Tree Team

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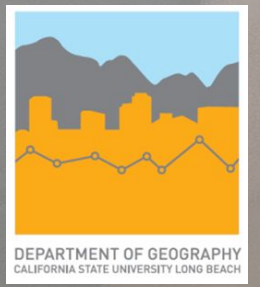
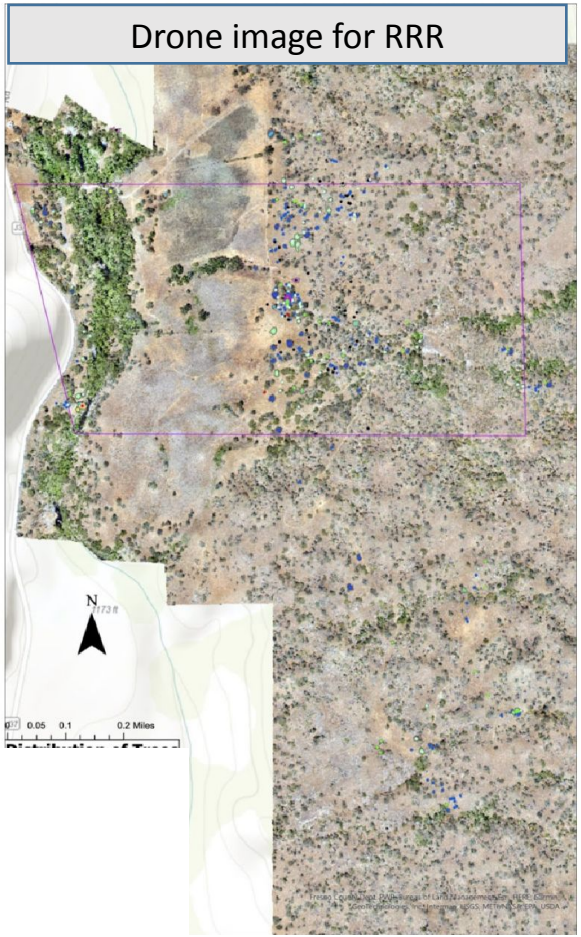
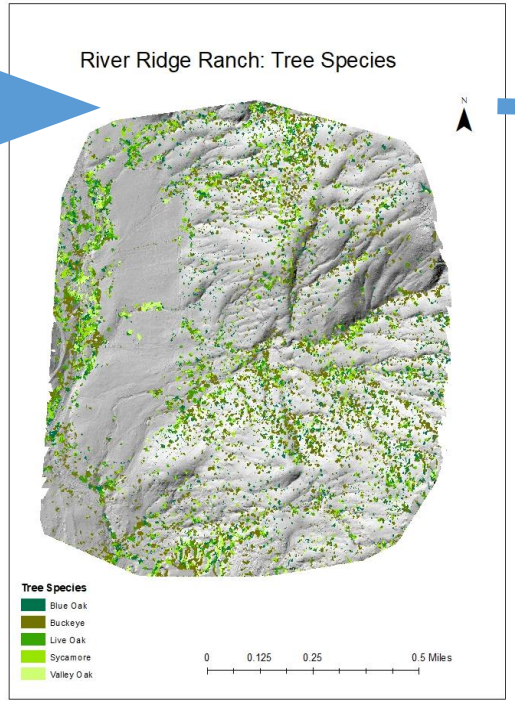


Objective: Develop a *remote* model for measuring tree carbon on ranchlands





Create an individual tree map using image processing software

Produce a tree canopy and height map from imagery

Merge field and drone data to model tree carbon

Measure DBH, Height and Canopy in the field with GPS

Species specific equations for tree biomass

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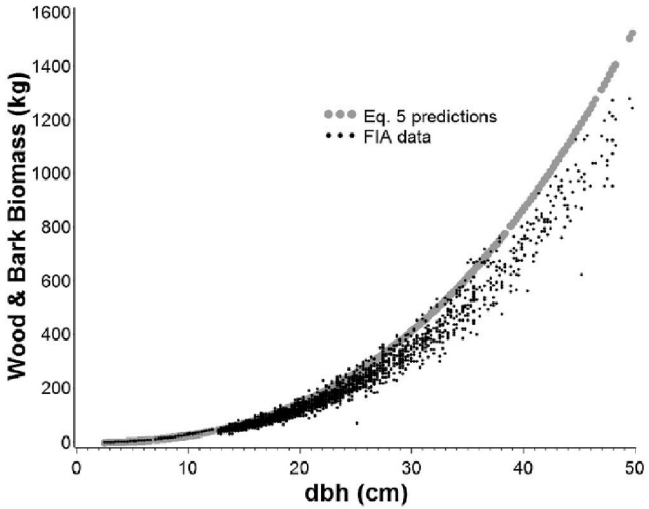


Relationship between DBH and Biomass for Blue Oak trees (derived from harvesting of 14 blue oaks in southern Sierra Nevada

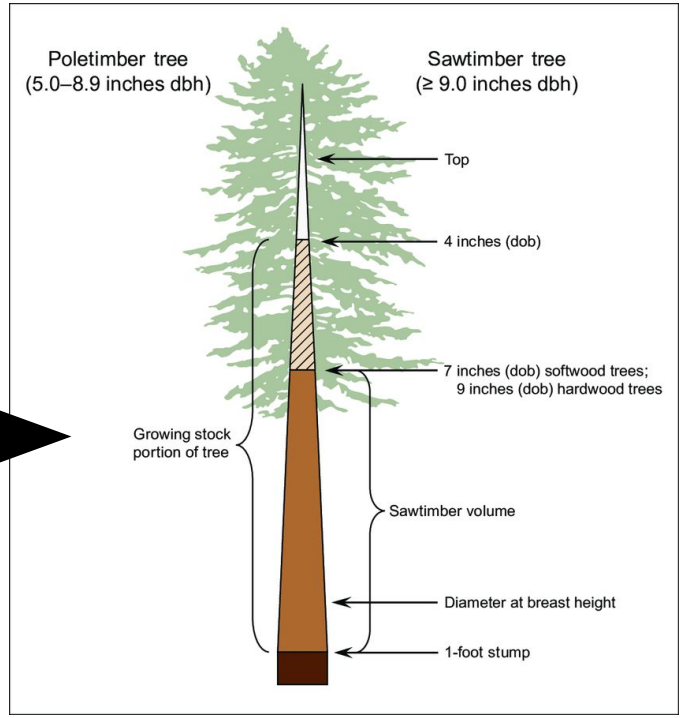
Traditional way to determine biomass of a tree (Carbon is about 48.5% of biomass for oaks)

Use measurements of tree height and DBH to calculate biomass using allometric equations

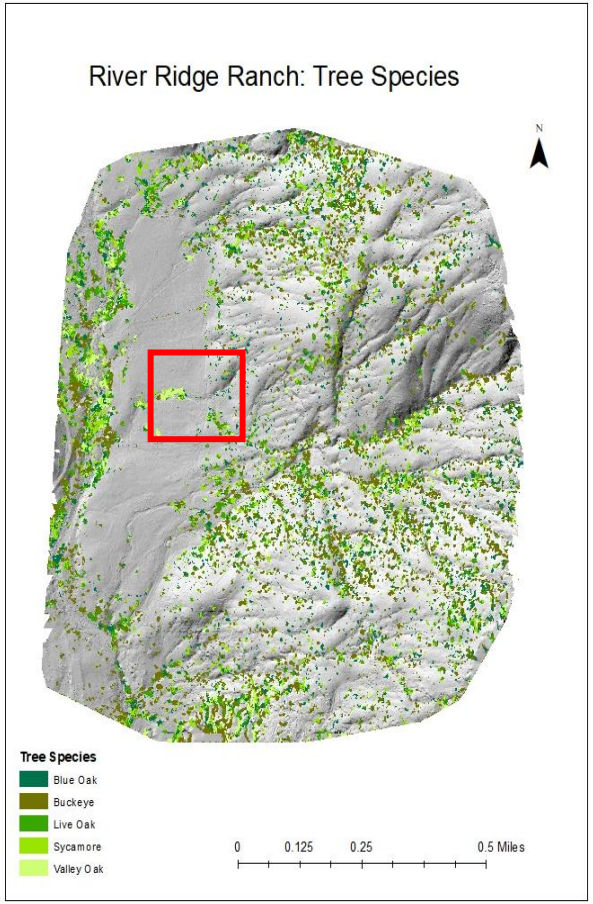
Diameter at breast height (DBH)

