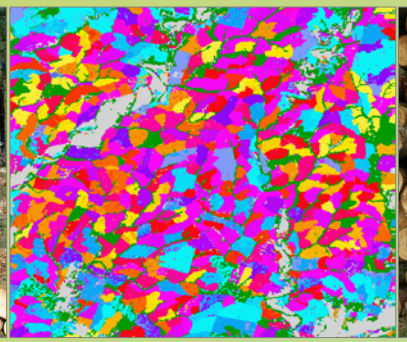
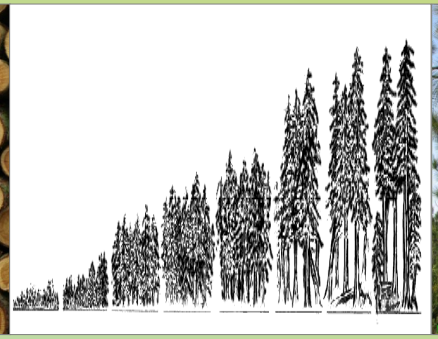
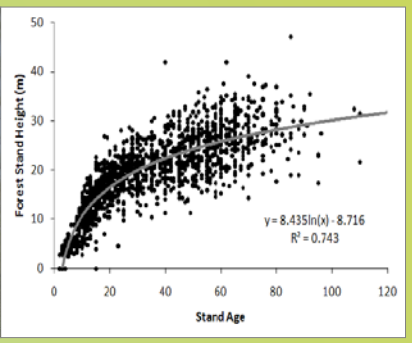







Assessment of North American Industrial Forests
Disturbances, Biomass Extraction
Growth Vigor

Chengquan Huang [1], Feng Aron Zhao [1], Xin Tao [1], Ming Feng [1], Pui-Yu Ling [1], Samuel Goward [1],

Karen Schleeweis [2], Matthew Hansen [1], Peter Potapov [1], Jennifer Dungan [3],

Andrew Michaelis [3], Matthew Fagon [4], Jeff Masek [5],

Ramakrishna Nemani [3], Michael Wulder [6]

[1] Department of Geographical Sciences, University of Maryland; [2] USDA Forest Service, Rocky Mountain Research Station; [3] NASA Ames Research Center; [4] University of Maryland Baltimore County; [5] NASA Goddard Space Flight Center; [6] Canadian Forest Service

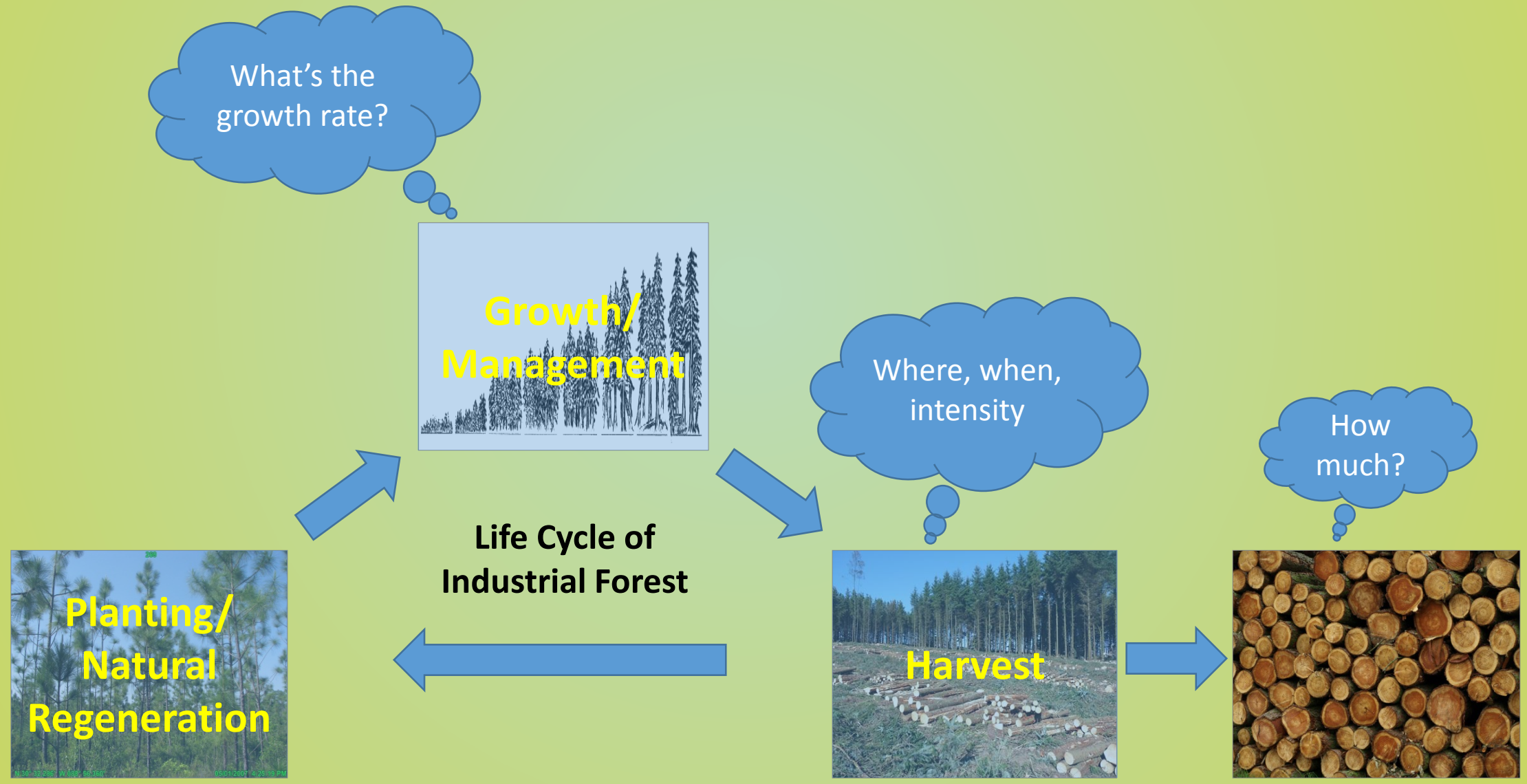
NASA LCLUC Science Team Meeting, Bethesda, MD, April 18 – 19, 2016

We Need Industrial Forests, But …

- Societal benefits:
  - Wood Products, Timber supply
    - Reduce cutting of natural forests
  - Carbon sequestration

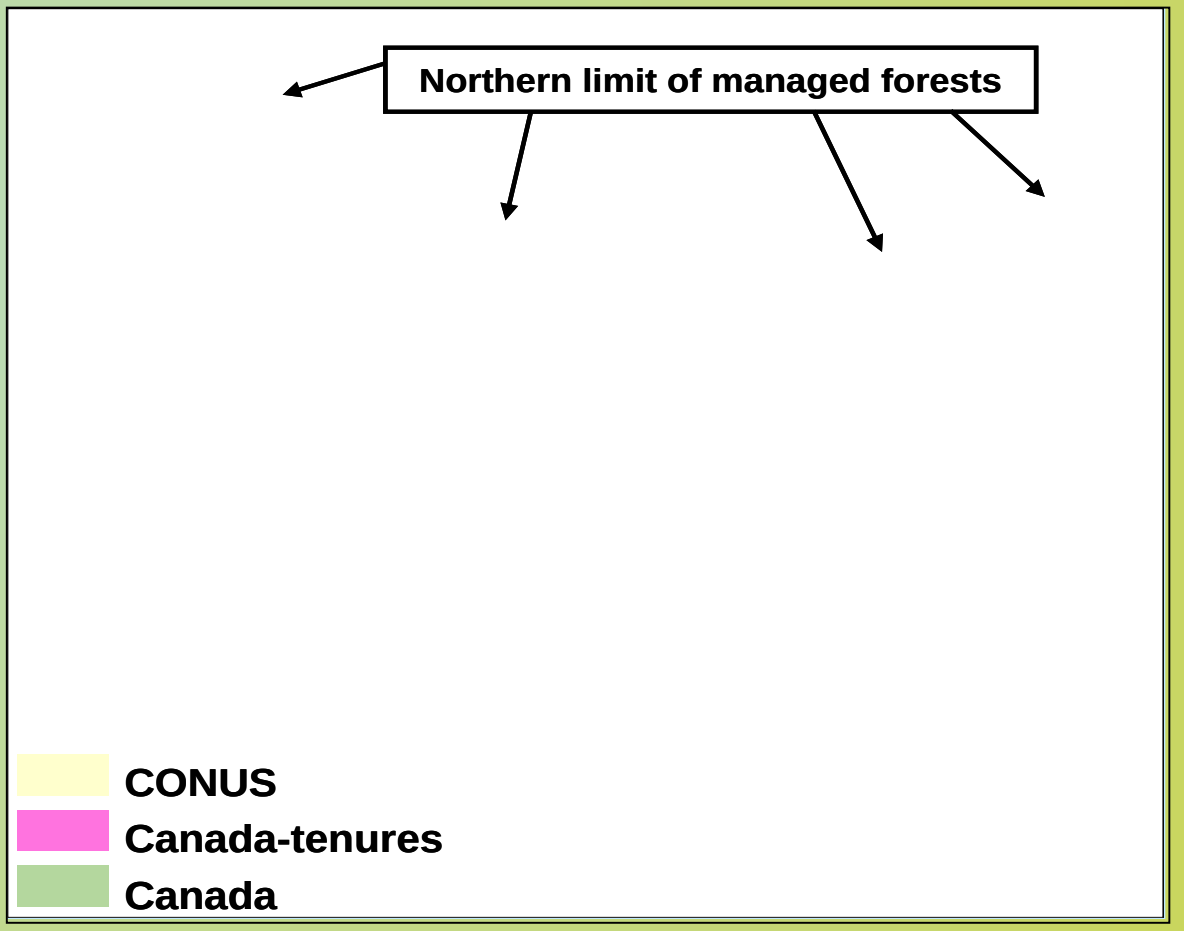
- Environmental impact
  - Mono-species
  - Not much structure variability
  - Rarely become old growth
  - Intensive management
  - Negative impact on soil, water, biodiversity

Key Assessment Questions

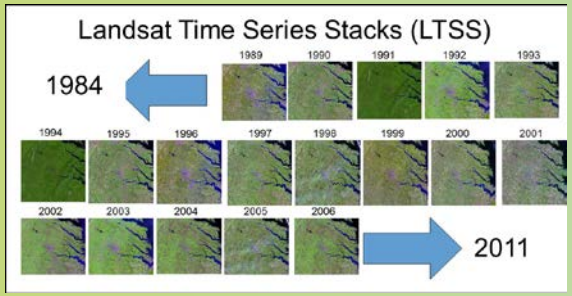


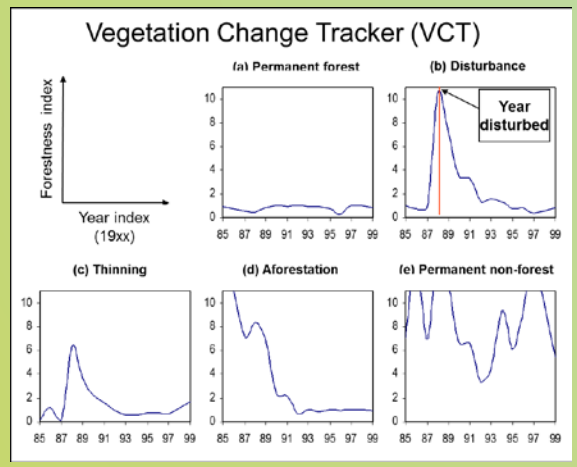
Study Area

- US
  - Private land
  - Some public land subject to industrial logging (e.g., national forest)
- Canada: timber tenure

