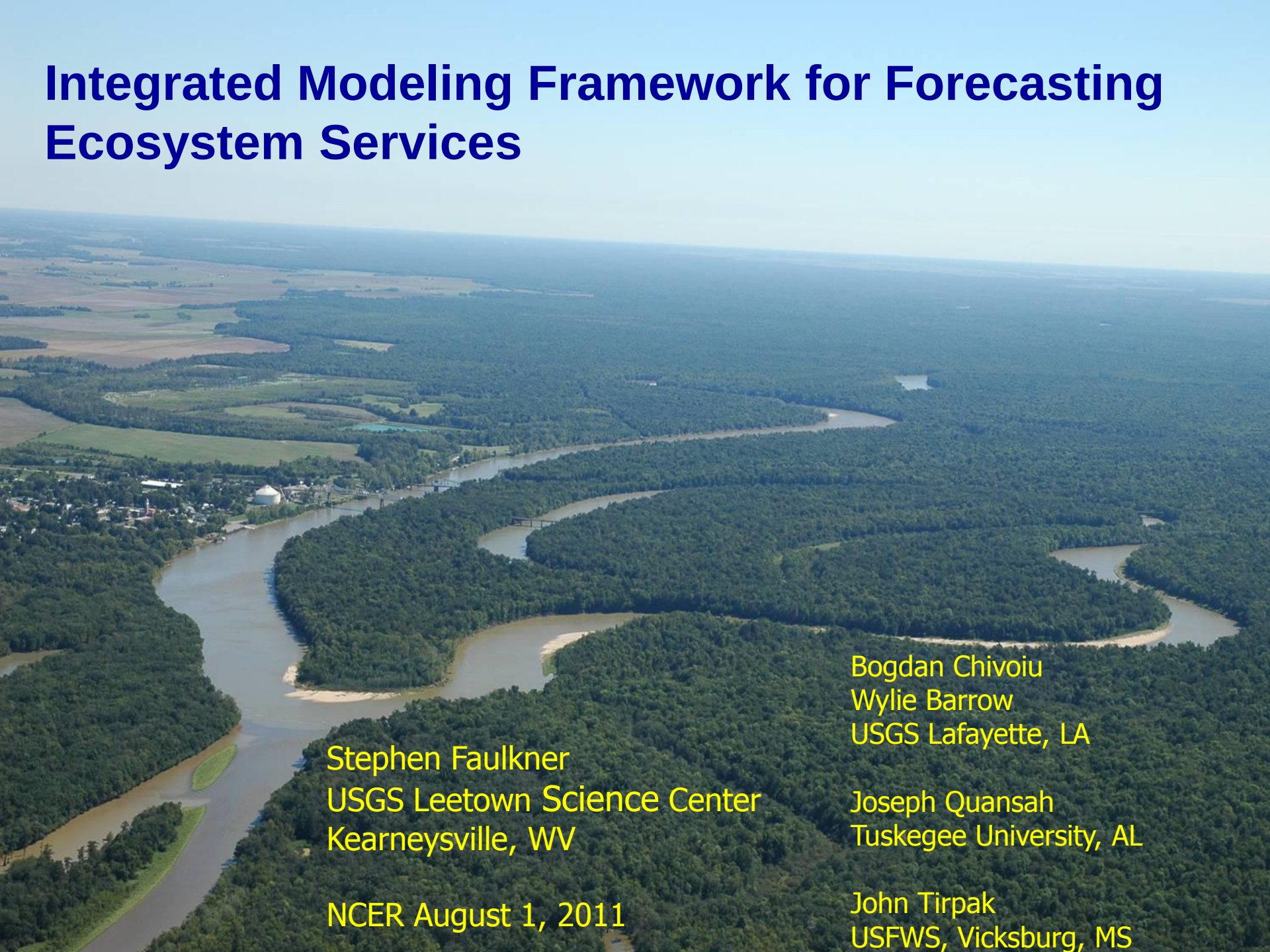
Integrated Modeling Framework for Forecasting Ecosystem Services



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NCER August 1, 2011

Key Points

- Ecosystem services provide a common framework for decision-making, evaluating trade-offs

- Understanding the relationships between natural and anthropogenic drivers and ecosystem services is fundamental

- Need a spatially explicit, empirically based approach to quantify multiple services under alternative scenarios

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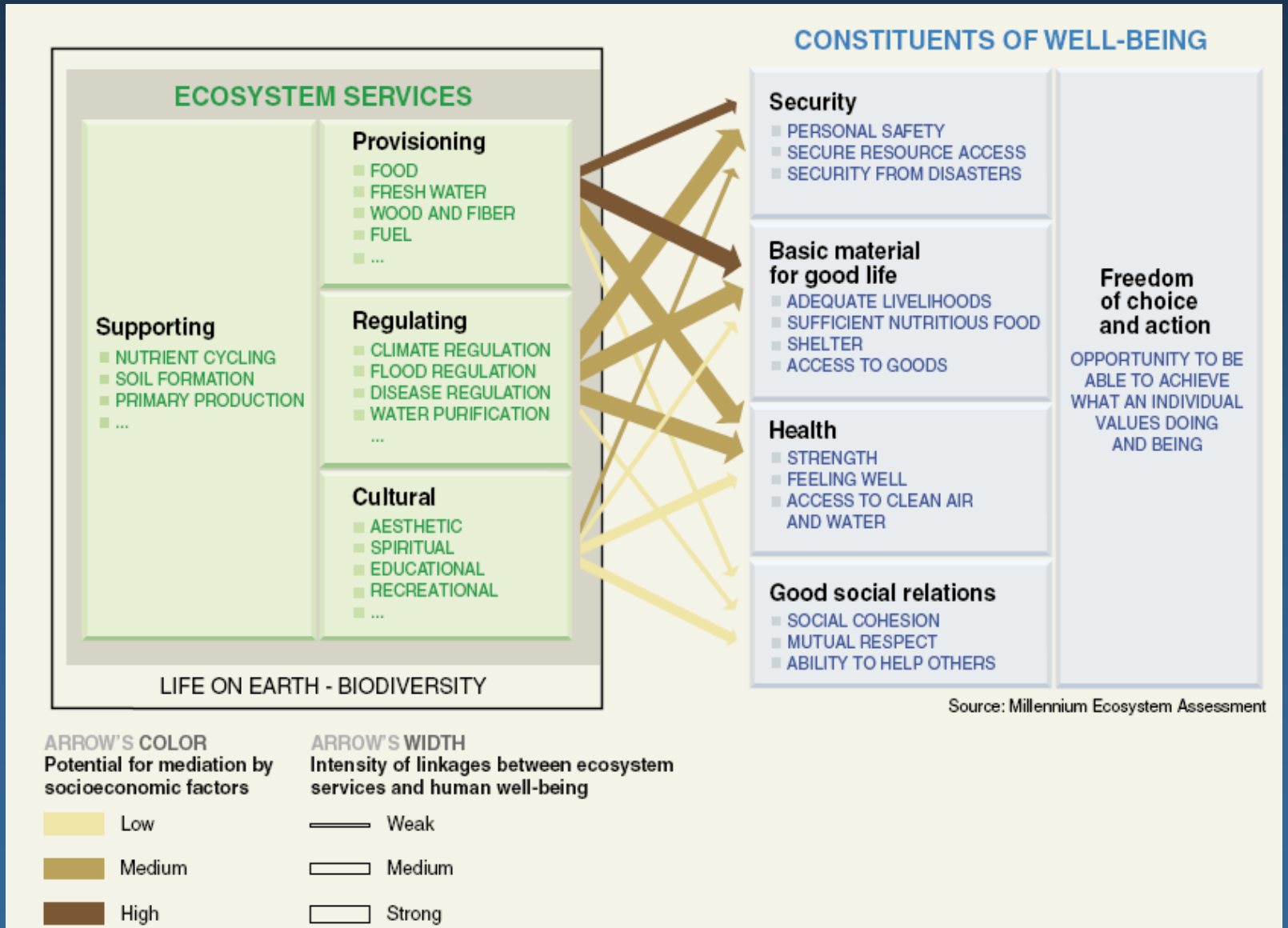
Defining the Problem



Defining the Problem

- The conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life (Daily, 1997)

- The benefits people obtain from ecosystems (Millennium Ecosystem Assessment, 2005)

- The transformation of a set of natural assets (soil, biota, air, water) into things that we value (goods) (Binning et al. 2001)

- Final ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being (Boyd and Banzhaff 2007)

