Project Summary and Proposed Modification

# A Neural Network Approach to Generating Leaf Area Index Estimates Using the Sentinel-2 Satellite Record → Leaf Area Index Estimates to Inform Midrotation Treatments

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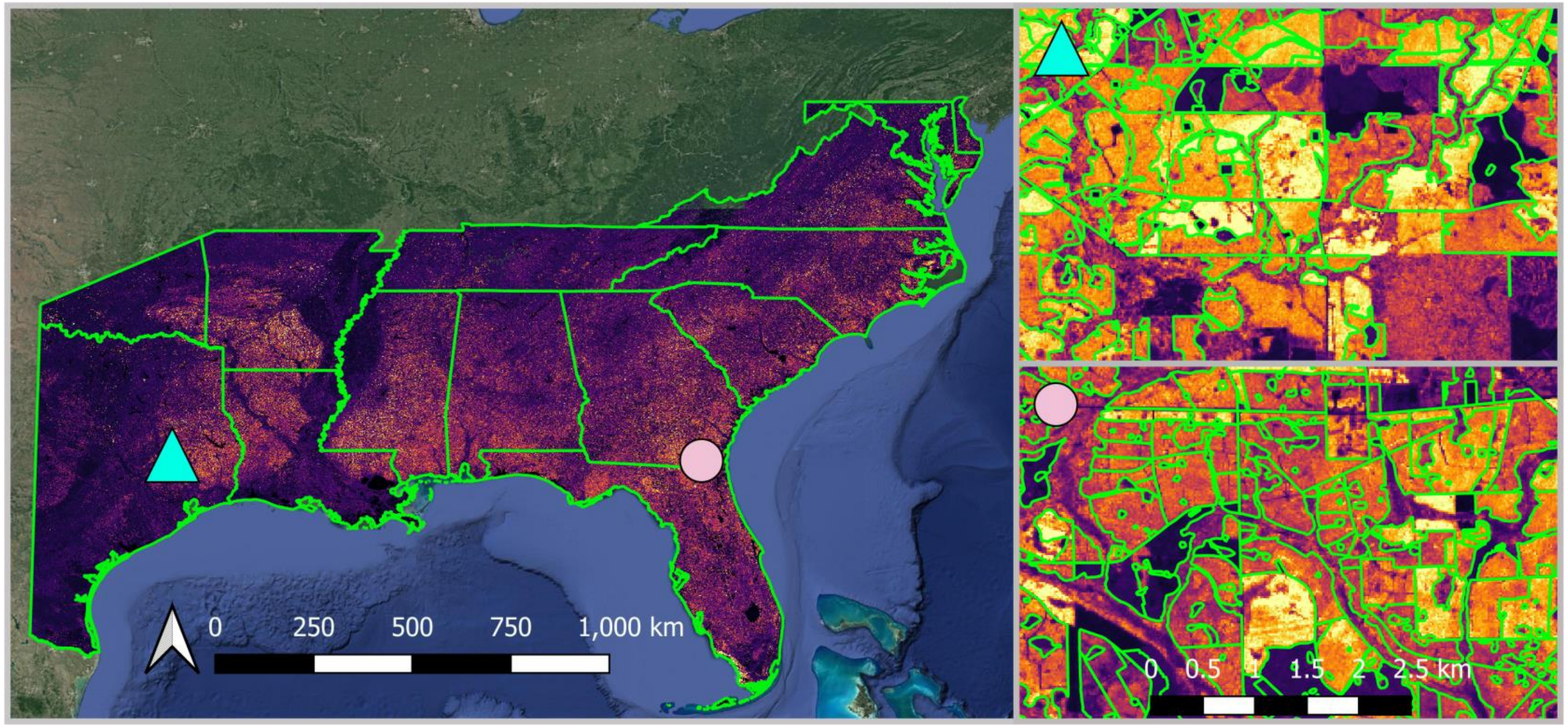
Project Code CAFS.21.87

Andrew Trlica presenting

# Modified Plan

- Use LAI model to develop potential productivity and response maps in conjunction with soils and climate data (Continued)
- Apply LAI tools to Midrotation silvicultural decisions
- Assess operational level response to herbicide and/or variable rate fertilization
- Use canopy LAI to make Fertilizer Rate decisions (vs Random rate)
- Assess response in canopy LAI due to changes in understory LAI
- Use repeat LiDAR flights (and ground truth data) to assess individual tree height and volume response to treatments

