Regionally Specific Drivers of Land-Use Transitions and Future Scenarios

A SYNTHESIS CONSIDERING THE LAND MANAGEMENT INFLUENCE IN THE SOUTHEASTERN US

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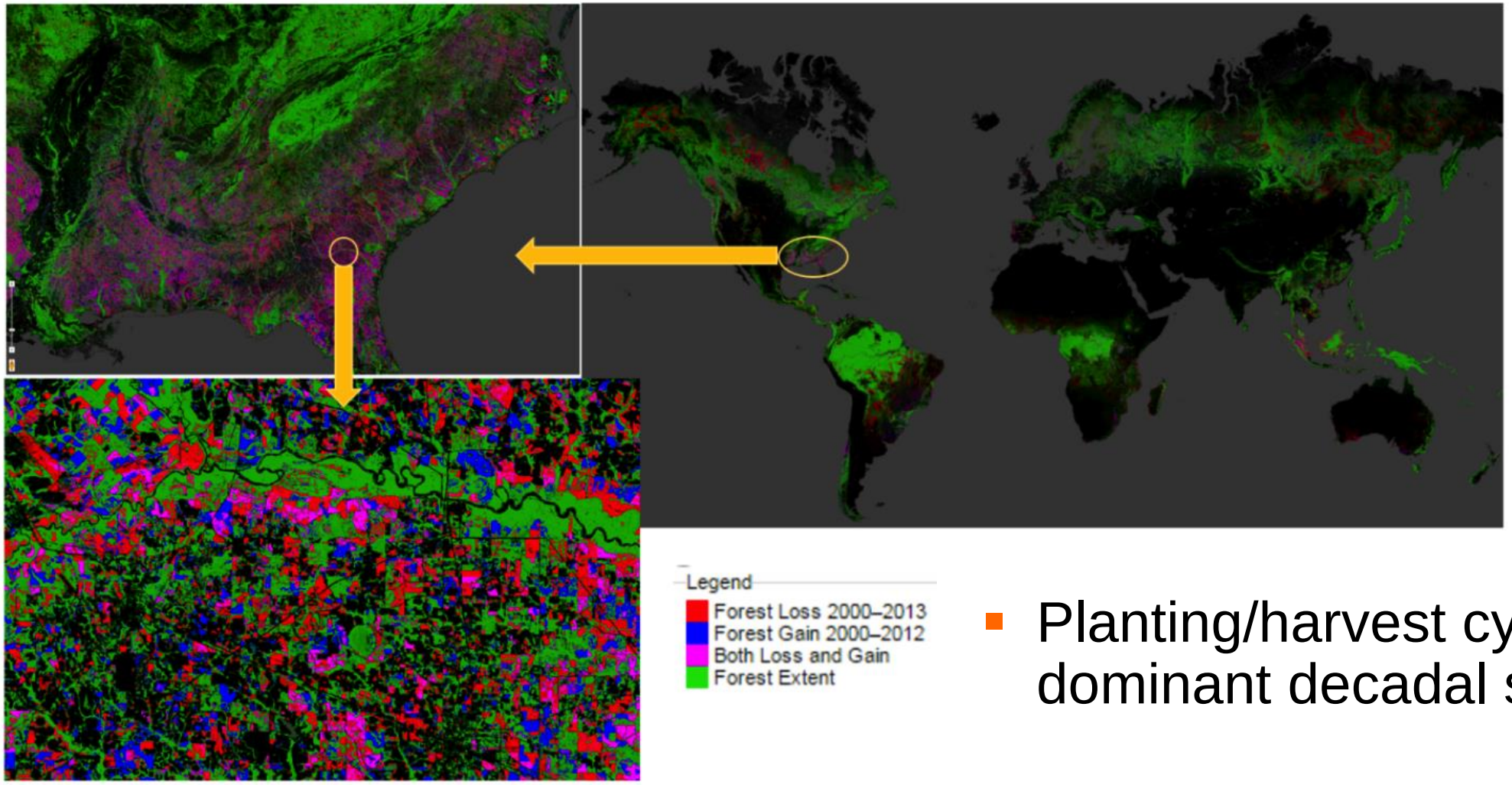
Outline

- Introduction/Background
  - The southeastern US is unique
- Research Goals
  - Land use/cover transitions
  - Management
- Methods
- Early Results
- Lessons Learned to Date

In the southeastern US, forests are dynamic



Derived from Hansen et al (2013

- Planting/harvest cycle dominant decadal signal

Two major land change patterns in the region

- Land-use changes
  - Forest ←→ Agriculture
  - Forest → Developed (urban)
  - Agriculture → Developed (urban)
- Periodic land cover changes reflecting forest management
  - Harvest, regeneration
  - Changes in density/composition
    - Naturally regenerating hardwoods → planted pine

2 parallel approaches to modeling past and future land use change

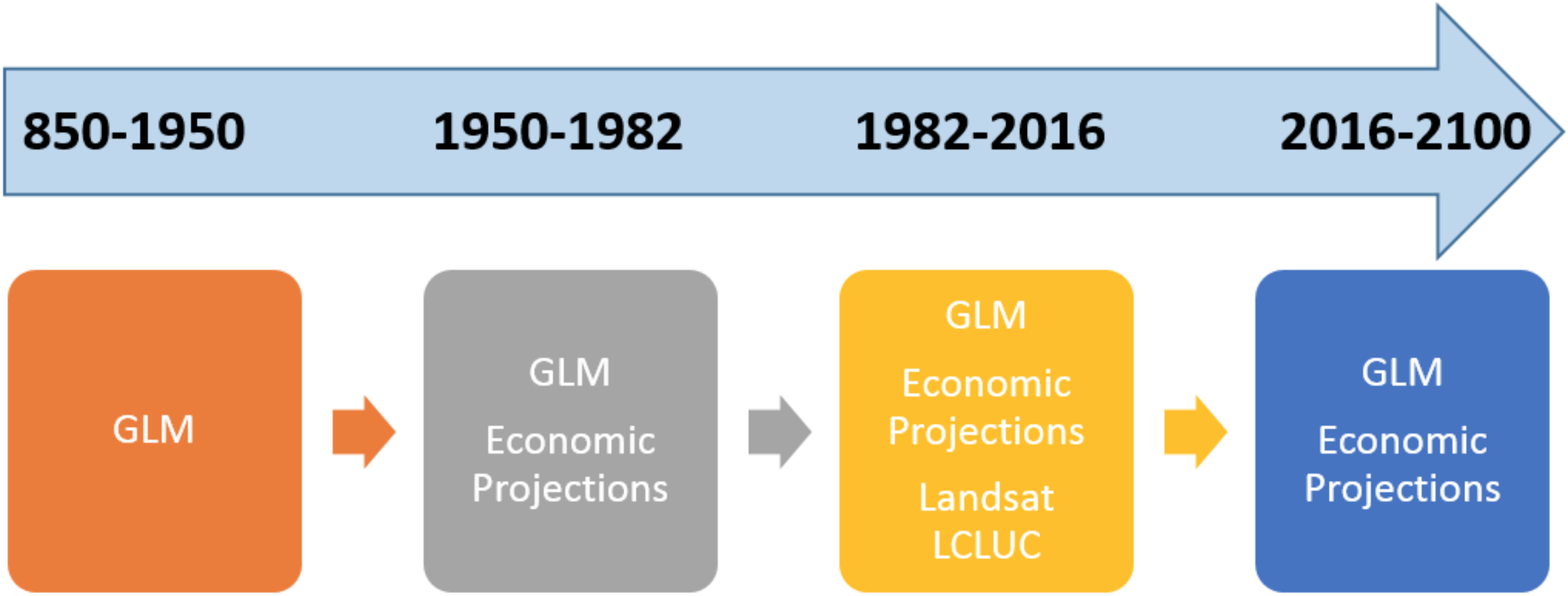
- Globally gridded land-use change products
- Regional, expert driven socioeconomic analysis

