Spatial Analysis of Relations among Conservation Practices, Aquatic Ecosystem Services, and Human Well-being in the Albemarle-Pamlico Basin

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Today's Presentation:

1. Brief rationale regarding links between conservation and ecosystem services

2. Overview of our new project in the Albemarle-Pamlico basin

3. Summary of our current thoughts about mapping / analyzing two ecoservices

Status of Freshwater Ecosystems
(Millennium Ecosystem Assessment 2005)

Taxa with the highest proportions of threatened species tend to rely on freshwater habitats.

"…inland water ecosystems are in worse condition overall than any other broad ecosystem type…"

Harsh Reality

Current management of ecosystems
is failing to protect aquatic biodiversity

Orr, D. W. 2003.
Walking north on a
southbound train.
Conserv. Biol. 17: 348-351

Reframing Conservation Outcomes

Conservation actions benefit biota
and maintain biodiversity

Conservation actions benefit biota
and contribute to human well-being via
ecological, economic, and cultural benefits

Relevant Agents for Conservation

Scientists

Environmentalists

Government agencies

Non-government organizations

Resource managers

Community organizations

Elected officials

Citizens

Consumers

Businesses

A new eco-sociological lens…

FRESHWATER ECOSYSTEM GOODS & SERVICES

Provisioning Services

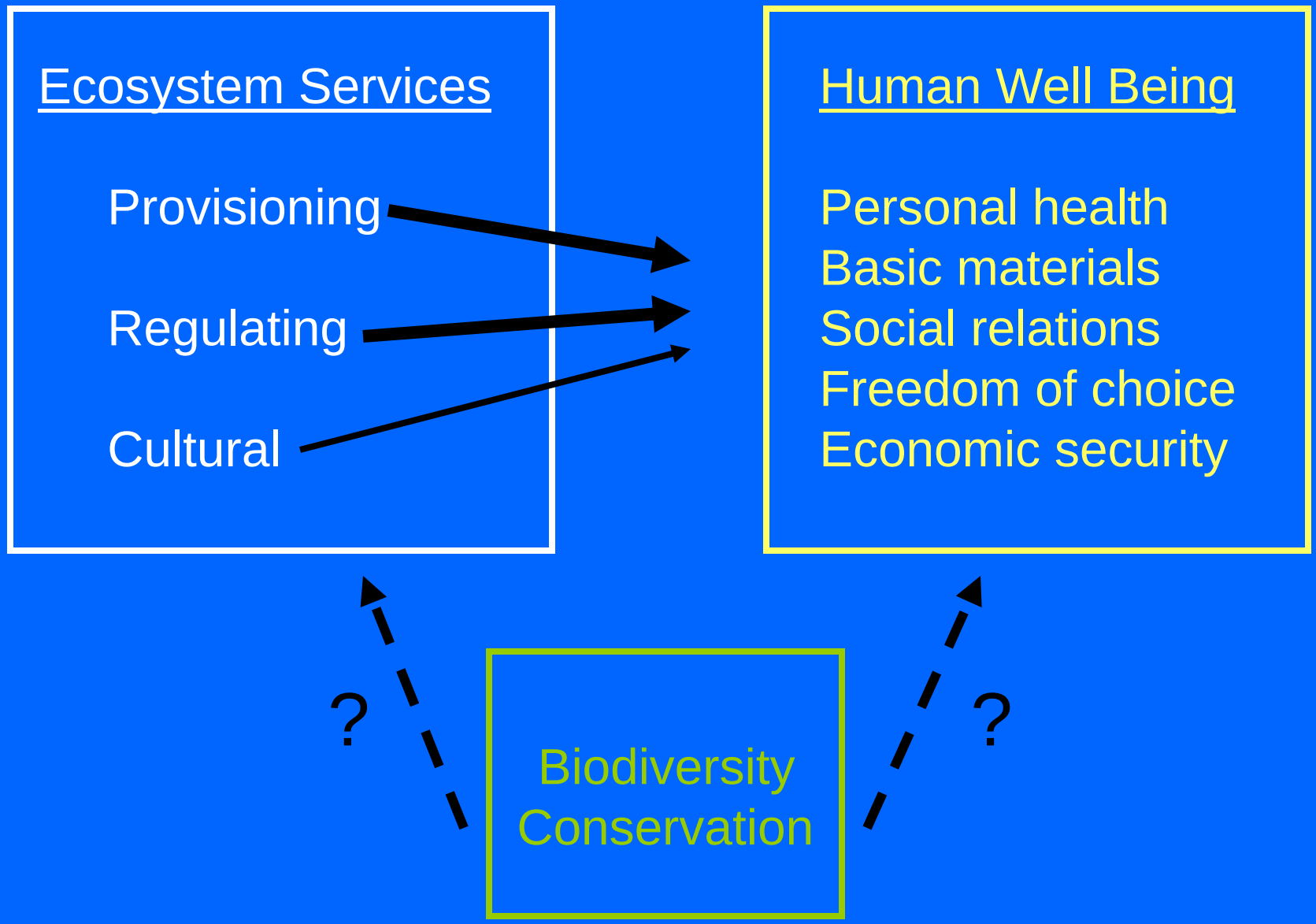
- Drinking water
- Bathing water (swimmable)
- Aquatic foods (fishable)