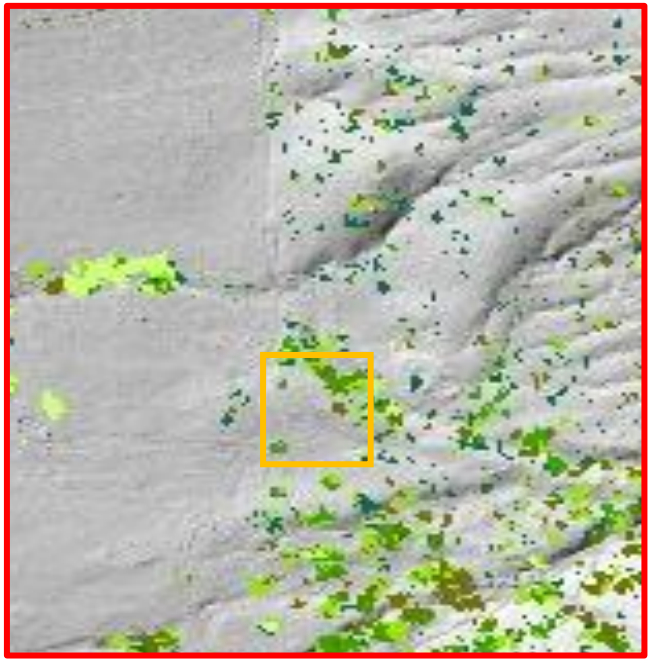
+

Height of tree



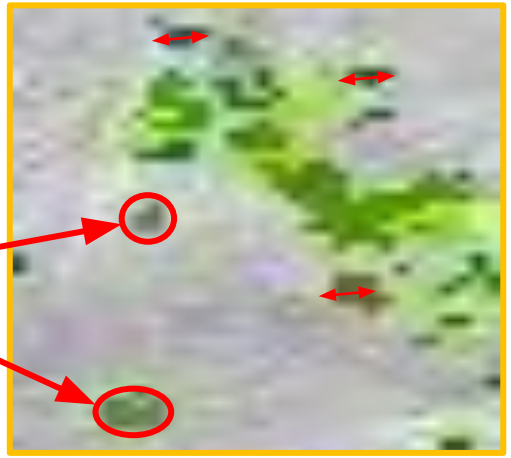
Allometric Equations based on decades of research in forestry



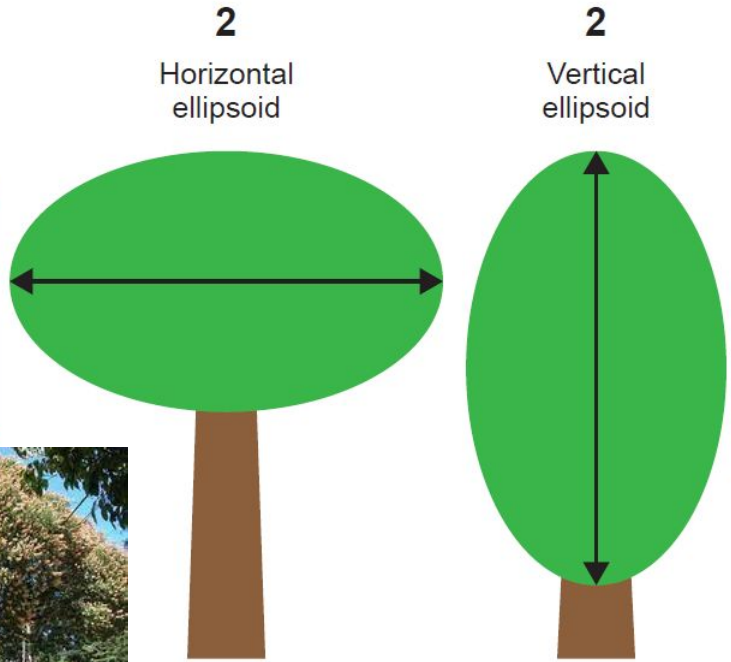


Measure tree canopy and height from tree map (drone data)

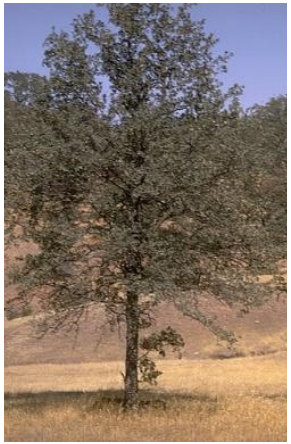
We can estimate canopy dimensions from drone imagery



Research Question: What dimensions are best to use by species?



Buckeye



Blue Oak

Took measurements of:

- Tree height
- Canopy perimeter.
- Canopy area
- Canopy area * Height

Tree Team Objectives

- Task 1: Drone derived tree canopy and height measurements for RRR
  - Canopy map produced by graduate student, Kenya Creer
  - Digital elevation model produced by Scott Winslow
- Task 2: Tree classification and canopy map
  - Imagery produced by Scott Winslow
- Task 3: Field-based data on tree height, DBH and canopy dimensions
  - Derive species based equations linking tree height and canopy to DBH
  - Use existing allometric equations linking DBH to biomass/carbon
  - Merge field and drone data to test accuracy of carbon model

Task 1

Using Drone Imagery and Geospatial Information Systems to determine the above ground biomass of trees on the ranch*

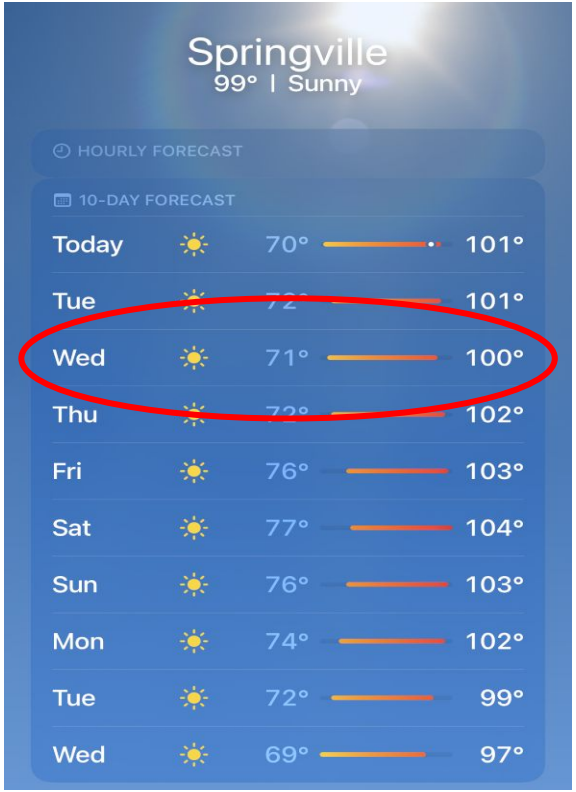
Why?

Simplified, Biomass = carbon sequestration

*Using a global equation

Why Use GIS?

