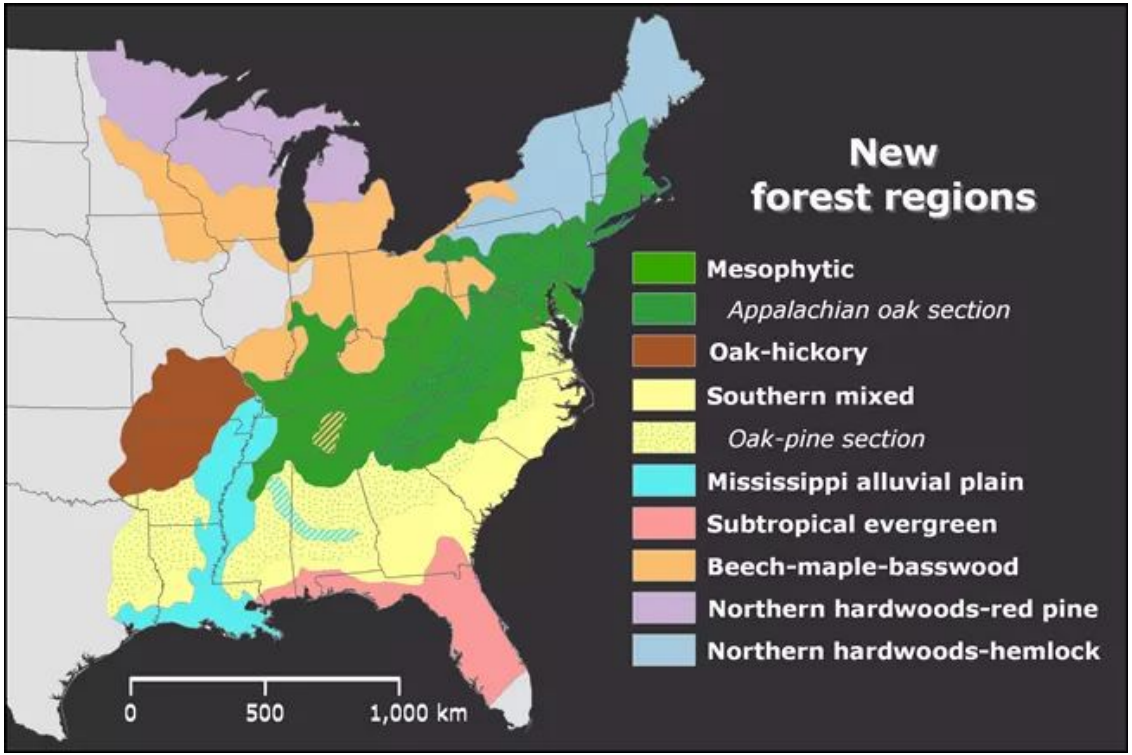
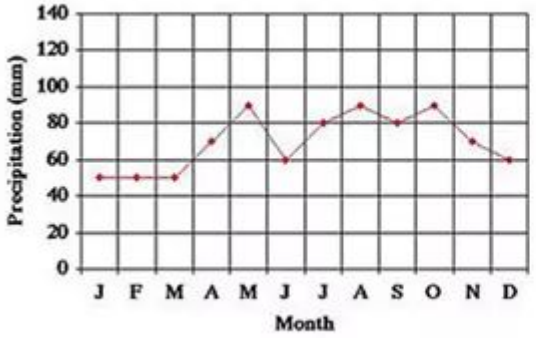
ASPRS Mid-South

April 21, 2023

Individual tree segmentation and parameter extraction from leaf-off LiDAR in deciduous forests

Eastern Deciduous Forest





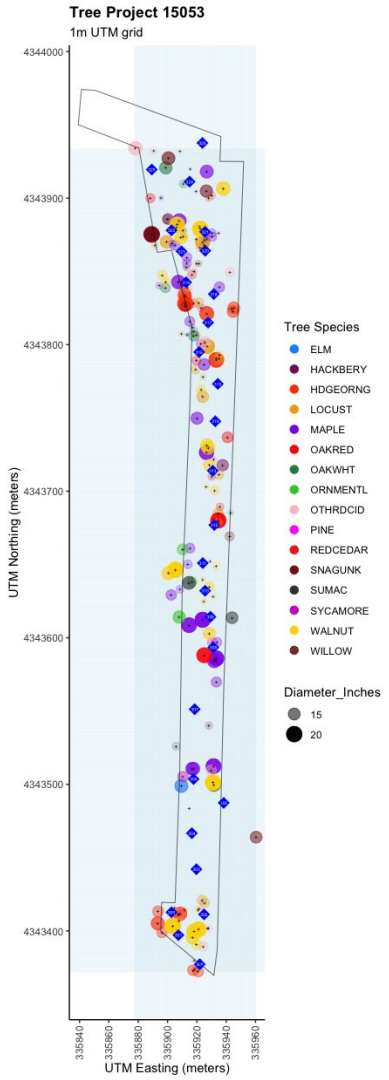
https://www.nps.gov/im/ncrn/eastern-deciduous-forest.htm


https://www.britannica.com/science/deciduous-forest

Economic context

Sewer line replacement near Leavenworth Kansas

- 254 trees located, measured & identified
- 170 trees > 10” in diameter in ~ 5.3 acres (2.16 ha)
- Average survey cost per tree ~$10 (est.)
- Estimated compensation for a single 12” tree by species:
    - *Black Walnut $2,266*
    - *Osage Orange $1096*
    - *Dogwood $869*
    - *Hickory $902*
    - *Oak $753*
    - *Maple $615*
    - *Hackberry $573*
    - *Locust $494*