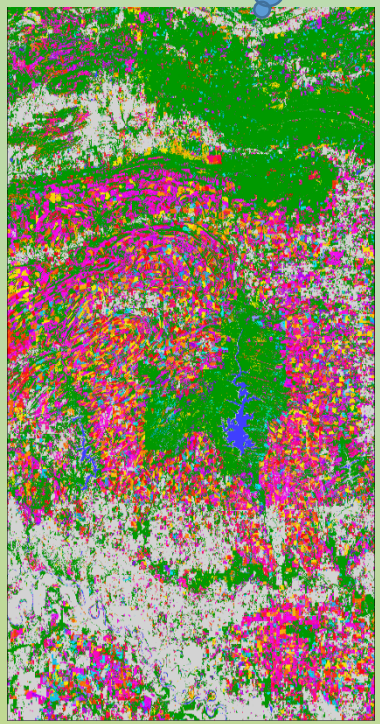


Overall Approach





Where, when, intensity

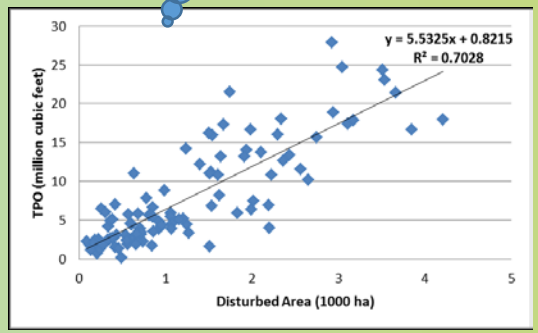


Attribution

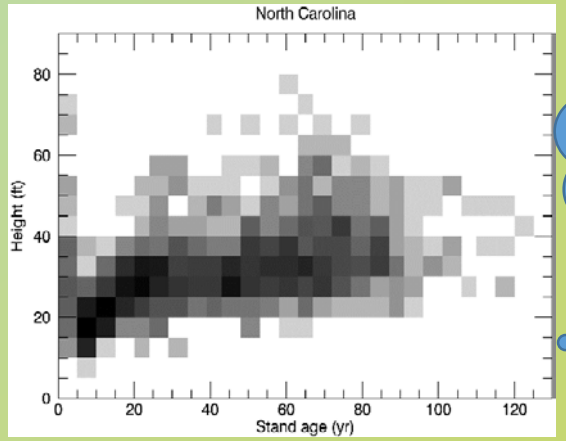
FIA

TPO

How much?

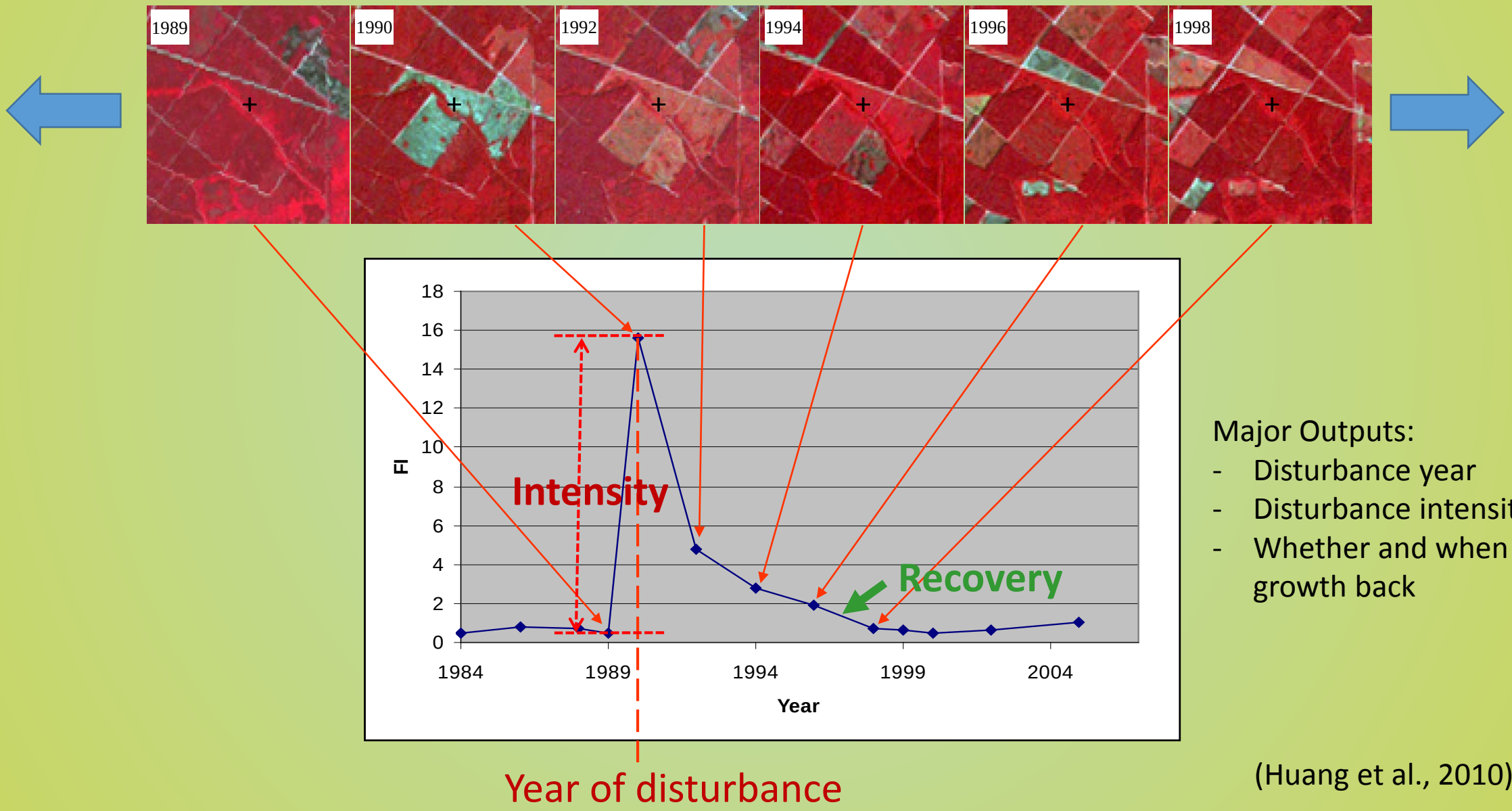


Field data



What's the growth rate?

Vegetation Change Tracker (VCT)

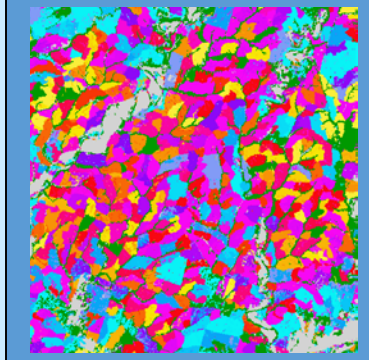


Major Outputs:

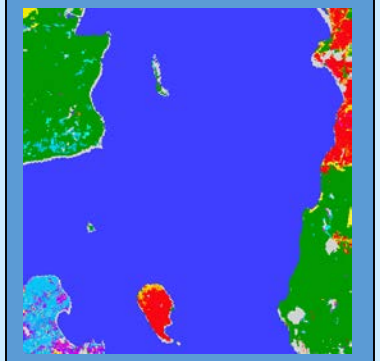
- Disturbance year
- Disturbance intensity
- Whether and when growth back

(Huang et al., 2010)

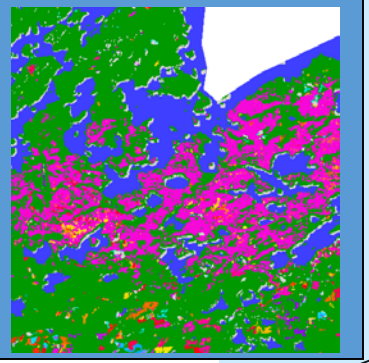
Little left undisturbed



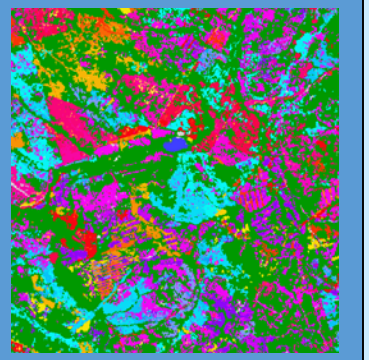
Whole Island burned



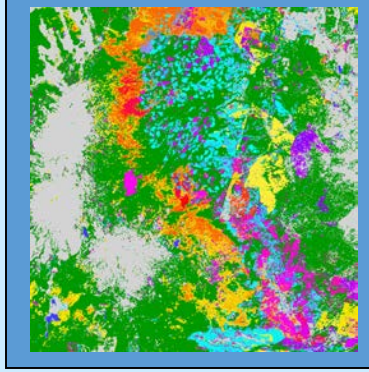
Severe wind blow-down

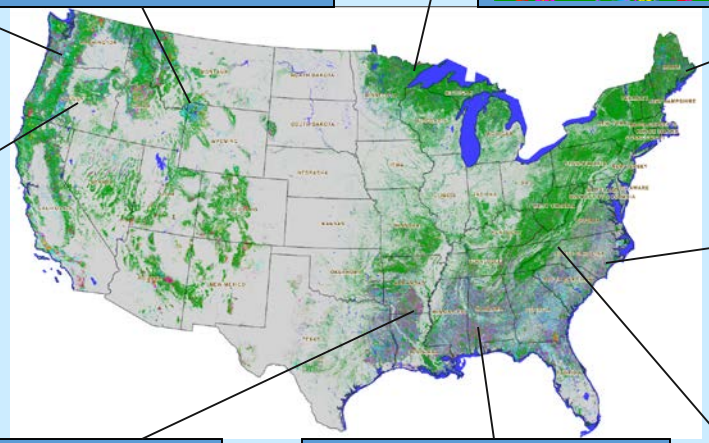


Logging industry

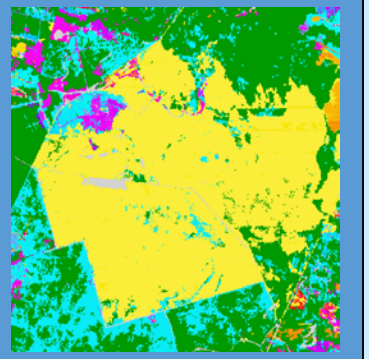


Fires and insects





Lightening induced fire



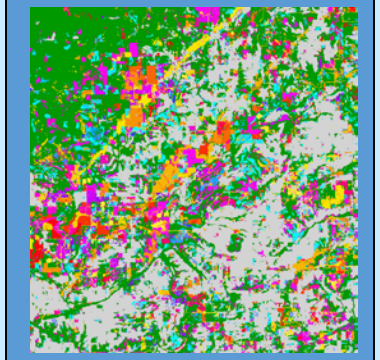
No change classes

- Persisting Nonforest
- Persisting Forest
- water

Disturbance year classes

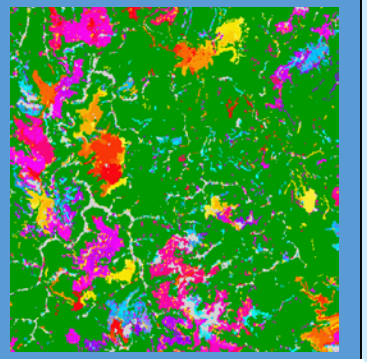
- Pre-observation
- 1985
- 1986
- 1987
- 1988
- 1989
- 1990
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011

