REGIONAL PRIORITIZATION OF WETLAND RESTORATION BASED ON SEDIMENT RETENTION FUNCTION: FINDINGS AND MANAGEMENT RELEVANCE

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Objectives

- Introduction to Synoptic Approach
  - What is it?
  - How does it work?
  - Why use it?
- Region 4 Sediment Reduction Assessment
  - Prioritization Criterion
  - Break Down of Model
- Can Landscape-Scale Information be Used in Mitigation Decision-making?

Synoptic Approach - What Is It?

- Designed for Geographic Prioritization of Wetlands Given Limited Effort and Information
  - Prioritization – restoration or protection
  - Effort limitations – time, money, labor
  - Information limitations – data, knowledge
  - Mapped output

Use of Synoptic Approach Appropriate When

- Quantitative, accurate information not available
- Cost of obtaining or improving information high
- Cost of wrong answer low
- High demand for information
- Prioritizing multiple decisions vs. optimizing single decision

Source: Abbruzzese, B. and S.G. Leibowitz. 1997. A synoptic approach for assessing cumulative impacts to wetlands. Environmental Management 21(3): 457-475.

Prioritization- Watersheds

- Synoptic Approach to Geographic Prioritization (Leibowitz and Hyman 1999)
  - Goal is to maximize ecological benefit (restoration or protection) gained from limited resources
  - Essentially a cost/benefit approach
    - Benefit = ecological endpoint
    - Cost = effort

Limited Effort: Benefit-Cost Framework

- Prioritization criterion: Marginal change in ecological function per management effort (*dF/dE*)
- Criterion is change in function, NOT total function

Source: Hyman, J.B. and S.G. Leibowitz. 2000. A general framework for prioritizing land units for ecological protection and restoration. Environmental Management 25(1): 23-35.

Prioritization Criterion

Creation of the Ranks

Protected

Avoided
DY_2

Protected

Avoided
DY_1

Unprotected Unprotected

$dY_2 / dE_j > dY_1 / dE_j$

dY_2 / dE_j

dY_1 / dE_j

DE

Y - ecological endpoint

E_0

E_{max}

E - management effort

Limited Information: Judgment Indicators

- Endpoints can be represented with indirect measurements of related variables (indicators)
- Judgment indicator: Relationship not known; does not allow estimation, but can be used for relative rankings

Source: Leibowitz, S.G. and J.B. Hyman. 1999. Use of scale invariance in evaluating judgment indicators. Environmental Monitoring and Assessment 58: 283-303.

A conceptual model guides indicator selection

- Model based on our understanding of relevant ecological processes
- Purpose is to formalize our understanding and guide indicator selection
- Model NOT developed for simulation, hypothesis testing, or direct analysis

Big Caveat

"...results should not be treated as empirical or field-tested findings. The conclusions of the assessment are based on judgment guided by scientific principles and a general understanding of the relevant ecological processes...Thus the results are somewhat akin to the conclusions of a scientist providing expert testimony at a trial."

Source: Schweiger, E.W., S.G. Leibowitz, J.B. Hyman, W.E. Foster, and M.C. Downing. 2002. Synoptic assessment of wetland function: A planning tool for protection of wetland species biodiversity. Biodiversity and Conservation 11(3): 379-406.

Region 4 Sediment Reduction Assessment

Prioritizing wetland restoration to maximize stream water quality

Source: Vellidis, G., M.C. Smith, S.G. Leibowitz, W.B. Ainslie, B.A. Pruitt. 2003. Prioritizing wetland restoration for sediment yield reduction: A conceptual model. Environmental Management 31(2): 301-312.

Water Quality and Wetlands

- Sediment is the number one nonpoint source pollutant in the United States
  - It is the 3rd most prevalent source of stream impairment on the 303(d) list in the southeast
- Wetlands have a demonstrated ability to retain sediments, thereby improving downstream water quality
  - Kellison (1998) estimates 20 million acres of "headwater wetlands" in SE currently down from 30-35 million acres
- Consequently, restoring wetlands in the right places can contribute to the amelioration of stream sediments

Goals of Region 4 Synoptic Prioritization

- Maximize Wetland Restoration to ameliorate sediment in streams – "Biggest Bang for the Buck!"
- Prioritize Restoration Efforts (Section 404 Mitigation Banking, TMDL Implementation, Watershed Program, Nonpoint Source Program)
- Use a Defensible, Rigorous and Repeatable Framework
- Continue Development of Synoptic Framework

Definition of Assessment Objective:

- If some level of funding were available for restoring headwater wetlands; where should restoration be targeted so as to provide the optimal reduction of sediment yield?