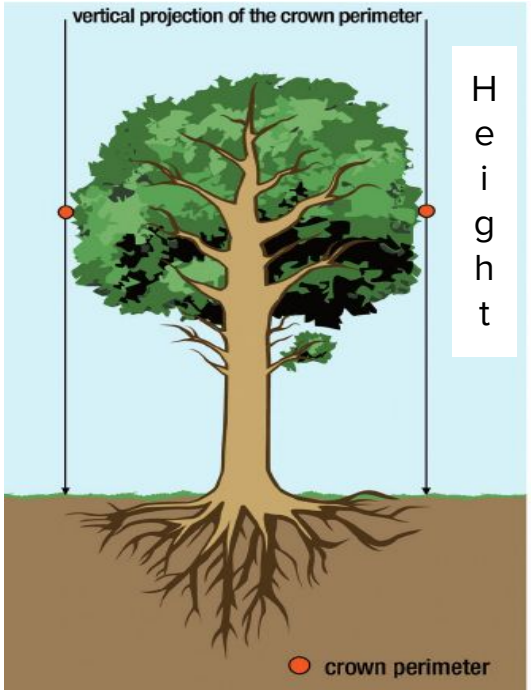
- Labor
- Time
- Terrain
- Weather
- Wildlife

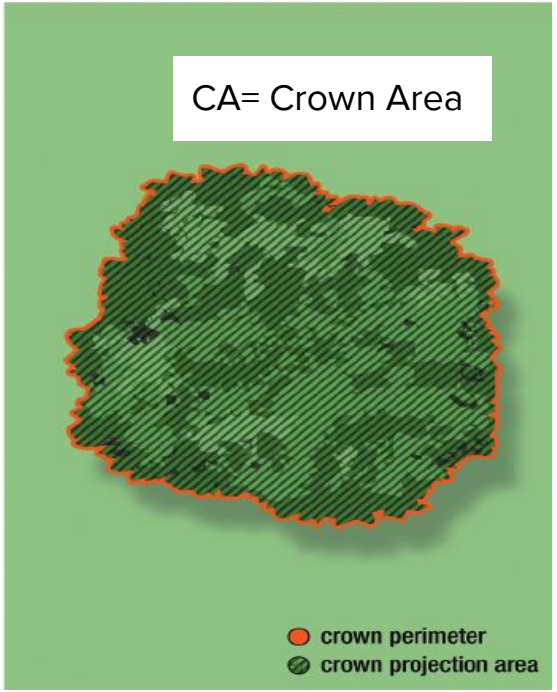


In order to calculate how much carbon is stored above ground on the ranch,

we began with a global formula.

EXP(-1.3304 + 1.44*LN(CA*HEIGHT)) = AGB





What do we have to work with?

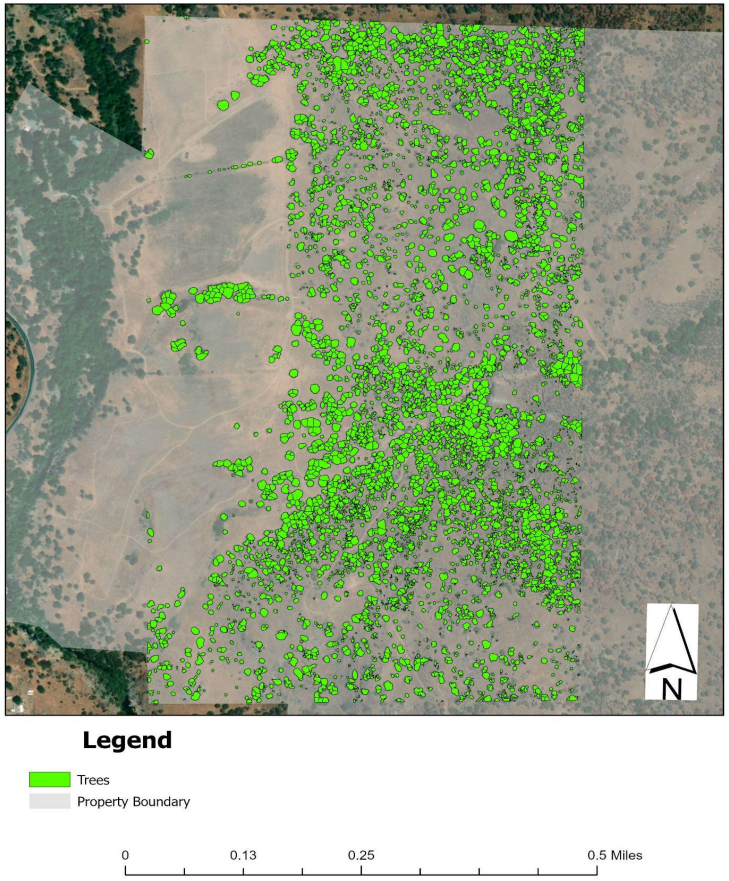
- A Data set with thousands of tree polygons*

- Not much data attached to them

FID	Shape	Class_name
0	Polygon	Trees
1	Polygon	Trees
2	Polygon	Trees
3	Polygon	Trees
4	Polygon	Trees

Developed by graduate student, Kenya Creer

Mapped Trees on RRR



Acquiring Data

Drone flies assigned path

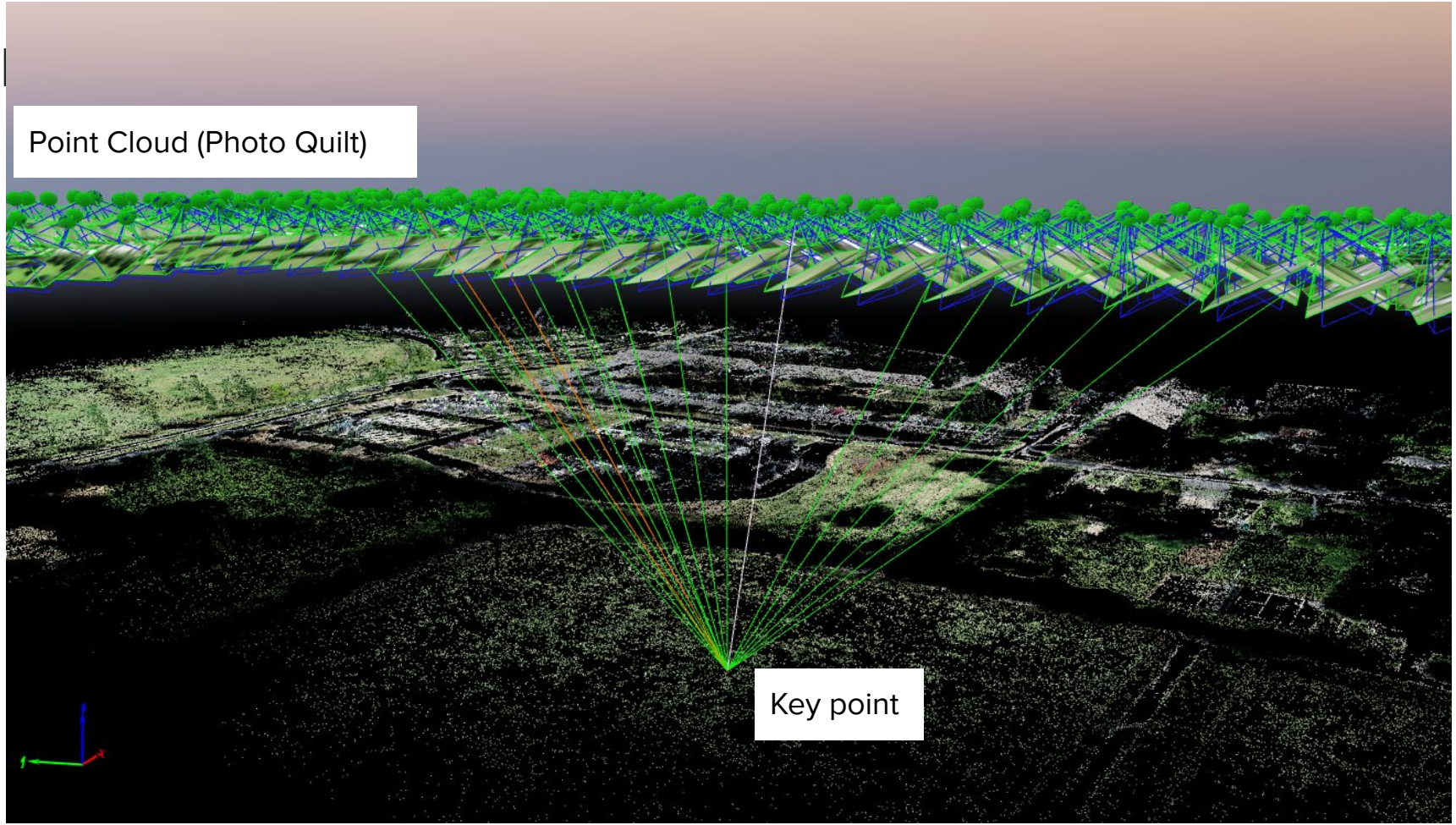
And takes

Pictures as it flies.

