Applications of Spherical Photos for Estimating Forest Attributes

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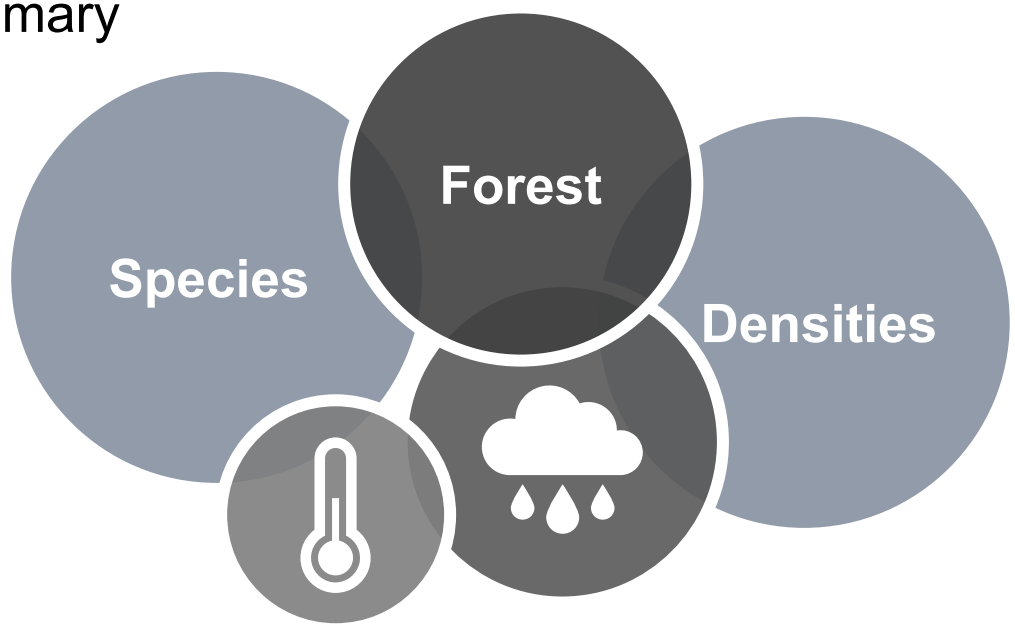
UNB

Forest Introduction

Dominant Terrestrial Ecosystem

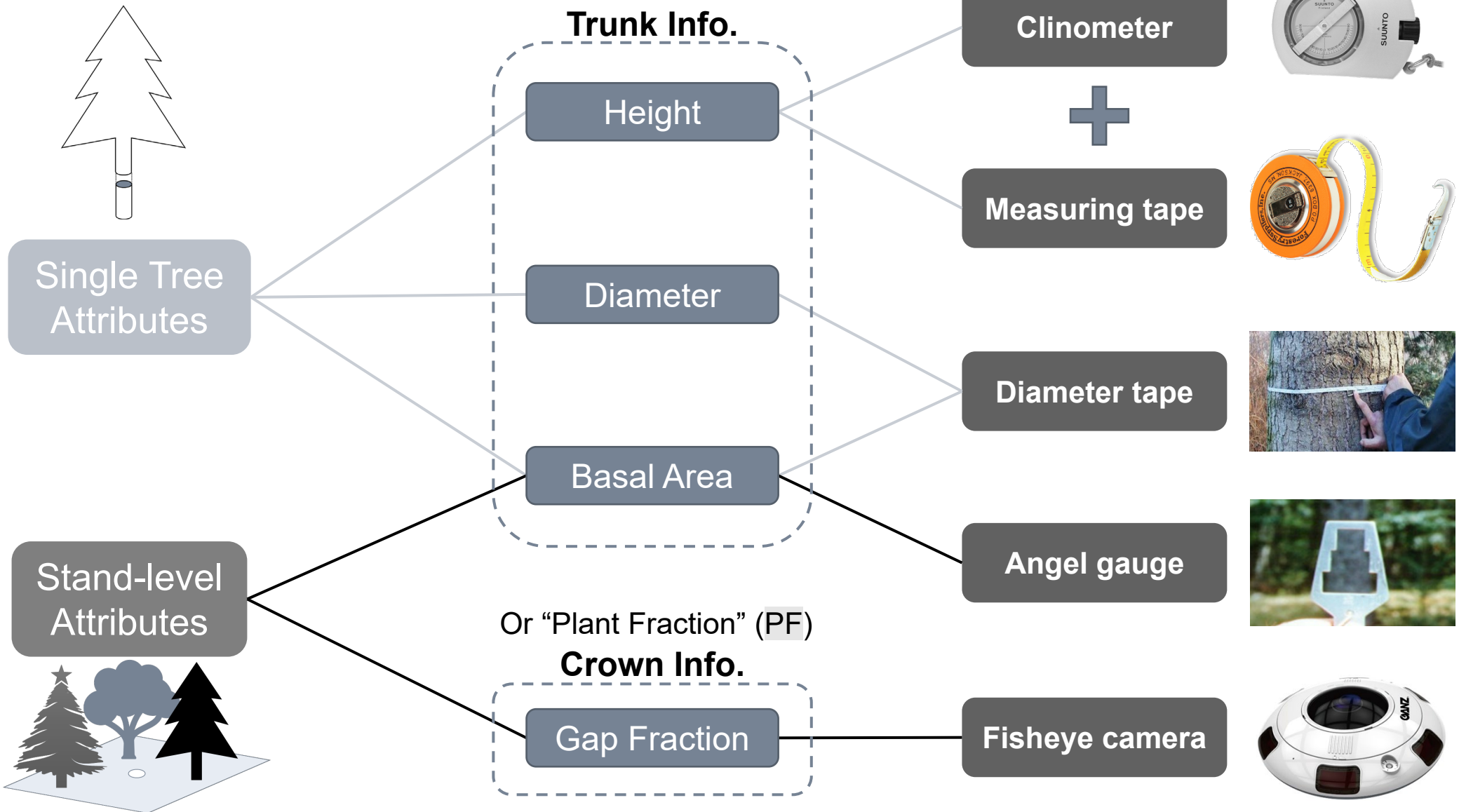
- **75%** biosphere gross primary productivity
- **80%** of plant biomass



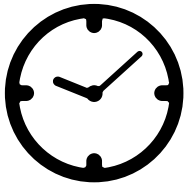
Service

- Watershed protection
- Soil maintenance
- Carbon Storage

Tree Attributes Field Measurement



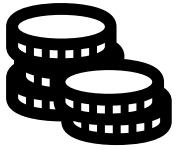
Current problems



Time consuming

Labor intensive

Revisit Validation



Unfriendly Price

Trunk Info.