Prioritization Criterion -- *dSY / d$*

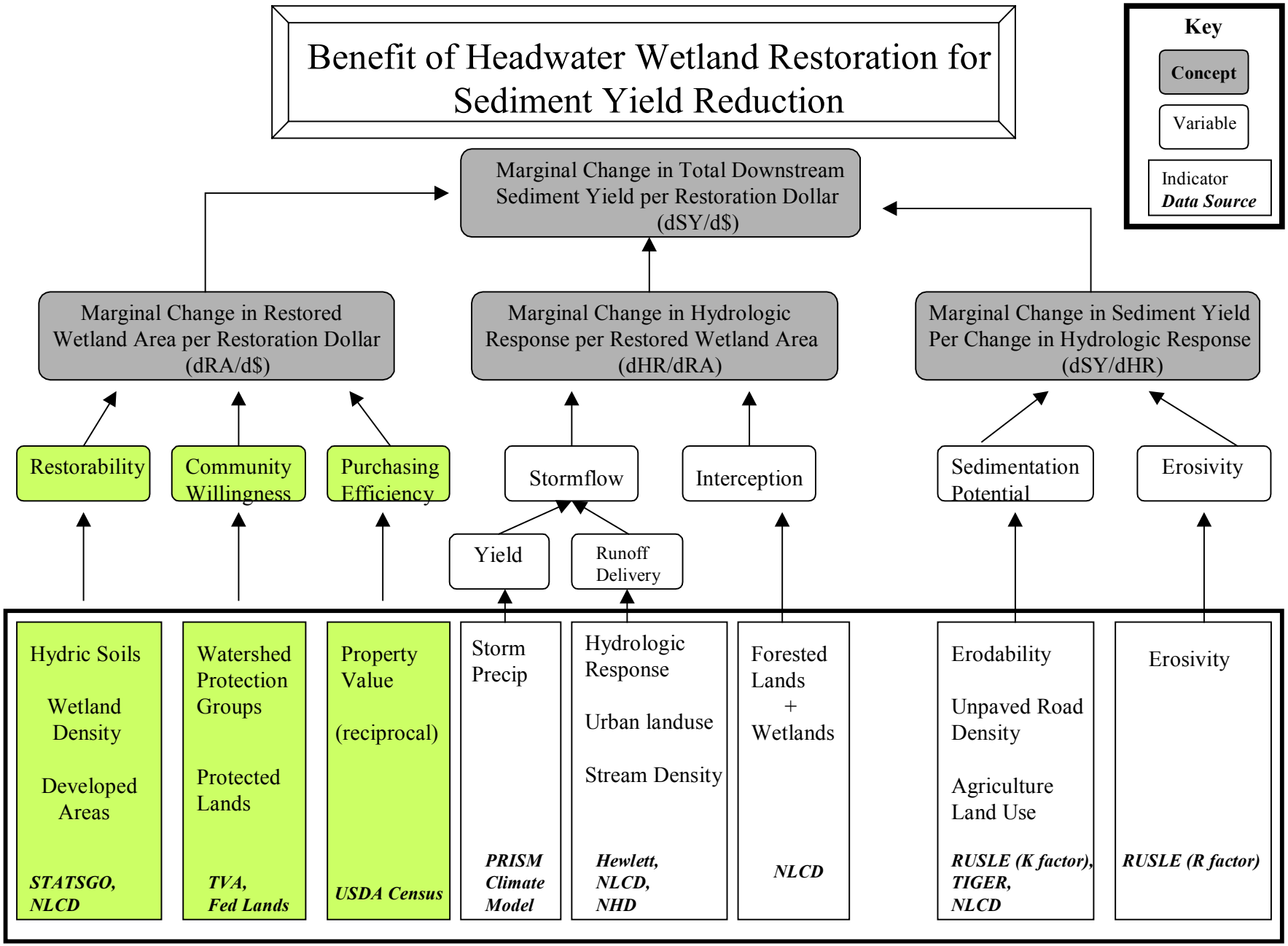
Marginal change in total downstream sediment yield (*SY*) per restoration dollar (*$*)

