### Smart Thinning: Implementing Precision Forestry with Modern Technology and DSS

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FORESTCARBOVISION





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**Northern Periphery and Arctic** 



• In Finland, 480 000 hectares of forest are thinned each year

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- 70% of all felling is thinning, which reinforces the vitality of the remaining trees and helps them to mature into sawn wood
- Thinning directly affects forest growth, carbon sequestration, and the forest's ability to protect itself against biotic and abiotic damage
  - Excessive thinning causes losses in both carbon sequestration and forest tree production



### Background

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- Many factors can affect the outcome of thinning
  - Harvester operator
  - Forest and harvesting conditions
  - Forest owner's objectives
  - Thinning recommendations (e.g. upgraded thinning recommendations in Finland)
  - Accuracy of forest data

#### Thinning intensity

Carbon sequestration and carbon stock

Development in total yield and volume growth

Growth of individual trees

Thinning accumulation and thinning income

Economic return

**Rotation period** 

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Damage risks

Dead wood

https://www.luke.fi/fi/uutiset/voimakkaat-harvennuksetpienentavat-metsikon-hiilensidontaa-ja-kasvua

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### **Current practices**

- Harvester operator training: 1.5 years
- Up-to-date information and technology
  - Using forest machine simulators in teaching practicing thinning models
  - Data from forests with national Lidar campaigns
  - Support for other open-source data (aerial photos, canopy height model, trafficability index)
- Recommendations (models) for thinning intensity in Finland are in use
  - With different stand parameters (density, tree size, fertility, tree species)
  - With different interest rates

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• Different options for taking carbon sequestration into account





### **Practices to monitor thinning intensity**

- Harvester operator's own subjective sampling of the thinning quality result
  - They need to monitor and report the sampling into the system of the timber procurement company
- Varying methods for follow-up of standing/remaining tree density or basal area (Nordström 2024)
  - Using the boom of the harvester (half circle sampling): 80%
    - Monitoring the stem density (number of stems per hectare) and distance between strip roads
  - Using relascope: 64 %
    - For monitoring the stem basal area
  - By visual overlook: 32%
    - More experienced harvester operators
- The Finnish Forestry Centre annually inspects the harvesting results of thinnings in different parts of Finland





Luke OLUONNONVARAKESKUS

### **Thinning intensity**

- Factors affecting on intensity of thinning removal  $\rightarrow$  impact on remaining stand and trees
  - The width of the strip road (thinning track)
  - The distance between strip roads
  - The removal intensity of trees at the tree growing area



### **Recent technology development**

- Development in GNSS accuracy
- Challenges under dense canopy
- Solutions
  - Improved RTK-positioning of the base machine
  - With sub-meter accuracy
  - Machine manufacturers offer options with accurate boom-tip positioning
    - Need the heading of the boom pillar base
    - Need censoring boom joints/cylinders





Ovaskainen ym.202

### **Recent development**

- Ponsse: Thinning Density assistant –concept version
- Ilmostar and UNITE Flagship projects
  - Testing various technologies to scan forest and used point cloud data for operator assisting



# TREE DETECTION IN REAL TIME WITH LIDAR



### **Recent development**

- More accurate tree maps can be created using dense LiDAR scanning.
  - Challenge is smaller trees under canopy cover of bigger trees
  - And trees close to each other





National Land survey of Finland provides nation vide tree maps as test manner in Metsäkanta web-service Based on national land survey (5 points per m<sup>2</sup>)



### Real-time thinning intensity monitoring in harvester work





Euroopan unionin rahoittama NextGenerationEU



### **Concept idea of R-TIM**

- The DSS would help in decision making for the landowner, wood buyer and machine operator & contractor
- R-TIM can provide **thinning intensity** information for the whole harvested area from the beginning of the site for **monitoring and reporting purposes**.
- Providing information of harvesting intensity on the active working area real-time monitoring and operator support



### **Concept idea of R-TIM**

The concept for real time monitoring of thinning intensity indicators is based on two main data sources:

- 1) recorded parameters of removed stems from HPR-data, and
- 2) preprocessed tree map data either from the high-accuracy ALS or MLS





## Impact of the harvester positioning accuracy on the accuracy of the tree matching



- Matching accuracy can be improved using tree parameters
- First results are promising when estimating remaining basal area of the stand in thinning site

### Thank you!



