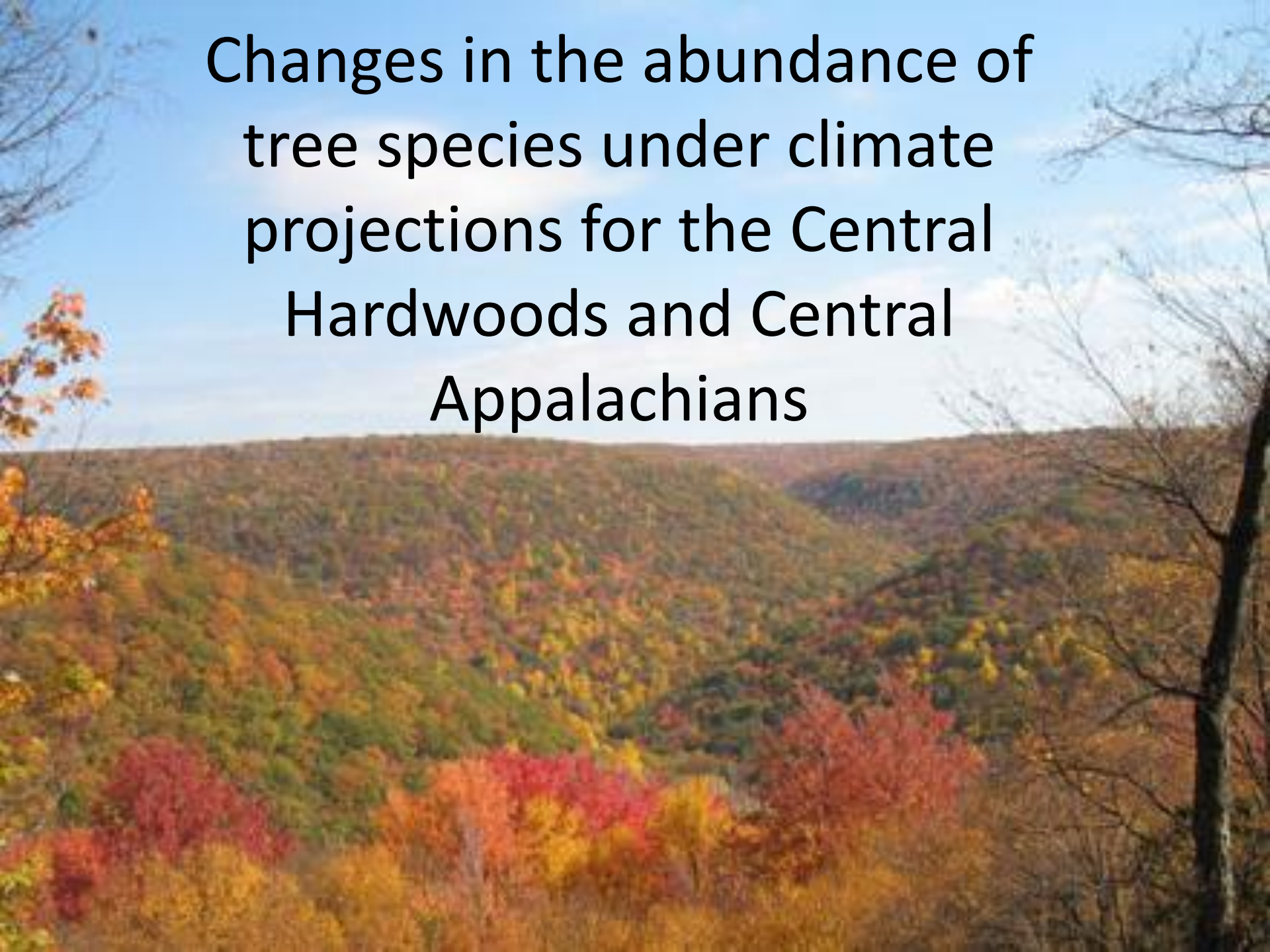
Changes in the abundance of tree species under climate projections for the Central Hardwoods and Central Appalachians



Changes in the abundance of tree species under climate projections for the Central Hardwoods and Central Appalachians

Bill Dijak, Frank Thompson	USFS Northern Research Station, Columbia MO
Hong He, Wenjuan Wang, Brice Hanberry, Jacob Fraser Jeffery Schniedermann,	School of Natural Resources, University of Missouri
Chris Swanston, Leslie Brandt, Patricia Butler	Northern Institute of Applied Climate Science, NRS, R9
John Tirpak	USGS Gulf Coastal Plains and Ozarks LCC

Objectives and Approach

- Impacts of climate change on:
  - Tree species composition (16-22 dominant species)
  - Landscape pattern
  - Wildlife habitat/abundance/viability
- Use an integrated modeling approach to consider
  - Alternative climate scenarios
  - Alternative forest management scenarios
  - Alternative disturbance regimes

Climate and Management Effects

Climate scenario	Forest management scenario			
	Current management	No harvest	Even-aged 10%	Uneven-aged 10%
Current Climate (1980-2003)	☑	☑	☑	☑
PCM-B1	☑	☑	☑	☑
GFDL-A1fi	☑	☑	☑	☑
CGCM3(T47)-A2	☑	☑	☑	☑

- These scenarios “bracket” the range of management applied within the study area and range of climate projections.

Climate Change Response Framework***

NIACS
Northern Institute of Applied Climate Science

Northern Research Station

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

***and other related projects

Modeling Approach

Climate Models

Predictions:

- Temperature
- Precipitation
- Solar radiation

Ecosystem Simulation

Linkages Model

Inputs:

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

Tree biomass at yr 10

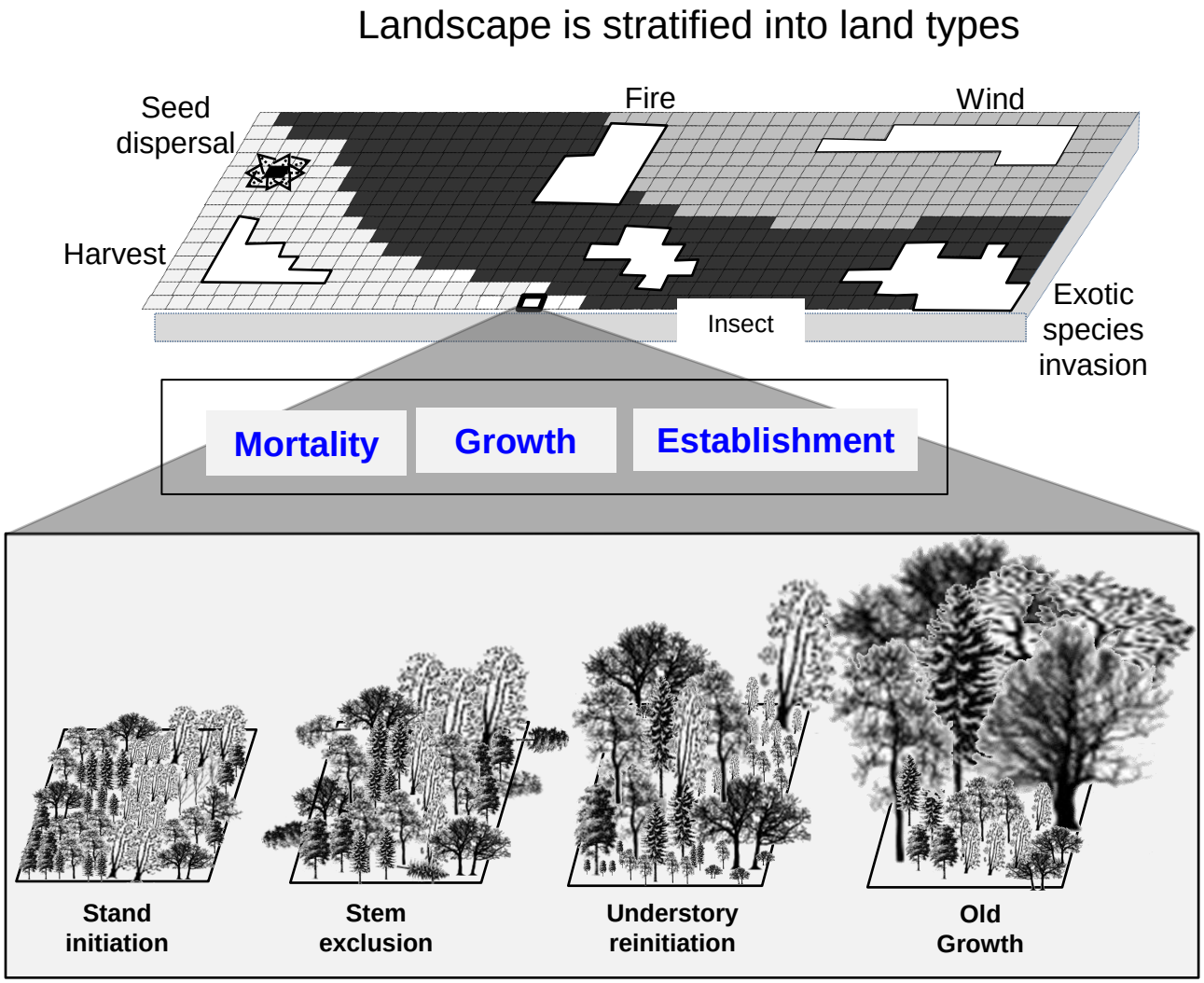
Landscape Simulation

LANDIS Model

Inputs:

- Species establishment
- Seed dispersal
- Vegetative reproduction
- Longevity
- Shade tolerance
- Fire tolerance
- Disturbance regime
- Management regime

LANDIS PRO Design



Landscape-level

- Fire/fire suppression
- Wind/hurricane/ice storm
- Insects
- Diseases
- Exotic species invasion
- Harvest/silverculture
- Fuel treatment

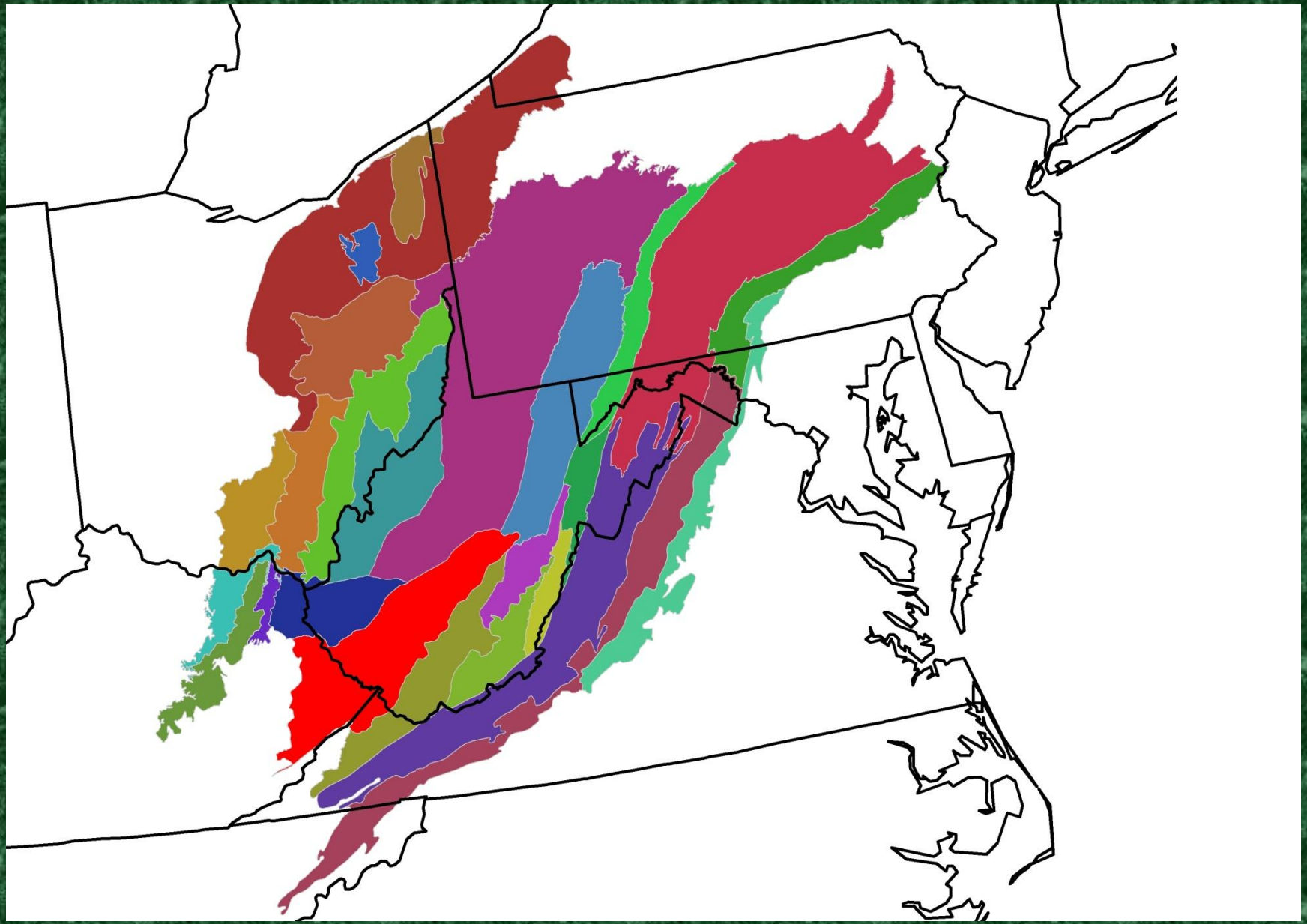
Tree species-level

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

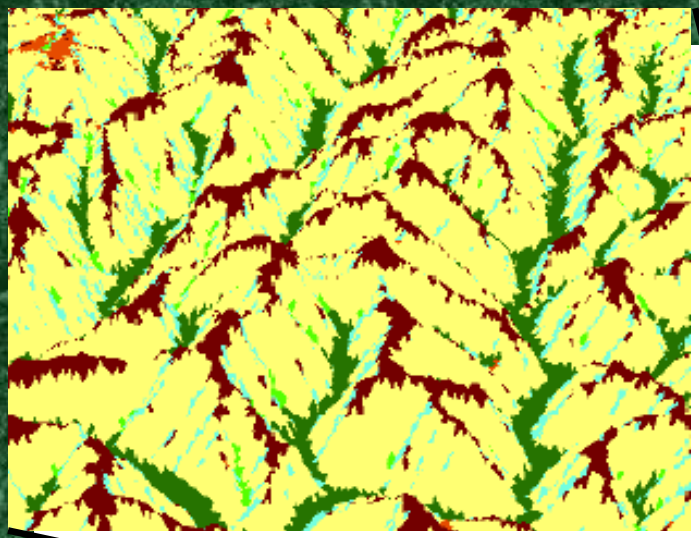
Stand/pixel-level

- Development stages
- Competition for growing space
- Regulate species level processes

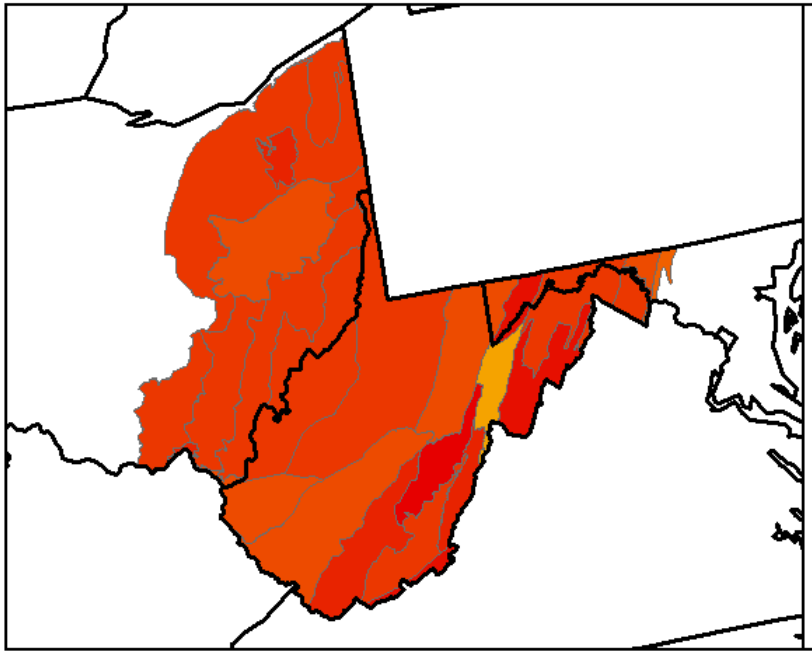
Ecomap 2007 Subsection Map



Landform, Subsection 890

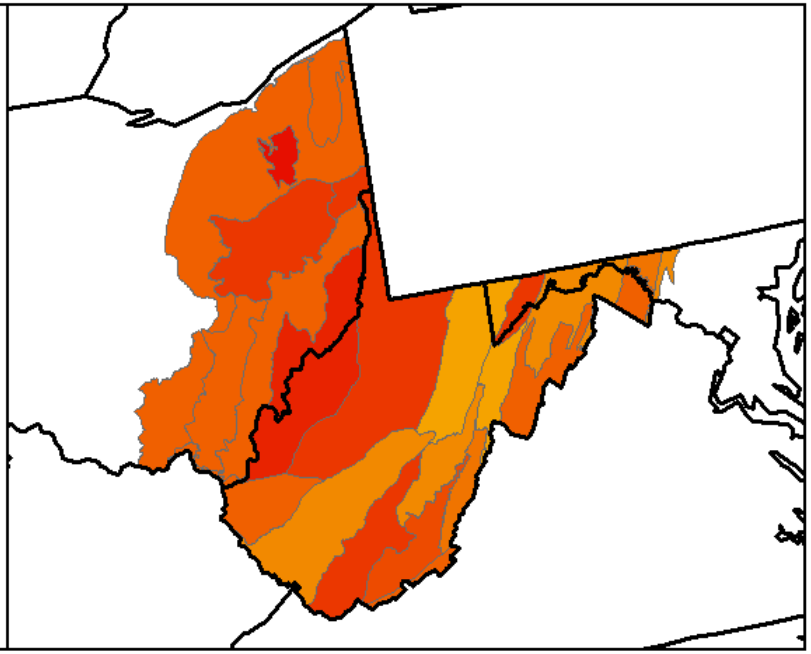


Mean Maximum Temperature Difference (°F)