Parallel tornados tracks



Intensive logging

Mountain top mining

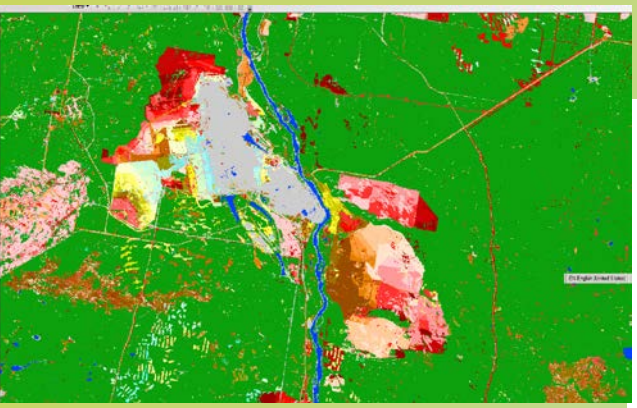


A Quarter Century History of US Forest Disturbances – NAFD-NEX Disturbance Product

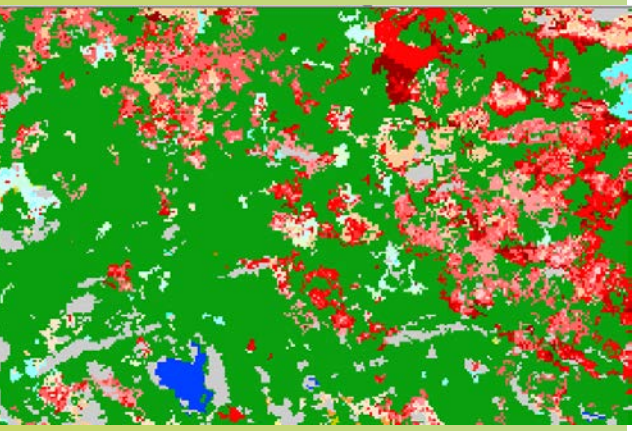
This NAFD-NEX product is distributed through ORNL DAAC.

US-Canada Forest Disturbance History Map

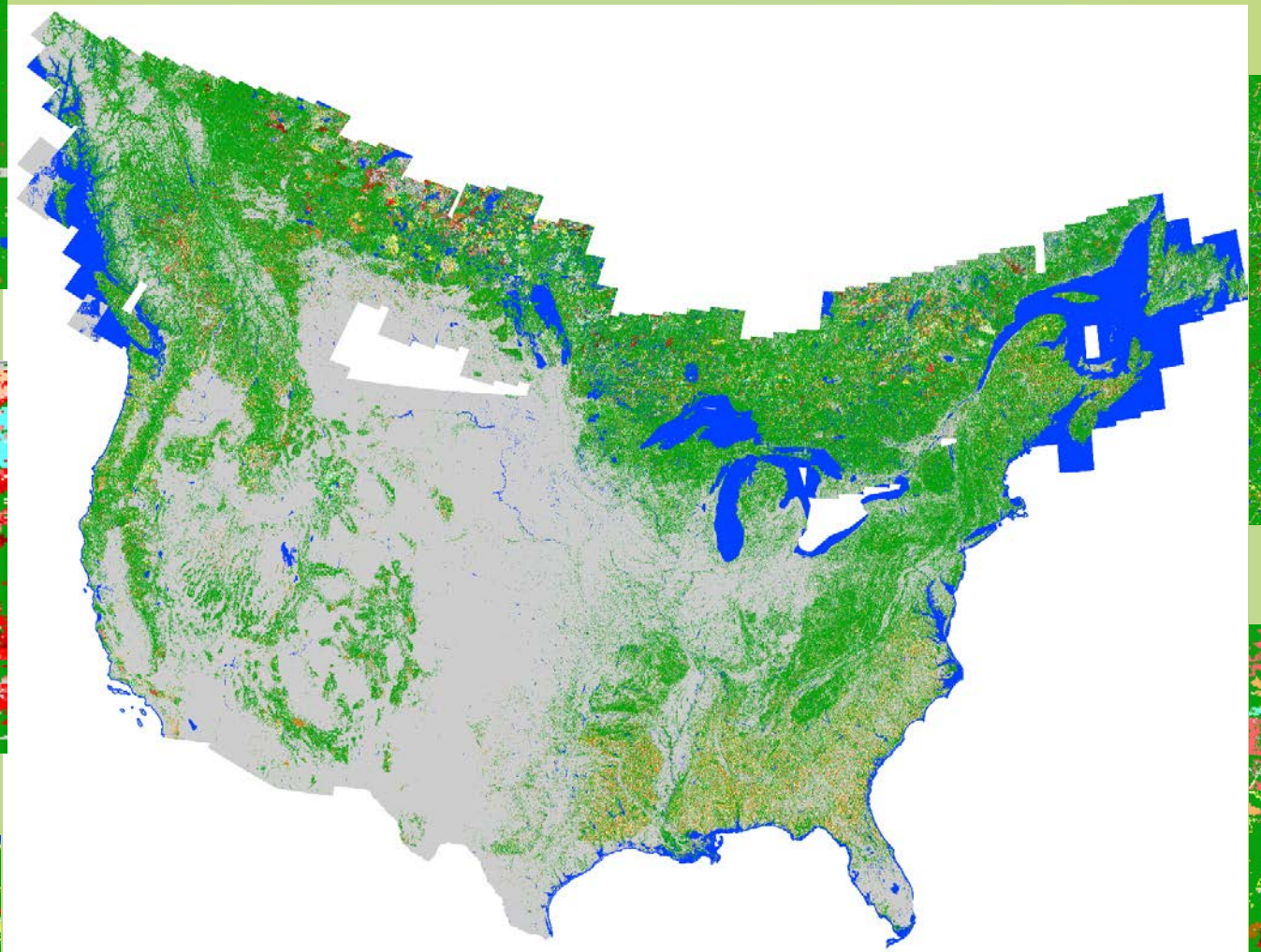
Sand oil exploration



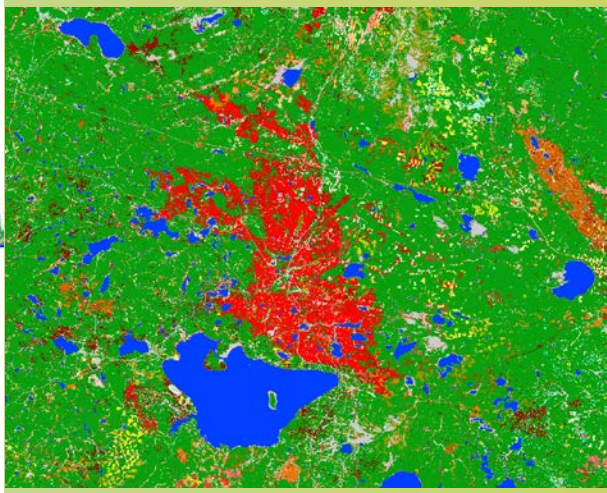
Beetle damage and salvage logging



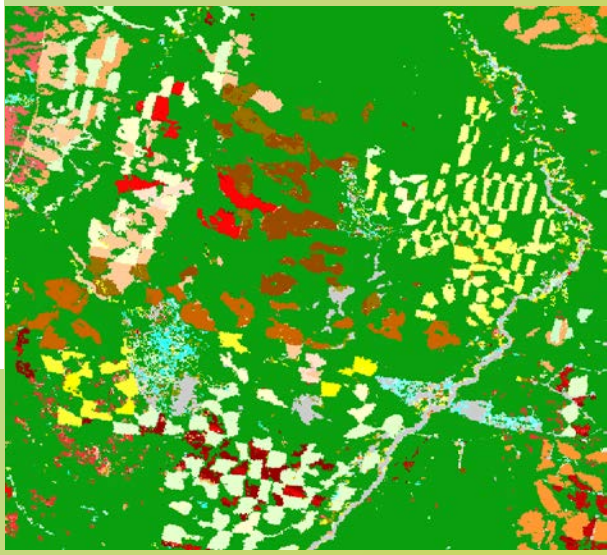
Urbanization



Fire



Harvest

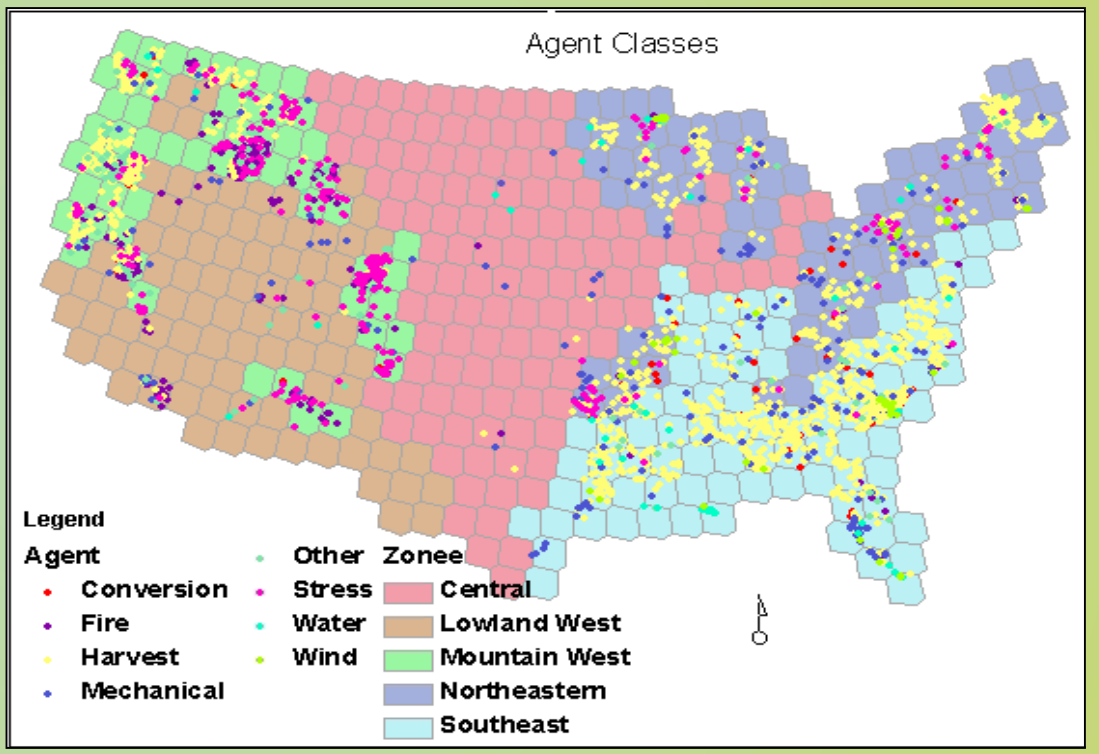


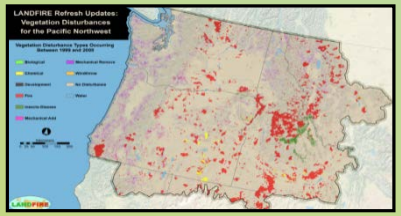
Attribution – Training Data

Probabilistic Sampling Design - 2 stage stratified random cluster

Response Classes:

- Harvest
- Wind
- Fire
- Stress *
- Conversion
- Other





- 7200 plots
- 30% FC * 1.5%$^{-yr}$ *25 yrs ~ 800 DF, but we got 1438 DF plots (Cohen et al. 2016)
- augmented with 560 disturbance plots from Pilot study

(Schleeweis et al.)

