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

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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

- What’s the growth rate?
- Where, when, intensity
- How much?

Growth/Management

Life Cycle of Industrial Forest

Planting/Natural Regeneration

Harvest
Study Area

• US
  • Private land
  • Some public land subject to industrial logging (e.g., national forest)

• Canada: timber tenure
Overall Approach

Where, when, intensity

How much?

What's the growth rate?

Landsat Time Series Stacks (LTSS)


Vegetation Change Tracker (VCT)

Year index (1984)

Annual index

(Year: 09)

(Year: 09)

Disturbance

Permanent forest

North Carolina

Field data

Attribution

TPO

FIA
Vegetation Change Tracker (VCT)

Major Outputs:
- Disturbance year
- Disturbance intensity
- Whether and when growth back

(Huang et al., 2010)
US-Canada Forest Disturbance History Map

Legend
- Unclassified
- Persisting Nonforest
- Persisting Forest
- Water
- Pre-1985

Pre-1985: Beetles, damage, salvage logging
Sand oil exploration
Urbanization
Harvest
Fire
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.)
Multiple Landsat time-series change algorithms:

- **VCT** (Huang et al. 2010)
- Shape-restricted splines (Meyer 2008, 2012)
- **MTBS** (P/A)

**TOPOGRAPHY**

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

**SOUTHERNITY**

**MAGNITUDE:**
- VCT – 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

**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

Disturbed Forest area by agent:
- Harvest: 96%
- Conversion: 2%
- Fire: 2%
Methods: Mapping tree plantations

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

Spectral

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

Structural

- G-LiHT aerial LiDAR data
- Metrics for 15 m bins
  - Canopy variability
  - Canopy shape
  - Understory cover
  - Forest cover

Temporal

Fagan et al., in prep
LiDAR-derived structure is a key predictor, across the different classification models

But the combination of spectral-temporal predictors is comparable!
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Survey Based Timber Volume Estimates

Forest Inventory and Analysis National Program

Program Features

Timber Products Output Studies

FIA conducts Timber Products Output (TPO) studies to estimate industrial and non-industrial uses of roundwood in a state. To estimate industrial uses of roundwood, all primary wood-using mills in...
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

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)
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Where, when,

Harvest

How much?

Planting/Natural
Regeneration
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