Conceptual Model

- 3 Key Concepts
  - Increase in wetland restoration per dollar
  - Decrease in hydrologic response
  - Decrease in sediment delivery

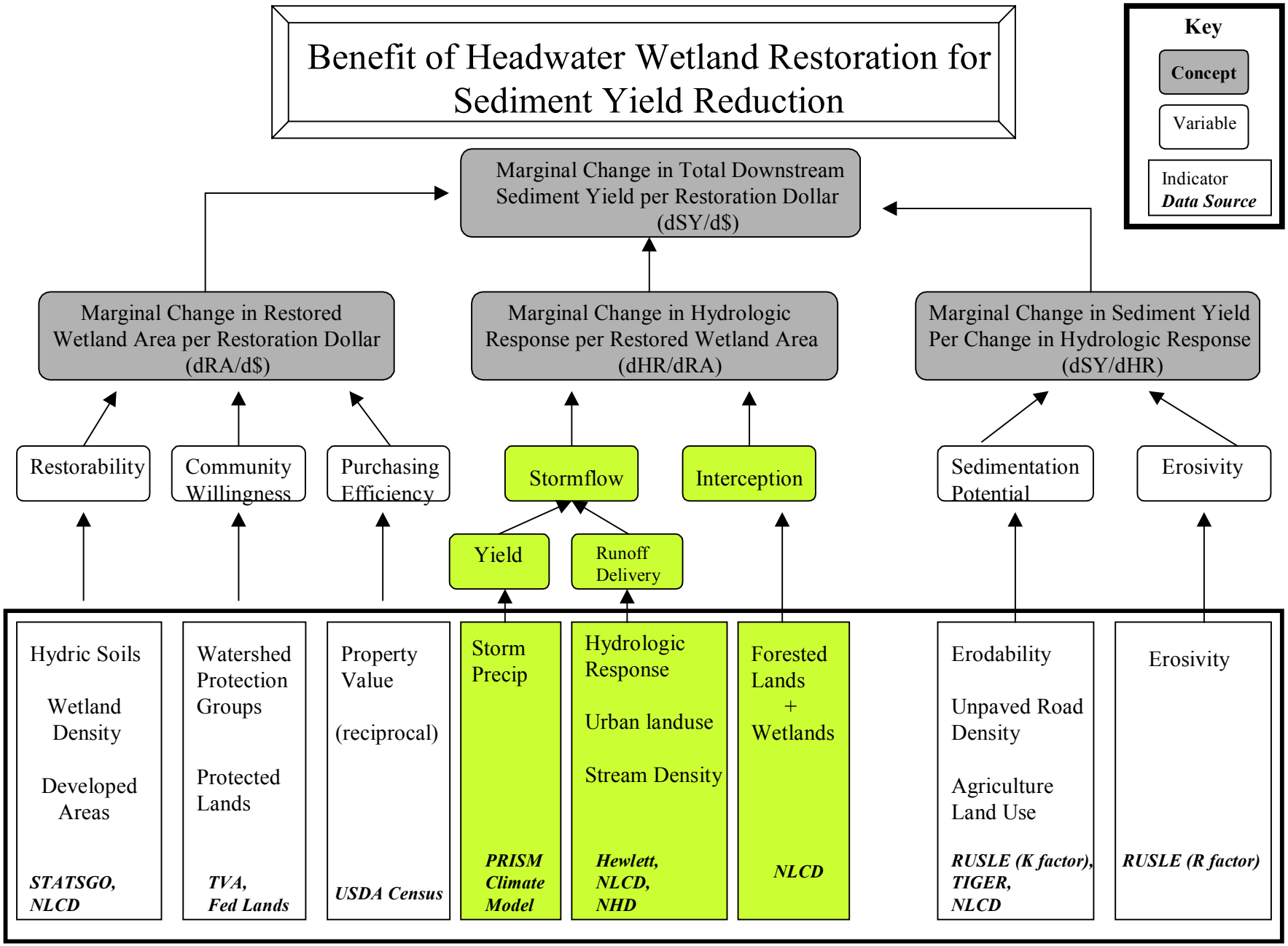
Conceptual Model – Wetland Restoration

- Wetland Restoration Index
  - Restorability Index
    - Hydric Soils
    - Wetland Density
    - Urban and Ag developed areas
  - Place Based Index
    - Watershed and wetland protection groups
    - Protected areas
  - Property Index (land values)


