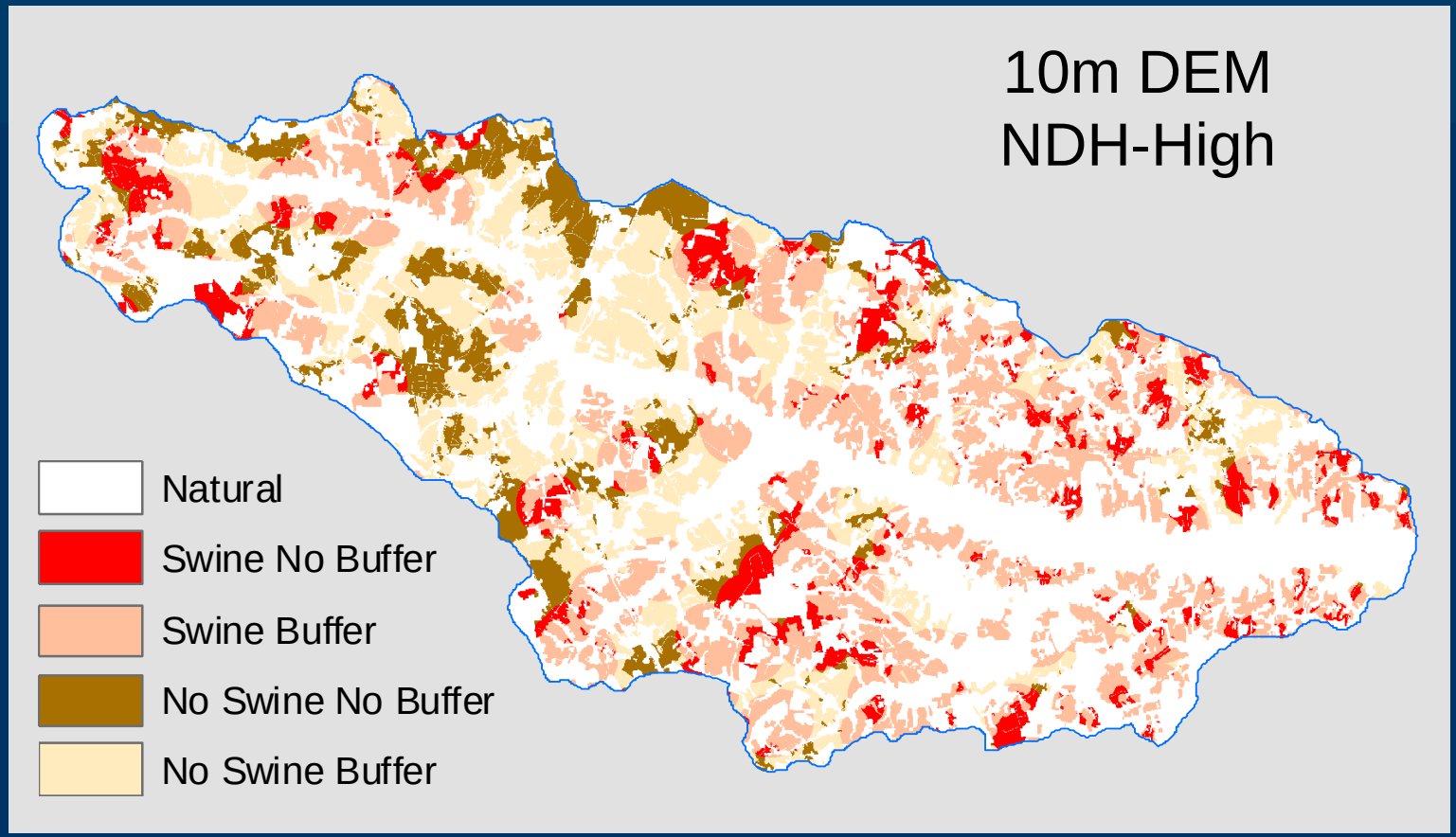
Buffer Output and Swine Lagoon Interaction



- 6.4% of Goshen – Swine and No Buffer (Red)
- 20.7% of Goshen – Swine and Buffer (Pink)
- 7.9% of Goshen – Non-swine Ag and No Buffer (Brown)

