Assessing Canopy Structure using LIDAR in Second Growth vs. Old Growth Sites in Forest Park, Portland, Oregon

Matt Cook and
Kimberly Brown

Background

Figure 1: Map illustrating how Forest Park connects the Portland Metro region and the Willamette Valley to the Oregon Coast Range

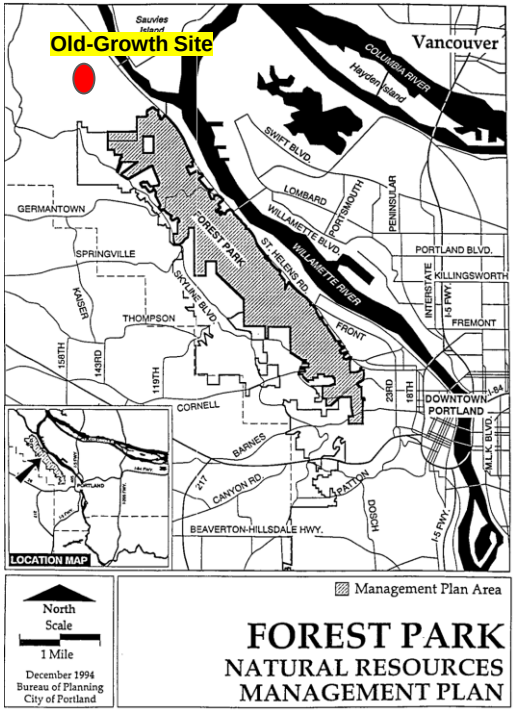


Figure 2: Map of Forest Park and its relation to the Portland Metro region.

Forest Park, Portland

- 5,200 acres
- Established in 1948
- Logging activity from 1850-1948
- Only 0.5% of the park is old-growth
- 75% of the park is second growth

Research Locations

2nd-Growth Forest Sites

Figure 3: a photograph of second growth in Forest Park; trees are mostly Bigleaf maples and alders

Old-Growth Forest Sites

Figure 4: a photograph of old-growth in Forest Park; trees are mostly large douglas firs

Research Goals/Questions

Research Goal: Visualize the difference between old-growth and second growth plots in Forest Park, Portland using LiDAR software and statistical analysis

Research Questions:

- Are there more forest gaps in the old-growth forests?
- Do the old-growth plots have higher canopies?
- Do the old-growth plots have higher canopy density?
- Do old-growth plots have higher structural complexity?

Methods

Data Sources: 2019 DOGAMI LiDAR data

Software:

ArcGIS Pro

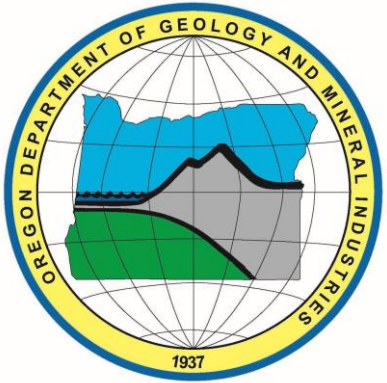
- Created 1 hectare sample and clipped LiDAR data for old-growth and managed site areas