- a limiting feature of previous studies has been the treatment of secondary forests as a single land use
  - lumping passively managed or unmanaged forests with those that are intensively managed

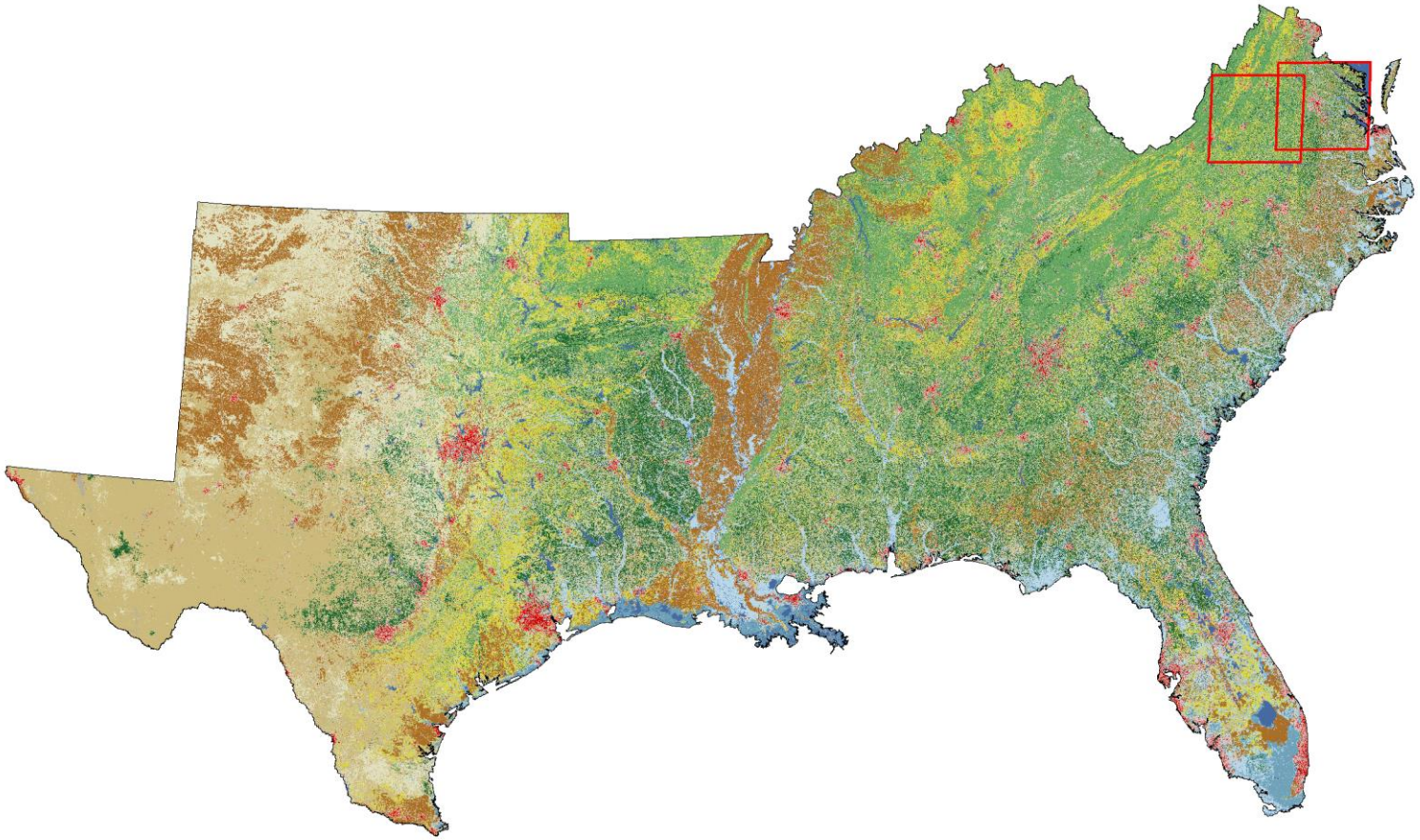
Overall project goal

- To develop regionally refined land-use transition matrices that consider the economic structure of land management and land use decisions, incorporating forest management

GLM Classes	Expanded Land-use Types	Relevance to the Southeast
Urban	**Urban**	Major driver of change
Crop functional types	**Crop functional types**	Major driver of change
Managed pasture	**Managed pasture**	Relevant class
Rangelands	Rangelands	Not a major class
Primary non-forest	Primary non-forest	Not a major class
Secondary non-forest	Secondary non-forest	Not a major class
Primary forest	Primary Forest	Only remnants remaining
Secondary forest	**Passive/low intensity mixed forest**	Non-industrial mixed
	Passive/low intensity needle-leaf forest	Non-industrial pine
	Passive/low intensity broad-leaf forest	Eastern hardwoods
	Medium intensity needle-leaf forest	Industrial pine forests
	Medium intensity broad-leaf forest	Not a major class
	High intensity needle-leaf forest	Genetic modifications
	High intensity broad-leaf forest	Not a major class.
	Short rotation needle-leaf forest	Biomass for energy. Not currently a major class.
	Short rotation broad-leaf forest	


850-1950
1950-1982
1982-2016
2016-2100
GLM
GLM
Economic Projections
GLM
Economic Projections
Landsat LCLUC
GLM
Economic Projections

Year One Accomplishments



Study area (USDA Forest Service, Region 8)