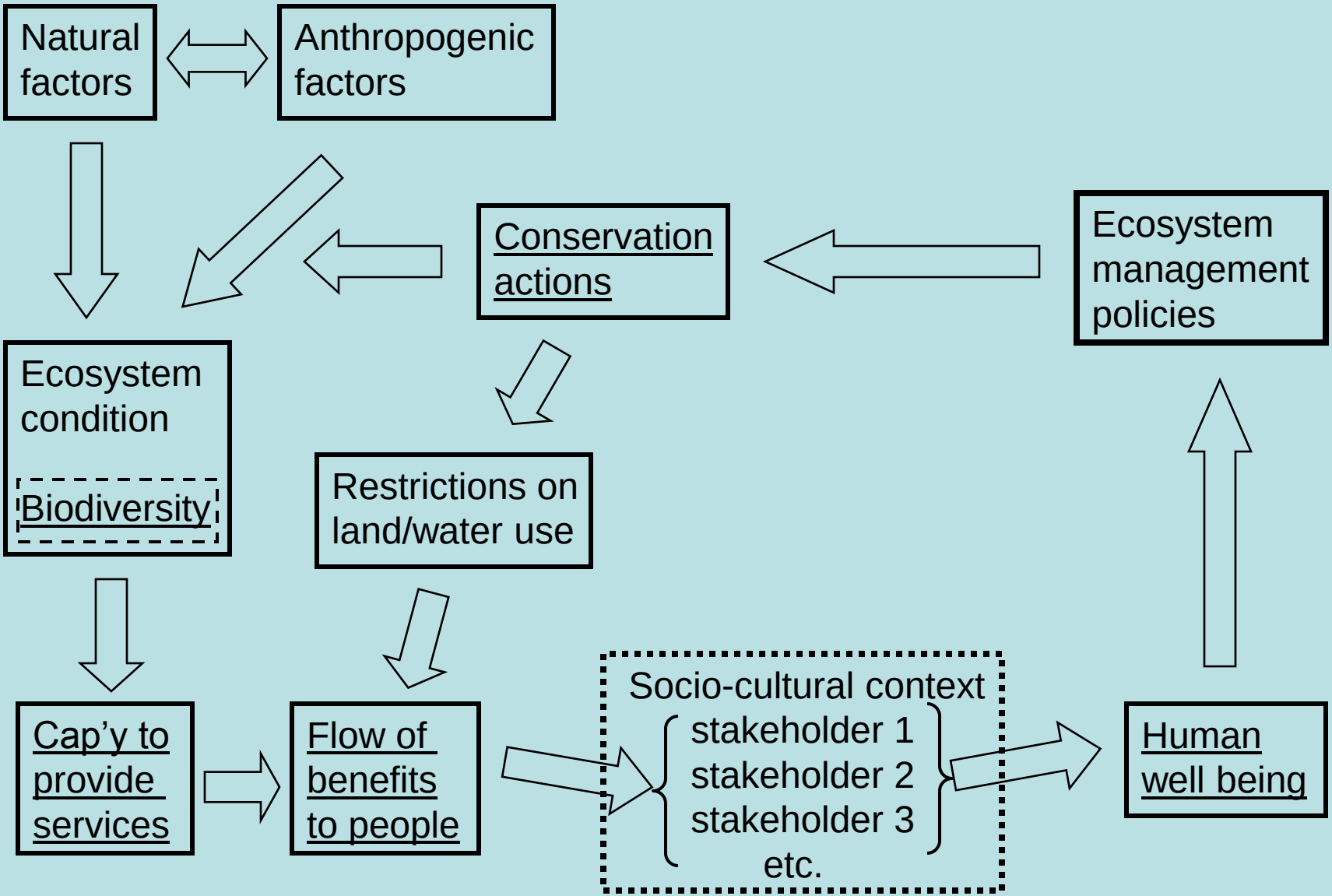
Regulating Services

- Water purification
- Flood modulation
- Disease regulation

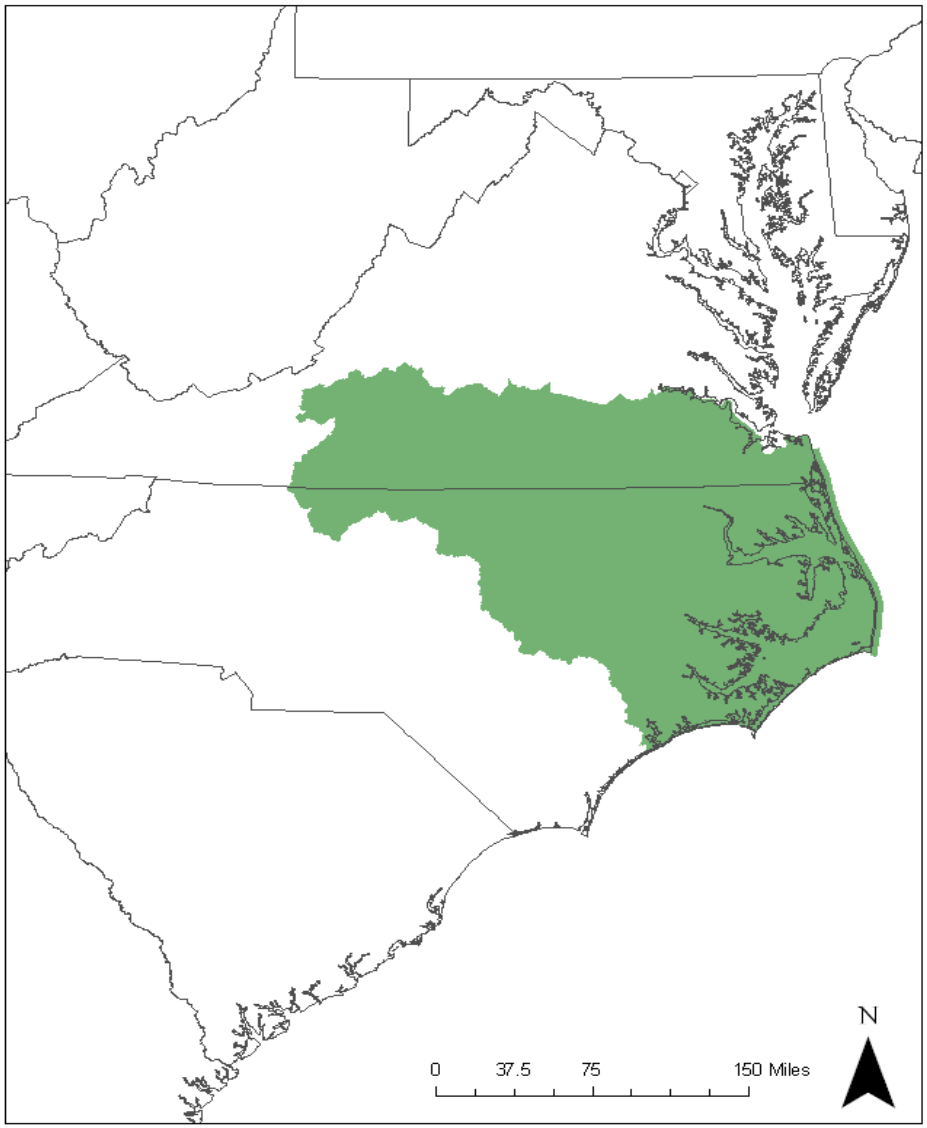
Cultural Services

- Recreation
- Beauty
- Spirituality


Ecosystem Services
Provisioning
Regulating
Cultural
Human Well Being
Personal health
Basic materials
Social relations
Freedom of choice
Economic security
?
Biodiversity
Conservation
?