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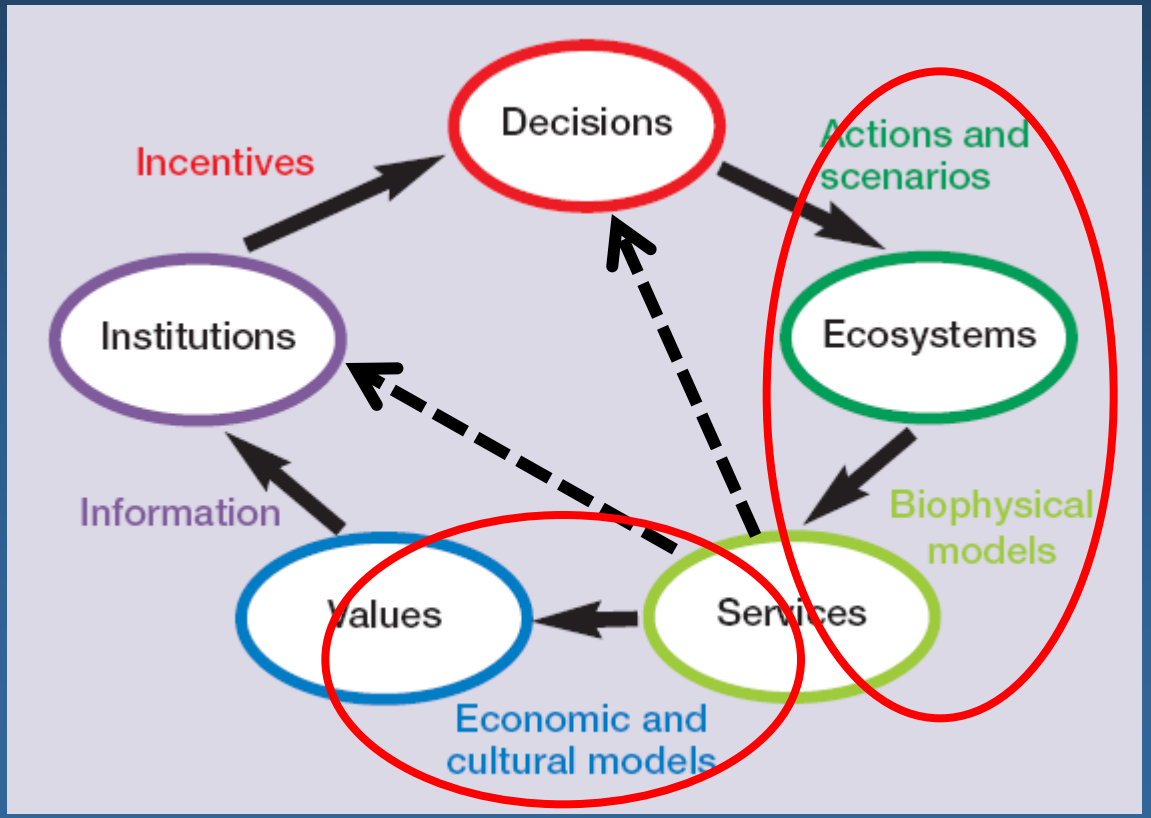
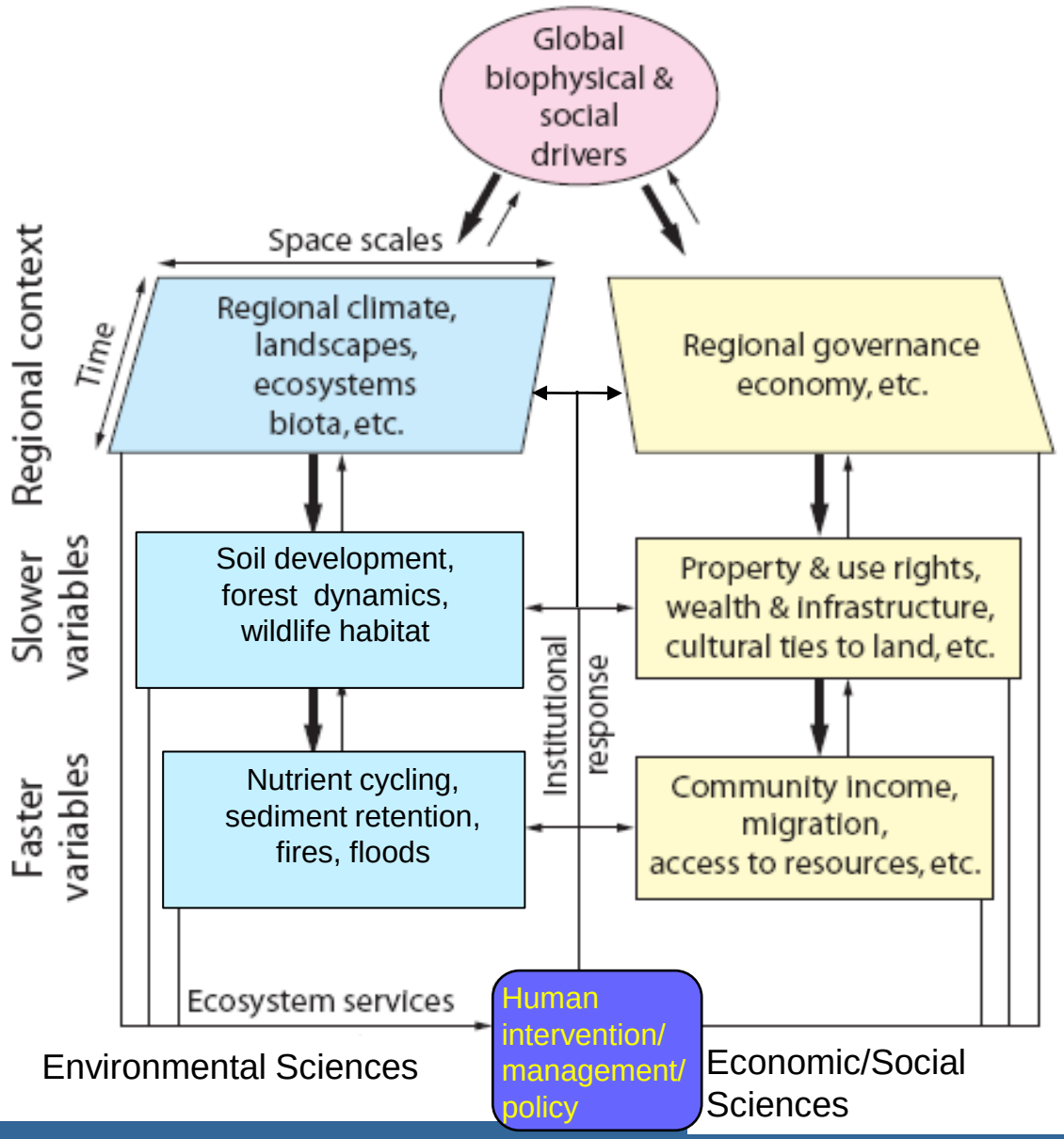
Goal

Decision-relevant science to facilitate incorporating science into decision making



Adapted from Daily et al. 2009



Adapted from Carpenter 2009

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Ecosystem Services – Key Research Needs

