# VALORISATION DU LIDAR AÉRIEN POUR LA CARACTÉRISATION DES PEUPLEMENTS FORESTIERS FEUILLUS IRRÉGULIERS MÉLANGÉS

Séminaire télédétection forestière

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LIÈGE université Gembloux Agro-Bio Tech

Regiowood II

Interreg Grande Région | Großregion

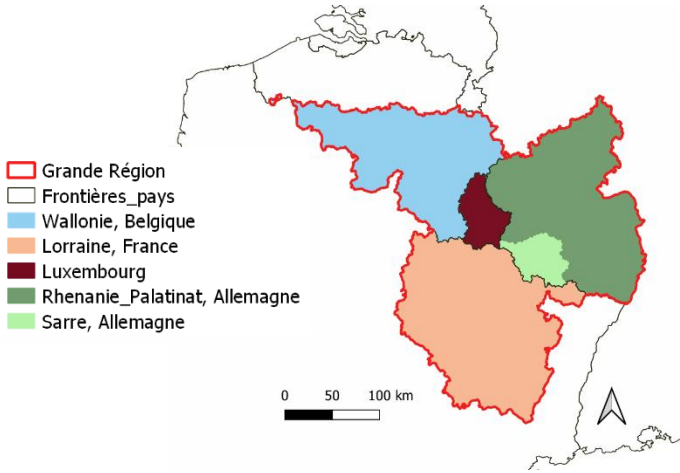
Wallonie

# Regiowood 2



Regiowood II

Interreg
EUROPEAN UNION
Grande Région | Großregion
Fonds européen de développement régional | Europäischer Fonds für regionale Entwicklung




## > Enhance sustainable management of private forests in the Greater Region

### Forest monitoring
- Forest type mapping
- Critical areas identification
- Detailed forest characterization

### Forest Resilience
- Diagnostic tools
- Innovative methods to enhance forest regeneration
- Appropriate techniques to control competing vegetation

### Forest renewal contract
- Accompanying of owners in reforestation
- Financial support

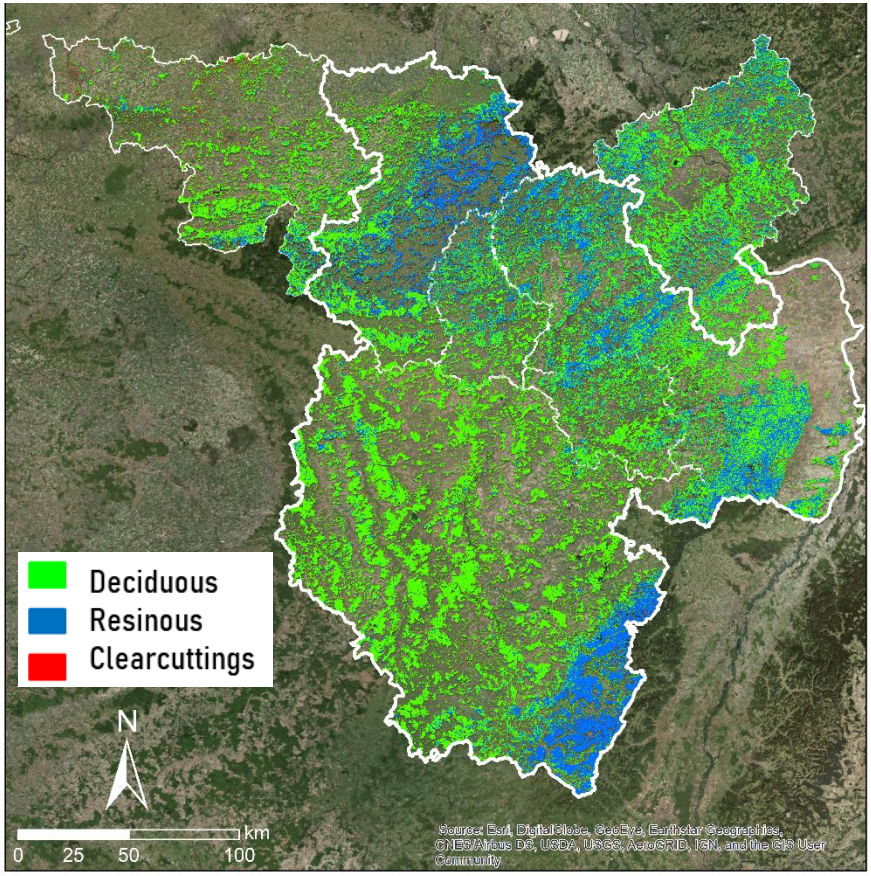
### Sustainable management tools
- Self-assessment tool
- Management support tool

