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Northeast Climate Science Center

# Theme #5:

# Ecosystem vulnerability and species response to climate variability and change

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USDA Forest Service Northern Research Station

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# Ecological vulnerability and species response to climate variability and change

- Determine how species, habitats, and landscapes are affected by climate change
  - Consideration of multiple drivers of landscape and population change.
  - Requires basic knowledge of species life history and how demographics are affected by environmental factors
  - Expert opinion; Predictive models, statistical or process based simulation models
- Develop tools to evaluate restoration and adaptation management approaches.
  - will often involve linking climate models with landscape change and population models

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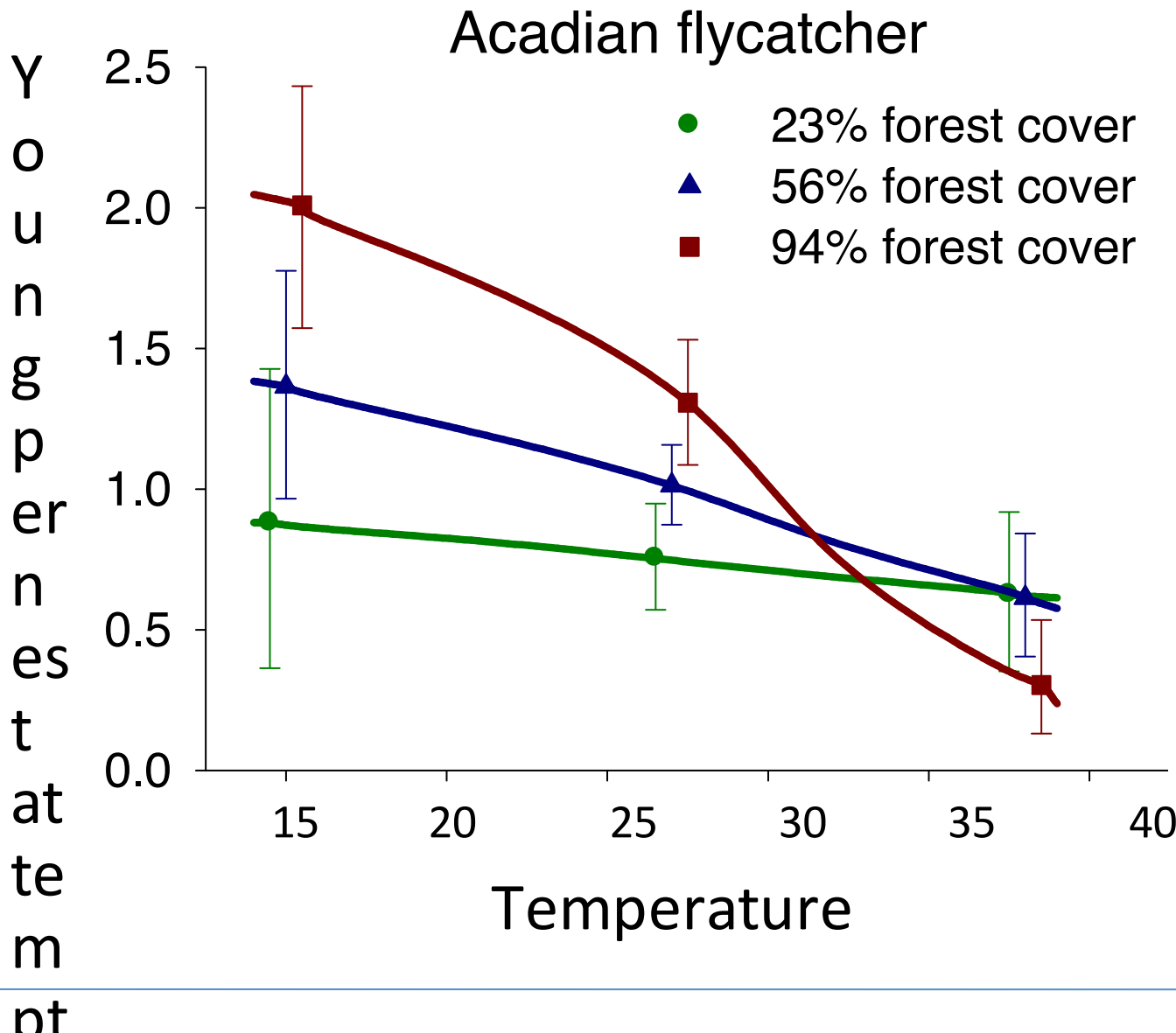
# Understanding effects of climate and other factors on population and landscape processes