- Height
- Diameter
- Basal Area

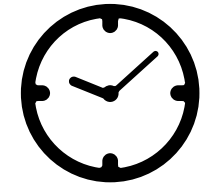
Or “Plant Fraction” (PF)

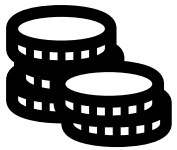
Crown Info.

- Gap Fraction

- **Clinometer** + **Measuring tape**
- **Diameter tape**
- **Angel gauge**
- **Fisheye camera**

Integrate Tool





Trunk Info.

Height

Diameter

Basal Area

Clinometer

+

Measuring tape

Diameter tape

Angel gauge

Or “Plant Fraction” (PF)

Crown Info.

Gap Fraction

Fisheye camera

Spherical Camera

Trunk Info.

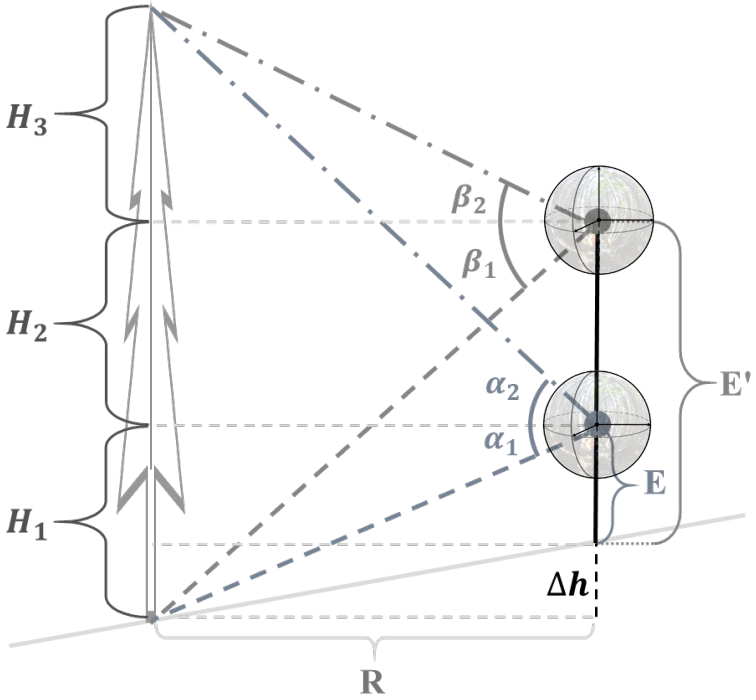
- Height
- Diameter
- Basal Area

Crown Info.

- Plant Fraction

- 360° Information
- Friendly price ($400)
- Light and Portable

Spherical Camera: Height&Diameter



1. Take images at 2 different elevations (E, E')
2. Pair two spherical images by 3 control points
3. Mark the base and top of the same tree in both images (α1, α2, β1, β2)

Trunk Info.

- Height
- Diameter
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Crown Info.

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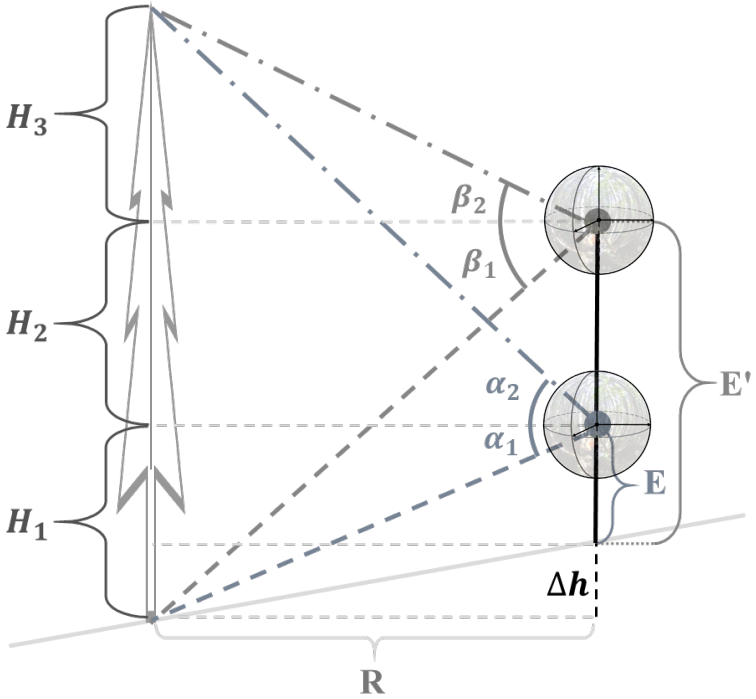
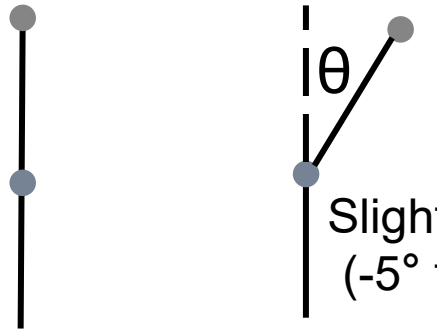
Spherical Camera: Height&Diameter



Trunk Info.