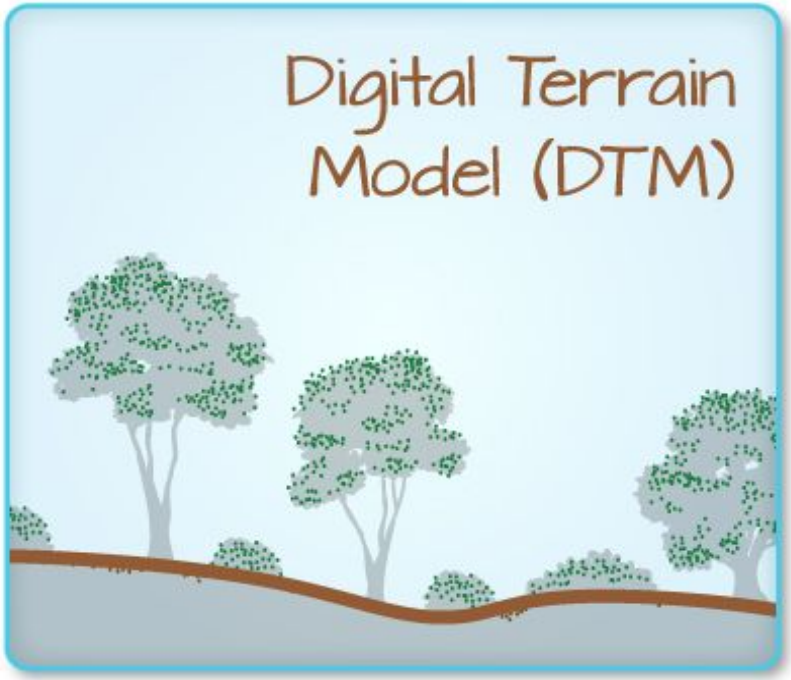
We’re talking a lot

Of pictures.

