Seeing the Trees for the Forest: Advances in Remote Sensing

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Forest NB Forum

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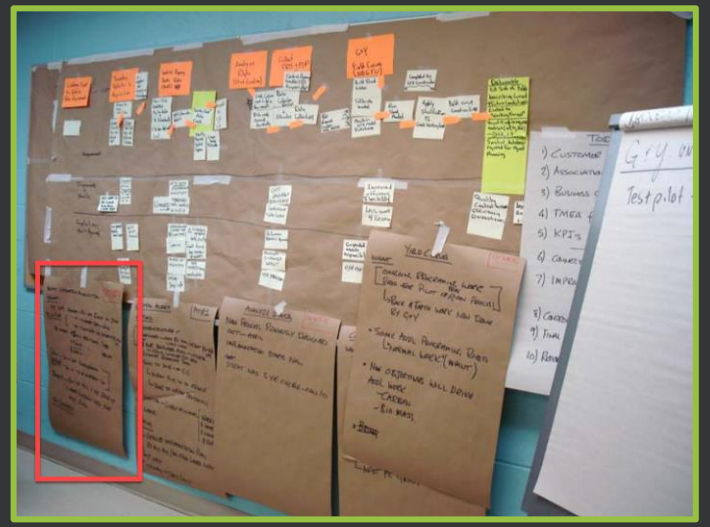
Topic List

- History and Context of Forest Inventories in NB
- Remote Sensing Acquisition Methods
- Forest Inventory Development
  - Stereo Photo Interpretation
  - Enhanced Forest Inventories
  - Satellite Based Analysis
  - Individual Tree Based Inventories
- Delineation of Stands

History on New Brunswick Forest Inventories

World Leader in Innovation

- Completed first Province-wide aerial stereo imagery in 1944-45
  - A team of photo-interpreters mapped softwood, hardwood and mixed conditions
- The Crown Lands and Forest Act (1982)
  - Created a paradigm shift
- The installation of the Arc GIS software by ESRI at DNR was a world first
  - A complete digital forest inventory completed by 1985
- Leading Edge Geomatics Established in 2008
  - Major driver in LiDAR-based Enhanced Forest Inventories
- Management Planning Process Improvement Event 2008
  - Part of the focus was on improving forest inventory



Why Forest Inventories are Important

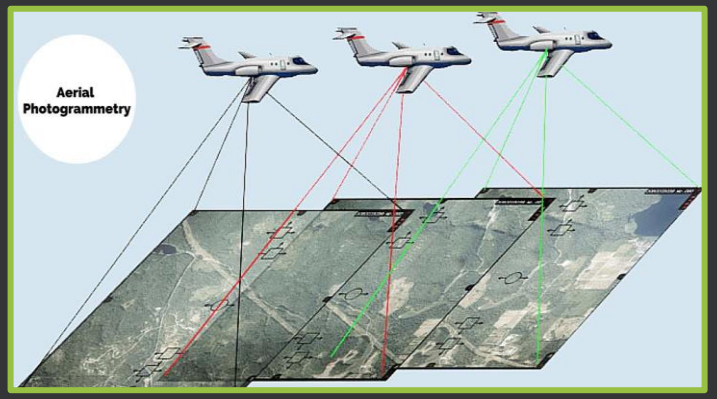
Forest Inventory is the Fundamental Building Block

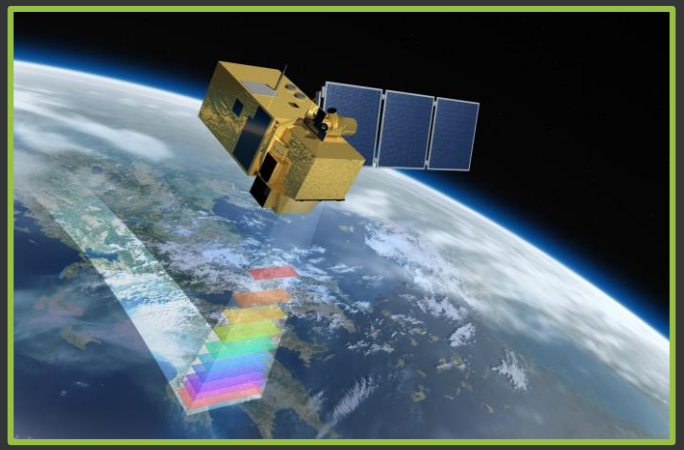
- Land-Use and Forest Policy Decisions
- Wildlife and Conservation Areas
- Strategic Planning
- Forest Health and Wildfire Planning
- Operational Planning