FUSION software- USDA Forest Service

- Performed point cloud analytics of forest inventory variables

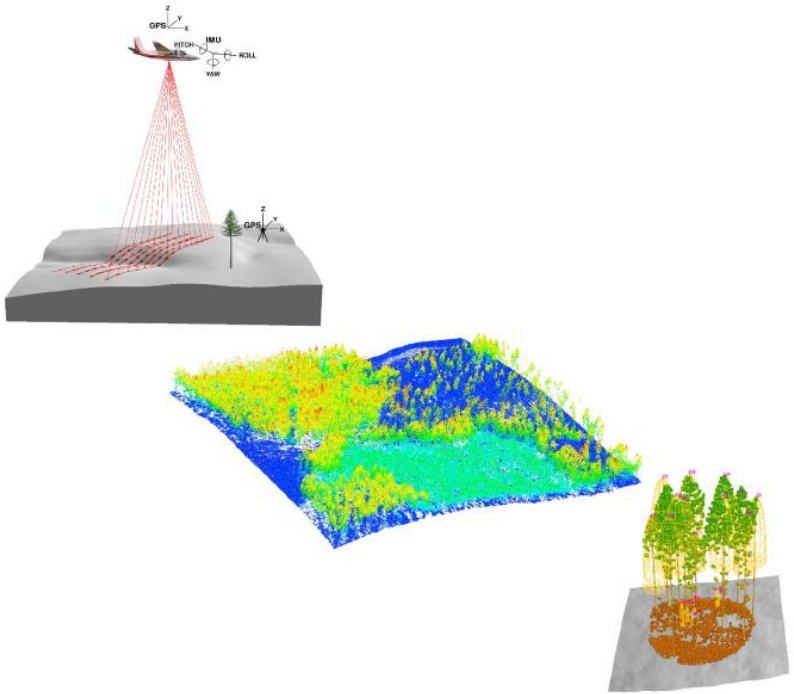
R Studio

- Performed a statistical analysis on the results from the Fusion software
- ForestGapR package



LiDAR Metrics

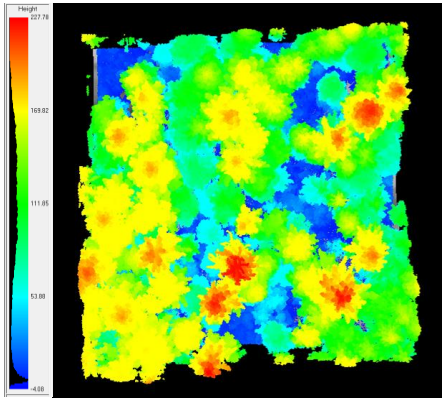
- The three dimensional arrangement of trees and their crowns is a fundamental attribute of forest ecosystems.
- Forest structure is typically described by the size and spatial distribution of trees and by the vertical and horizontal distribution of foliage
- Researchers can use LiDAR data to map forest structure and to assess the development stages of forests



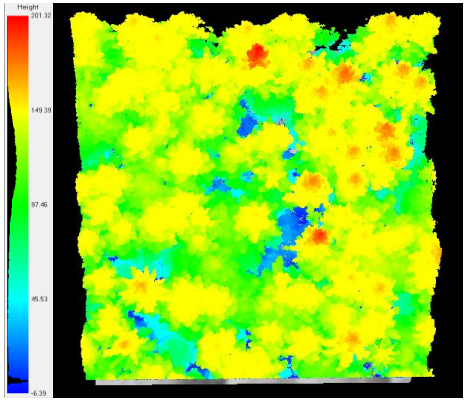
LiDAR Metrics

LiDAR-based metrics	Description
95th percentile height of first returns (m)	Similar to maximum height but less sensitive to outliers
Mean height of first returns (m)	A measurement of tree height that is sensitive to distribution of foliage along the stem
SD first return heights	Standard Deviation (SD); a measurement of canopy height
CV first return heights	Coefficient of variation (CV); a measurement of canopy density
Rumple index	Ratio of canopy outer surface area relative to ground surface area, higher rumple values are results of more vertical and horizontal 3D heterogeneity
Canopy density	Proportion of first returns greater than a lower height limit of 3m above ground in the DTM

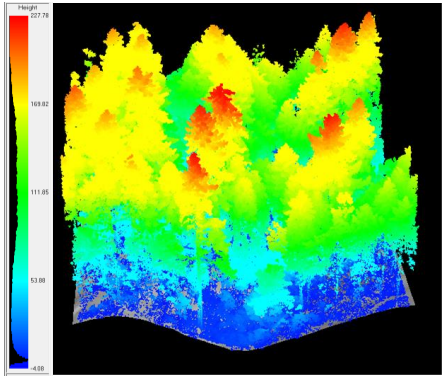
3D LiDAR Visualization - Fusion Software