Natural factors
Anthropogenic factors
Conservation actions
Ecosystem management policies
Ecosystem condition
Biodiversity
Restrictions on land/water use
Cap'y to provide services
Flow of benefits to people
Socio-cultural context
stakeholder 1
stakeholder 2
stakeholder 3
etc.
Human well being

Albemarle – Pamlico Basin



Ecological profile of APB

Large rivers: Chowan, Roanoke, Tar-Pamlico, and Neuse

Physiographic regions: Blue Ridge, Piedmont, and Coastal Plain

Albemarle-Pamlico Sound is 2nd largest estuary in the US

8 diadromous fish species; >350 bird species, many aquatic

Major fisheries for blue crab and American oyster

3,000,000 people (extensive urbanization and agriculture)

200 animal, 300 plant species “at risk” or extirpated

11 fed. endangered animals (eg, Roanoke logperch, shortnose sturgeon)

Severe impacts of projected climate change by 2050

General research questions:

What are the spatial linkages among biodiversity conservation, AES, and HWB across a landscape?

When / where do actions and practices to conserve biodiversity enhance or diminish delivery of valued AES?

When / where do different conservation actions reinforce or undermine each other's societal benefits provided via AES?

To what extent does biodiversity conservation contribute to HWB?

Partners / Advisors

Albemarle-Pamlico National Estuary Program
Dean Carpenter

Audubon North Carolina
Chris Canfield

Environmental Defense Fund
Sam Pearsall

The Nature Conservancy
Chuck Peoples, Brian van Eerden

U.S. Fish and Wildlife Service
Pete Benjamin

U.S. Geological Survey
Andrea Ostroff

Focal Aquatic Ecosystem Services

Provisioning Services

- Providing water supply

Regulating Services

- Water purification
- Nitrogen regulation

Cultural Services

- Wildlife-based recreation (bird-watching, fishing)

General Research Tasks

Task 1: Define and map current capacity for focal AES

Task 2: Define and map current flows of focal AES

Task 3: Define and map current conservation actions

Task 4: Define and map current human well-being

Task 5: Analyze spatial relations among components in Tasks 1-4

Task 6: Develop and map scenarios of plausible future conditions in APB

Task 7: Conduct workshop to present findings to stakeholders

Conservation Actions

Establish reserves

Restore wetlands, riparian zones

Apply easements

Implement best management practices

Human Well Being

Broadly defined (quality of life)

Potential metrics

- Environmental quality
  - air quality
  - water quality
  - land use change
- Economic vitality
  - average wage
  - unemployment rate
  - home ownership rate
- Social vitality
  - college education rate
  - crime rate
- Personal health
  - life expectancy
  - incidence of disease

General Tasks and Stakeholder Roles

Tasks 1- 4: Define current AES capacity
AES flow
conservation actions
human well-being

Stakeholder role: Review definitions, mappable metrics (via workshops?)

Task 6: Develop and map scenarios of plausible future conditions in APB

Stakeholder role: Co-develop scenarios via workshops

Task 7: Conduct workshop to present findings to stakeholders

Stakeholder role: Provide feedback to ensure research products are useful

Map Products for Stakeholders (for each selected scenario)