Remote Sensing Acquisition Methods

Cost-Effective Options at Industrial Scales

- Aerial Stereo Photos
- Airborne Laser Scan - LiDAR
- Satellite Sensors





Aerial Photo Interpretation

Description

- Requires full stereo coverage
  - Typically at 30cm resolution or better, 4-band
- Completed in two phases
  - Delineation of “like-areas” called stands
  - Attributing each stand with average tree characteristics
- Combine similar stands together to create strata
  - Establish ground plots to get quantitative measures at a strata-level

Aerial Photo Interpretation

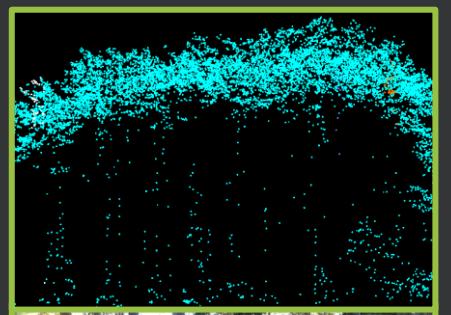
Pros and Cons

- Pros
  - Tried and true method
  - Well suited for strategic analysis (long term wood supply)
  - Overall great statistical accuracy
  - Good species composition data

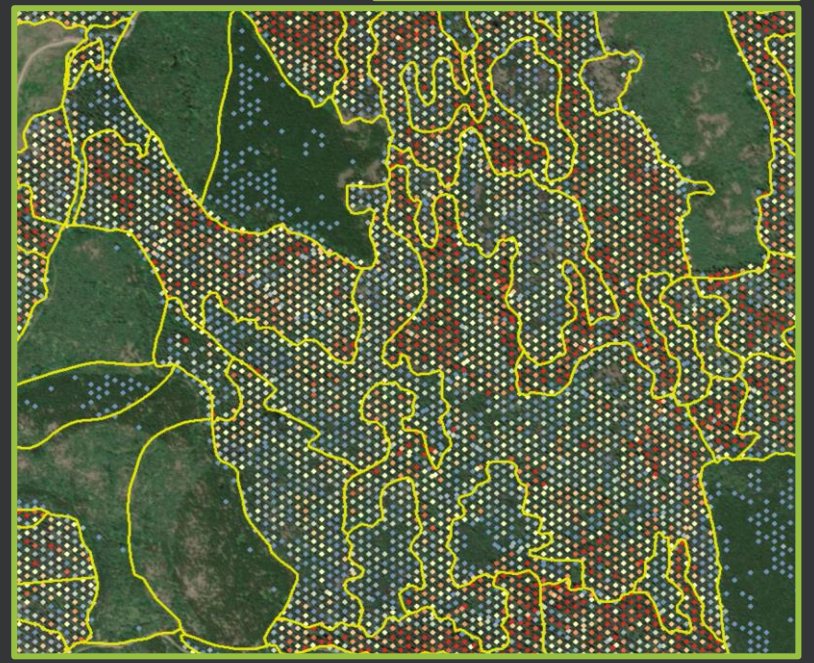
- Cons
  - Fixed delineation which is virtually impossible to adjust
  - Piece-work which does not scale well
  - Significant lag time from image capture to final product on large projects
  - Interpretation is very subjective
  - Fewer and fewer interpreters around

Area-Based EFI (Enhanced Forest Inventory)

Description



- Acquire low to medium density LiDAR (2-8ppsm)
- Create LiDAR metrics on every 20x20m cells from the point cloud
- Measure ground plots representing the range of forest conditions
- Create attribute prediction models on plot training
- Predict attributes on every cell across the entire area
  - Volume, Basal Area, stems per hectare
  - Average Height, DBH, piece size



Area-Based EFI (Enhanced Forest Inventory)

Pros and Cons

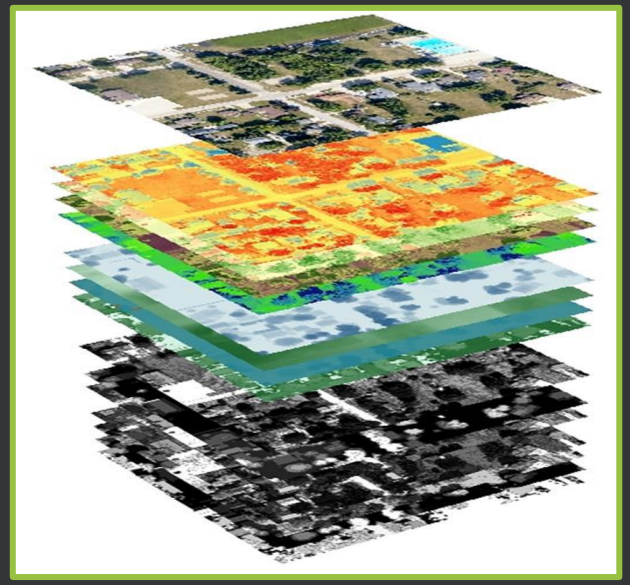
- Pros
  - Wall-to-Wall cell-based coverage (no blind spots!)
  - Provides quantitative attributes (per hectare and averages)
  - Relatively quick turn-around
  - Allows a “within stand” view for more detailed operational planning