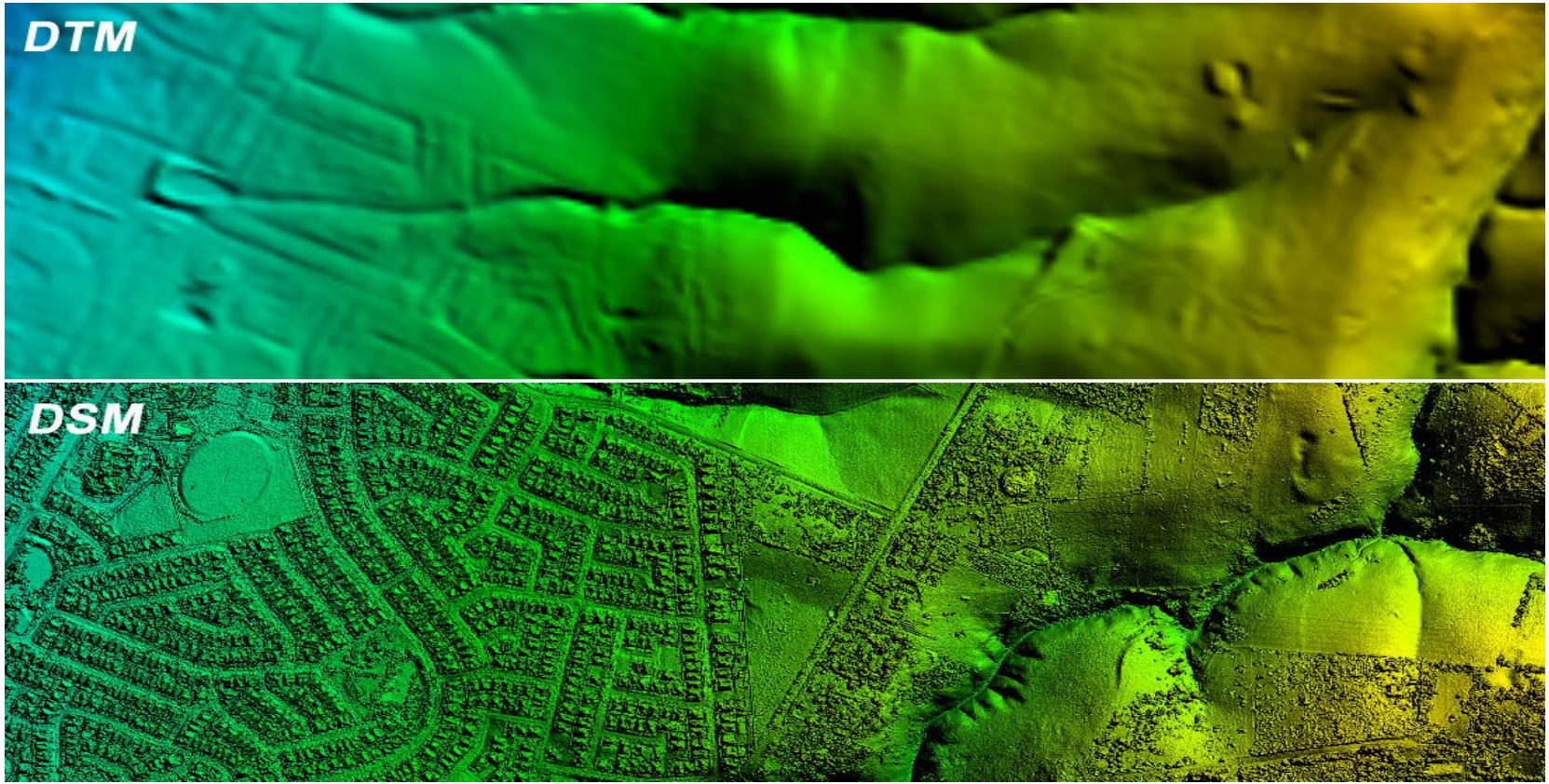
Calculating 3D data with Photogrammetry



Output: DSM and DTM



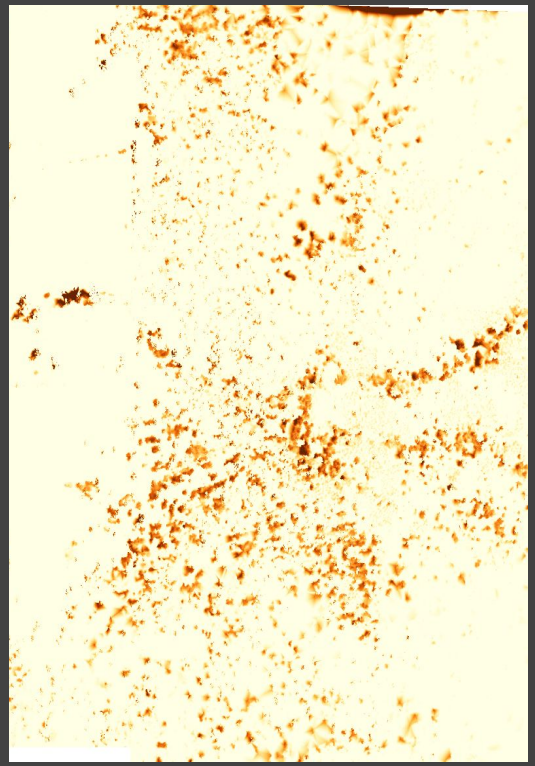
Output: DSM and DTM

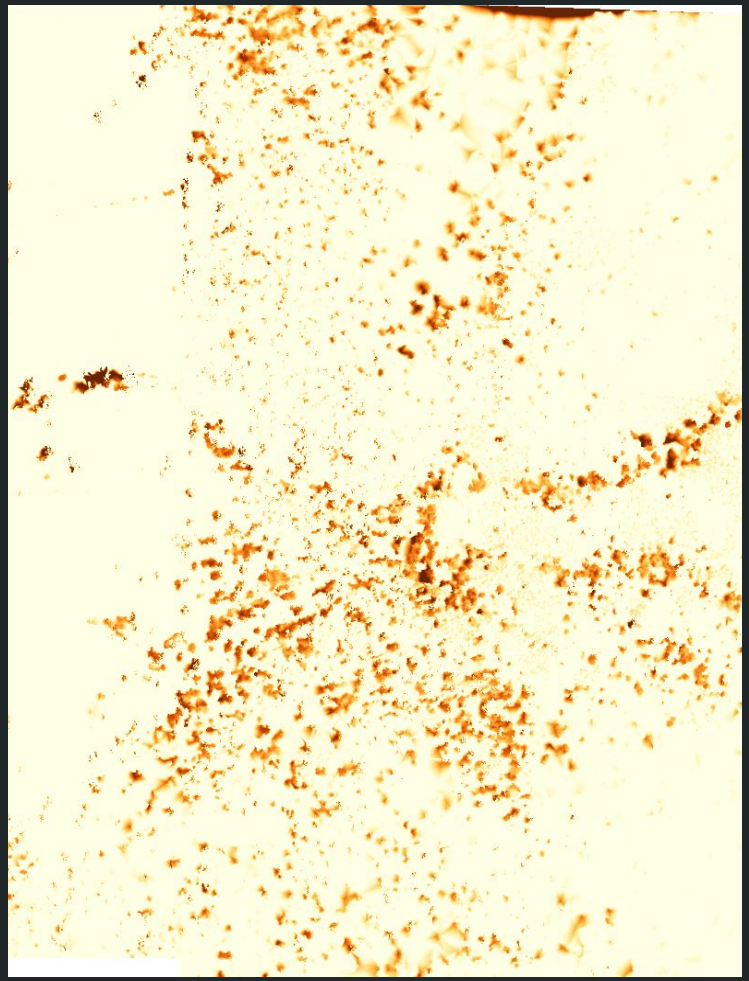


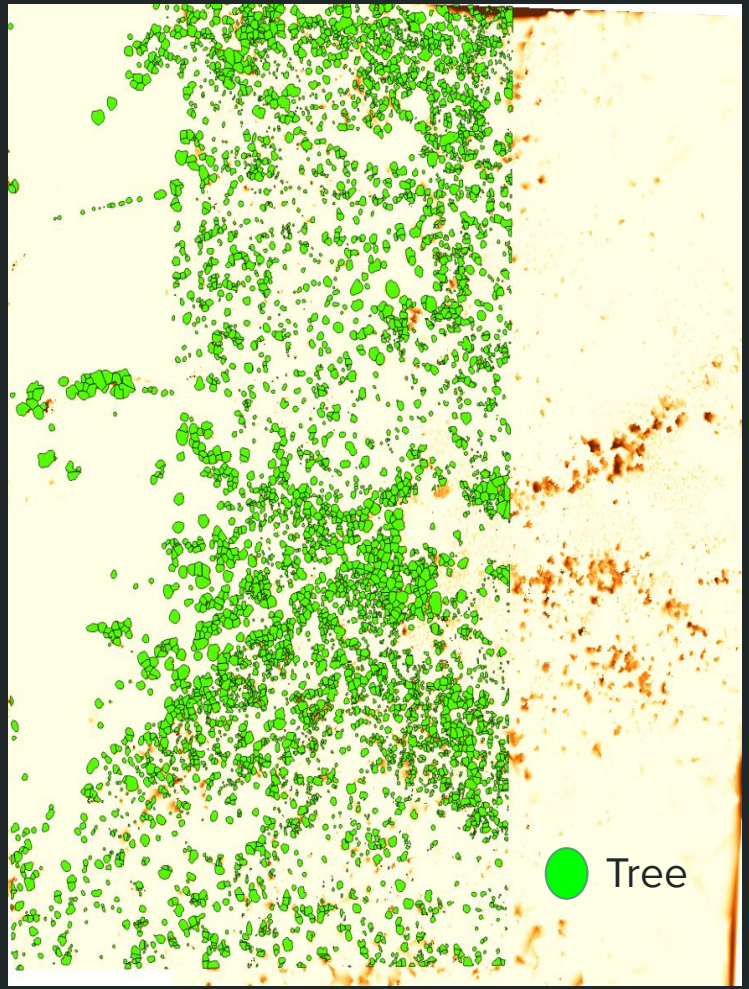
Digital Surface Model

Digital Terrain Model

Heights found above ground






Tree

Finding Area

Used a GIS tool to calculate the geometry of the polygons and it gave us the areas values for each tree polygon

Now we have all these values

FID	Area	AREA	MIN	MAX	MEDIAN	PCT99
0	9.957477	9.89	0	0.099731	0.035034	0.094922
1	93.018076	93.04	0	1.710999	0.448425	1.516399
2	56.58894	56.58	0	1.586304	0.725098	1.502468
3	53.990752	53.98	0	3.077332	0.063446	1.175629