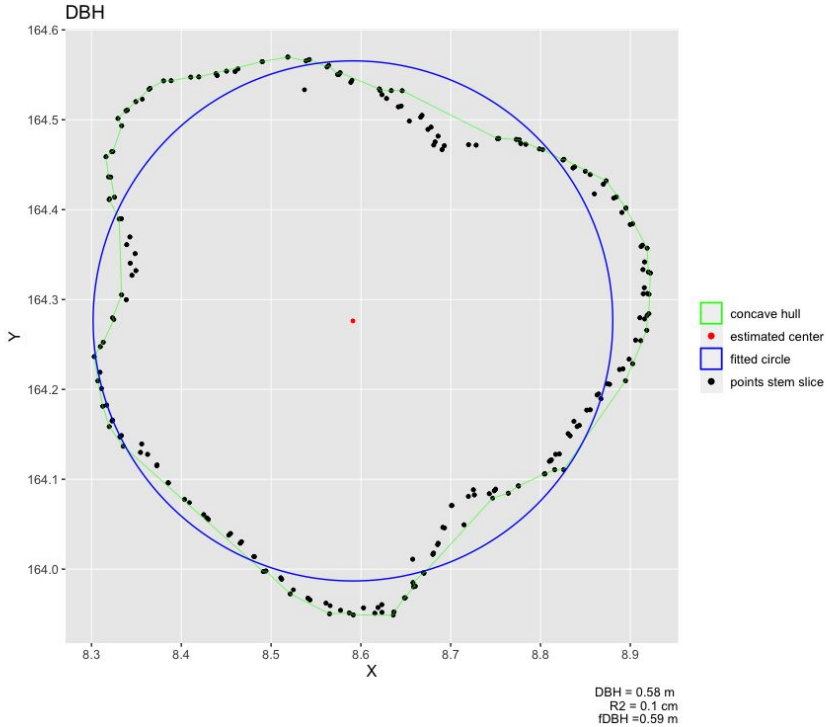
Project Objectives

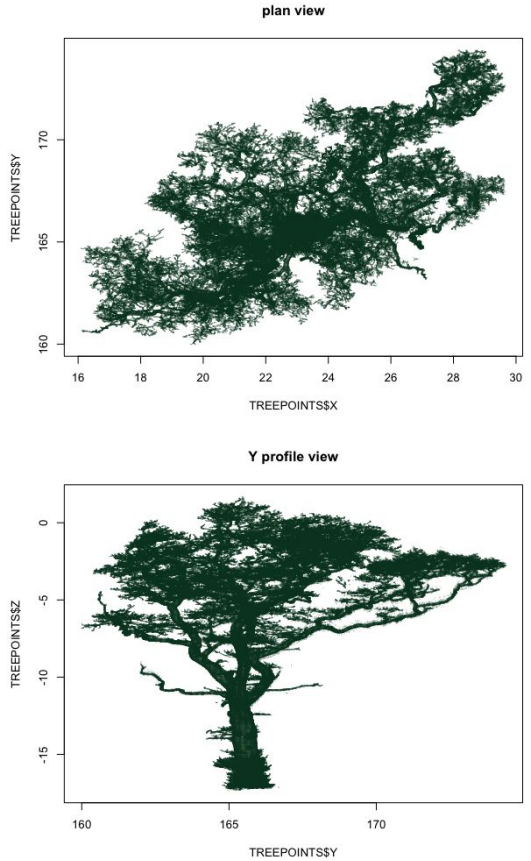
1. **Enable rapid site survey of trees for CE project planning**
    a. Tree location
    b. Tree size (DBH & height)
    c. Tree species

2. **Improve estimates of total wood / carbon / fuel per tree**
    a. Measure “whole tree” attributes directly
        i. Typical allometric equations not sensitive enough for carbon
    b. Rapidly generate site-specific allometric equations
        i. Allometric equations are typically biased low
        ii. It's easier to cut & weigh smaller individual trees
        iii. Climate change is altering existing empirical relationships
        iv. “Within species” variation can exceed “between species” variation