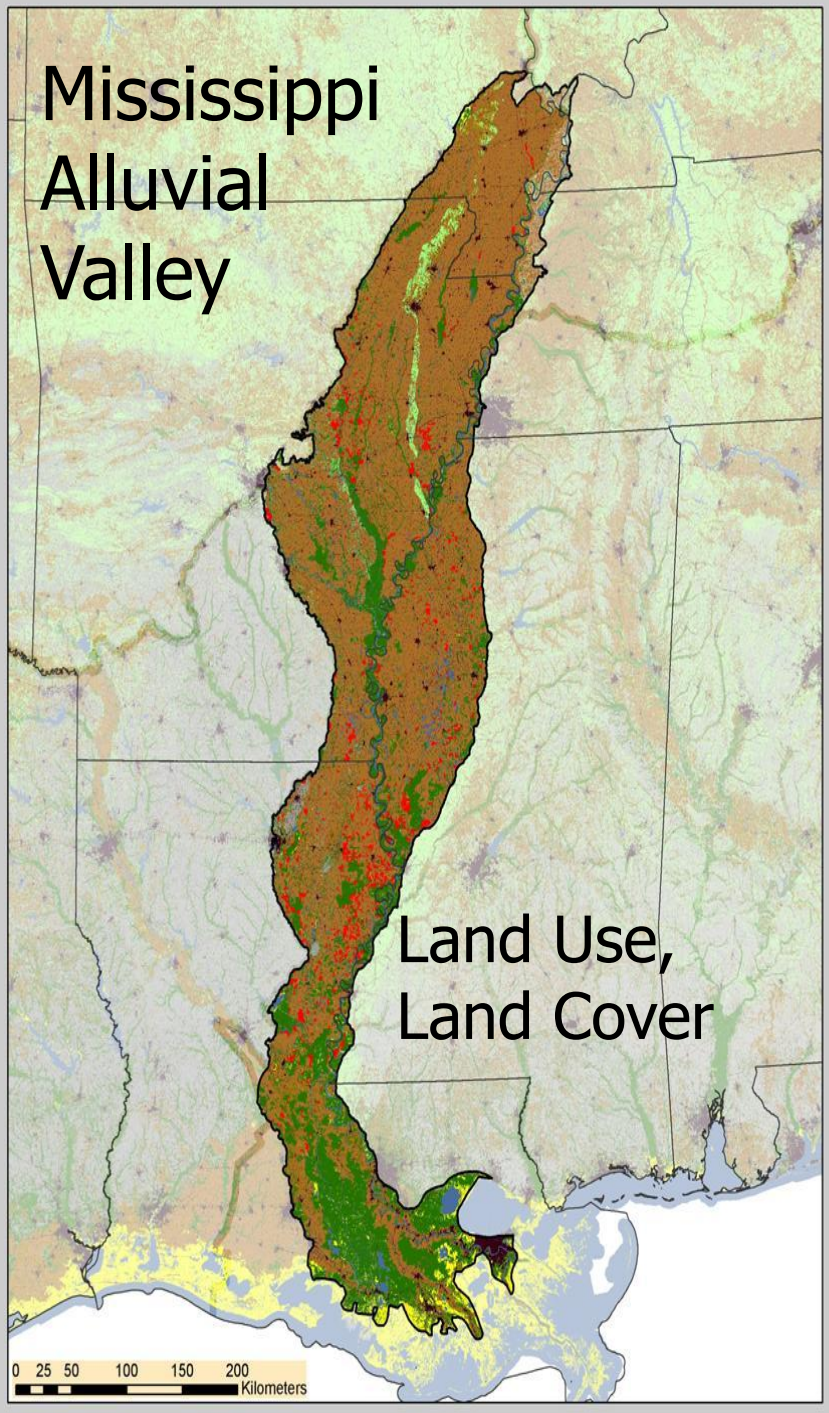
Effects of scale on services and interactions

Optimization/Maximizing/Targeting – who, what, when?

Evaluating ecological trade-offs

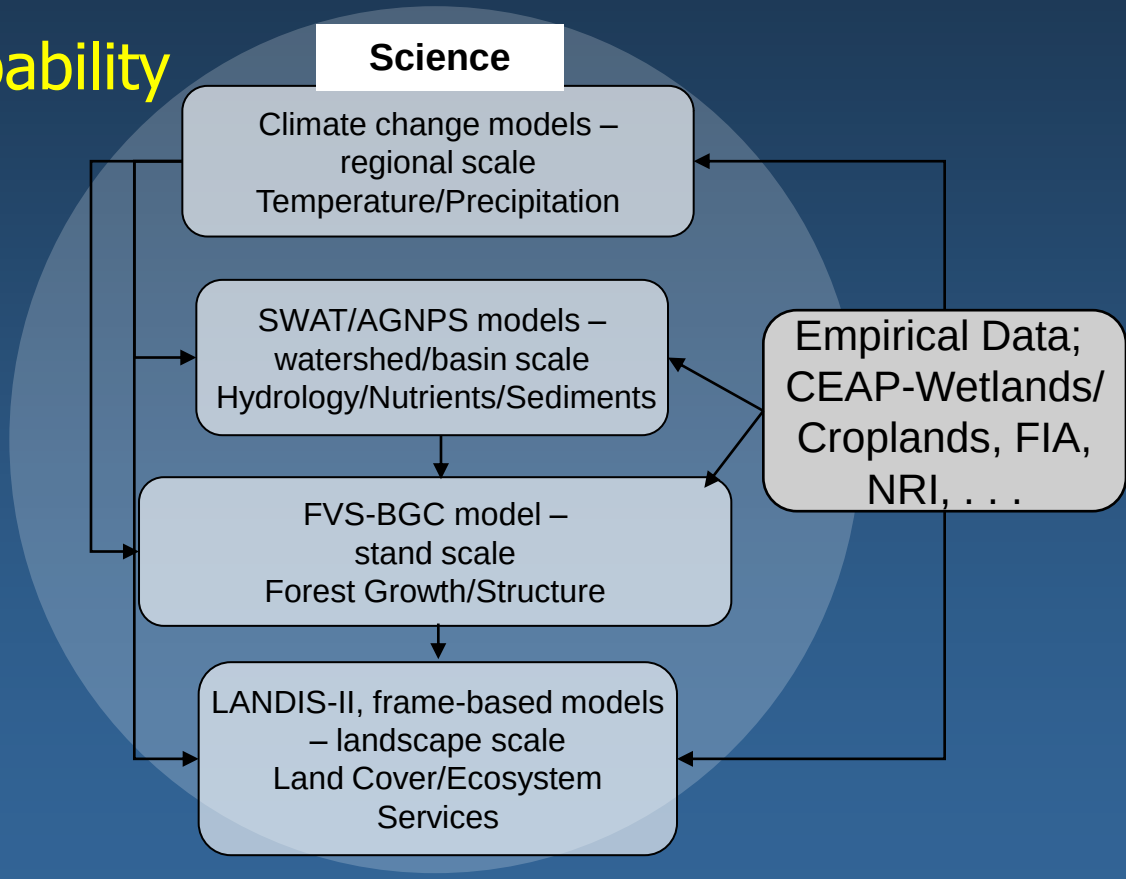
Incorporating climate-change effects

Articulating these issues and solutions across a range of stakeholders


Mississippi
Alluvial
Valley
Land Use,
Land Cover
0 25 50 100 150 200
Kilometers

Ecosystem Services Integrated Modeling Framework

Applied Science Goal:
Develop predictive capability to model/evaluate scenarios and impacts



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Ecosystem Services Integrated Modeling Framework

- Carbon sequestration
- Wildlife habitat
  - amphibians
  - waterfowl
  - neotropical migrant birds
- Water quality
  - erosion reduction/sediment retention
  - nitrate retention

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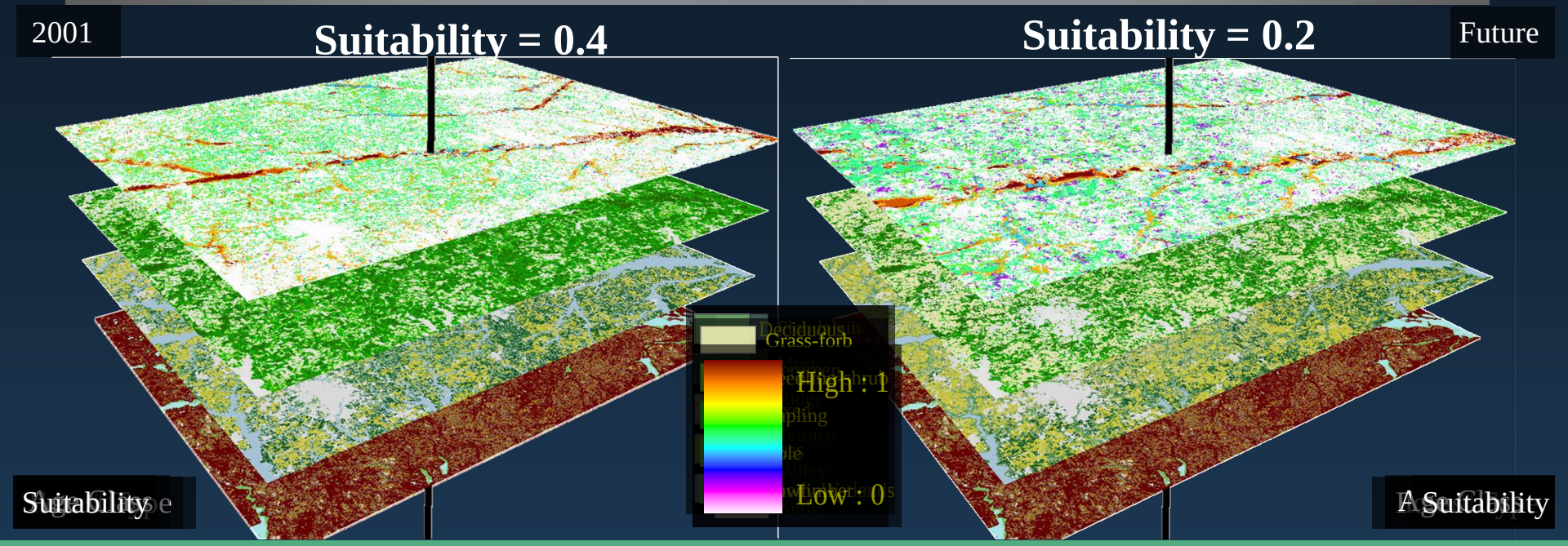
Ecosystem Service: Wildlife Habitat

