

Biophysical Limits to Adoption of Denitrification Management Systems

Brian Needelman
University of Maryland

Lowell Gentry
University of Illinois

ASA-CSSA-SSSA Annual Meetings
OCTOBER 21-24, 2012, CINCINNATI, OH



DEPARTMENT OF ENVIRONMENTAL
SCIENCE & TECHNOLOGY
College of Agriculture & Natural Resources

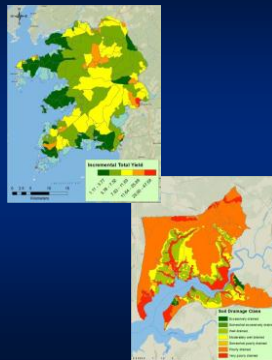
www.enst.umd.edu

Denitrification management systems and biophysical limits to adoption

- Systems have high potential
- Mixed rates of implementation
- Social barriers integrated with biophysical
- Context within NIFA-funded synthesis project
 - Geospatial data needs and limitations
 - Landscape-based limits

Geospatial Data

- Soil survey
- Elevation/topography
- Water quality
- Land use
- Hydrology
- Climate
- Land drainage
- Cropping systems
- Surficial geology



Geospatial data for siting denitrifying bioreactors and constructed wetlands

- Synthesis
 - What data are being used? How? Scales?
 - Under-utilization of data?
 - Data limitations?
- Information transfer
- Solutions

The Nature Conservancy
Protecting Nature. Preserving Life.

BMP Targeting and Prioritization

Targeted Wetland Restoration:
Ditch Plugs

Terraced Wetlands

Floodplain Reconnection

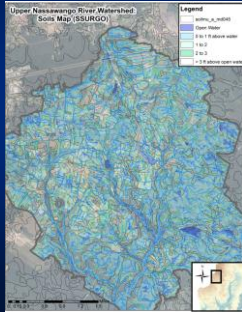
Case study: Siting wetland restoration in the Pocomoke watershed
Kathy Boomer, Amy Jacobs

TMDLs, WIPS and wetland restoration in the Chesapeake Bay

- Chesapeake TMDL – 25% N reduction by 2025
- Watershed Implementation Plan (WIPS)
 - Bi-annual milestones
- Maryland statewide goals for wetland “restoration”:
 - 2013 – 261 ha
 - 2017 – 1097 ha
 - 2025 – 1827 ha

TNC Case Study: Soil Survey and Hydric Soils

- Complexes and “partially hydric”
- Scale and site-specific planning



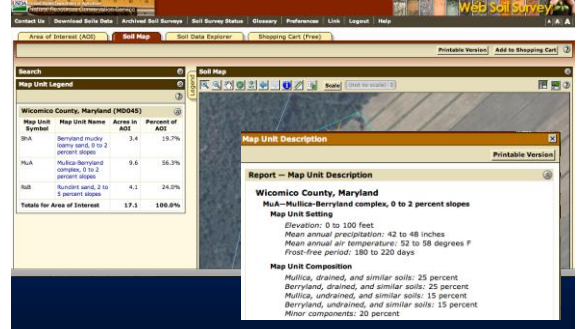
Soil survey data needs

- Hydrologic
 - Hydric soils
 - Natural soil drainage class
 - Subsurface flow rates
 - Water-restricting layers
- Soil properties
 - Surface organic matter content
 - Surface soil water content

Nature and associated limitations of soil survey data

- Scale
 - Legend-based: Not truly site-specific
 - Major and minor components
 - Complexes
- Data reliability

The map unit complex

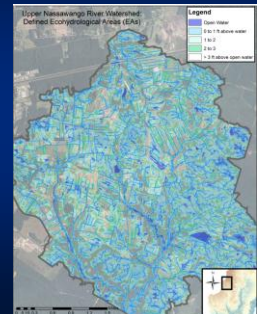


New Web Soil Survey Interpretations

- Two new interpretations for the states of Maryland, Delaware, and Illinois
 - Denitrifying Bioreactors
 - Constructed Wetlands for Agricultural N Treatment
- NRCS collaborators: Amanda Moore (MD & DE), Gary Struben (IL)