- Height
- Diameter
- Basal Area

- 360° Information
- Friendly price ($400)
- Light and Portable



Ideally

Actual

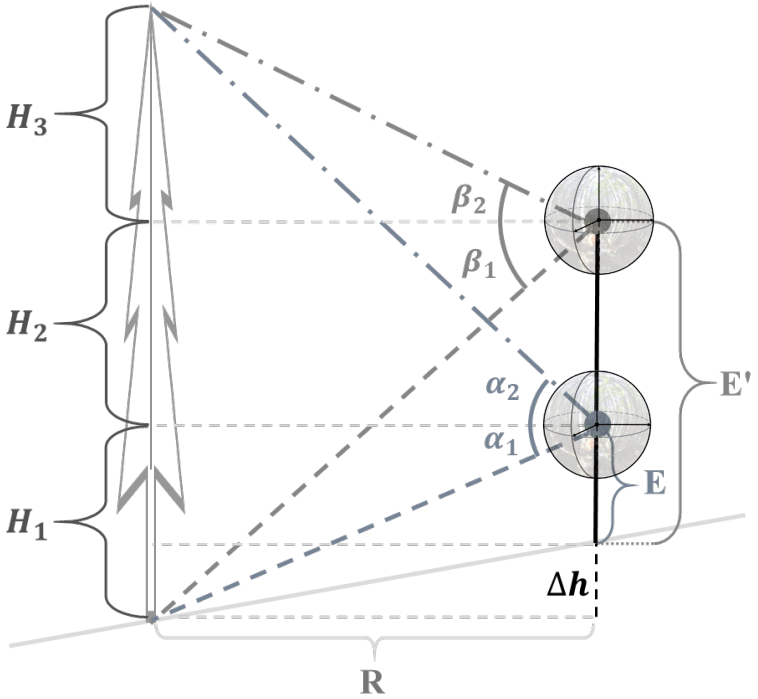
Slight lean
(-5° to 5°)

Lean Effect

Crown Info.

- Plant Fraction

Spherical Camera: Height



Height Dev. $\Delta h = \frac{tan(\beta_1) \cdot E - tan(\alpha_1) \cdot E'}{tan(\alpha_1) - tan(\beta_1)}$

Distance tree2camera $R = \frac{E + \Delta h}{tan(\alpha 1)}$

$$H = mean \begin{cases} R \cdot \tan(\beta 2) + R \cdot \tan(\beta 1) \\ R \cdot \tan(\alpha 2) + R \cdot \tan(\alpha 1) \end{cases}$$

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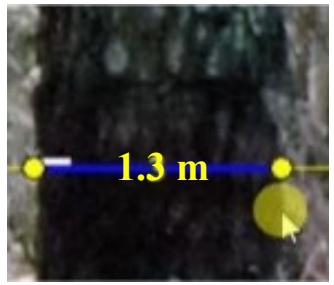
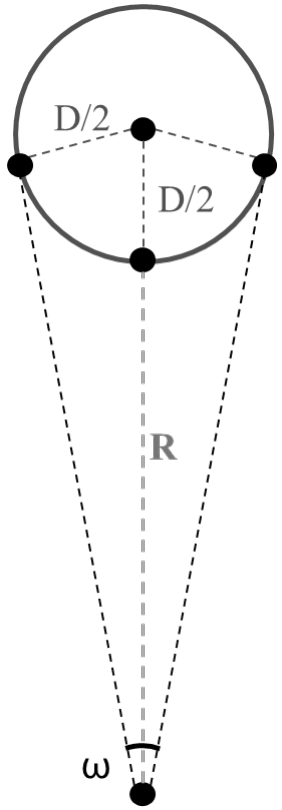
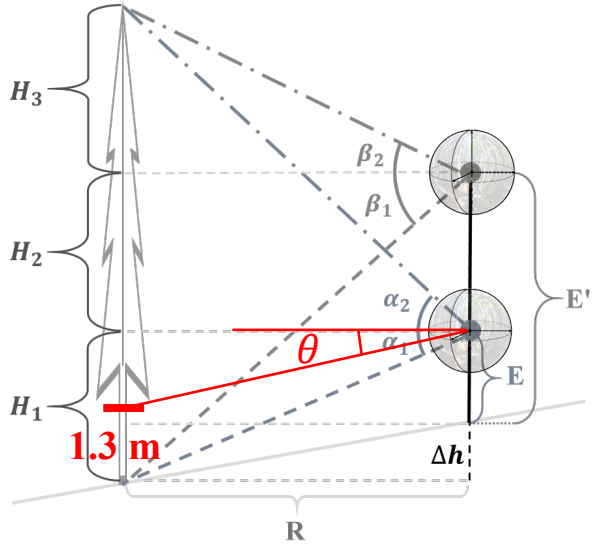
Spherical Camera: Diameter







1. Find breast height
2. Mark the left and right edge of a tree at 1.3m (breast height)
3. Projected Angle ω

Trunk Info.

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Spherical camera

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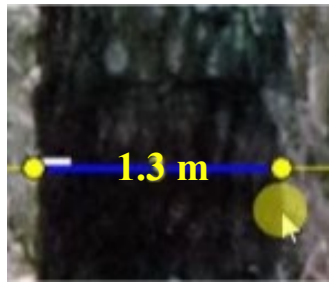
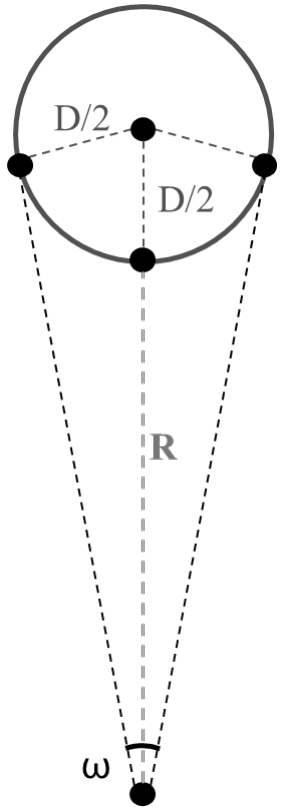
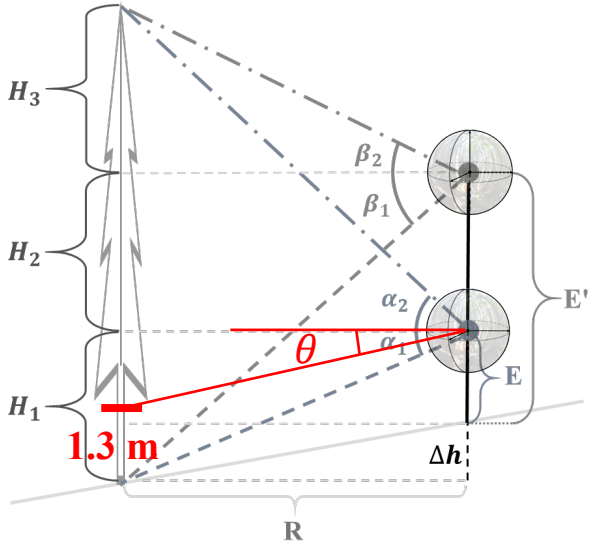
Spherical Camera: Diameter







