Assessing Landscape Dynamics to Understand Ecosystem Service Resilience and Sustainability

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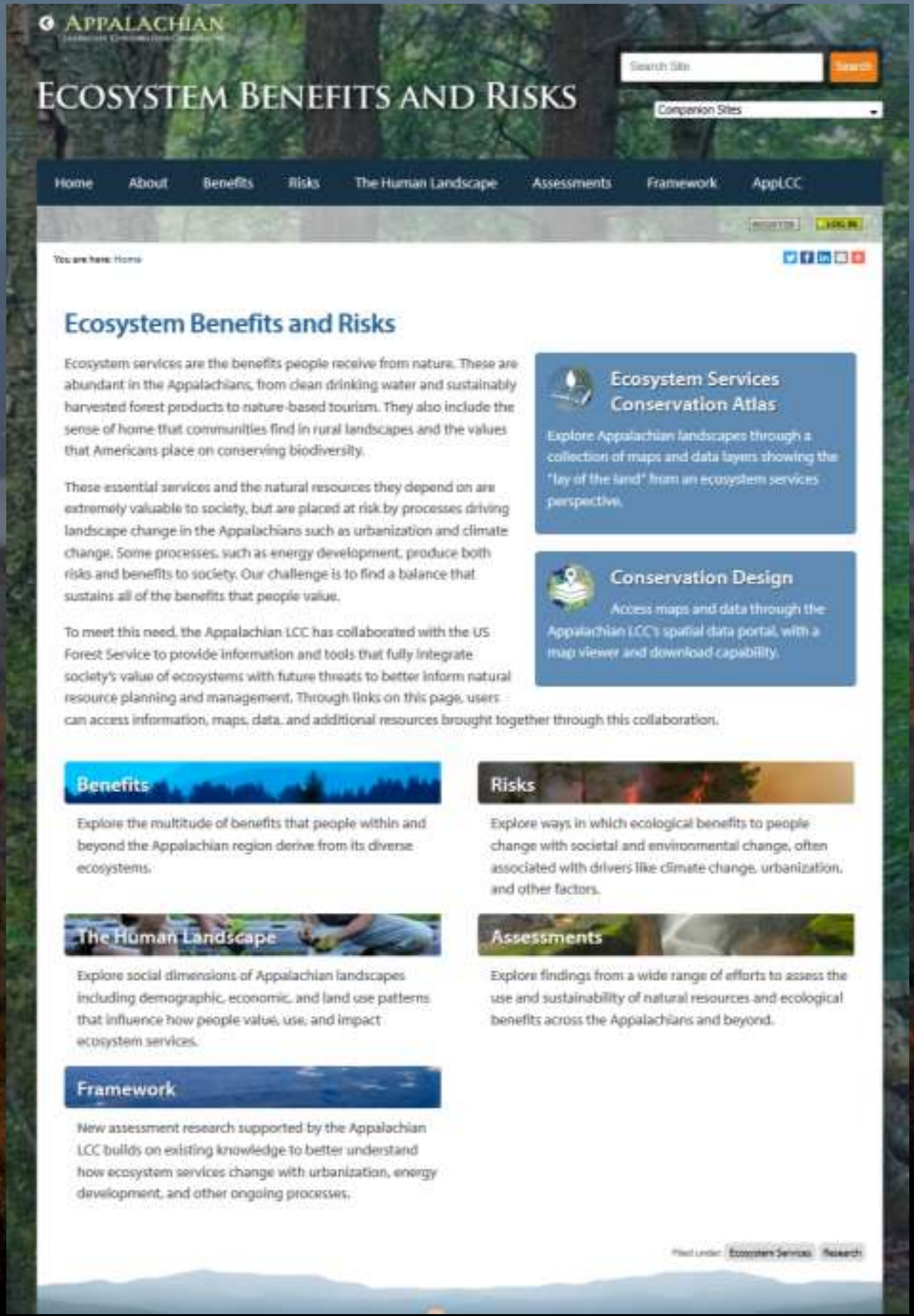

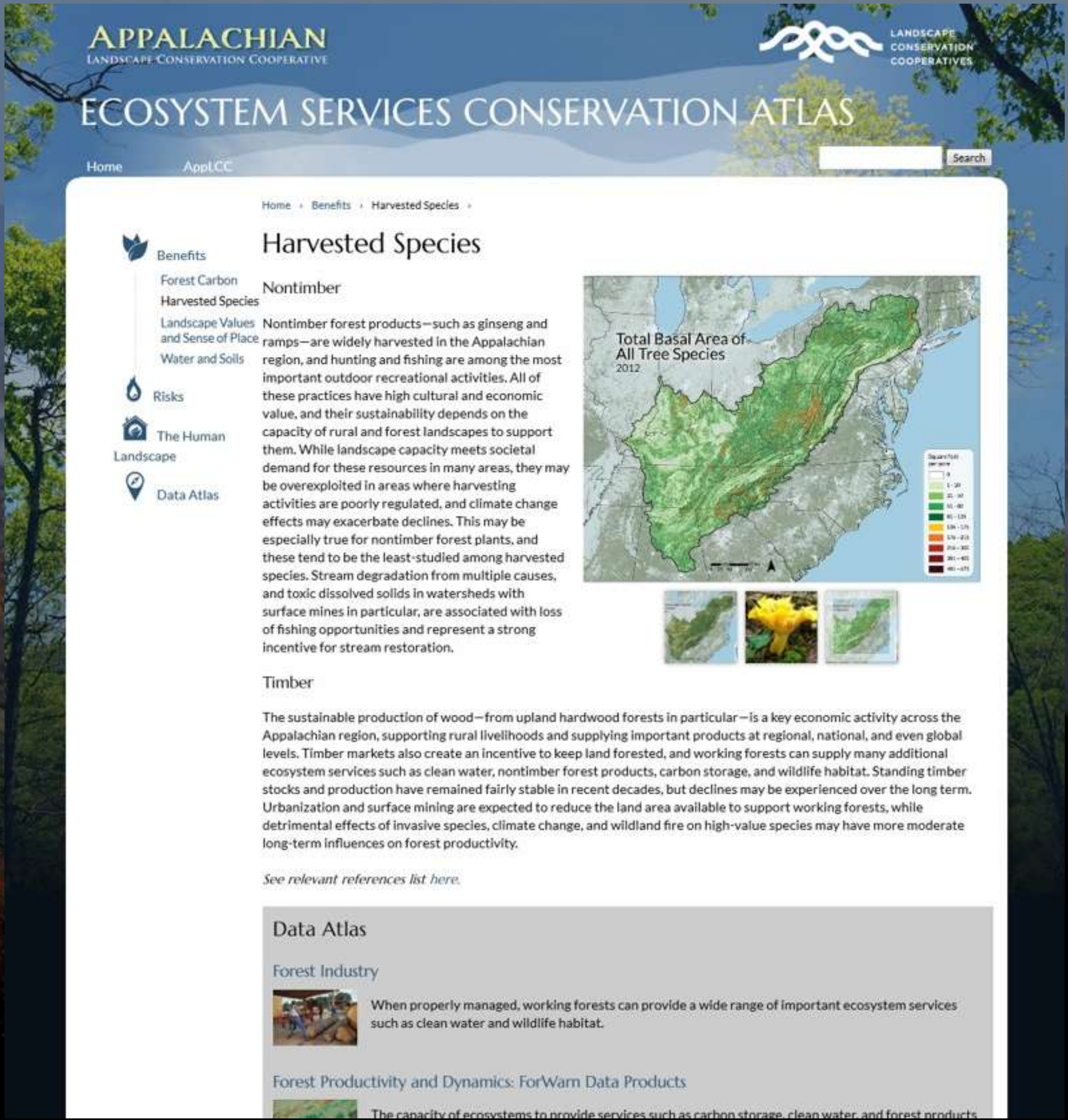

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APPALACHIAN
Landscape Conservation Cooperative