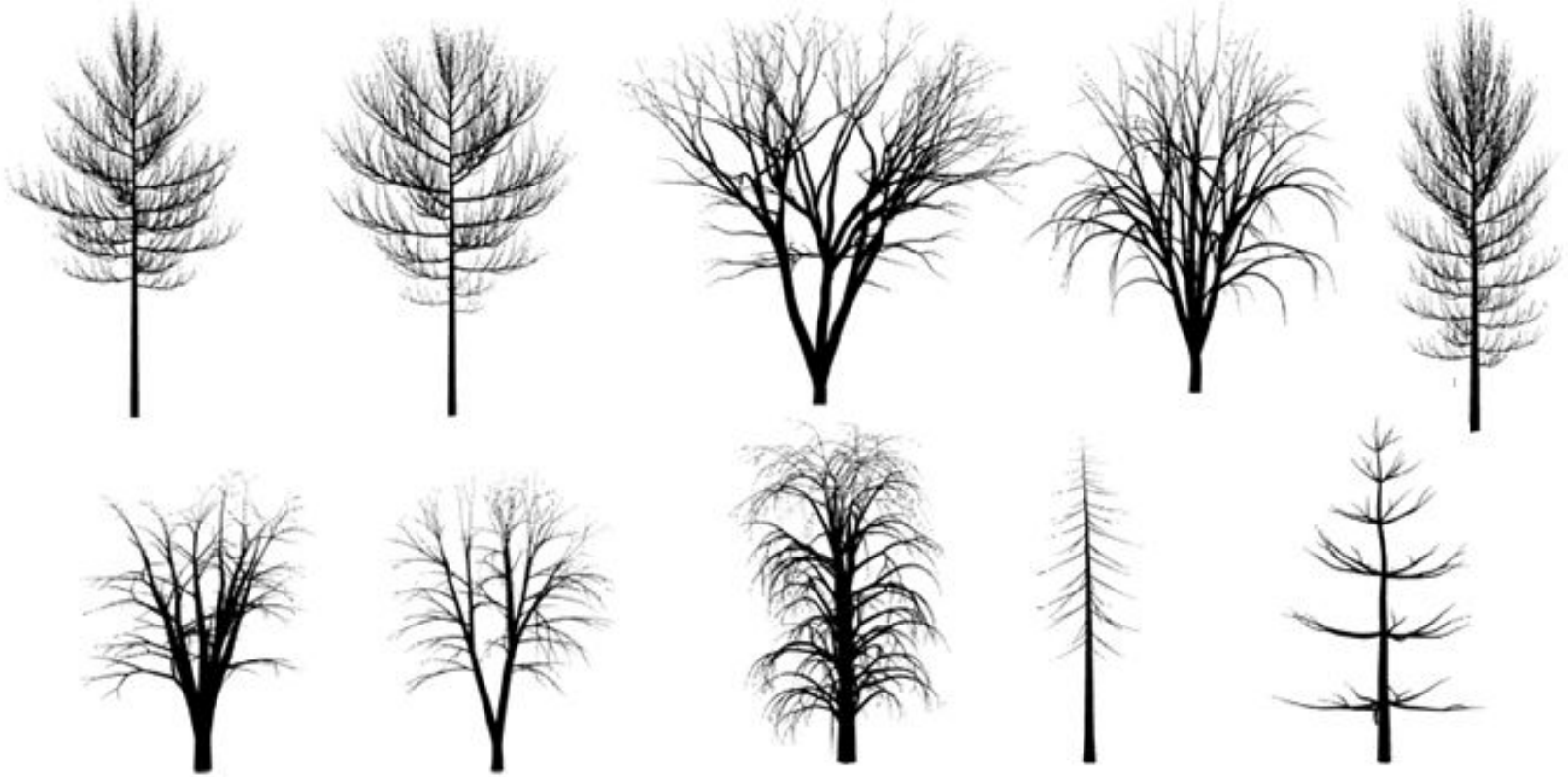
Key tree measurements

1. **Diameter at Breast Height (DBH) [1.4m]**
2. **Species**
3. **Location**
4. **Height**
5. *Crown Ratio*
6. *Crown Volume*
7. *Age*
8. *Canopy Base Height (fuel)*
9. *Crown Bulk Density (fuel)*
10. *Quality classification (timber)*