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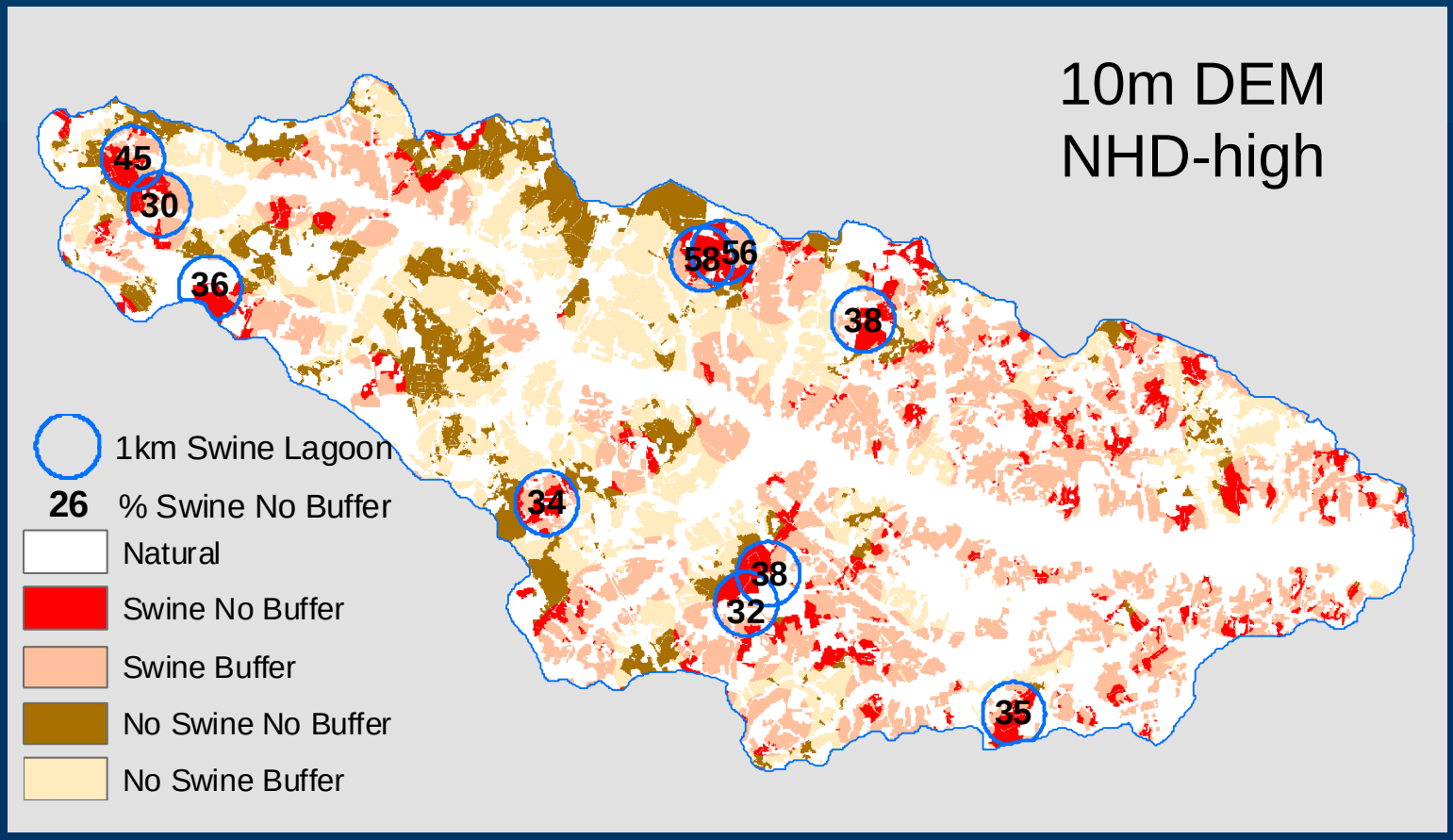
Selection of riparian restoration around CAFOs