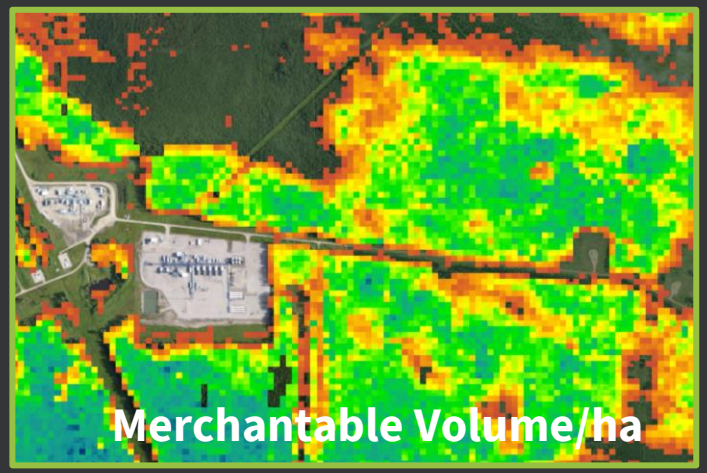
- Cons
  - Not cost effective at smaller scales
  - Does not provide species information

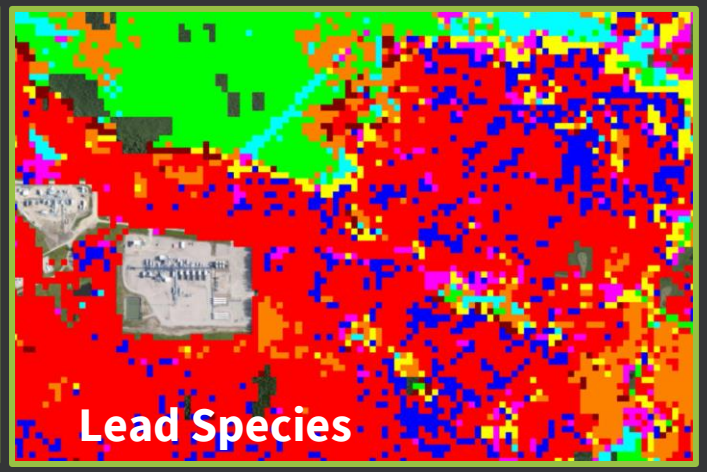
Satellite Image Analysis

A Variety of Spectral, Radar, LiDAR and Other Formats

- Through a machine learning approach
  - Create a “Stack” of various sensor images
  - Supply training data (e.g. ground plots)
  - Predict attributes across the entire area (20x20m cell)
    - Volume/ha, avg DBH, Basal Area, Height
    - Can predict Species proportion







Satellite Image Analysis

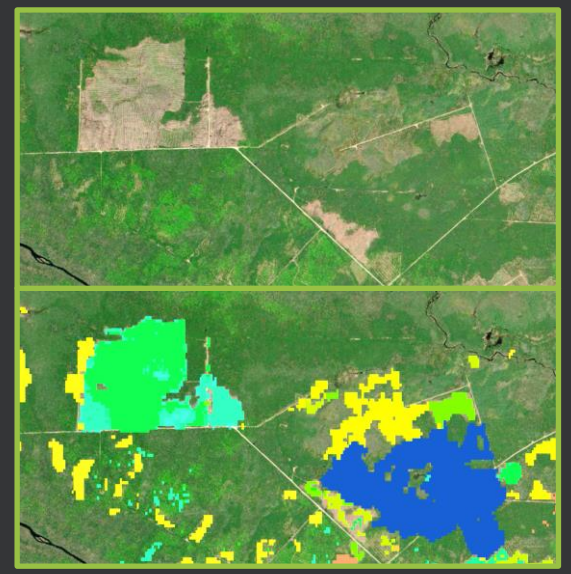
Pros and Cons

Pros

- Plentiful open-source images available
- Very cost effective
- Ability to determine species composition
- Good for identifying recent harvest (especially clearcuts)
- Great for Land Classification