Conservation actions

Availability of focal services

Threats to service availability

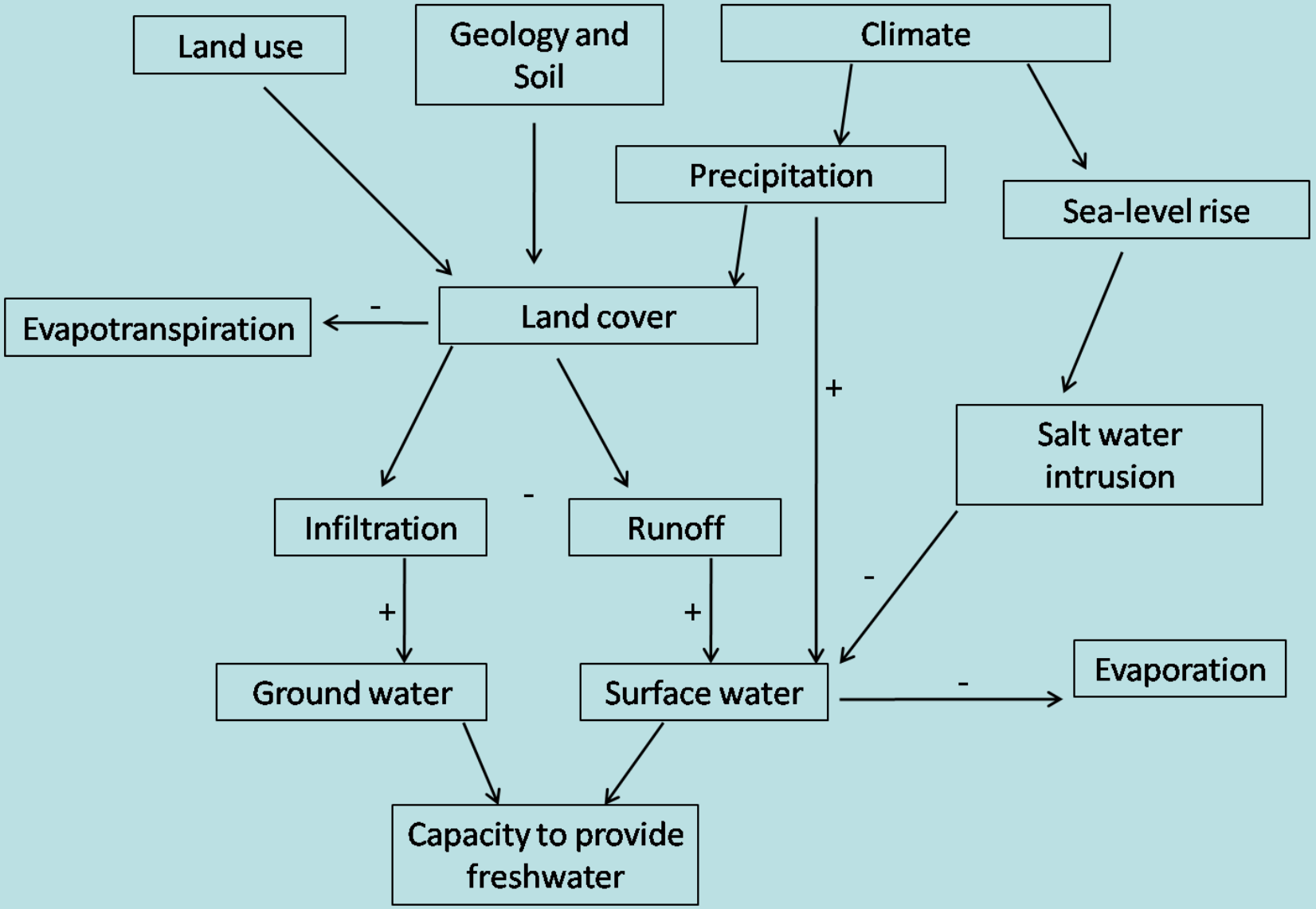
Use of focal services

Human well being

Water Supply

Total potential surface and ground water available for withdrawal

Conceptual Model of Water Supply Capacity



Ranked Contribution of Land Cover to Surface Water Yield

Cover Type	Rank
Open water	1 (greatest contribution)
Developed land	2
Barren land	3
Shrub, grass	4
Cultivated crops	5
Forest	6
Wetland	7

Ranked Contribution of Soil Group to Ground Water Supply

NRCS Soil Hydrologic Group	Soil Characteristics
A	Well drained sand, gravel (greatest contribution)
B	Fine to moderately coarse
C	Moderately fine to fine
D	Clay or shallow soil over impervious layer