Attribution – Predictor Variables

Multiple Landsat time-series change algorithms:

VCT (Huang et al 2010)

Shape-restricted splines (Meyer 2008, 2012)

MTBS (P/A)

MAGNITUDE :

VCT – FI,NDVI, B5, NBR

Shapes – FI,NDVI,B5,NBR

TEMPORAL PATTERNS:

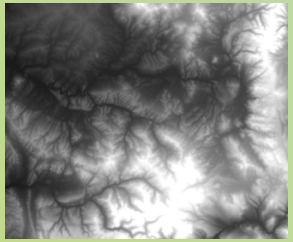
VCT- year, frequency,

Shapes FI,NDVI,B5,NBR– duration, pre-rate, Post-rate,

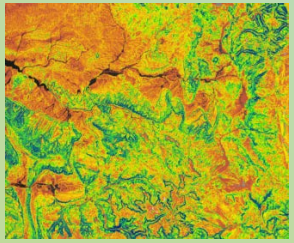
Spatial pattern (VCT):

VCT - Area, perimeter, shape index, fractal index

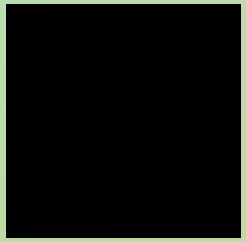
Elevation



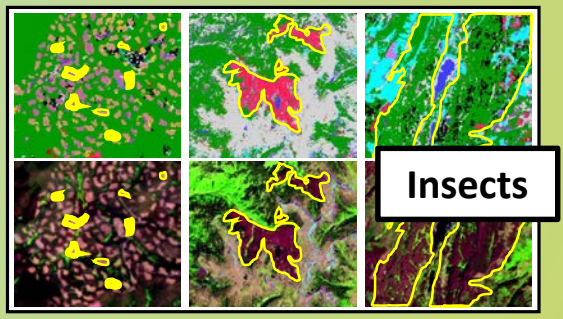
Slope



Cos Aspect



TOPOGRAPHY



DISTANCE TO:

- Roads, Navigable Waterways,
- Areas of housing density increases (Theobald 2004),
- ADS confidence/severity (Schleeweis 2013),
- Tornadoes tracks (NOAA)
- Hurricanes tracks (NOAA)

VEGETATION:

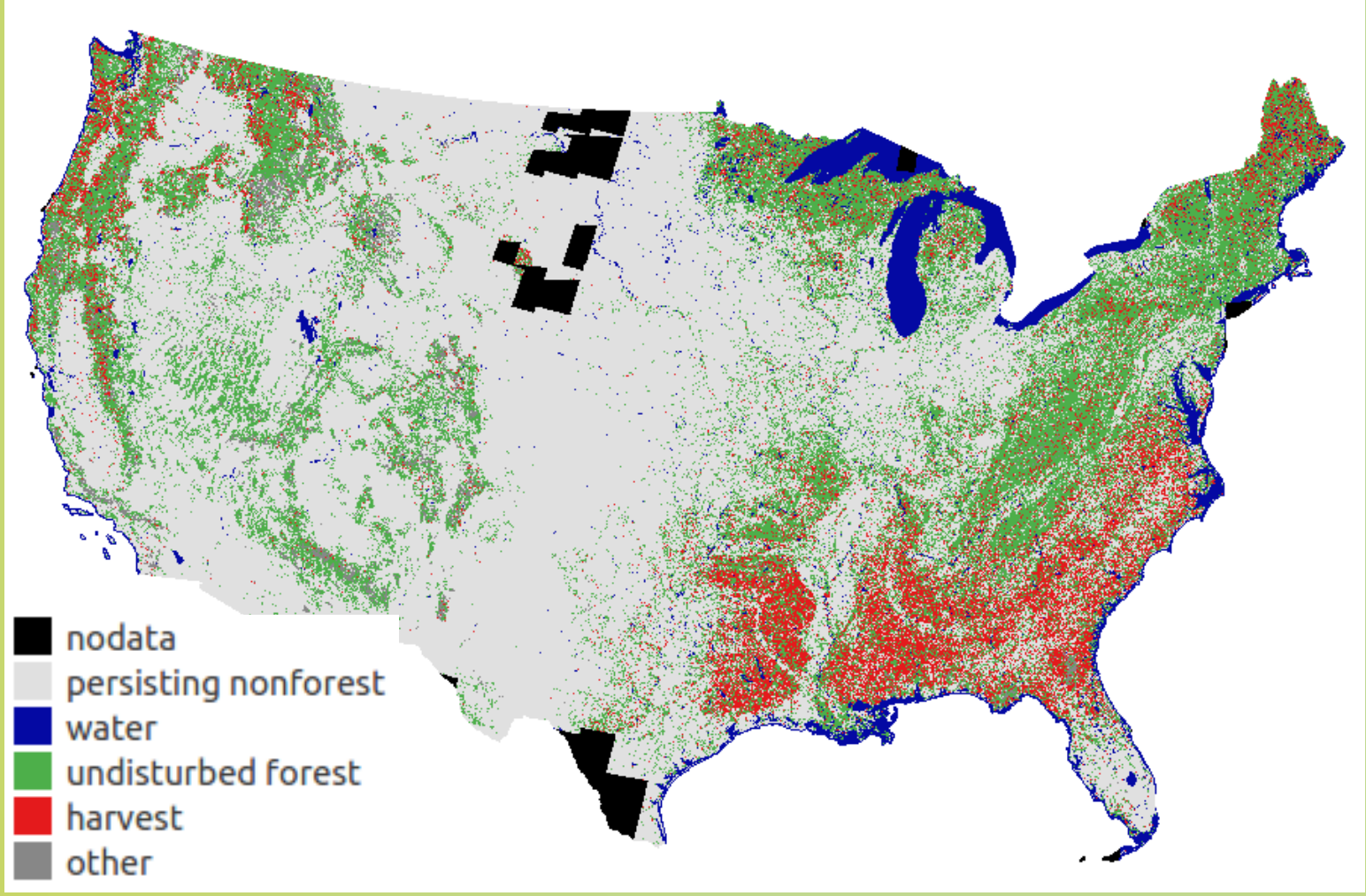
- Forest Probability (Blackard et al.)
- Forest Type Group (Ruefenacht et al.)

STATUS

- **GAP status**

(Schleeweis et al.)

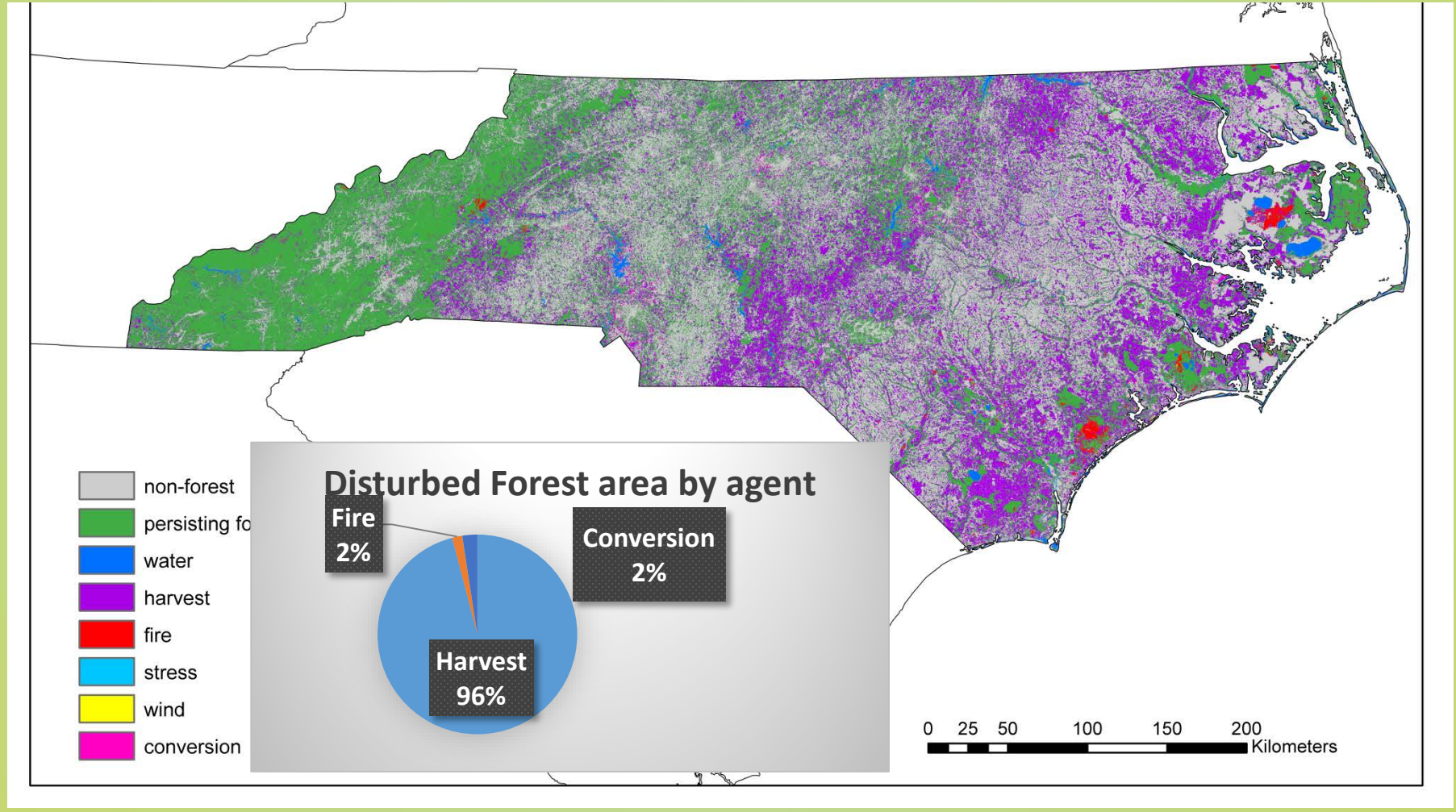
Preliminary US Forest Harvest Map



~25% of Forest land in CONUS harvested 1985-2010

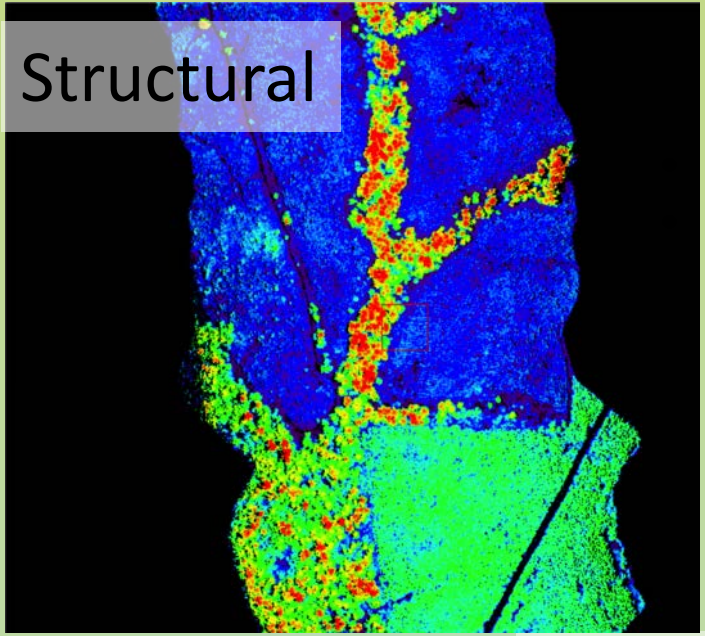
(Schleeweis et al.)