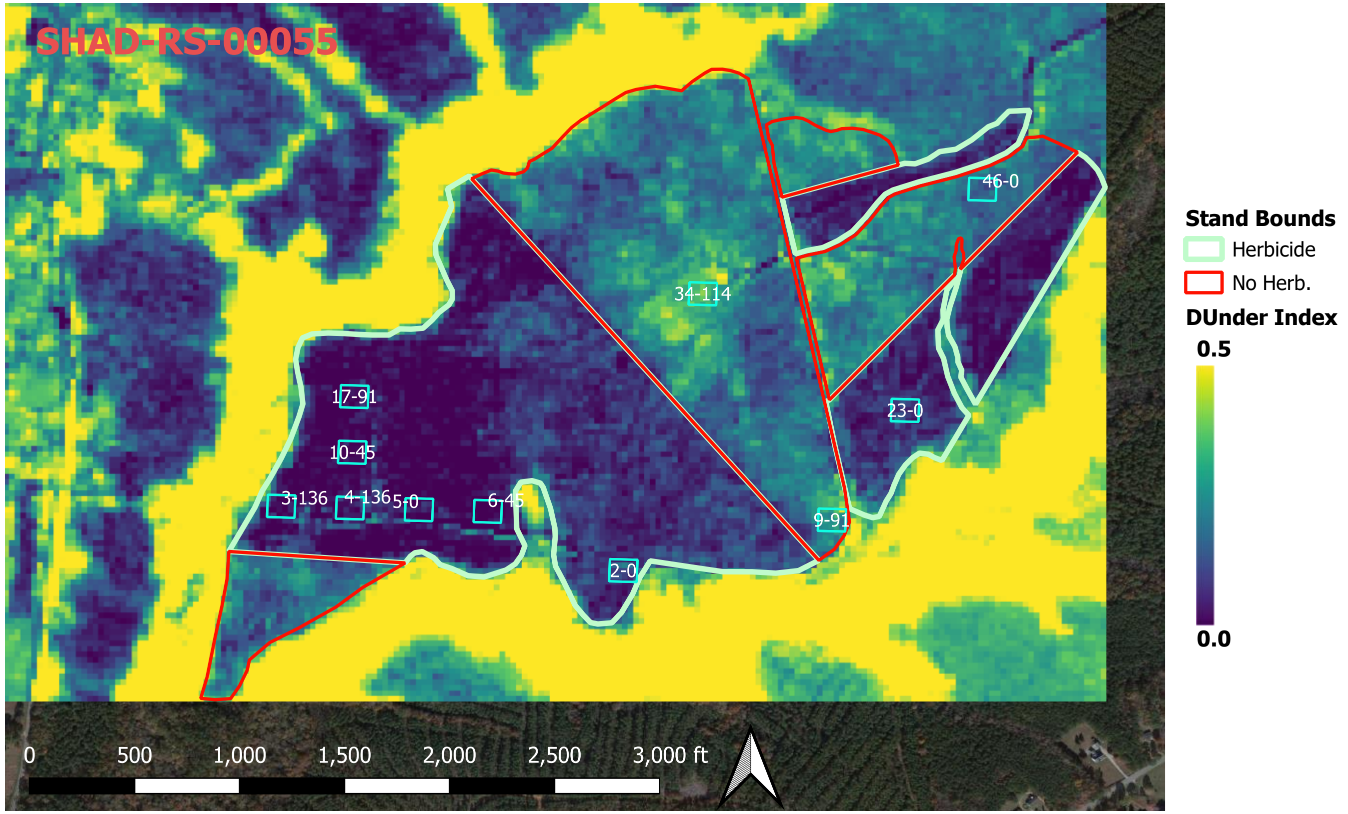
# Canopy LAI in Loblolly




- Use Earth Engine to produce wide-scale LAI estimates
    - Sentinel-2 10m
    - Landsat 7/8/9 30m
- LAI model improvements ongoing

Methods

# Deciduous Understory Quantification (Loblolly)

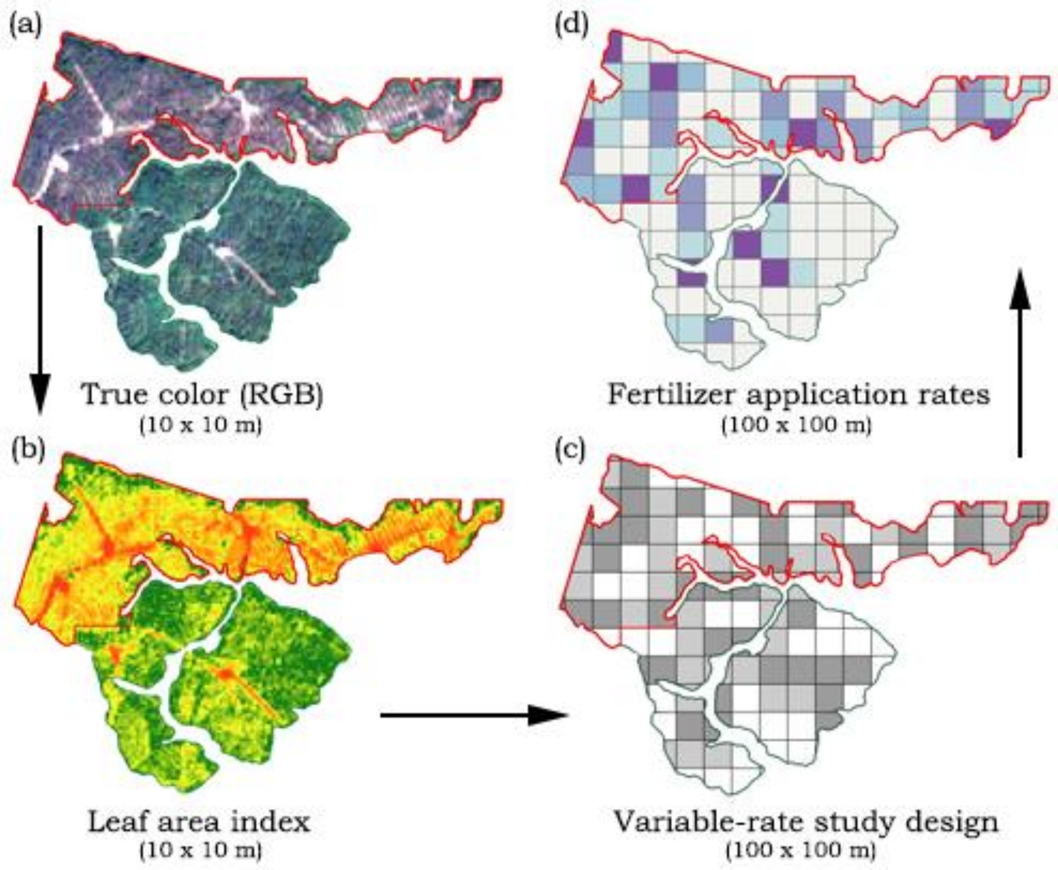



- Imagery based in EE like LAI
- Uses seasonal differences in green-up timing
    - Spring vs Winter

# Experimental Design

- Herbicide vs No Herbicide
- + Random application N (lb) + 10% P
  - 100
  - 200
  - 300
- OR: LAI-based rates of elemental N (lb/ac) + 10% elemental P

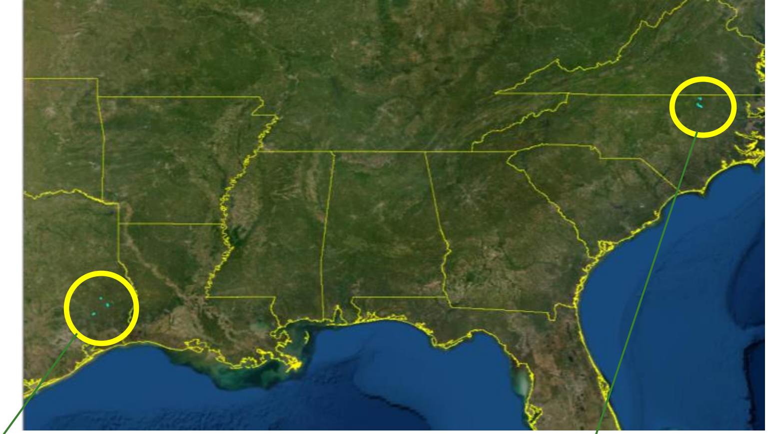
| LAI | N Rate lb/ac |
|---|---|
| >3.5 | 0 |
| 3.0-3.5 | 100 |
| 2.5-3.0 | 150 |
| 2.0-2.5 | 200 |
| 1.5-2.0 | 250 |
| 1.0-1.5 | 300 |