# Using models to forecast changes in populations, species, landscapes under alternative climate scenarios

## Climate Models

**Predictions:**
- Temperature
- Precipitation
- Solar radiation

## Ecosystem Simulation

### Linkages Model

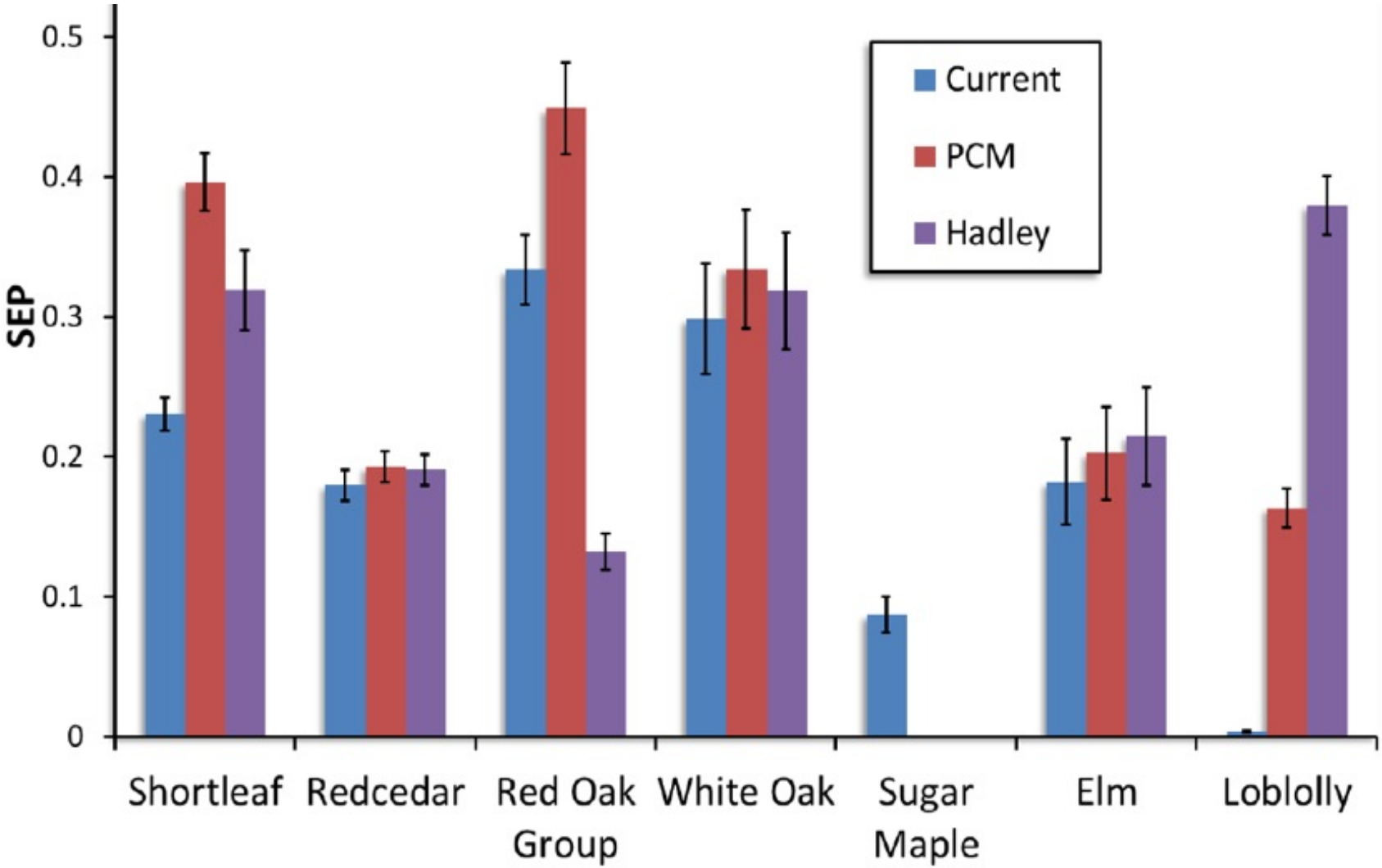
**Inputs:**
- Location
- Tree sps vital attributes
- **Climate**
- Soil characteristics