Satellite Observed Disturbance Dominated by Harvest in NC



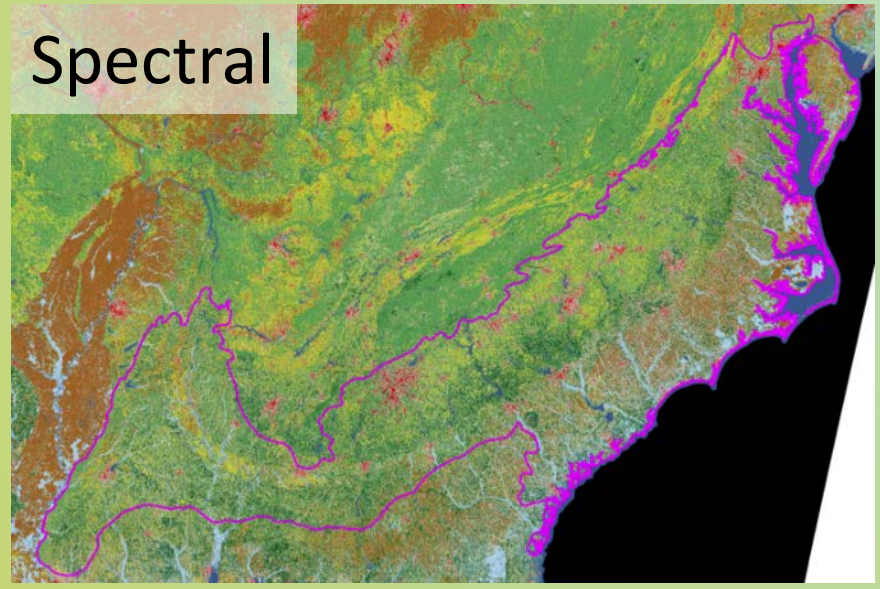
Fagan et al.

Methods: Mapping tree plantations



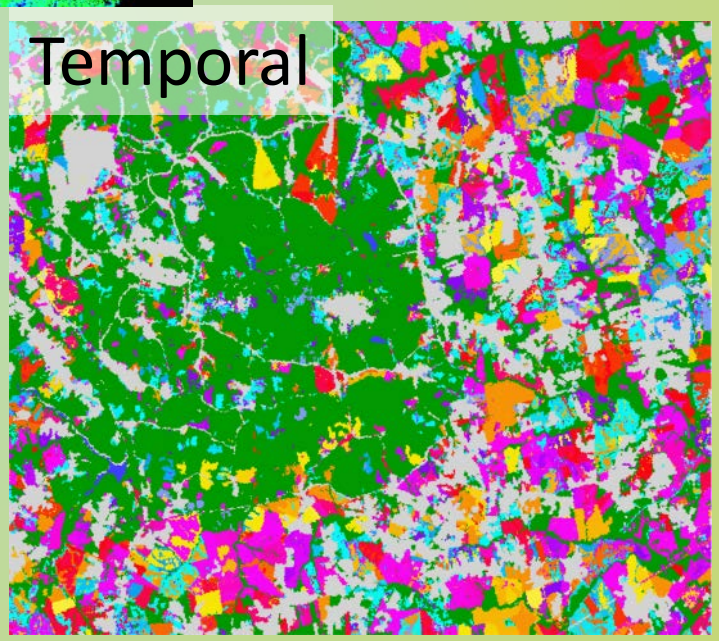
G-LiHT aerial LiDAR data
Metrics for 15 m bins

- Canopy variability
- Canopy shape
- Understory cover
- Forest cover



- National Land Cover Database (NLCD)
- NDVI (2011 summer-winter, texture)
- LiDAR reflectance

+



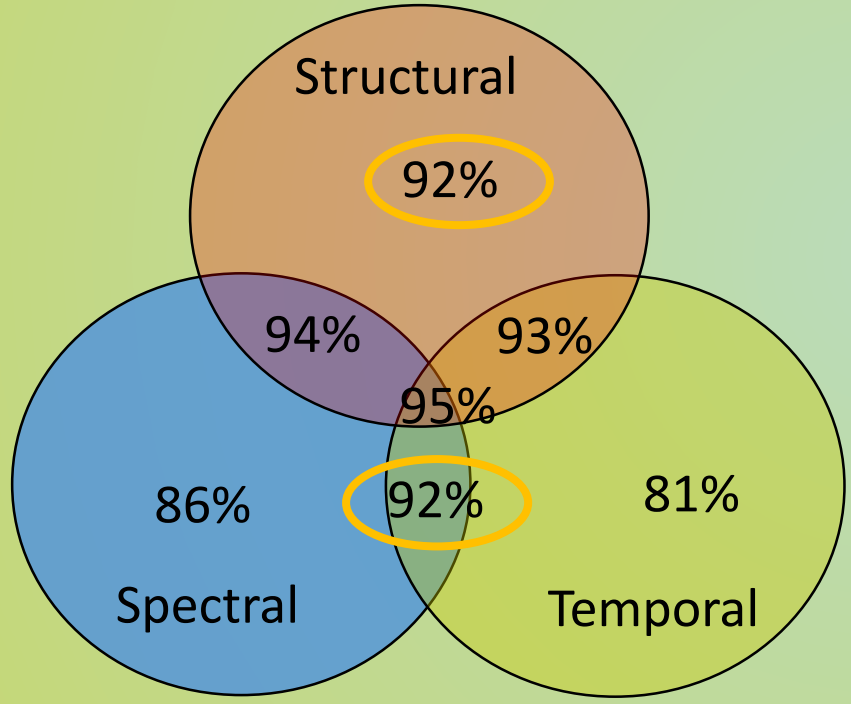
- Vegetation Change Tracker (VCT), 1985-2011
- Hansen Forest Change data, 2000-2013

Fagan et al., in prep

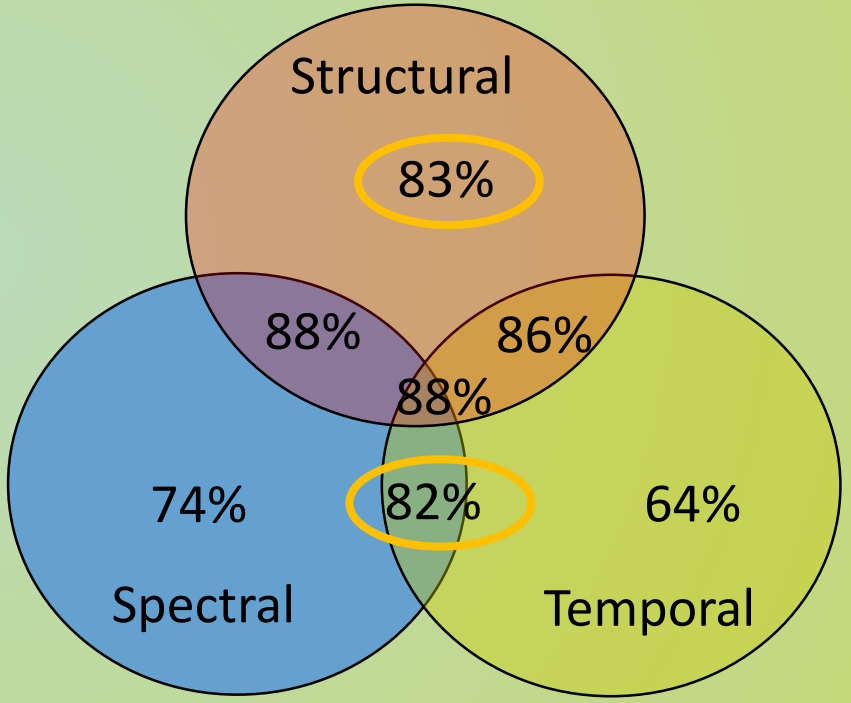
Fagan et al.

LiDAR-derived structure is a key predictor, across the different classification models