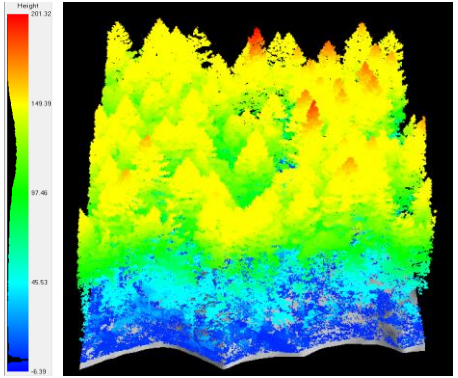
Old-Growth Overhead



2nd-Growth Overhead



Old-Growth Side Profile



2nd-Growth Side Profile

Statistical Results – Height

- Larger max height at old-growth sites compared to 2nd-growth sites
- Mean heights are similar but slightly larger at old-growth sites

Canopy Metrics	Old-Growth	2nd Growth
% Cover	94.8	95.5
Max Height (ft)	227.8	201.3
Mean Height (ft)	98.5	96.5

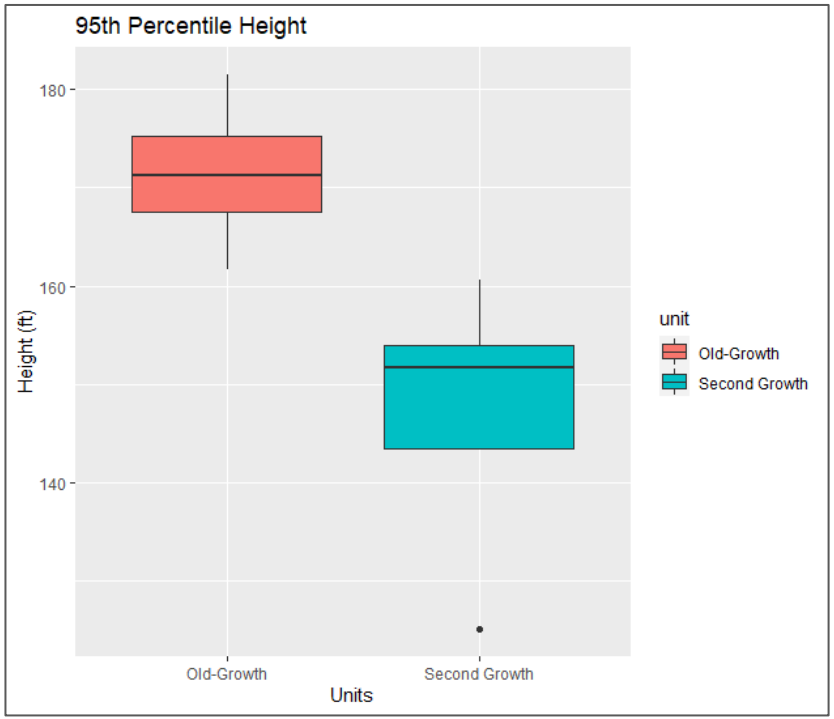


Figure 3. Boxplots displaying 95 percentile height values from lidar point cloud data from old-growth and 2nd-growth sites.