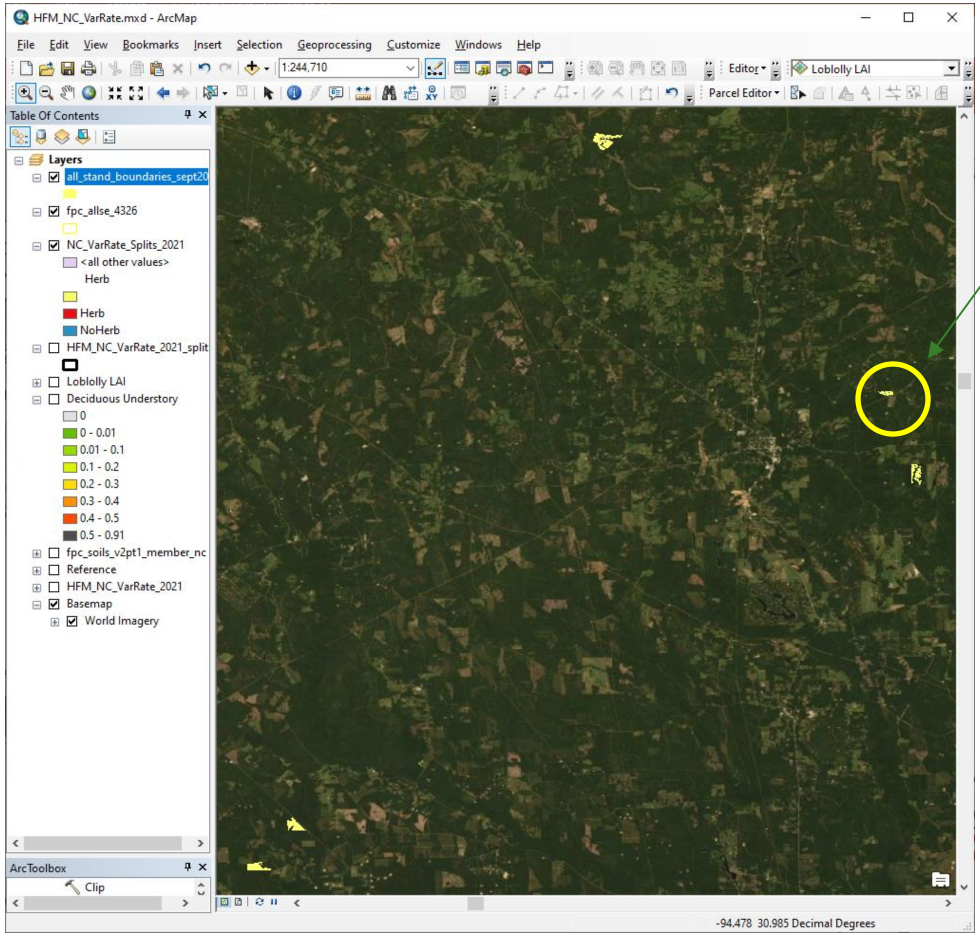



Treatments based on 1 ha grid

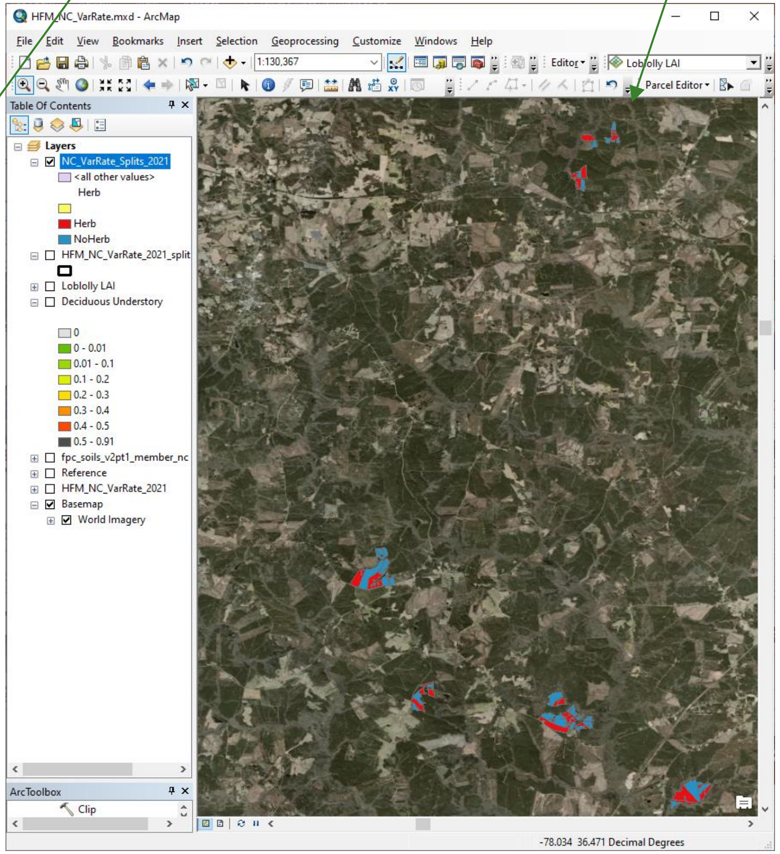
# Study Locations

## Methods






630 acres



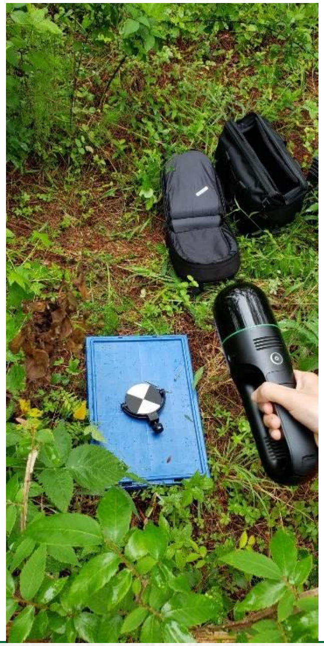

1500 acres

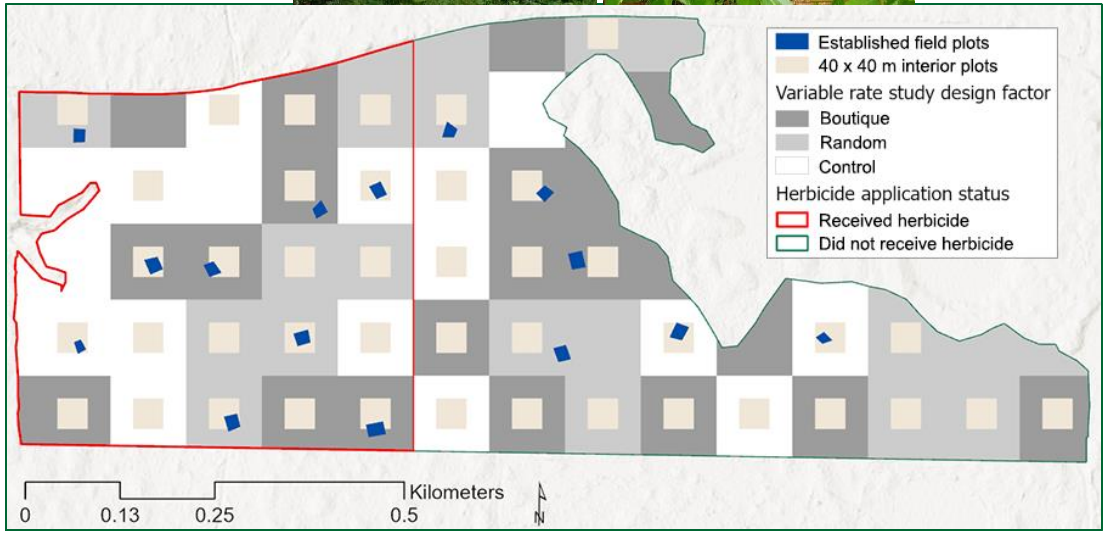
## Methods

# Field data collection

# Measurements taken:

- Diameter
- Height
- Height to live crown
- Understory metrics
    - total percentage of ground cover occupied by understory with living foliage
    - fraction evergreen and/or deciduous
    - max & mean heights