# Regiowood 2



## Forest monitoring

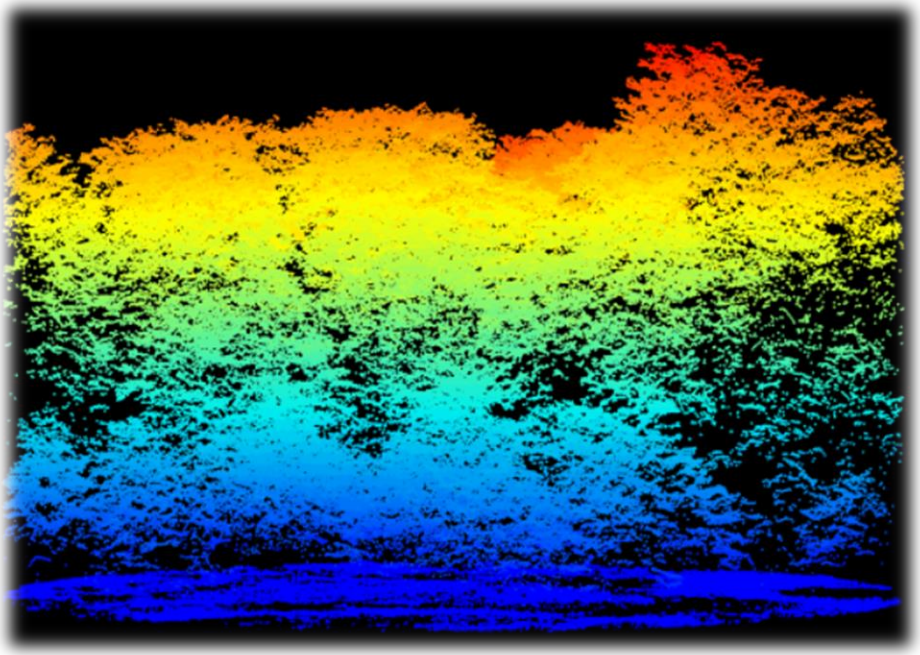
### > Forest type mapping




### > Action 7 : Bark beetles


### > Detailed characterization of forest resources

# AIRBORNE LIDAR DATA FOR THE CHARACTERIZATION OF MIXED IRREGULAR DECIDUOUS FOREST



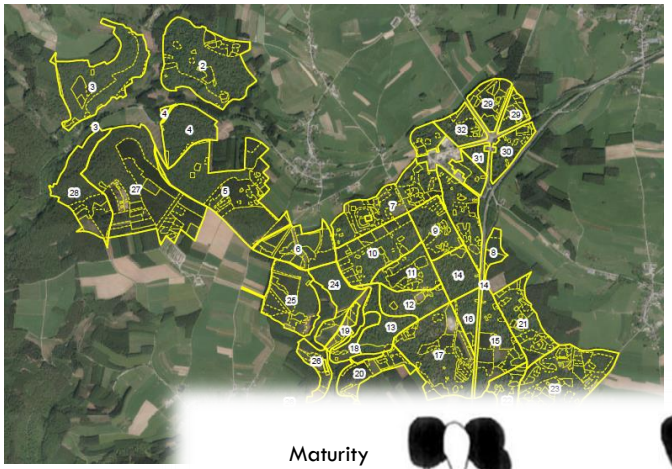
# Introduction

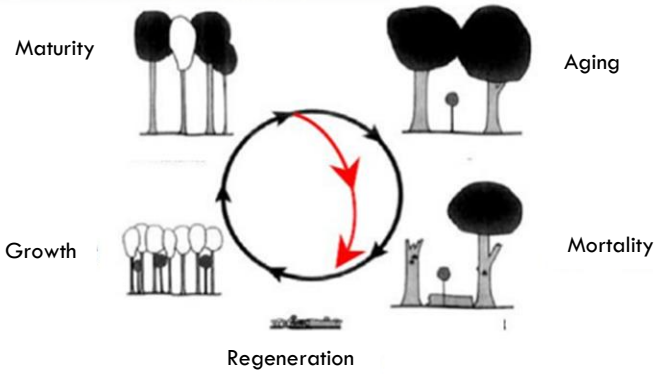


Need : Accurate description of forest resources

> Sustainable forest management

> Global Changes






# Introduction



## Traditional characterization: field inventories


Inventory sampling
Complete inventory

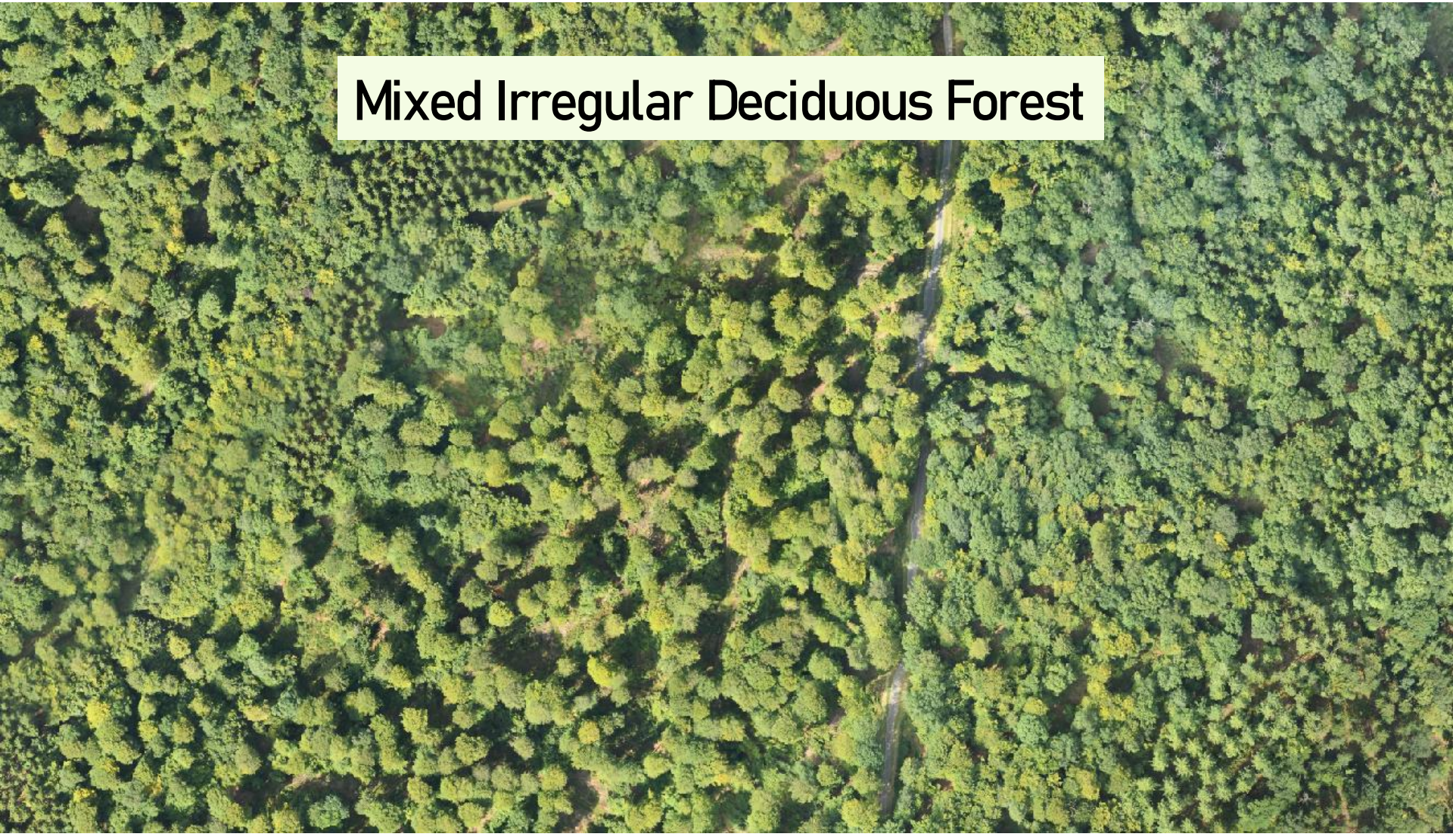

Remote sensing: ↗ acquisition speed, ↗ acquisition scale, ↘ costs

# Objectives



# Objectives





# Objectives



Mixed Irregular Deciduous Forest

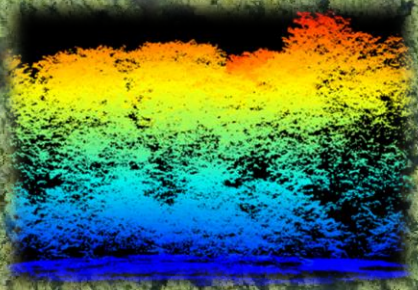
## Structure X Composition

> Model tree girth distribution by species

## Regeneration

> Identify and map development stages

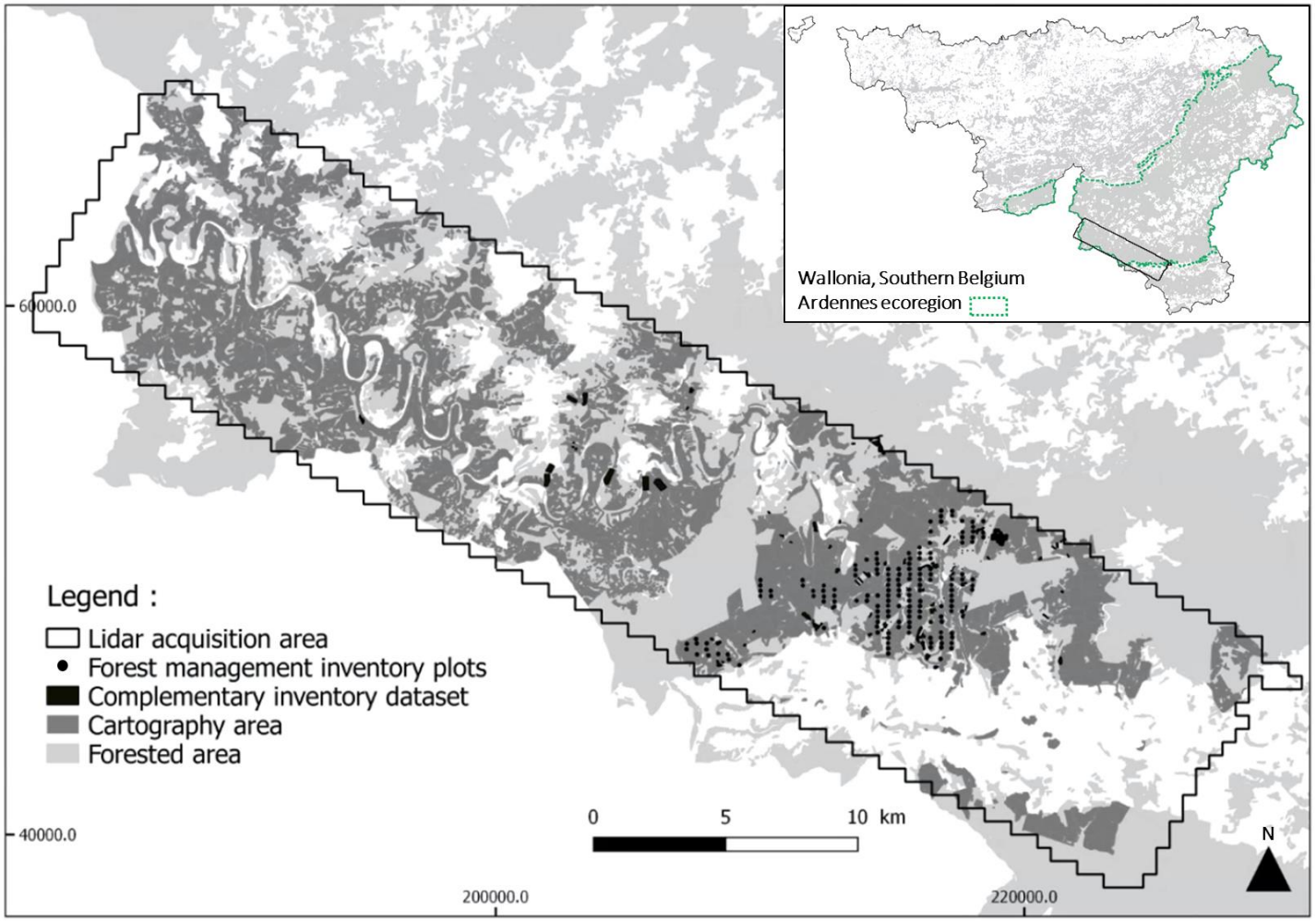
Lidar data



Management tools

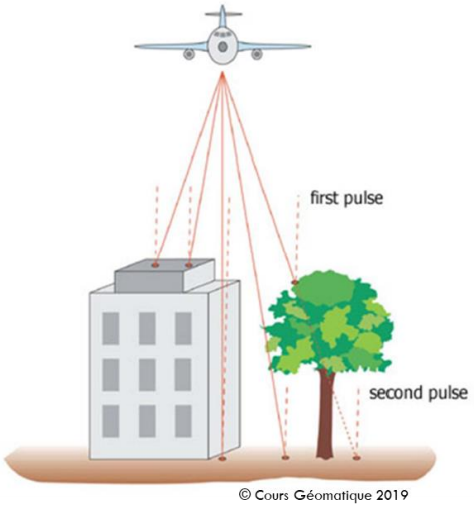
# Study area




Wallonia, Southern Belgium
Ardennes ecoregion
Legend :
Lidar acquisition area
Forest management inventory plots
Complementary inventory dataset
Cartography area
Forested area
60000.0
40000.0
200000.0
220000.0
0
5
10 km
N

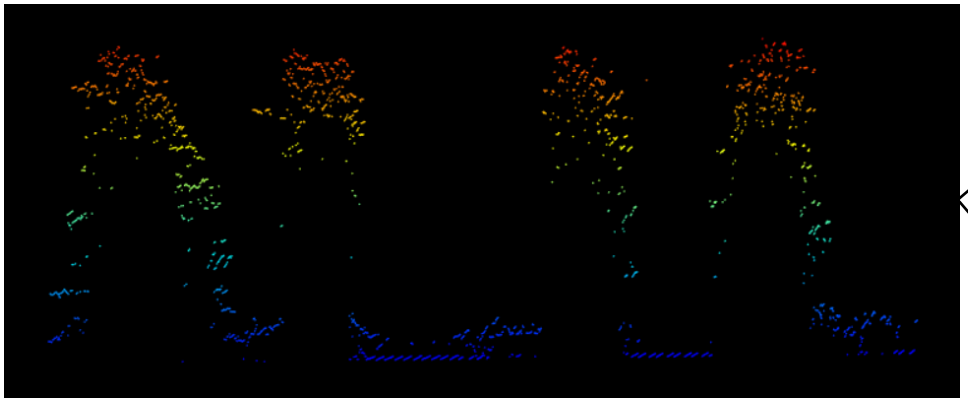
# Lidar data

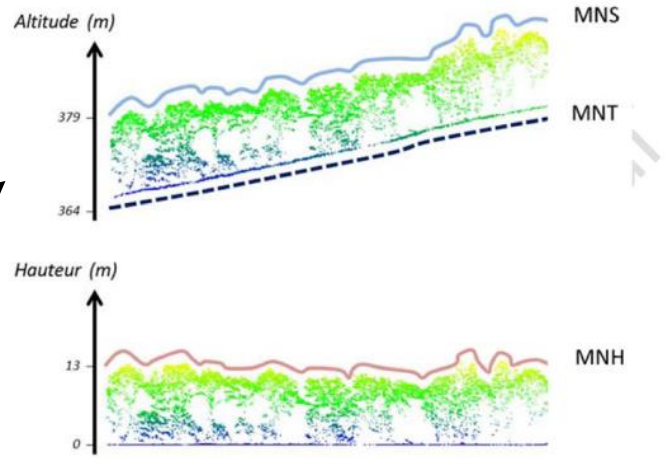





| Sensor properties | |
|---|---|
| Number of returns recorded | 4 |
| Pulse frequency (kHz) | 200 |
| Scanning frequency (Scans/s) | 70 |
| Footprint diameter (m) | 0.28 |

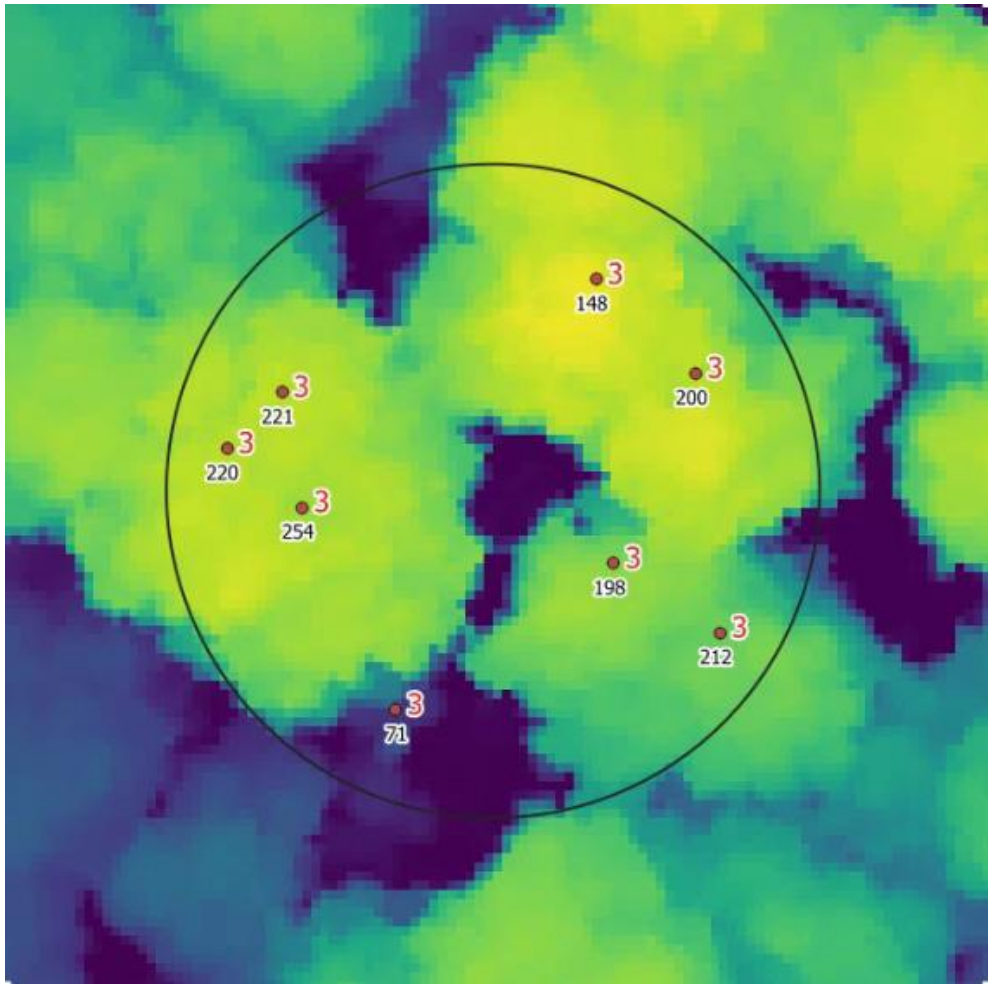
| Canal | Wavelength (nm) | Points density (pts/m²) |
|---|---|---|
| C2 | 1064 | 56 |
| C3 | 532 | 48 |





# Field data






TREE data

Position
Girth at 1.50m height (C150)
Species
Crown health status
Height (3 dominants)

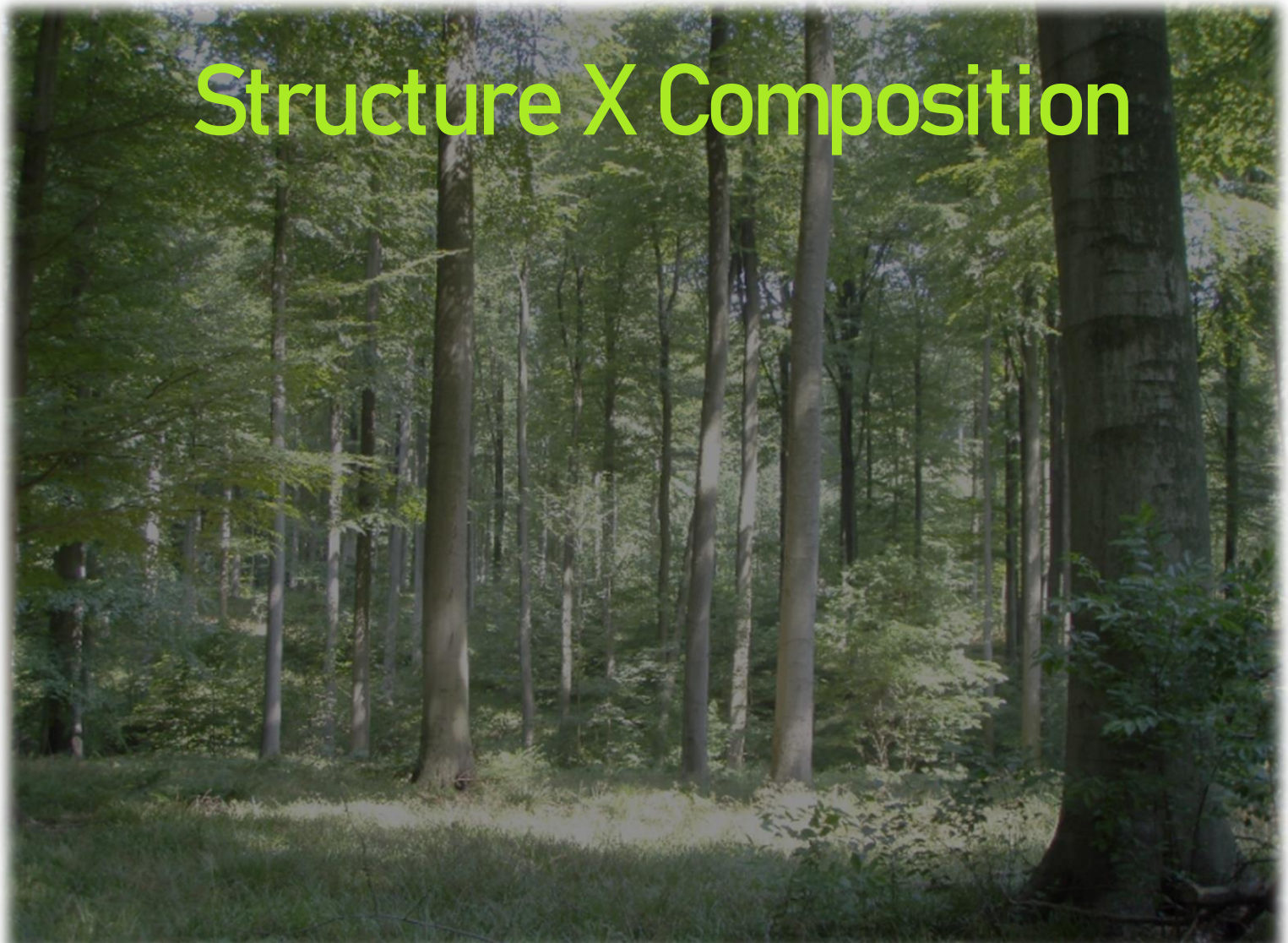
Inventory threshold:
C150 ≥ 40 cm

# Mature forest characterization



# Mature forest characterization





# Mature forest characterization



## Structure X Composition

- Model tree girth distribution by species for mixed irregular deciduous forest

# Mature forest characterization



## Structure X Composition

- Model tree girth distribution by species for mixed irregular deciduous forest
- Use LiDAR data
- Use forest management inventory data

# Mature forest characterization



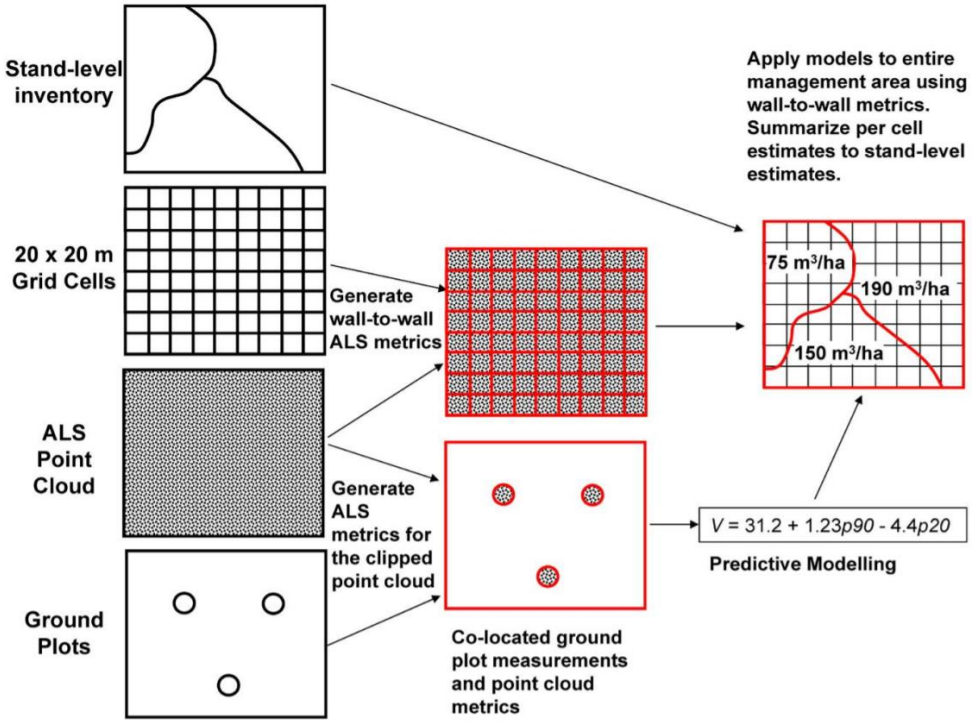
## Structure X Composition

- Model tree girth distribution by species for mixed irregular deciduous forest
- Use LiDAR data
- Use forest management inventory data
- Map forest resources
- Produce useful information for managers