## Landscape Simulation

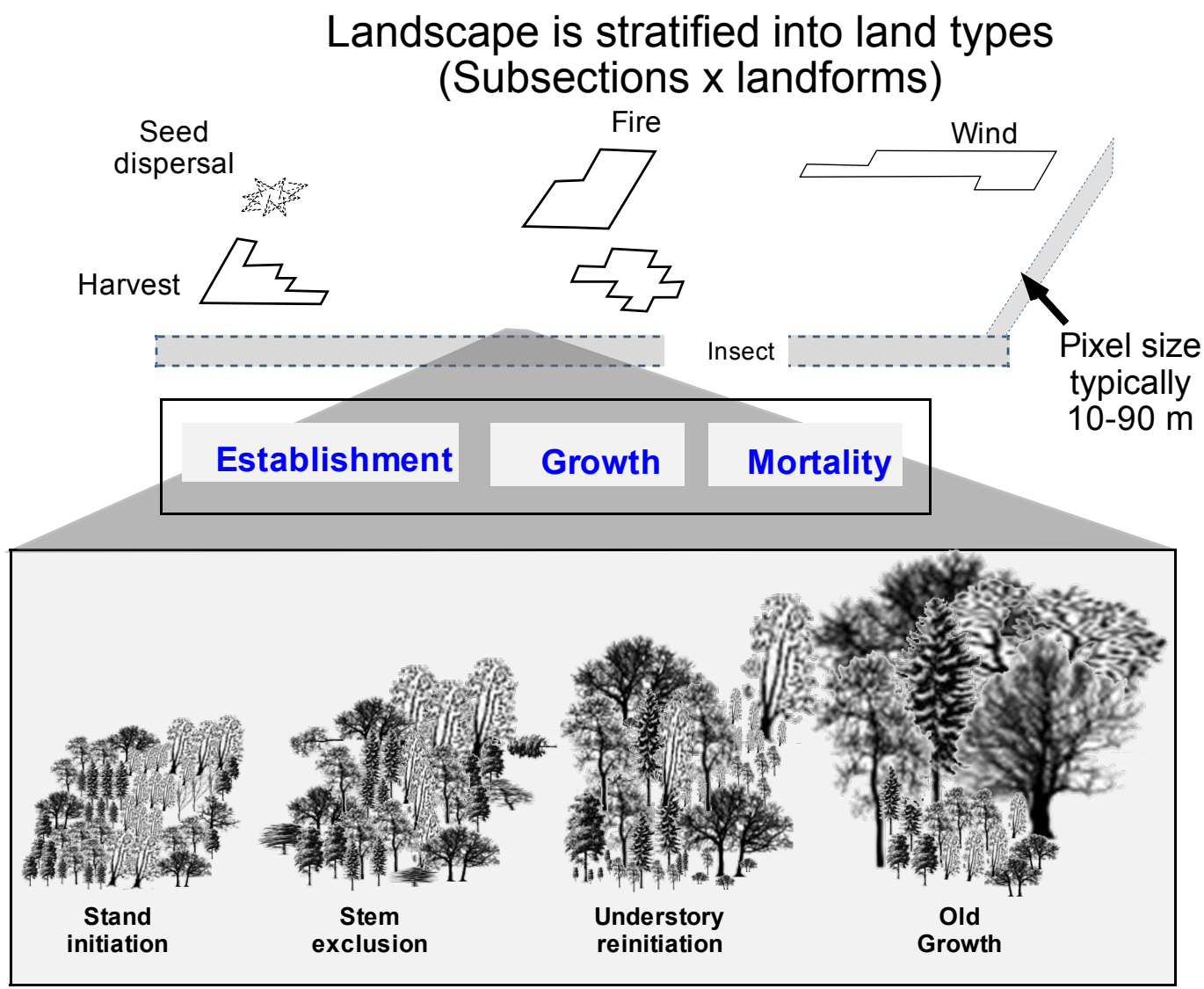
### LANDIS Model

**Inputs:**
- Tree establishment, growth
- Seed dispersal
- Vegetative reproduction
- Longevity
- Shade tolerance
- Fire tolerance
- Disturbance regime
- Management regime

# Linkages: Species establishment probabilities under alternative climate scenarios in Missouri



# LANDIS PRO Design




**Landscape-level**
- Fire/fire suppression
- Wind/hurricane/ice storm
- Insects
- Diseases
- Exotic species invasion
- Harvest/silviculture
- Fuel treatment

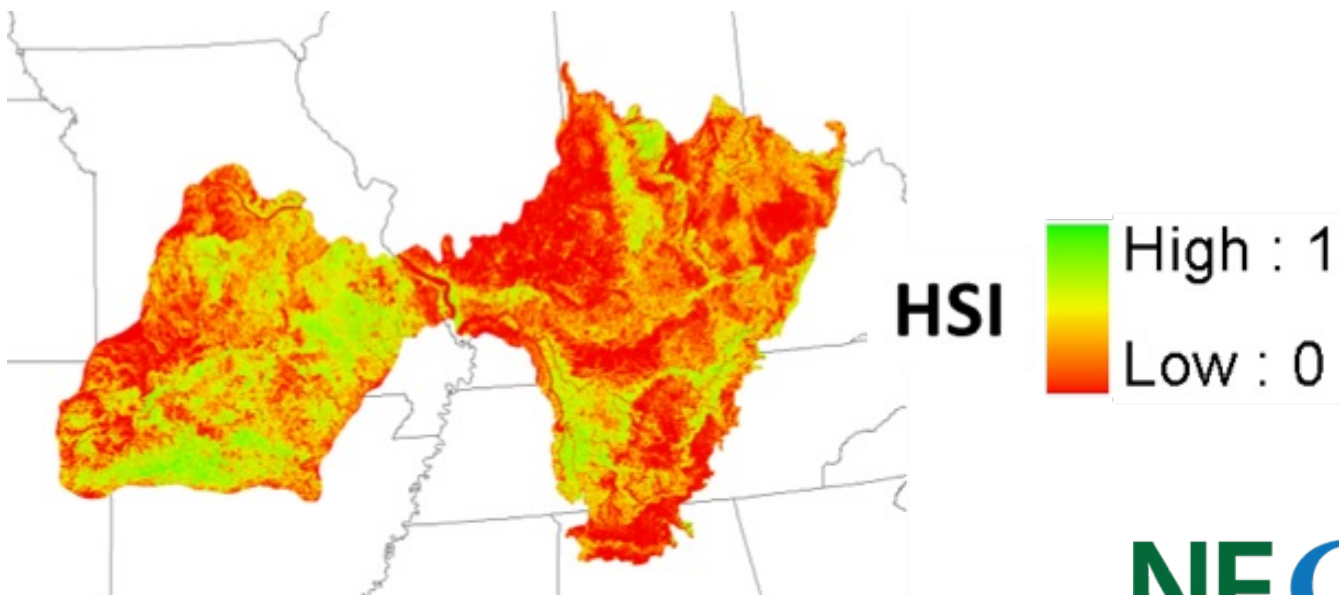
**Stand/pixel-level**
- Tracks tree counts by sps and age cohorts, biomass, carbon
- Models growth, competition, mortality

**Tree species-level**
- Longevity/Maturity
- Shade tolerance
- Maximum DBH
- Average seed numbers
- Dispersal distance
- Fire tolerance
- Disturbance susceptibility

# LANDIS Pro: Shortleaf Pine Density, 2100

# Assessing effects of climate and landscape change on wildlife

- Landscape-scale habitat suitability models
- Statistical based models predicting abundance

