Progress Report

INTERN: Improving Forest Sample Estimation Through UAS Canopy Structure Stratification

Project Code: CAFS.21.90

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Justification

- Increased demand for more accurate and time/cost-efficient forest inventories
- Explore practical use of modern remote sensing techniques. How can we use inexpensive RS technology to meet demands?
- **Objective:** Evaluate the use of UAS to improve traditional stand inventories through photogrammetric stratification of imagery-derived canopy height models
- Collaboration with LandVest, WA DNR, and University of Idaho
- Mentorship
  - Learn from experienced professionals
  - Participate in weekly team meetings
  - Feedback on performance

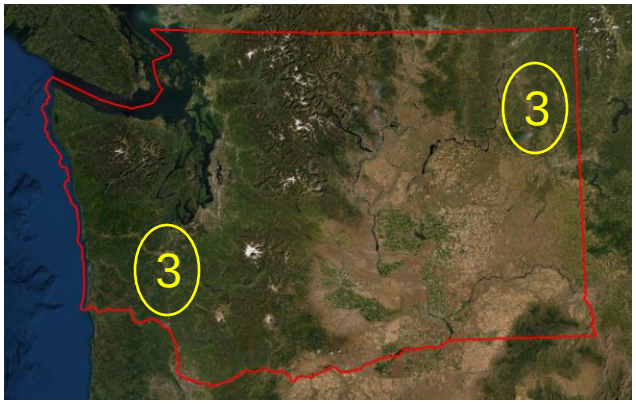
Hypotheses

- **#1**: UAS-derived imagery and photogrammetric processes can be used to perform a sufficient height-based stratification to improve volume estimation.

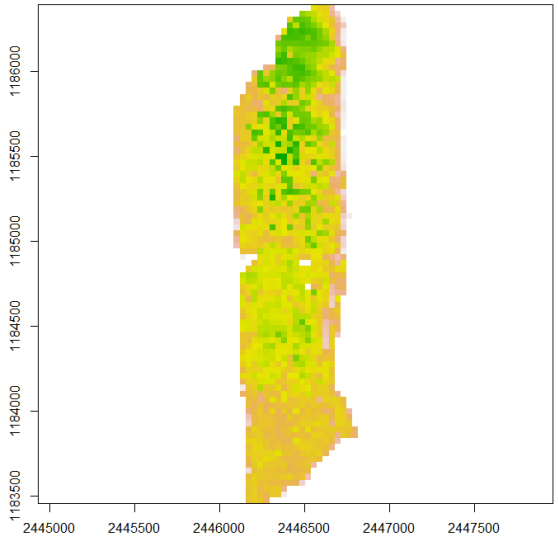
- **#2**: Sample sizes can be optimized through UAS stratification to reduce costs associated with traditional systematic inventories

Methods

- **Methods:**
  - Six stands selected
    - 3 Westside, 3 Eastside Washington
  - Aerial imagery collected with DJI Mavic 2 Pro drone
  - Agisoft Metashape software used to generate 3D point clouds from imagery
  - 3D point clouds used to create canopy height models (CHM)
  - Rasterized height pixels from CHMs clustered to identify within-stand strata
  - Sample sizes created for each strata according to within strata variability and strata size
  - Plots randomly placed within strata
  - Plots cruised and compared to cruise results of traditional systematic inventory methods



Methods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Major Findings

- For most stands, UAS-stratified cruises yielded higher (worse) error statistics
- Potential time savings resulting from UAS plot optimization do not outweigh inadequate error statistics
  - *For this particular analysis

	Net Vol (bf/ac)		
Unit	Traditional	Stratified	% Diff
CAPRA U2	48,031	45,857	4.6
OXBOW U2	28,644	26,868	6.4
OXBOW U5	23,772	21,394	10.5
WILDWOOD U1	32,360	32,167	0.6
WILDWOOD U3	26,004	22,174	15.9
WILDWOOD U4	25,107	15,498	47.3

	SE%	
Unit	Traditional	Stratified
CAPRA U2	7.4%	14.9%
OXBOW U2	5.1%	9.3%
OXBOW U5	9.1%	18.5%
WILDWOOD U1	5.3%	13.7%
WILDWOOD U3	12.3%	17.6%
WILDWOOD U4	**21.7%**	**14.0%**

Major Findings

- Height alone may not serve as a sufficient stratifier when using UAS
- Inclusion of a density or basal area metric may improve UAS stratification methods

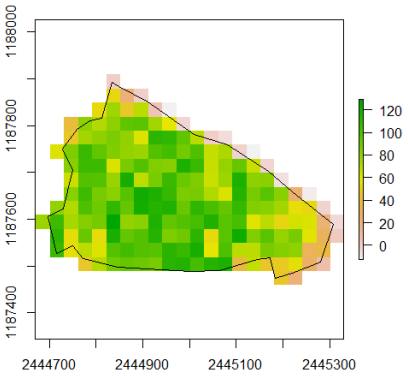
Row Labels	Sum of TPA	Sum of BAC	Sum of VAC
1	**361.08**	**320**	**44108**
1	60.62	40	4514
2	271.87	220	30770
3	28.59	60	8824
2	**969.13**	**720**	**109060**
4	233.81	220	35720
5	287.88	180	23908
6	447.44	320	49432
3	**714.07**	**660**	**108978**
7	290.4	260	46272
8	184.64	160	24092
9	239.03	240	38614

Deliverables

- *Upon improved stratification methods…
  - A newly developed protocol for operational use of UAS for forest stratification
    - Cost efficient alternative to other methods
      - Systematic, LiDAR, etc.

Company Benefits

- *Upon improved stratification methods…
  - More accurate error statistics relative to traditional systematic inventories
  - Time/cost savings resulting from needing fewer sample plots relative to other inventory methods



Recommendations

- The use of a density metric in addition to avg. height when stratifying stands
  - Tree crown count, etc.

- Increase minimum sample sizes for strata
  - Decrease time savings, but improve estimate accuracy

Summary

- Cruise data collected using UAS height-based stratification was inferior to systematically-collected cruise data (for most stands)
- Improvements to UAS stratification methods are needed to yield a more accurate and operationally-feasible product
- Positive/beneficial learning experience
- So… The answer is LiDAR