Statistical Results – Canopy Structure

- All canopy structure metrics larger at old-growth sites (Rumple Index, SD, and CV)
- Canopy cover similar at both sites

Canopy Metrics	Old-Growth	2nd Growth
Rumple Index	4.8	4.1
SD of 1st returns	40.2	29.2
CV of 1st returns	0.38	0.28

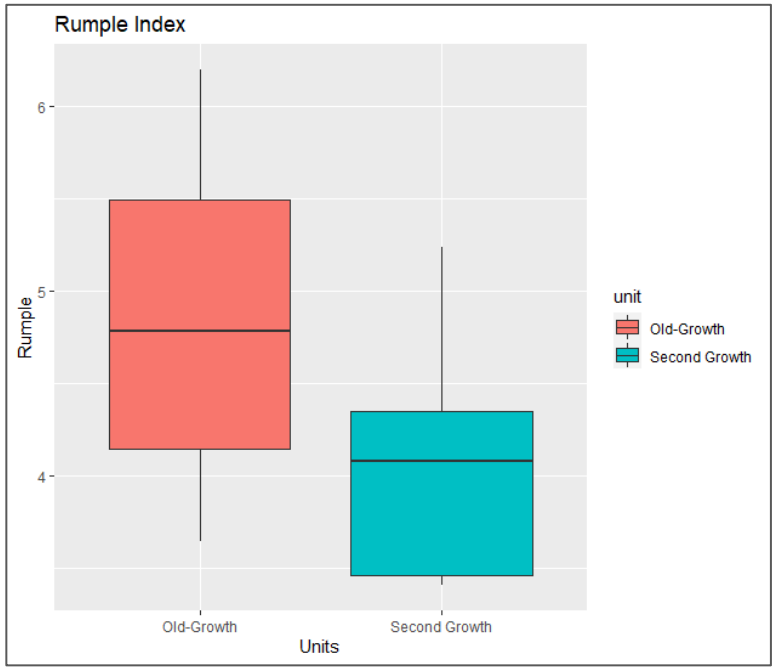
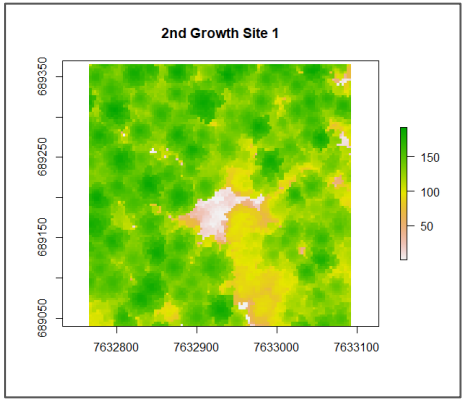


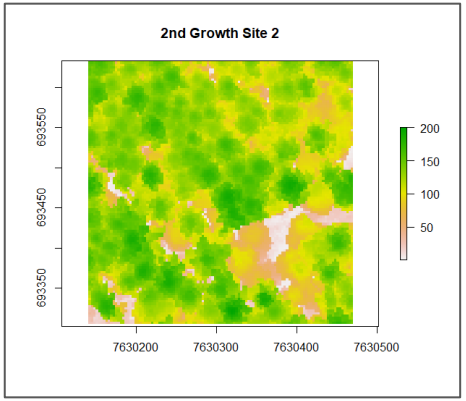
Figure 4. Boxplots displaying rumple index values from lidar point cloud data from old-growth and 2nd-growth sites.

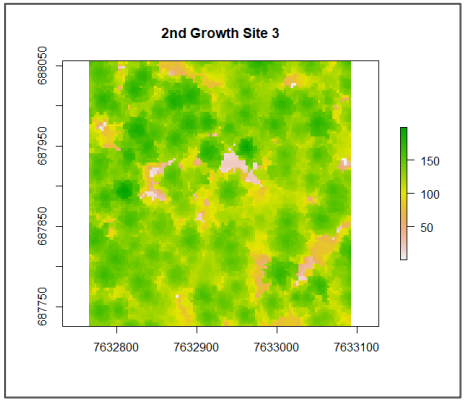
Results – 2nd Growth Sites Gap Analysis

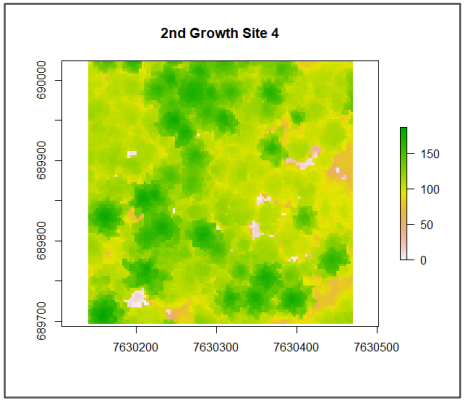
- Average of 18 gaps at 2nd-growth sites
- Gap sizes ranged from 1188 - 9 square feet