- **Swainson's warbler**
  - **Neotropical migrant**
  - **Habitats**
    - **Mature bottomland hardwoods**
    - **7-10 year old pine stands**
  - **High small stem densities**
    - **Mean = 34773 stems/ha**
  - **Large forest blocks**
    - **>4500 ha**

- Density SI
  - SI_1: Landform, forest type, age class
  - SI_2: Forest patch size
  - SI_3: Proportion forest in 1-km radius
  - SI_4: Small stem density (stems/ha)

Model Habitat Suitability



Landform	Forest type	Age Class: Grass-Forb	Shrub-Seedling	Sapling	Pole	Saw
Terrace/Mesic	Transitional/Shrubland	0.000	0.000	**0.200**	0.000	0.000
	Deciduous	0.000	0.000	**0.200**	**0.500**	**0.600**
	Evergreen	0.000	0.000	0.000	0.000	0.000
	Mixed	0.000	0.000	0.000	0.000	0.000
	Woody Wetlands	0.000	0.000	**0.400**	**0.800**	**0.800**

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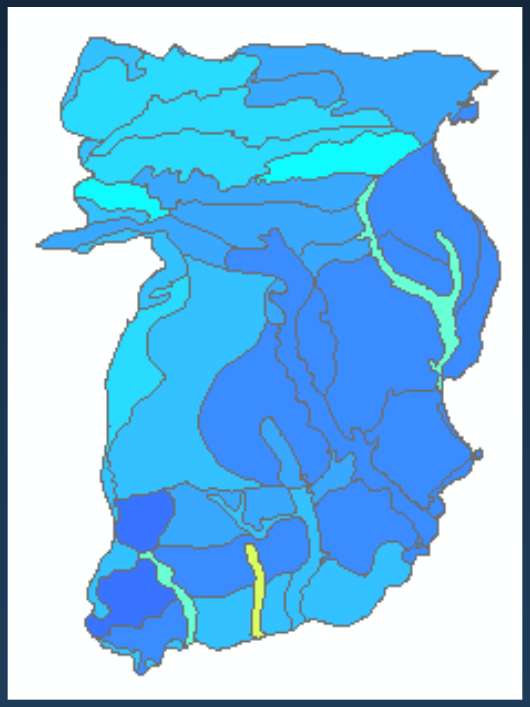
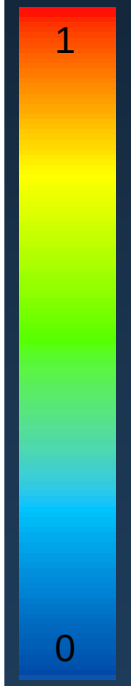
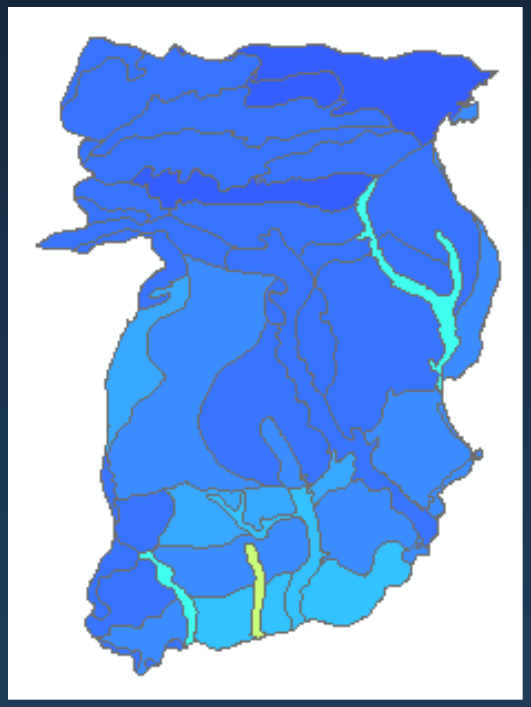
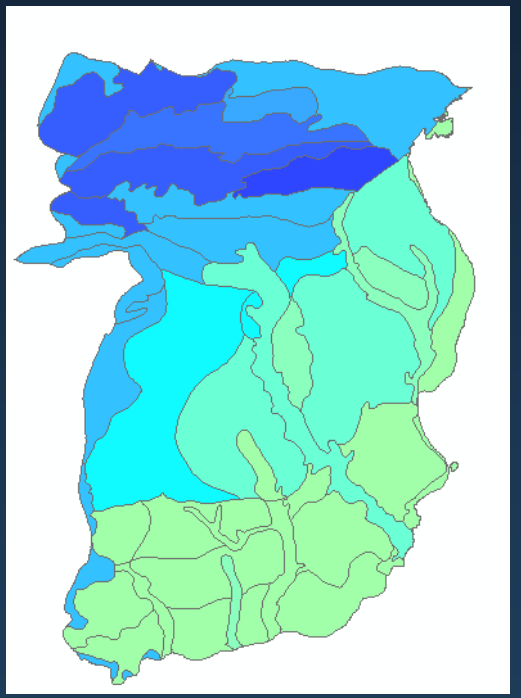
Spatially Explicit Habitat Suitability

Swainson's Warbler









2001 Density

Future Density

Change

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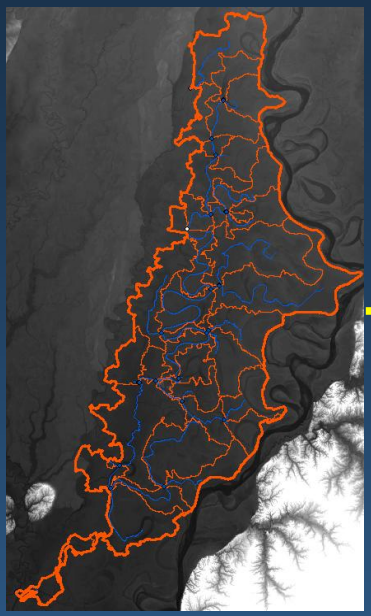
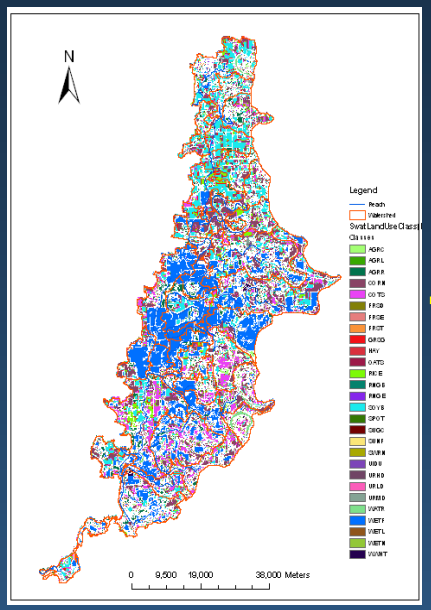
Soil Water Assessment Tool (SWAT) modeling inputs and process



DEM – streams/reach/ outlets/subbasins/slope

+



Landuse – NASS /NLCD2001

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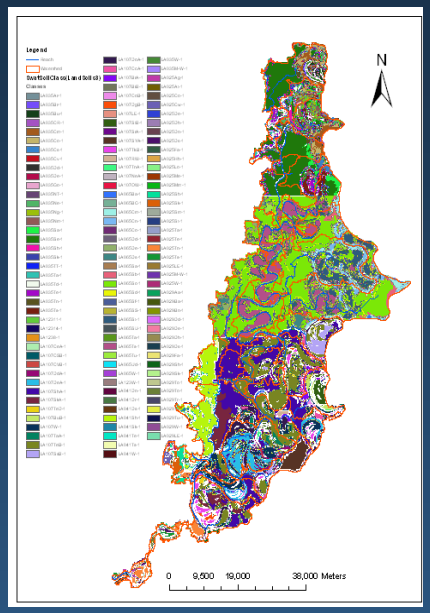