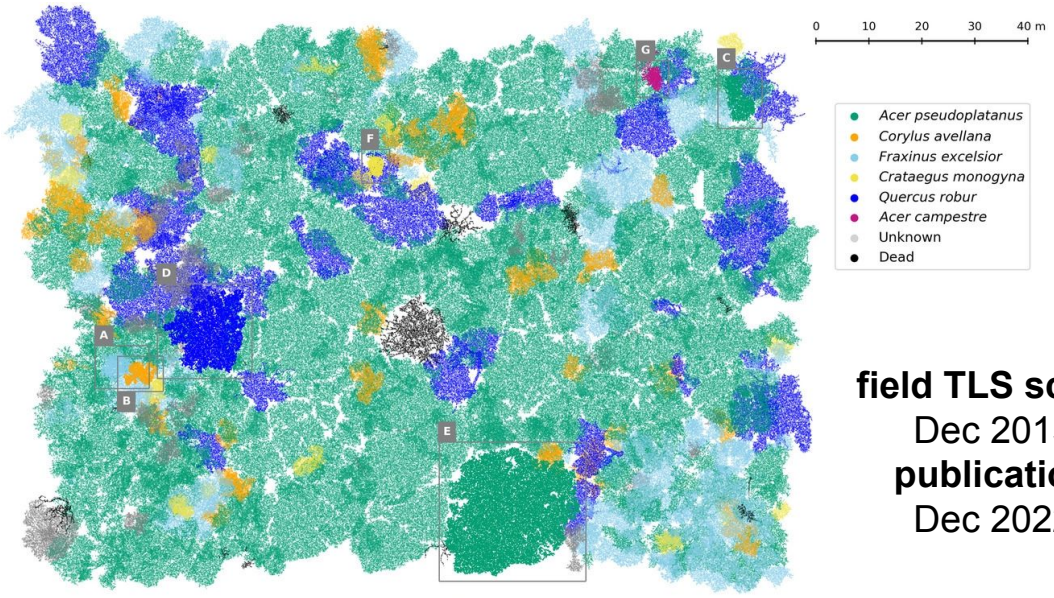




Structural shapes are diagnostic



Calders et al 2022



field TLS scans
Dec 2015
publication
Dec 2022

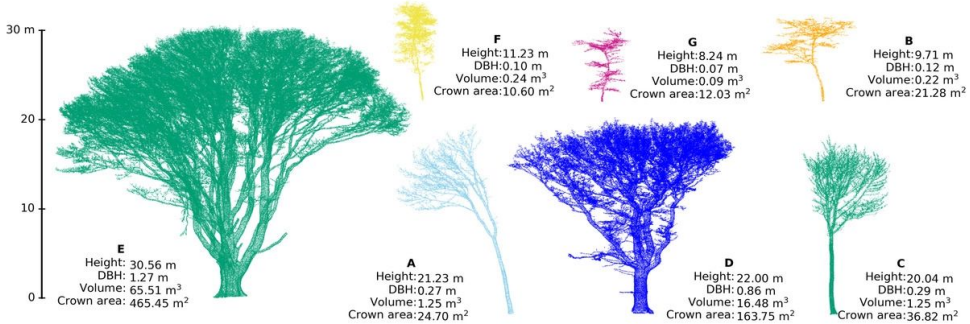