+13
+12
+11
+10
+9
+8
+7
+6
+5
+4
+3
+2
+1
0
-1

Mean Minimum Temperature Difference (°F)

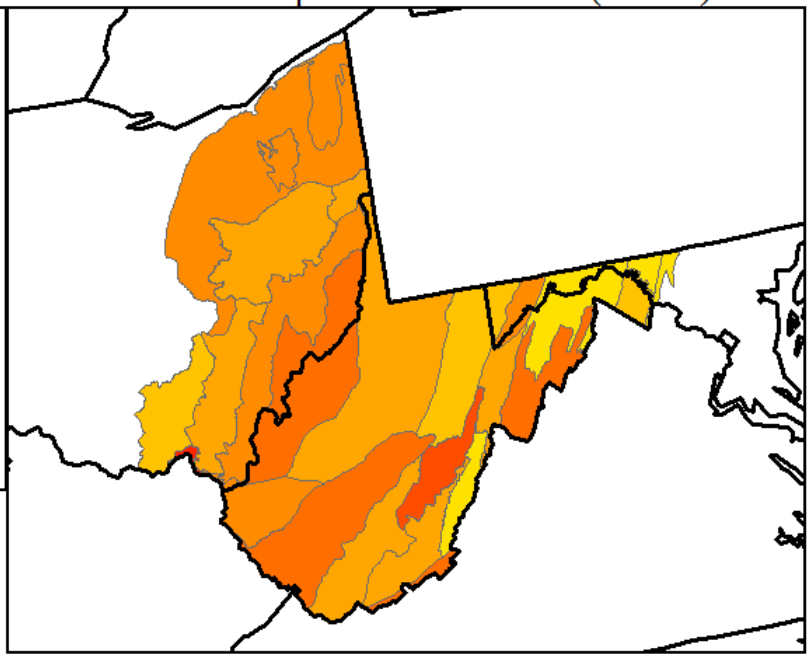


GFDL-A1fi Model

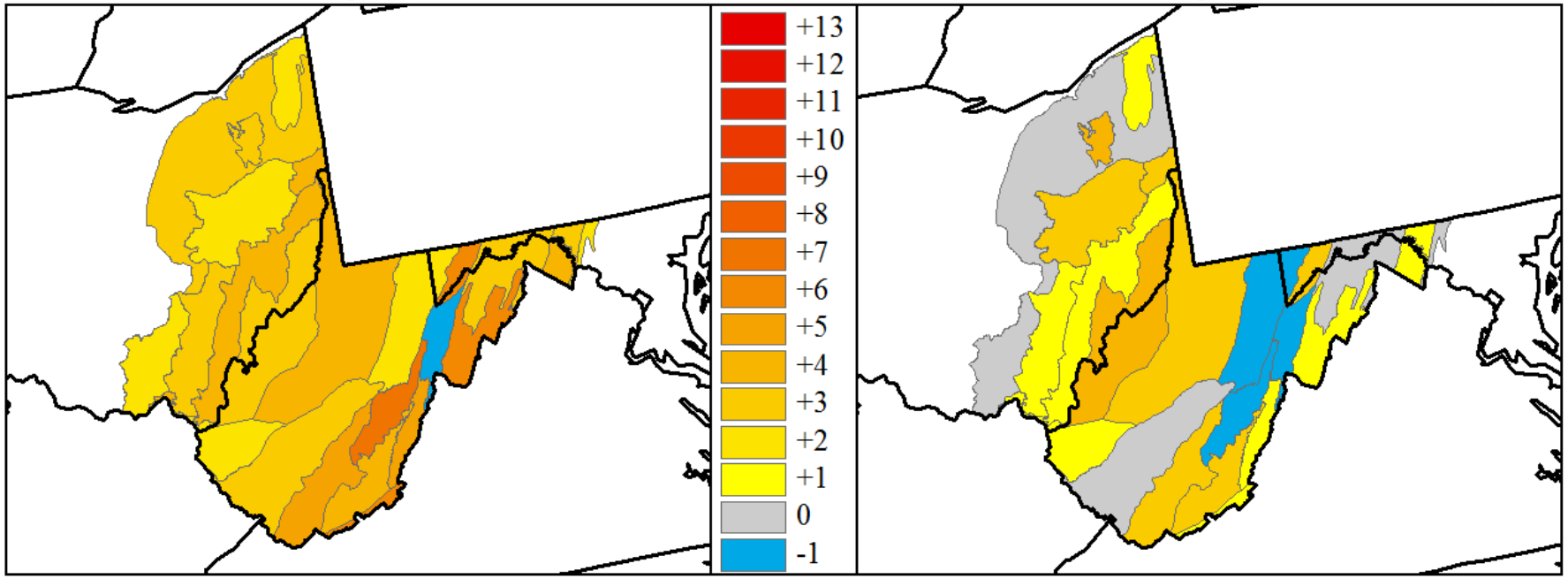
Growing Season Projections
Departure From Baseline

Mean Precipitation Difference (Inches)

+2
+1
0
-1
-2
-3
-4
-5
-6
-7
-8



Mean Maximum Temperature Difference (°F)



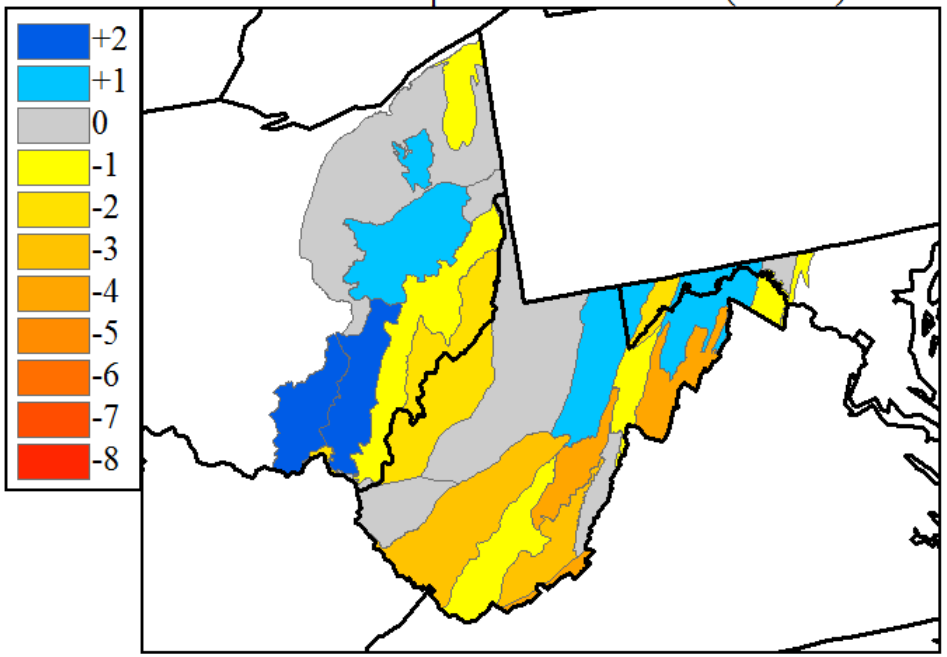
Mean Minimum Temperature Difference (°F)

PCM-B1 Model

Growing Season Projections

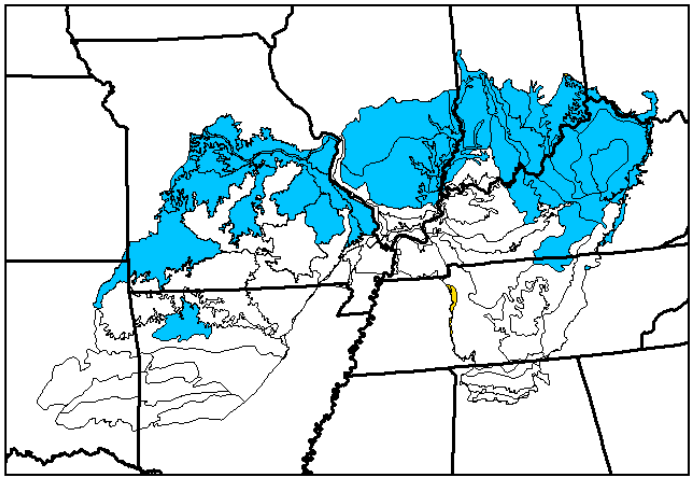
Departure From Baseline

Mean Precipitation Difference (Inches)



Linkages predictions for % change in establishment and early growth of Sugar maple