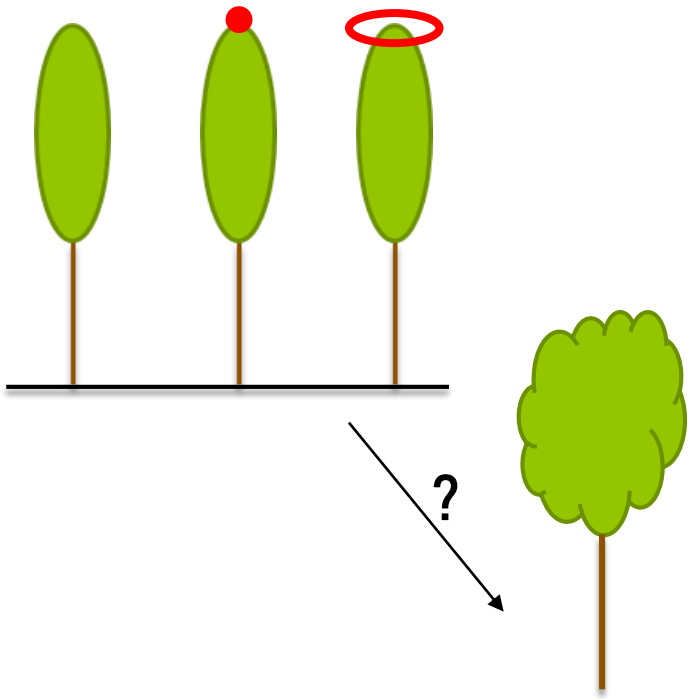
# Mature forest characterization

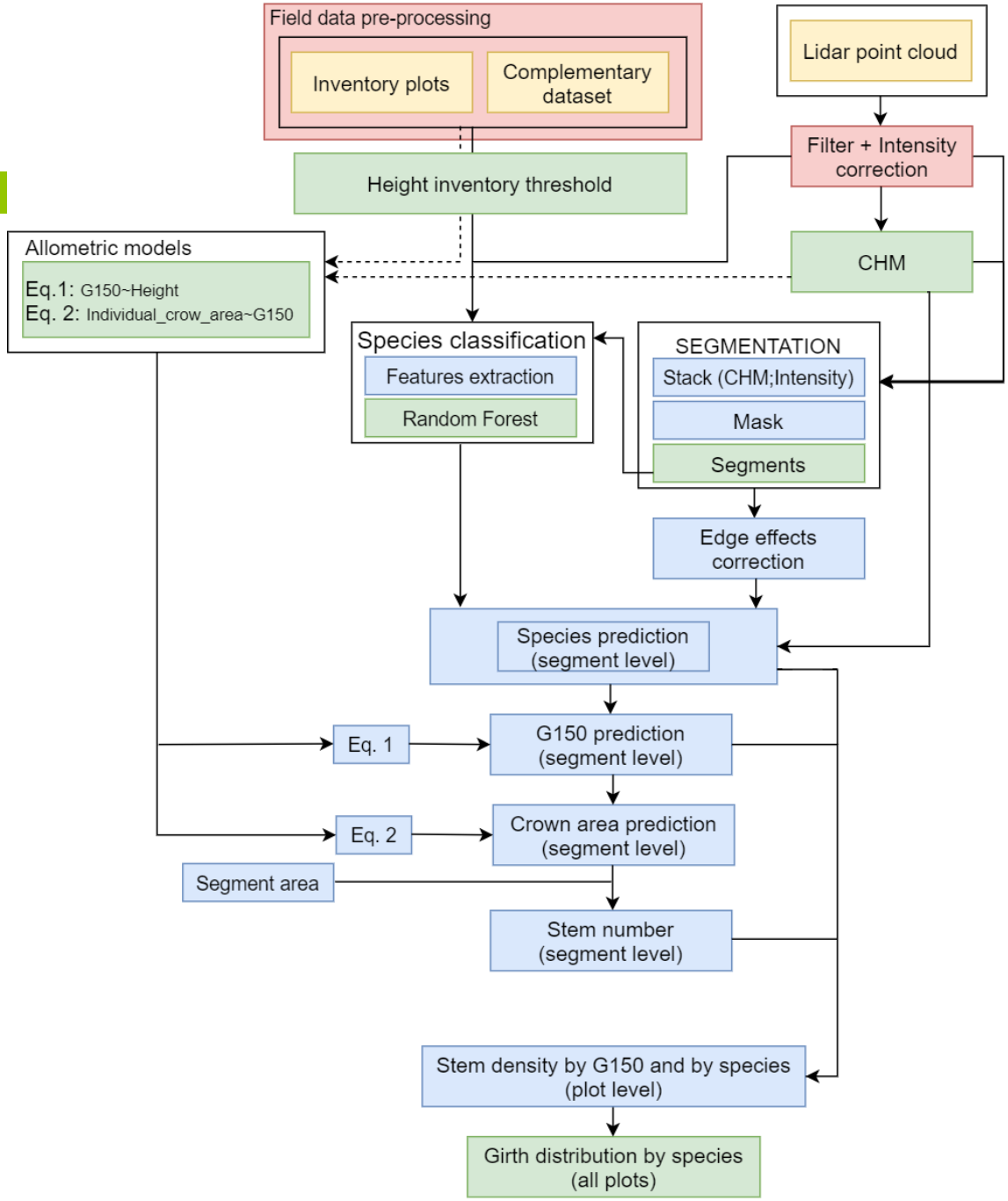


## Area Based Approach (ABA)




## Individual Tree Crown (ITC)

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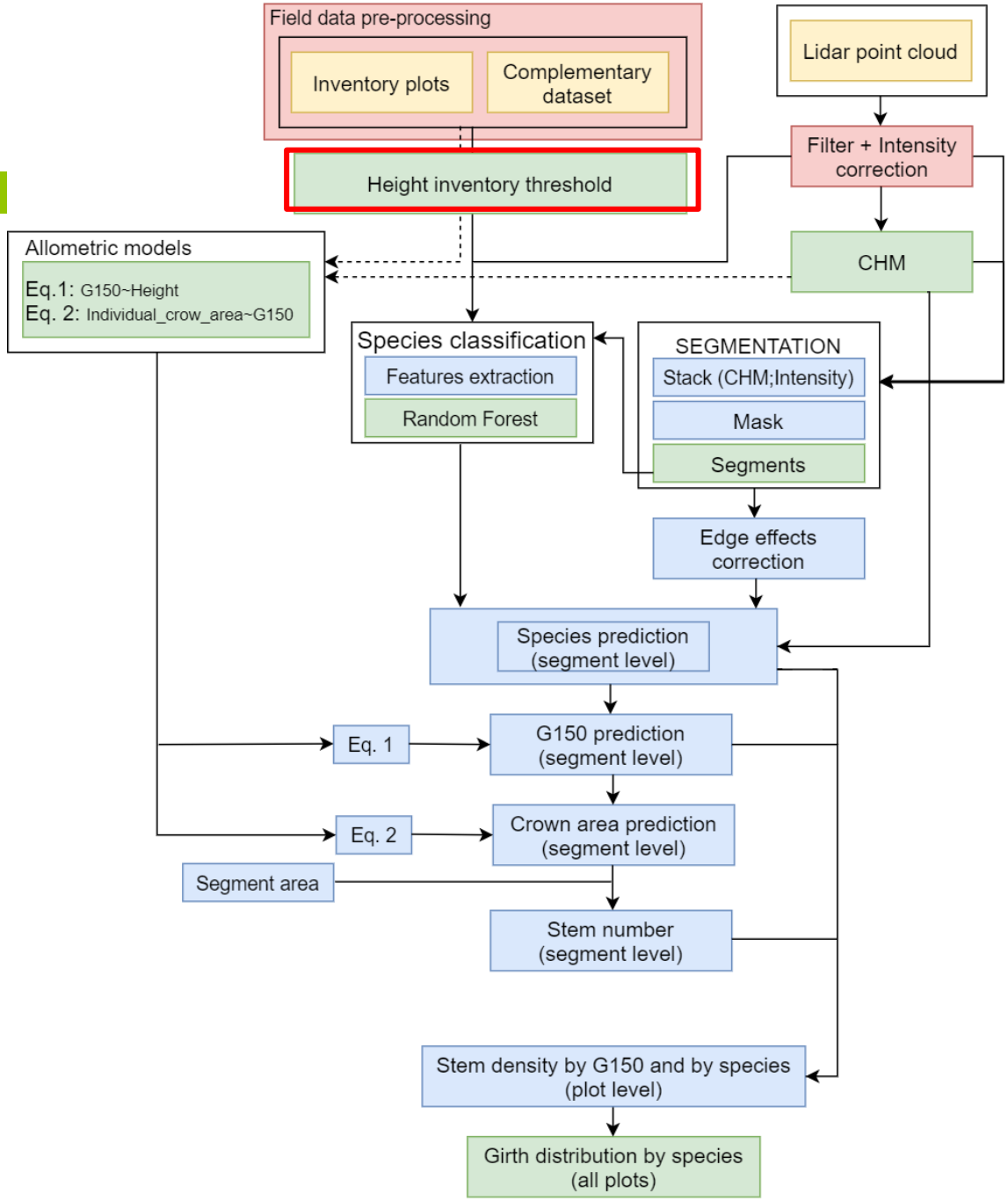
Girth distribution by species (all plots)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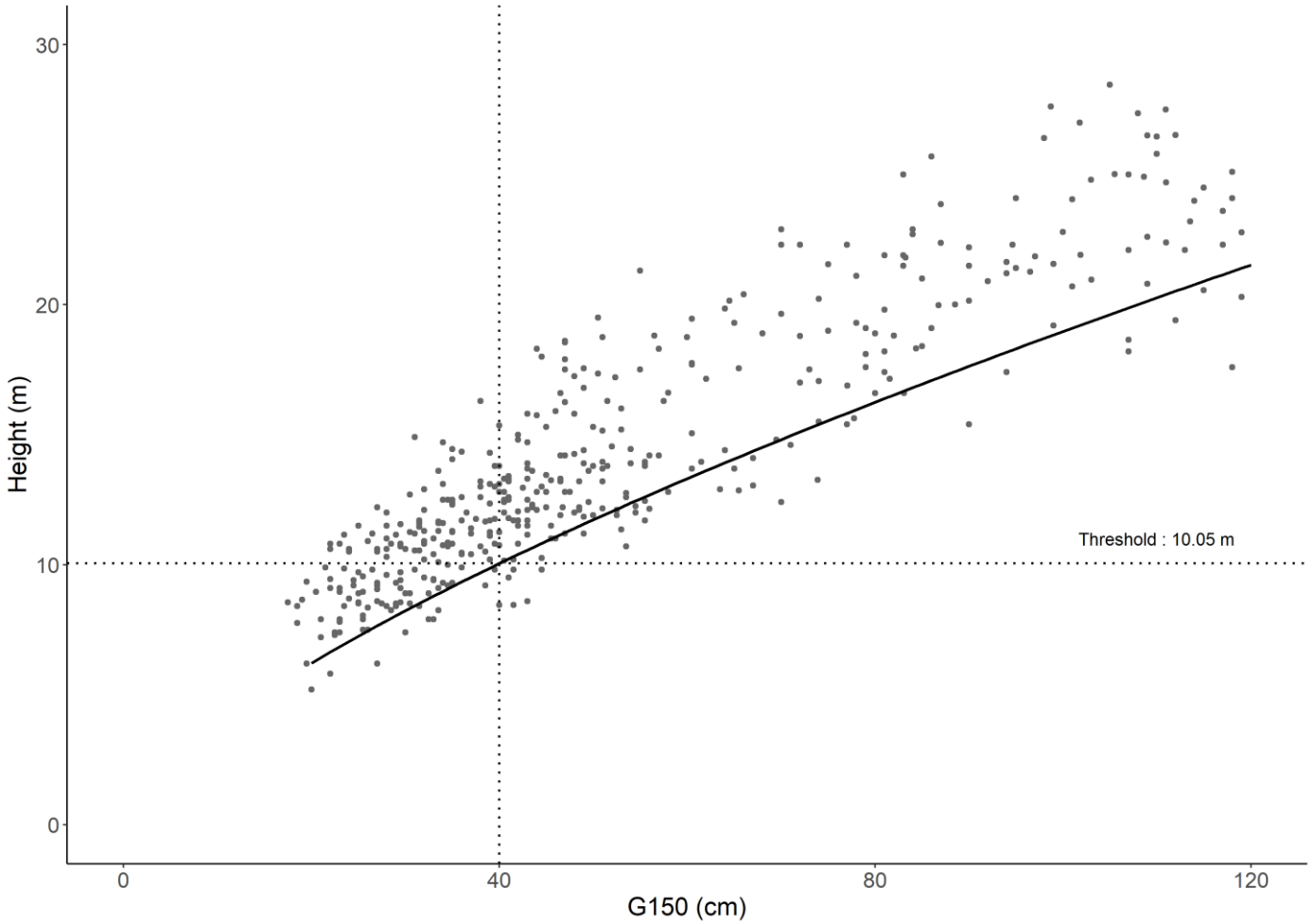
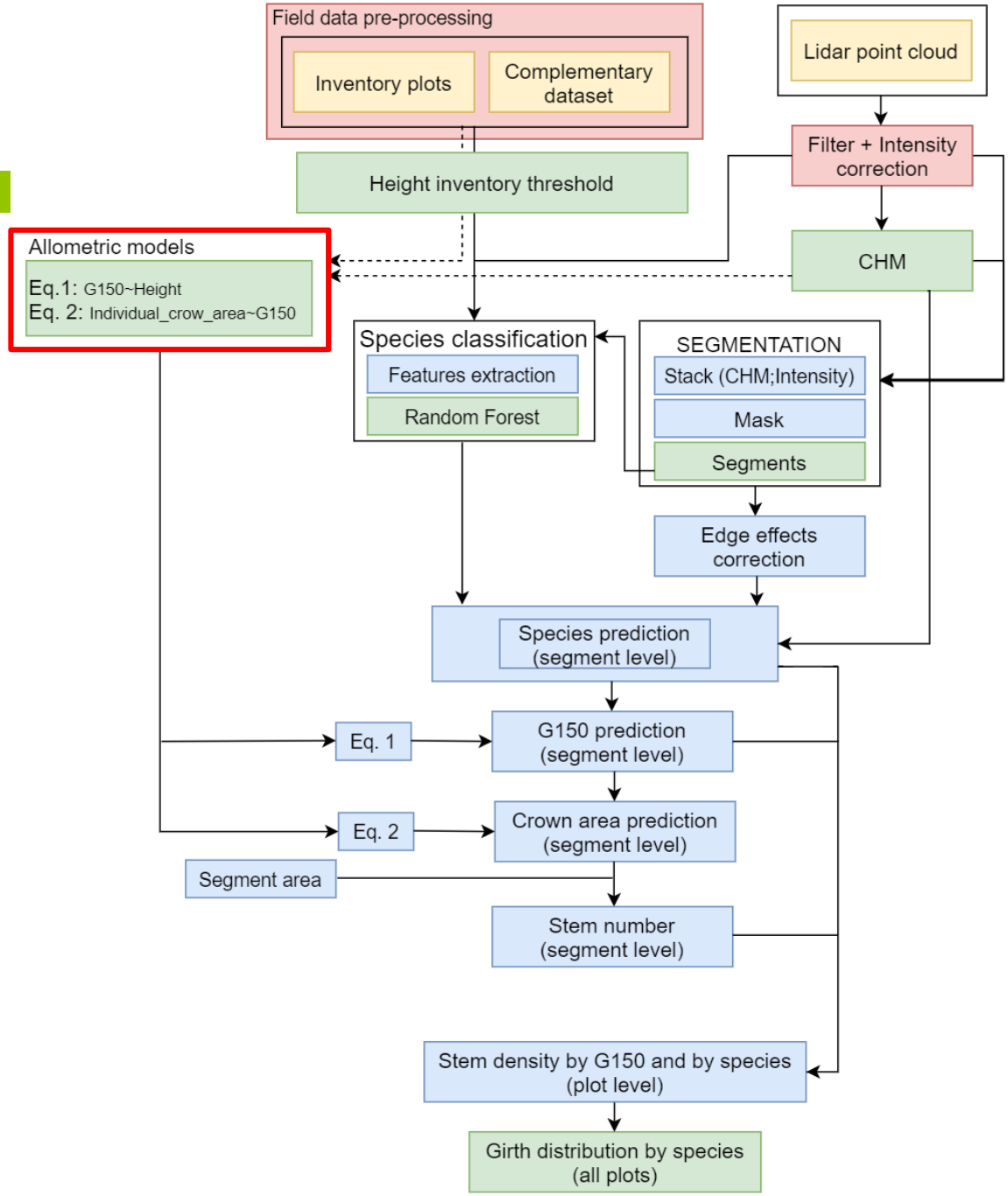
# Mature forest characterization