Overall accuracy



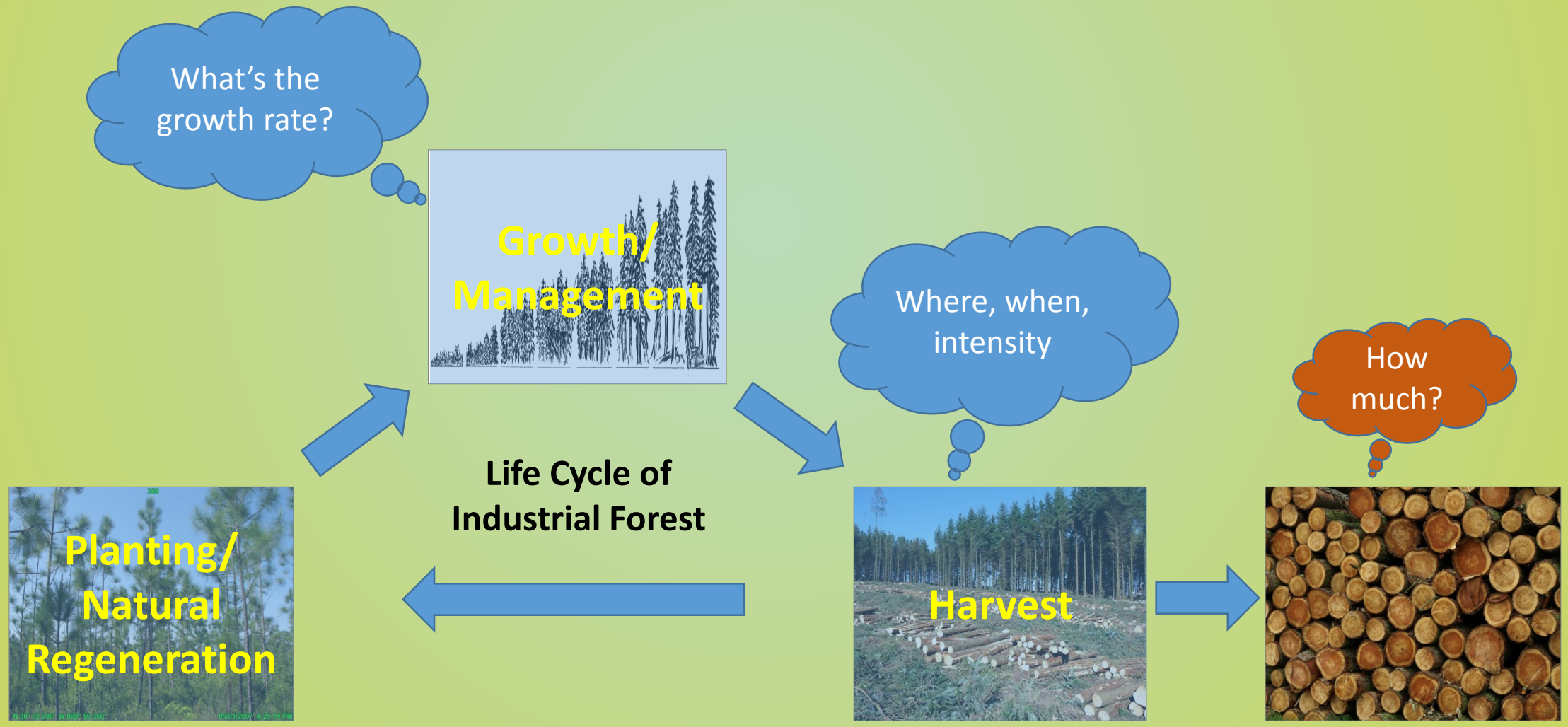
Pine plantation class accuracy



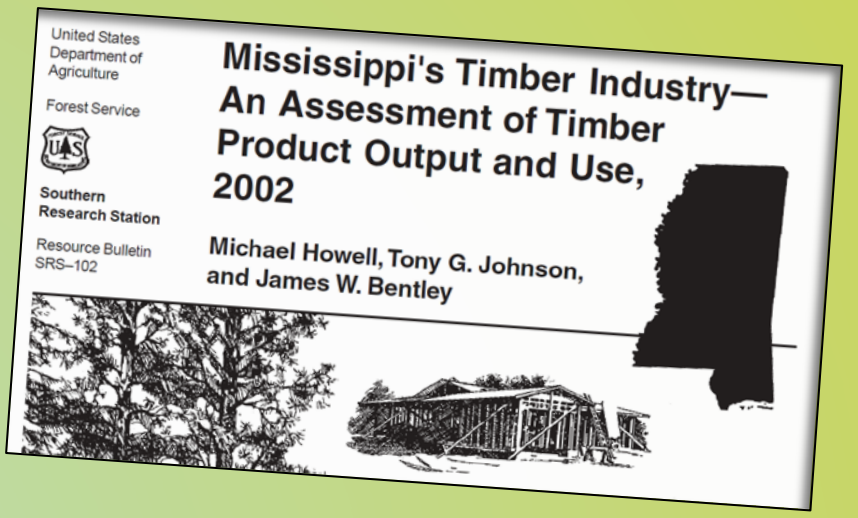
But the combination of spectral-temporal predictors is comparable!