Fig 2 in Ecol Sol and Evidence, Volume: 3, Issue: 4, First published: 19 December 2022, DOI: (10.1002/2688-8319.12197)

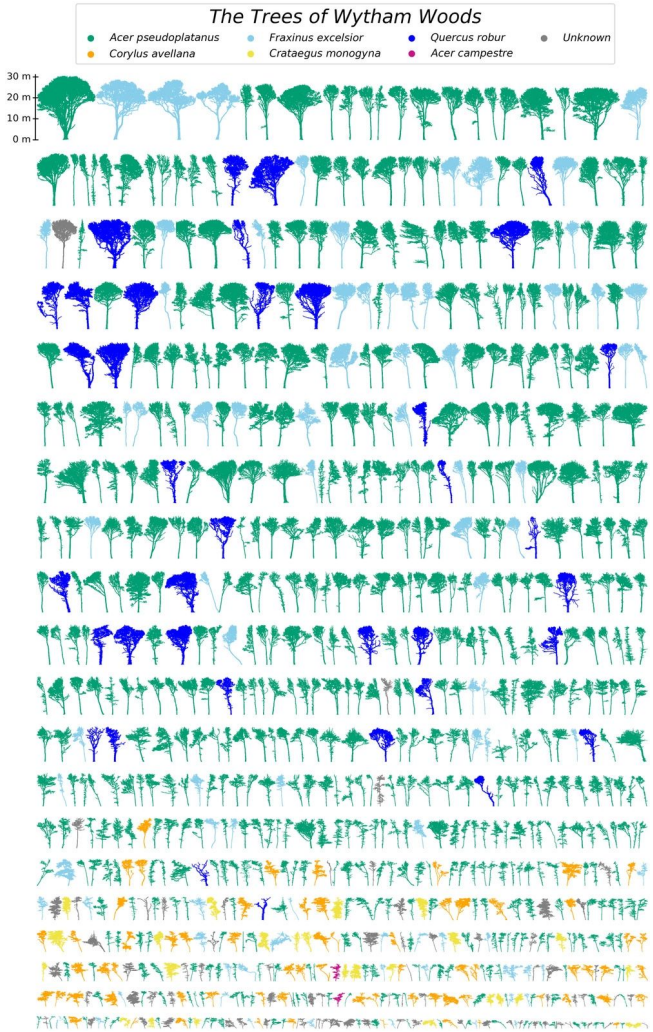
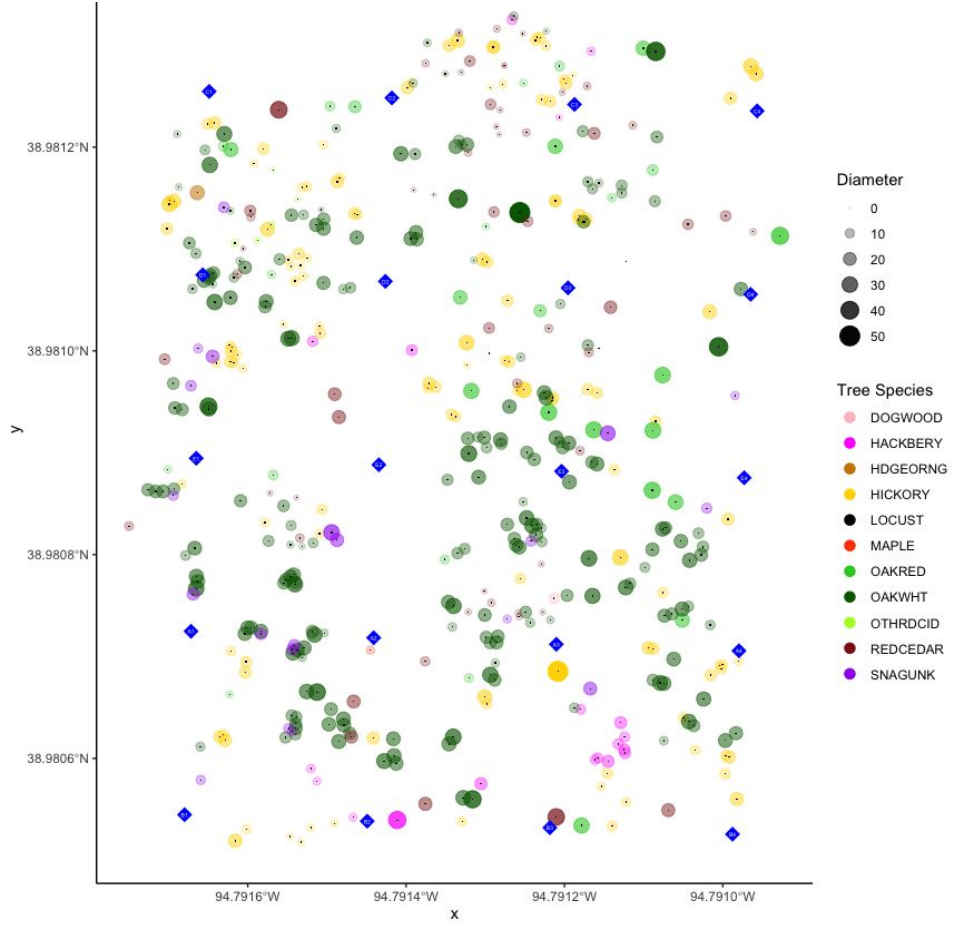
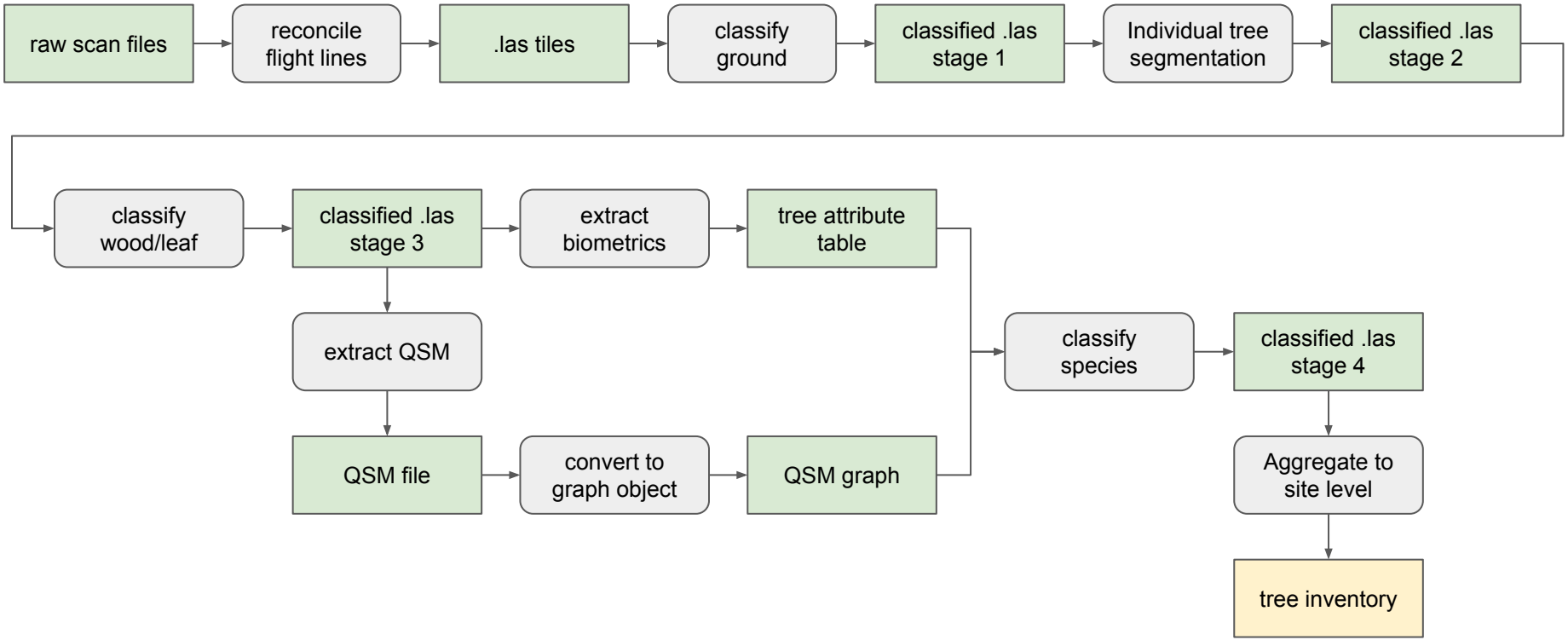