Compilation of harvesting dataset

FOR CALIBRATION, VALIDATION, AND BEYOND

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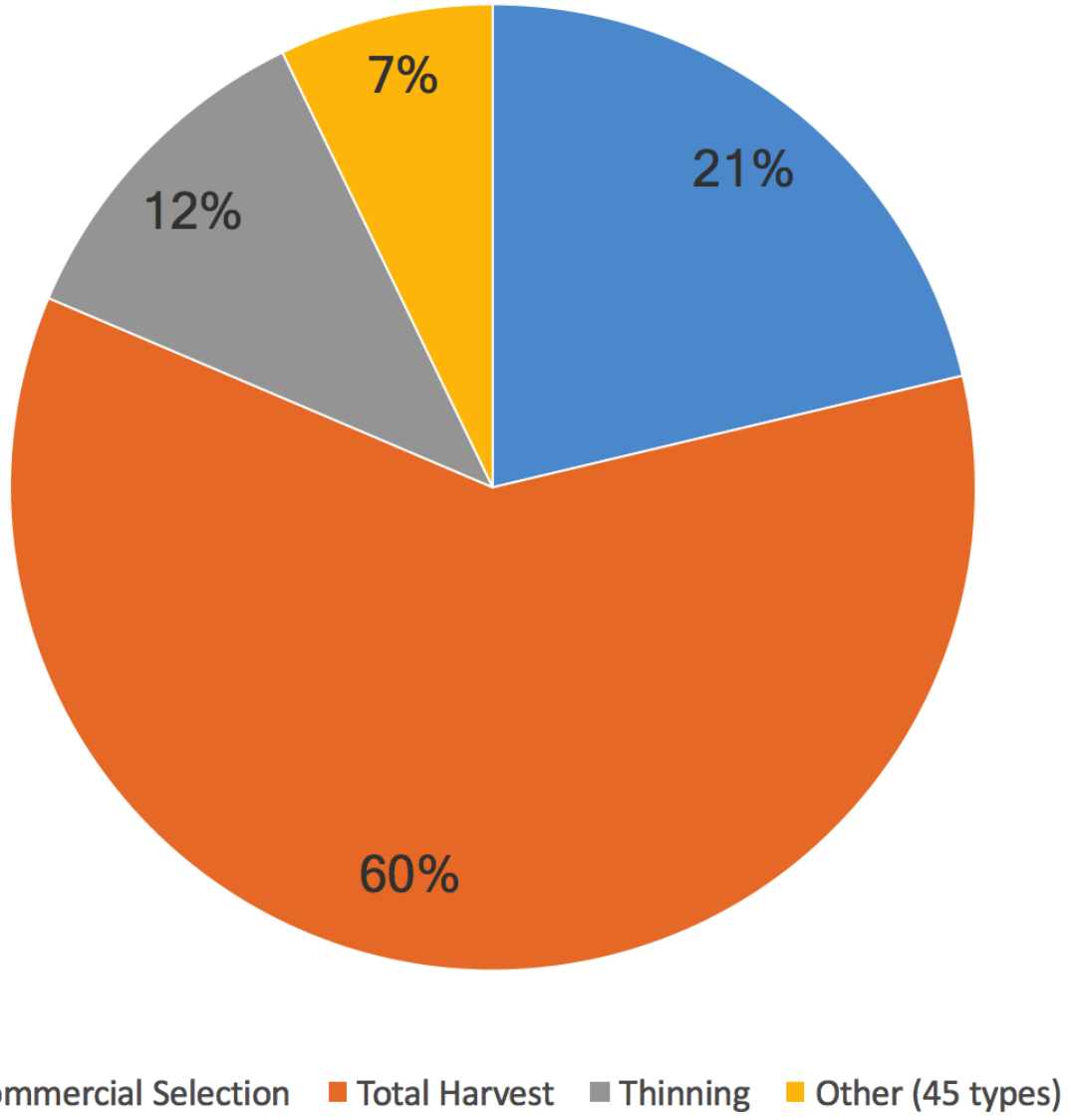
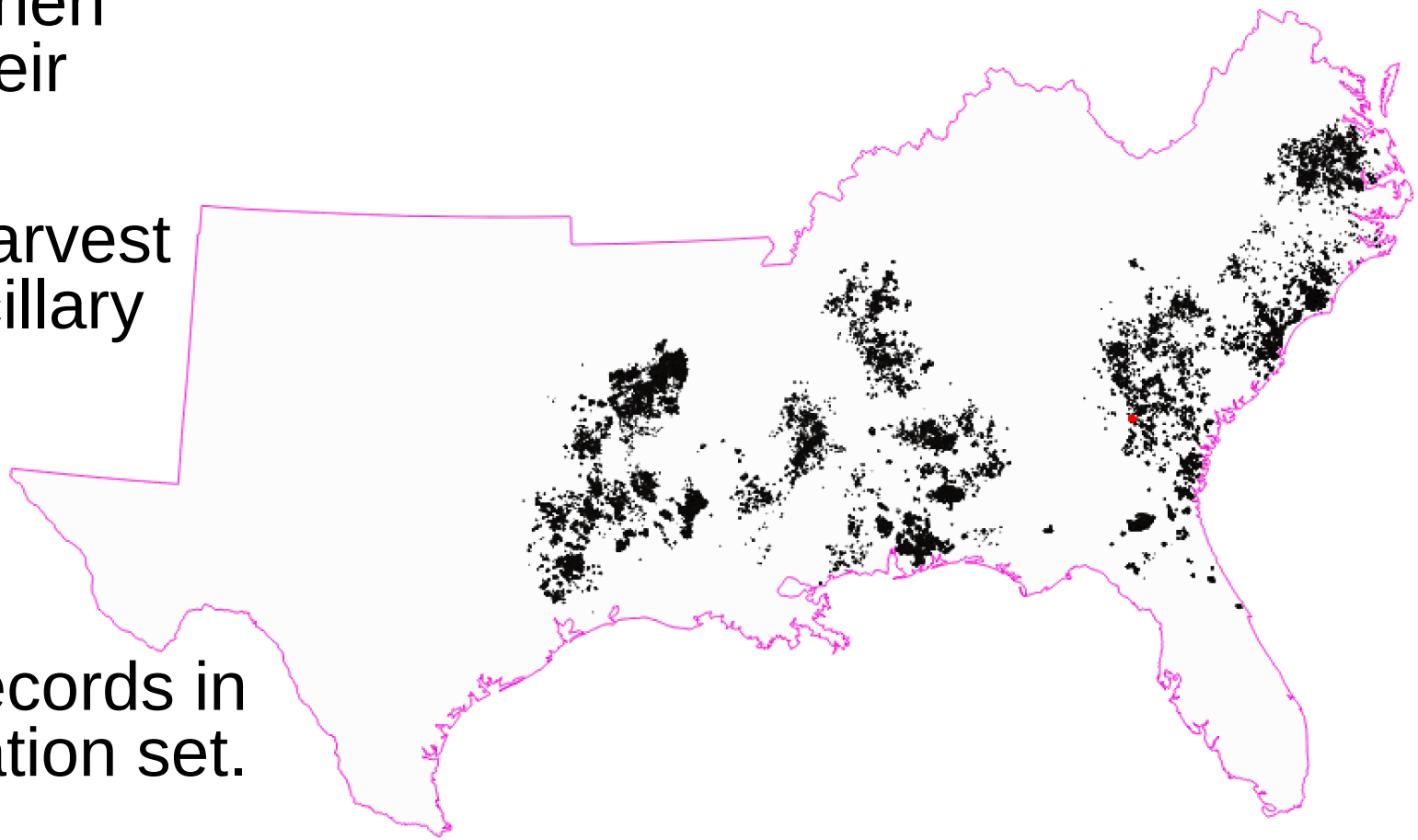
VDOF Harvest Records

- By law, all harvests in Virginia must be reported and inspected
- VDOF maintains a database of harvests and ancillary information
- Since 2014
  - 8127 harvests in Virginia
- 43590 records in the database



International Paper harvest records

- Prior to 2007, when they divested their holdings
- Over 130,000 harvest records and ancillary data
- Over 170,000 records in combined validation set.