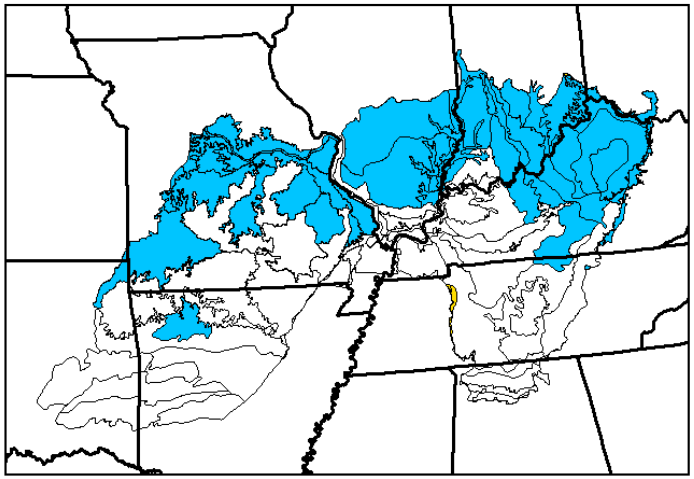
GFDL-A1fi



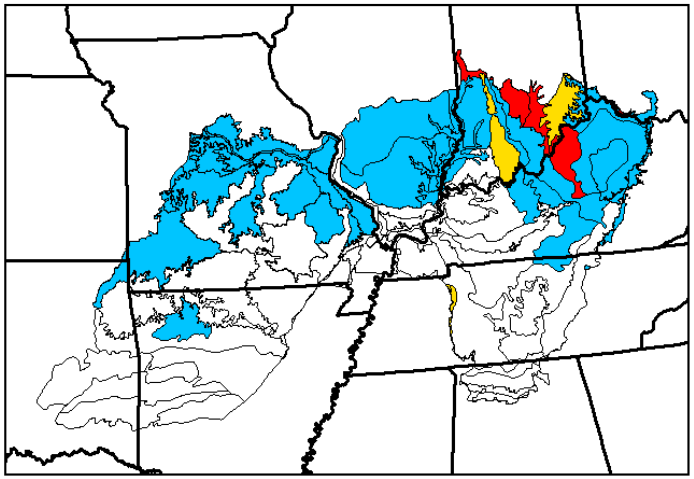
Sugar Maple

- Not Present
- Extirpated
- Large Decrease
- Small Decrease
- No Change
- Small Increase
- Large Increase
- Migrated

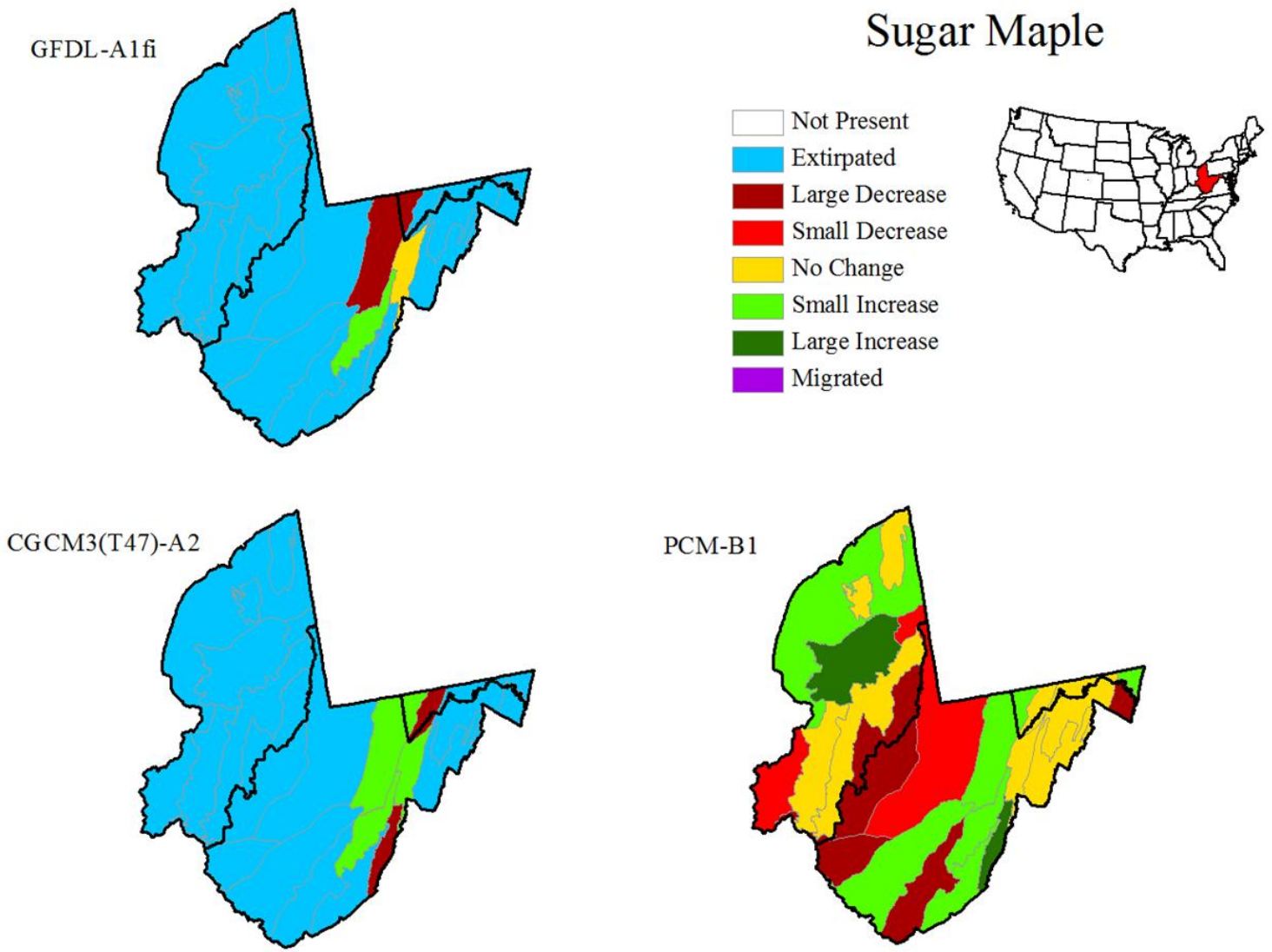
CGCM3(T47)-A2



PCM-B1

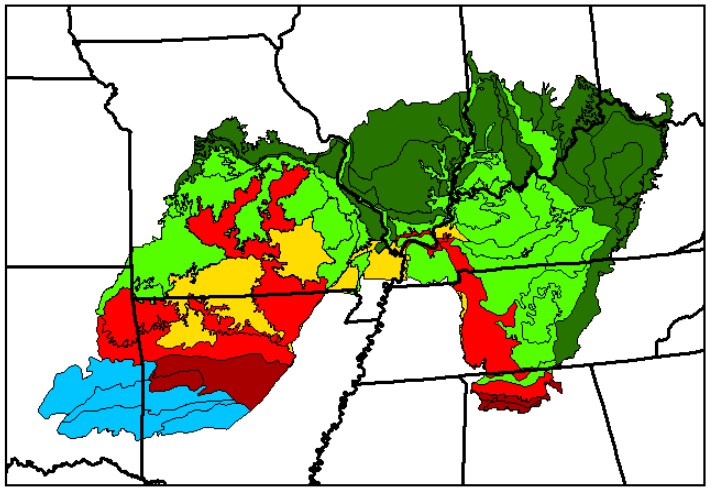


Linkages predictions for % change in establishment and early growth of Sugar maple



Linkages predictions for % change in establishment and early growth of Shortleaf pine

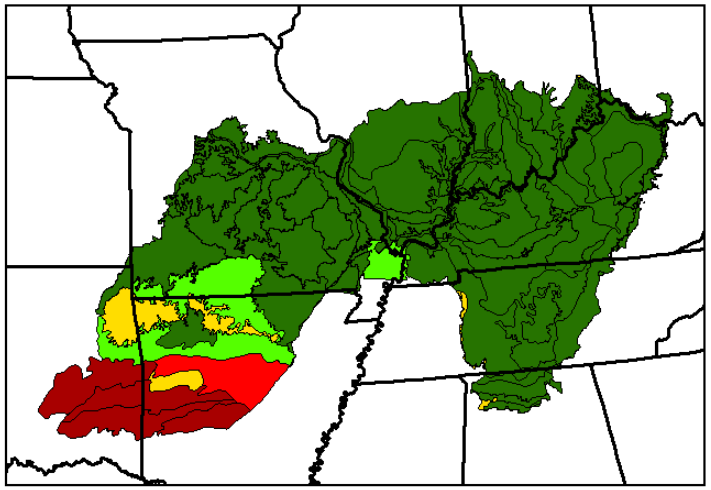
GFDL-A1fi



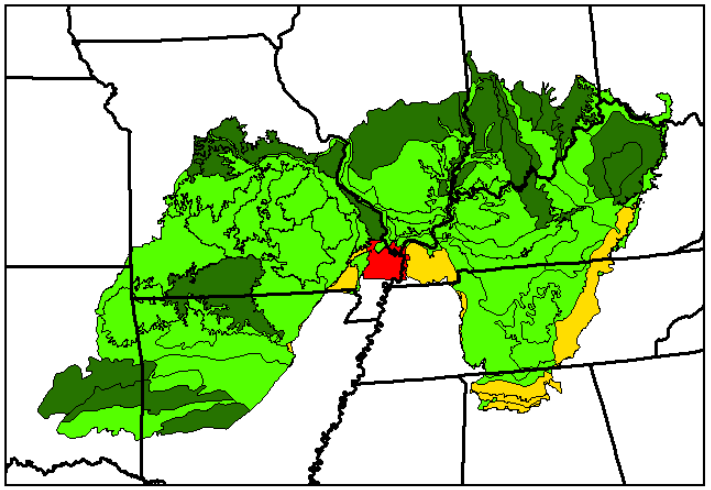
Shortleaf Pine

Not Present
Extirpated
Large Decrease
Small Decrease
No Change
Small Increase
Large Increase
Migrated