1. Breast height angle (θ)

$$\theta = \arctan\left(\frac{E + \Delta h - 1.3m}{R}\right)$$

2. DBH

$$\mathrm{D/2} = \frac{sin\left(\frac{\omega}{2}\right) \cdot R}{1 - \sin\left(\frac{\omega}{2}\right)}$$

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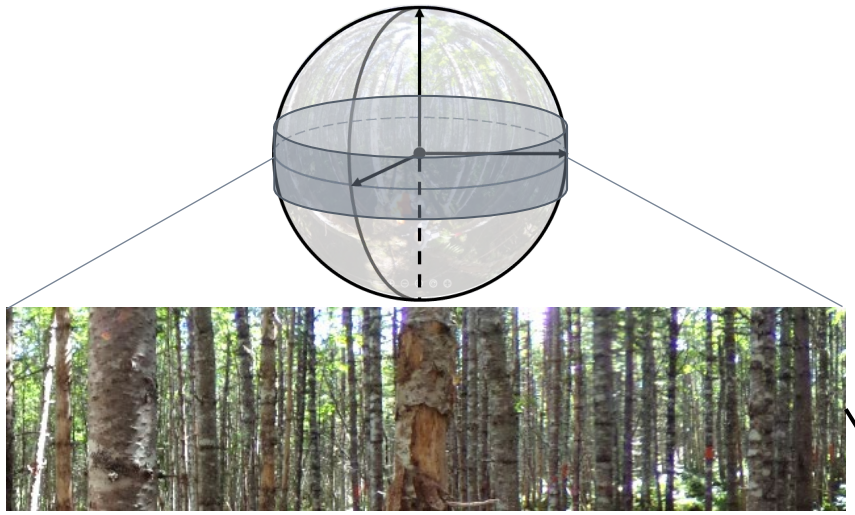
Spherical Camera: Basal Area



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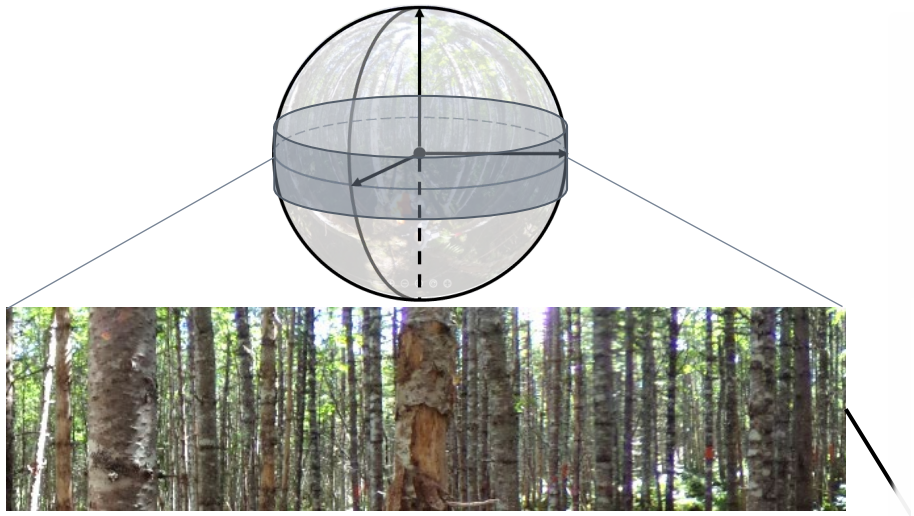
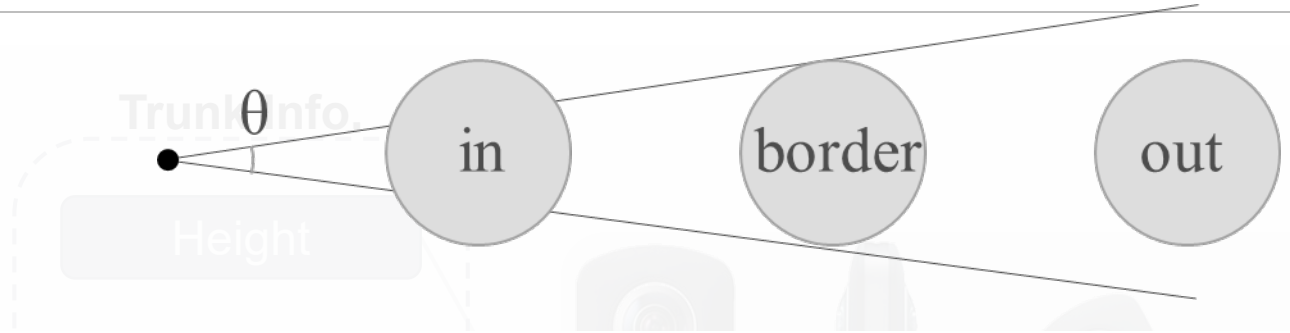
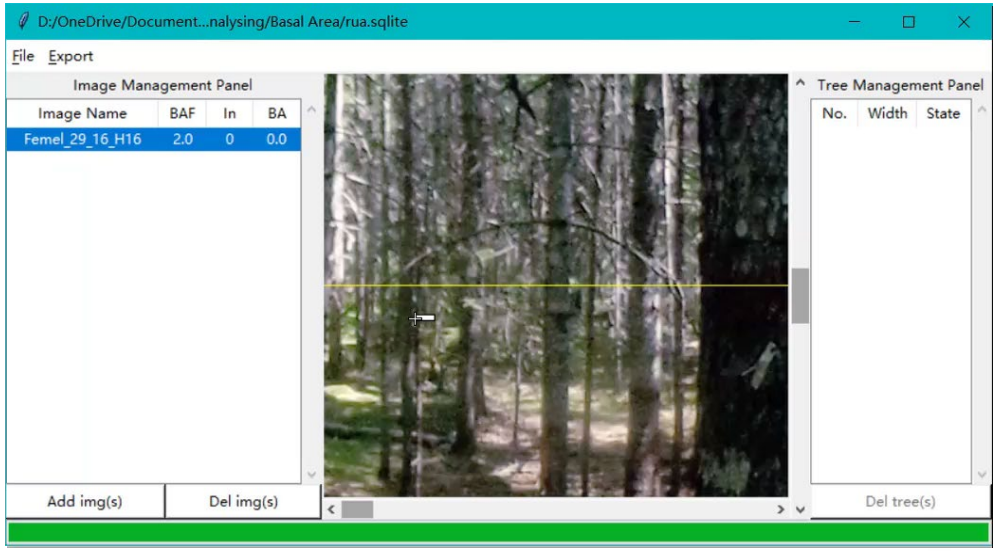
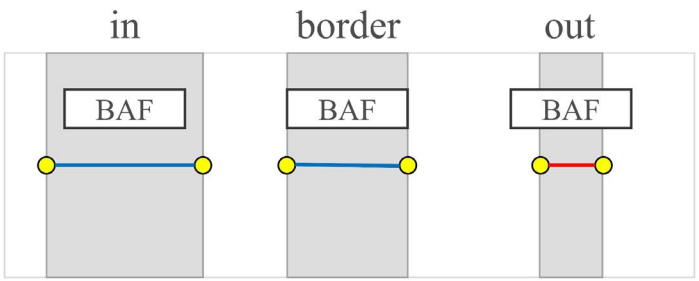
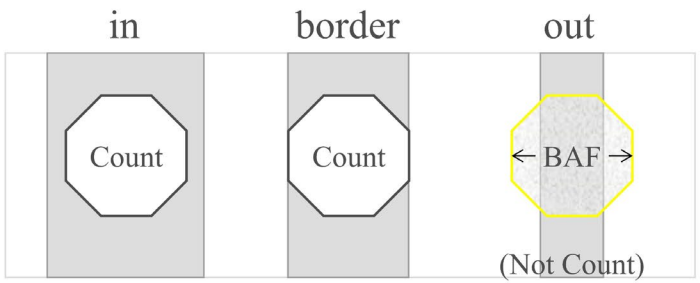