Mapping Moderate Intensity Forest Management

WITH MULTITEMPORAL LANDSAT

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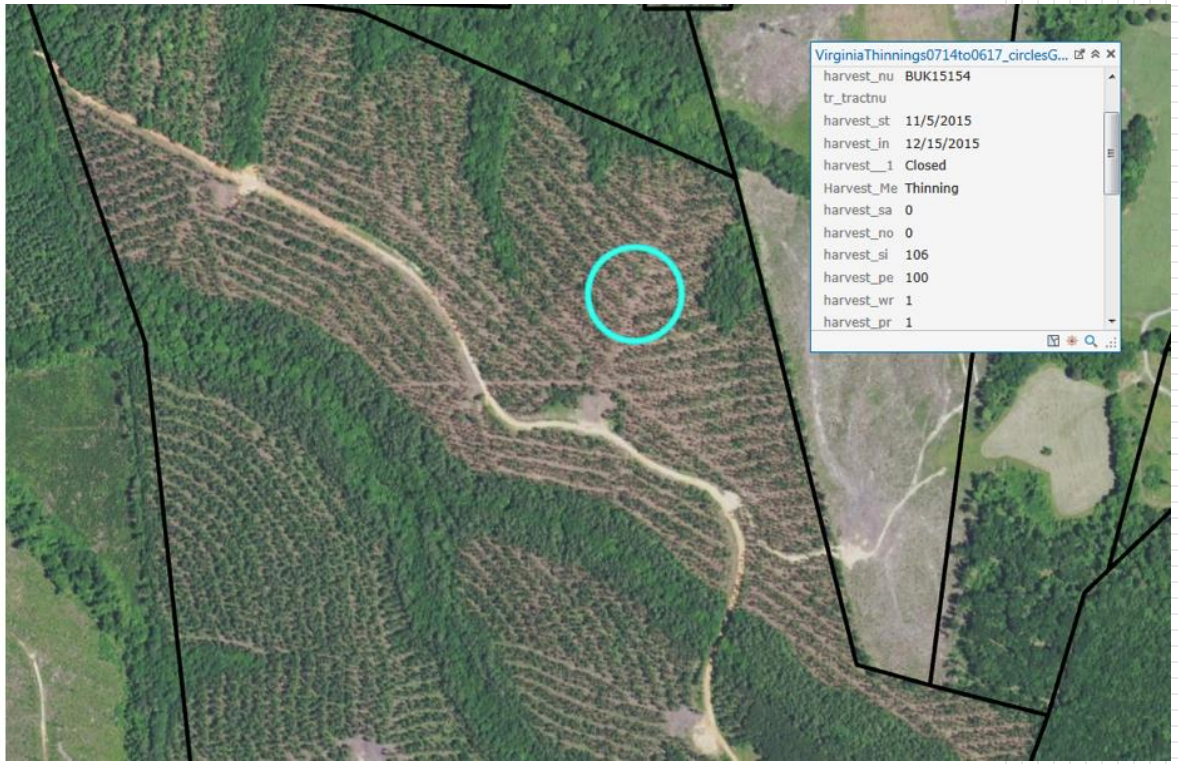
Remote Sensing Goal

- Expand the classification of forests in the SE to **include medium intensity** management
  - Passive/low intensity = non-industrial forests with minimal management activities
  - Medium intensity management = common silvicultural practices
    - controlling for planting density, thinning, fertilization and weed control
  - High intensity management = genetic modification



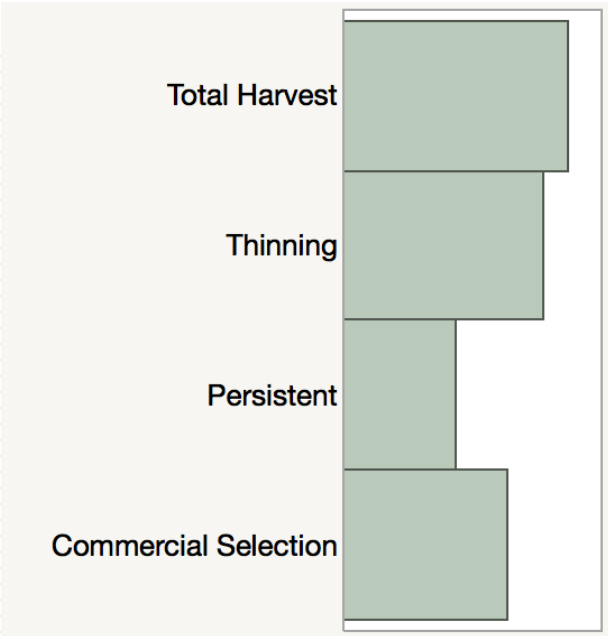
Synthesis of Initial Management Classes

In VDOF Database	Management Intensity
Commercial Selection	Low/Passive
Thinning	Moderate
Total Harvest	Total Harvest ▪ Could be either

From Airphoto Interpretation

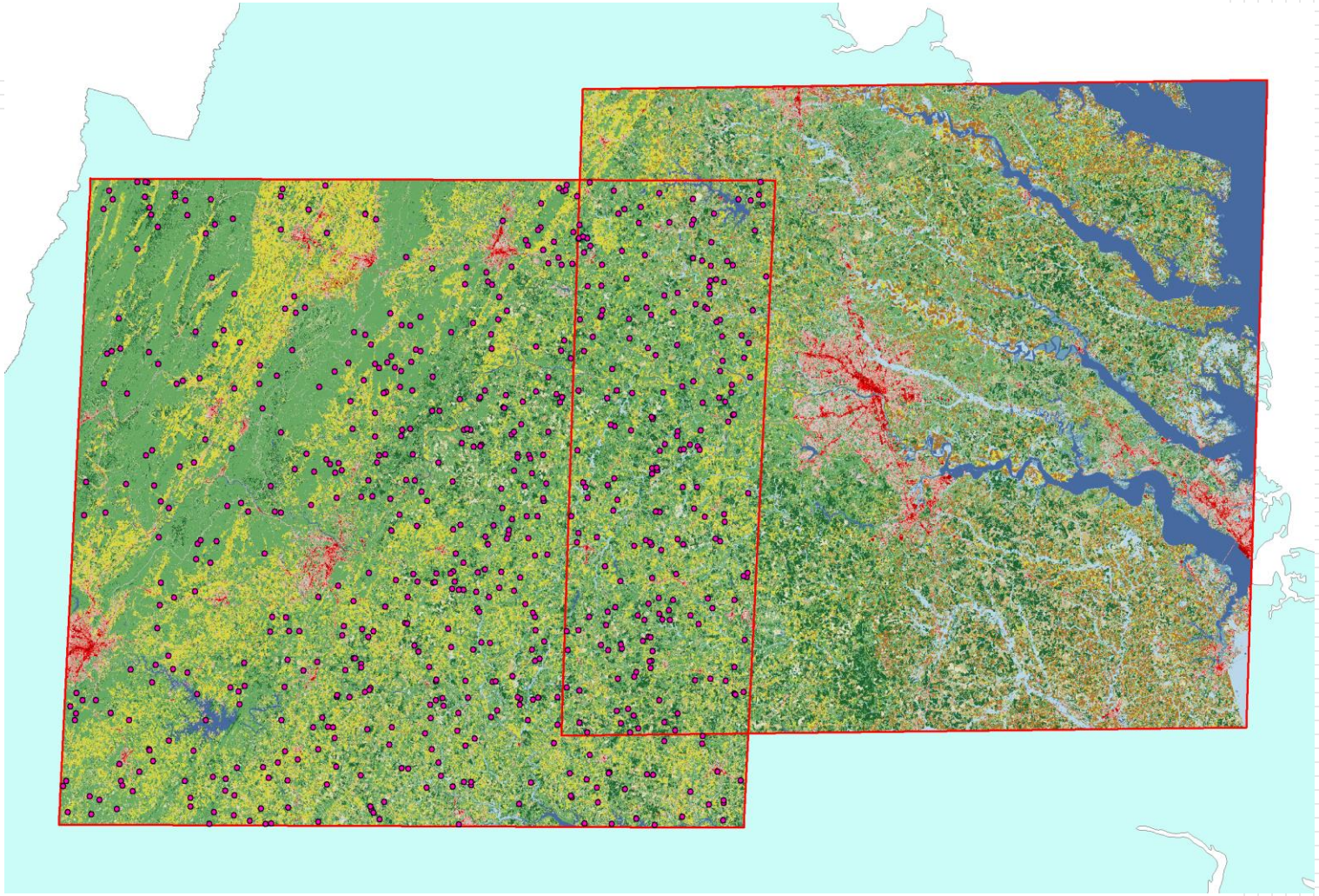
Persistent Forest Random-generated points within forested parcels that have never been recorded in VDOF database	Low/Passive ▪ Either broadleaf or needleleaf