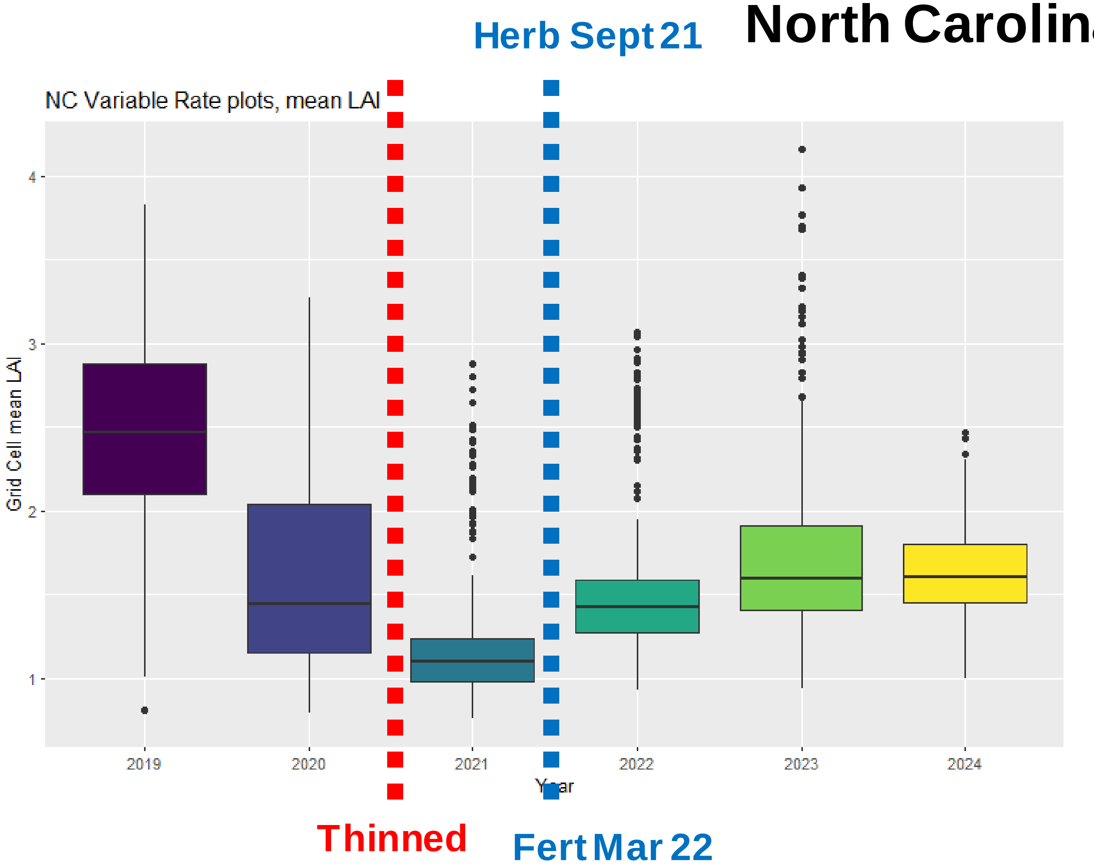


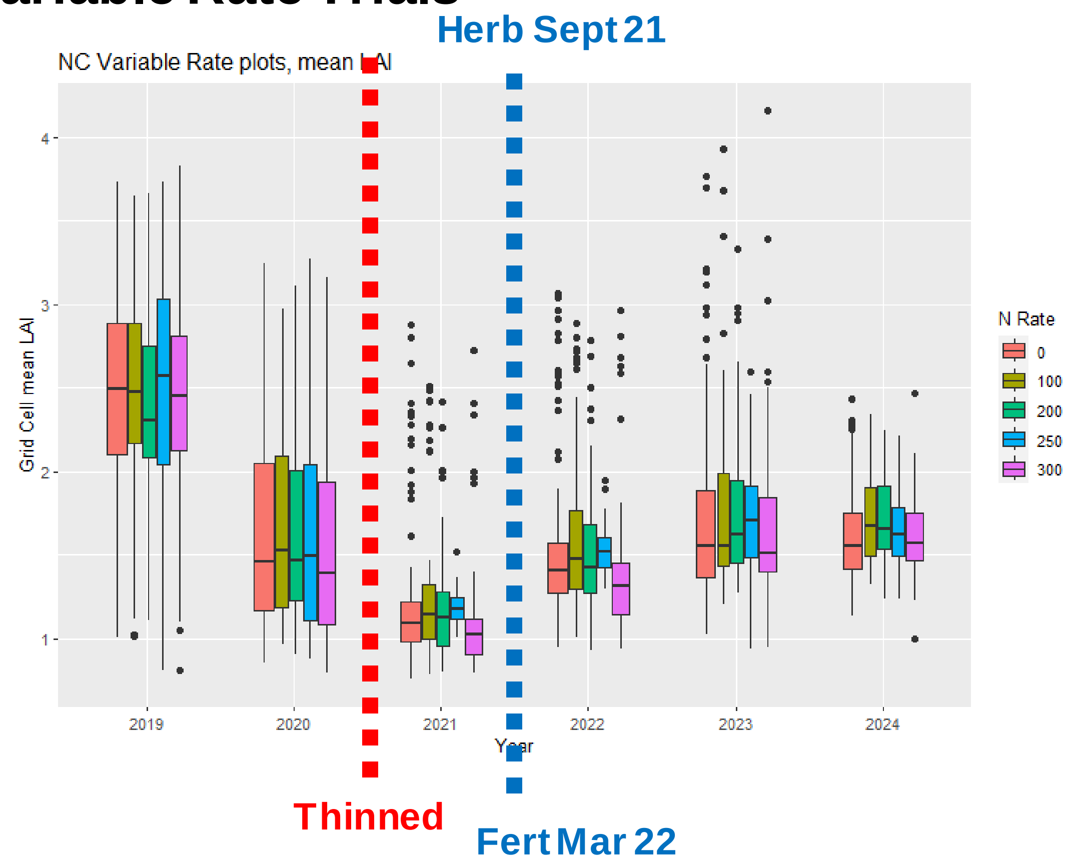


# Major Findings

# Canopy LAI response

## North Carolina Variable Rate Trials

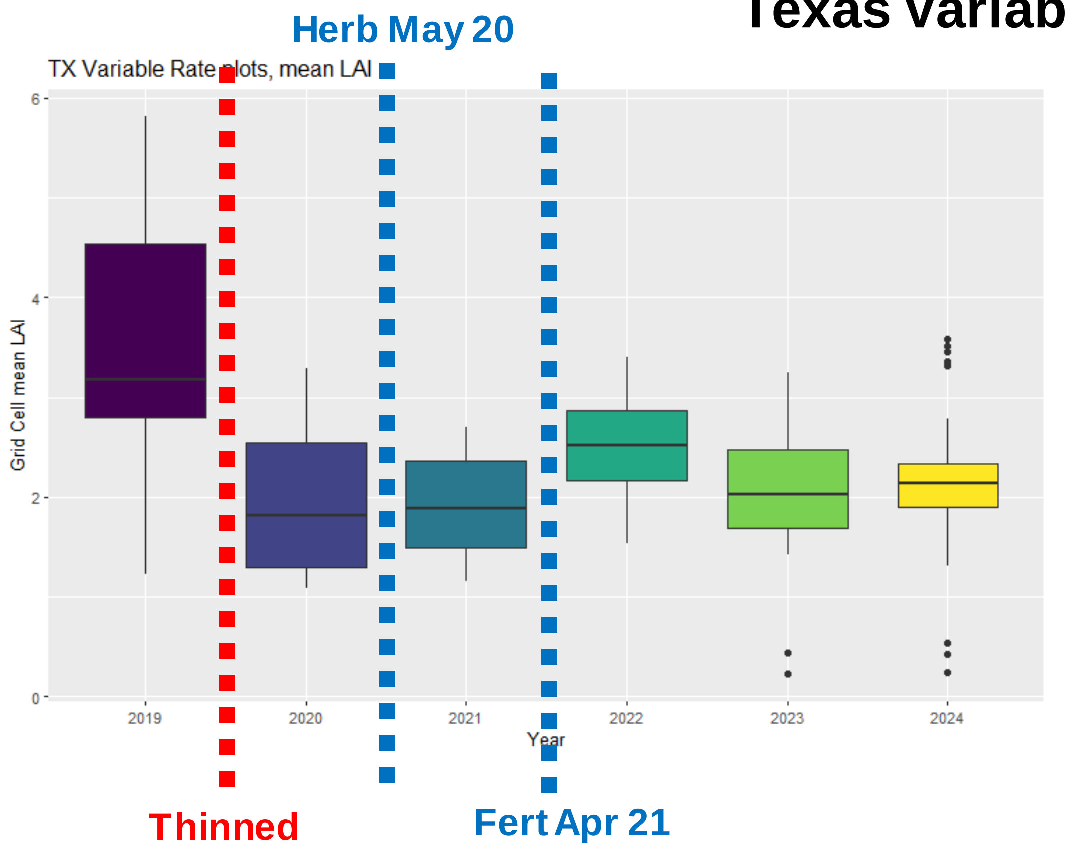


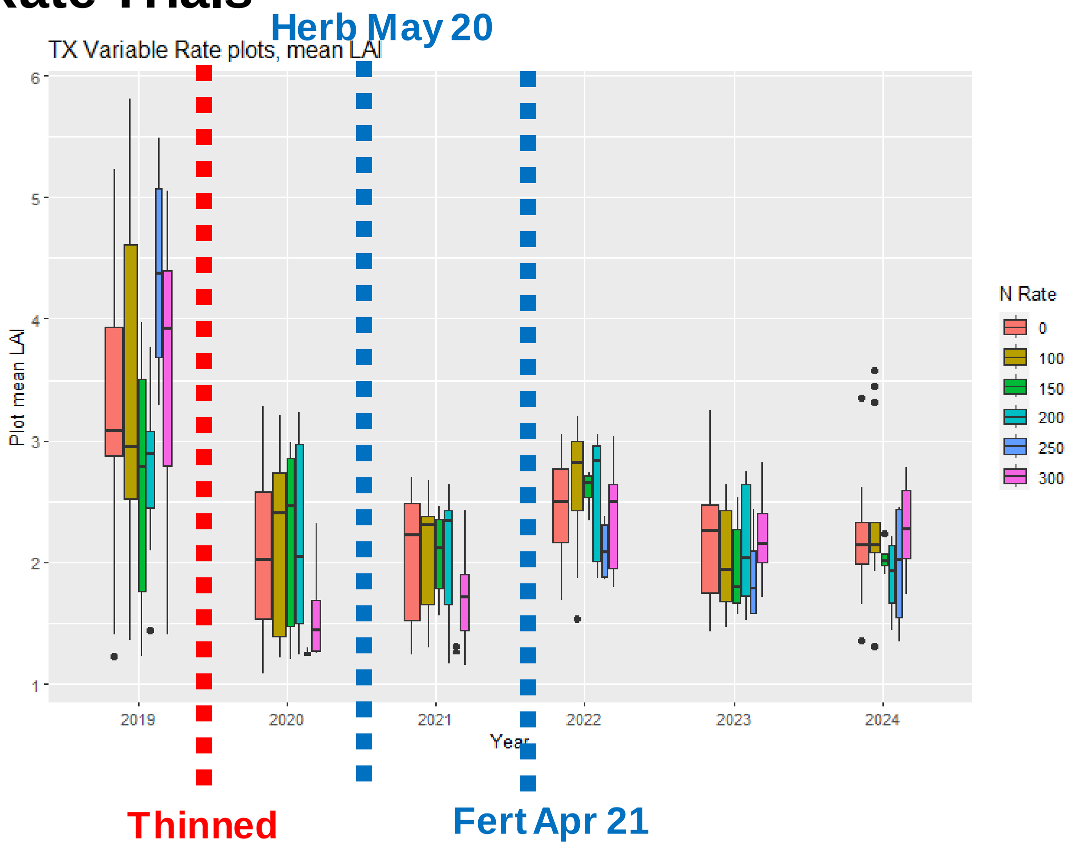



## Major Findings

# Canopy LAI response

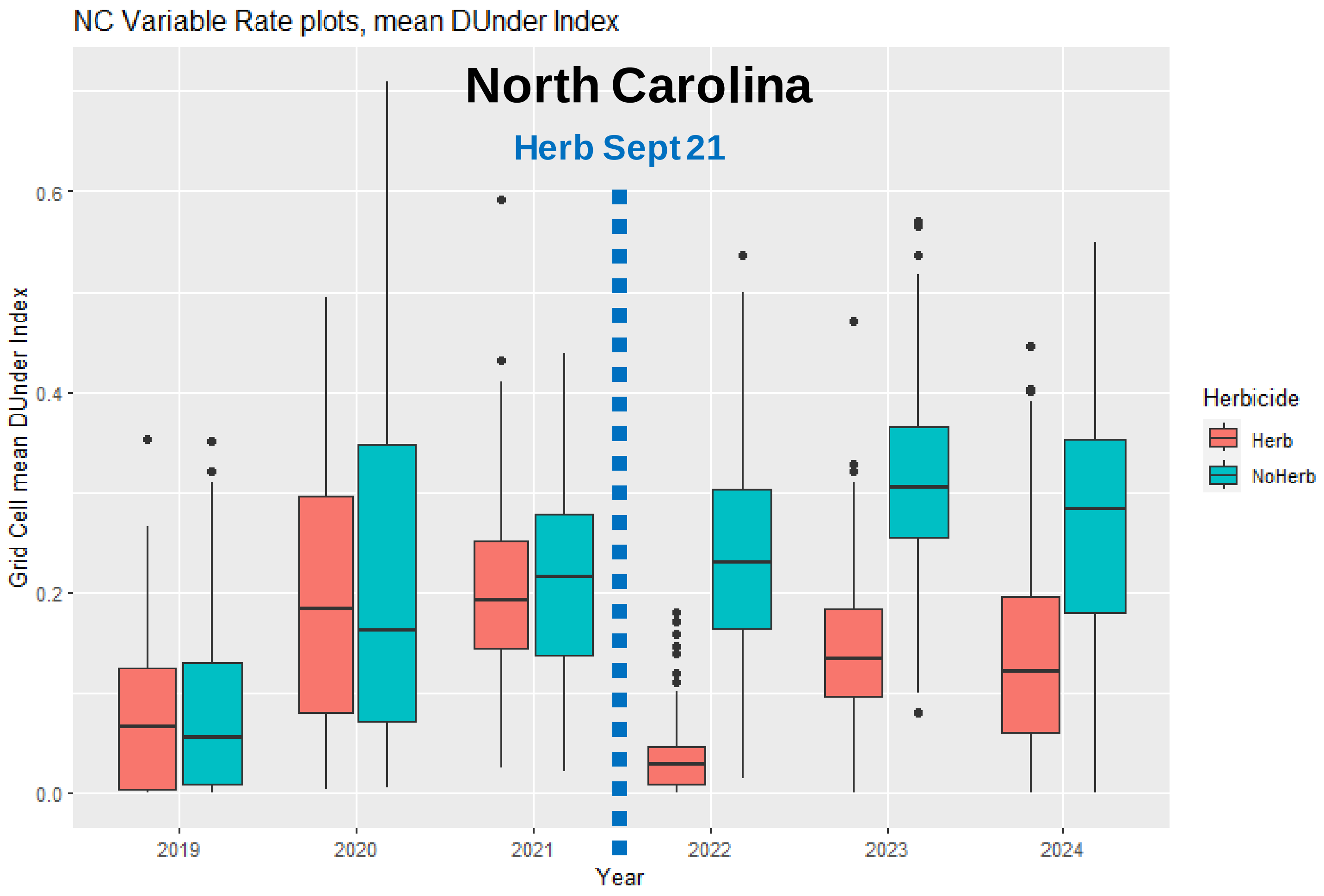
### Texas Variable Rate Trials



## Major Findings

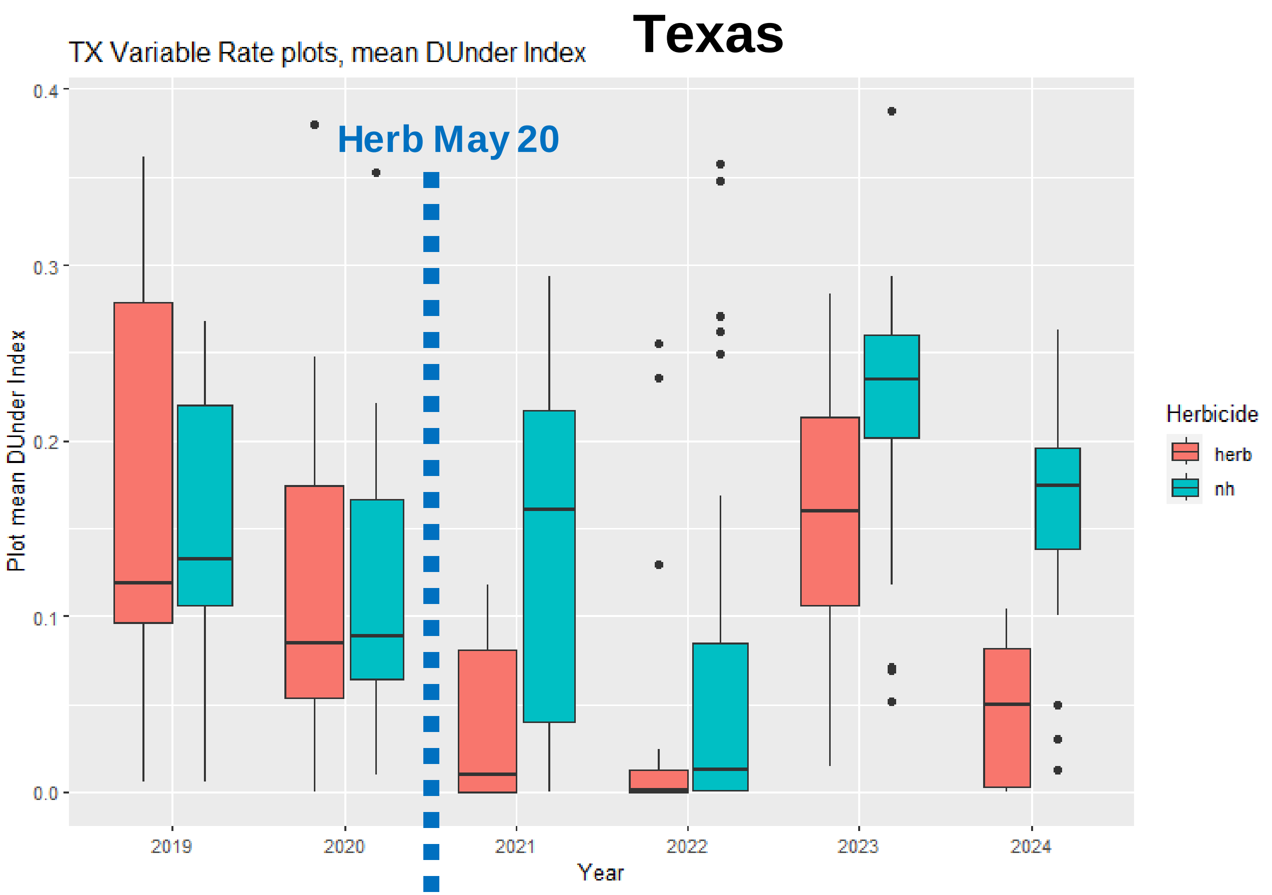
# Deciduous Understory response




Consistent decrease in DUnder Index post-herbicide