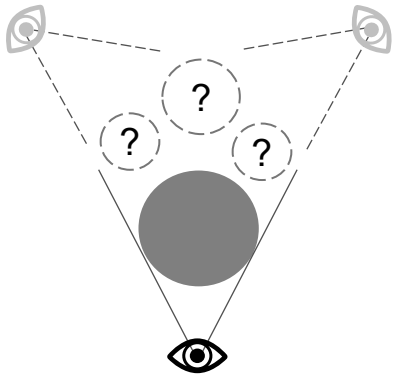


(a) Edge Marking



(b) Target Count

Spherical Camera: Basal Area



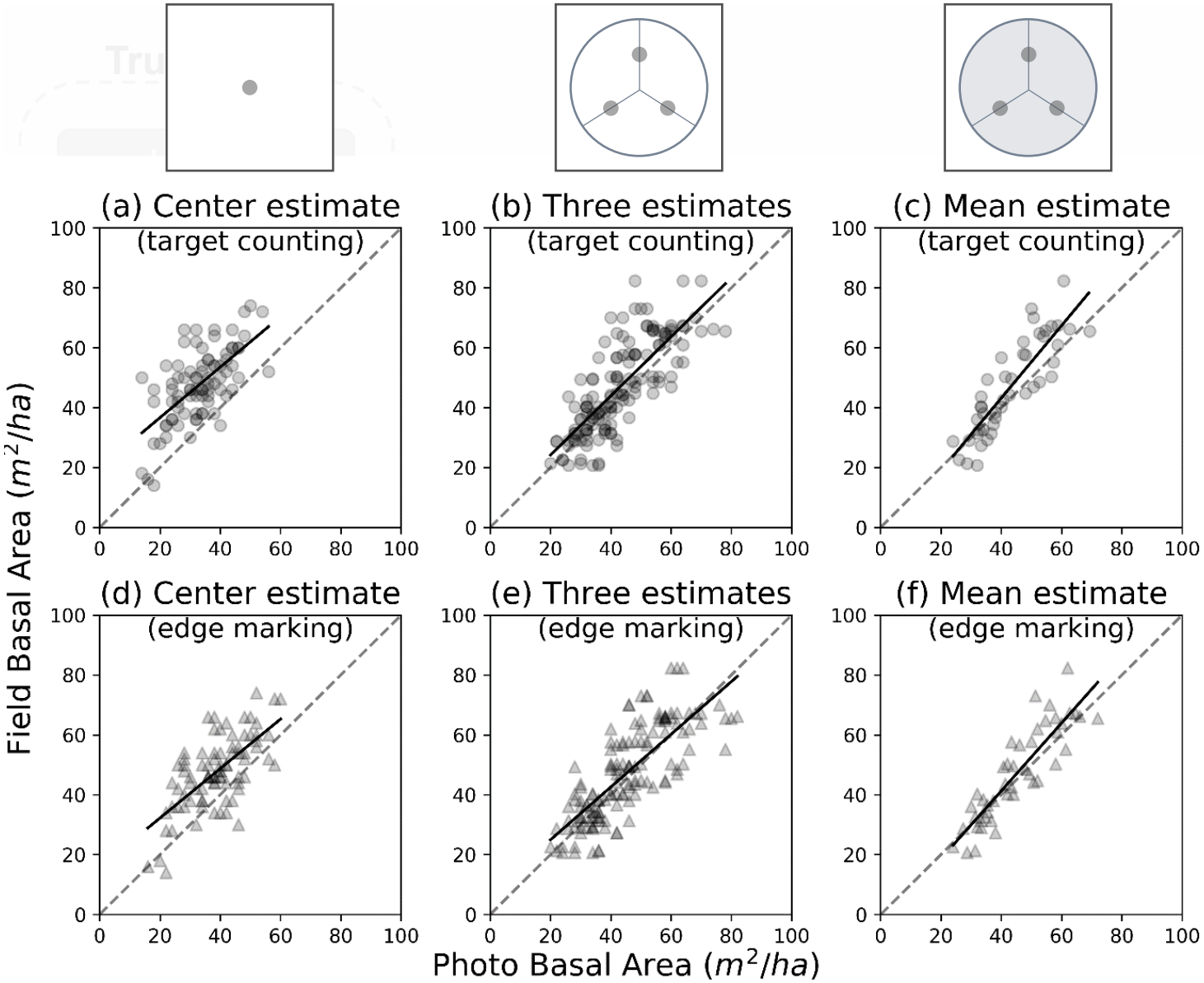
1. Hidden Tree

How different digital sample locations helps decrease its effect

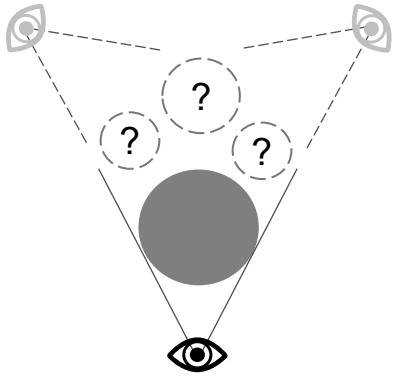
(a) Edge Marking

(b) Target Count

1. Three estimates better than one
2. The mean of three has smallest deviation to on hidden tree effects
3. Target Count better than Edge Marking