Vetted Harvest Records for late 2015-2017



Frequencies

Level	Count	Prob
Commercial Selection	135	0.23276
Persistent	93	0.16034
Thinning	166	0.28621
Total Harvest	186	0.32069
Total	580	1.00000



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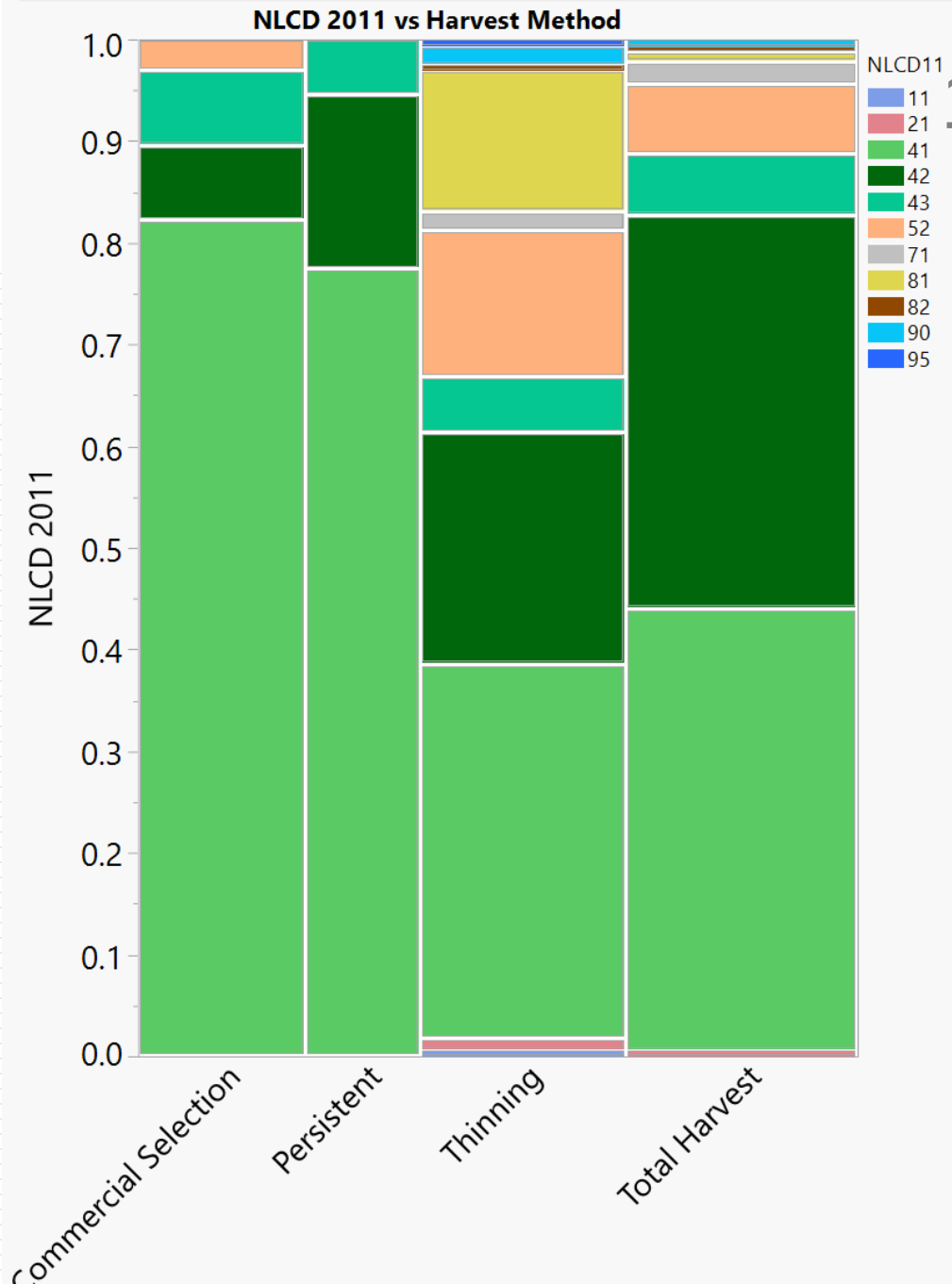
Moderate intensity managed forests (Thins) have multiple NLCD classes