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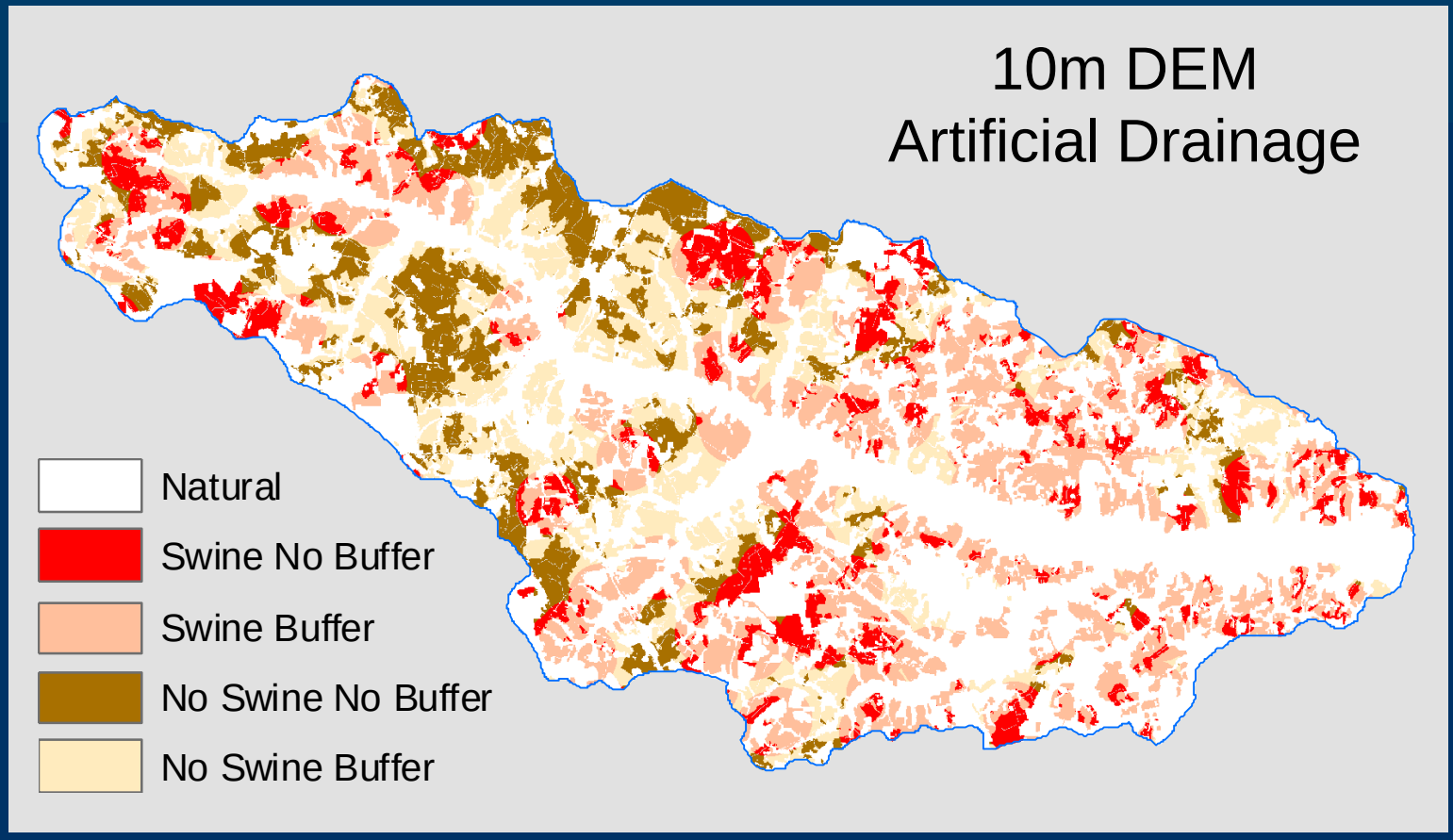

- 8.3% of Goshen – Swine and No Buffer (Red)
- 18.8% of Goshen – Swine and Buffer (Pink)
- 10.3% of Goshen – Non-swine Ag and No Buffer (Brown)