Benefit of Headwater Wetland Restoration for Sediment Yield Reduction
Key
Concept
Variable
Indicator
Data Source
Marginal Change in Total Downstream Sediment Yield per Restoration Dollar (dSY/d$)
Marginal Change in Restored Wetland Area per Restoration Dollar (dRA/d$)
Marginal Change in Hydrologic Response per Restored Wetland Area (dHR/dRA)
Marginal Change in Sediment Yield Per Change in Hydrologic Response (dSY/dHR)
Restorability
Community Willingness
Purchasing Efficiency
Stormflow
Interception
Sedimentation Potential
Erosivity
Yield
Runoff Delivery
Hydric Soils
Wetland Density
Developed Areas
STATSGO, NLCD
Watershed Protection Groups
Protected Lands
TVA, Fed Lands
Property Value
(reciprocal)
USDA Census
Storm Precip
PRISM Climate Model
Hydrologic Response
Urban landuse
Stream Density
Hewlett, NLCD, NHD
Forested Lands + Wetlands
NLCD
Erodability
Unpaved Road Density
Agriculture Land Use
RUSLE (K factor), TIGER, NLCD
Erosivity
RUSLE (R factor)

Conceptual Model – Hydrologic Response

- Stormflow Index
  - Runoff delivery index
    - Hydrologic response
    - Proportion urban land use
    - Stream density
  - Precipitation
- Interception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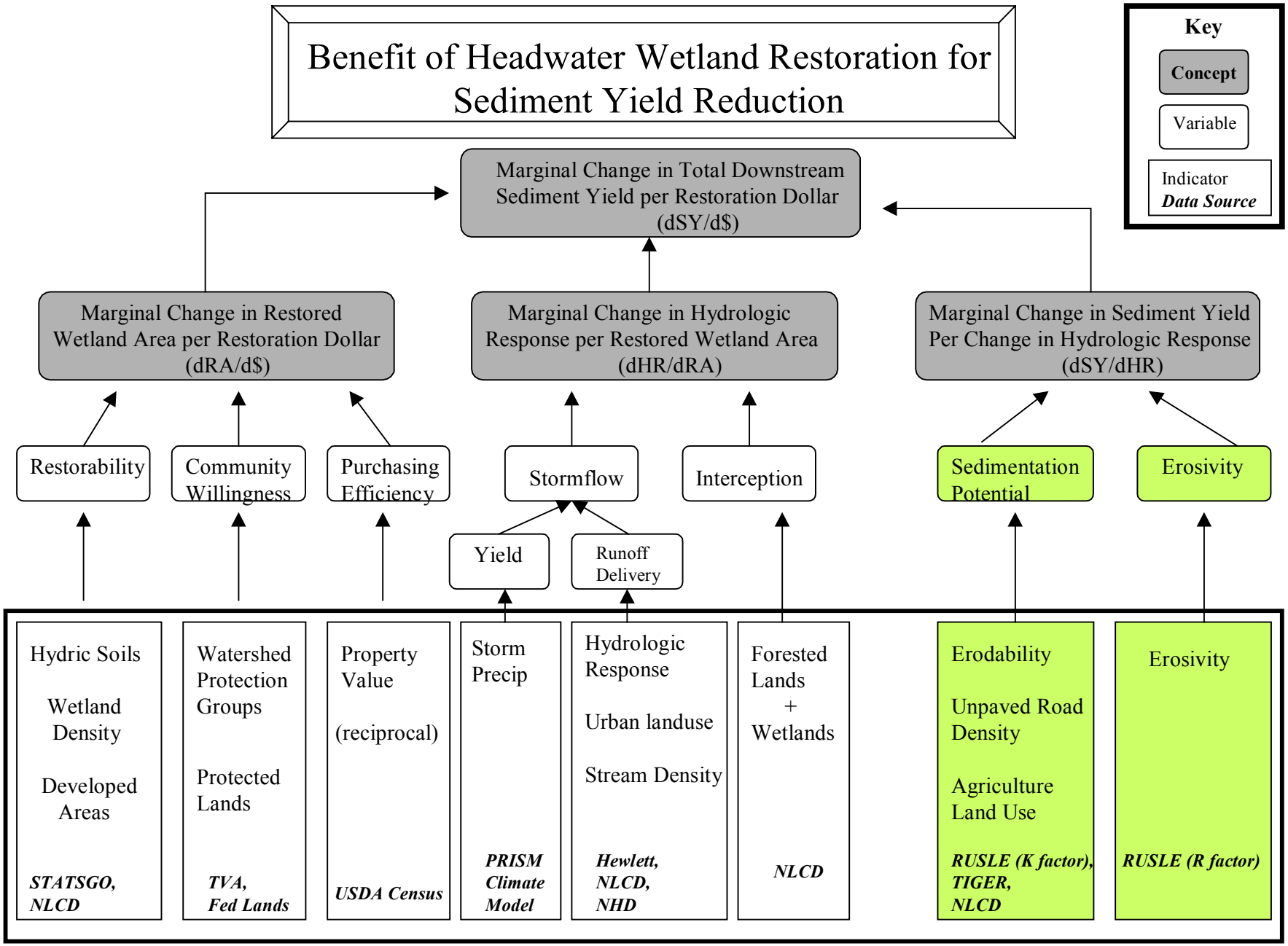
Conceptual Model – Sediment Yield