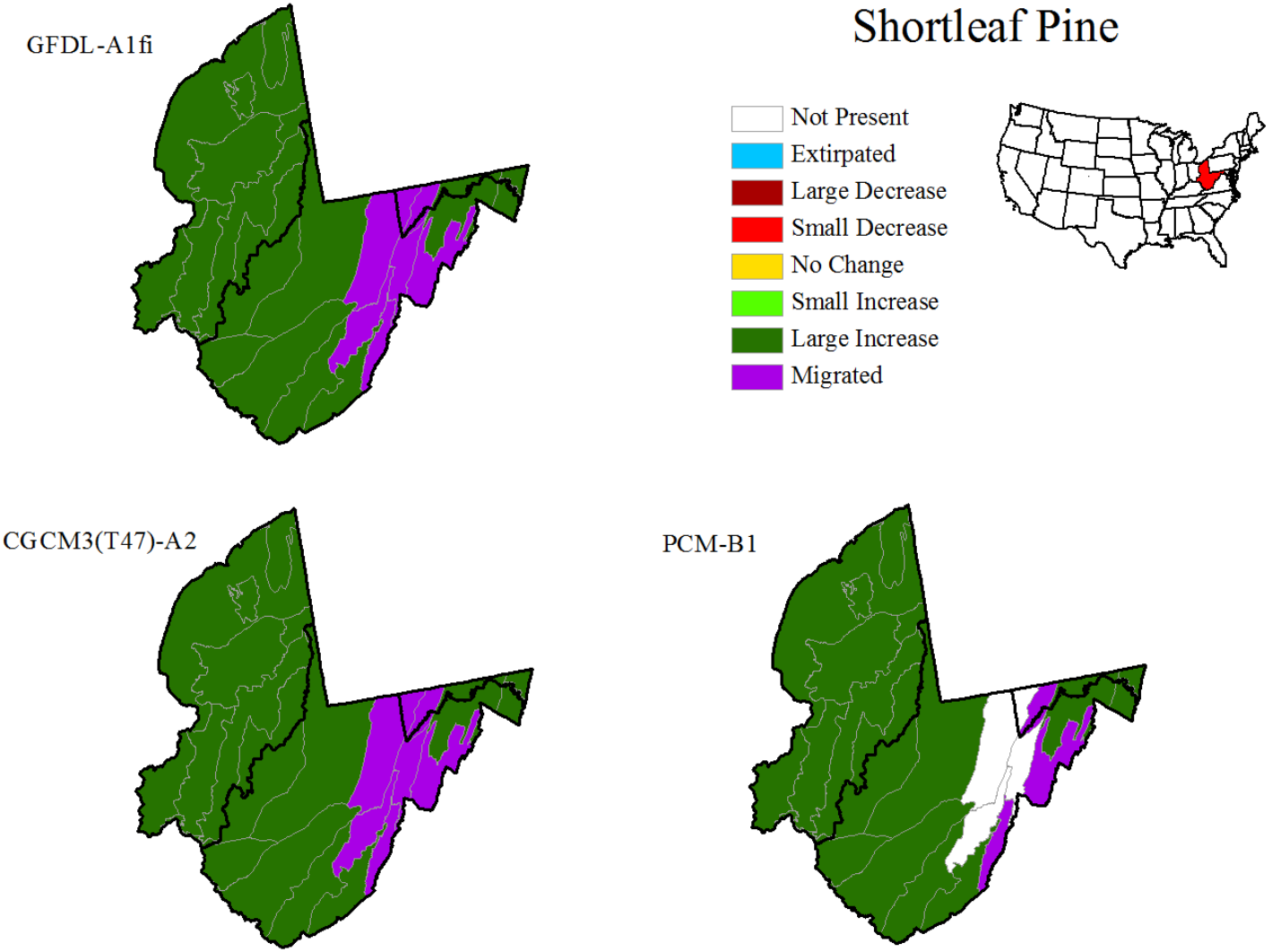
CGCM3(T47)-A2



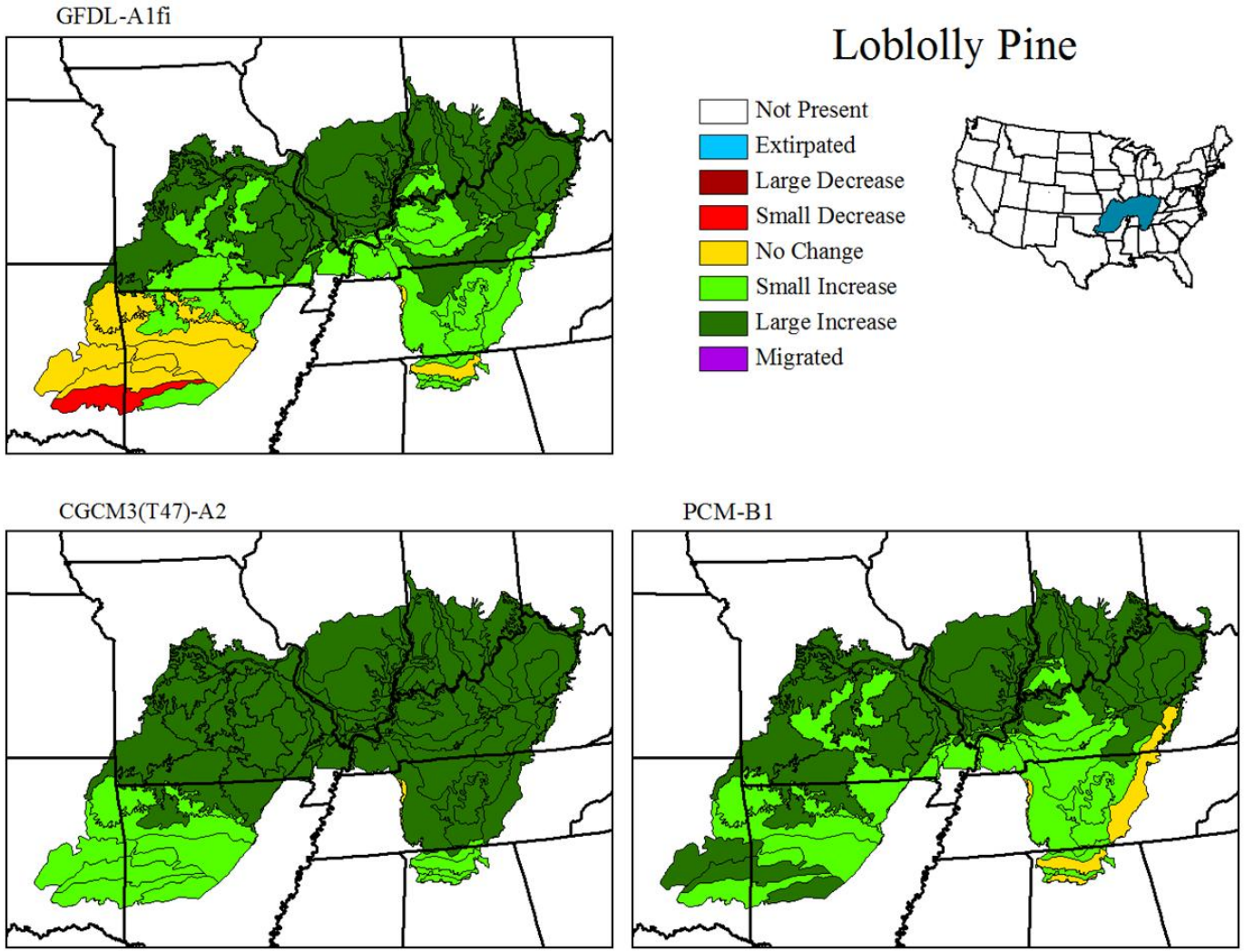
PCM-B1



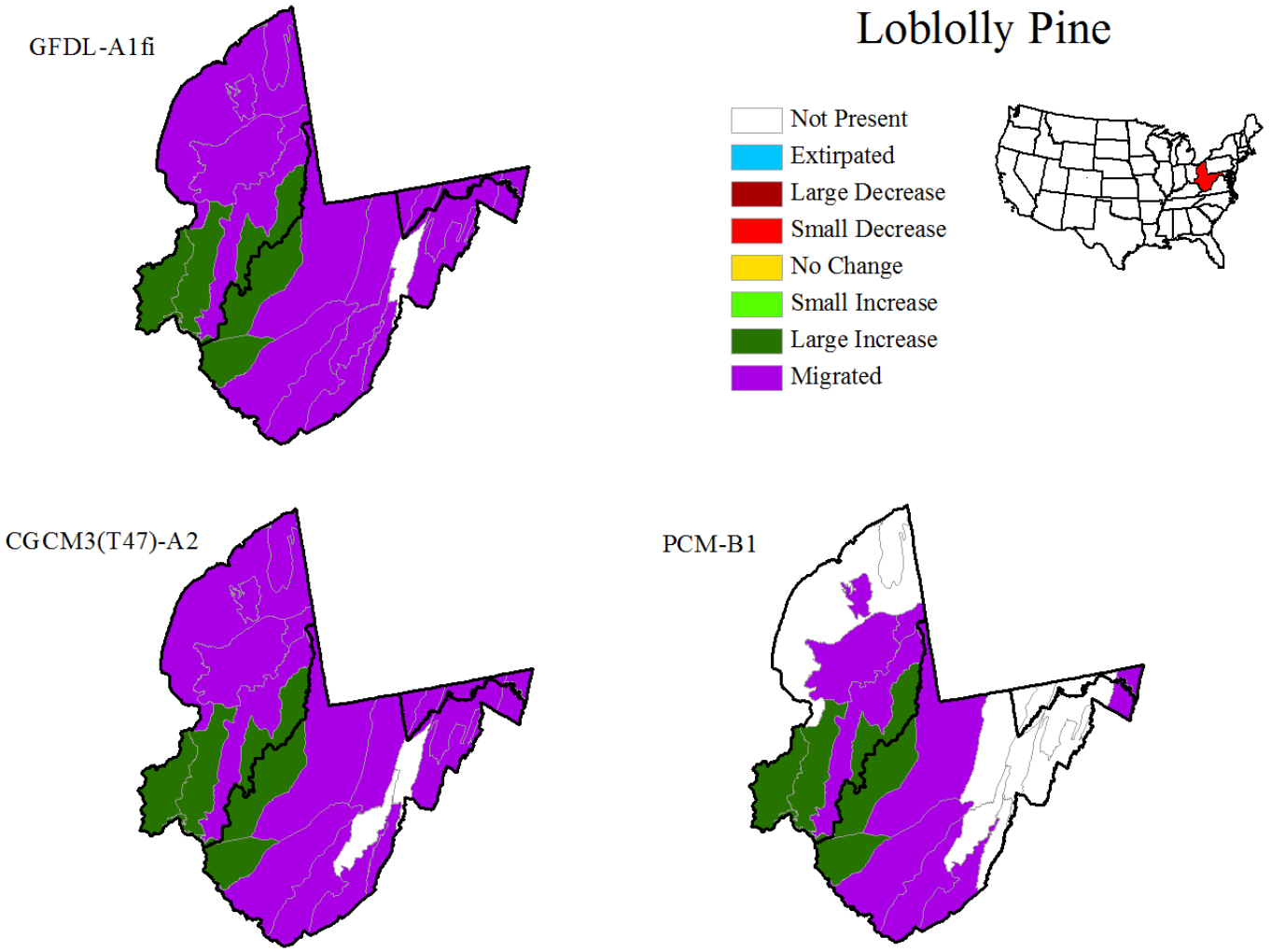
Linkages predictions for % change in establishment and early growth of Shortleaf pine