## Step 1 : Height inventory threshold definition

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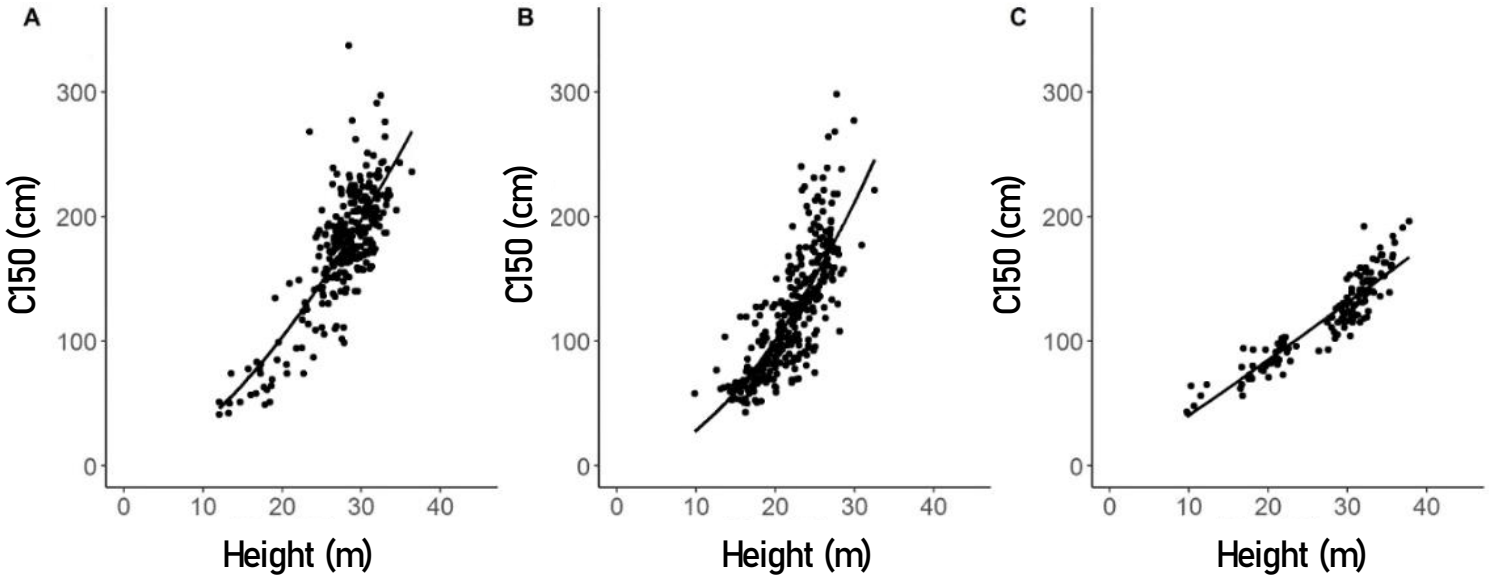
# Mature forest characterization



## Step 2 : Allometric models

Eq 1 : C150 ~ k1 * Height^k2

A : Beech
B : Oak
C : Spruce




$R^2adj$ = 0.72 ; RMSE = 28.18cm ; Erreur moyenne = 0.00cm

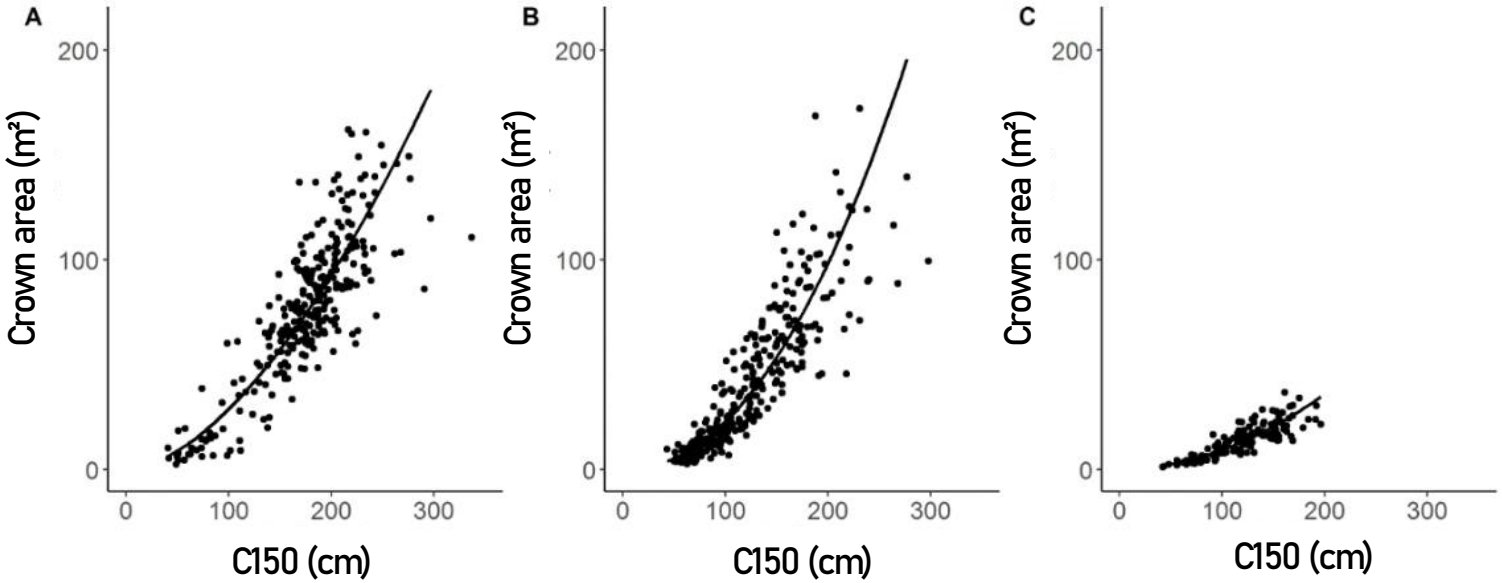
# Mature forest characterization



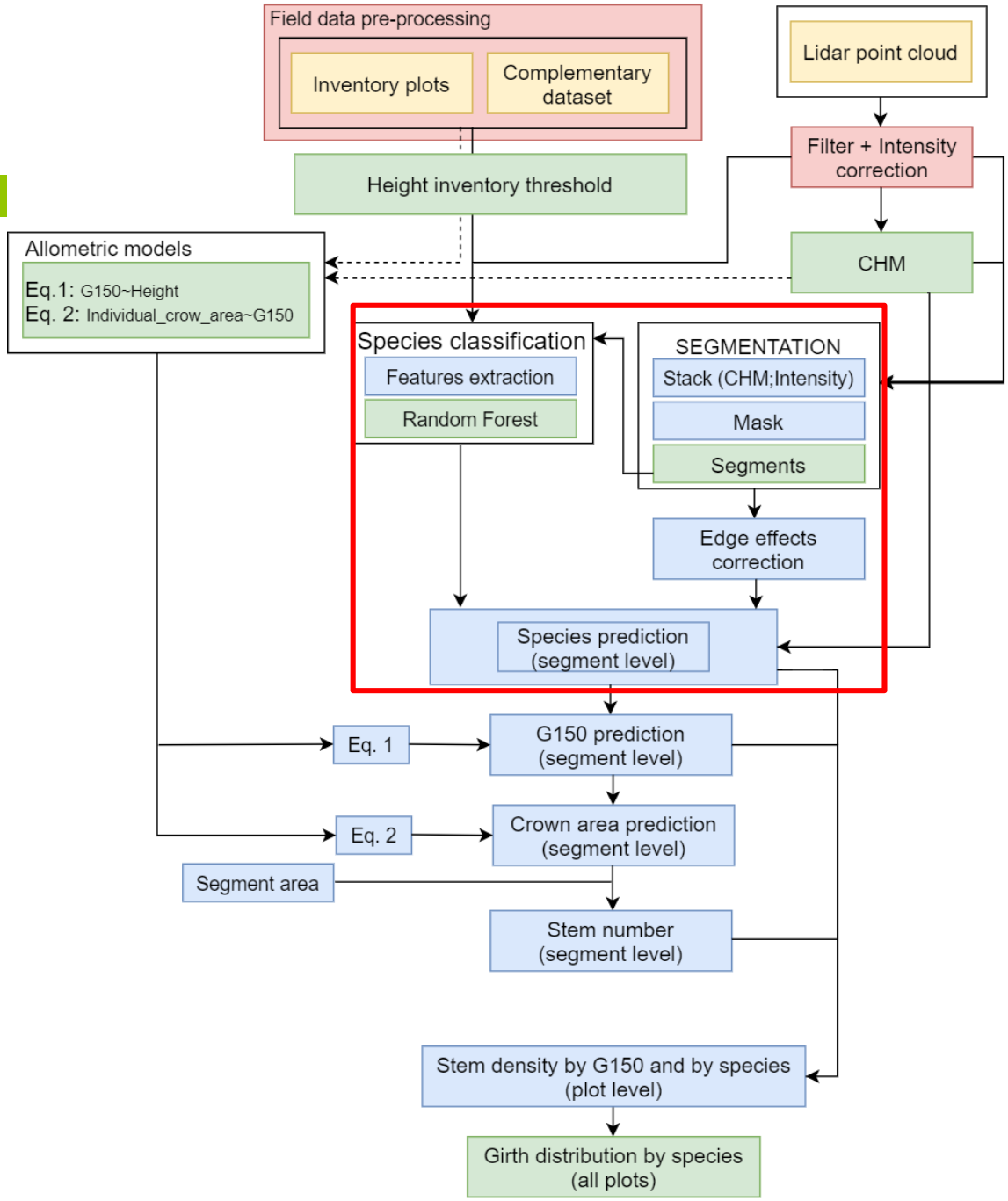
## Step 2 : Allometric models

Eq 2 : Crown_area ~ k1 * C150^k2

A : Beech
B : Oak
C : Spruce




R²adj = 0.78 ; RMSE = 18.46m² ; Erreur moyenne = -0.48m²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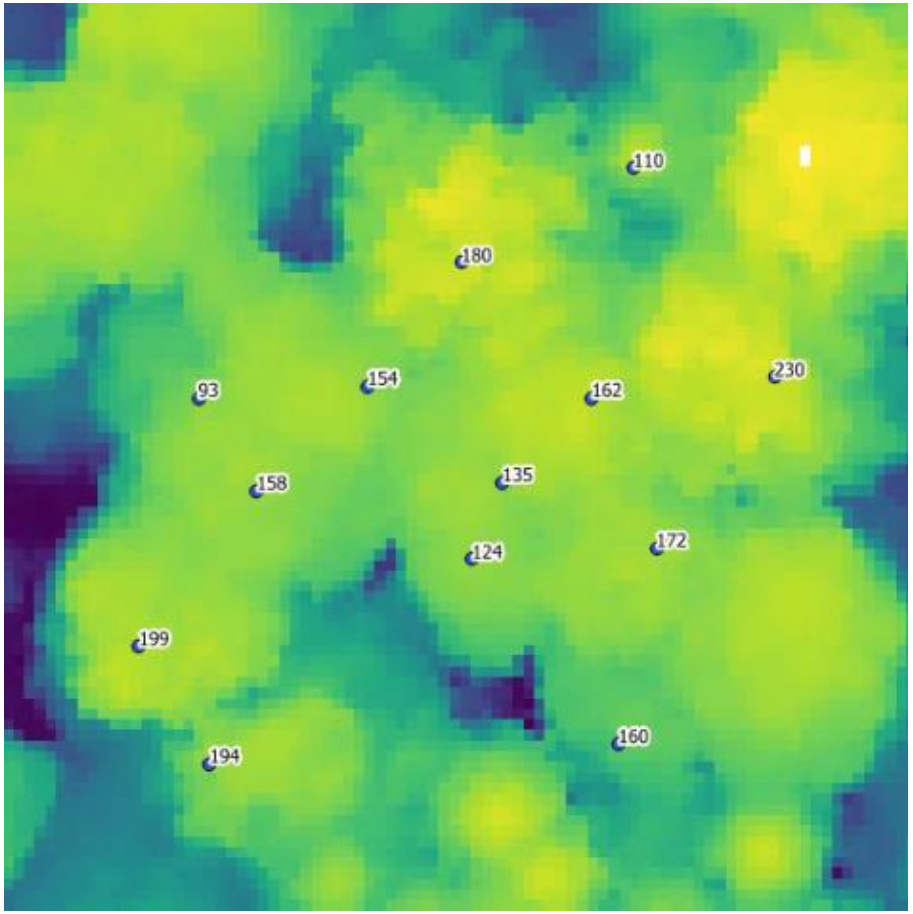
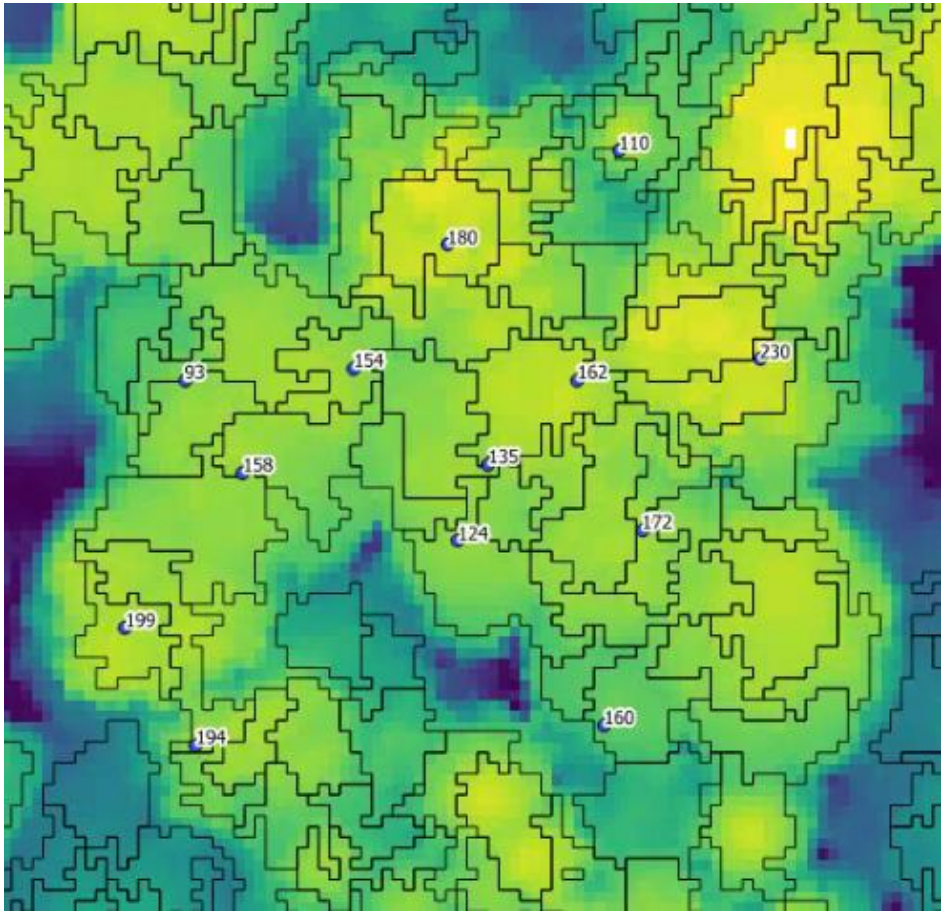
# Mature forest characterization