- Sedimentation Potential for Watershed
  - Erodability
  - Density of unpaved roads
  - Proportion agricultural
- Erosivity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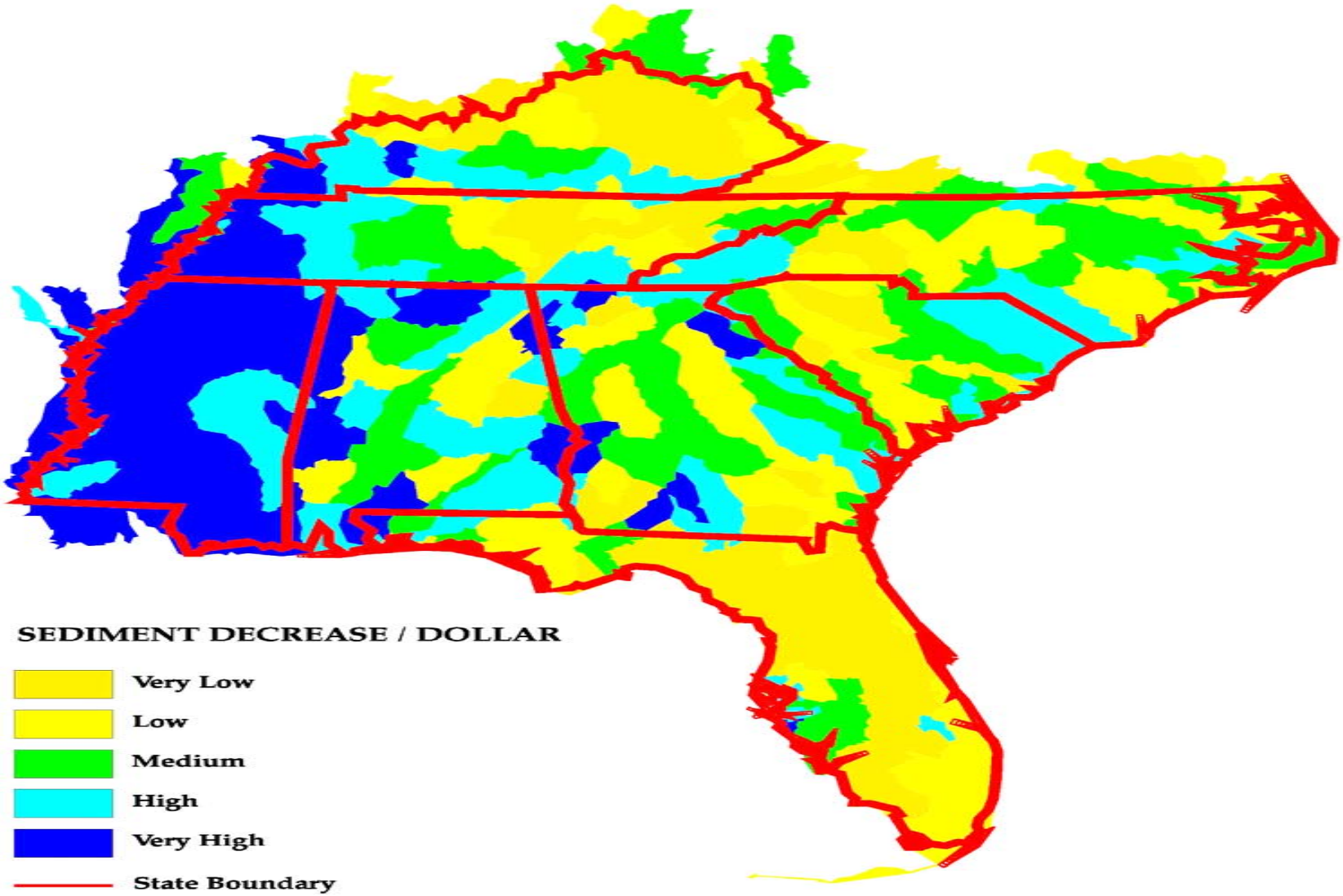
Synopsis of Synoptic