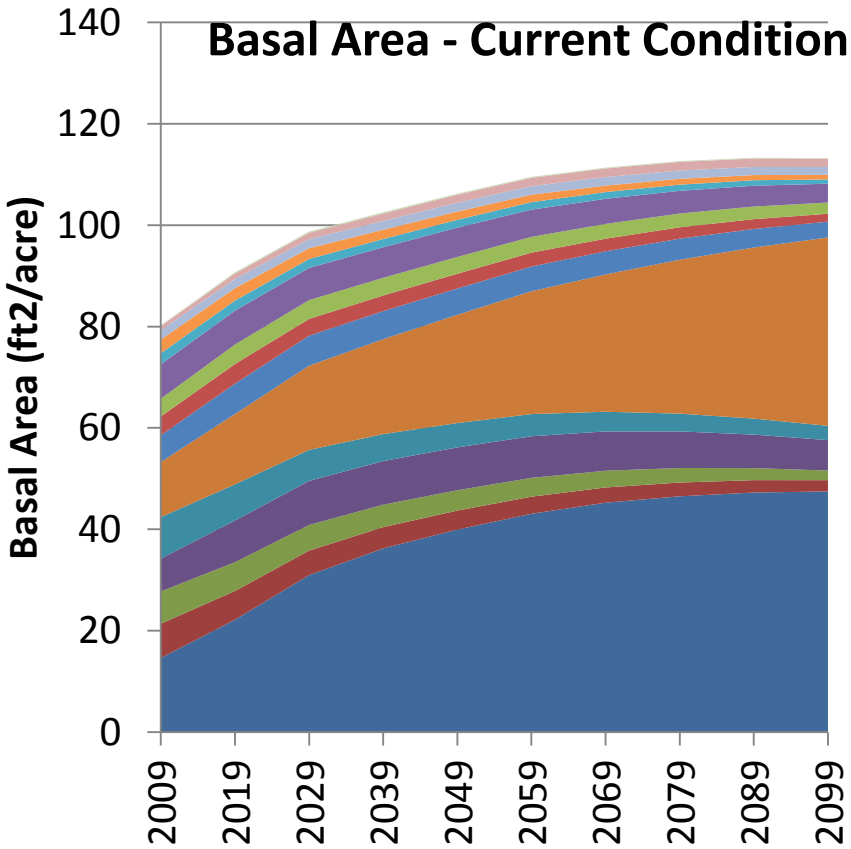
Linkages predictions for % change in establishment and early growth of Loblolly Pine

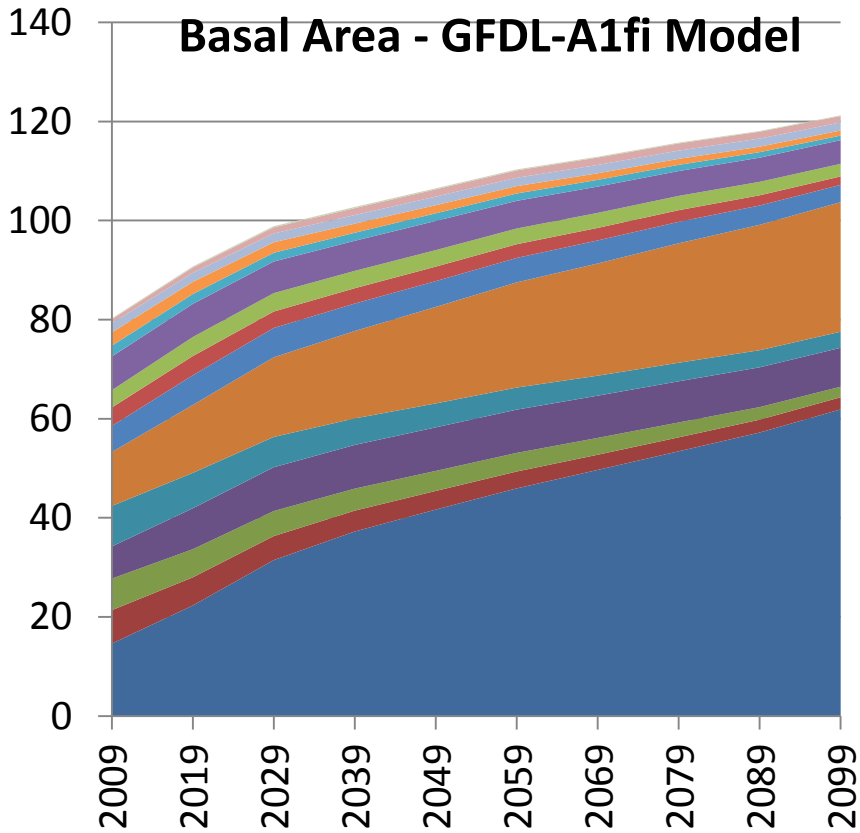


Linkages predictions for % change in establishment and early growth of Loblolly Pine