## Step 3 : Canopy segmentation
## 2D OTB – Over-segmentation



# Mature forest characterization



## Step 3 : Tree species classification

4 classes : Beech (808) – Oak (808) – Spruce (808) – Other deciduous species (162)

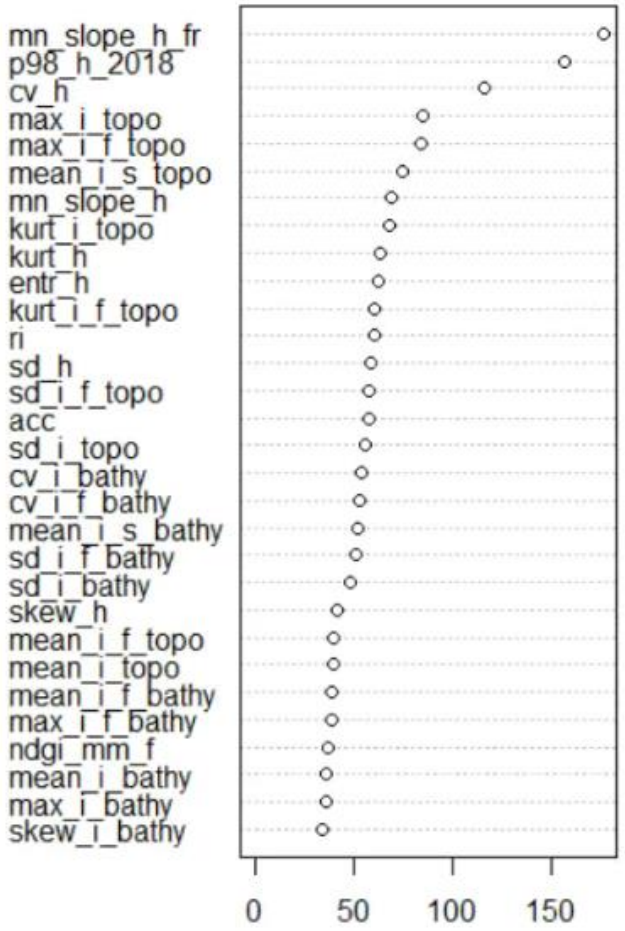
Metrics (H, I)

Vsurf selection + Random Forest

```
Call:
 randomForest(formula = essence ~ ., data = spect_sel)
               Type of random forest: classification
                     Number of trees: 500
No. of variables tried at each split: 5

        OOB estimate of  error rate: 13.93%
Confusion matrix:
     1   3  5  41 class.error
1  727  86 12  17  0.13657957
3  112 686  8  36  0.18527316
5   35  23 98  18  0.43678161
41   5  21  3 813  0.03444181
```

Oak
Beech
Other d.
Spruce

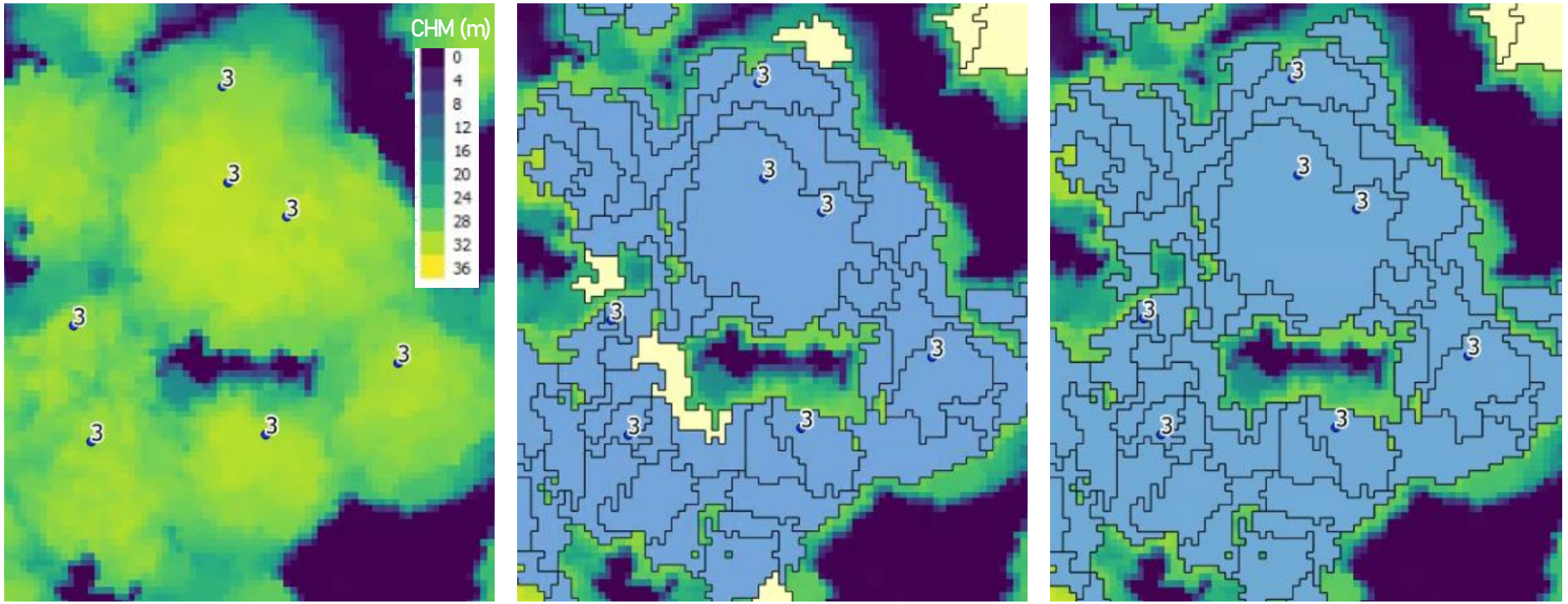


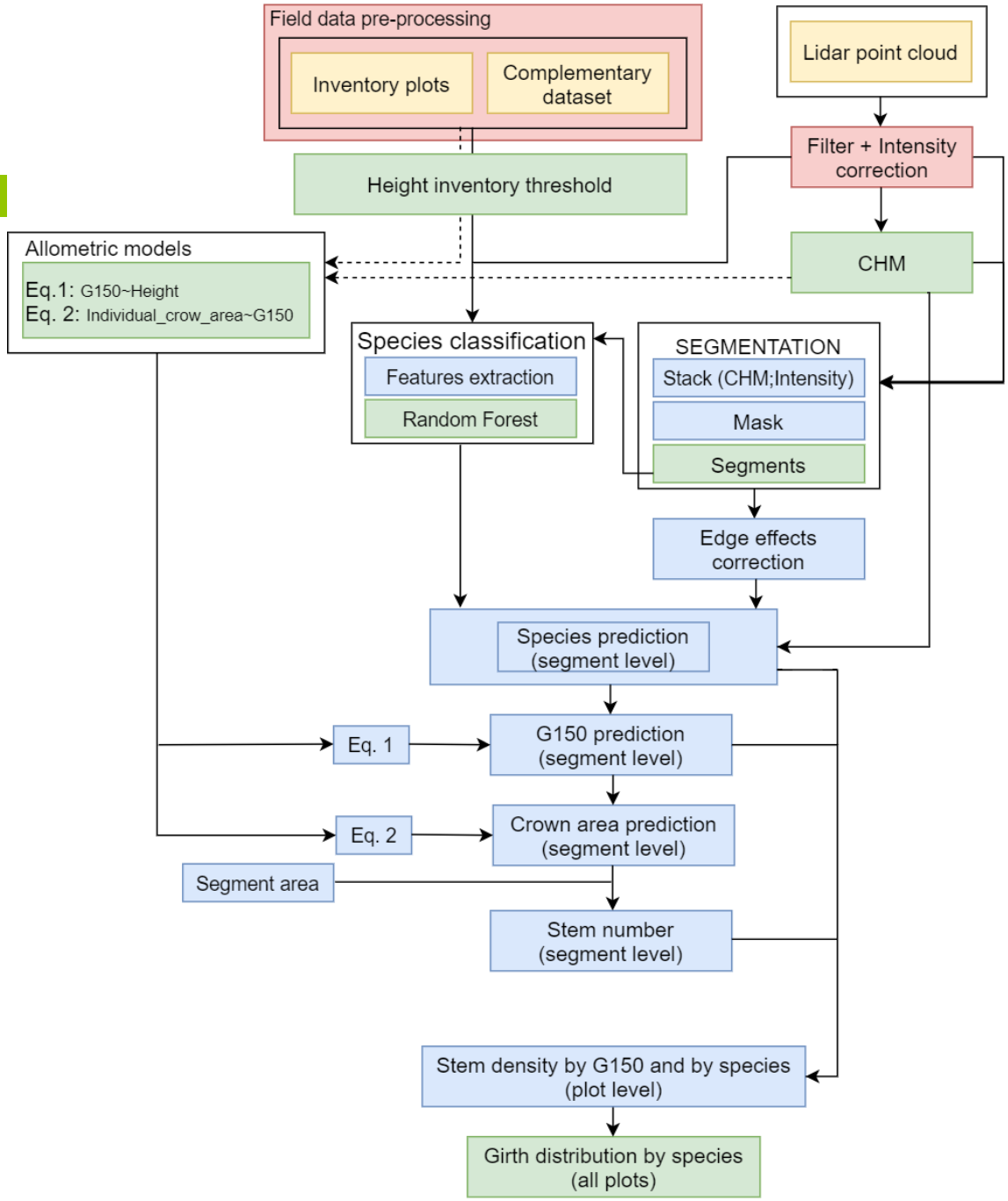
# Mature forest characterization



## Step 3 : Species prediction
## Prediction + Post- treatment

3 - Beech
5 - Other deciduous species

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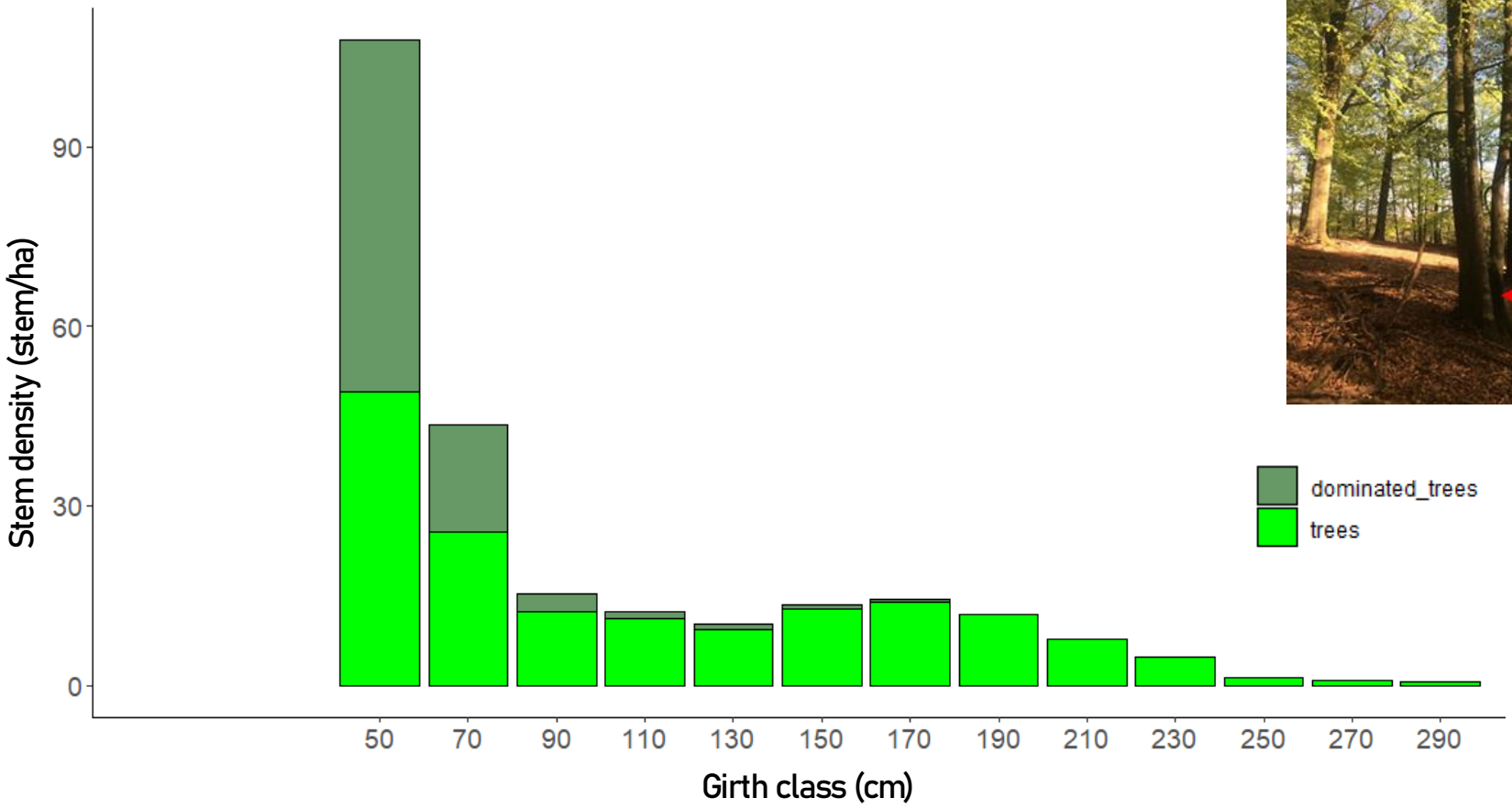