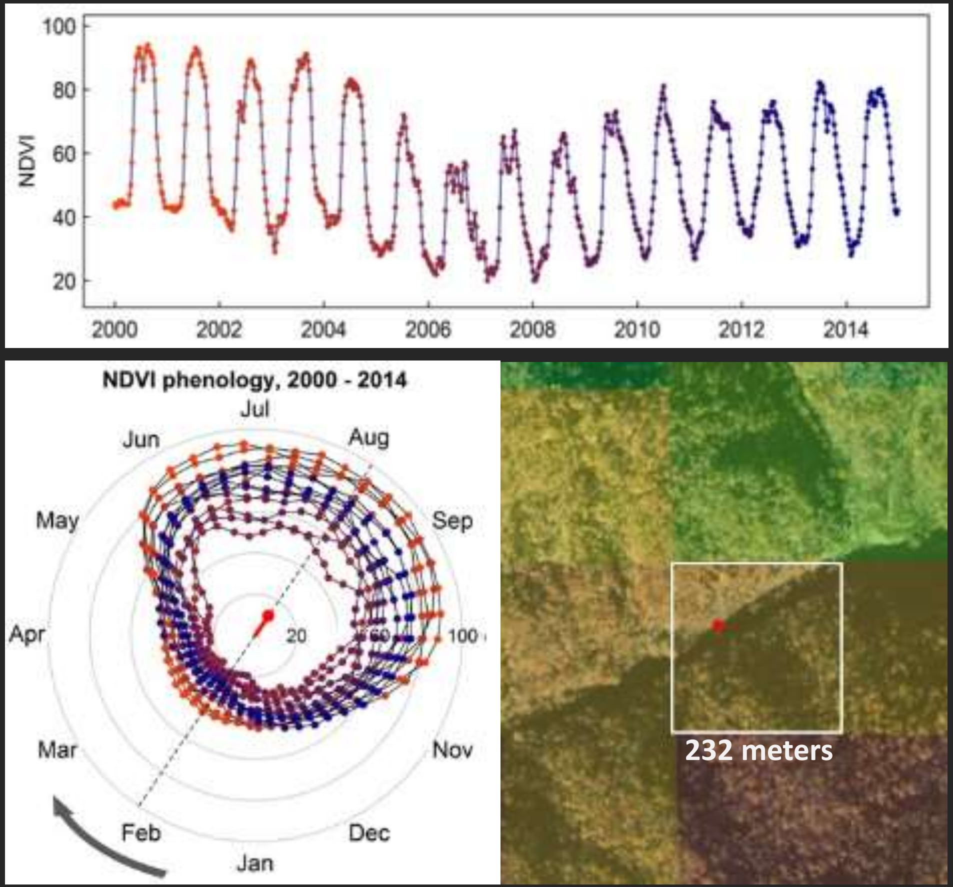
Landscape resilience

Capacity to maintain defining characteristics and functions, even while landscape change is ongoing.

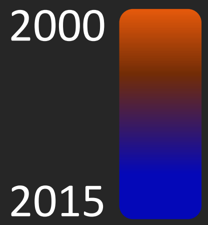
Landscape dynamics assessment: data source

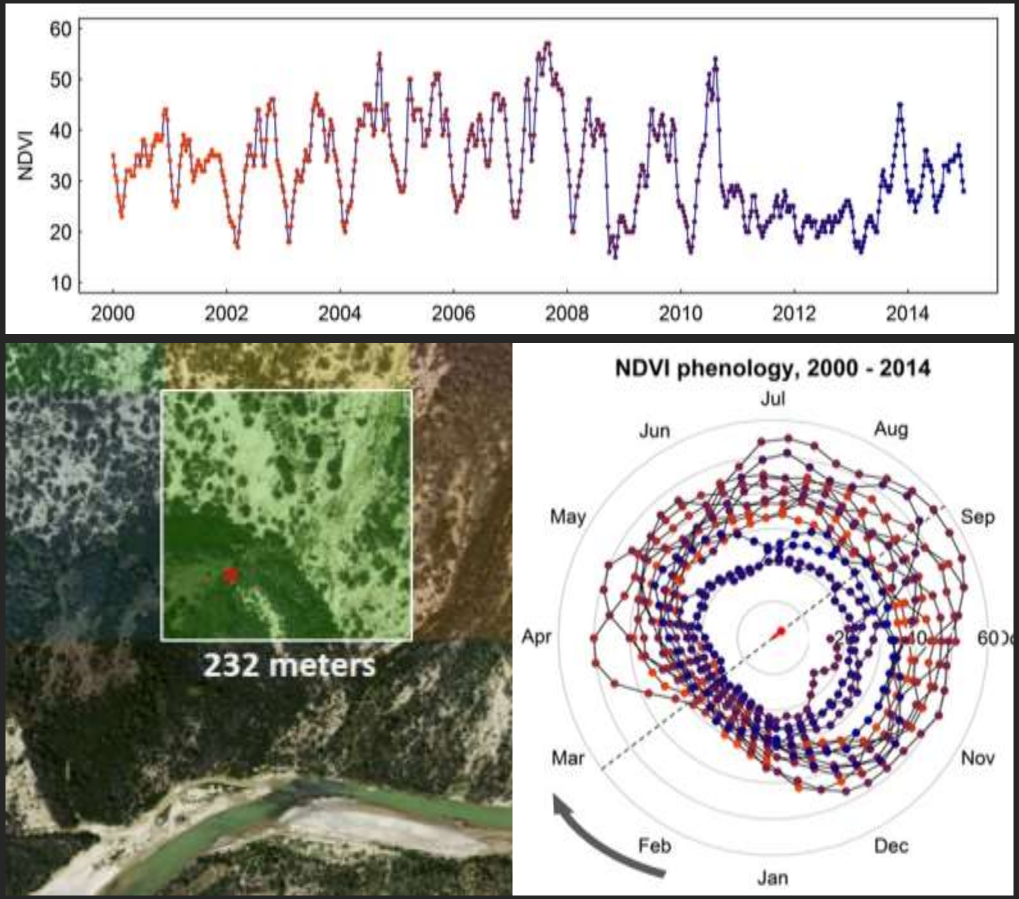
MODIS Normalized Difference Vegetation Index (NDVI), 2000 – 2015