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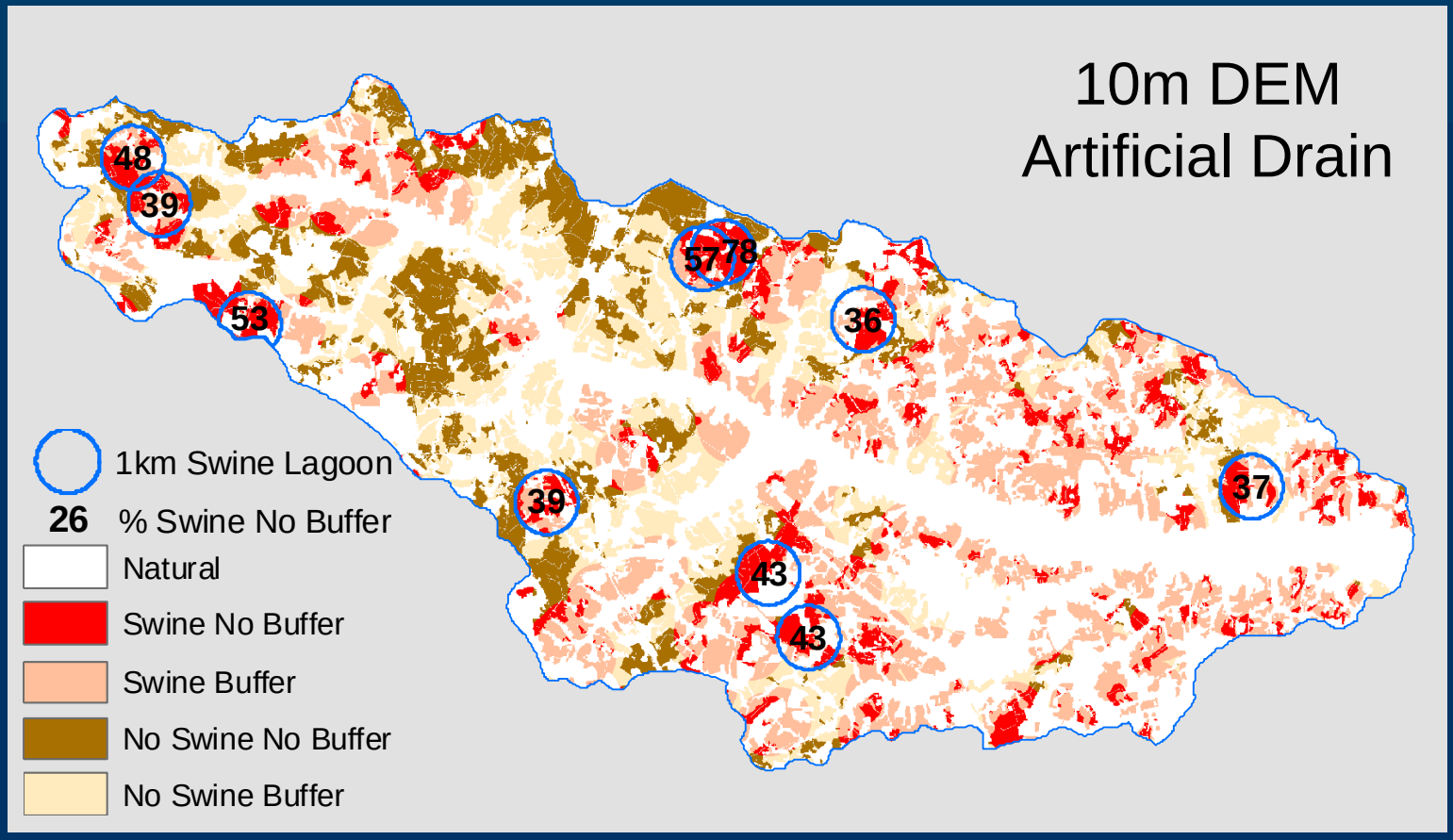
Selection of riparian restoration around CAFOs