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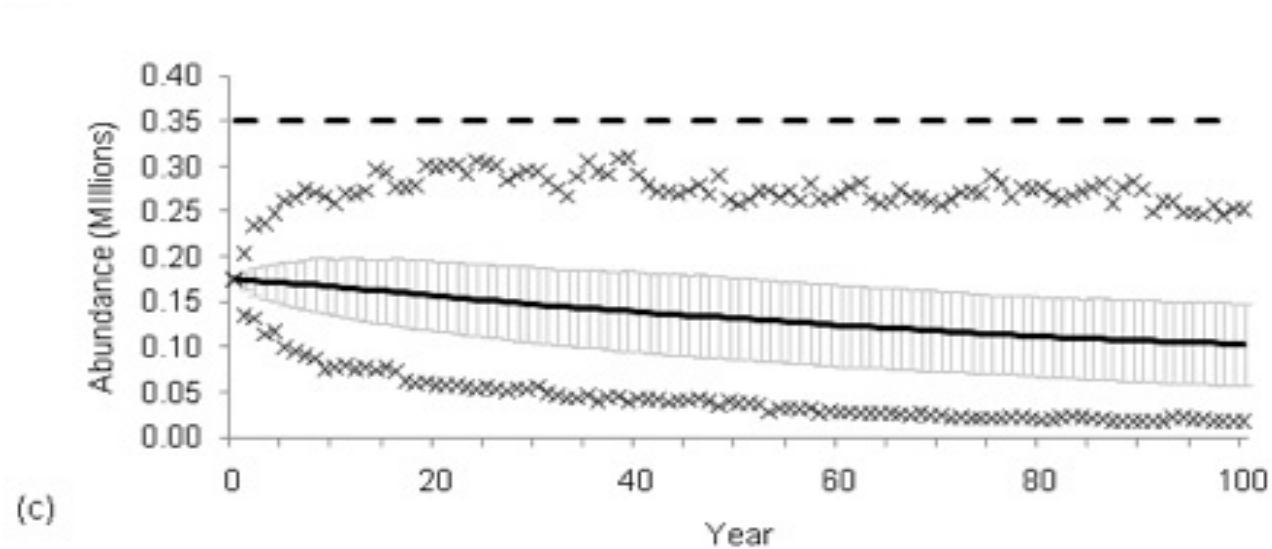
# Assessing effects of climate and landscape change on wildlife