NLCD Land Cover Classification Legend

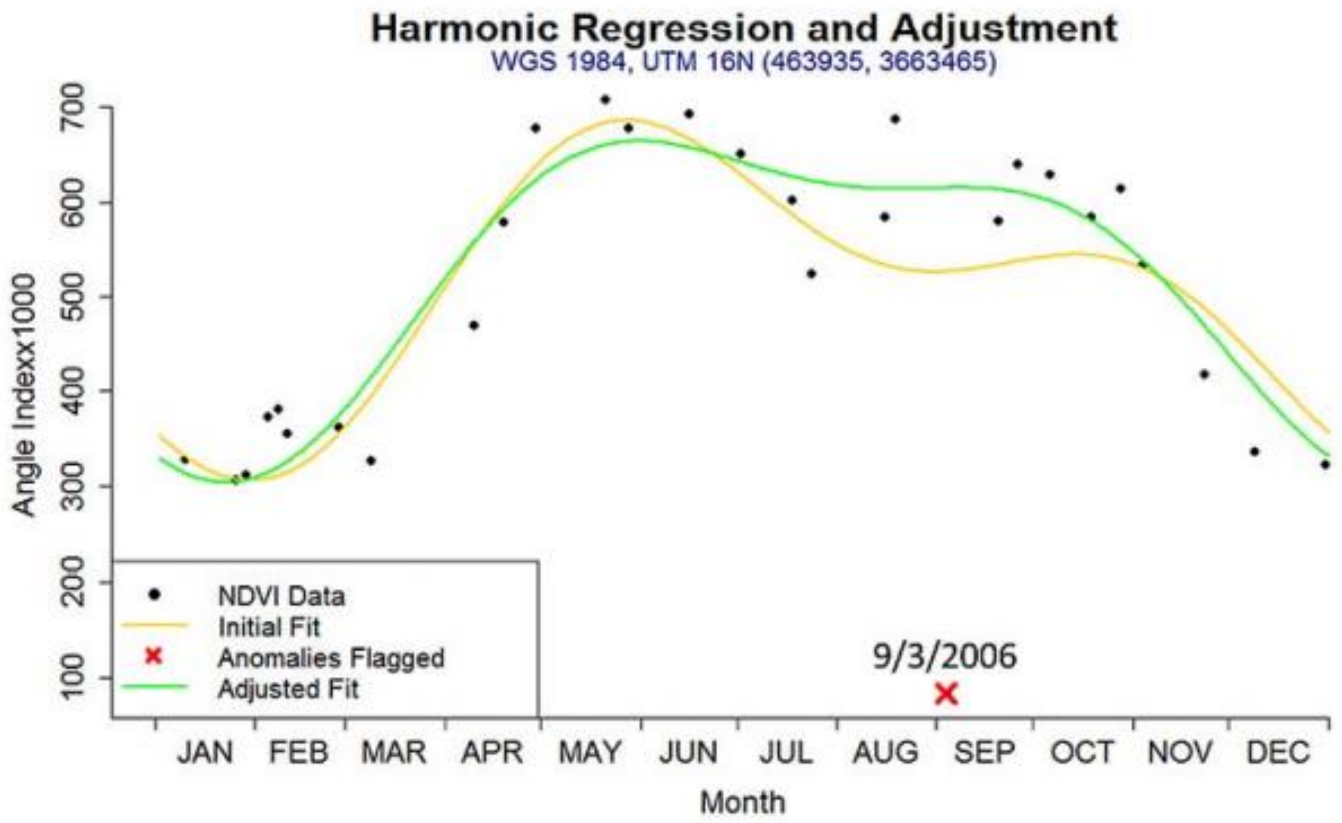
- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

* Alaska only



Are Harmonic Regression Coefficients Good Predictors of Management Classes?

- Includes temporal information for training period
- Has been shown in other projects to be valuable for forest inventory
- Serves as the 'base' for multiple change detection algorithms
  - CCDC & EWMA CD



Harmonic Regression, Brooks, et al, 2012 and Brooks, et al., 2014

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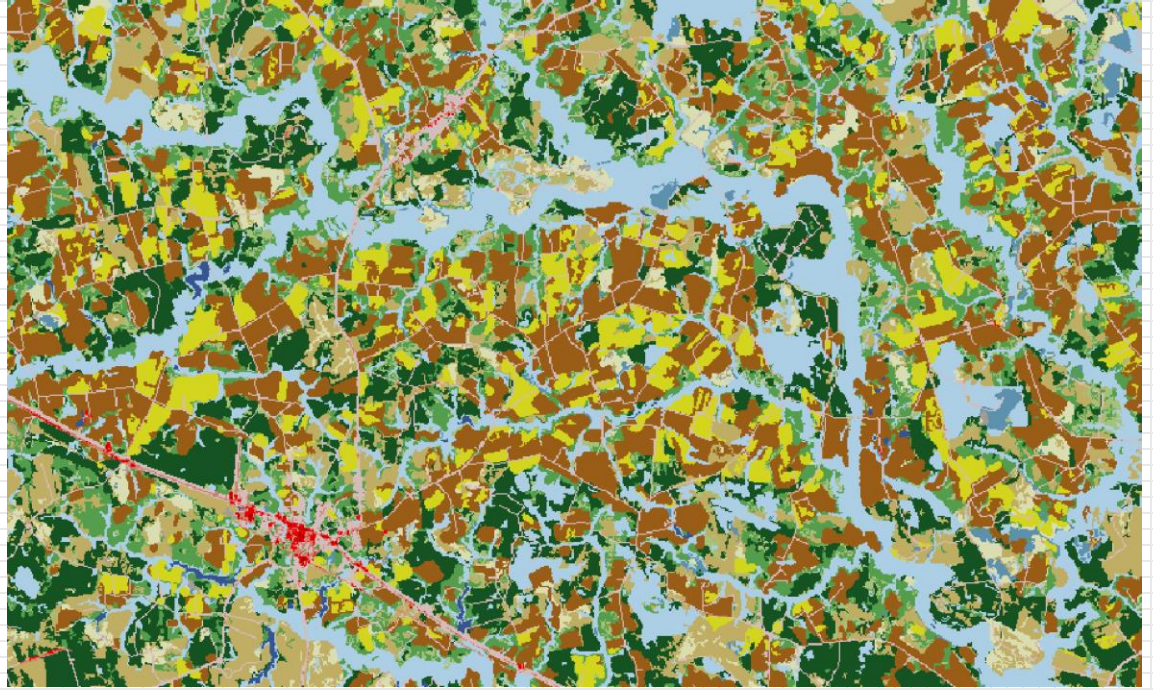
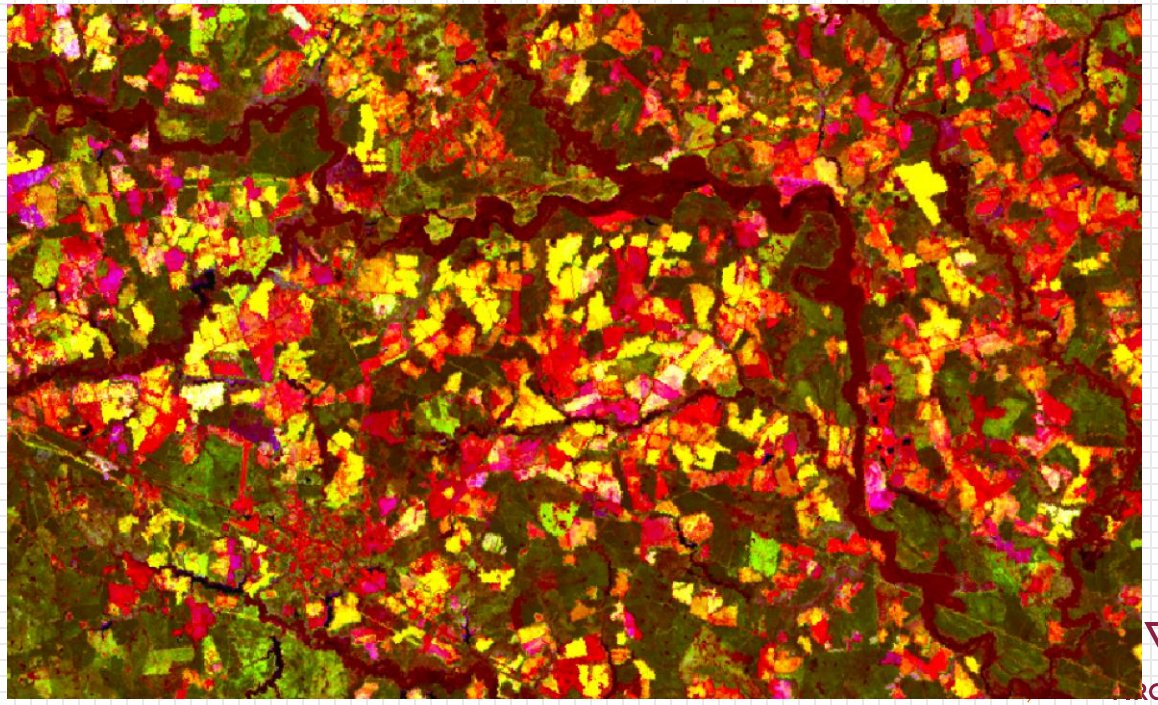
Harmonic Regression Computed for Region 8