Grand Total

8308337 Kilograms*

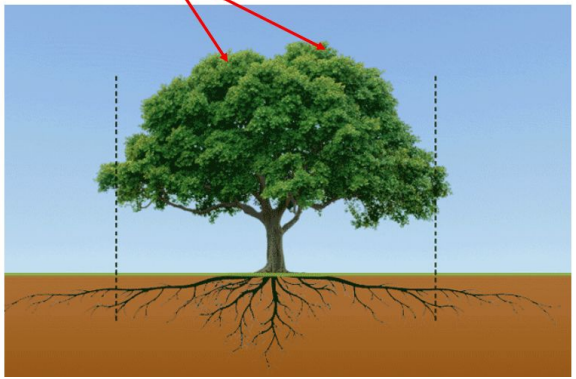
Based on global formula

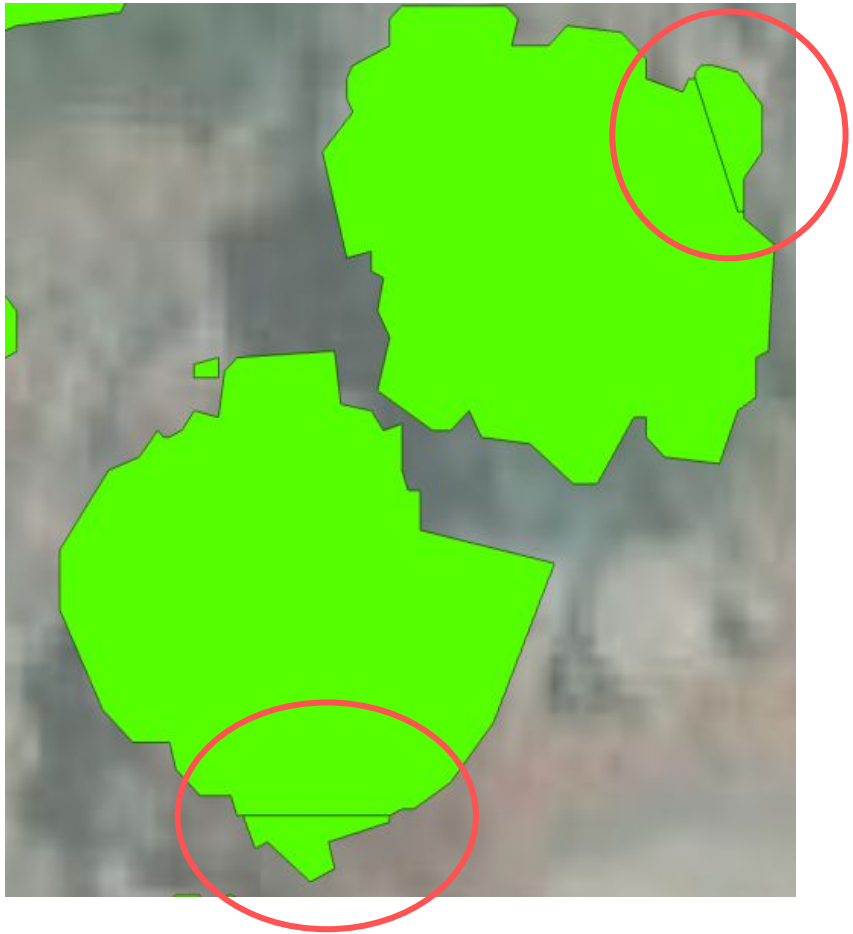
Problems

-Over segmentation

(Software assigns 2 polygons to one tree)

Very different crown shapes
with multiple peaks!



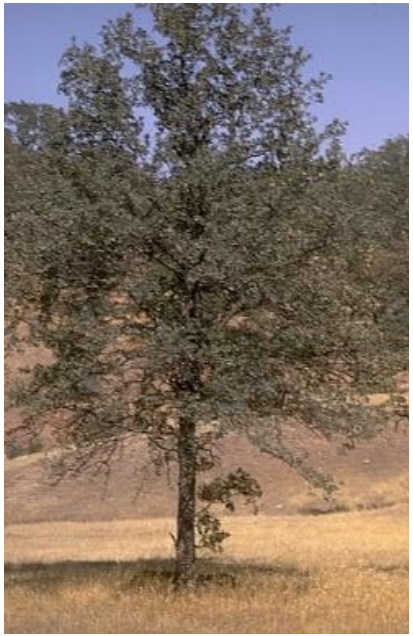


Problems

*Global formula is based on all hardwood trees

Species specificity

Buckeye



Blue Oak

Questions?

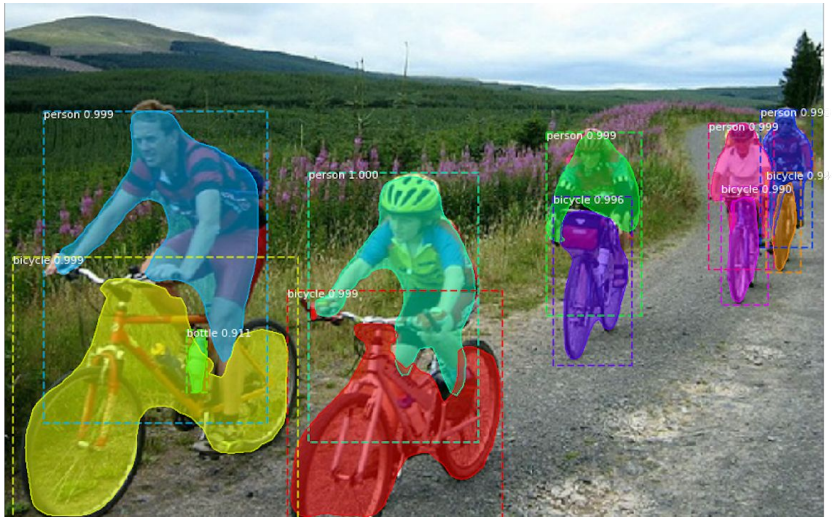
Task 2: Tree classification and canopy map

-We need a map of all the trees by species and the canopy area of each tree

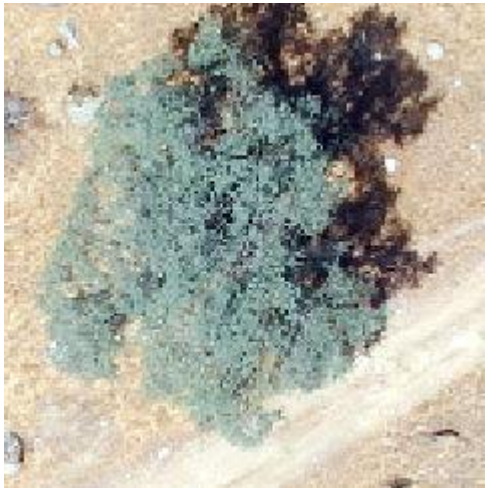
-There are three ways we can do this:

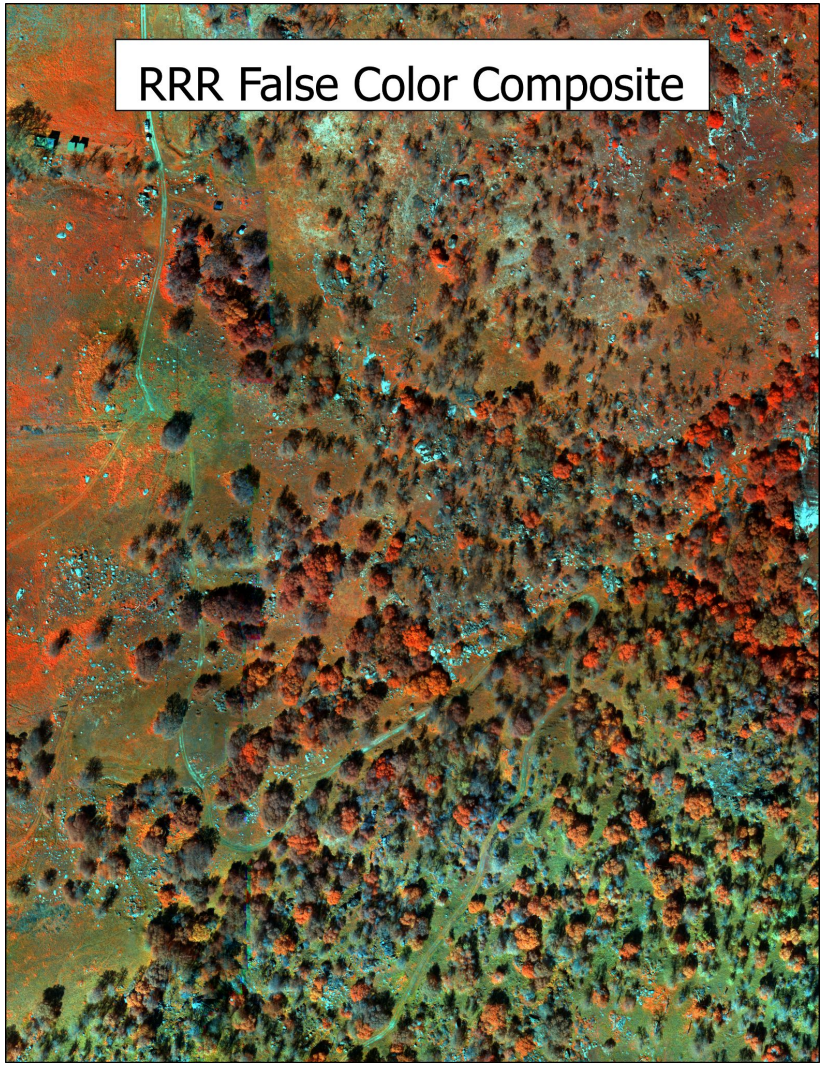
1. We can go out and walk the canopy for every tree on the ranch
2. We can manually draw polygon for every tree on the ranch using our UAV imagery.
3. We can use automated Machine Learning methods to classify trees and their canopy map (I choose this one)