Water Supply -- Water Quality Interaction

Water Supply

- land cover
- precipitation
- evapotranspiration
- infiltration

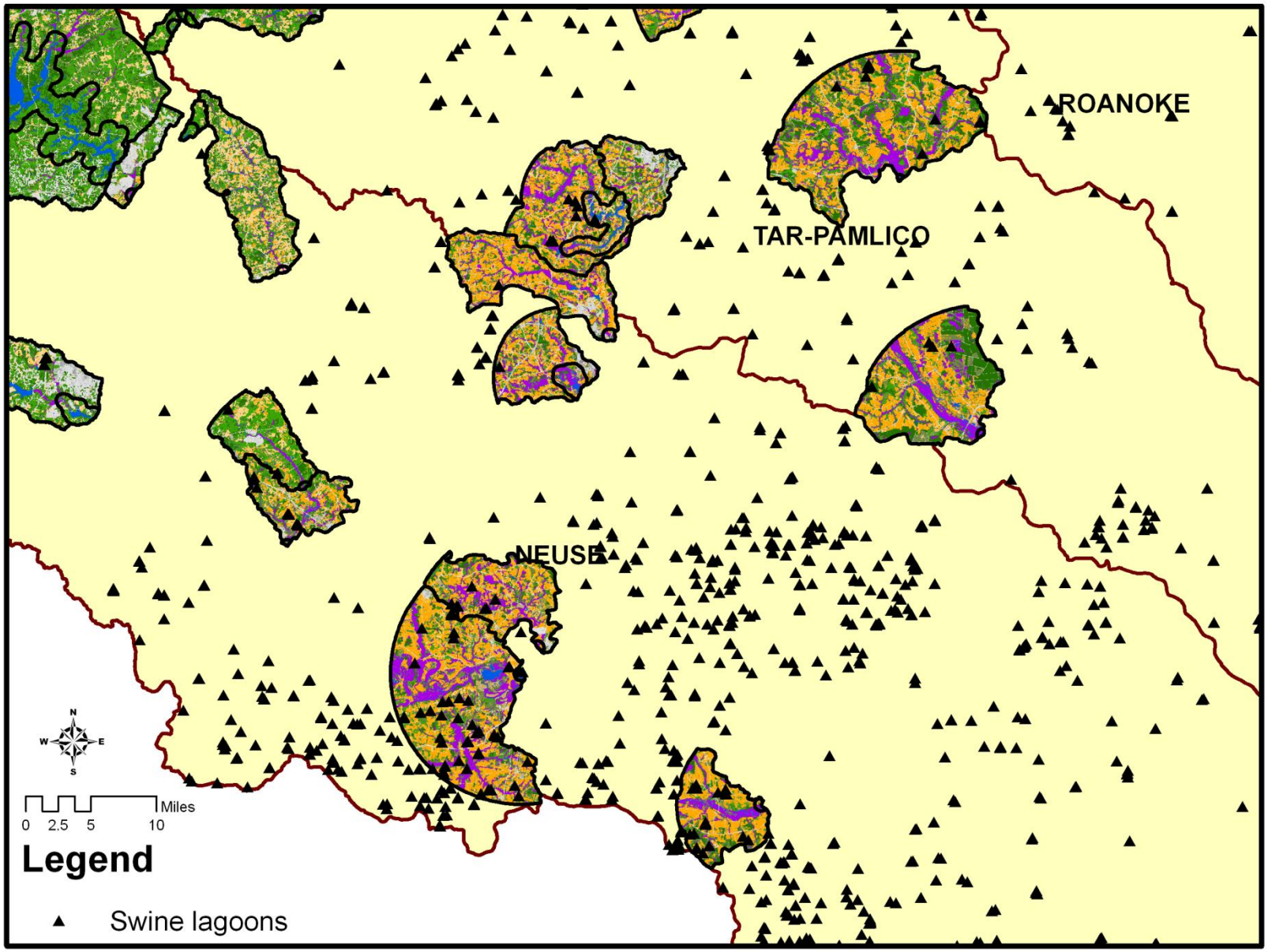
Water quality

- water purification (natural processes and water treatment plants)
- water pollution (e.g. point & non-point sources)

Intended water uses

- drinking water (highest quality)
- agriculture
- domestic/household use
- industrial

Land Use within Water Supply Watersheds



Water Supply versus Climate Change

Increase in temperature (1.5 – 2.5 degrees C)

Increase in precipitation (0 – 20%)

-- Net effects on water supply equivocal

Sea-level rise

Saltwater intrusion

27.5” rise in sea level → loss of 1350 sq. mi. of land (IPCC)
- unavailable to intercept, retain precip.