Soils – SSURGO

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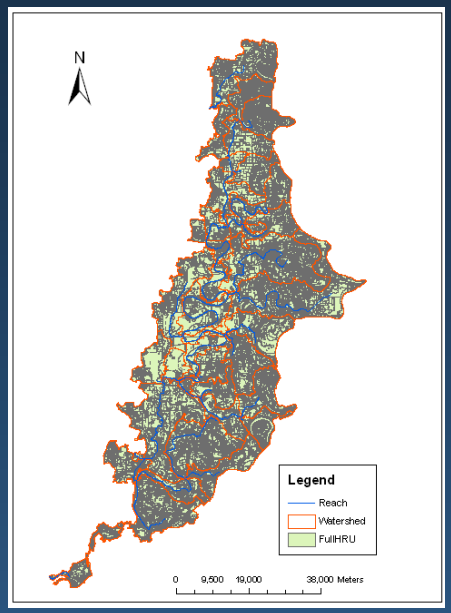
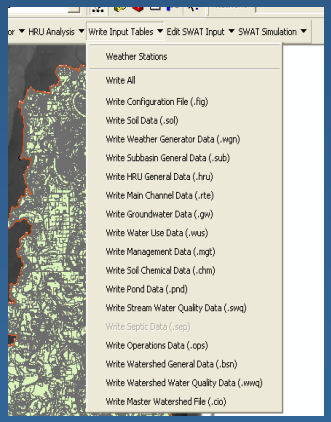
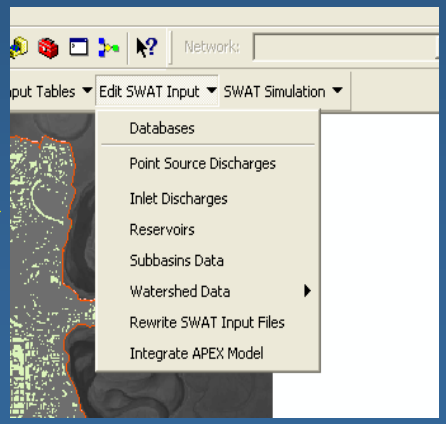


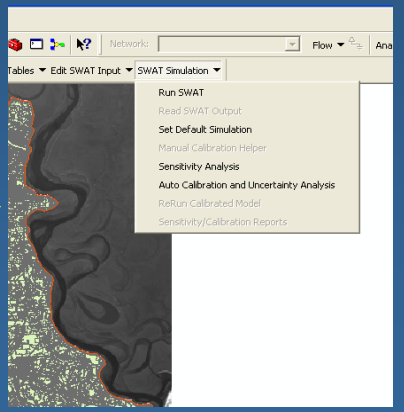
Hydrologic Response Units (HRU)



Write Inputs for weather and hydrologic processes



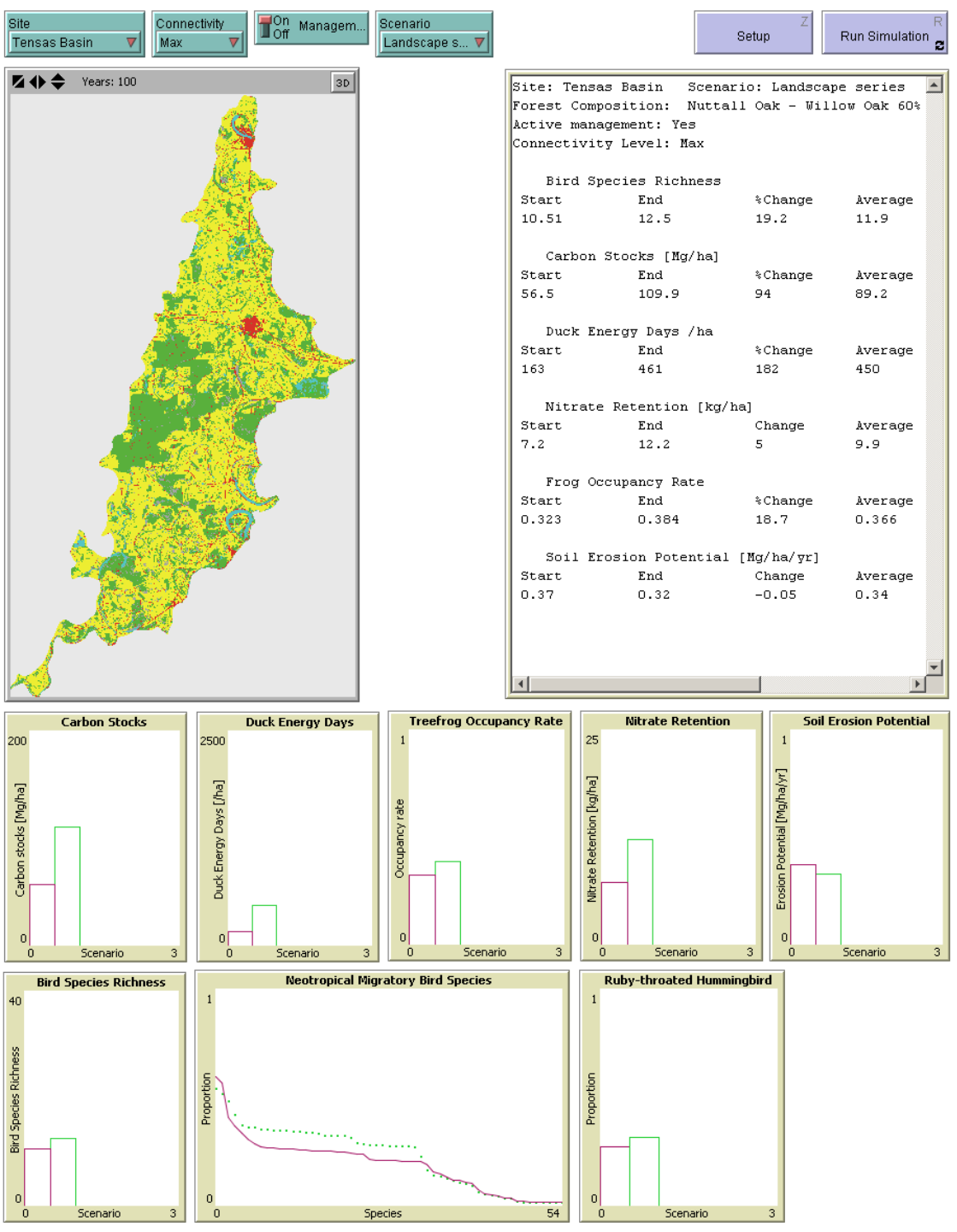
Model Input edits



Model Simulation, Calibration and Validation

Ecosystem Services Model

Run



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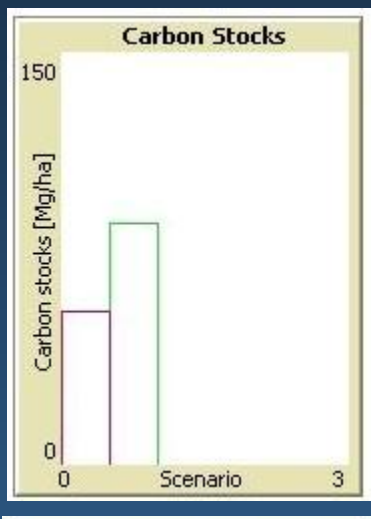
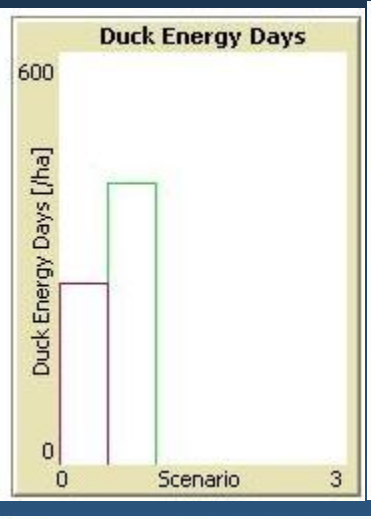
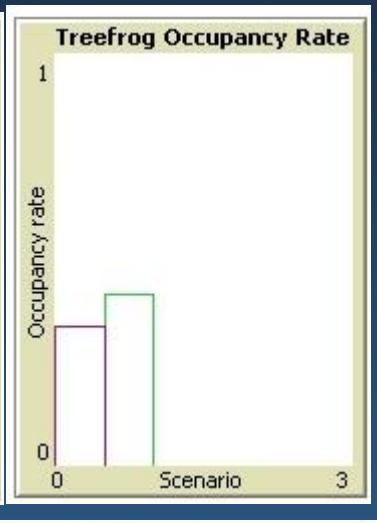
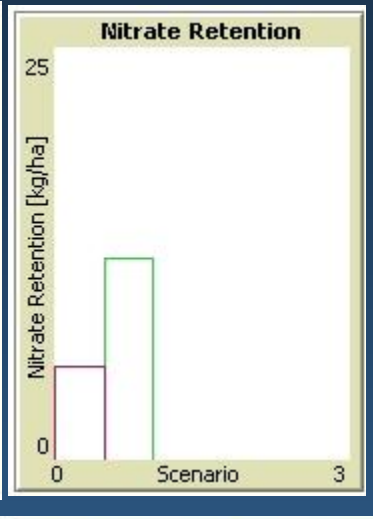
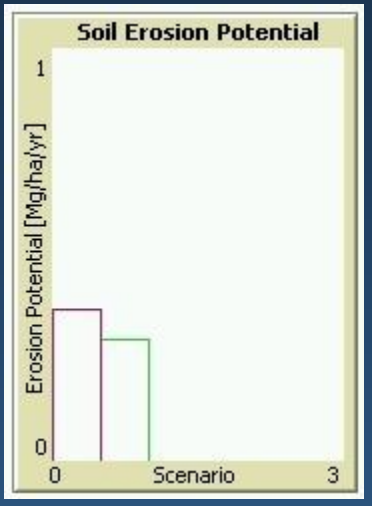
Graphic Outputs