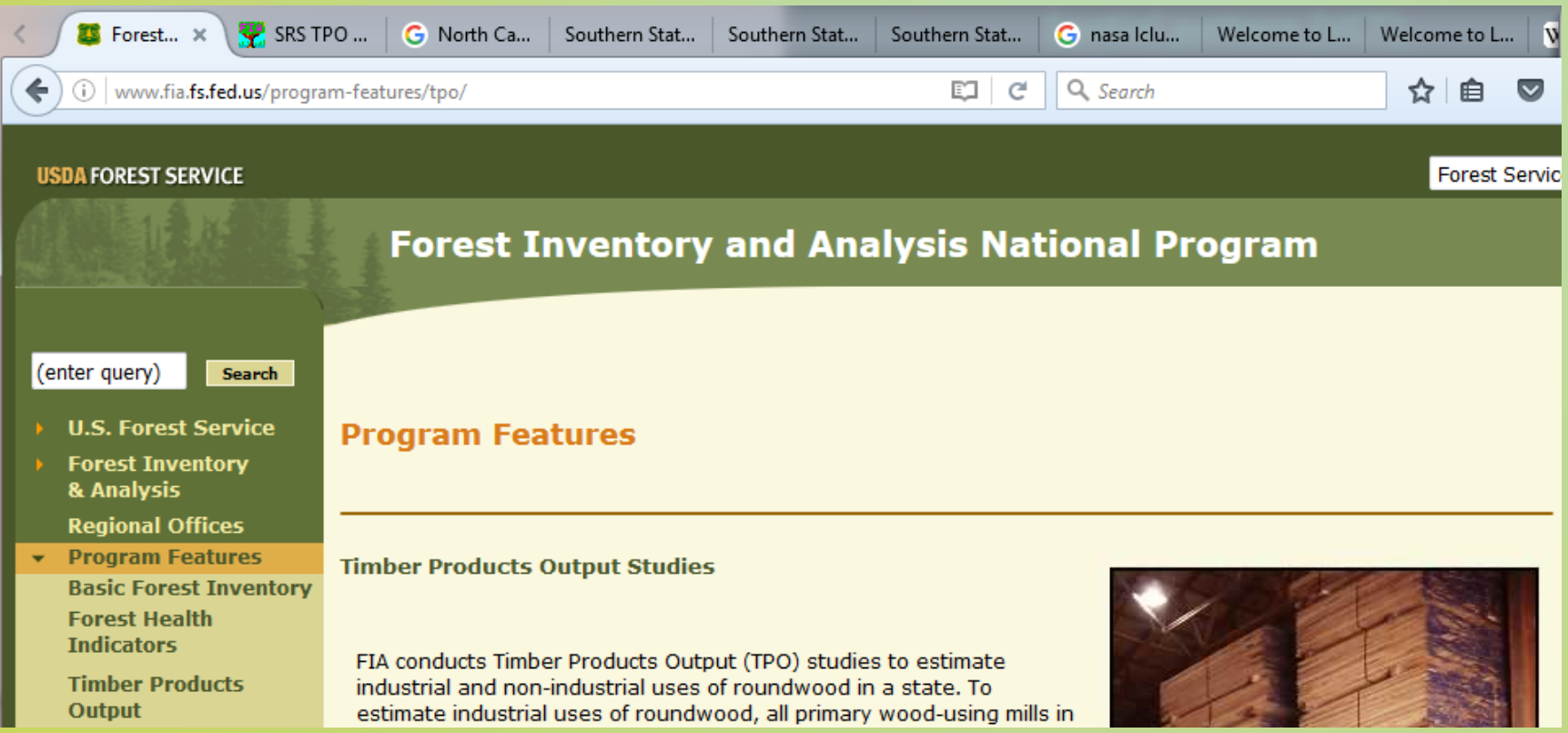
Fagan et al., in prep

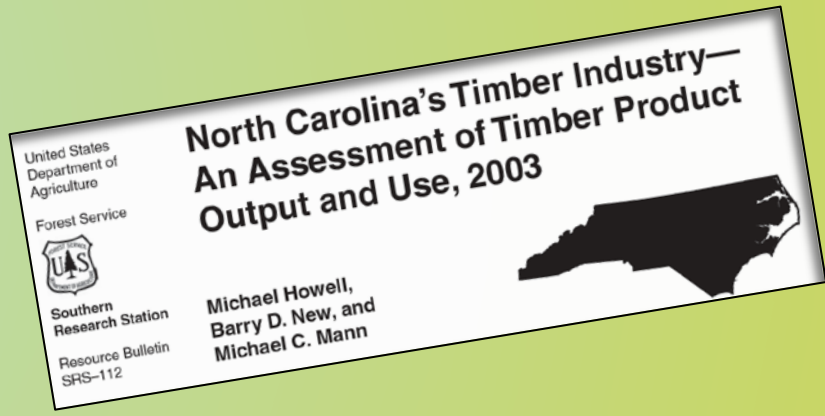
Key Assessment Questions

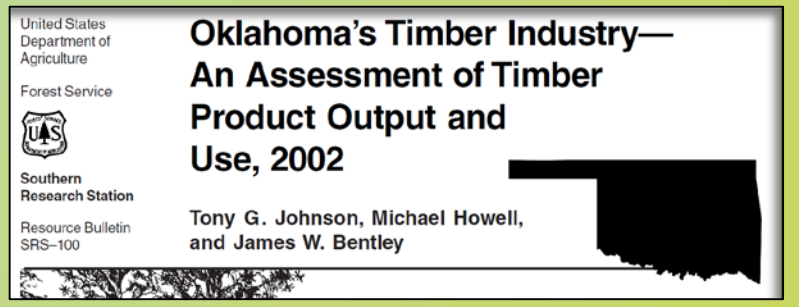


Survey Based Timber Volume Estimates









Availability of USFS TPO Data Limited & Inconsistent

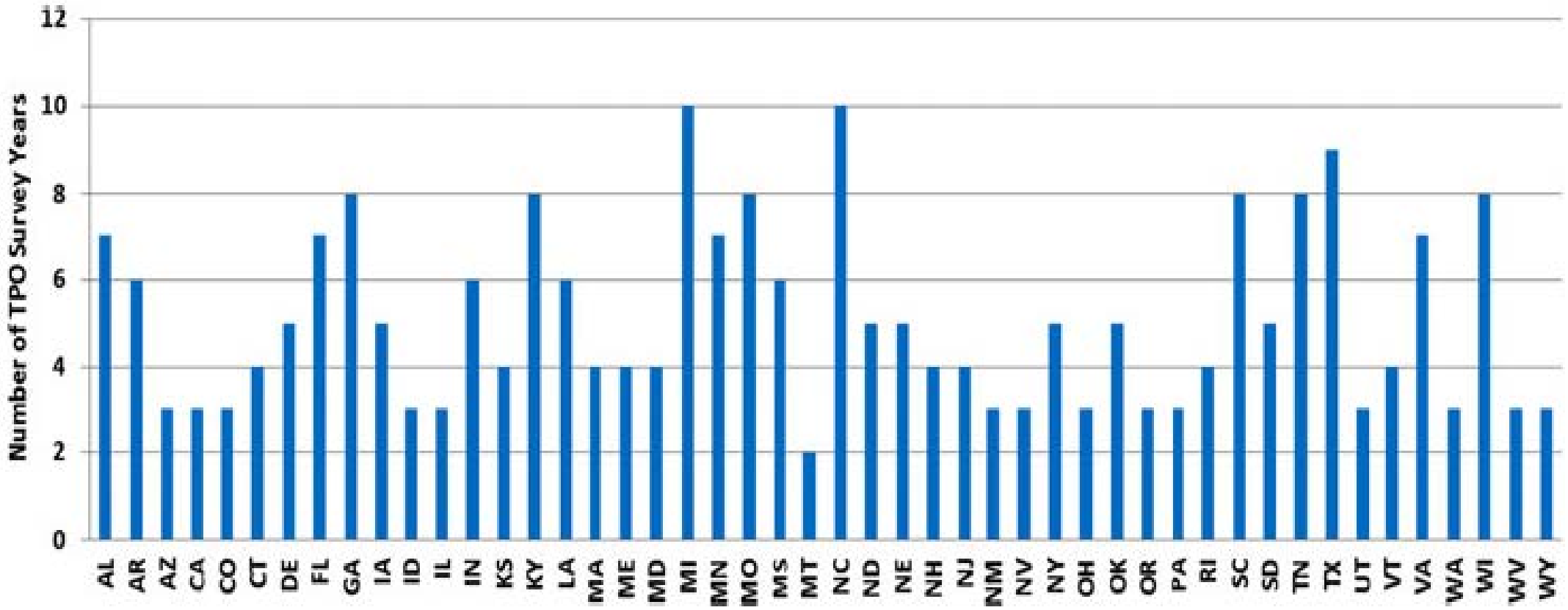
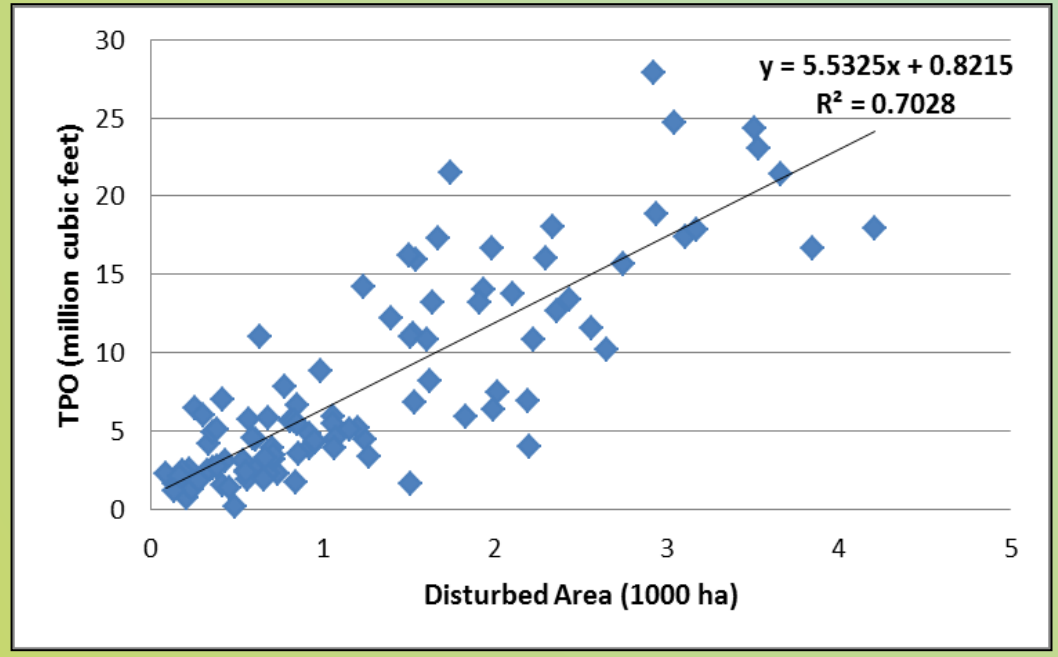
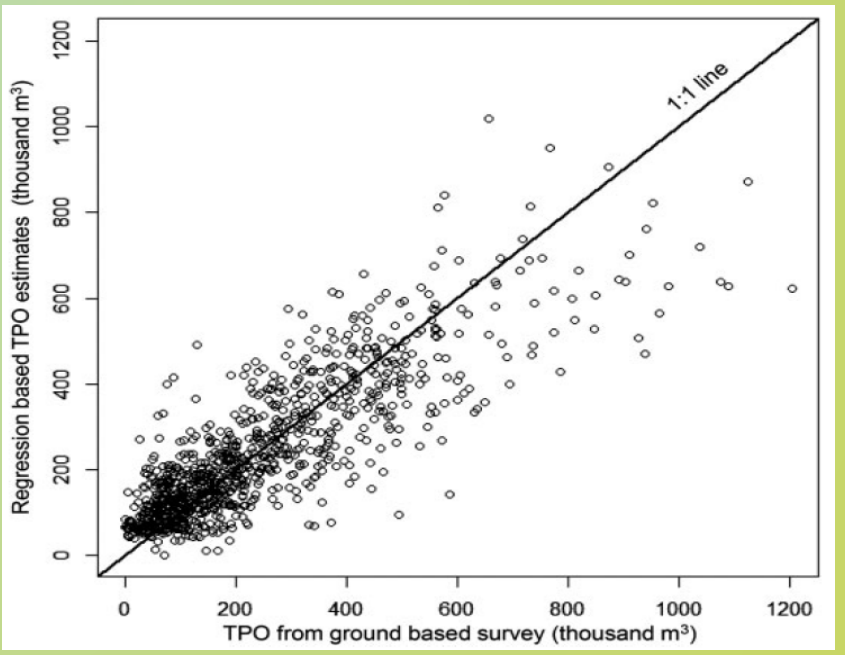


Figure 1. Number of years for which ground-based TPO survey data exist in the conterminous USA (updated as of June 2013).

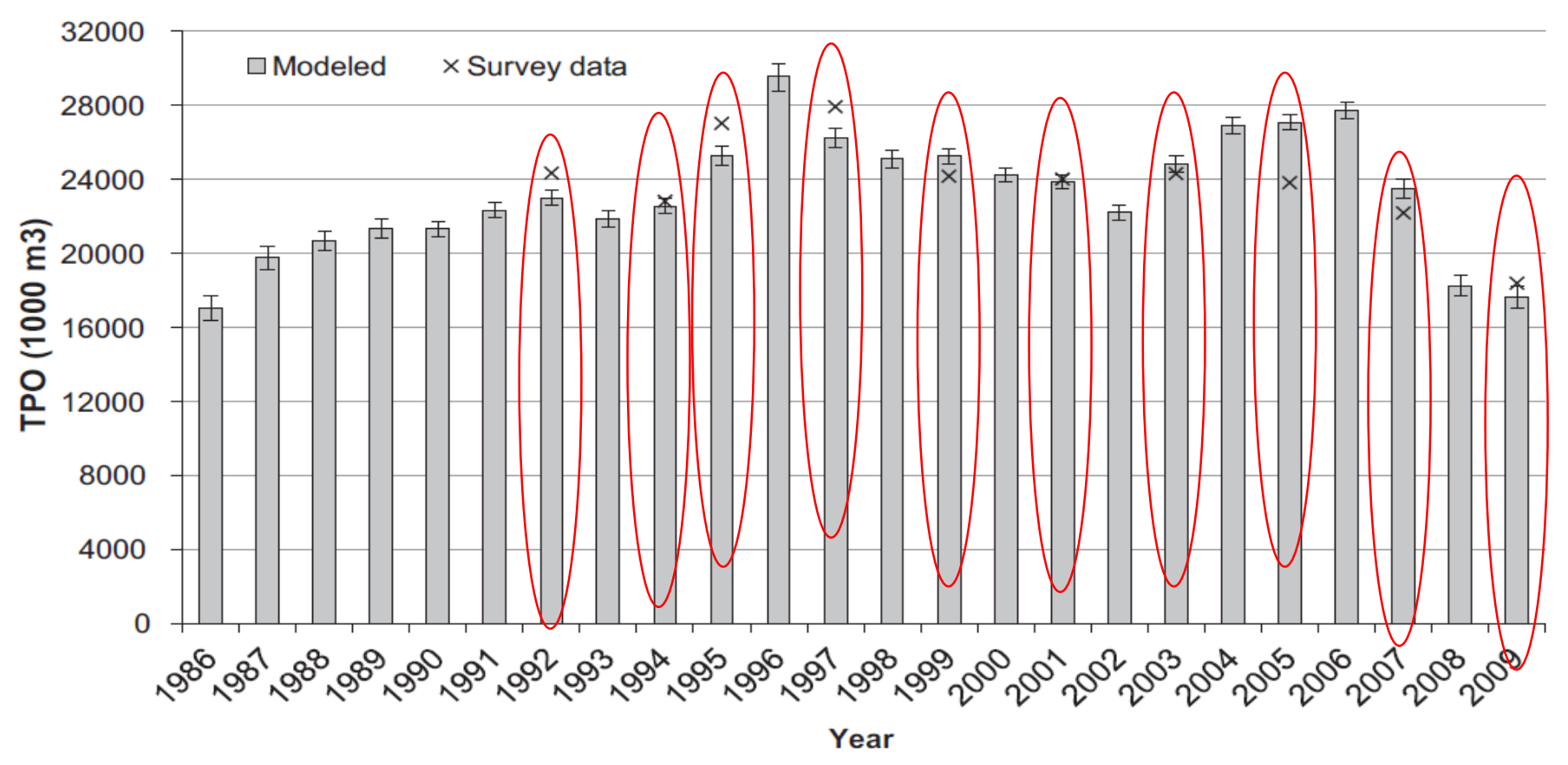
Establish Annual TPO Record Using Landsat-Based Disturbance/Harvest History

- TPO correlated with disturbance data
  - Establish TPO-disturbance model based on available TPO survey data
  - Apply model to all years covered by disturbance data