Cons

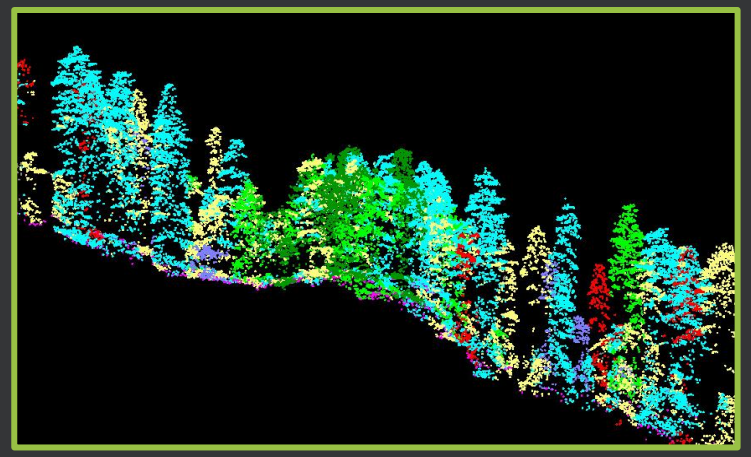
- Quantitative attributes are possible but relatively low accuracy

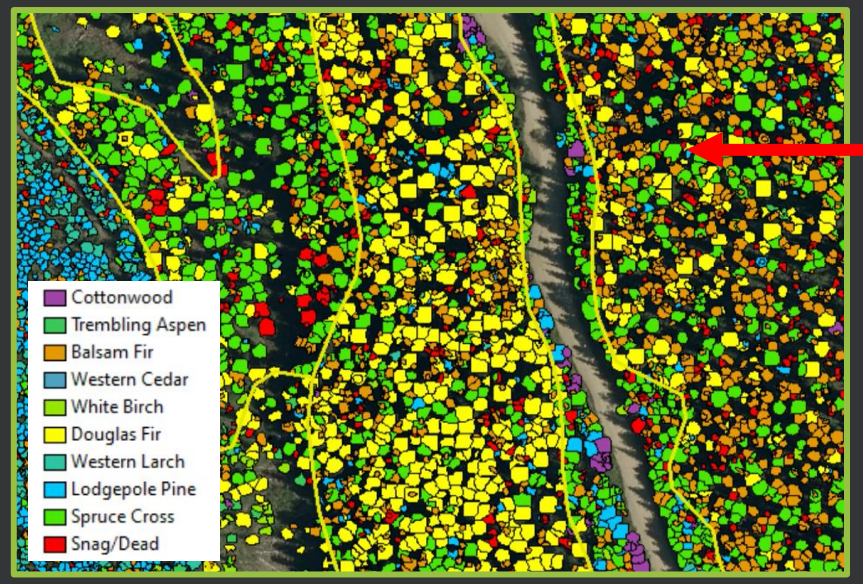


Individual Tree Based Inventory

Description

- Using a higher density LiDAR (16ppsm)
- Trees are individually segmented the point cloud
- Species is determined on unique species signatures
- Tree size is based on species, height, local density





Attribute	Value
Tree No	FL_193_8195571
Height (m)	18.5
DBH (cm)	28.8
Local Density (tph)	854
Canopy Area (m^2)	25.6
Species	Balsam Fir
Gross M Vol (m^3)	0.415
Basal Area (m^2)	0.065
No of Logs	4
Log 1 Length (m)	4.88
Log 1 Type	Saw
Log 1 Top Diameter (cm)	22.7
Log 1 Volume (m^3)	0.205
Log 2 Length (m)	4.88
Log 2 Type	Saw
Log 2 Top Diameter (cm)	17.8
Log 2 Volume (m^3)	0.145
Log 3 Length (m)	2.44
Log3 Type	Stud
Log 3 Top Diameter (cm)	14.8
Log 3 Volume (m^3)	0.43
Log 4 Length (m)	2.44
Log 4 Top Type	Pulp
Log 4 Top Diameter (cm)	10.2
Log 4 Volume (m^3)	0.022

Individual Tree Based Inventory

Pros and Cons

- Pros
  - Very good species accuracy
  - Excellent piece size metrics allowing for virtual bucking by species
  - More targeted pest control treatments or selecting wildlife trees
  - Generate treelists based on “actual” trees
  - Separate stands into over/under-story
  - Flexibility to rollup tree data at any scale