Annual land surface phenology: timing of vegetation change



Appalachian forest pixel, southwestern WV

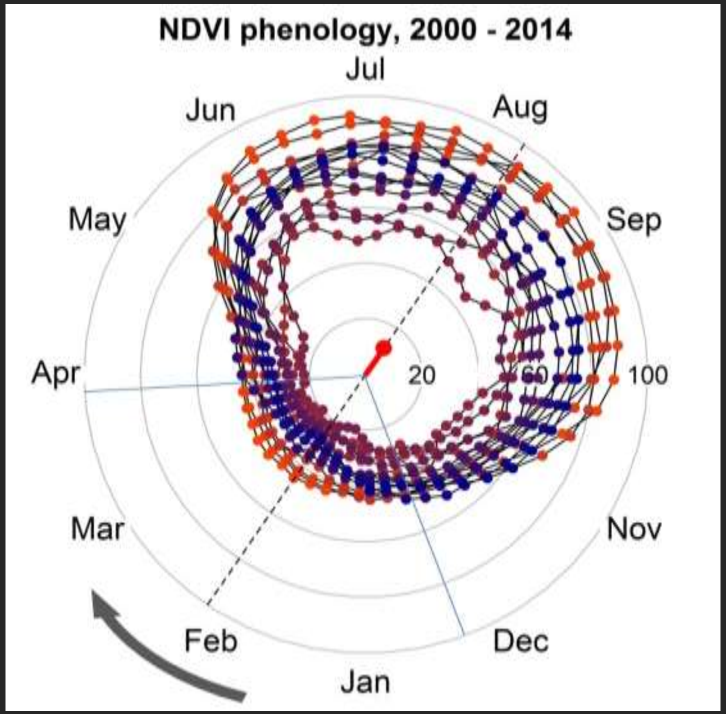


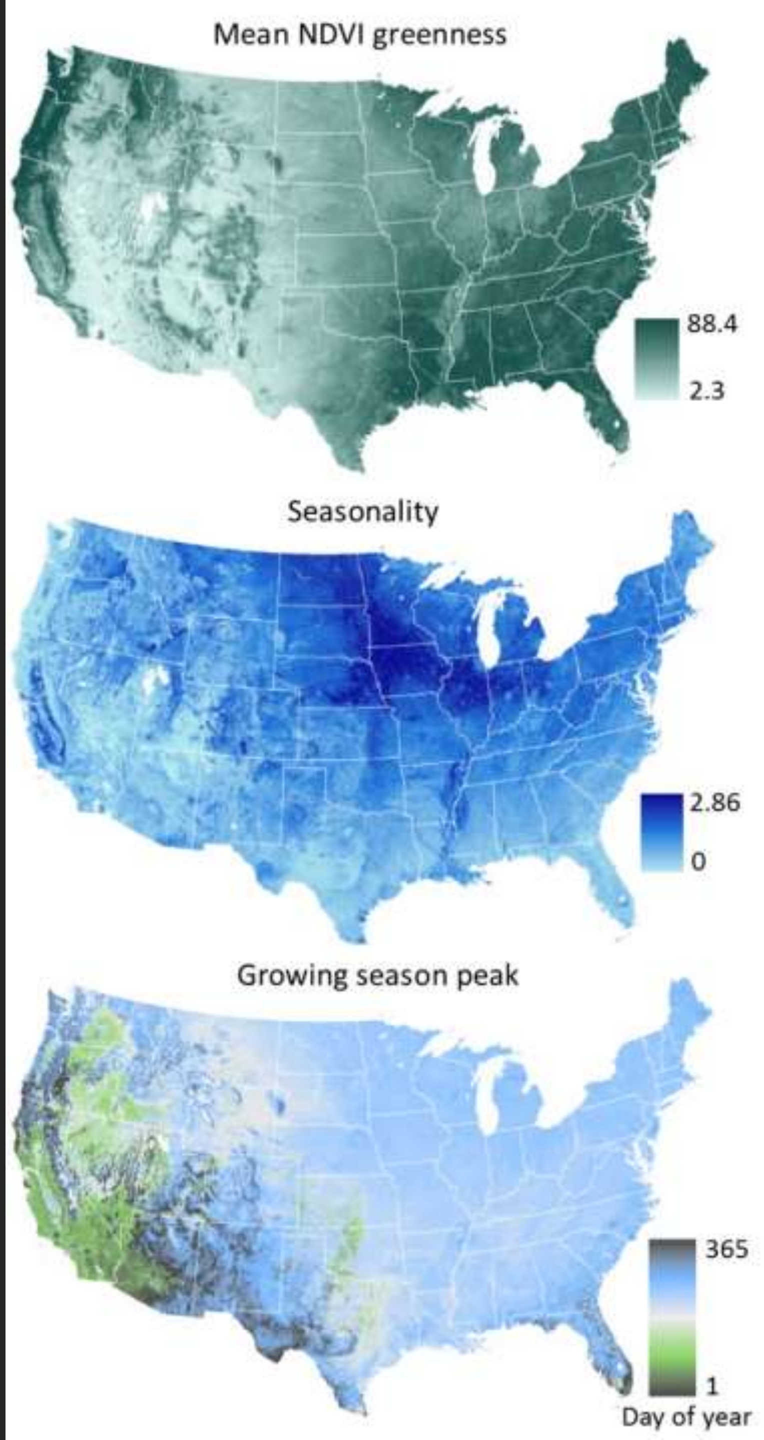


Rio Grande riparian pixel, west Texas

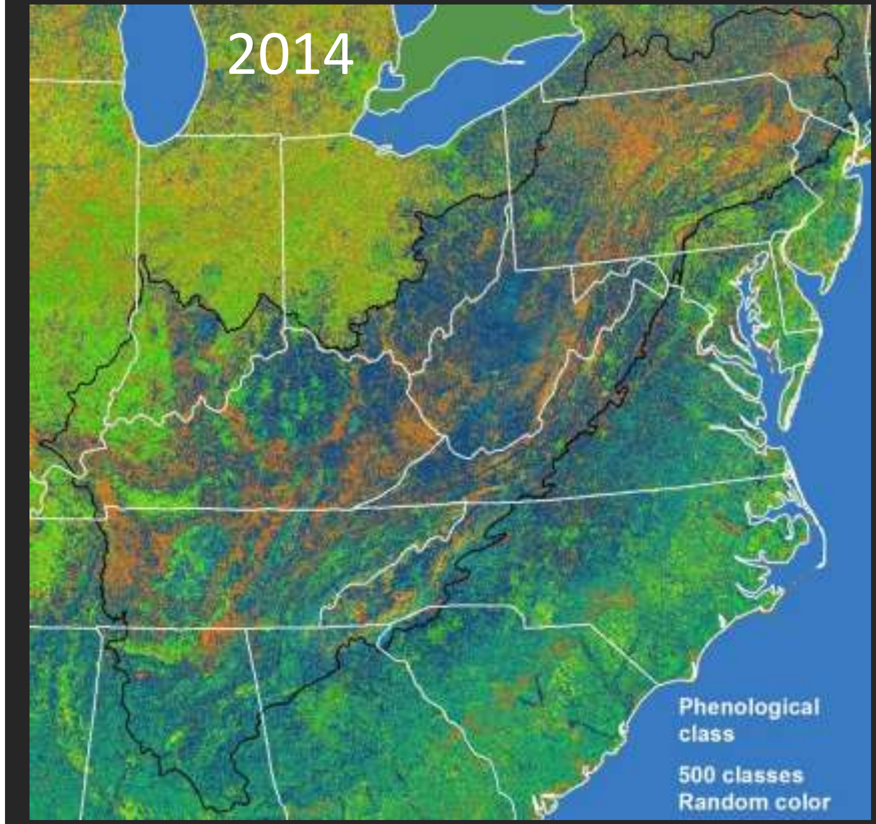
Phenological description: NDVI Within-year variability