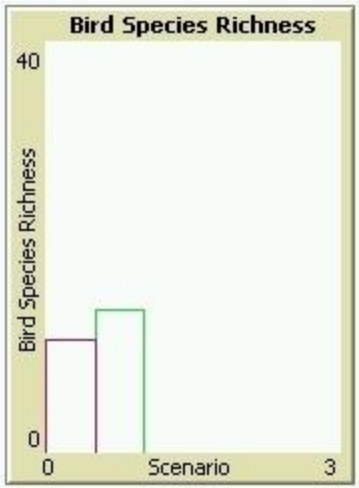


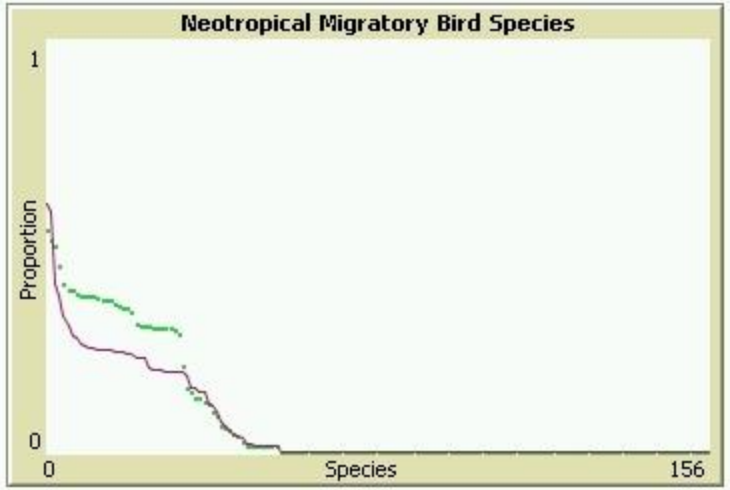


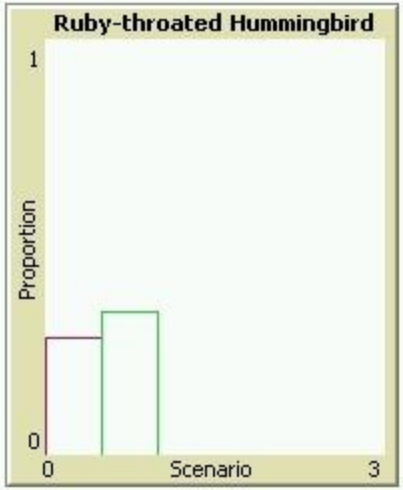












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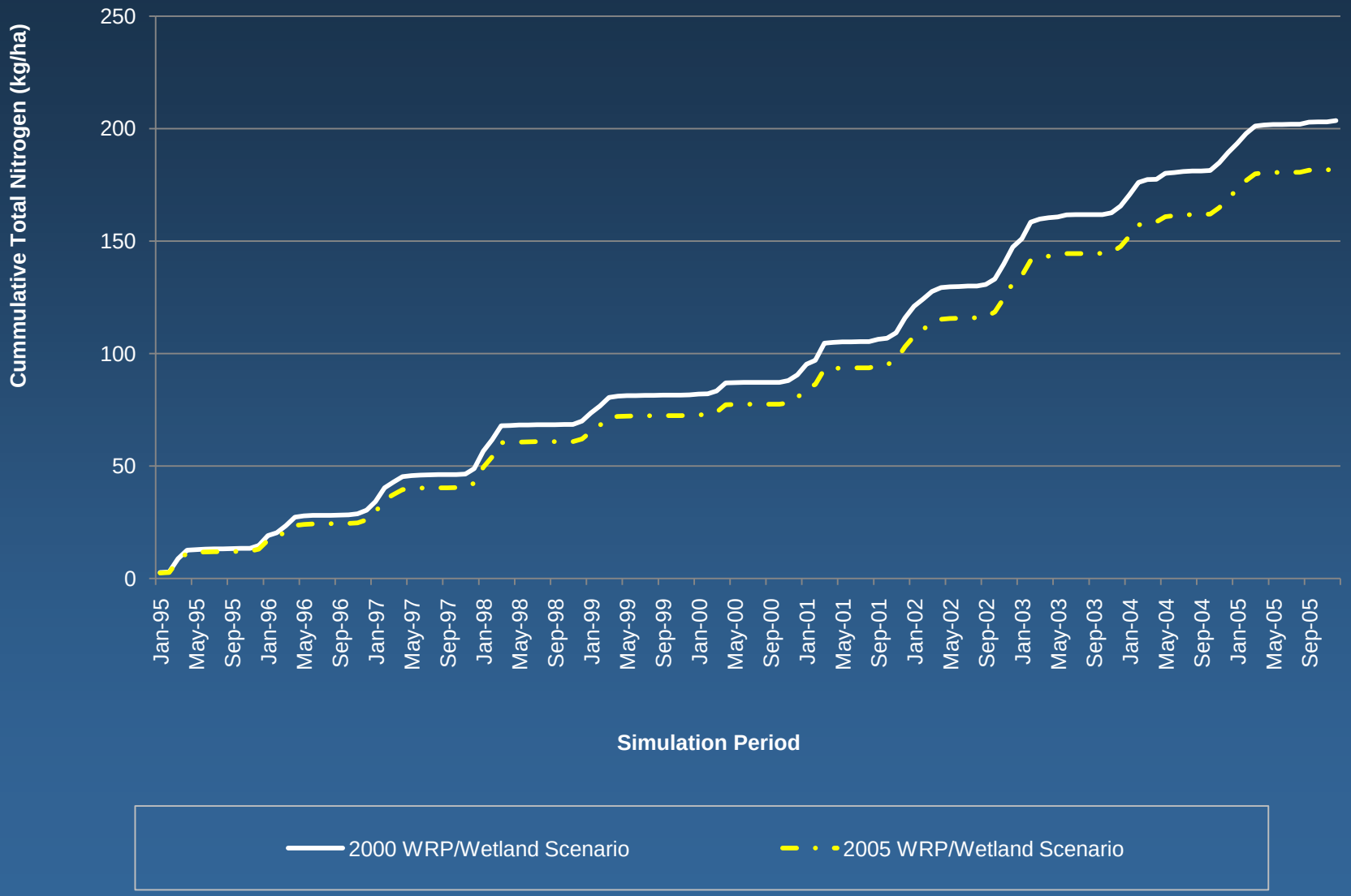
Model Application: Quantify Impact of Conservation Practices on Water Quantity and Quality