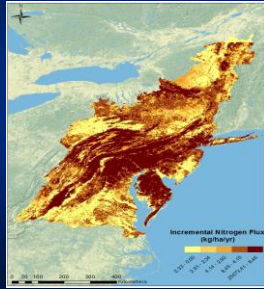
TNC Case Study: Elevation analysis

- Defined critical areas using Lidar
- Critical area = within 1 m of elevation of target reach



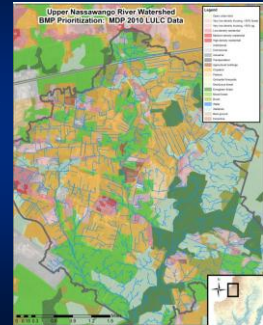
Water Quality

- SPARROW (SPAtially Referenced Regressions On Watershed attributes)
 - Predicts N fluxes and delivery on catchment basis
- Watershed models



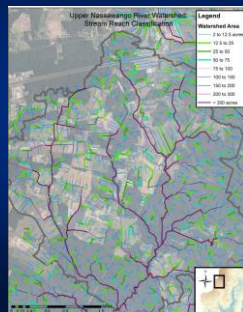
TNC Case Study: Land Use

- National Land Cover Data
- State-level planning data
 - Maryland Department of Planning Land Use Data



TNC Case Study: Hydrography

- NHDPlus
 - National Hydrography Dataset (NHD)
- Targeting stream reaches with contributing areas from 5 to 30 ha (12.5 to 75 acres)

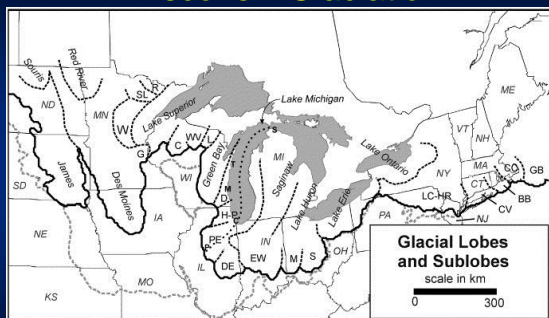


Landscape-based Limits Bioreactors and Wetlands

Site suitability and physical constraints

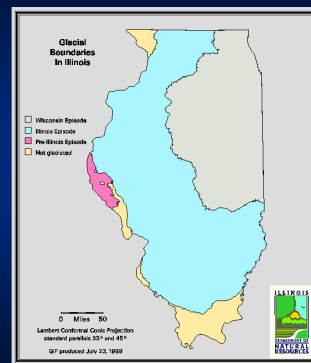


Wisconsin Glaciation



From Mickelson and Colgan (2003)

Glacial Boundaries in Illinois



We need drainage (and it pays) ←



installation of 30 cm tile for field outlet



spool of 15 cm tile for lateral lines

Tile installation is faster than ever

Pattern systems on 25 m spacing

It's so flat that...



a town is called Flatville and rows are long and straight.

Small drainage ditches without a filter strip

Deep drainage ditches without a filter strip and dredge spoil is farmed

Deep ditch with filter strip (potential site for a bioreactor)



Tiles may drain more than 100 ha
Our research indicates to decrease NO₃⁻ load by 50%
bioreactor size = 120 m³ to treat 20 ha

Wood chip bioreactor



Bioreactor construction



Farmed Floodplain



Constructed wetlands



Conclusions

- in flat areas typical of Illinois:
 - dredged spoil lined streams a problem
 - bioreactors need to be in a filter strip
 - limitation on the acres drained
 - wetlands fit best in floodplains
 - floodplains flood
- in rolling land more opportunities
 - in Iowa easier to incorporate wetlands

Acknowledgements

- Data Sources
 - Kathy Boomer and Amy Jacobs, TNC
 - USGS (SPARROW) (Brian Milstead, EPA)
- Funding: USDA-NIFA Agreement No. 2011-51130-31120