- Population viability models

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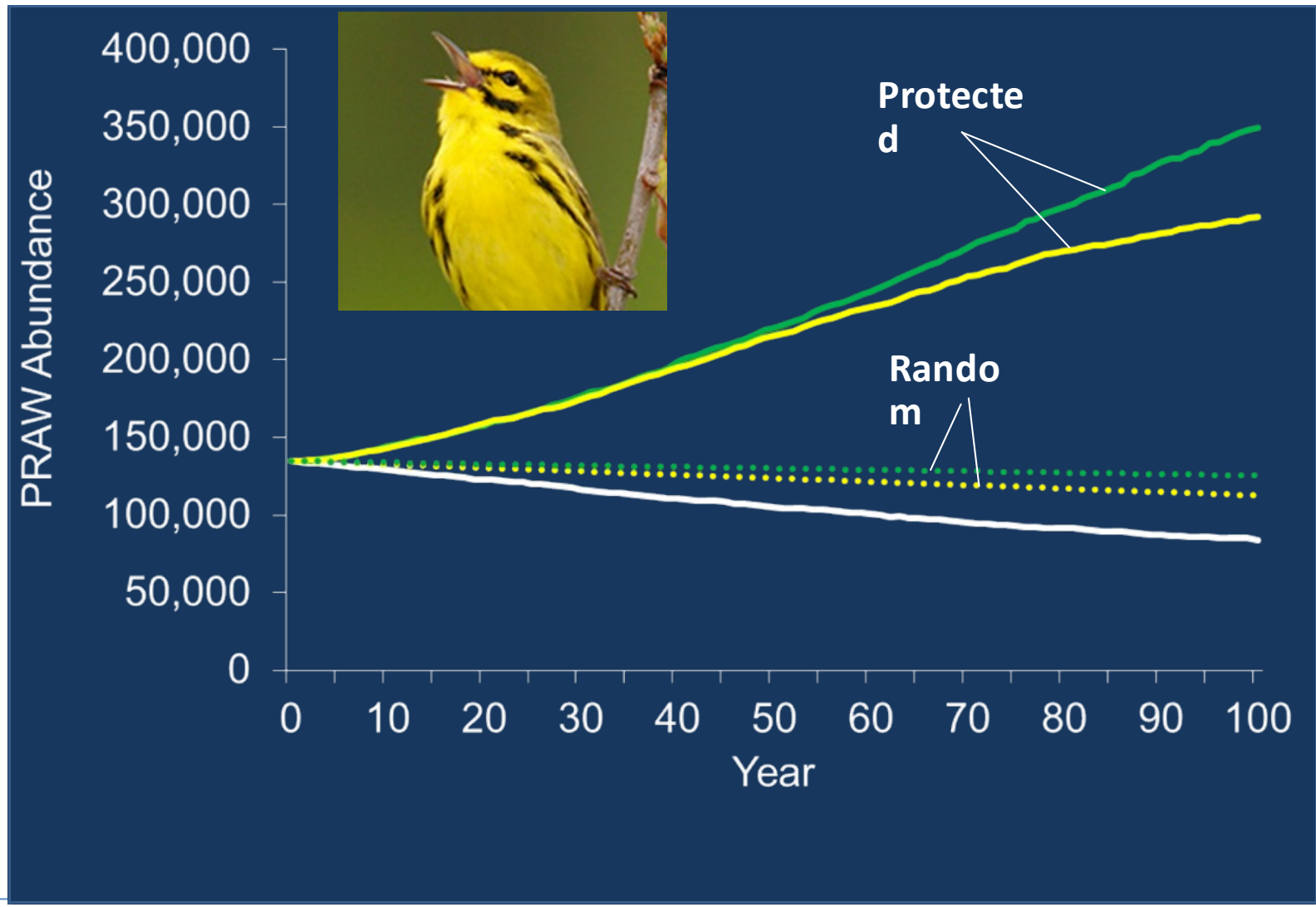
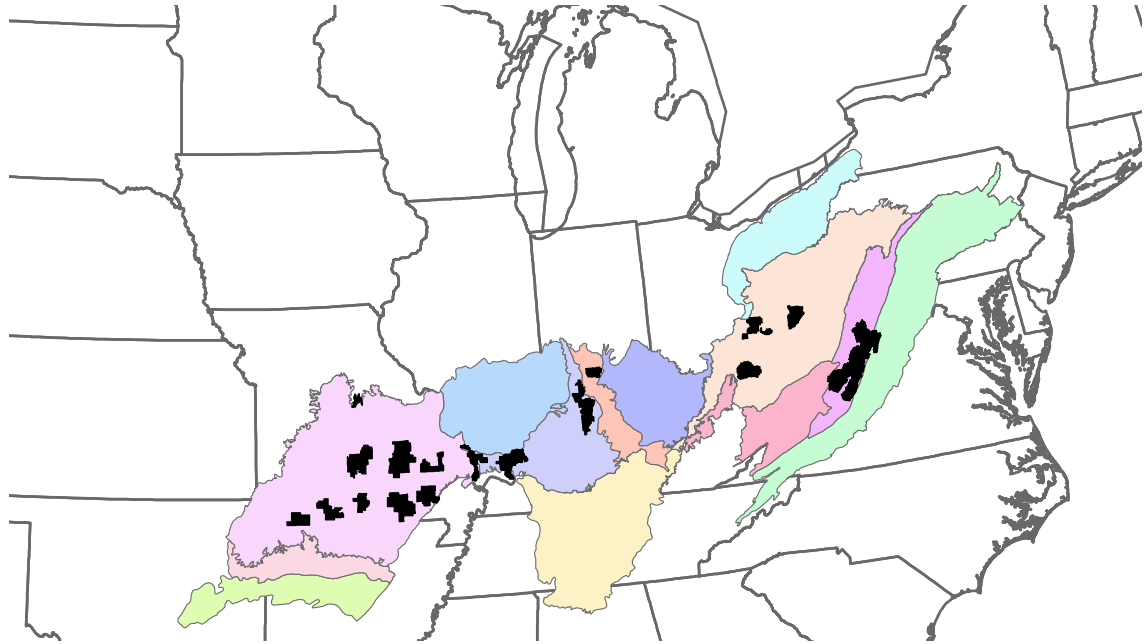
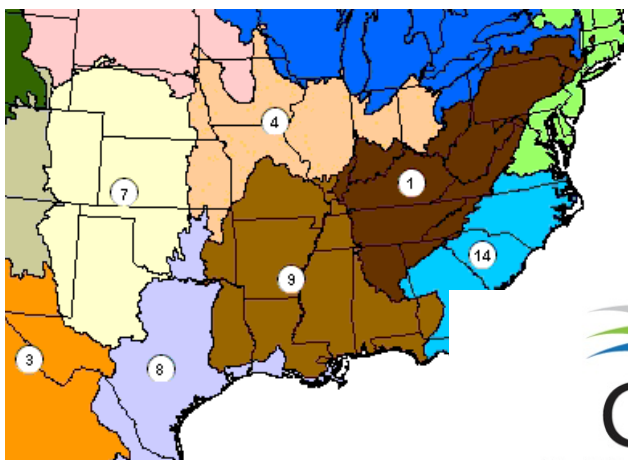
# In addition to assessing vulnerability, we can evaluate conservation strategies



# Stakeholder engagement

NIACS
Northern Institute of Applied Climate Science



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Landscape Conservation Cooperative

Central Hardwoods Joint Venture
partnerships for conservation

# Gulf Coastal Plains & Ozarks Landscape Conservation Cooperative

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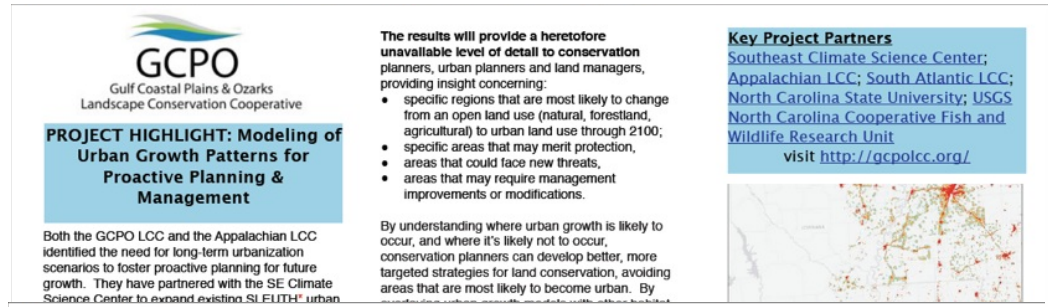
# The GCPO LCC and our Mission:

- Mission of the GCPO LCC
  - The mission of the Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative is to articulate the shared vision for sustainable natural and cultural resources in the face of a changing climate and other threats, foster a cooperative capacity within the collective conservation community to effectively meet the challenges of achieving that vision, and facilitate the refinement of that vision through targeted evaluation over time