Assessment of WRP Impact on Water Quality – Tensas Basin



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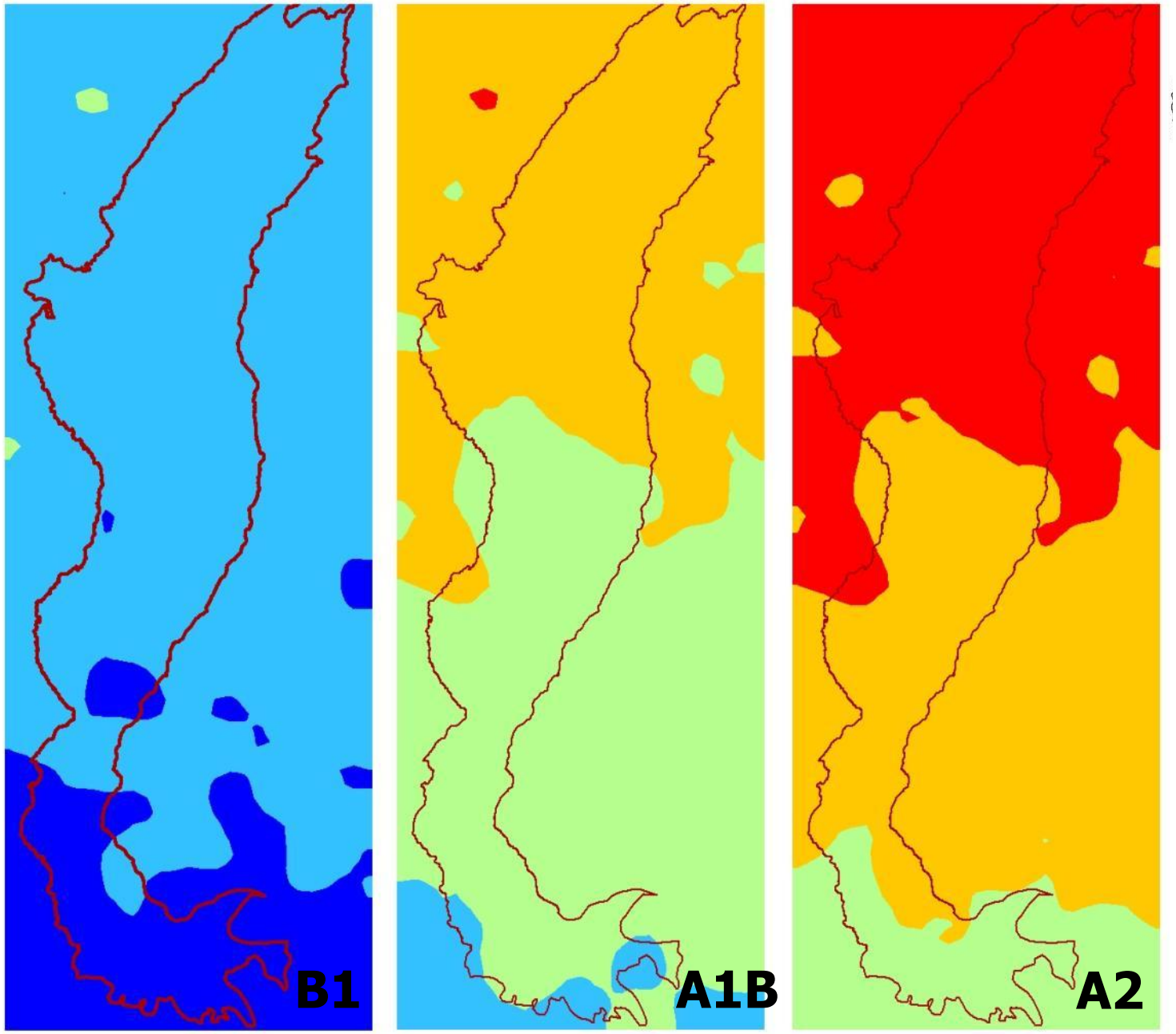
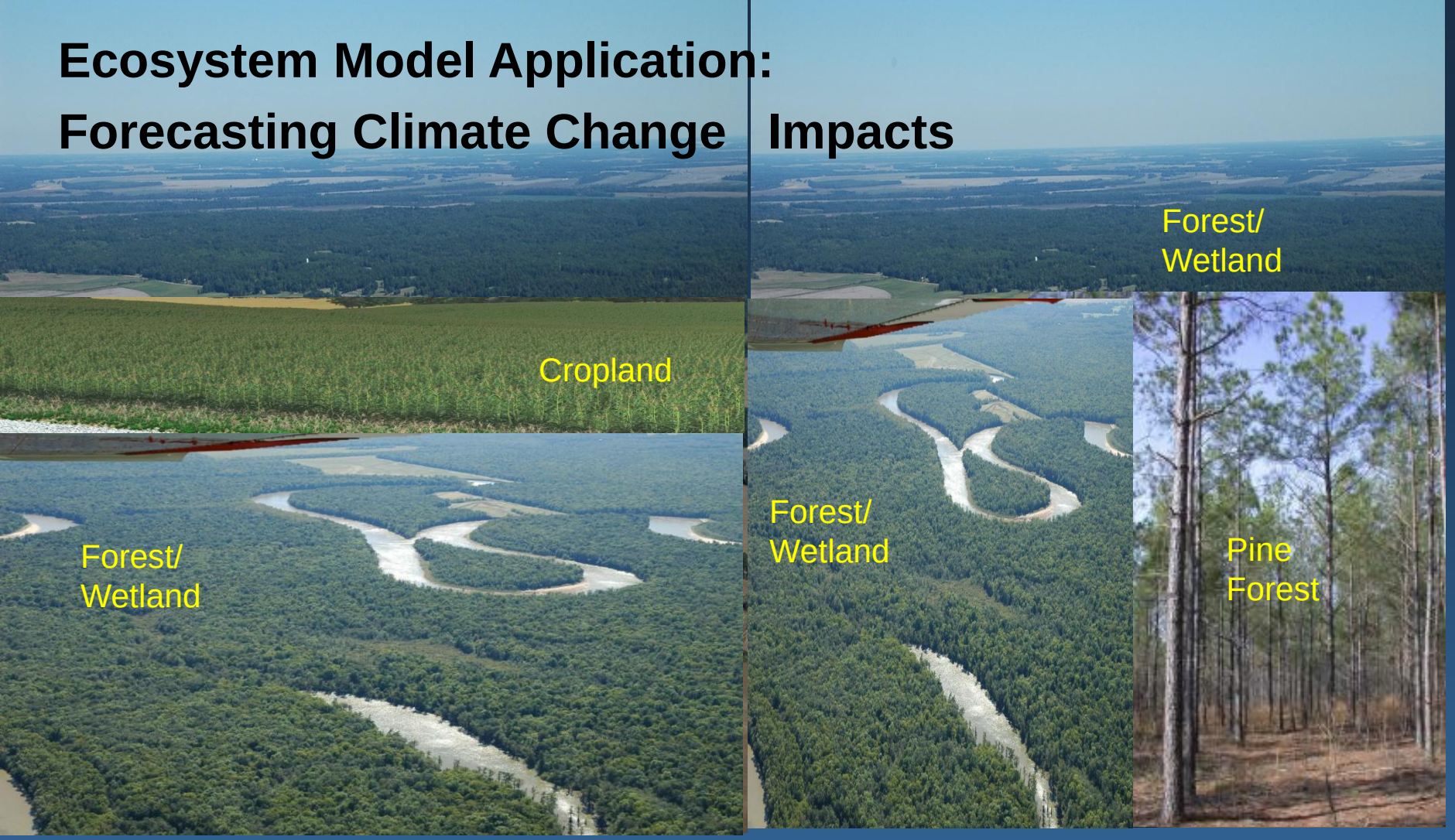
Average annual temperature anomaly in 2099



Ecosystem Model Application: Forecasting Climate Change Impacts



Scenario A:
Restore cropland to native forests and wetlands

Scenario B: Climate change shifts land cover types

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Simulation of site: Louisiana WRP2 Scenario: 1 Years: 100
Forest Composition: Nuttall Oak - Willow Oak 100%
Active management: No Connectivity level: Min

Bird Species Richness

Start	End	%Change	Average
9.8	14.5	48	12

Carbon Stocks [Mg/ha]

Start	End	%Change	Average
47.9	79.3	66	59.9

Duck Energy Days /ha

Start	End	%Change	Average
210	512	144	352

Nitrate Retention [kg/ha]

Start	End	Change	Average
1.9	3.3	1.4	2.6

Frog Occupancy Rate

Start	End	%Change	Average
0.32	0.49	52	0.39

Soil Erosion Potential [Mg/ha/yr]

Start	End	Change	Average
1.5	0	-1.5	0.7

Climate Change Adaptation - Pine Forest

effects

Simulation of site: Louisiana WRP2 Scenario: 1 Years: 100
Forest Composition: Nuttall Oak - Willow Oak 60% Loblolly Pine 40%
Active management: No Connectivity level: Min

Bird Species Richness

Start	End	%Change	Average
9.82	19.3	96	13.8

Carbon Stocks [Mg/ha]

Start	End	%Change	Average
47.9	184.3	285	101

Duck Energy Days /ha

Start	End	%Change	Average
203	517	154	361

Nitrate Retention [kg/ha]

Start	End	Change	Average
1.9	4.6	2.7	3.2

Frog Occupancy Rate

Start	End	%Change	Average
0.32	0.61	93	0.46

Soil Erosion Potential [Mg/ha/yr]