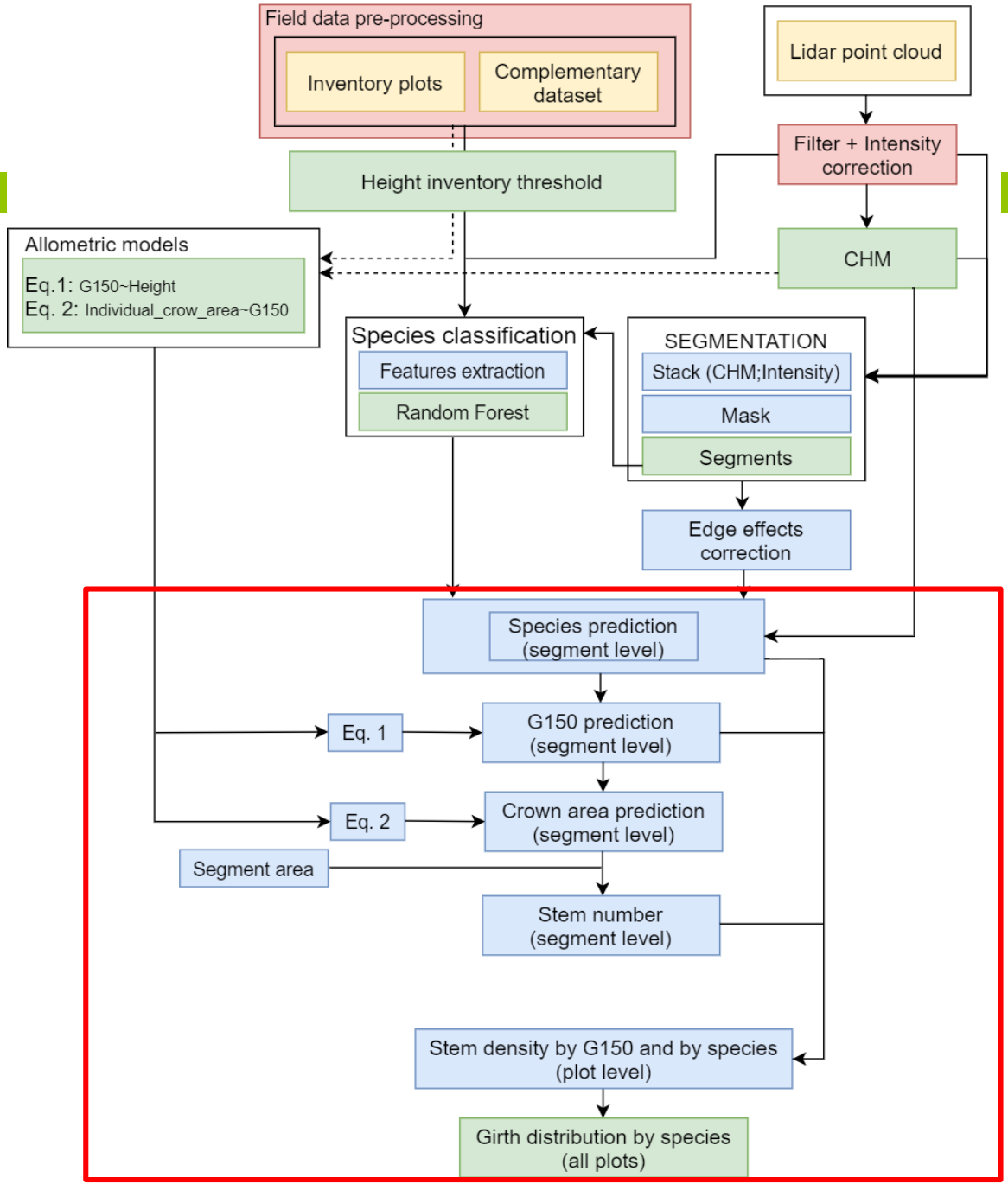
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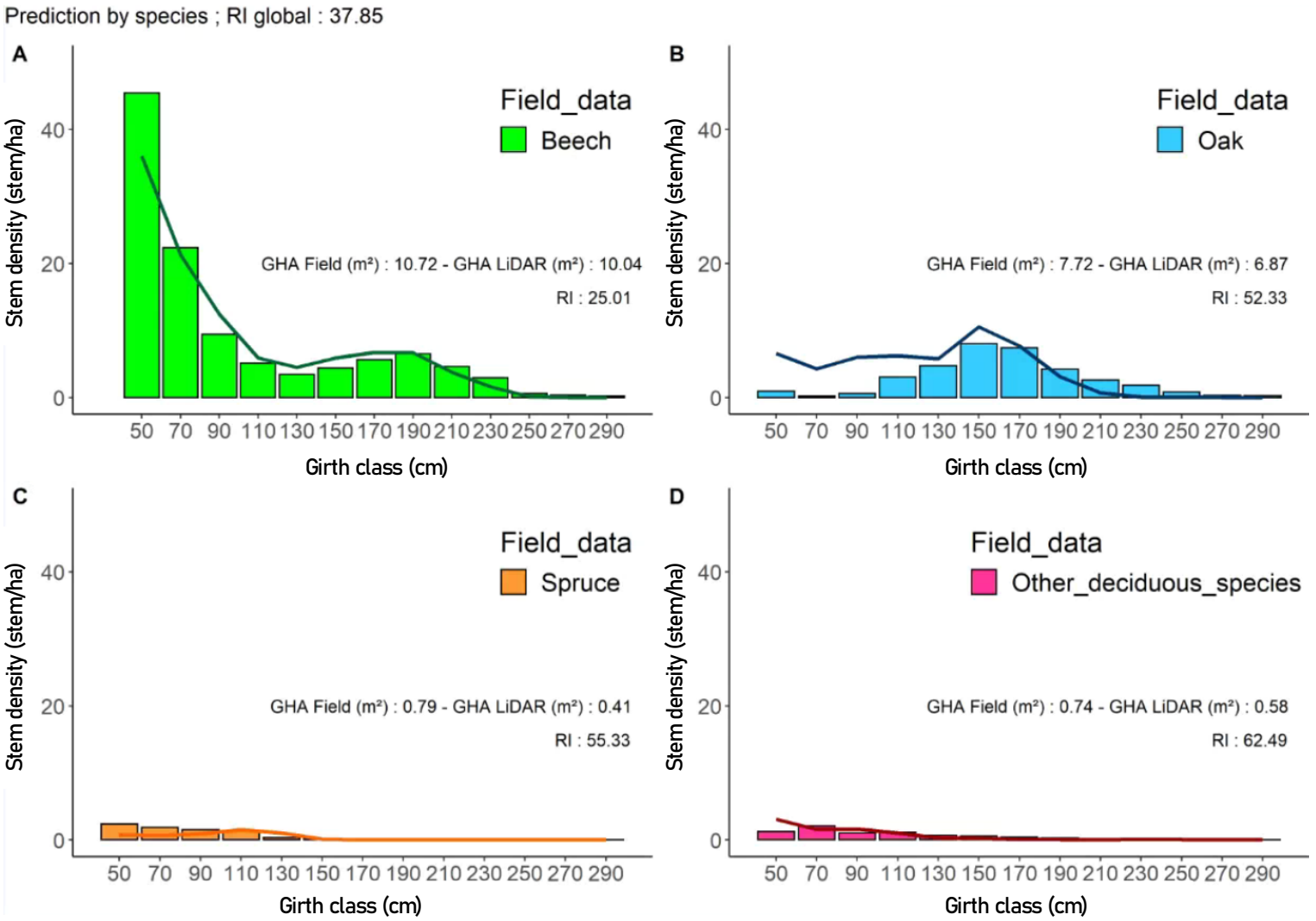
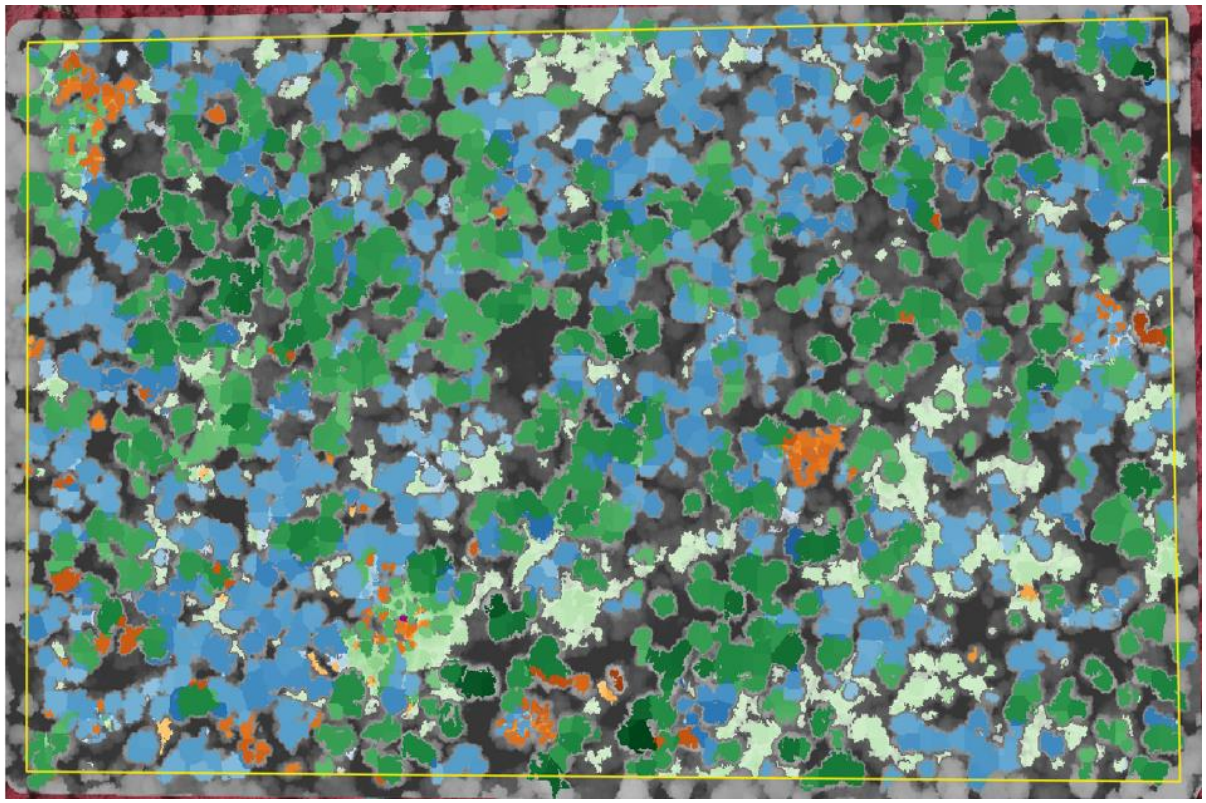


# Mature forest characterization



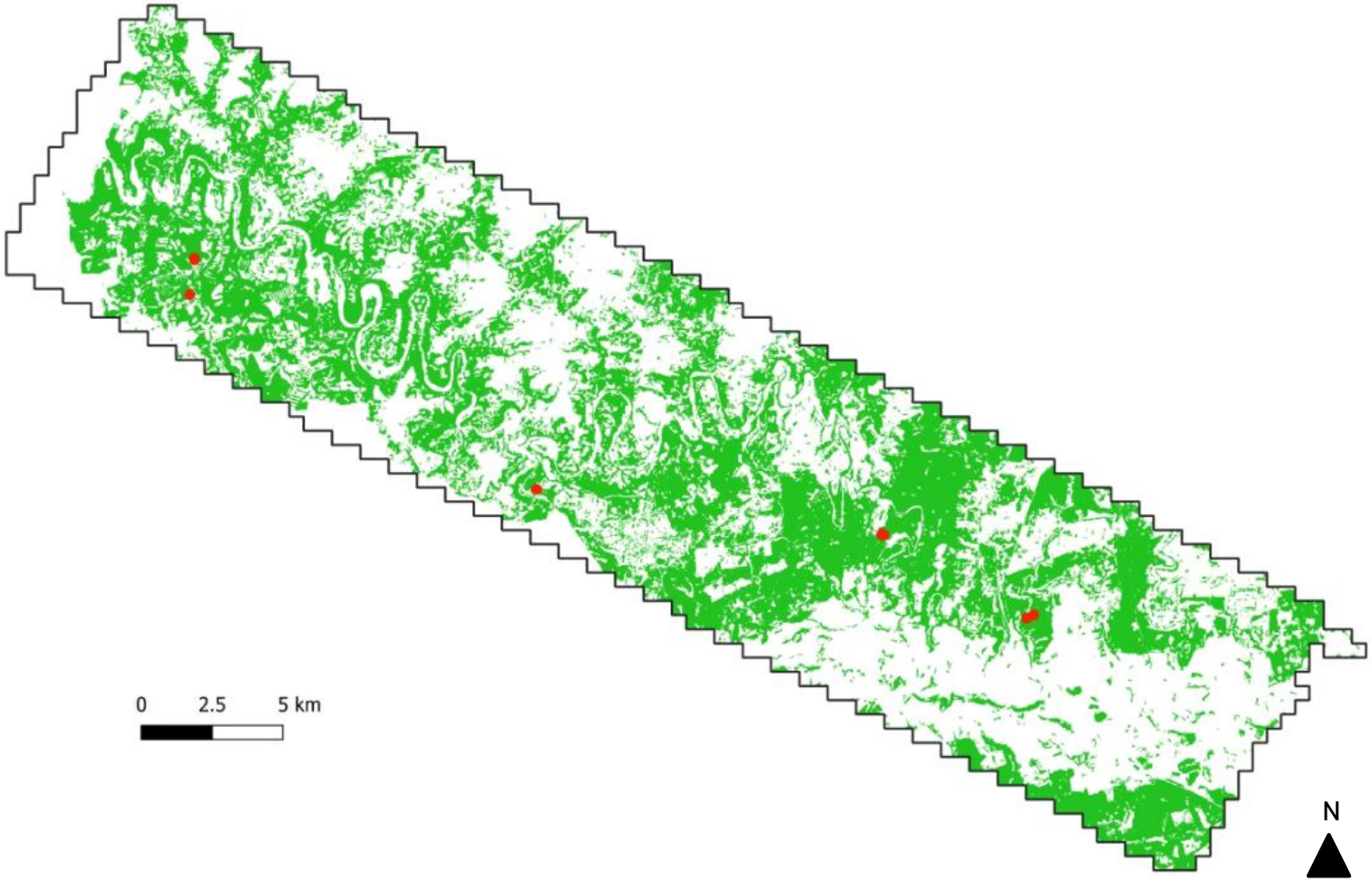
## Forest mapping



# Mature forest characterization



Validation in progress...