Mask RCNN - Convolutional Neural Network

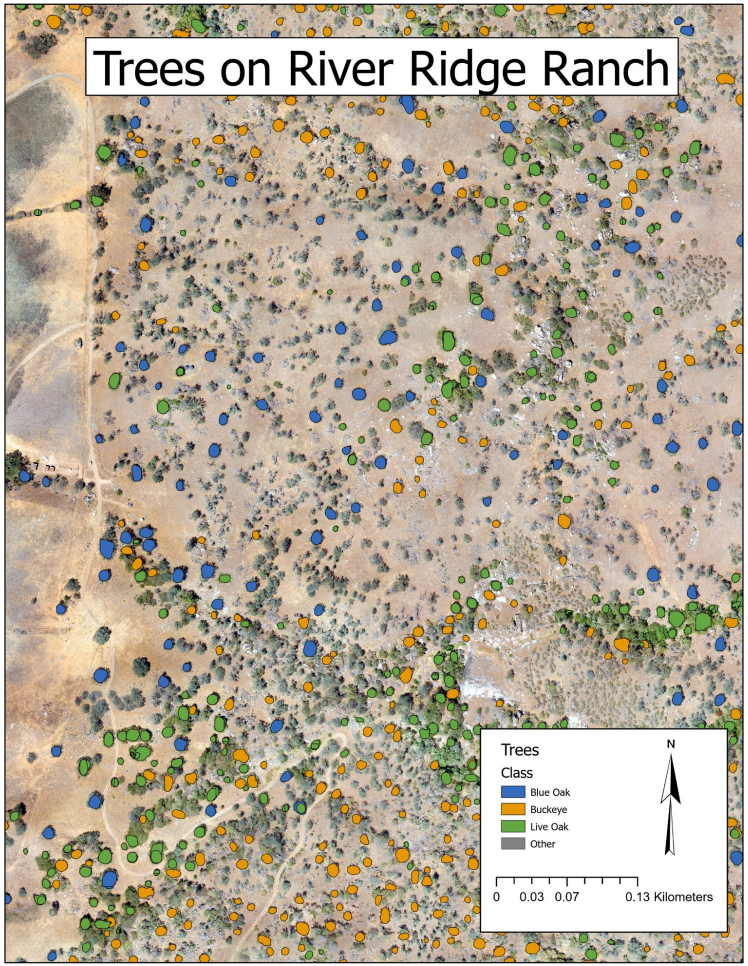


Training Samples (What is a Tree?)

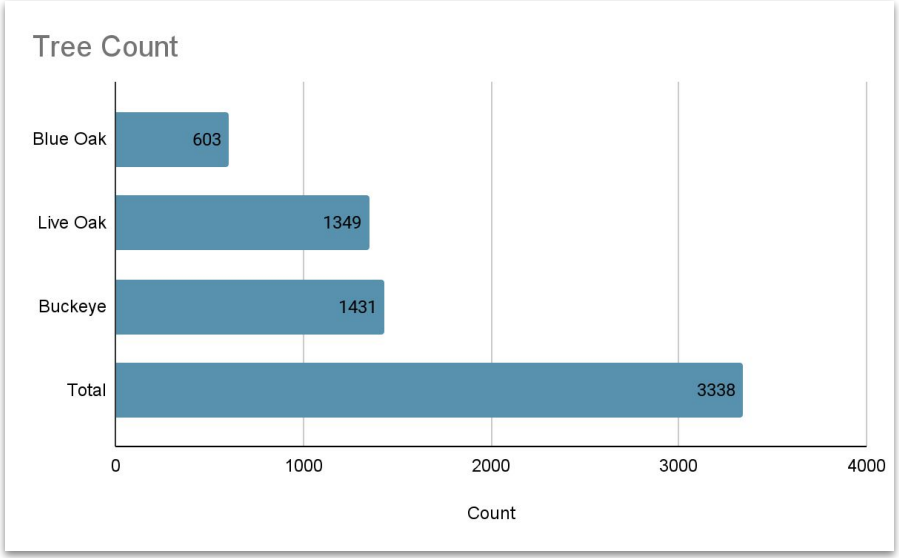



RRR False Color Composite


RRR High Resolution

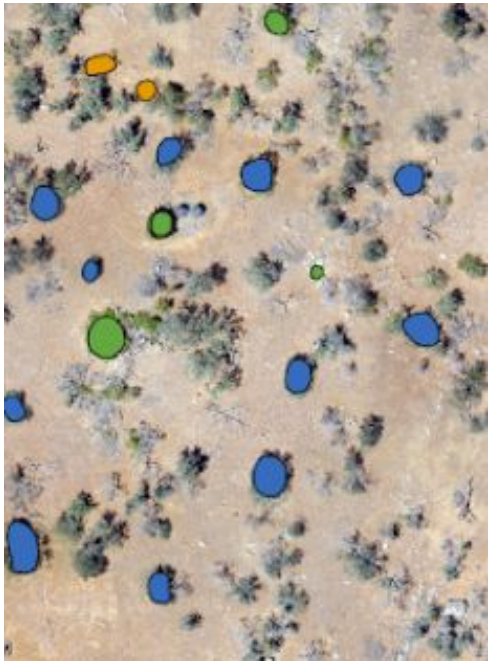


Preliminary Results



Limitations

- Not all trees are mapped
- Some False Positives
- My Knowledge (different parameters better outcomes?)



Positives

- Mask RCNN is detecting tree species and canopy with accuracy (Fewer over segmented trees)
- Going forward what can we do to improve the model so it can detect even more trees?

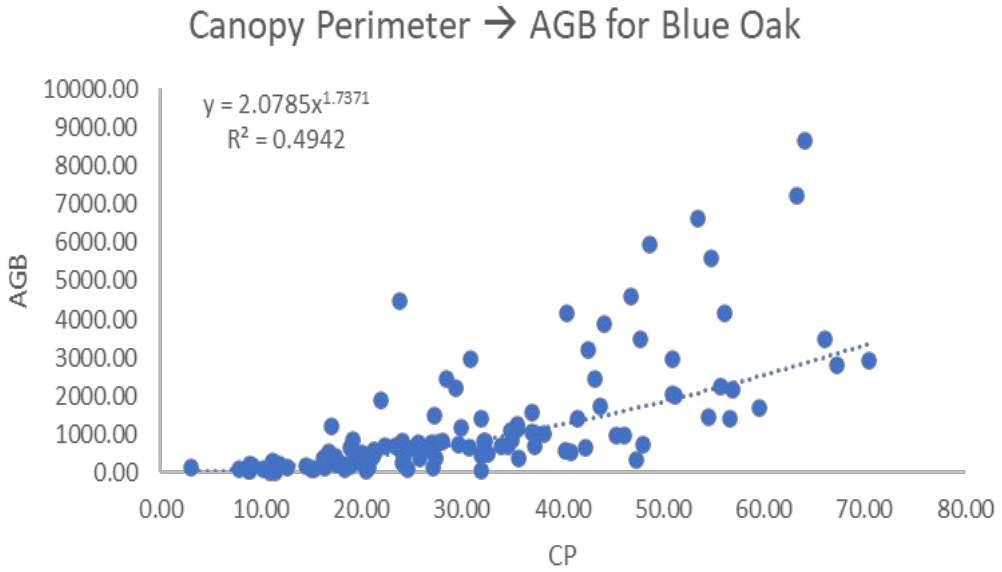
Questions?