Start	End	Change	Average
1.5	0	-1.5	0.4

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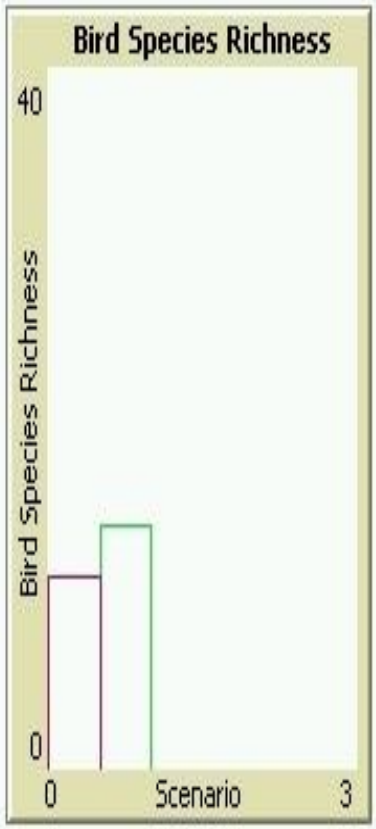
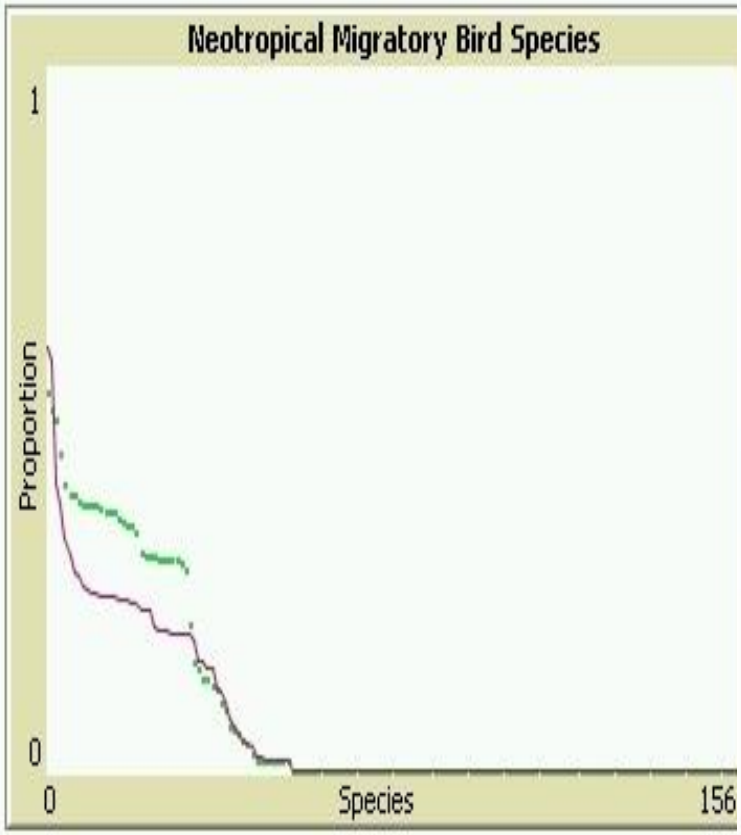
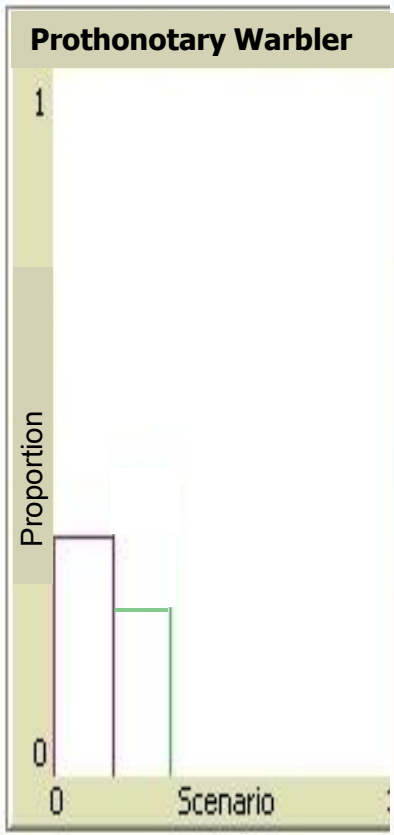
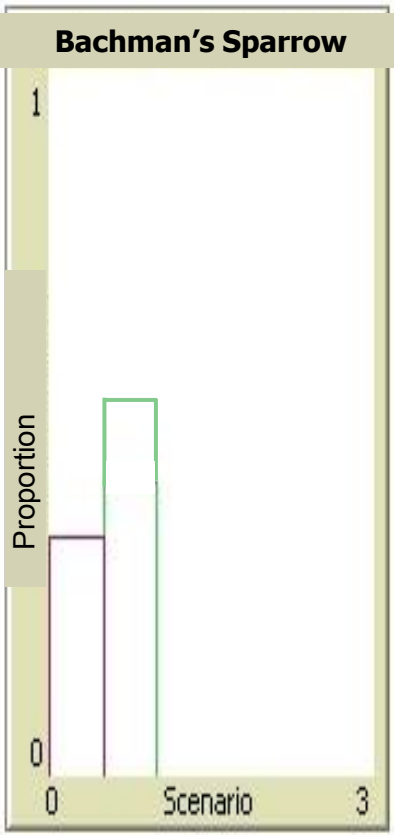
Pine Forest Climate Change Scenario









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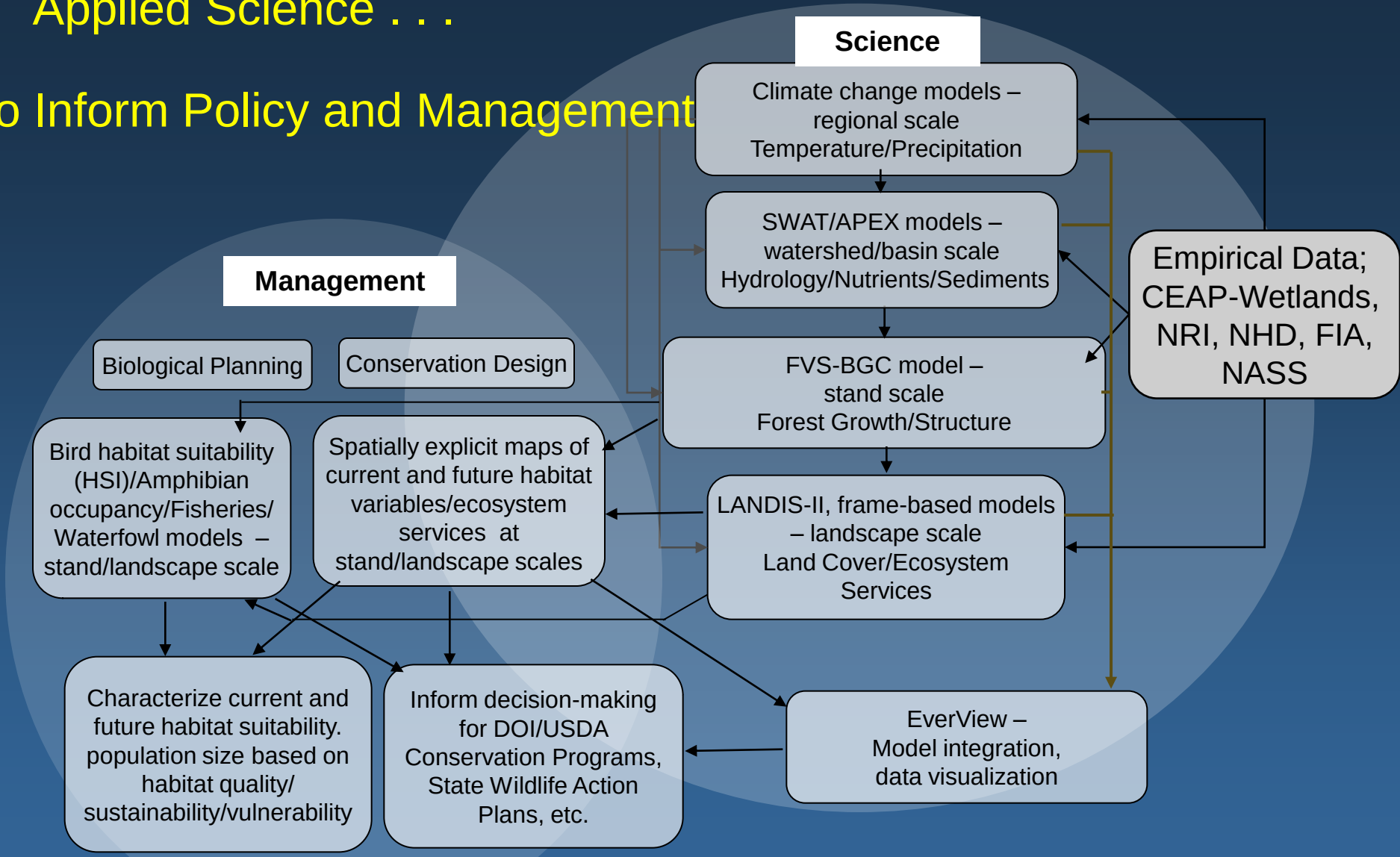
Applied Science . . .

to Inform Policy and Management



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Questions??
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