# Regeneration characterization



# Regeneration characterization



# Regeneration characterization



# Regeneration characterization



# Regeneration characterization

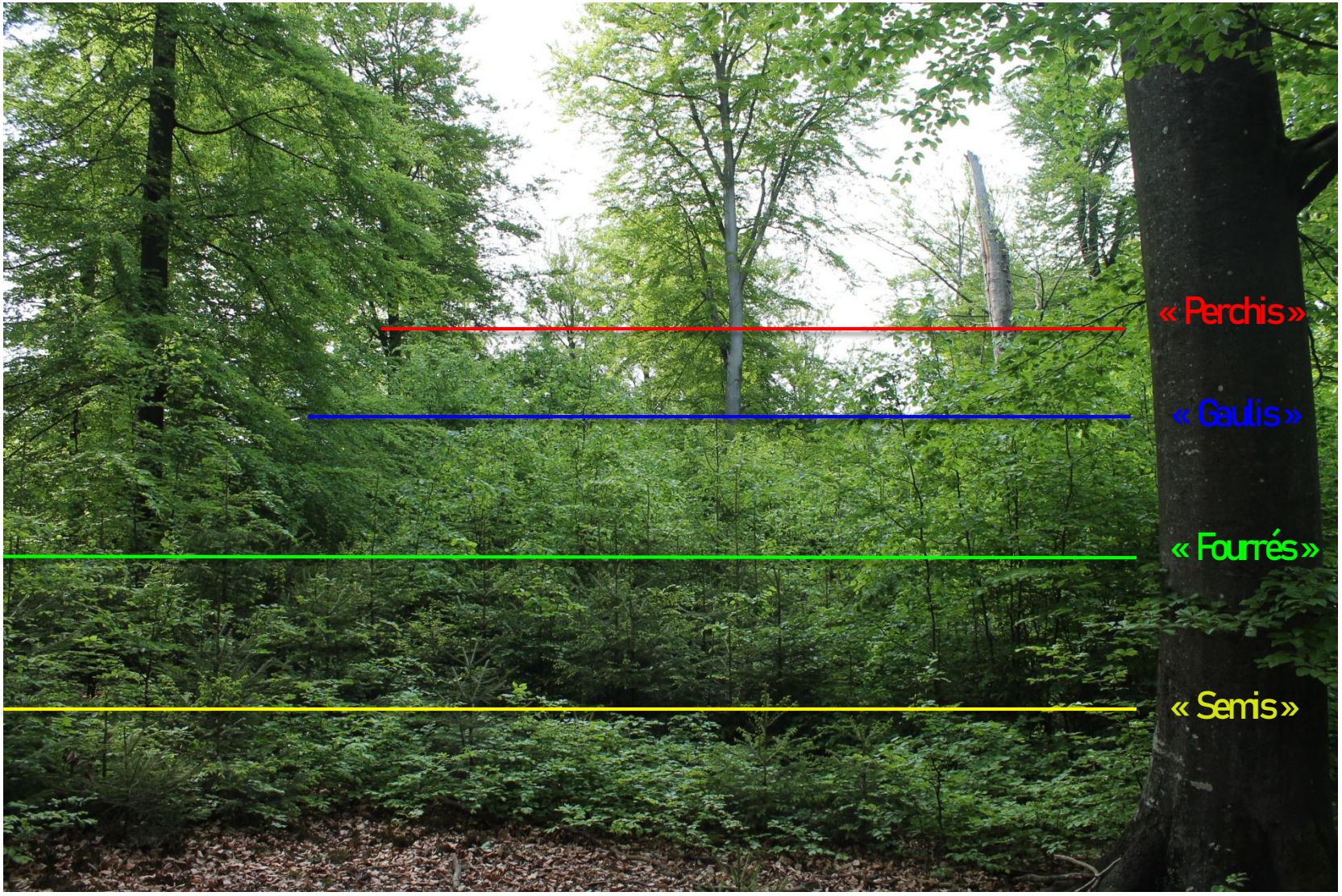


# Regeneration characterization



# Regeneration characterization



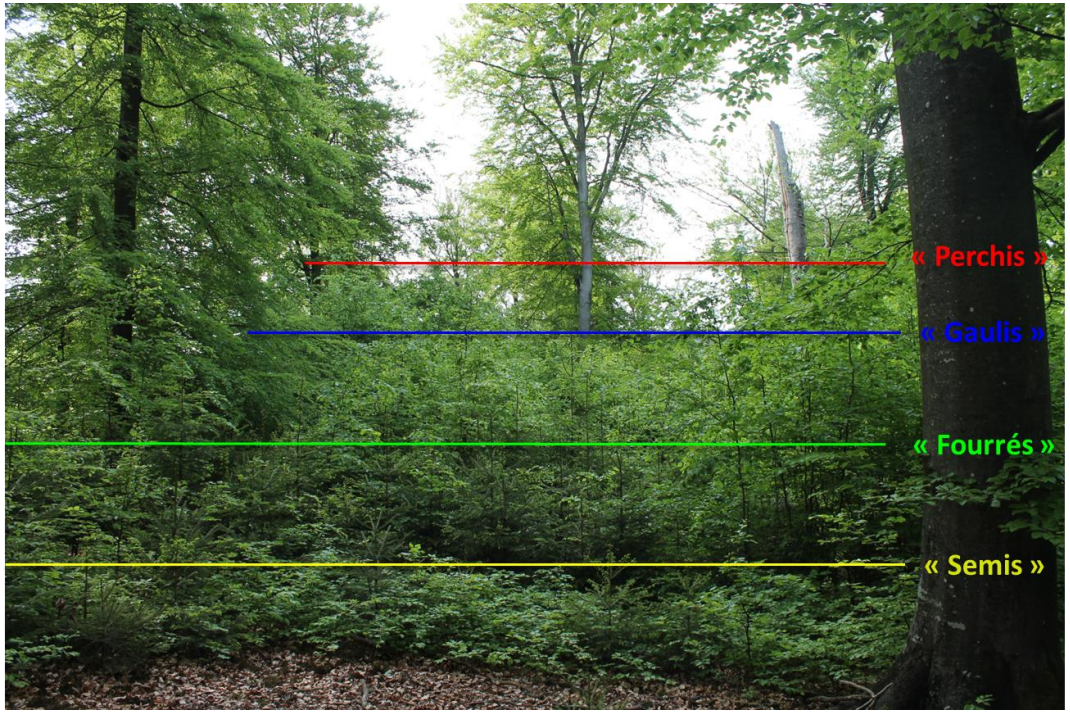


# Regeneration characterization



## - Development stages definition

| | 0 – 1.5m | 1.5 – 3m | 3 – 6m | 6 – 10.05 m | >10.05m |
|---|---|---|---|---|---|
| Not ligneous | « Autres » | | | | |
| Ligneous | « Semis » | « Fourrés » | « Gaulis » | « Perchis » | |



# Regeneration characterization



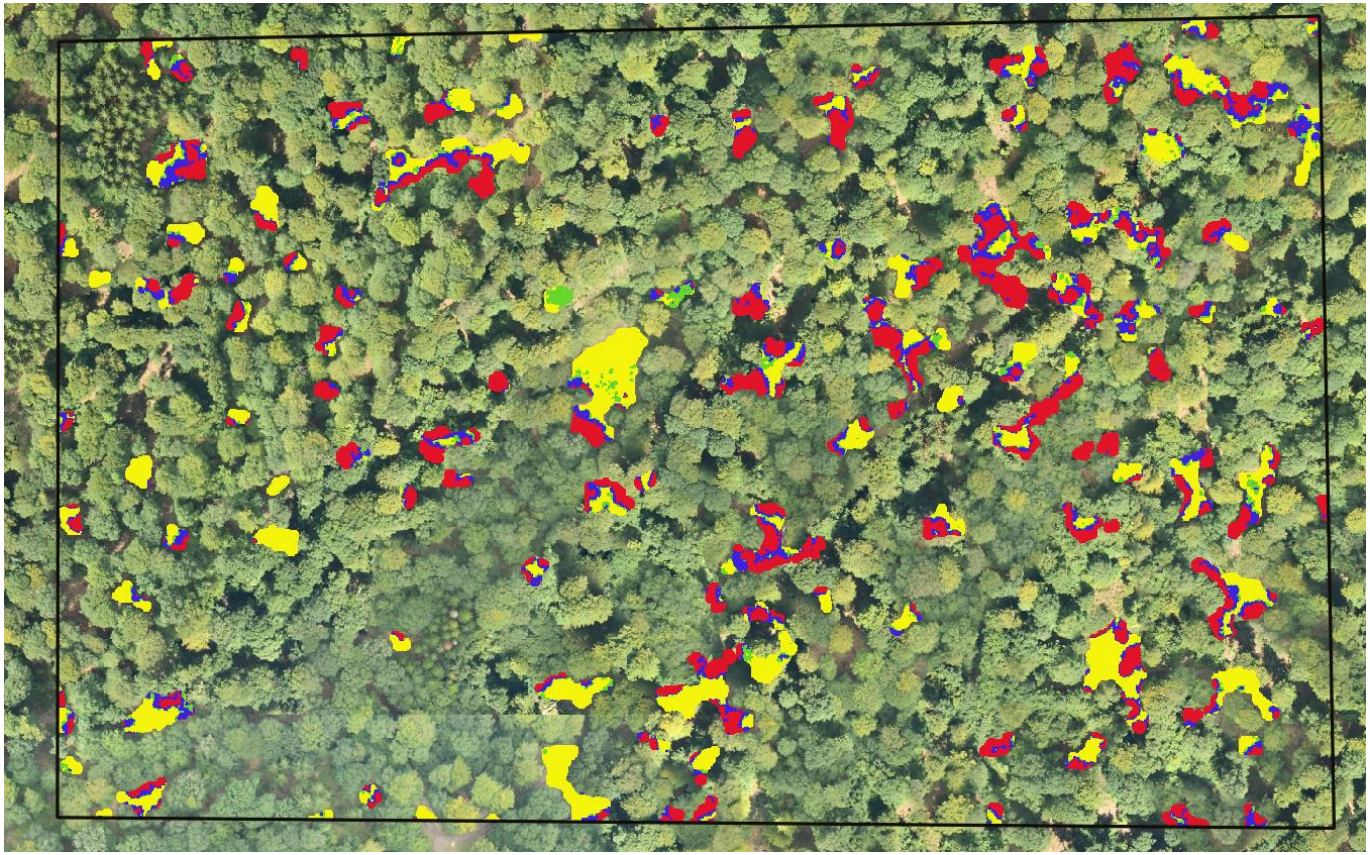
## - Gaps delineation


Definition
- Height : 10.05 m
- Minimal area : 50m²
- Minimal width: 4m
- Slope-CHM : < 80°

# Regeneration characterization



## - CHM classification

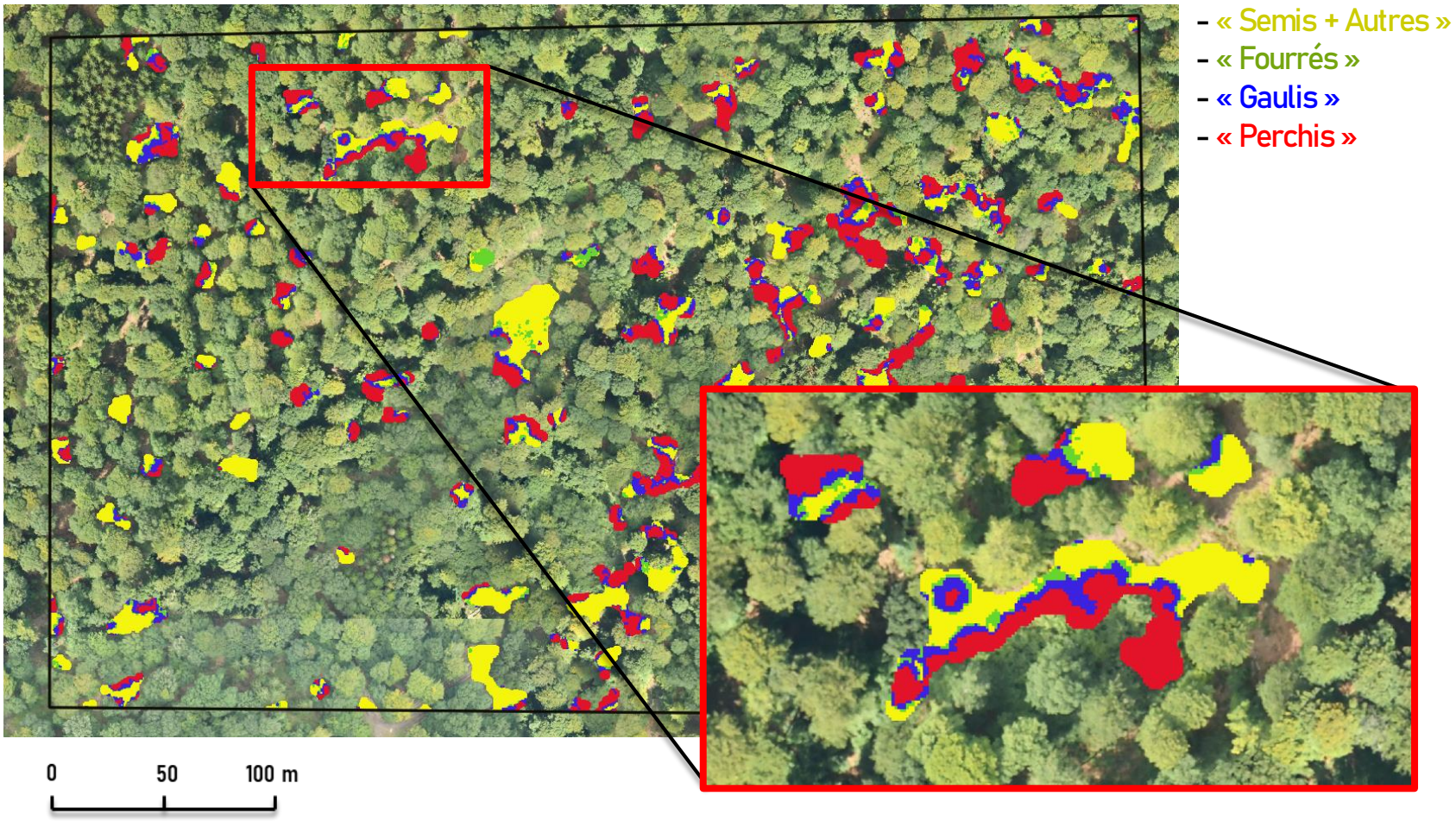



- « Semis + Autres »
- « Fourrés »
- « Gaulis »
- « Perchis »

# Regeneration characterization



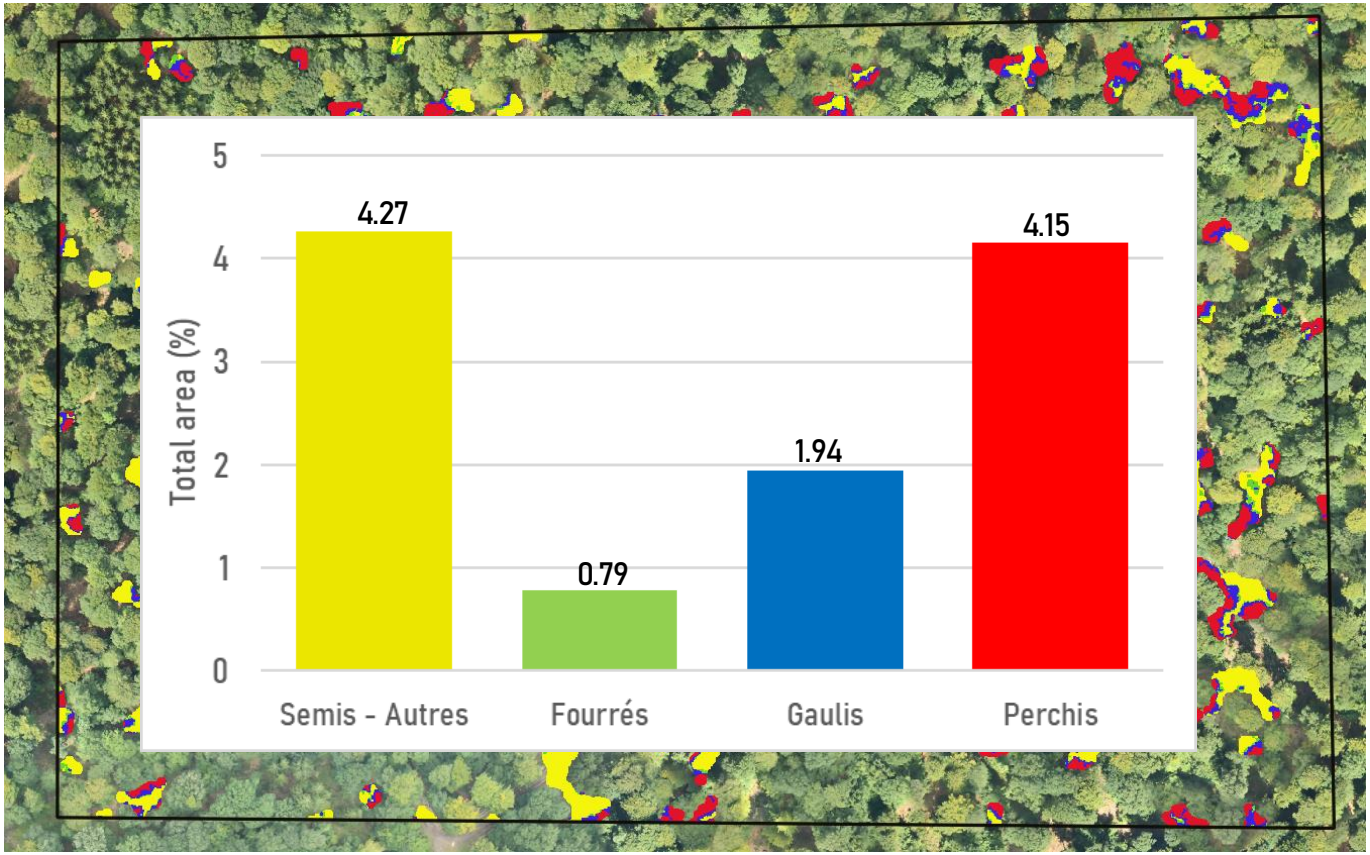
## - CHM classification



# Regeneration characterization



## - Regeneration assessment



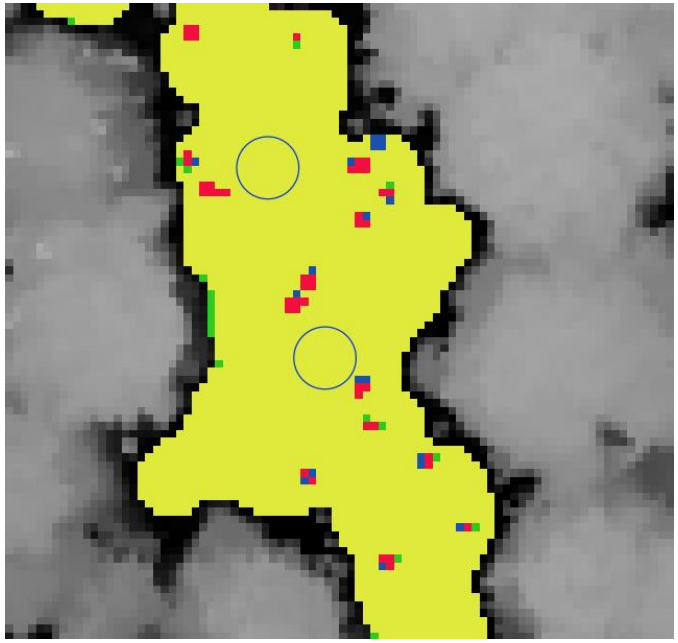

- « Semis + Autres »
- « Fourrés »
- « Gaulis »
- « Perchis »