# Functional Roles of Landscape Conservation Cooperatives

- Offer partners a landscape perspective for their conservation activities
- Develop explicit linkages across existing conservation partnerships that span multiple taxa and habitats
- Help incorporate future change into conservation planning (e.g., urbanization, sea-level rise)
- Pull these pieces together to help conservation partners define and design sustainable landscapes
  - Conservation Adaptation Strategy



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**PROJECT HIGHLIGHT: Modeling of Urban Growth Patterns for Proactive Planning & Management**

Both the GCPO LCC and the Appalachian LCC identified the need for long-term urbanization scenarios to foster proactive planning for future growth. They have partnered with the SE Climate Science Center to expand existing SLEUTH® urban

**The results will provide a heretofore unavailable level of detail to conservation** planners, urban planners and land managers, providing insight concerning:

- specific regions that are most likely to change from an open land use (natural, forestland, agricultural) to urban land use through 2100;
- specific areas that may merit protection,
- areas that could face new threats,
- areas that may require management improvements or modifications.

By understanding where urban growth is likely to occur, and where it's likely not to occur, conservation planners can develop better, more targeted strategies for land conservation, avoiding areas that are most likely to become urban. By

**Key Project Partners**
Southeast Climate Science Center; Appalachian LCC; South Atlantic LCC; North Carolina State University; USGS North Carolina Cooperative Fish and Wildlife Research Unit
visit http://gcpolcc.org/



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**PROJECT HIGHLIGHT: Mangrove Migration Modeling**

Researchers at the USGS National Wetlands Research Center and the Southeast Climate Science Center are using observed and projected climate data to forecast the potential impacts of climate change on coastal salt marsh and mangrove forest ecosystems in the southeastern United States.

Changes in temperatures resulting from climate change portend species migrations, including plants - in this case grass-to-tree conversions in coastal wetlands. These migrations have implications for many fish and wildlife species in the Gulf region. Our understanding of these changes and their implications will help us to develop better, more targeted and cost-effective conservation strategies to prepare for these changes.

**While the project is ongoing, the preliminary results are striking in terms of the potential for mangrove forest range expansion** and the importance of the GCPO LCC Gulf coast as a zone that is likely to retain salt marsh in the region.

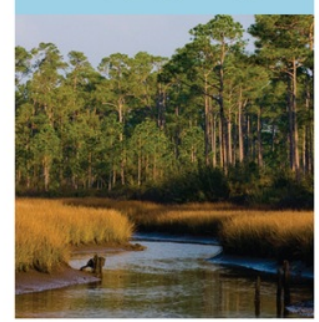
Like marshes, mangroves protect coastlines/ Kristine Paulus/FlickrCC

**The GCPO LCC's Research Scientist, based at the National Wetlands Research Center, is leading this investigation** as part of a larger initiative to better understand the ecological and natural resource management implications of alternative climate and land use change scenarios.

As part of this effort, the National Wetlands Research Center and the University of Louisiana-Lafayette recently co-hosted a workshop focused on mangrove forest range expansion in the northern Gulf of Mexico. The workshop brought together scientists and resource managers to discuss research and knowledge gaps related to mangrove forest expansion, salt marsh displacement, climate change, and sea level rise. One of the products of this workshop will be a Mangrove Expansion Working Group and Global Community of Practice for sharing knowledge and increasing communication regarding salt marsh-mangrove forest interactions in the region.


Sections of the northern Gulf coastline within the GCPO may become the last holdouts of salt marsh in the Gulf of Mexico/GCPO LCC

**Key Project Partners**
USGS – National Wetlands Research Center; Southeast Climate Science Center; NOAA.
visit http://gcpolcc.org/