Single harmonic calculated for region for 2009-2011 and 2014-2016

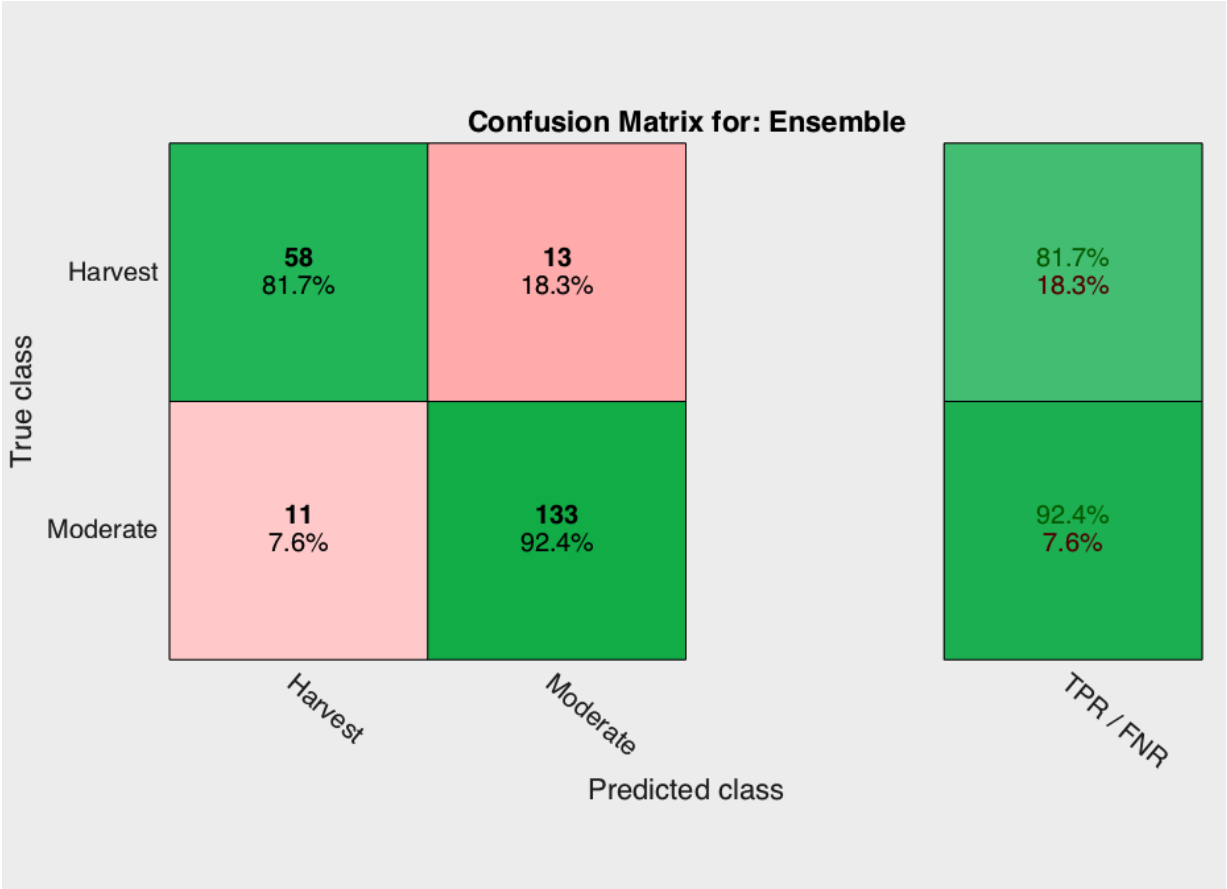
(Yang 2017)

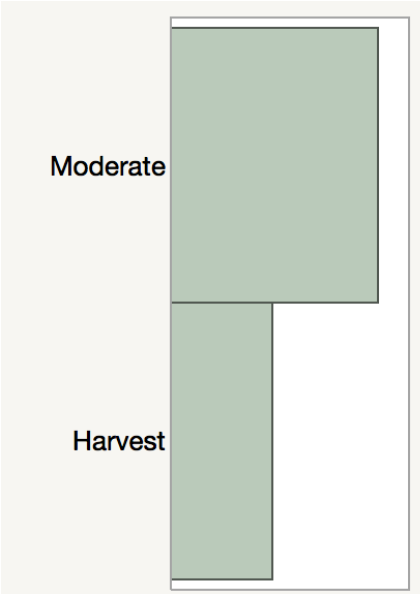




Management class accuracy within pines

- Random Forest Classification with cross validation
- Overall Accuracy 89%
- Needs additional persistent forest





Frequencies

Level	Count	Prob
Harvest	71	0.33023
Moderate	144	0.66977
Total	215	1.00000
N Missing	0	

Landsat-derived LAI by management class for regional projections of productivity and fertility

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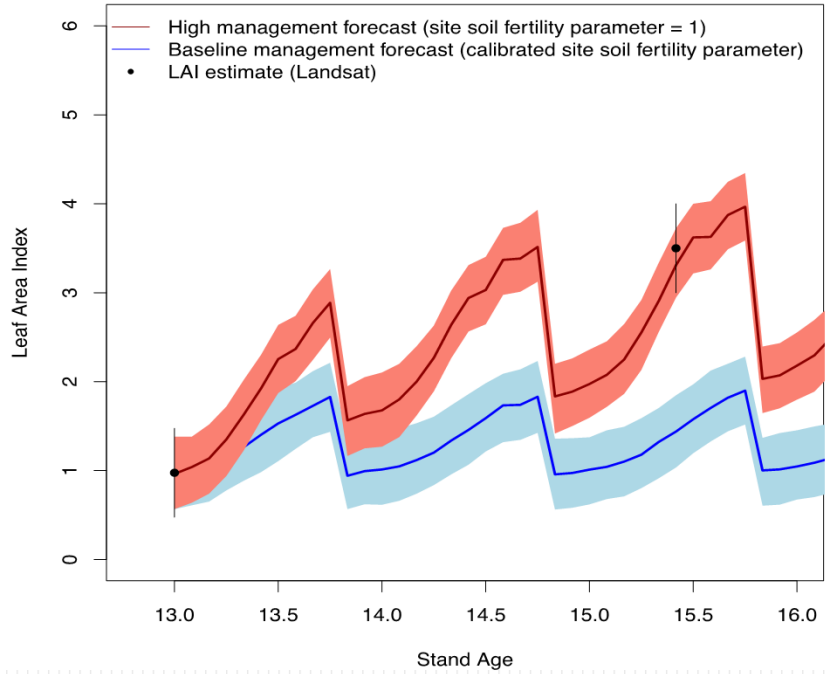
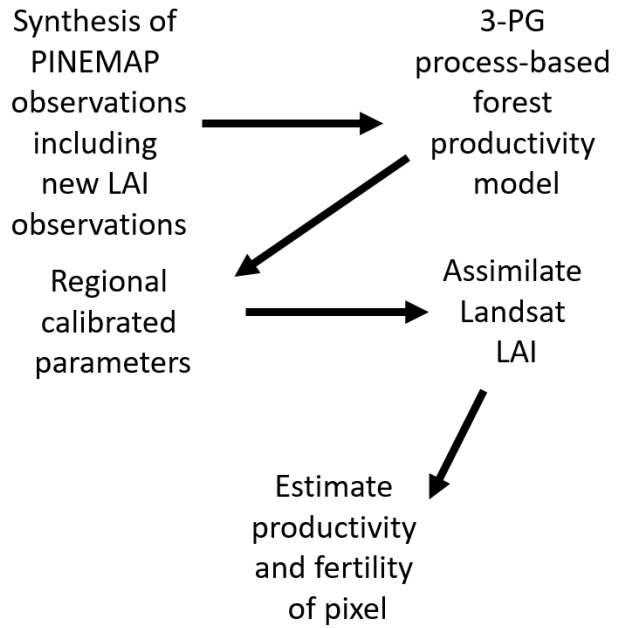
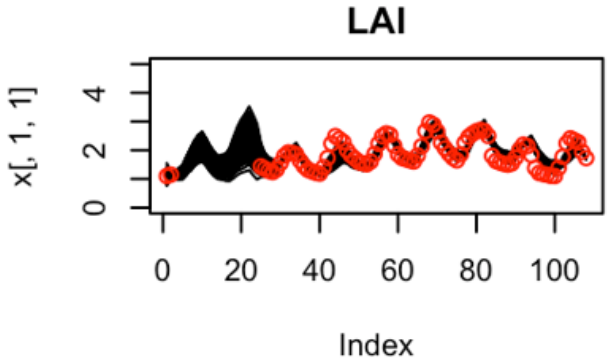
Synthesis of RS with Ecological Forecasting