- ★ **Mean growing season NDVI (greenness)**
- ★ **Magnitude of mean vector NDVI (seasonality)**
- ★ **Midpoint of growing season (peak)**
- **Beginning of growing season**
- **Length of growing season**
- **Growing season NDVI standard deviation**

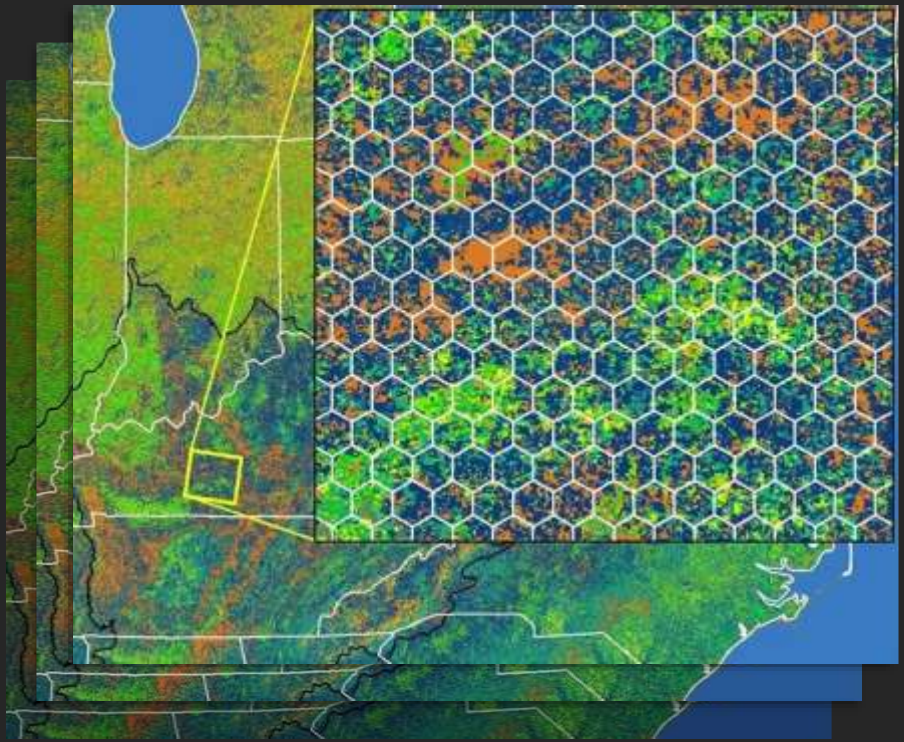




Annual phenological classification



Using information theory
to characterize landscape organization and dynamics



Phenological class in 2000, 2001,…2015

Landscape sizes: 81 pixels: ~ 435 ha
450 pixels: ~ 2400 ha

P = Transition probability

H = Shannon diversity

$$H = -\sum_i (P_i \cdot \log_2(P_i))$$

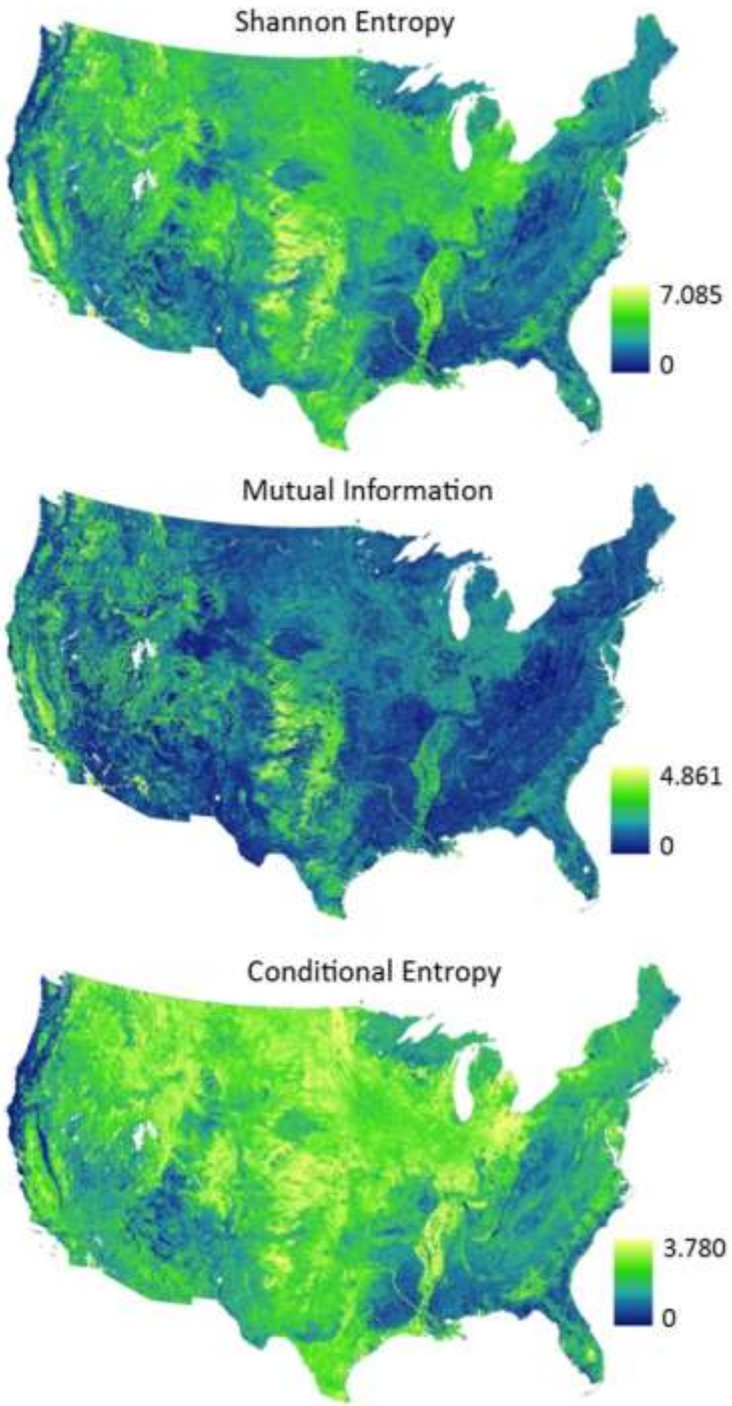
MI = Mutual Information

$$MI = \sum_i \sum_j \left(P_{i,j} \cdot \log_2\left(\frac{P_{i,j}}{P_{.i} \cdot P_{.j}}\right)\right)$$