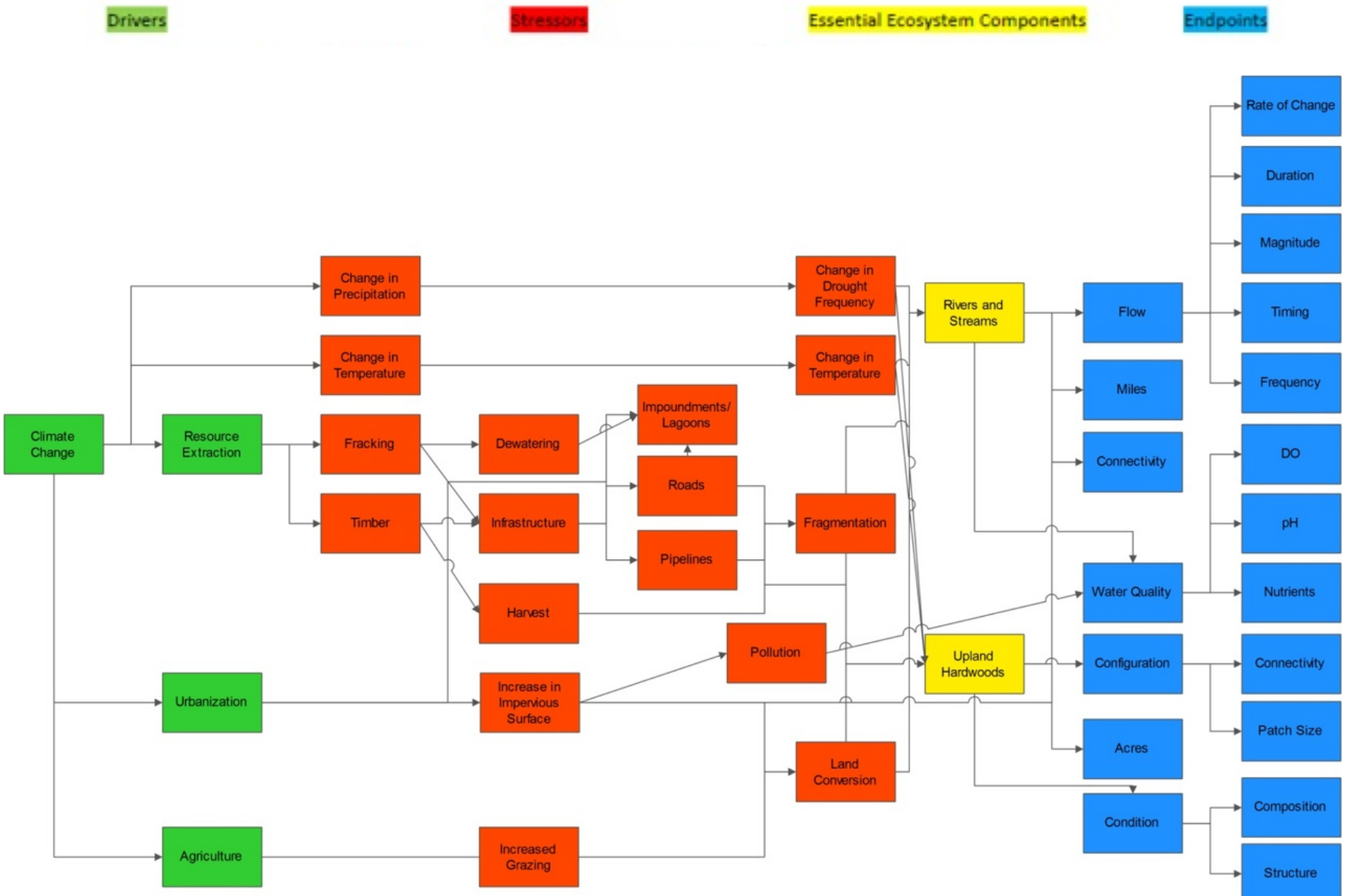
Salt marsh lines the tidal rivers of Grand Bay National Wildlife Refuge in Mississippi/USFWS

High densities of shrimp and blue crabs use northern Gulf marsh surfaces/Marcie Casas/FlickrCC

# Ecological vulnerability and species response to climate variability and change

- Broad explanation of science needs
  - Assessing and predicting landscape change
    - Assessing drivers of landscape change (CC, urbanization, etc.)
    - Response of ecological systems to climate change and other major environmental stressors
    - Identifying thresholds of ecological integrity in the face of landscape change
    - Developing conceptual models of ecological systems
    - Integrating terrestrial, aquatic, and subterranean ecological systems.
- Case study
  - Shortleaf Pine Initiative – developing Desired Forest Conditions (DFCs) in open pine systems

# Draft Model for Indentifying Stressors Influencing Attributes of Essential Ecosystem Components in the Ozarks/Ouahcita Subgeography



# Guiding Management Decision

- LINKAGES outputs
  - Quantifying Species Establishment Probabilities (SEPs) under alternative climate futures provides guidance on species composition for restoration