Gap Metrics	Values
Average # of Gaps	18
Average Gap Size (ft^2)	71.2





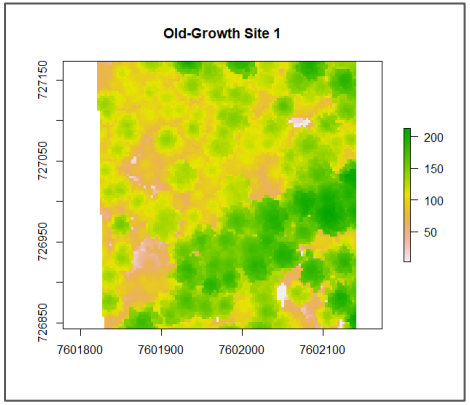


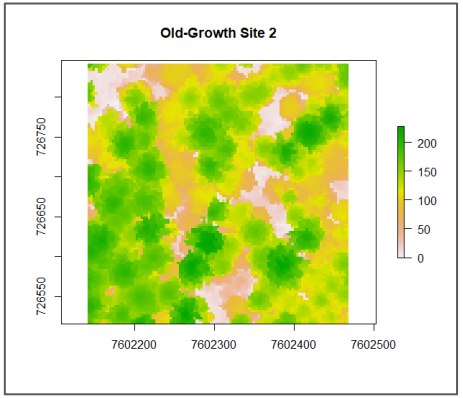


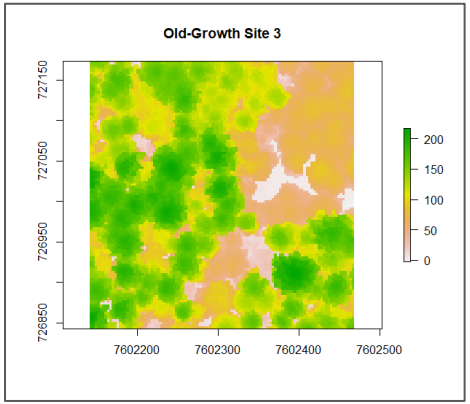
Results – Old Growth Sites Gap Analysis

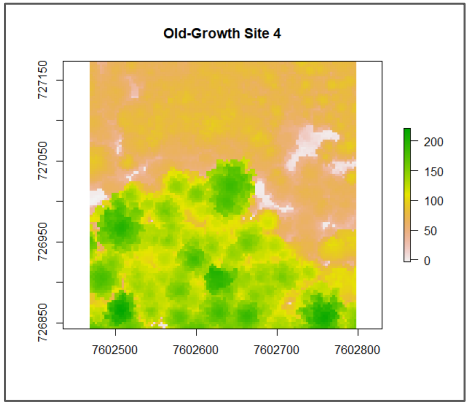
- Average of 23 gaps at Old-growth sites
- Gap sizes ranged from 1755 to 9 square feet

Gap Metrics	Values
Average # of Gaps	23
Average Gap Size (ft^2)	104.4









Conclusion

- The old-growth sites were distinguishable from the 2nd-growth sites using height metrics (older, taller trees at present in old-growths sites)
- Larger structural complexity at old-growth sites (larger rumple index, SD of heights, CV of heights)
- There were more canopy gaps present on average at the old-growth sites and the average gap size was larger at these sites as well
- Overall, the canopy structure observed at old-growth site exhibited greater structural complexity than the 2nd-growth sites.

References

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