$Conditional\ Entropy = mean\ H - MI$

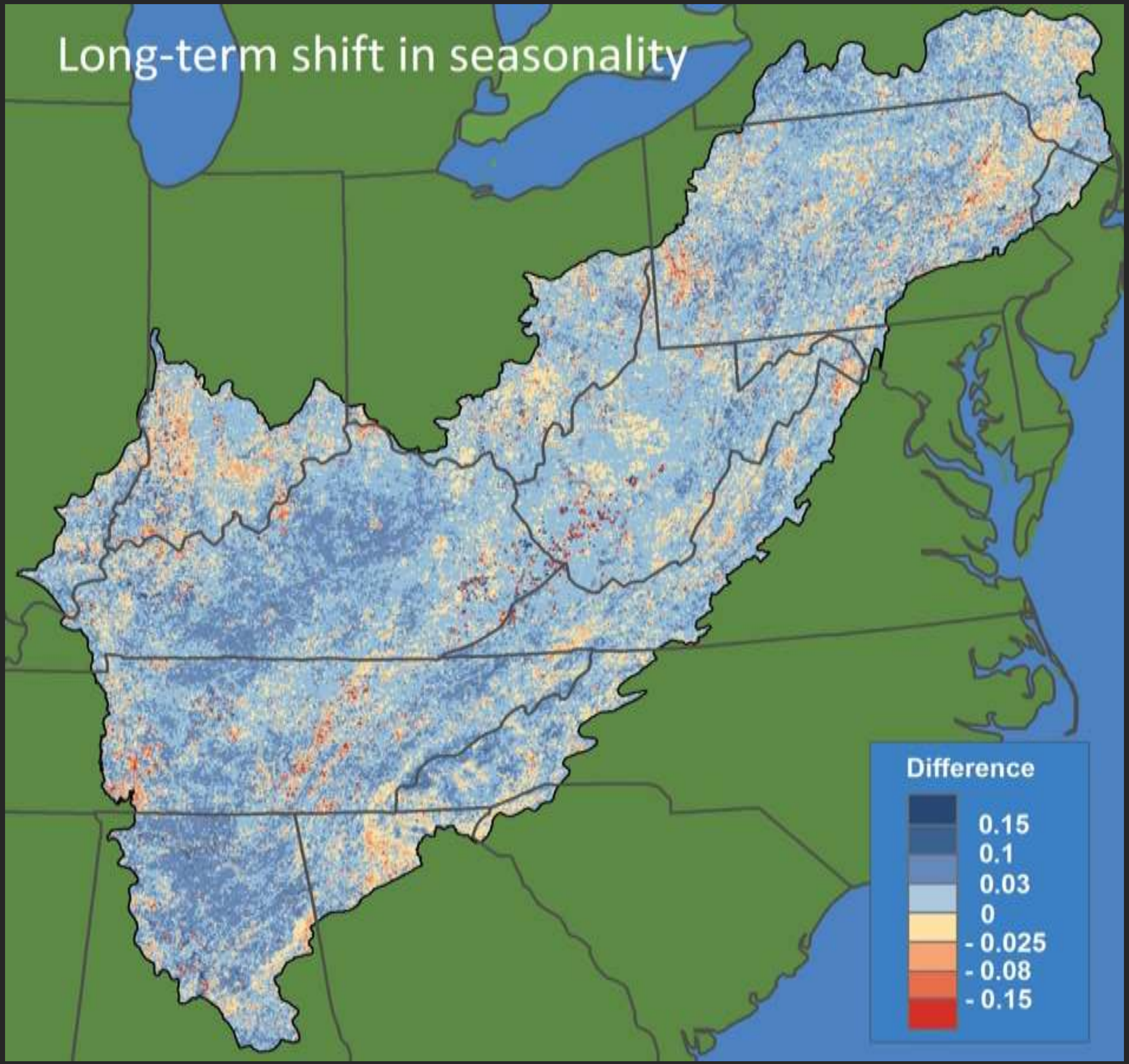
$Ascendency = MI \cdot mean\ NDVI$

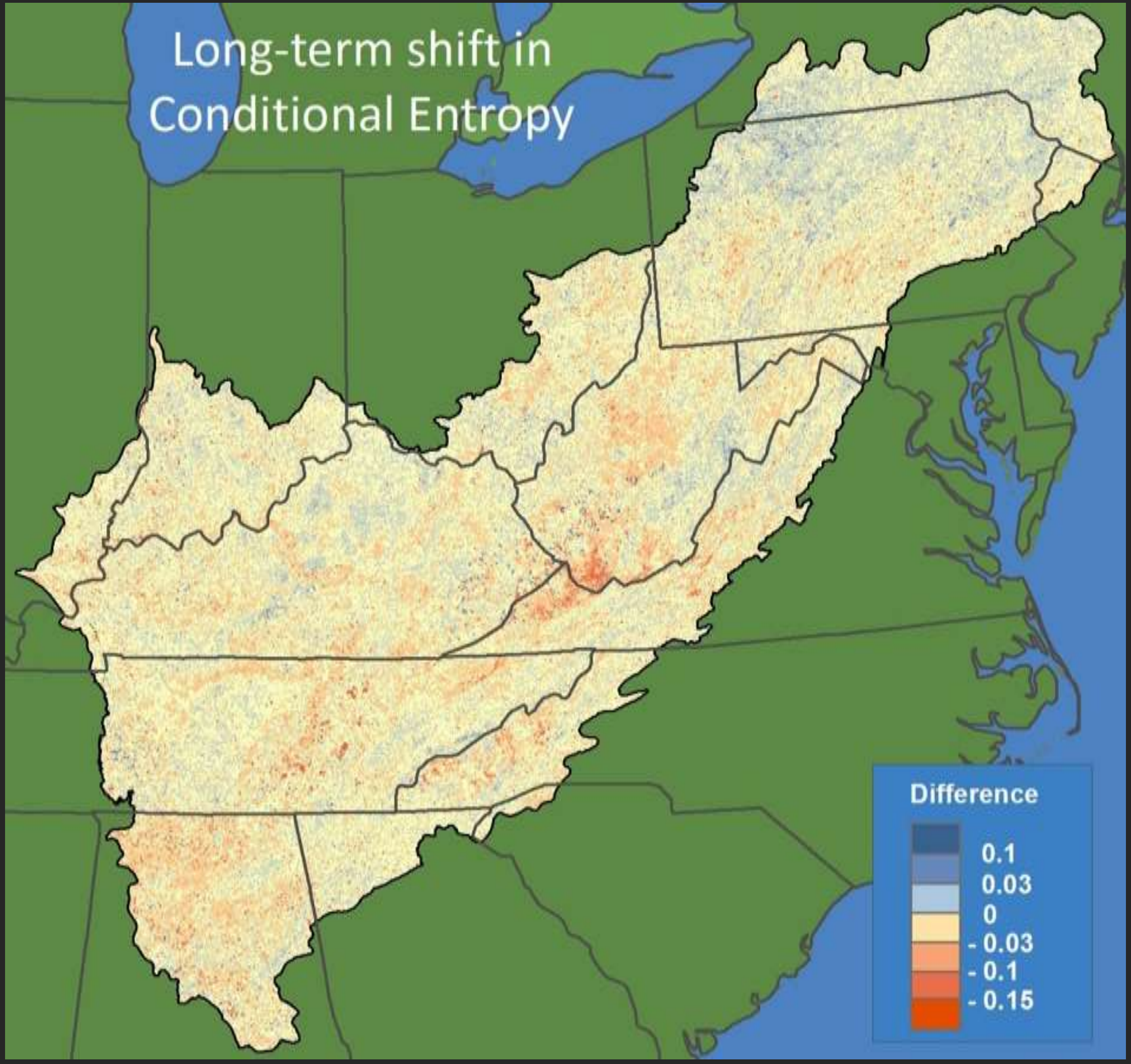
$Overhead = CE \cdot mean\ NDVI$



Mapping long-term landscape change

Difference between current phenoclass composition and projected equilibrium composition