-- Clear loss of water supply

Nitrogen Regulation

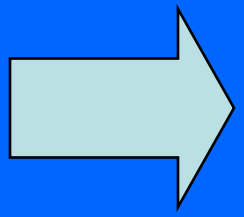
Collective processes that constrain the biological availability of N

Metric: amount of N, primarily NH_3 and NO_3, excluded or removed from water

Low N loading

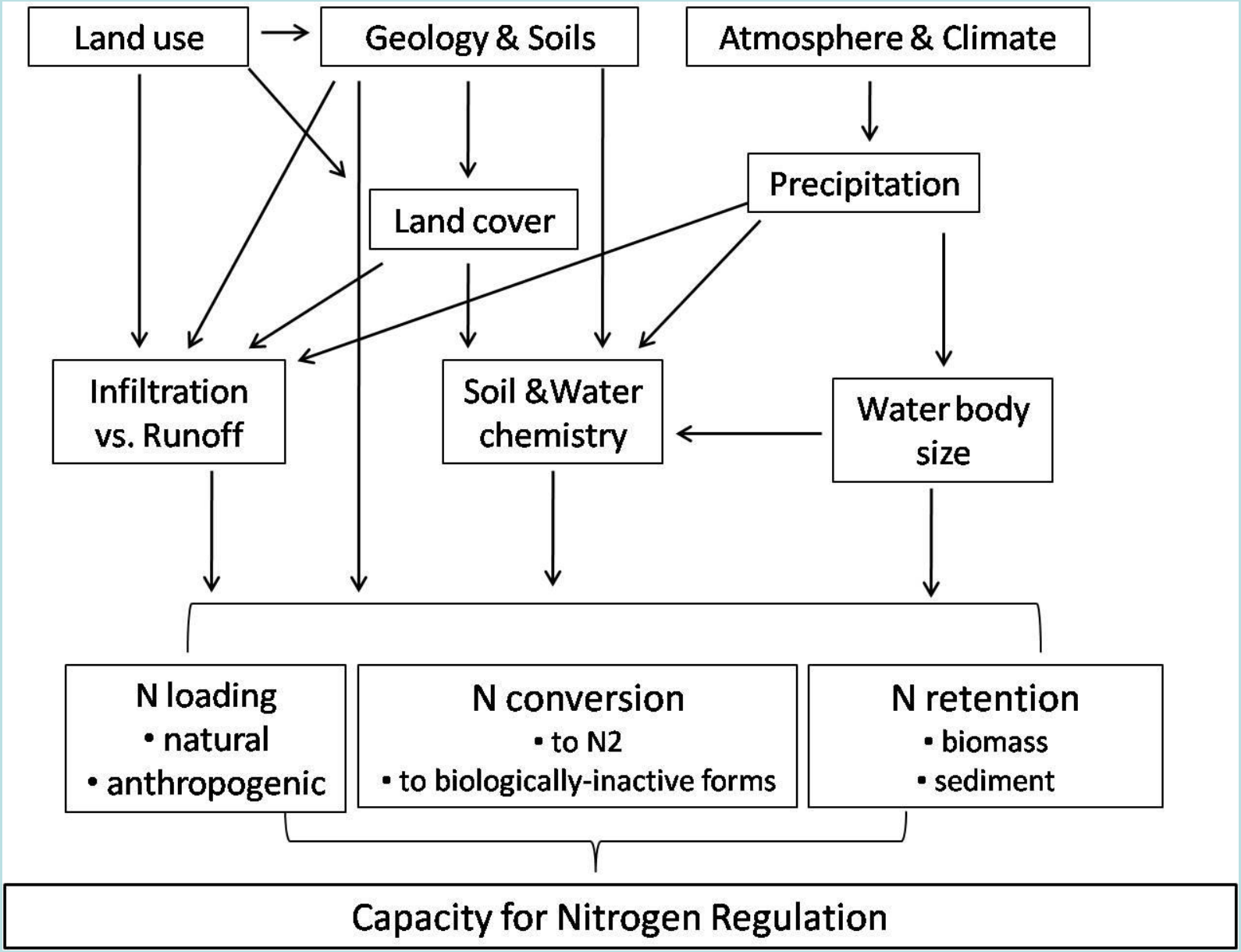
High N retention

High N conversion



High N regulation capacity

Conceptual Model of Nitrogen Regulation Capacity



Ranked Contribution of Land Cover

N Loading	N Retention	N Conversion
Animal operations	Wetland	Wetland
Fertilized crops	Forest	Open water
Developed land	Shrub, grass	Forest
Shrub, grass	Open water	Shrub, grass
Barren land	Barren land	Fertilized crops
Open water	Developed land	Barren land
Forest	Fertilized crops	Developed land
Wetland	Animal operations	Animal operations

Soil and Water Assessment Tool

(USDA Agricultural Research Service)