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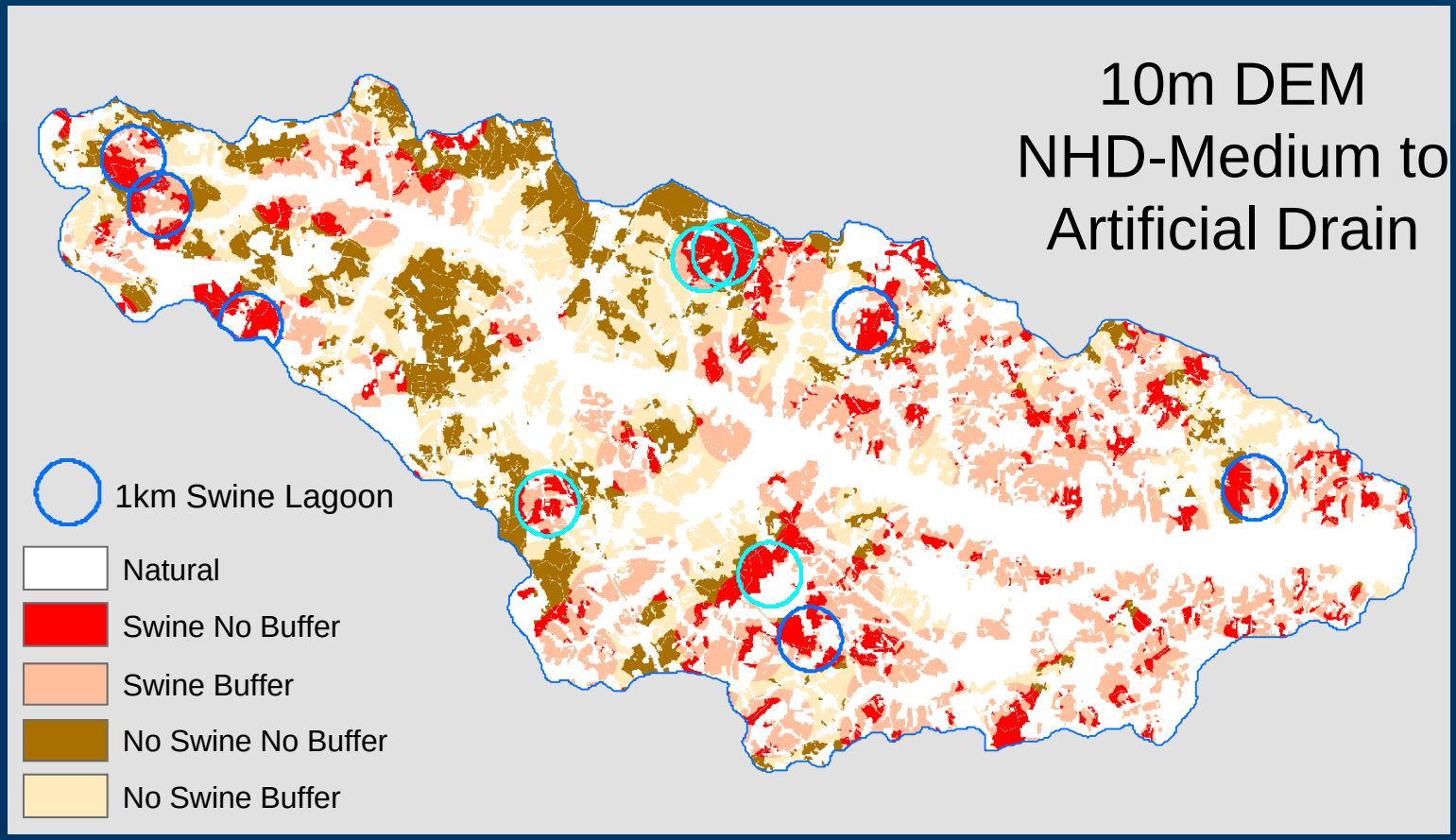

Only 4 Potential Priority Sites remained unchanged

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Summary

- Metrics connect upland landuse with flows to streams
  - Identification of interaction of buffered and non-buffer ag lands and CAFOs
- Elevation slight impact on outputs
- Stream resolution influences metric outputs (Baker et al. 2007)
  - Increased no buffer extent with increased resolution
  - Greatest amount of no buffer – CAFO with artificial drainage
  - Altered the identification of top priority restoration targets
- Inclusion of Artificial Drainage in Hydrologic/Riparian models important

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GIS Riparian tool

Limitations:

- Continued assumption that hydrology of system is surface/shallow sub-surface driven
- Dependent on 30m resolution land cover
- Assumption of spray field locations
- Lack of validation
  - Artificial Drainage Coverage
  - Influence of shallow versus deep GW

- On the ground inspection of potential restoration sites would still be needed but tool identifies key areas

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Questions?

- Jay Christensen: christensen.jay@epa.gov