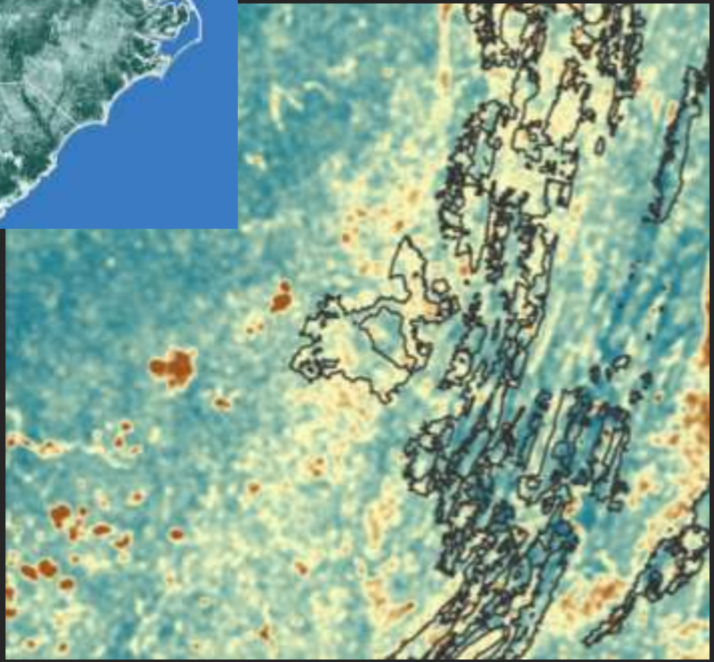




Mapping long-term landscape change

Dark outline = federal protected areas

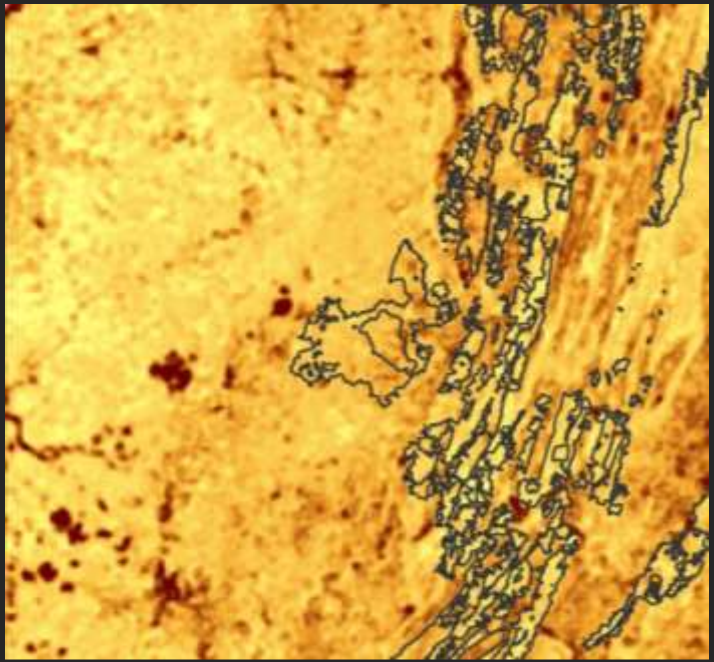
NDVI vegetation greenness



NDVI change, 2000-2015

High

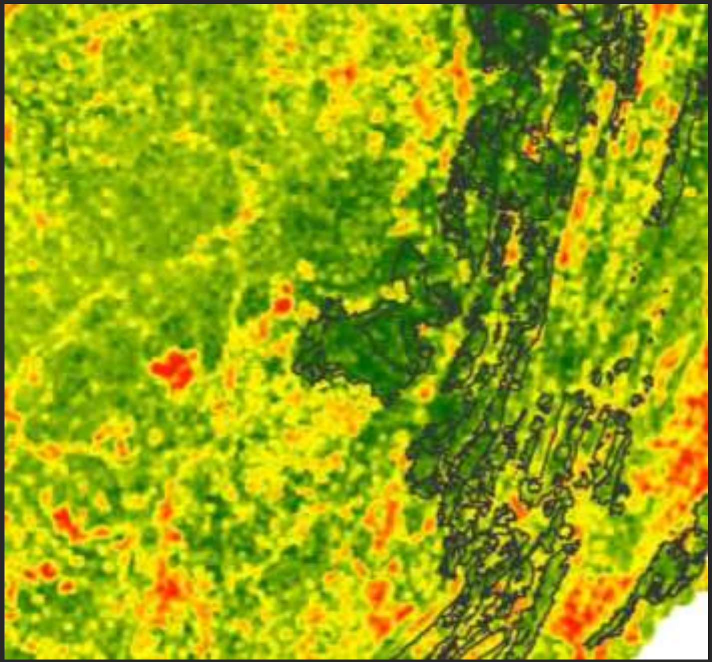
Low



Change type diversity

High

Low



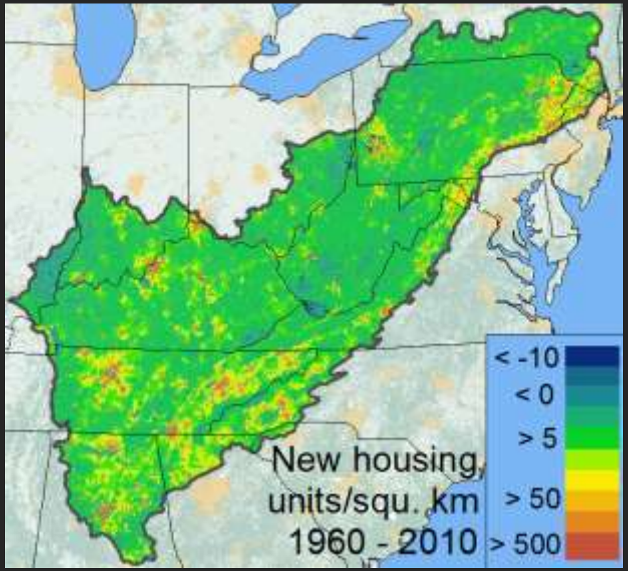
Modeled carbon density

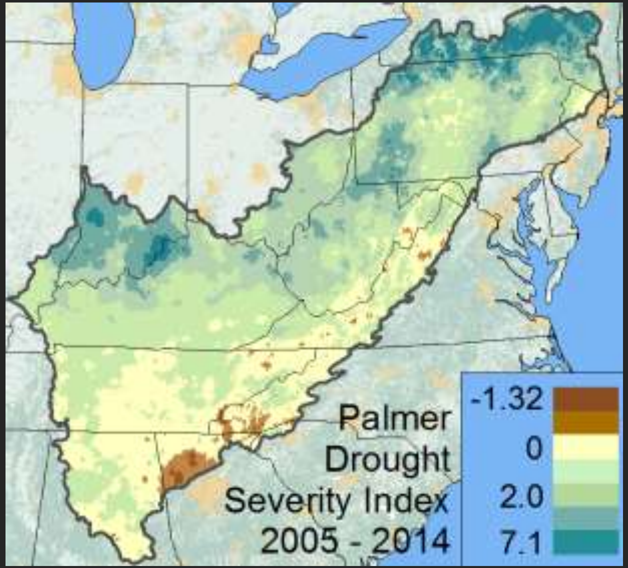
High

Low

Ecosystem service resilience and vulnerability

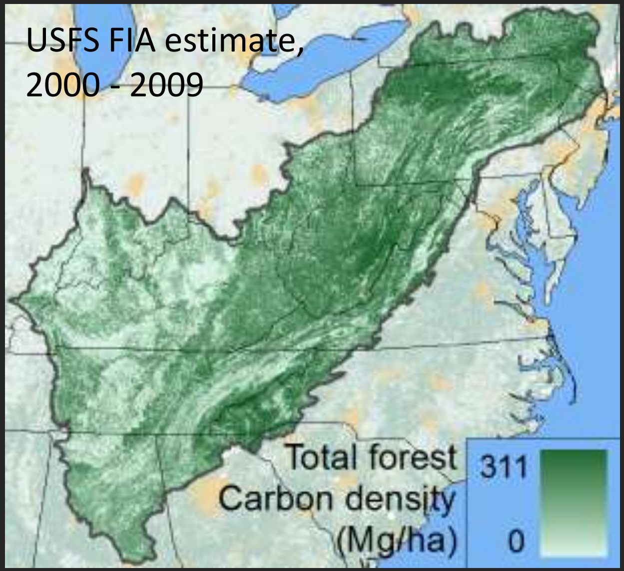
Measuring the changing capacities of large landscapes to sustain ecosystem services