Spherical Camera: Basal Area



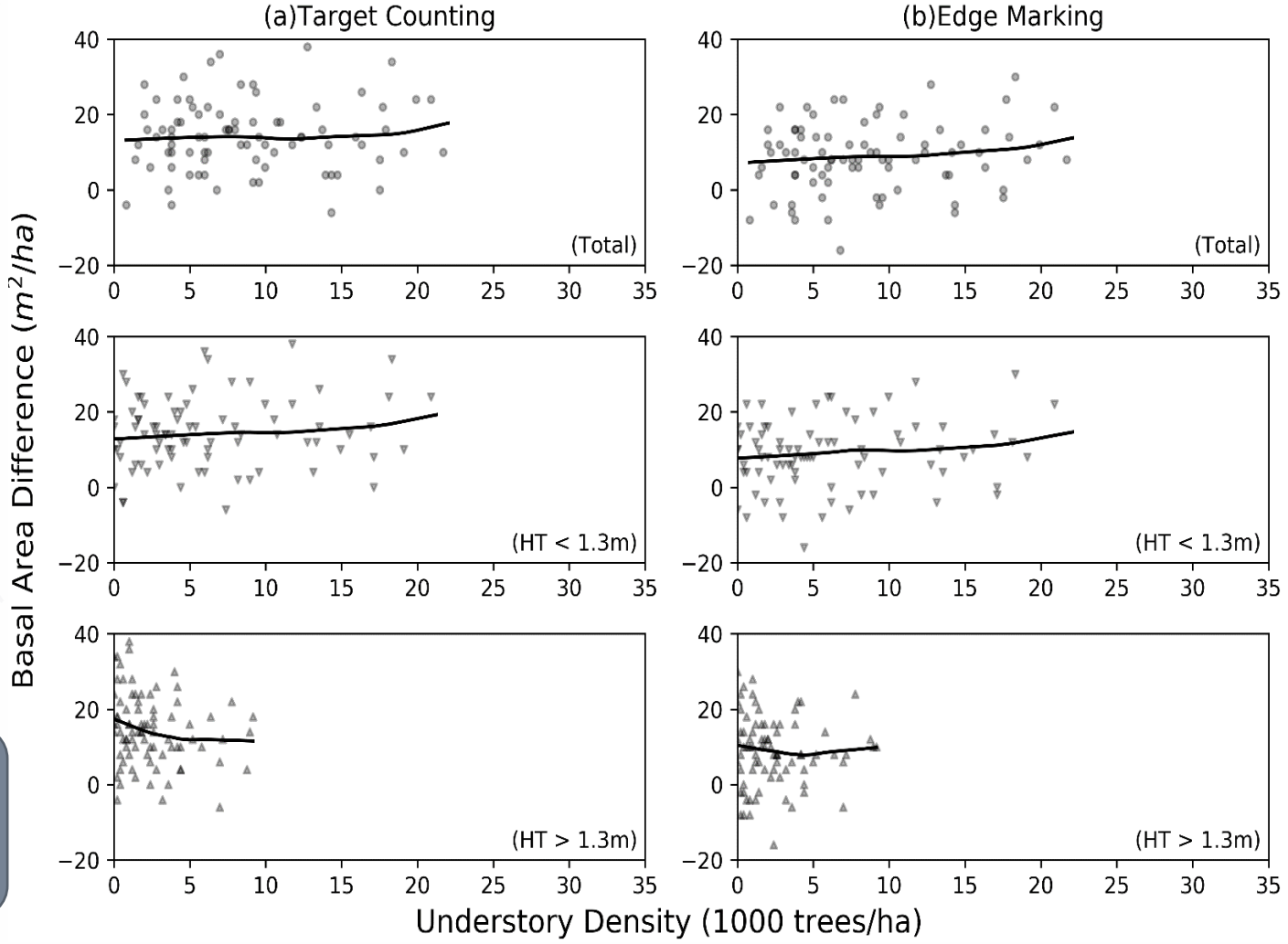
1. Hidden Tree

How different digital sample locations helps decrease its effect

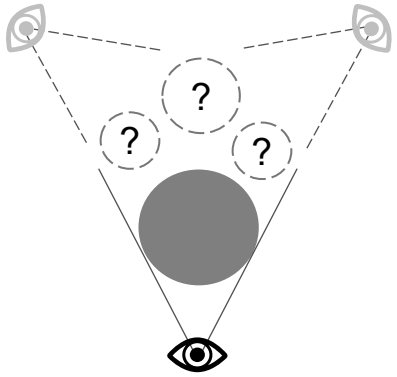
2. Understory Density

Trees HT < 1.3m not measured in field, but may be marked in Photo

Understory tree does not have significant impact on both marking methodologies



Spherical Camera: Basal Area