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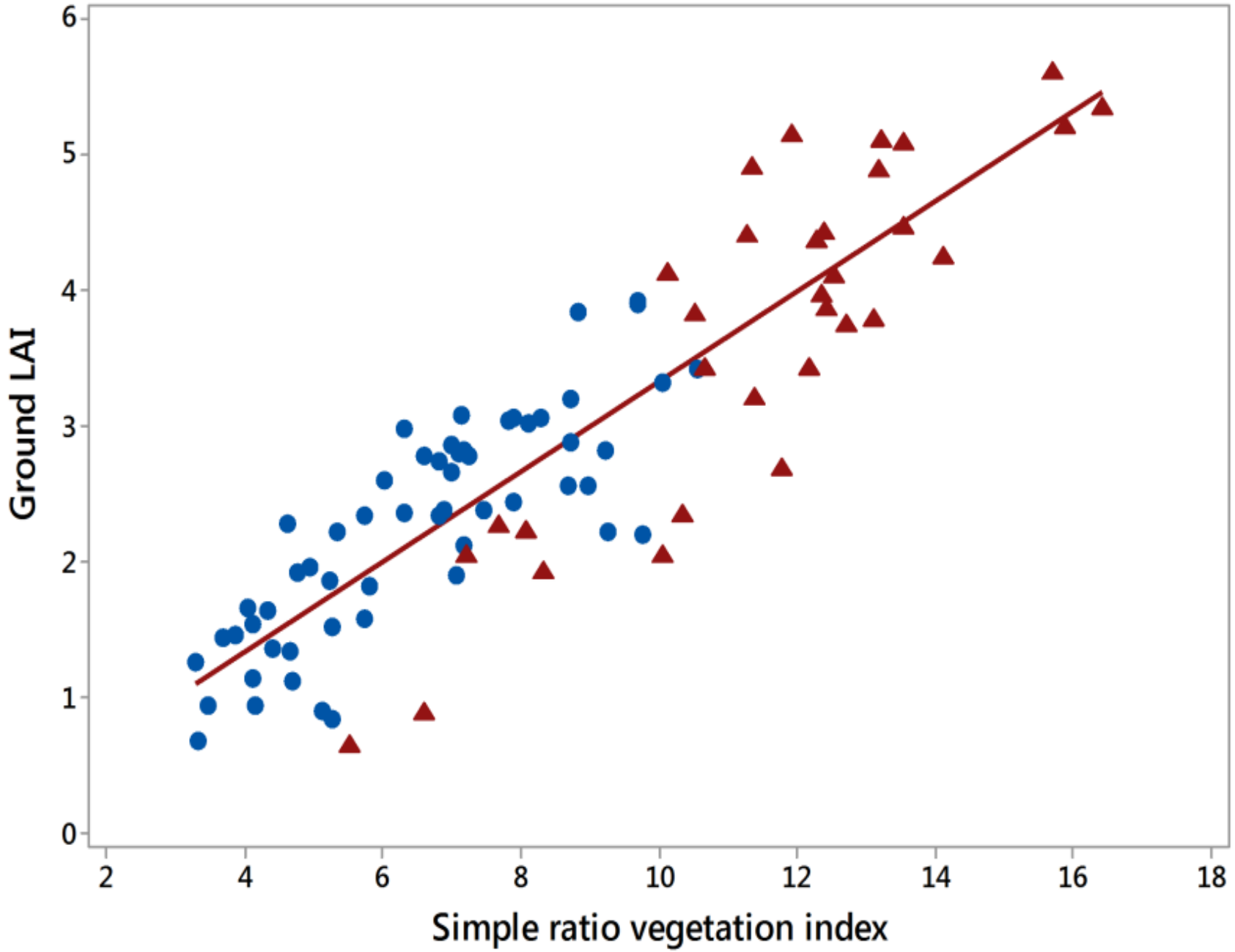
Ground LAI
0
1
2
3
4
5
6
2
4
6
8
10
12
14
16
18
Simple ratio vegetation index

Synthesis and Intercomparisons

- Synthesis of
  - Landsat classifications
    - At GLM scale
  - Southern Forest Futures
    - At GLM scale
  - GLM Land Use transition matrices
- Establish a baseline to quantify the impact of regionally-specific land use transition matrix.

GLM Class	NLCD Class
Urban	21 Developed, Open Space 22 Developed, Low Intensity 23 Developed, Medium Intensity 24 Developed High Intensity
Crop Functional Types	82 Cultivated Crops
Managed Pasture	81 Pasture/Hay
Rangelands	71 Grassland/Herbaceous
Primary Non-Forest	31 Barren Land (Rock/Sand/Clay)
Secondary Non-Forest	11 Open Water 12 Perennial Ice/Snow 51 Dwarf Scrub 52 Shrub/Scrub 72 Sedge/Herbaceous 73 Lichens 74 Moss 95 Emergent Herbaceous Wetlands
Secondary Forest	41 Deciduous Forest 42 Evergreen Forest 43 Mixed Forest 90 Woody Wetlands

Next steps

- Complete assessment of USGS Gap, Global Forest Change, and NLCD TCC products to supplement the base classification of pines to include thins.
- Applying the LAI models across management classes
- Upscaling the Southern Forest Futures projections to the GLM to finalize the baseline comparison between the GLM, NLCD, and Southern Forest Futures land use transition matrices.
- Completing the mapping of forest management intensity across the Southeast over time.
- Incorporating forest management and risk into the economic projections.

Questions?

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International Paper