Task 3: Field-based data on tree height, DBH and canopy dimensions

- Collected DBH, height, canopy perimeter and canopy area for roughly 260 trees
- Calculated the actual AGB with species-specific allometric equations
- Ran regression models to determine the best way to estimate AGB (without having to collect field data)

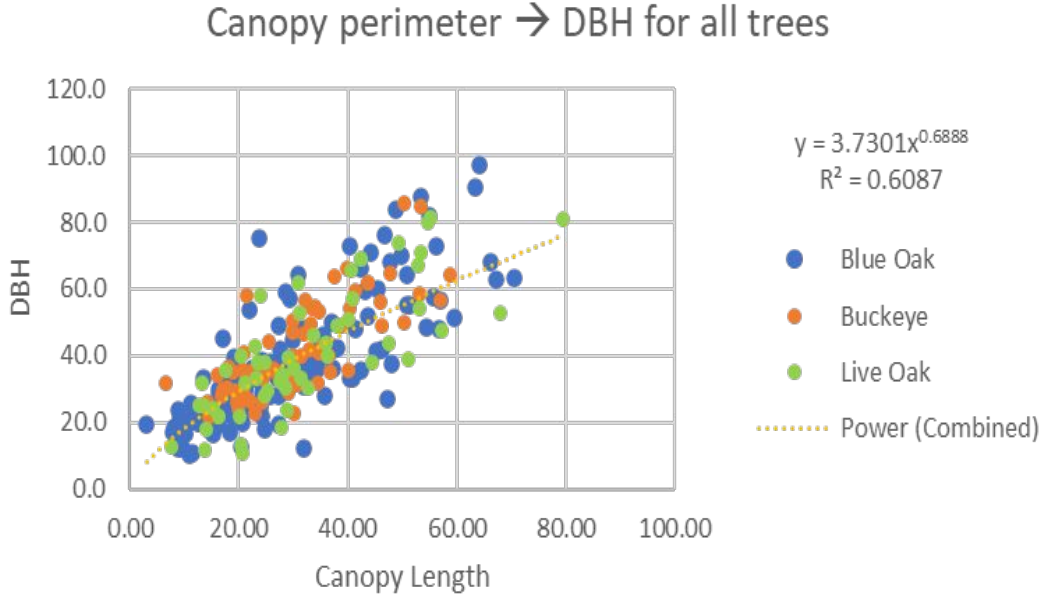
Regression: Canopy dimensions to AGB

	Actual AGB	AGB Estimate 1 (CA*H-->AGB)	AGB Estimate 2 (CP-->AGB)	AGB Estimate 3 (DBH-->AGB)
	270168.2	225951.0	220849.8	266551.7
Margin of Error		16.4%	18.3%	1.3%



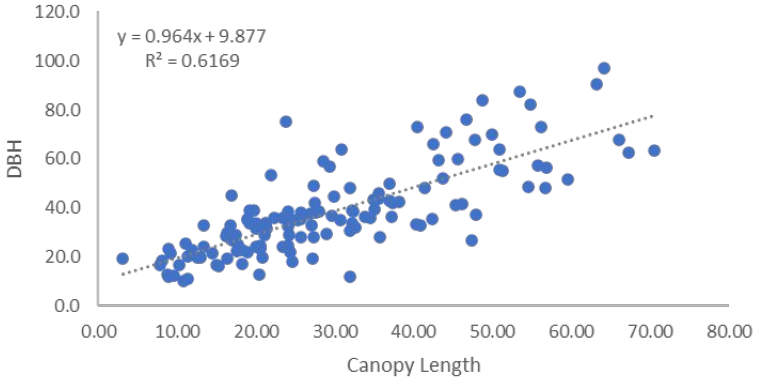
Regression: Canopy Dimensions to DBH

	Actual AGB	AGB Estimate 4 (CA*H-->DBH-->AGB)	AGB Estimate 5 (CP-->DBH-->AGB)	AGB Estimate 6 (combination of 4 & 5)
	270168.2	224855.6	236786.7	241224.5
Margin of Error		16.8%	12.4%	10.7%

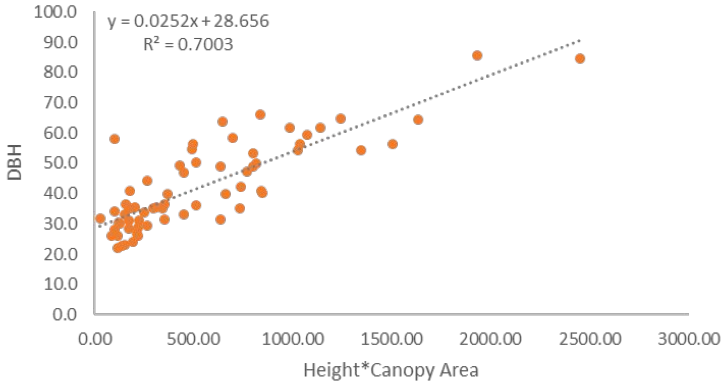


DBH Regressions

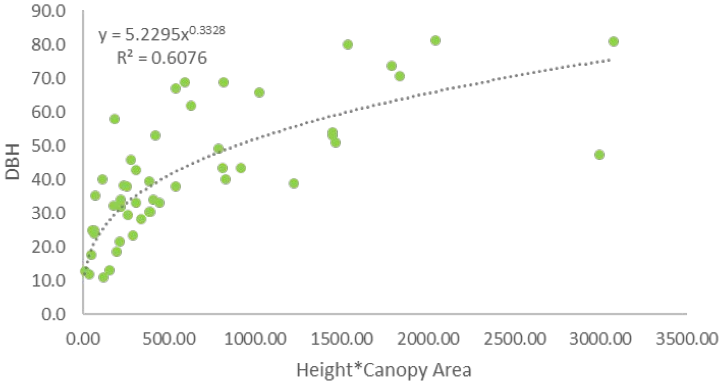
Canopy perimeter → DBH for Quercus douglasii



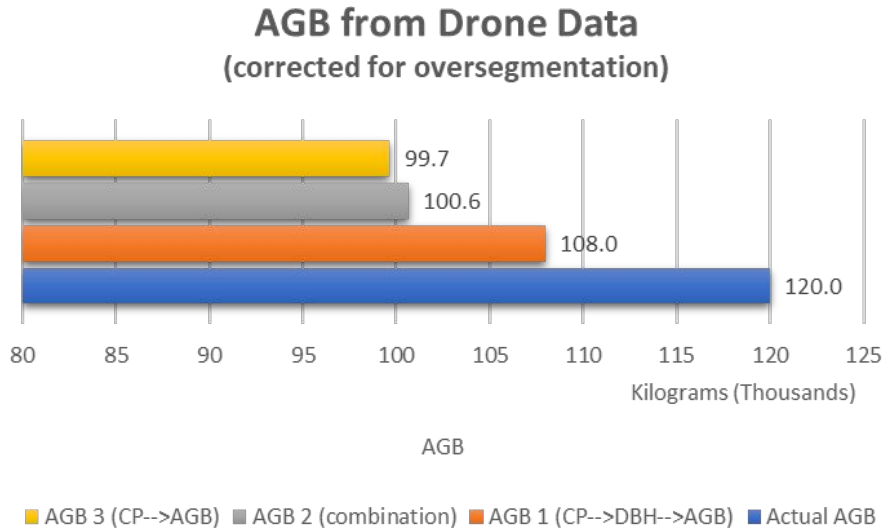
CA*H → DBH for Aesculus californica



CA*H → DBH for Quercus agrifolia



Species-Specific Model Drone Based Estimates of AGB



- 90 of the remotely sensed polygons overlapped with our tree polygons collected in the field
- Calculated the AGB of the subset using the field data and compared it to the RS data
    - I made two datasets: one where I fixed for oversegmentation, and one with the raw RS data
- I used species-specific formulas I generated relating Canopy Perimeter and Canopy Area multiplied by Height to DBH
- Plugged in the predicted DBH values to allometric equations

Conclusion

We’re on the right track! Our AGB model with the drone data subset only underestimates by roughly 10%. If we can generate better polygons, then perhaps we can get an even better estimate.

We find that it is important to develop species-specific equations if you want accurate results for a localized region.

Future work should aim to improve the algorithm so that it can map all trees at the species level while eliminating the over segmentation issue.

We’d also like to test our model on other local ranches, and see how slight geographic differences may affect it