Fig 4 in Ecol Sol and Evidence, Volume: 3, Issue: 4, First published: 19 December 2022, DOI: (10.1002/2688-8319.12197)

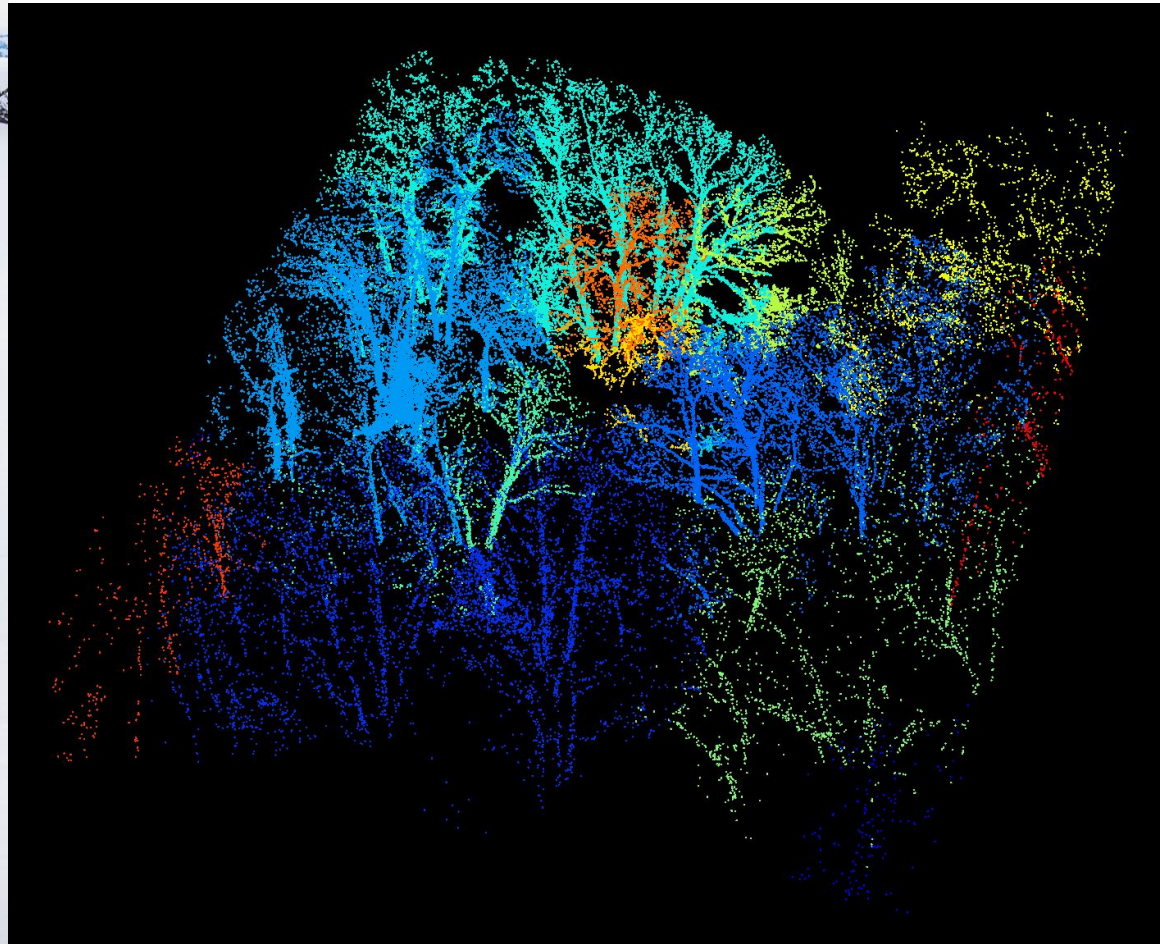
Field data collection



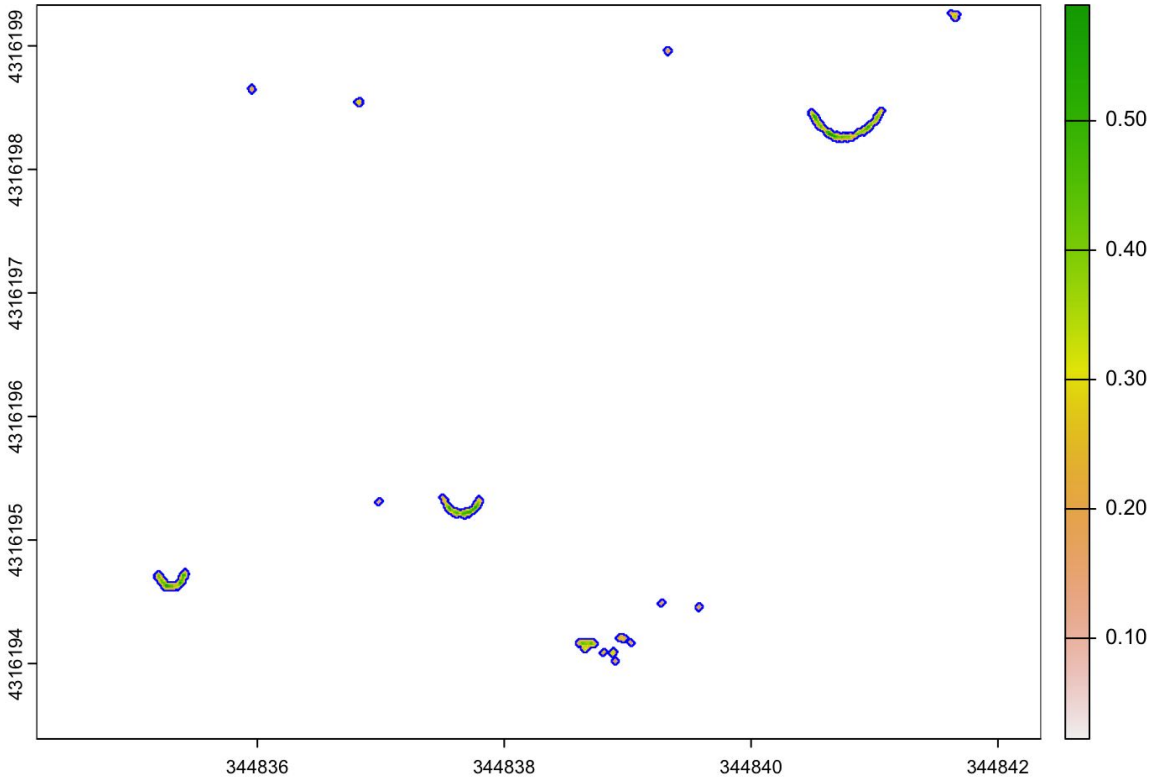