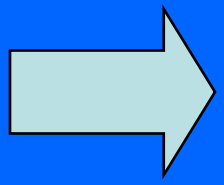
Precipitation

Topography

Soil type

Land cover

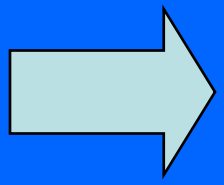
Land use



N loading

N retention

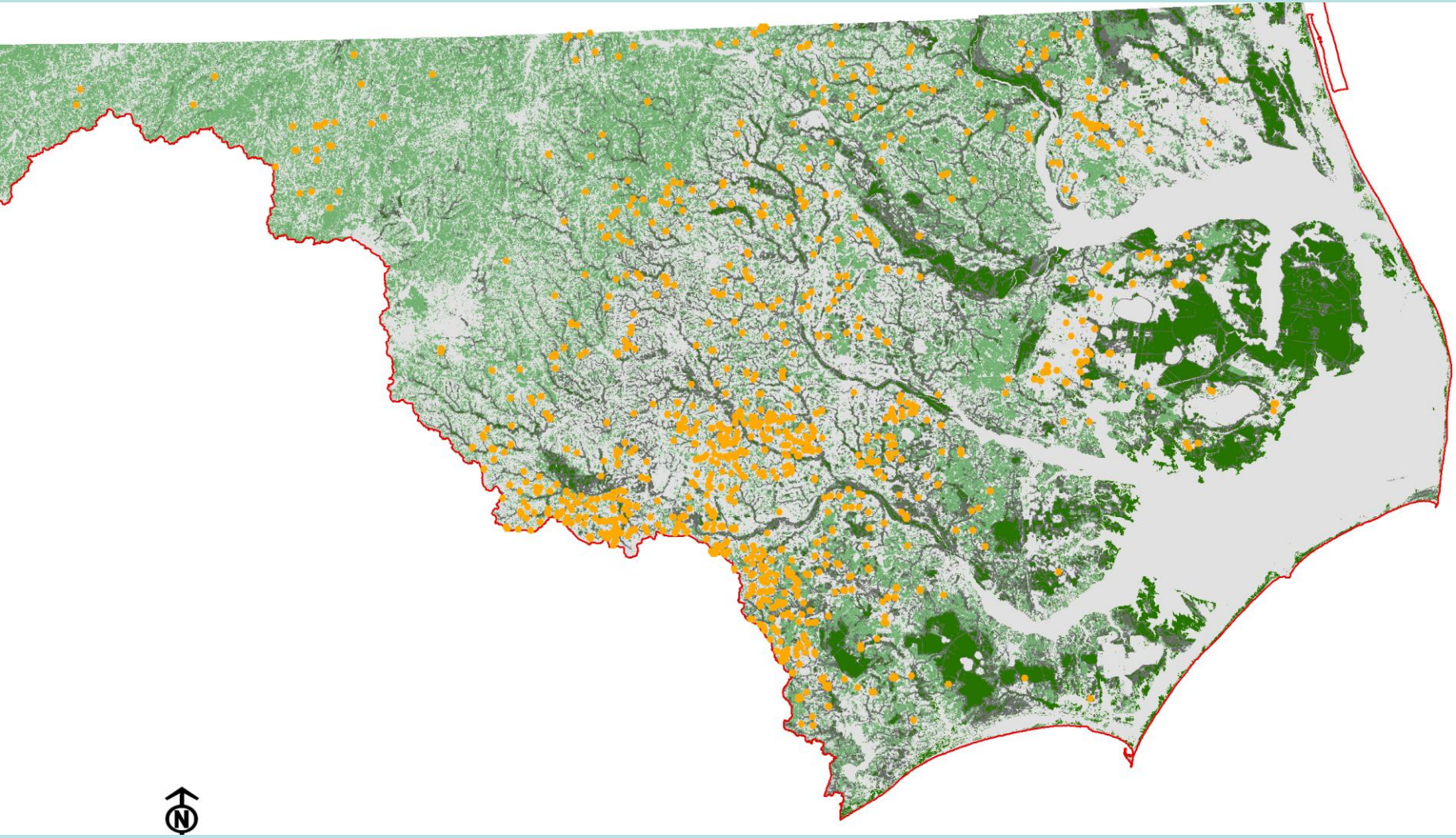
N conversion



Stream flow

Water quality

Forest, Wetland, and Swine Lagoon Land Cover



Any questions or comments?