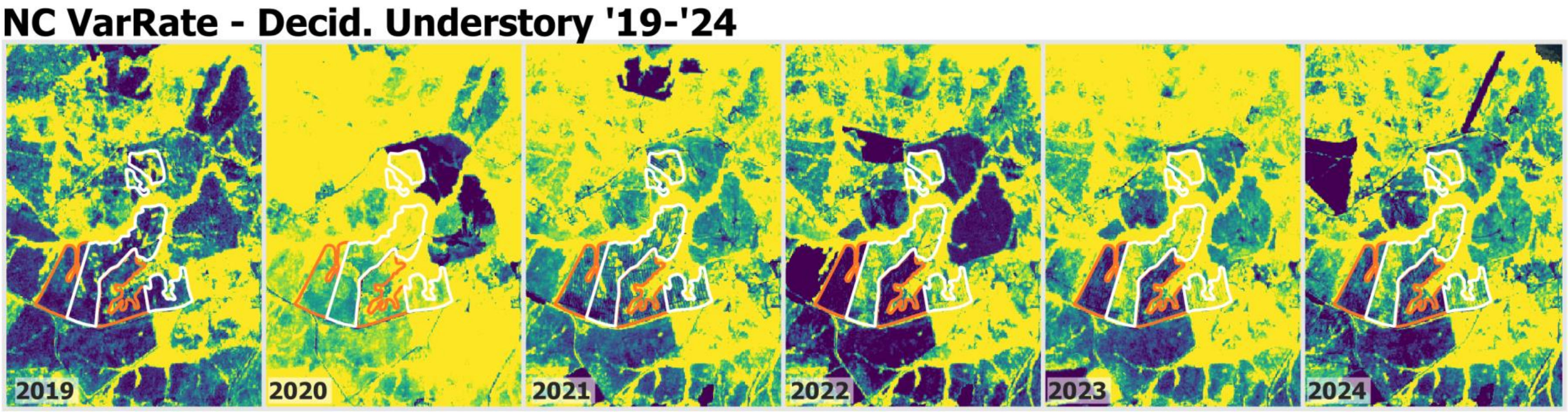
## Major Findings

# Deciduous Understory response



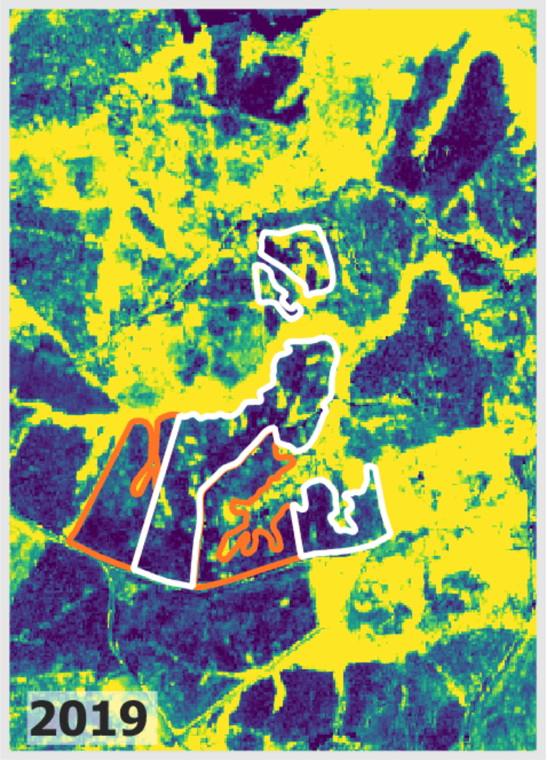

Yaupon (evergreen) understory may not be apparent with this technique

# Canopy LAI + Decid. Understory over time

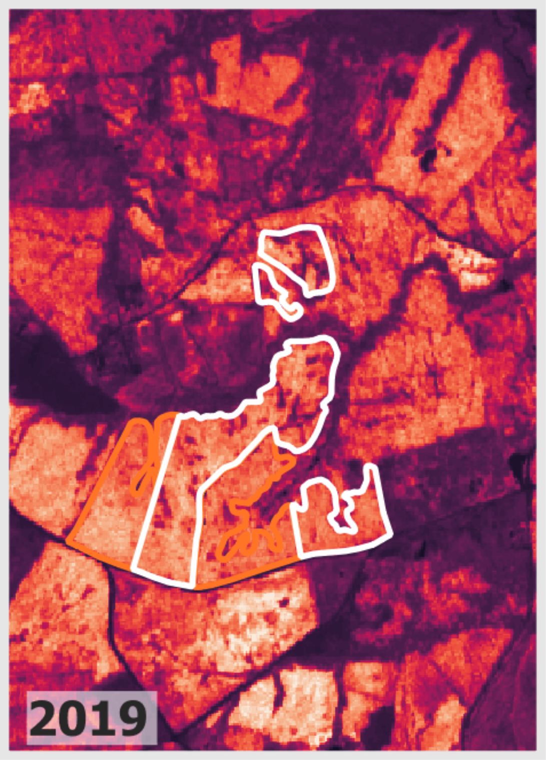



## Major Findings

# Sentinel-2: Canopy LAI + Decid. Understory over time




**Decid Understory**

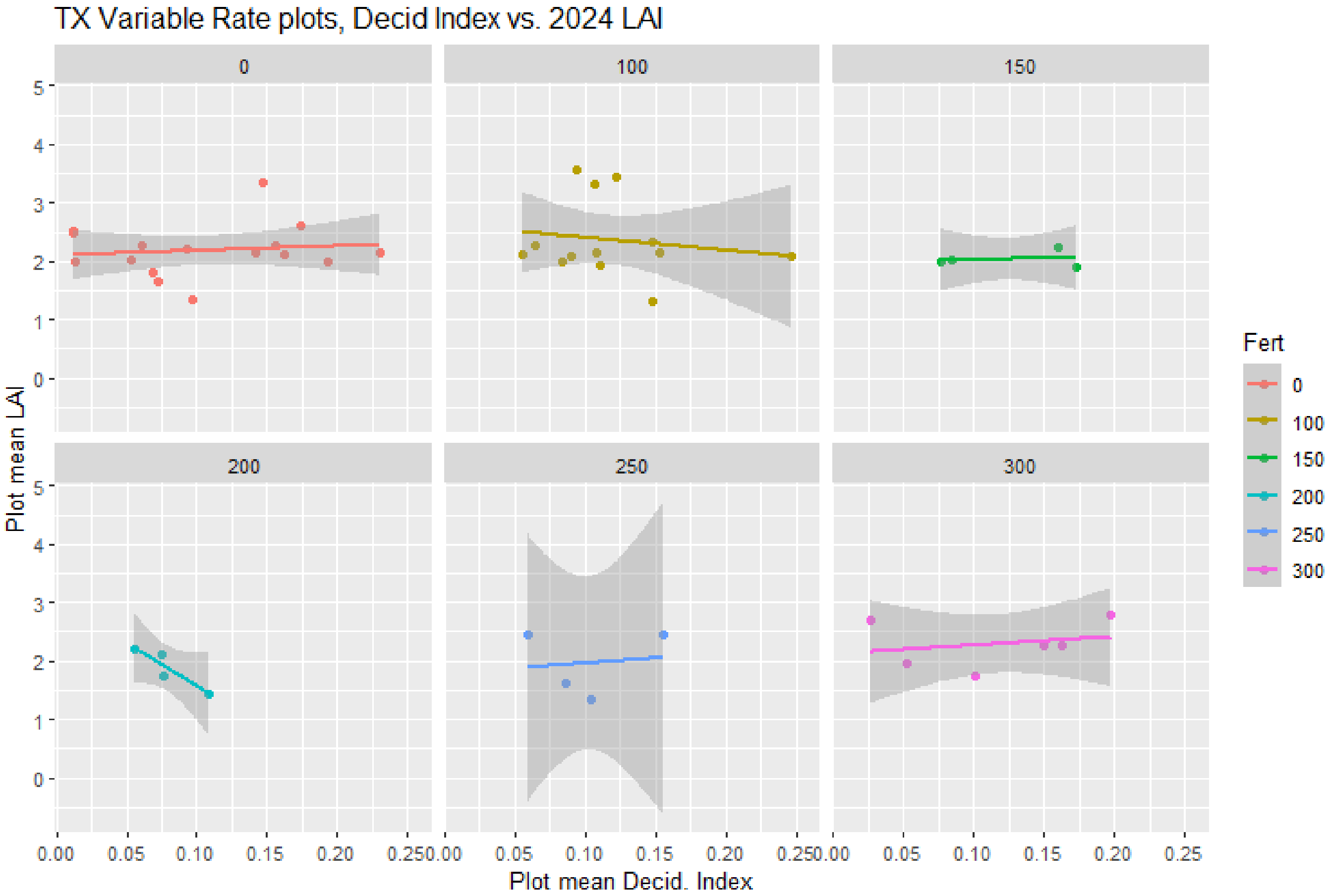



**Canopy LAI**

- Significant interannual variation
  - Cloud cover