- dSY/d$ = dRA/d$ X dHR/dRA X dSY/dHR X HW
  - The change (decrease) in sediment yield due to wetland restoration is dependent upon the wetland restoration being cost effective, attenuating the hydrologic response, and intercepting sediment. All 3 of which vary geographically across Region 4 thus allowing for the geographic prioritization

MARGINAL DECREASE IN SEDIMENT DELIVERY PER RESTORATION DOLLAR IN WATERSHED



Remember!

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Application Issues

- Scale of assessment vs scale of mitigation
- Transfer into commercial banking (incentives)
- Relation to on-site/in-kind
- Mono-functional aspect of Synoptic
- Interagency priorities

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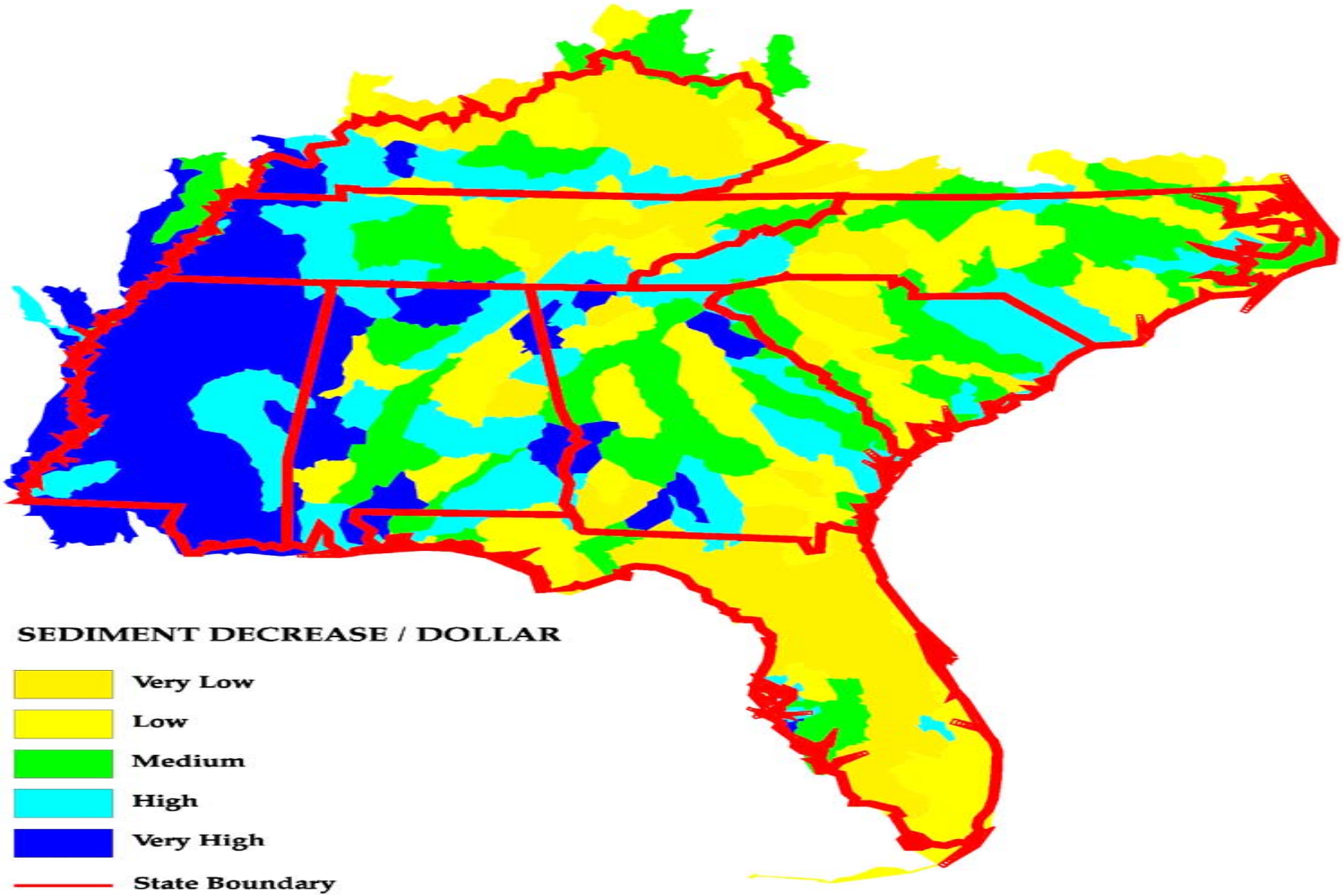
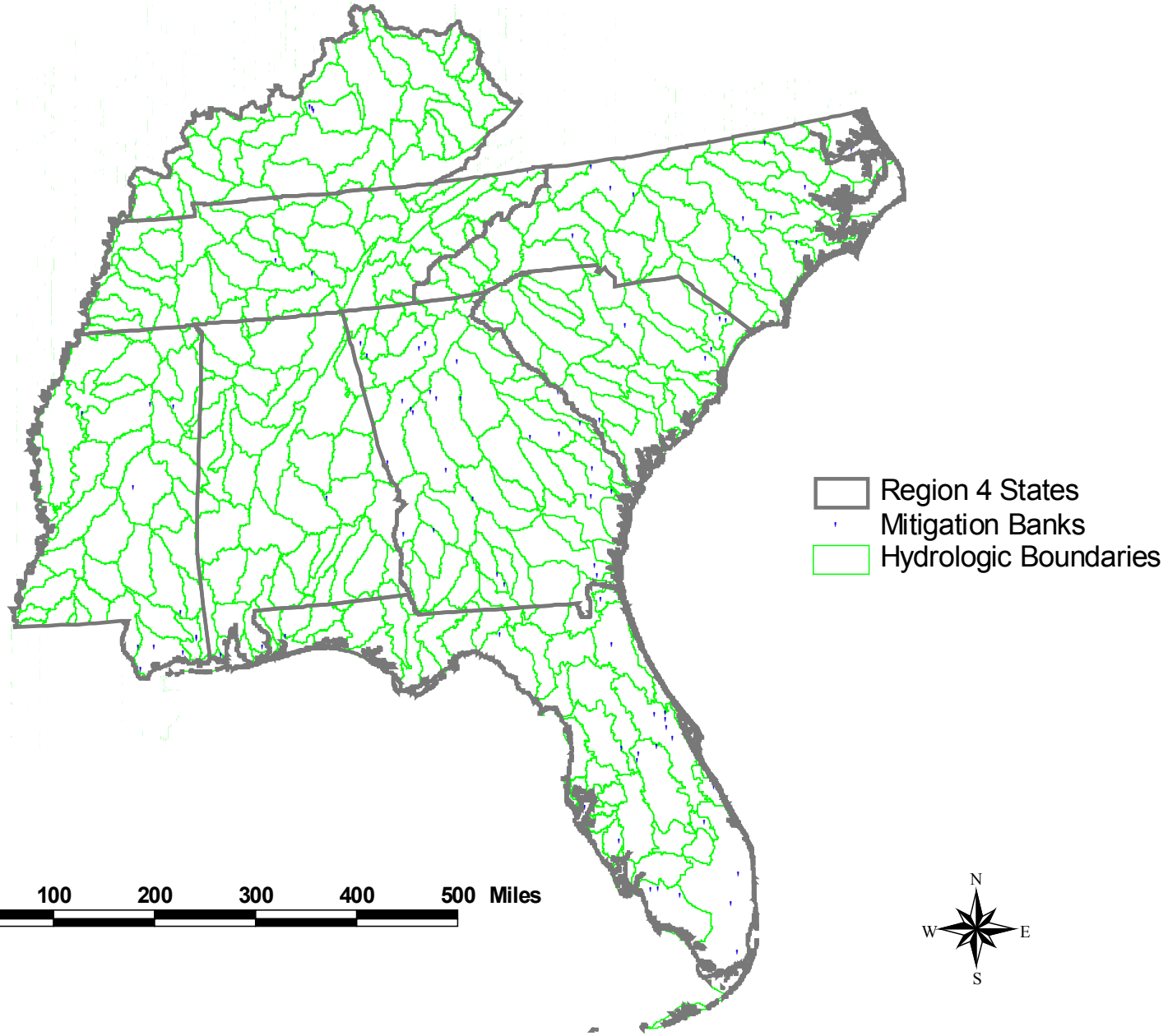
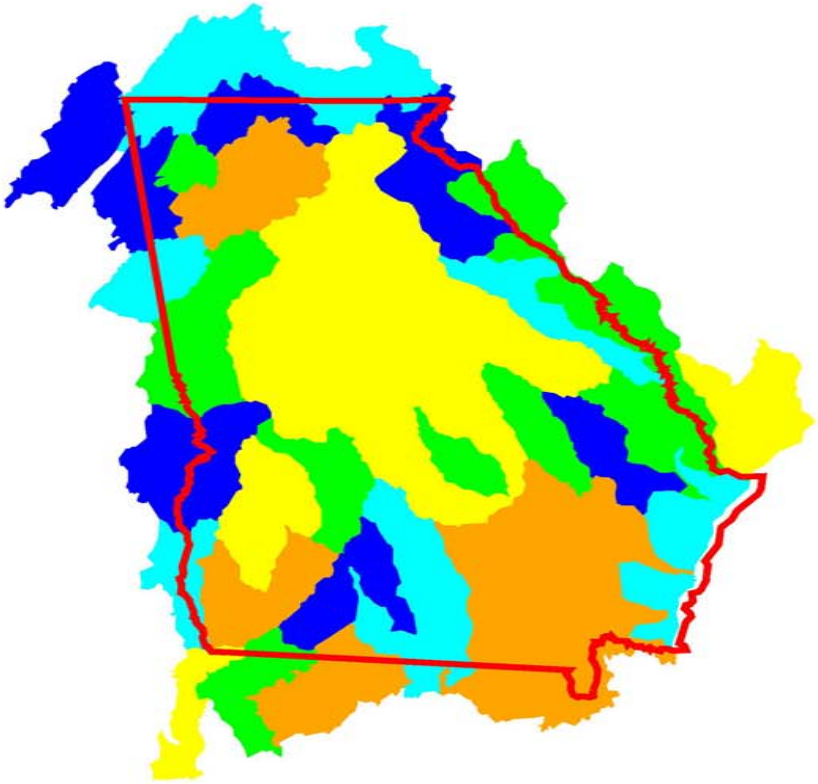


Wetland Mitigation Banks in Region 4



SEDIMENT DECREASE / DOLLAR



Summary

- Synoptic Approach is a prioritization technique to maximize ecological benefit given limited resources.
- Region 4 used Approach to prioritize wetland restoration for amelioration of sediment delivery
- Application of synoptic results may be appropriate in 404 program
- At the very least the assessment in Region 4 provides a basis for discussion of mitigating in a watershed context.

Acknowledgments

The following individuals have contributed to the development of the Region 4 synoptic assessment:

Scott Leibowitz

Jeffrey Hyman

Henry Strickland

Jim Bricker

George Vellidis

Matt Smith

Bruce Pruitt

Wade Nutter