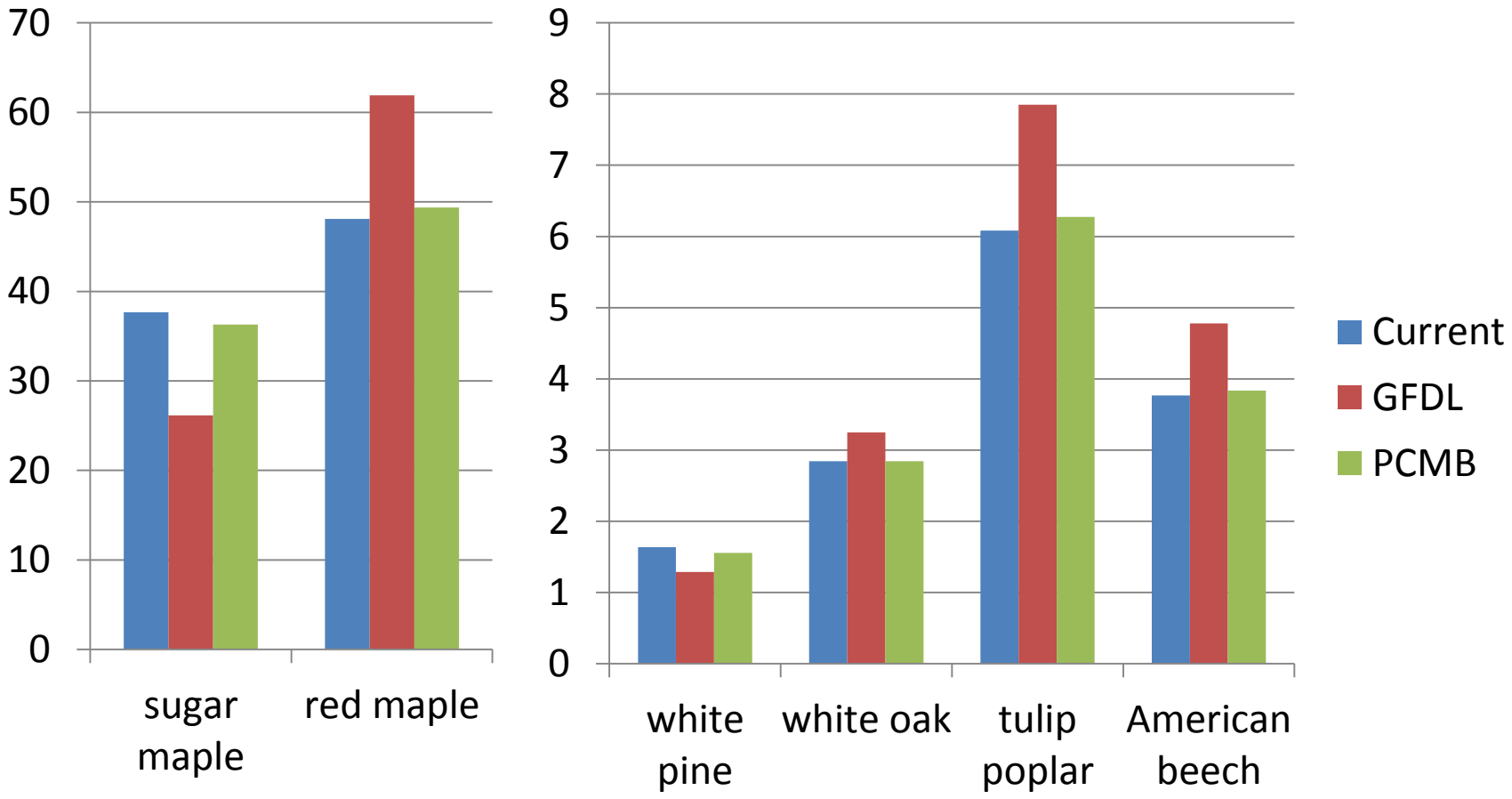


LANDIS projections of basal area by species over time for Central Appalachian Region