  - Image quality/selection
  - Seasonal timing

**Major Findings**

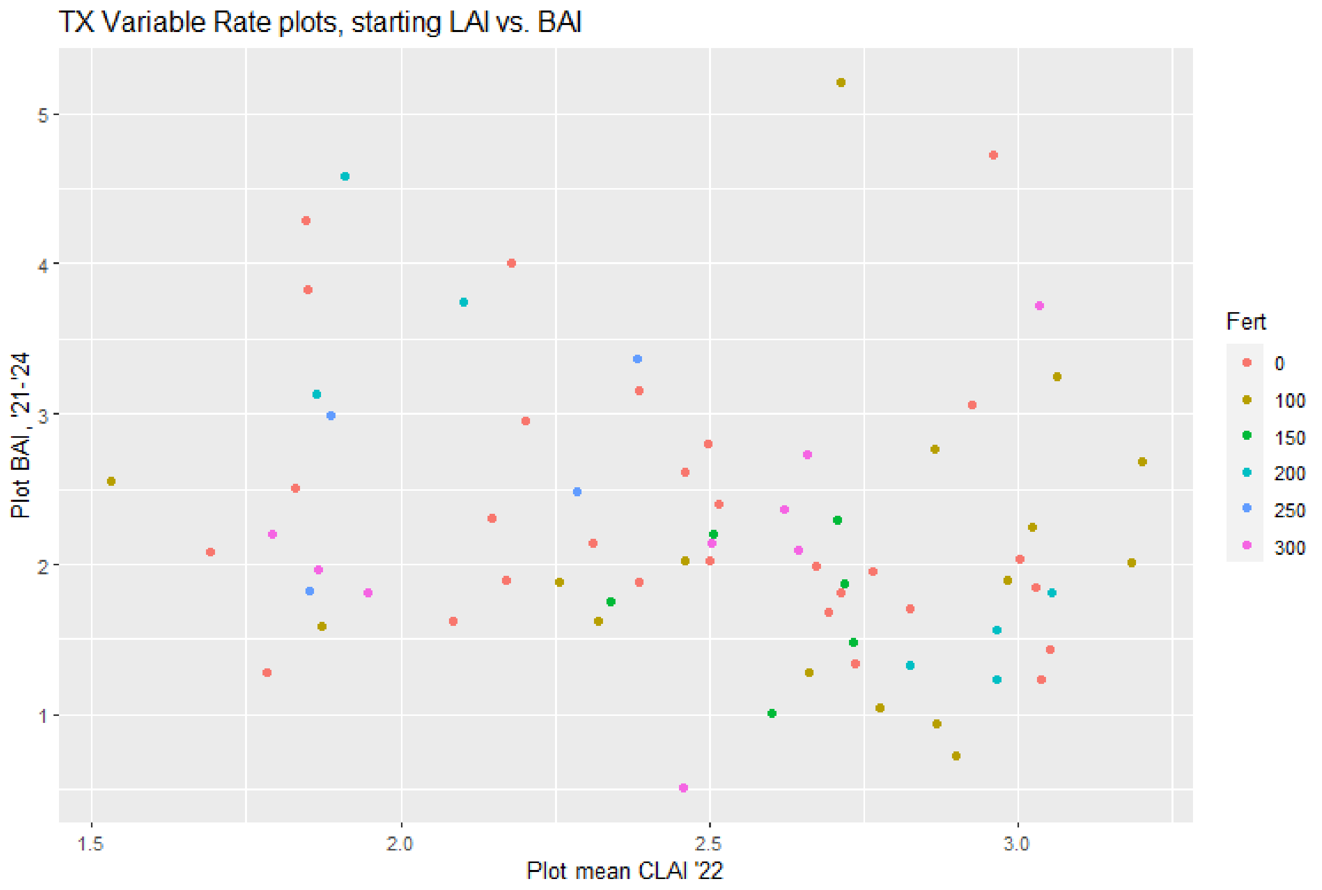
# Sentinel-2: Canopy LAI + Decid. Understory over time




- NC: Decrease in LAI with greater Understory (detection artifact?)
- TX: No evident relationship LAI ~ DU

## Major Findings

# Sentinel-2: Canopy LAI + Decid. Understory over time




- TX: LAI 1-year post-fertilization did not clearly predict BAI over the next 3 years
  - Preliminary, needs closer analysis of available field data

# Company Benefits

- Accessibility to LAI canopy layers
- Operational scale results from mid-rotation fertilization vs herbicide across soils and geology
- With time, ability to assess return on investment for: rates of fertilization and/or herbicide
- Determination of when/where LAI-based, variable rate fertilizer application can be beneficial.
- Combined with soils map and Site Index models, ability to estimate fertilizer response based on present canopy/understory conditions

# Summary

- **Study work ongoing**
  - Continuing to collect data in the field (TX 3 years post-treat; NC 2 years post treat)
  - Helicopter and aerial LiDAR acquisitions
  - Continuous satellite imagery
- **A full analysis of field and RS data forthcoming** by PhD student Ivan Raigosa-Garcia (NCSU)
- **LAI and Deciduous Understory model improvements** are ongoing
  - Evergreen understory model?
- **Integration of this work with soils and Site Index modeling** could unlock efficiencies in silvicultural planning over a broad swath of potential pine land.