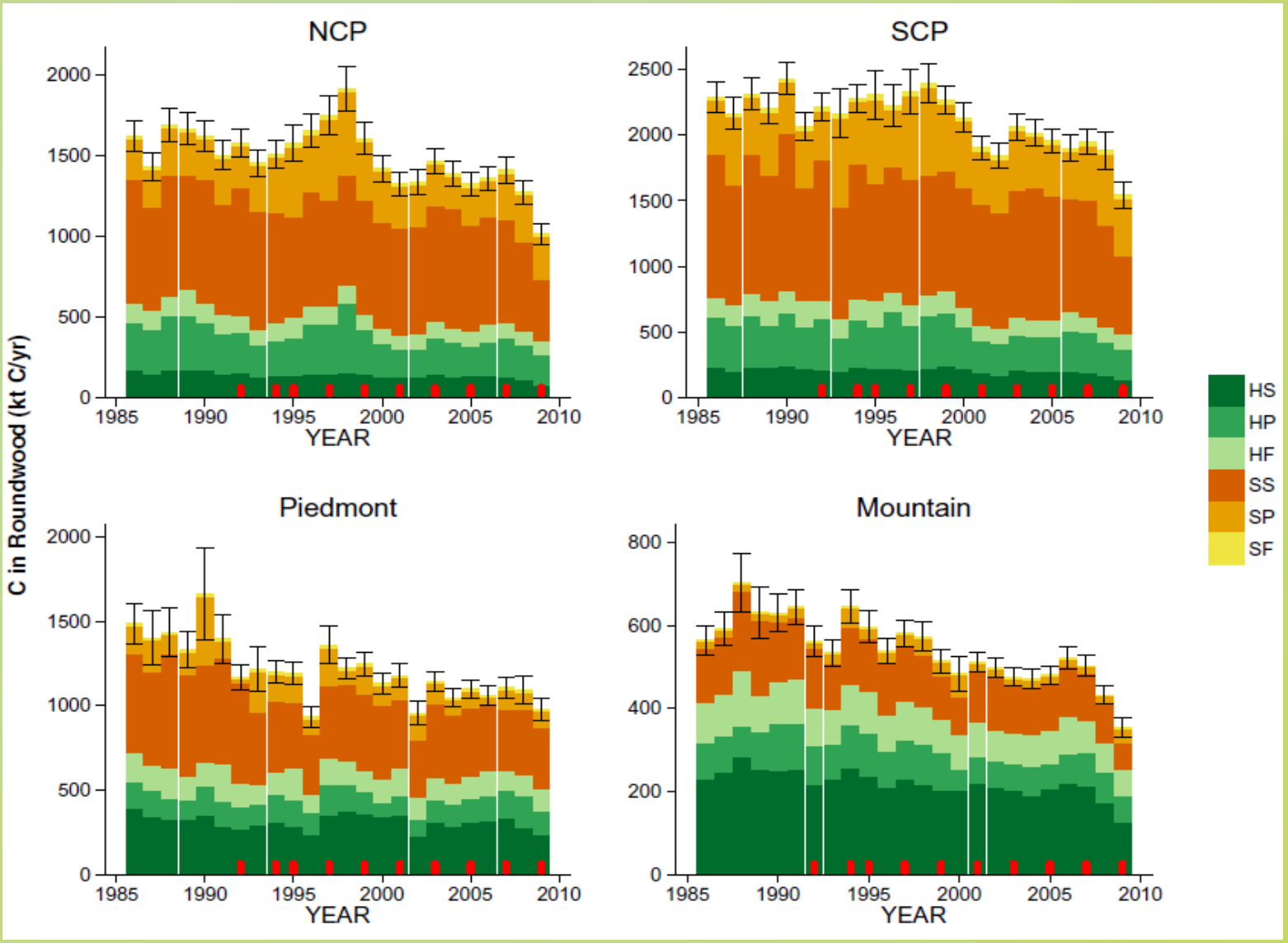


An Annual TPO Record for NC



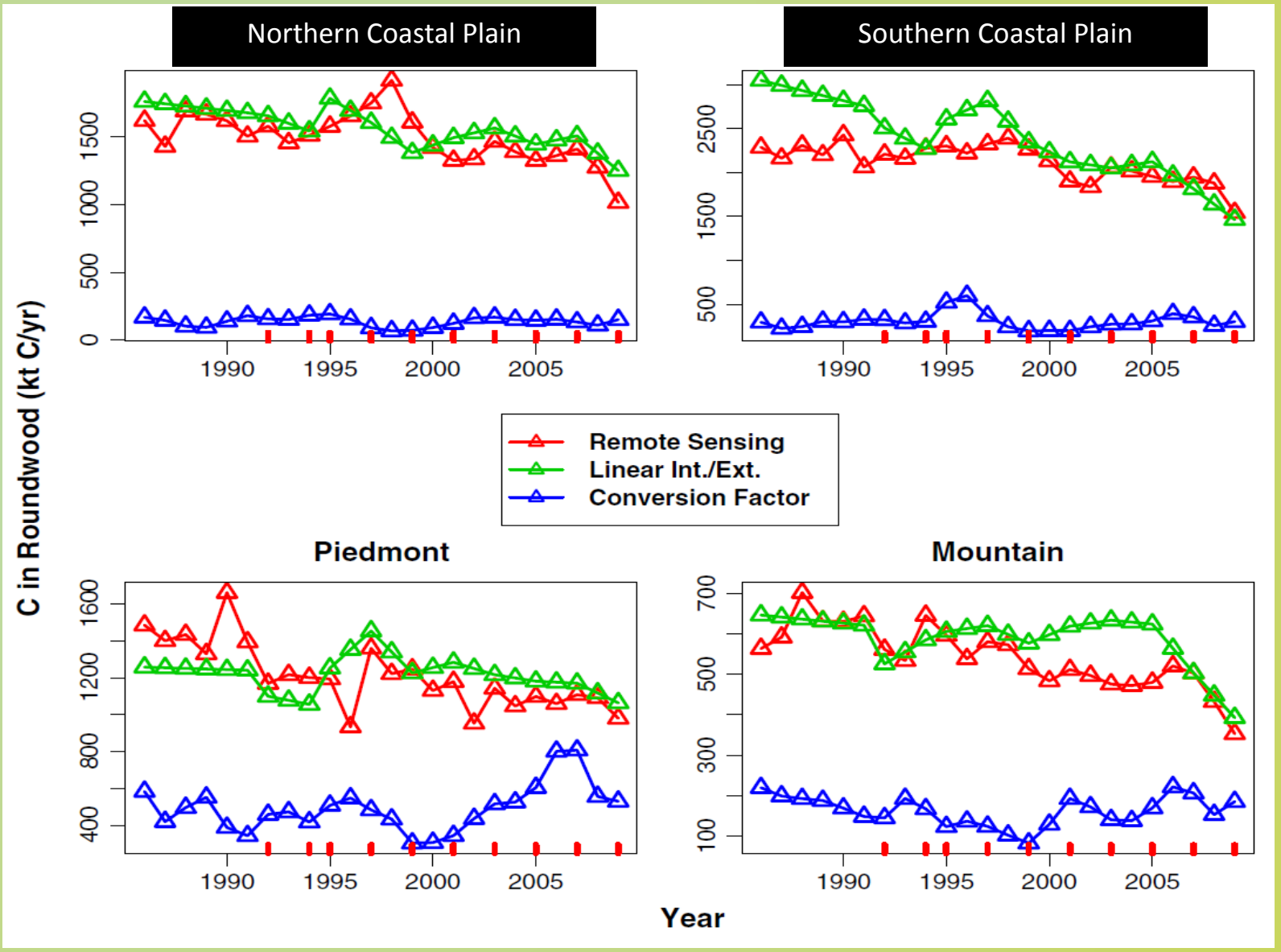
Huang, C., Ling, P.-Y. and Zhu, Z., 2015. North Carolina's forest disturbance and timber production assessed using time series Landsat observations. International Journal of Digital Earth, 1-23.

Estimation of C in Different Species of Wood Products



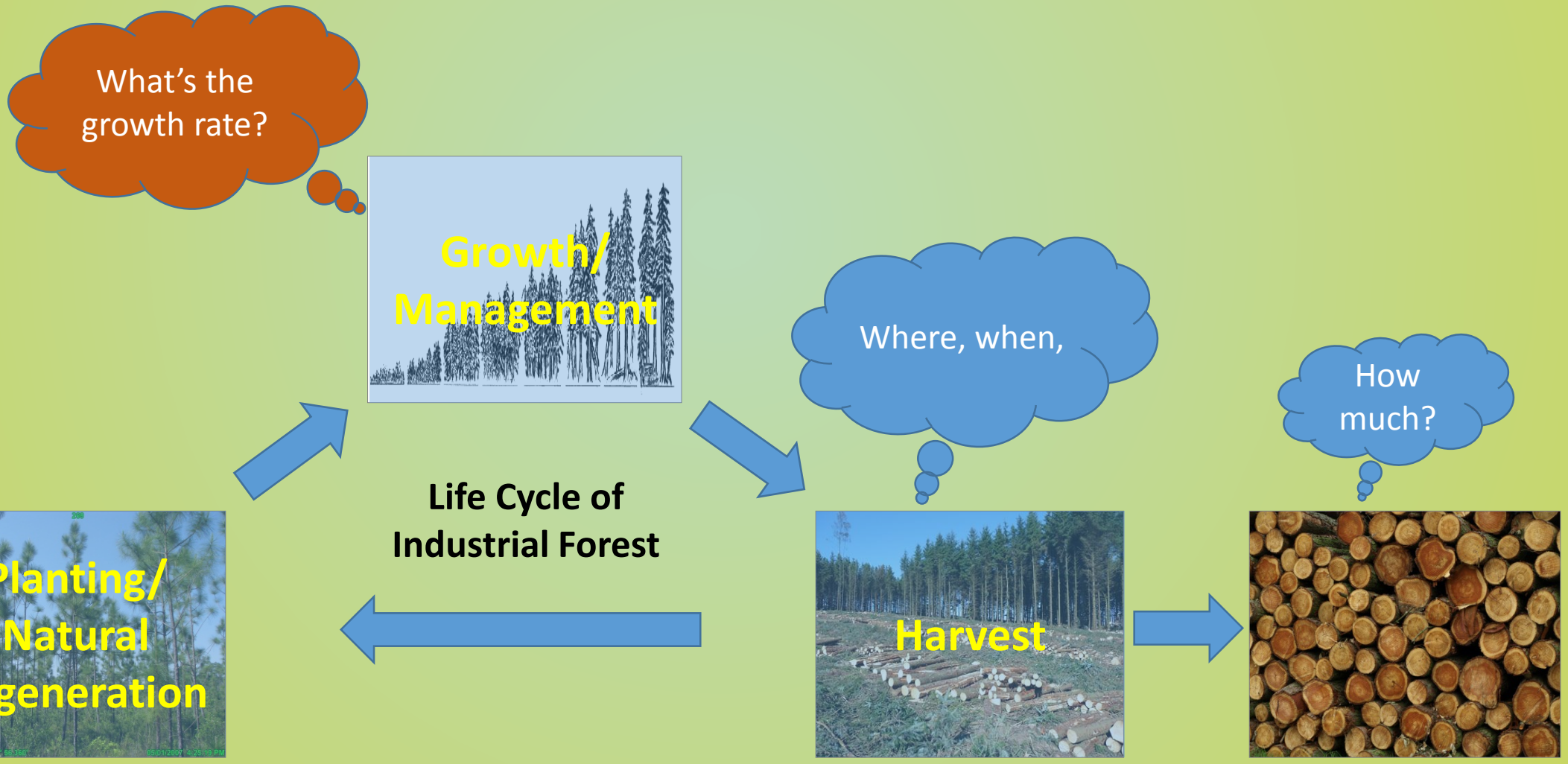
(Ling et al., 2016, DOI 10.1007/s10584-015-1510-3)

Disturbance-Based Estimate of C in Wood Products Likely More Realistic



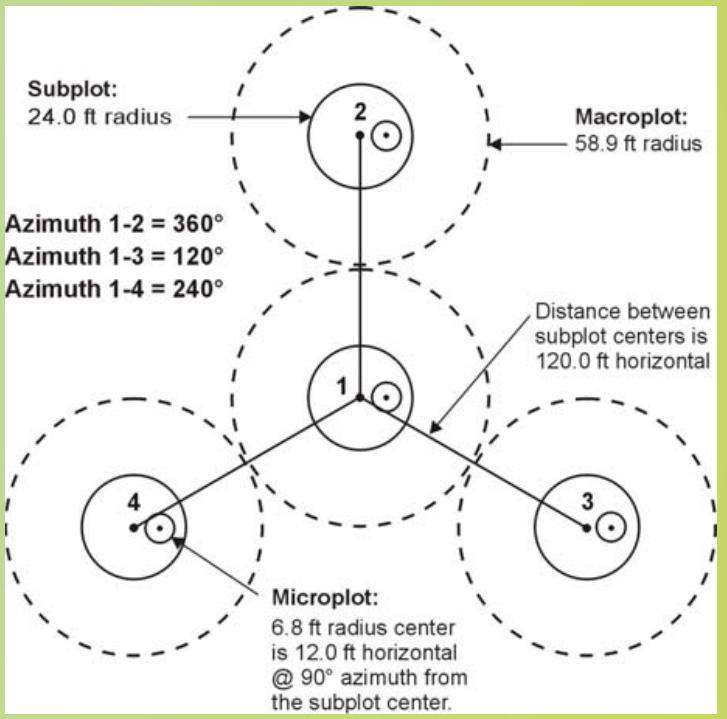
(Ling et al., 2016, DOI 10.1007/s10584-015-1510-3)

Key Assessment Questions



Use FIA Data to Quantify Disturbance Intensity and Regrowth Rate

- FIA plots
  - Standardized since 2000
  - Distributed across CONUS at 5 km intervals
  - Revisited once every 5 years in eastern US and every 10 years in Western US
  - Most plots measured at least twice since 2000
    - Disturbance intensity
    - Growth rates
- Link field measurements to satellite based disturbance data
  - Need to tease out errors in the FIA data
  - Some remeasurements may not be from the same location



FIA Plot Design

More to come, thanks to the support of this great program