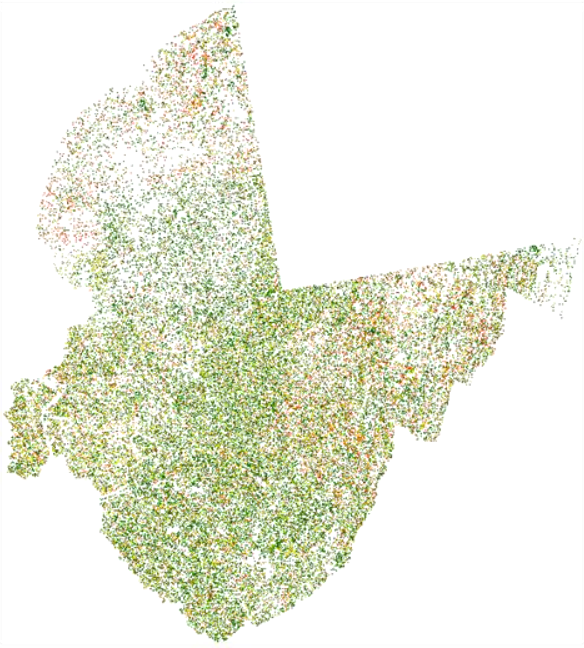


LANDIS predictions for Central Appalachian Region, basal area 2099

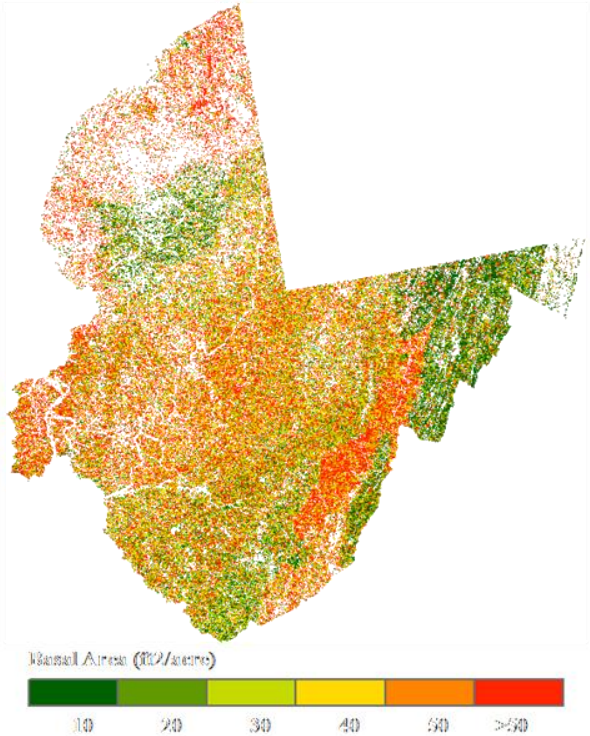


LANDIS predictions for Sugar maple in Central Appalachian Region

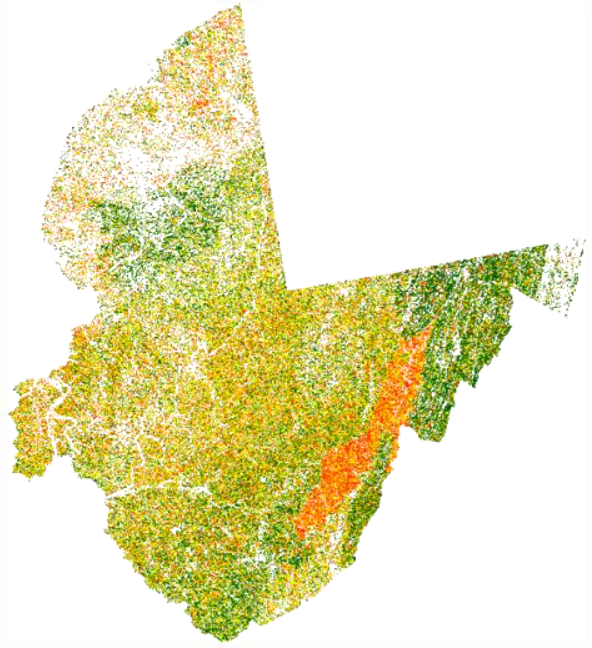
Current climate, 2009



Current climate, 2099

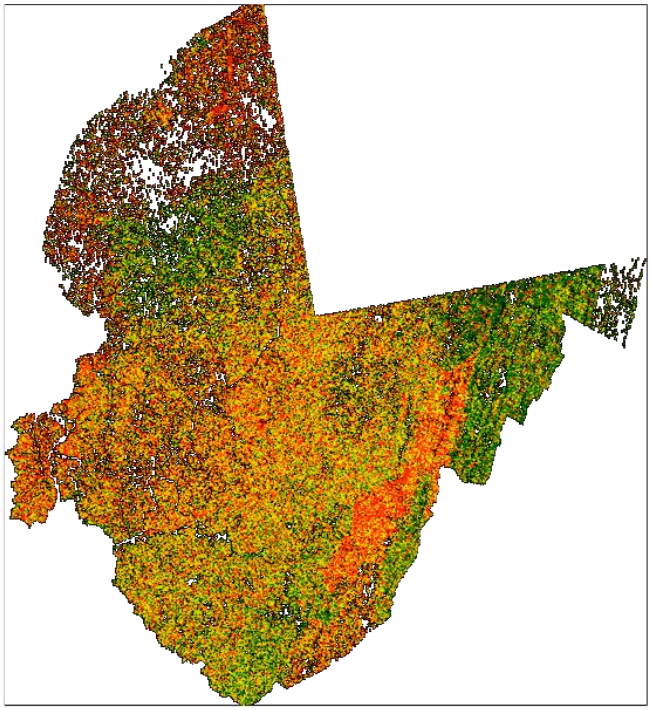


GFDL Climate model , 2099



LANDIS predictions for Sugar maple in Central Appalachian Region

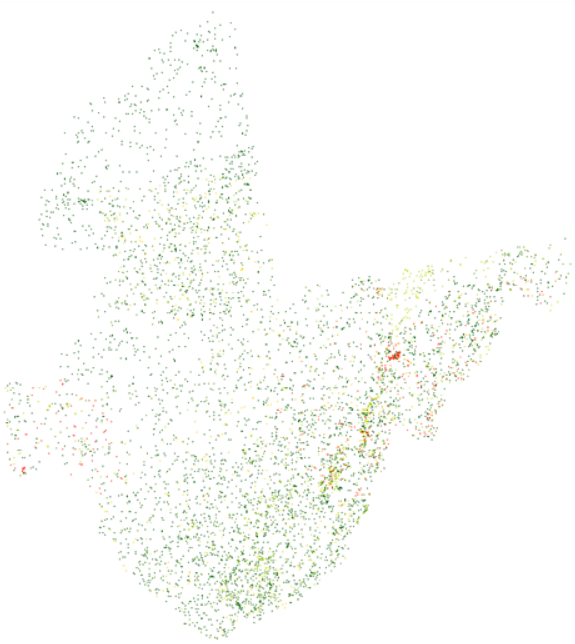
Current climate, 2099



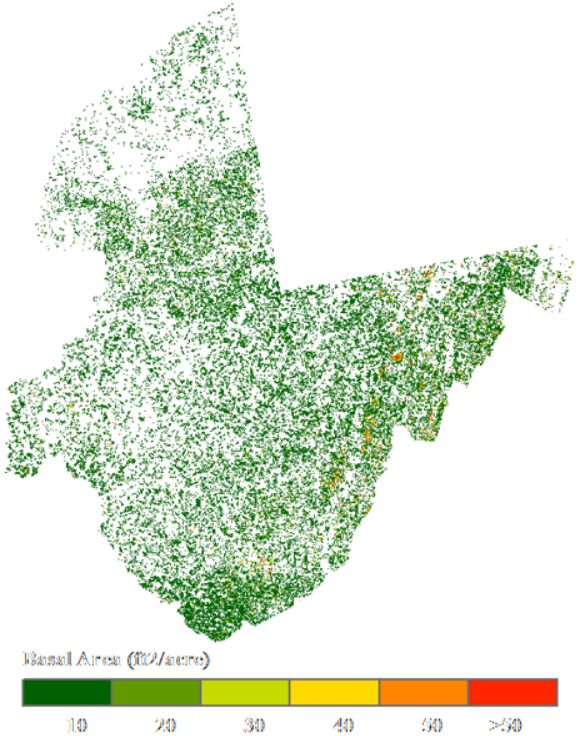
GFDL Climate at 2099 for 100 years

LANDIS predictions for White Pine in Central Appalachian Region

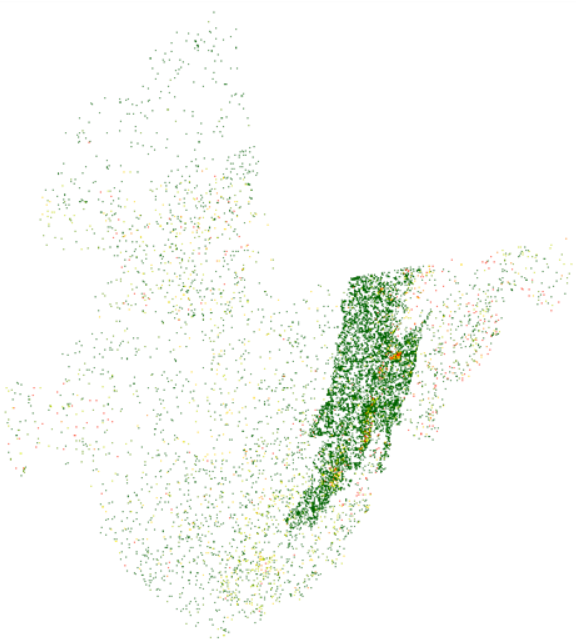
Current climate, 2009



Current climate, 2099



GFDL at 2099 for 100 years



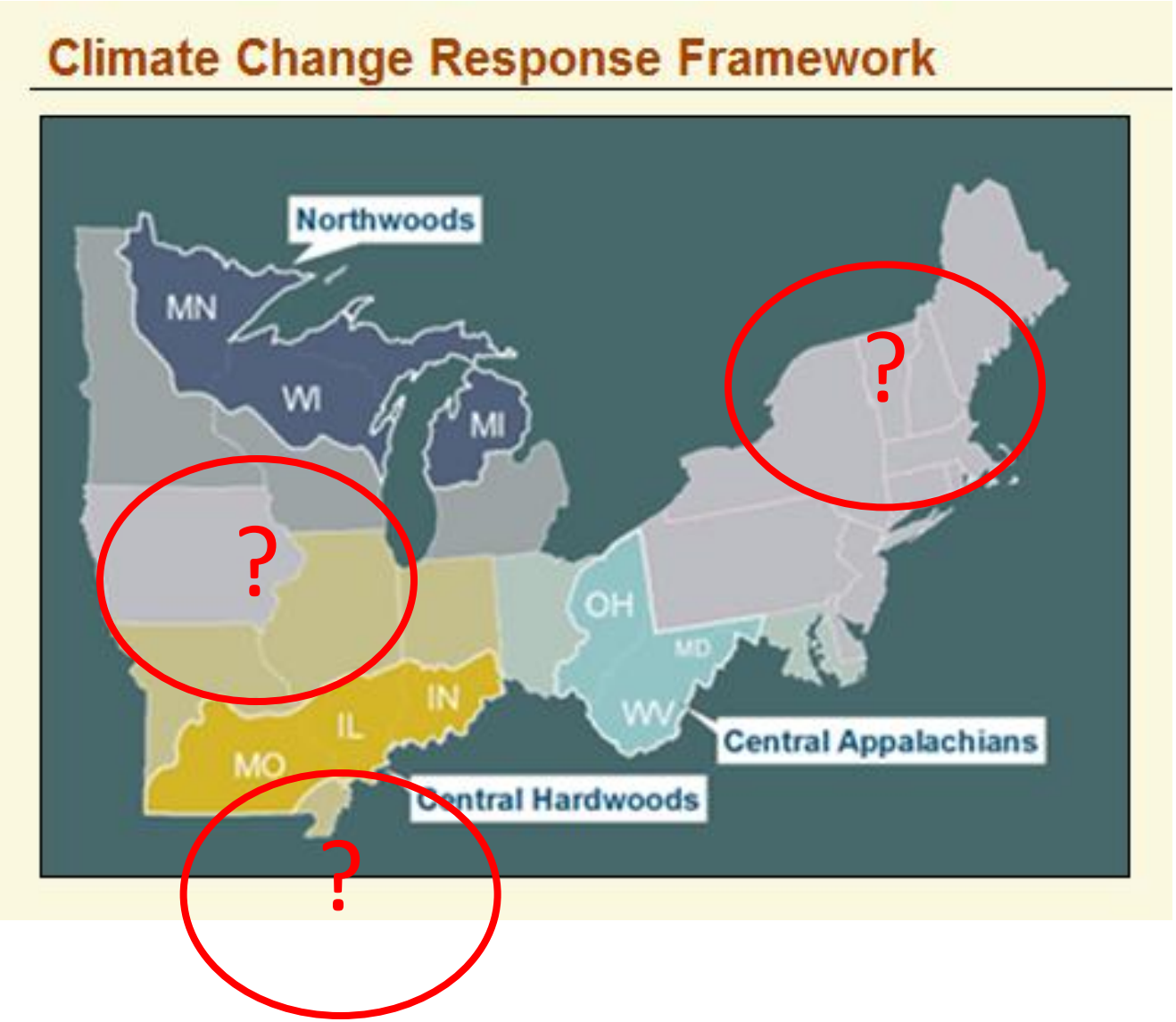
Summary Points

- More xeric or drought tolerant species do better than mesic species
- Southern species increase
- Northern species decrease
- Complex interactions with site characteristics, succession, competition, disturbance, and management that we are still investigating
- Current successional trajectories, along with management and disturbance, will likely have a greater impact than climate change in next 100 years.

Next Steps

- Verification and validation of results
- Input into Climate Change Response Frameworks
- Scientific publications supporting the modeling approaches
- Investigation of impacts on other resources dependent on forest (e.g. wildlife)
- Investigation of interactions of climate driven change with others drivers of landscape change
- Synthesis of forest changes across Northeastern U.S.

Next Steps


Climate Change Response Framework
Northwoods
MN
WI
MI
?
?
?
OH
MD
WV
IN
IL
MO
Central Appalachians
Central Hardwoods