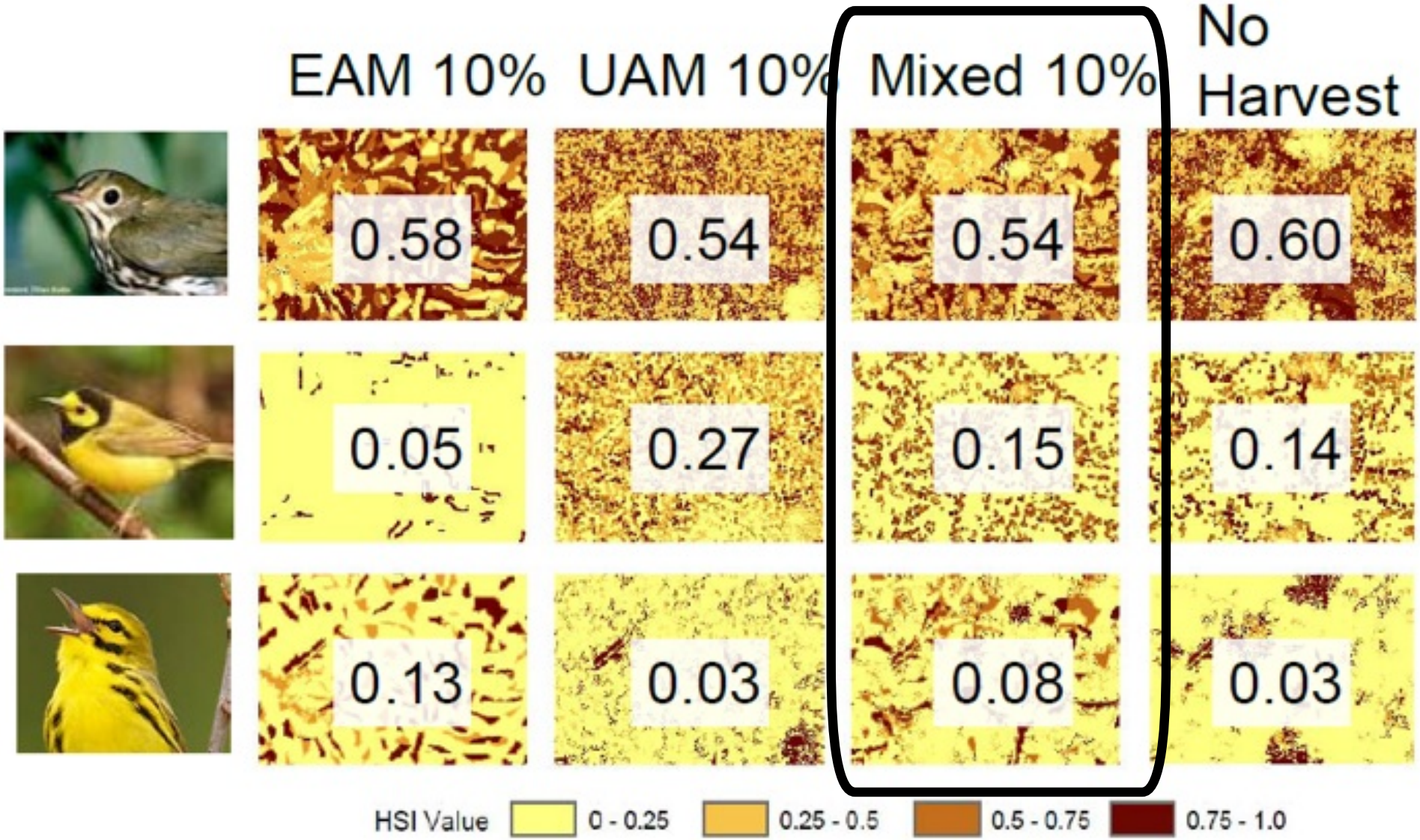
Shortleaf Pine

White Oak

# Guiding Management Decision

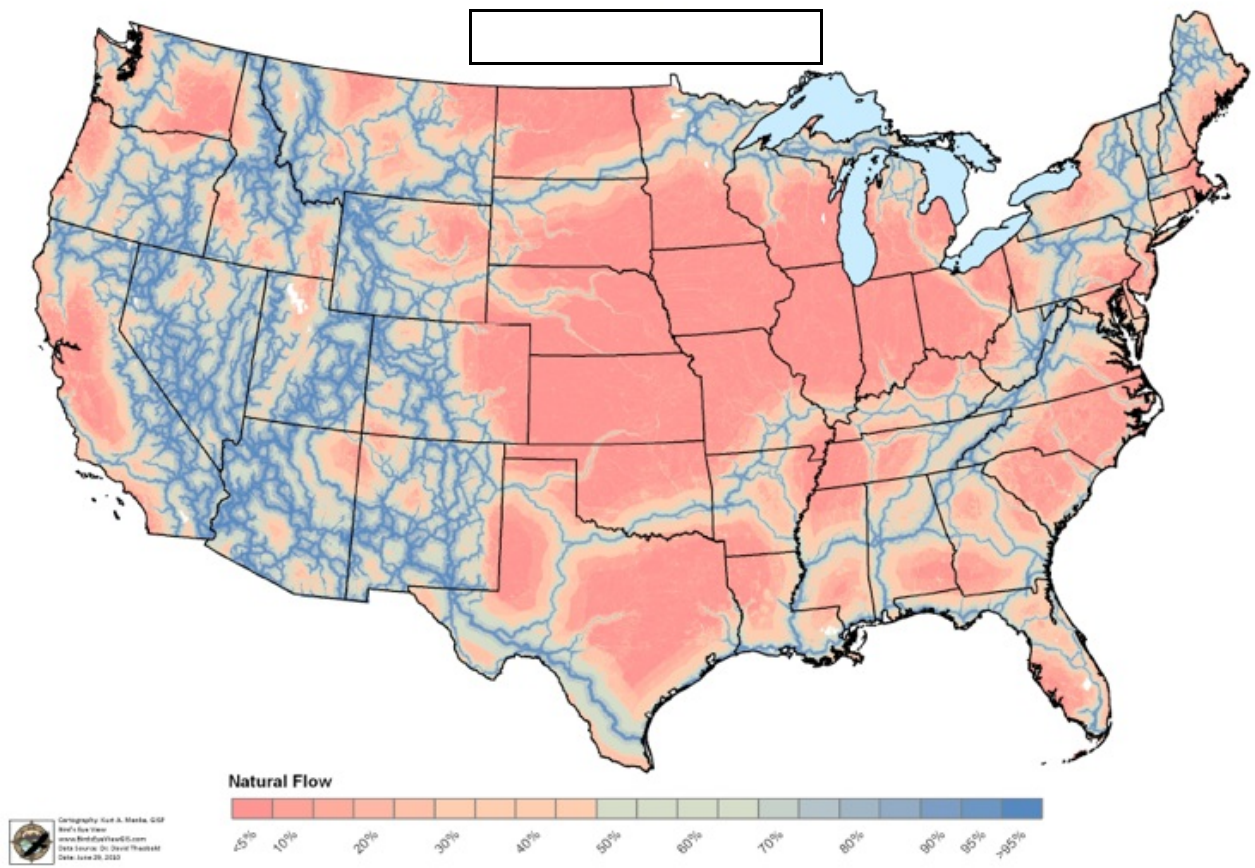
- LANDIS outputs
  - Predicting landscape composition and structure under alternative climate and management scenarios provides guidance on which management activities would best meet desired outcomes
    - What are “optimal” decisions?
    - What are “no regrets” strategies?

# Habitat suitability



# Future Directions

- Influencing “large landscape” structure
  - Continental connectivity



# Ecosystem vulnerability and species response to climate variability and change

Thank you!

Please join our discussion:
[room #]

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