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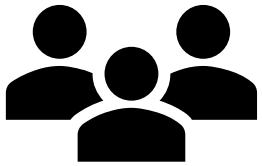
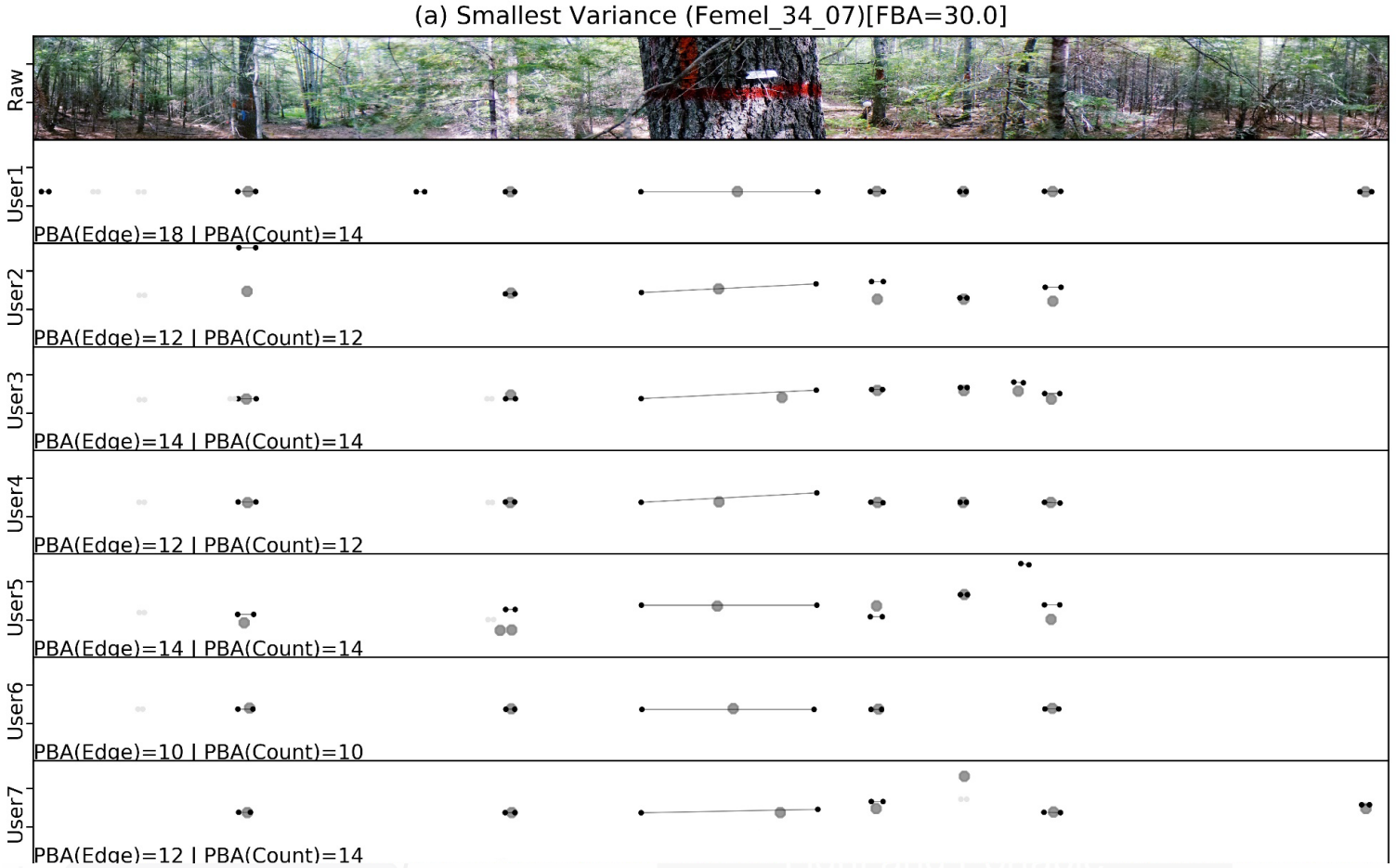
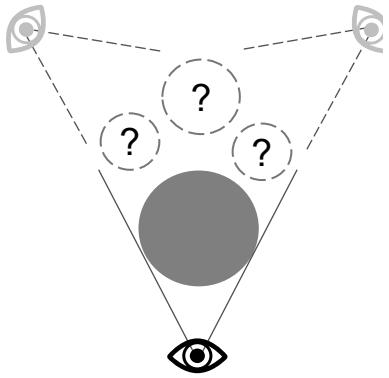


How stable of the novel method among different users

3. Inter-observer Error



Spherical Camera: Basal Area



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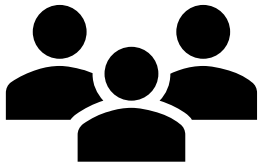