LiDAR scan to tree inventory workflow



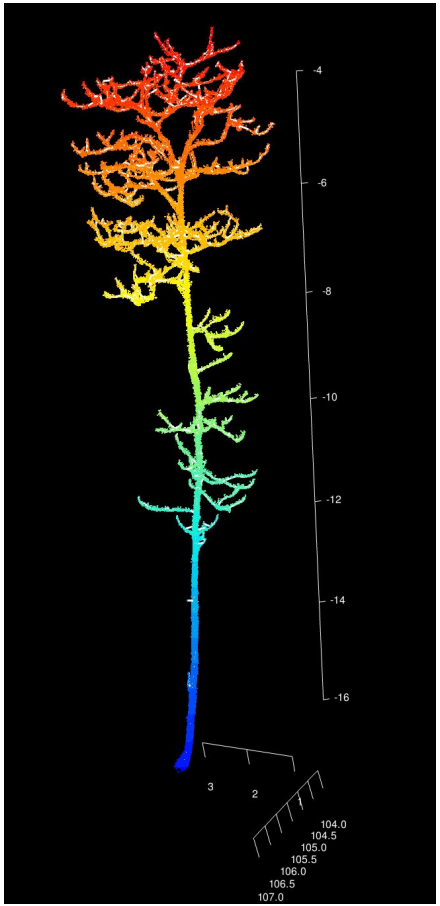
Crux #1 Tree segmentation

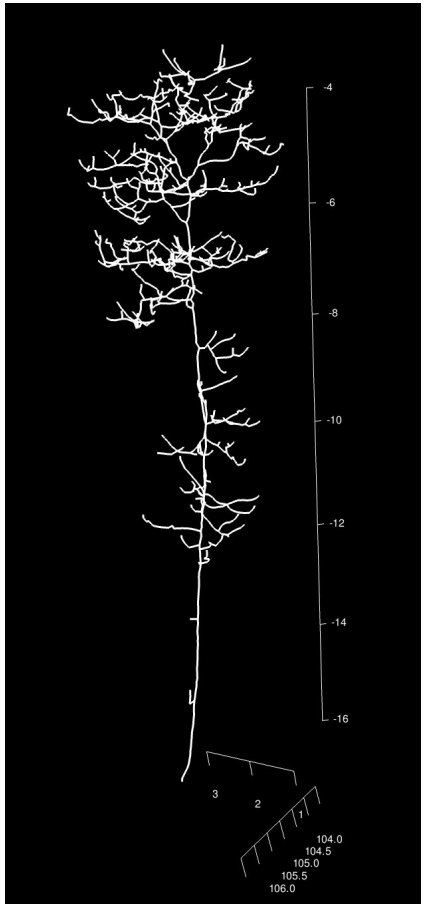


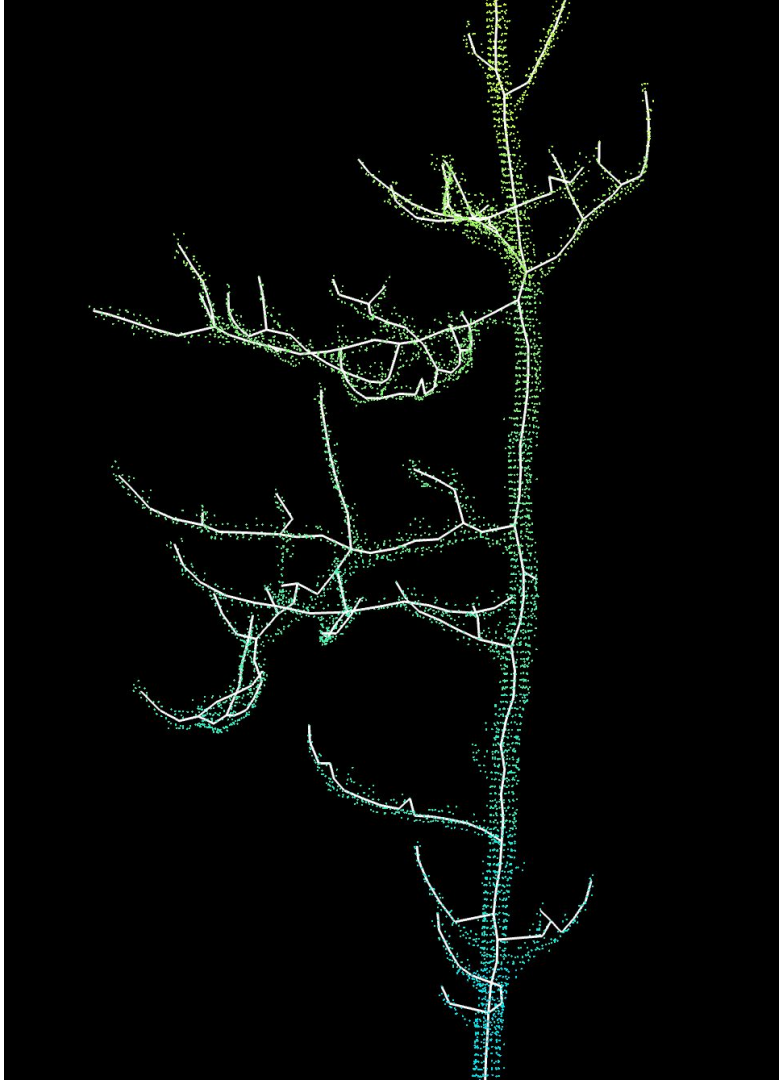
Crux #2: occlusion