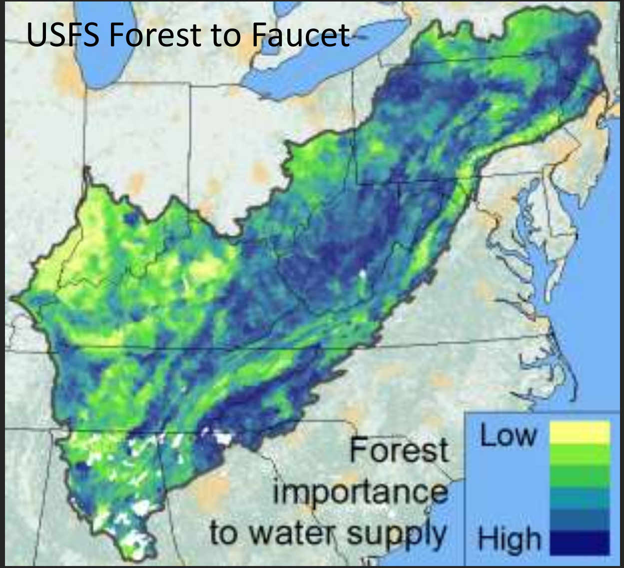




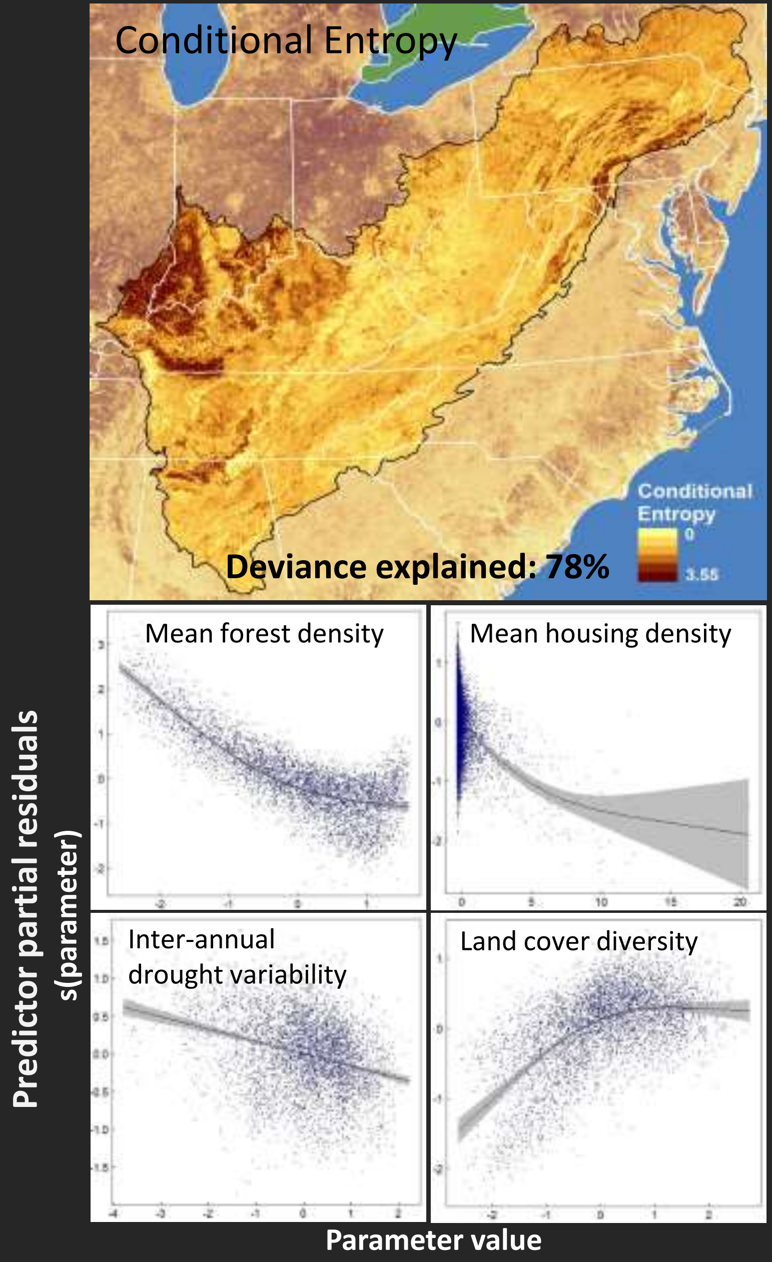
Drivers of change

Landscape capacity



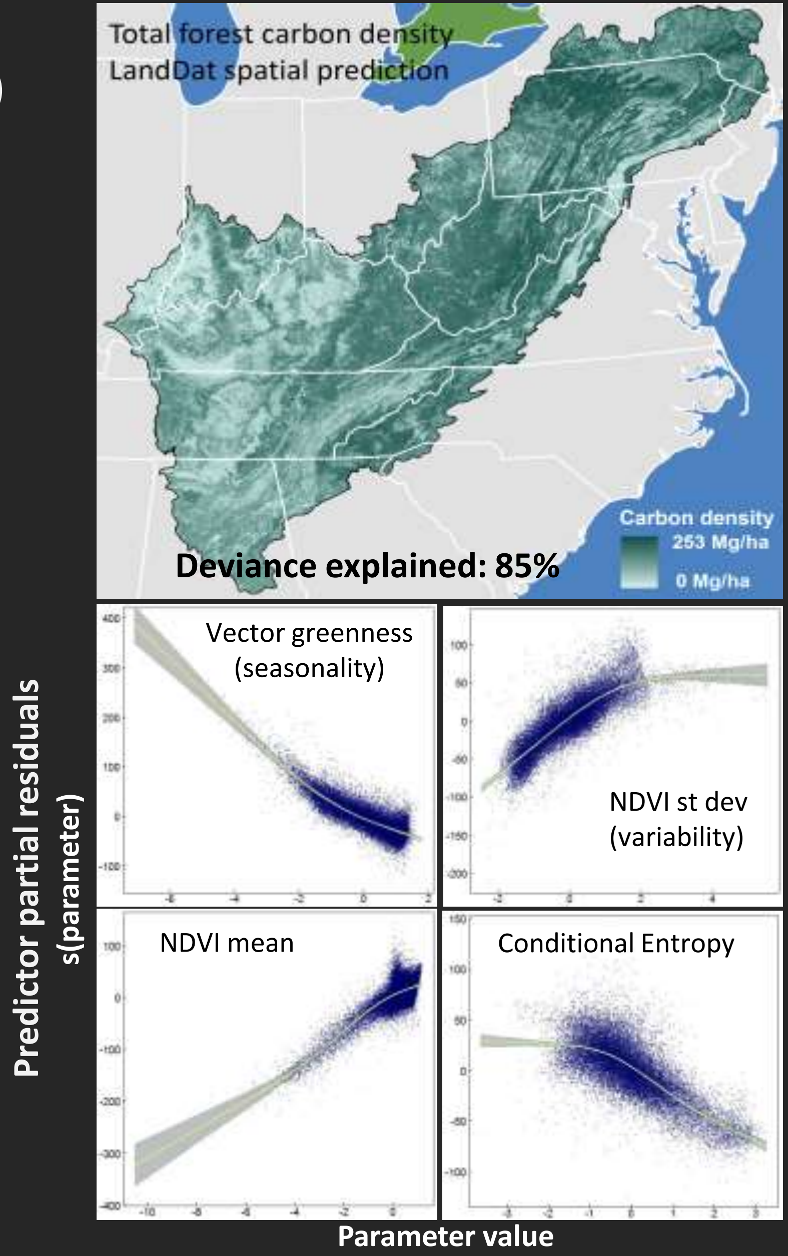


Landscape correlates of the phenology and Information−theoretic measures

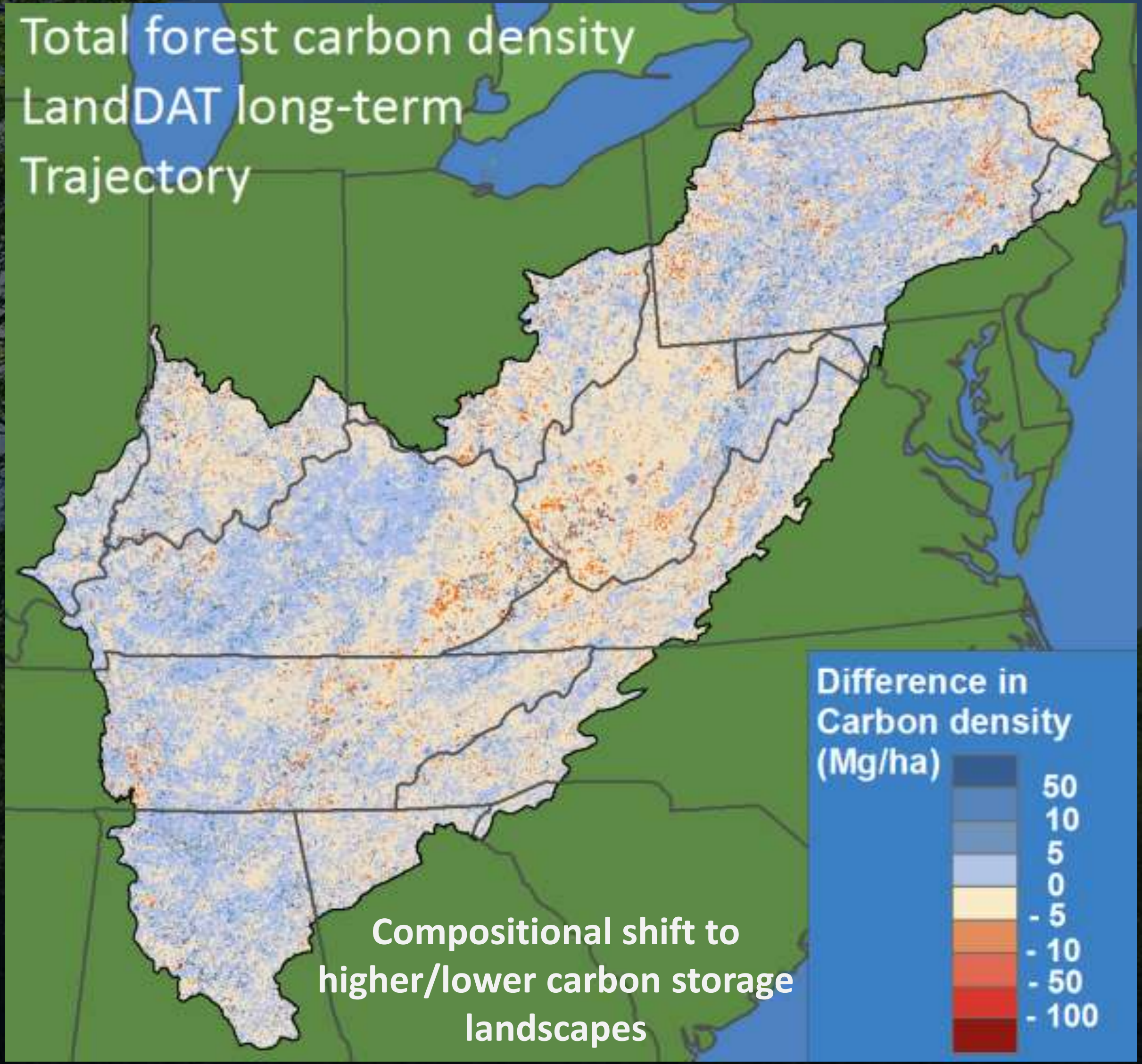


Generalized Additive Models (GAM) and AIC model selection

Phenology-derived resilience metrics can link drivers with resources



Mapping long-term landscape change, given the observed dynamics



Applications

- Spatial planning with respect to resilience and vulnerability
  - Monitor and interpret landscape change
  - Spatial modeling for species and resources of concern
- Ecosystem management

  Understand the shifting landscape mosaic in an integrative context
  - Climate variability
  - Land use change
  - Ecological disturbance regimes
- Identify opportunities for restoration, other conservation actions

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Thank You!

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