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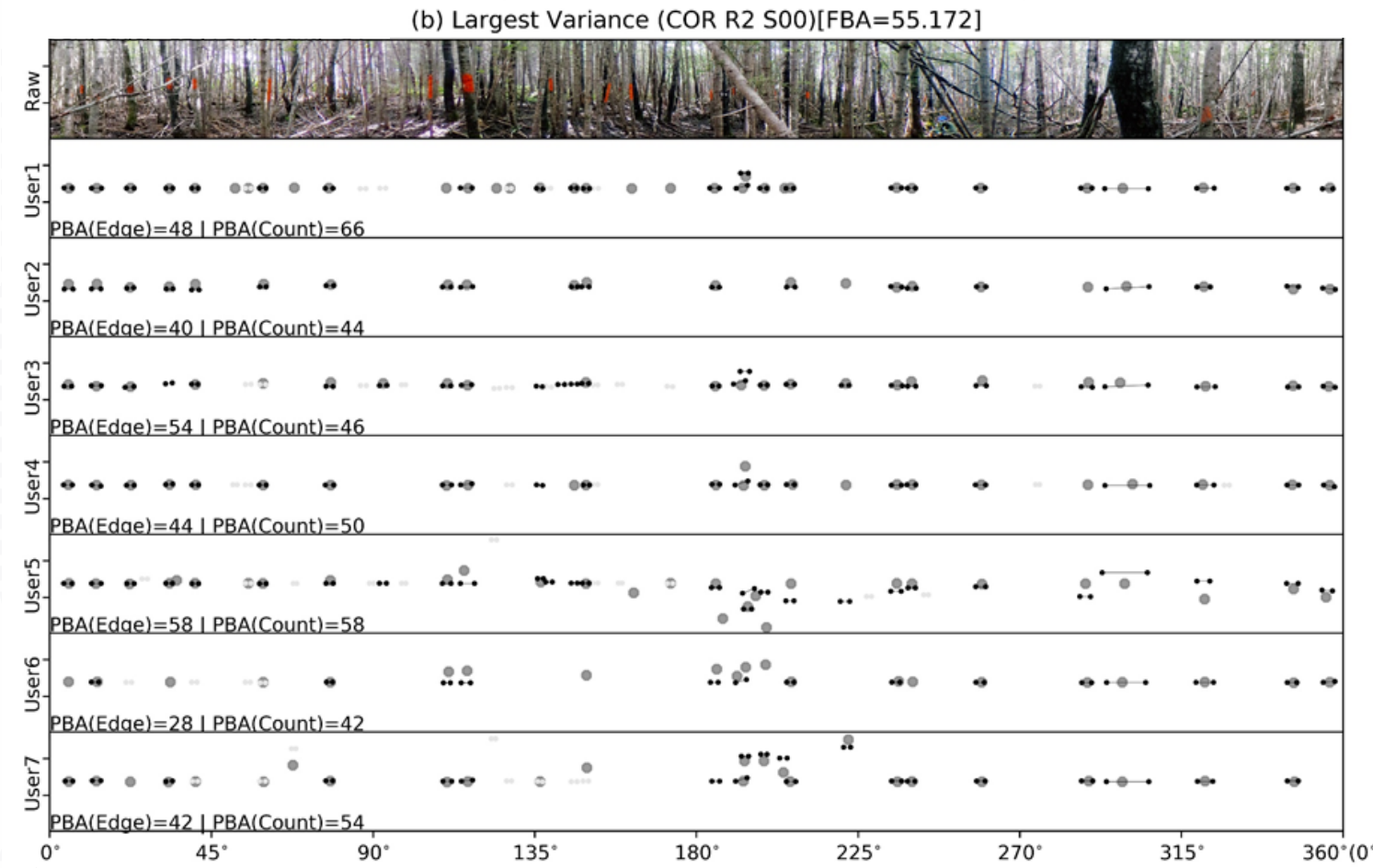
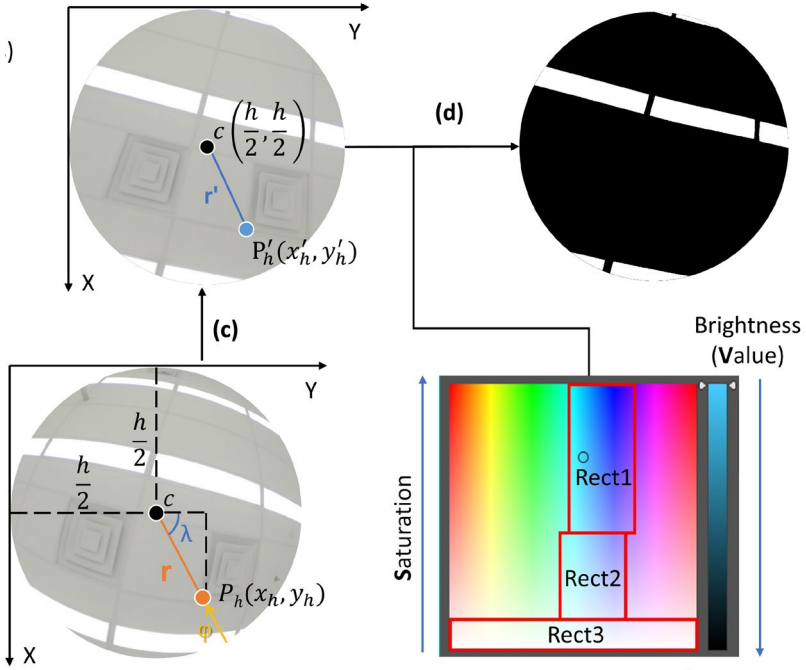
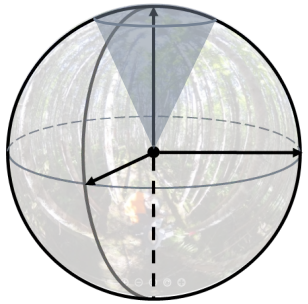


Spherical Camera: Plant Fraction



Calibrate→Classify



Trunk Info.

- Height
- Diameter
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Thanks for listening
Questions?

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2019.06.24