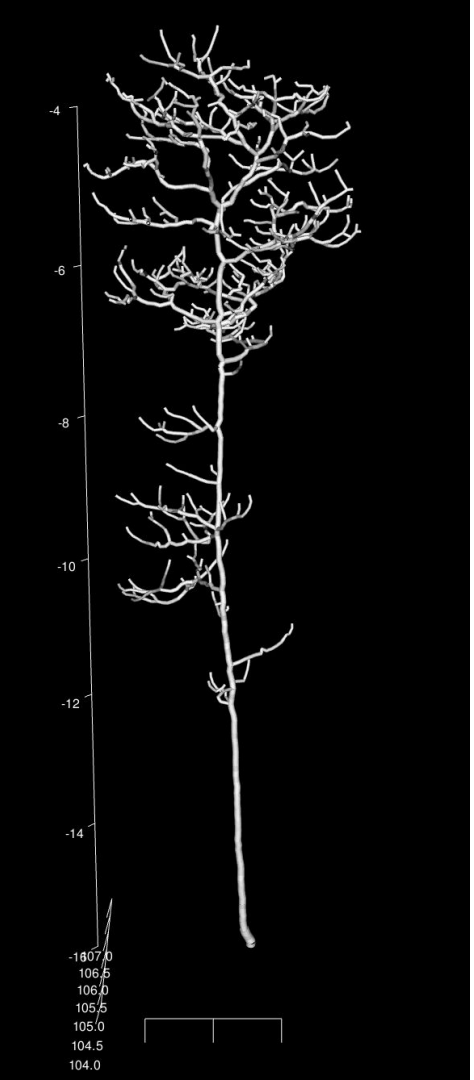
Trees are directed graphs

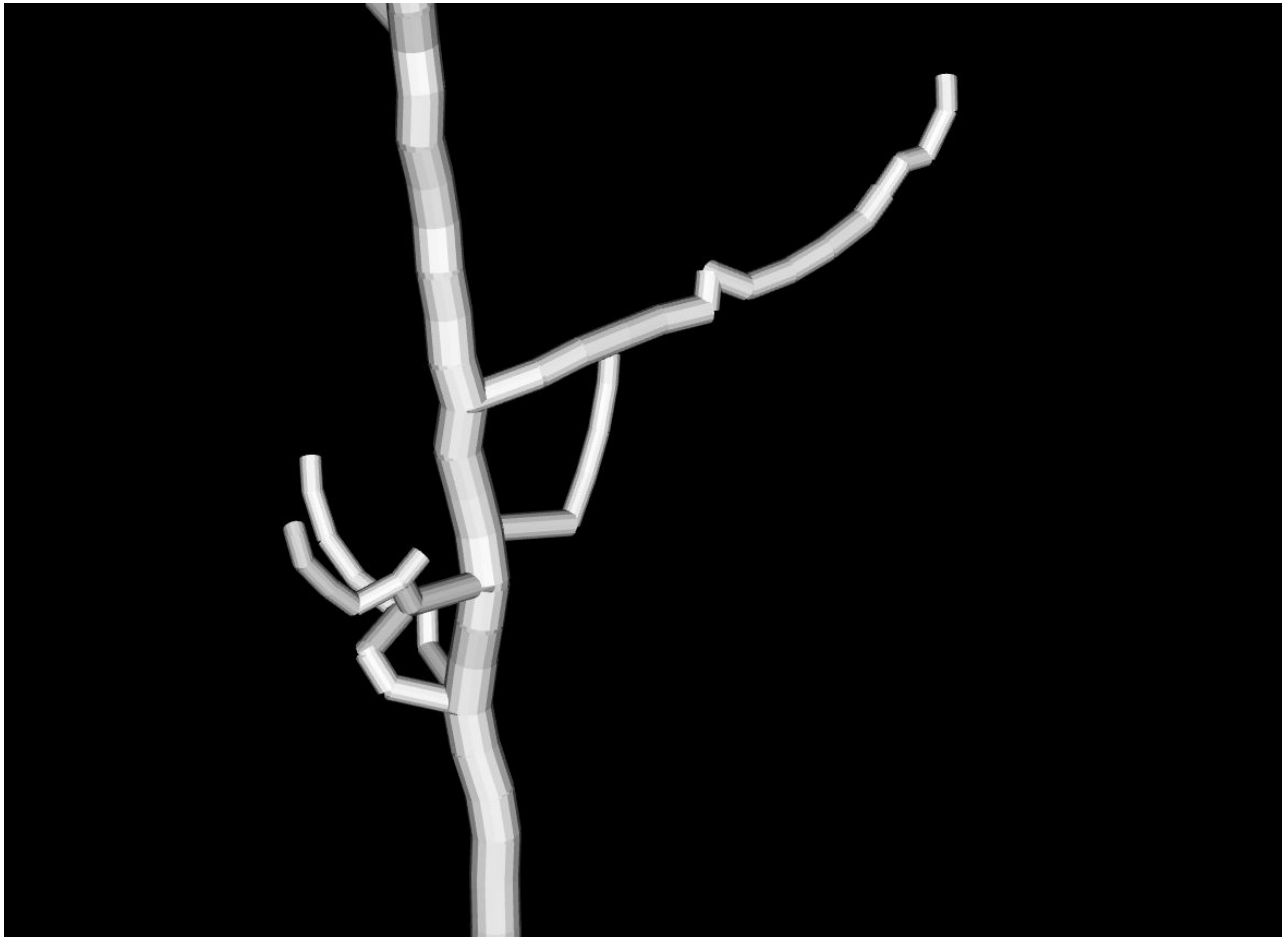






Quantitative Structure Models (QSMs)






Thank you
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