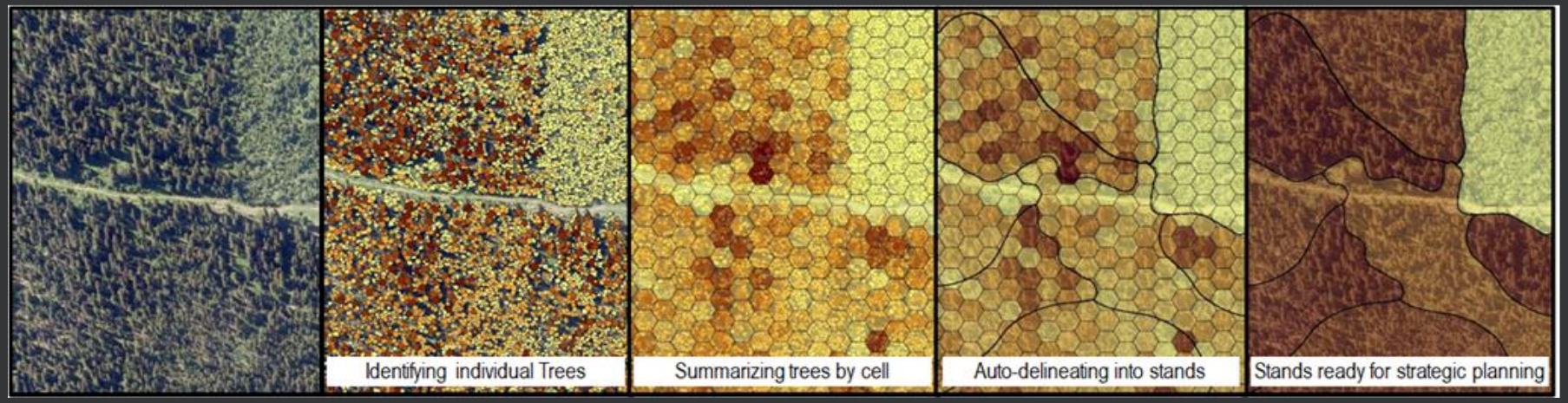
- Cons
  - Requires higher density LiDAR (>=16ppsm)
  - Requires 20cm stereo imagery
  - Not possible to find every tree

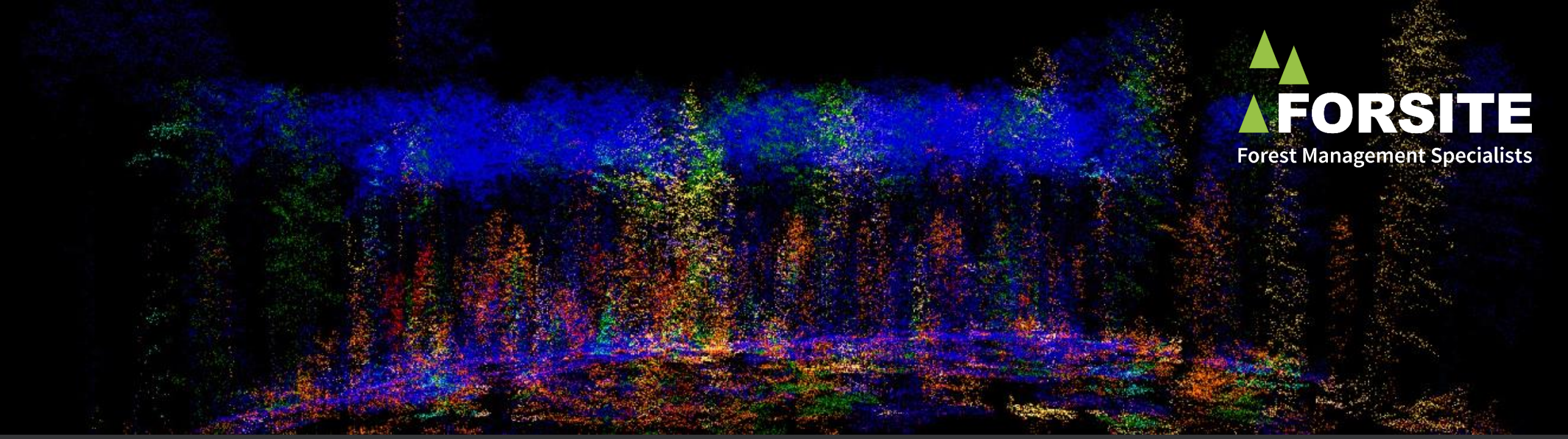
Auto-Delineation of Stands

Using Specialized Software for Aggregating “Like Cells”

Individual Tree →

Area Based →





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Thank you!

Any Question?

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