# Regeneration characterization



## - First development stage characterization

| | 0 – 1.5m | 1.5 – 3m | 3 – 6m | 6 – 10.05 m | >10.05m |
|---|---|---|---|---|---|
| Not ligneous | « Autres » | | | | |
| Ligneous | « Semis » | « Fourrés » | « Gaulis » | « Perchis » | |



Field phase:
100 micro plots

-> geolocalised at very high precision (Emlid Reach RS+ GPS)

-> % plot area

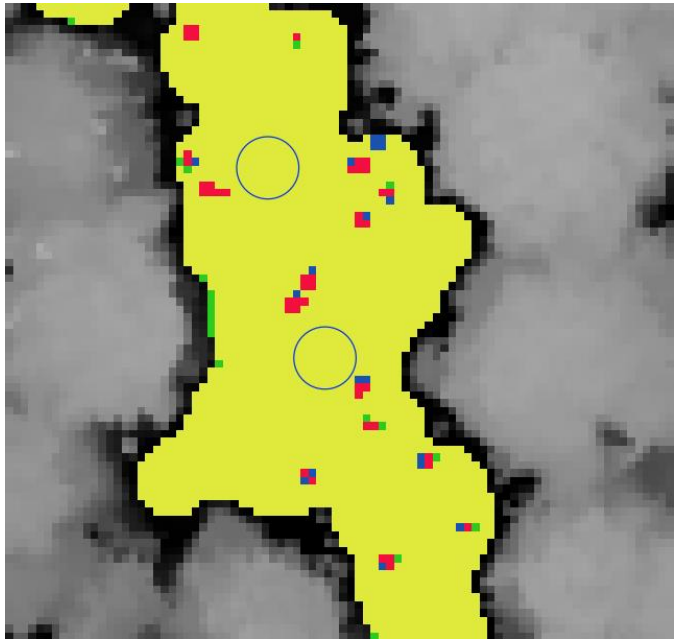
Deciduous regeneration– Resinous regeneration - herbaceous - litter/ground

# Regeneration characterization



## - First development stage characterization

| | 0 – 1.5m | 1.5 – 3m | 3 – 6m | 6 – 10.05 m | >10.05m |
|---|---|---|---|---|---|
| Not ligneous | « Autres » | | | | |
| Ligneous | « Semis » | « Fourrés » | « Gaulis » | « Perchis » | |



Modeling :

Metrics (H, I, ΔH)

Stepwise Selection

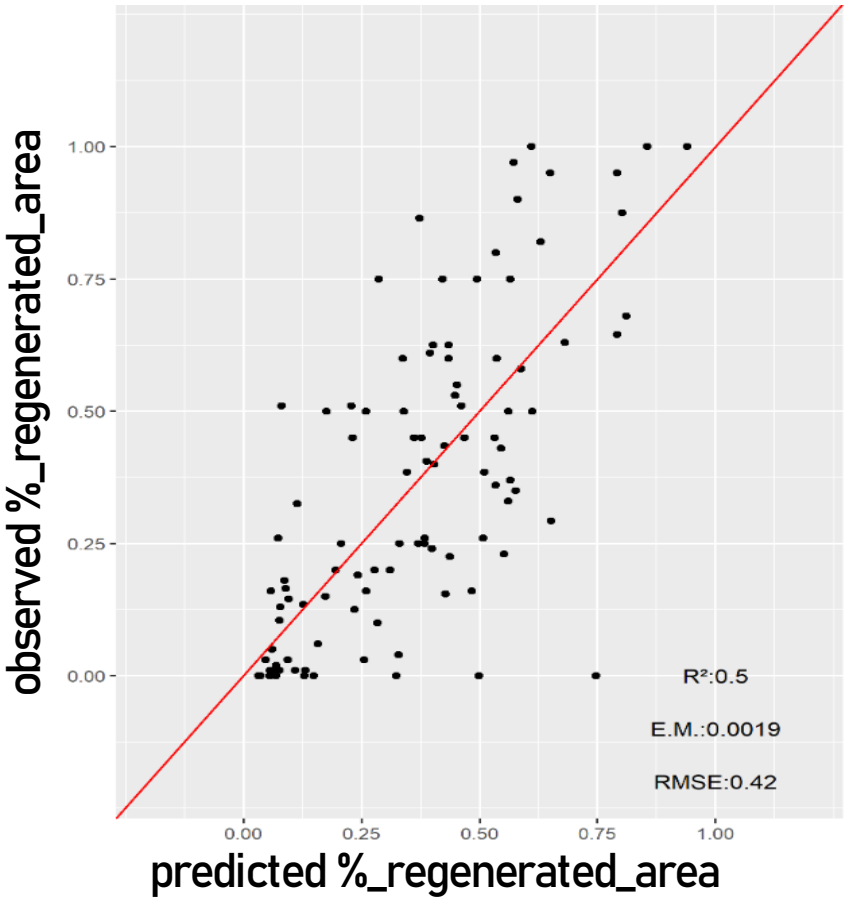
Modeling with transformation (Asin et logit)
% total area for each class

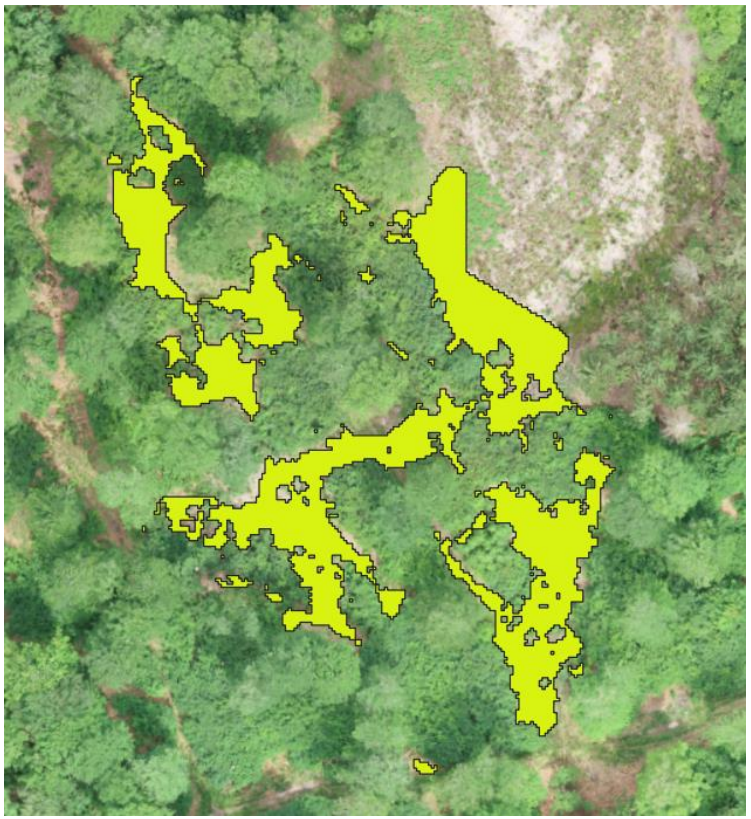
# Regeneration characterization



## - First development stage characterization

% regenerated area (Deciduous + Resinous)



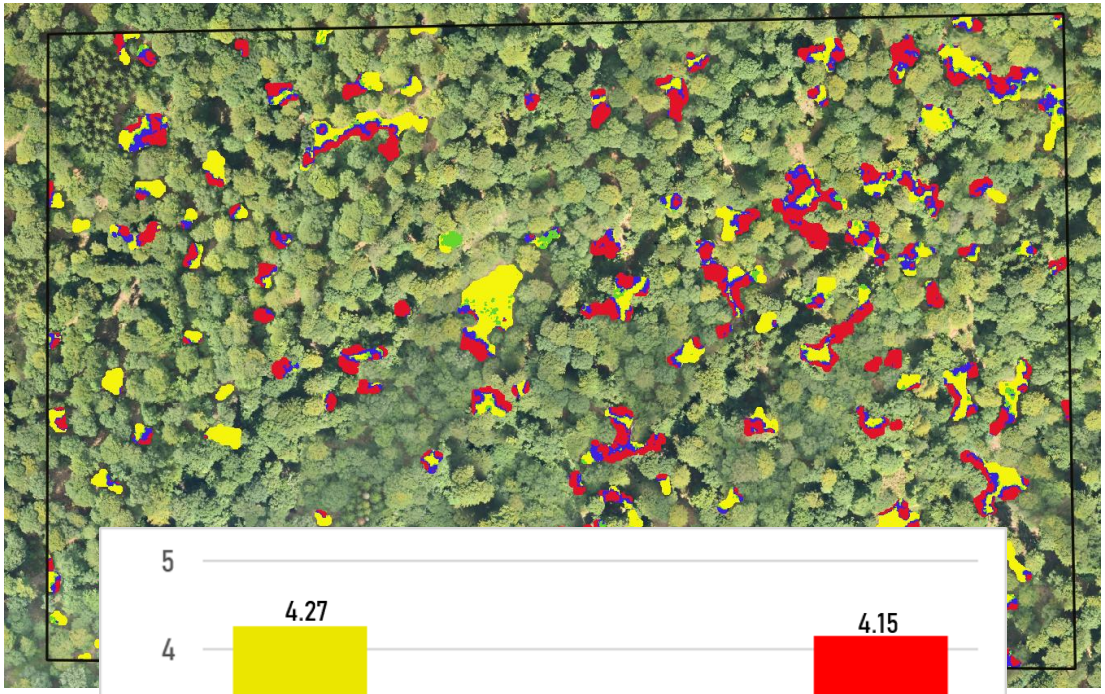
# Regeneration characterization

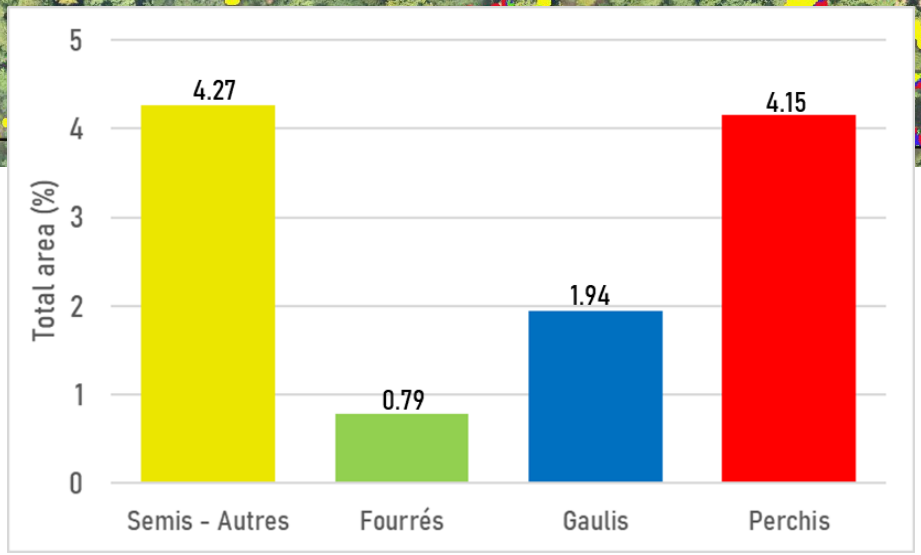


% regenerated area

< 50%

>= 50%





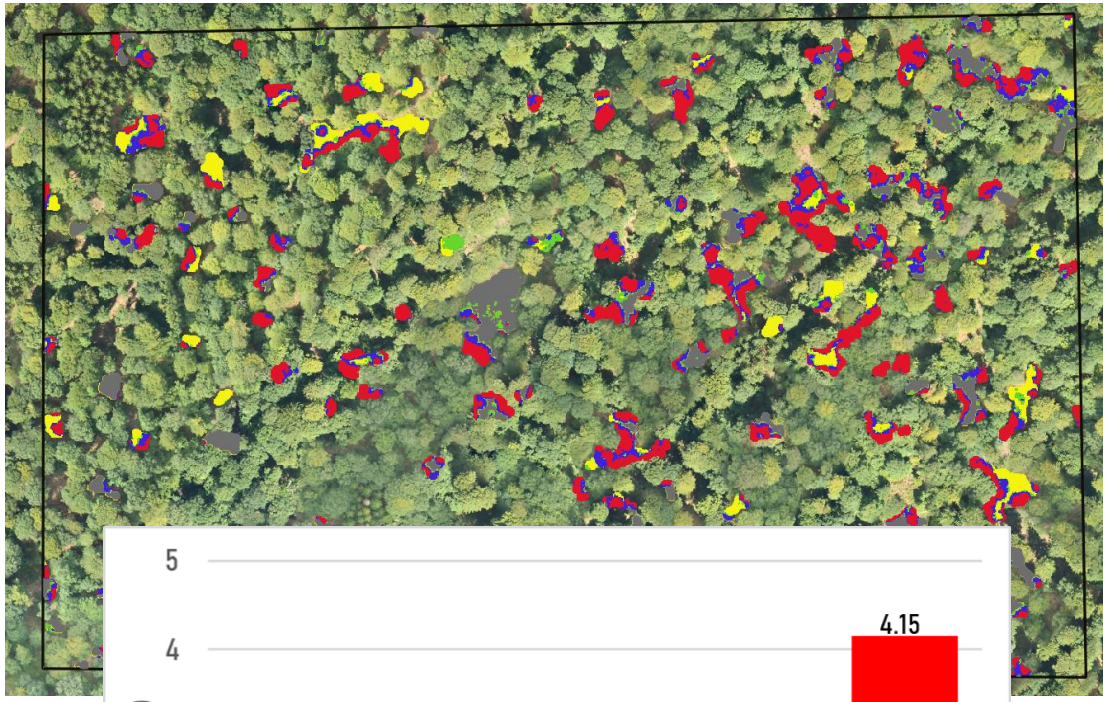
# Regeneration characterization

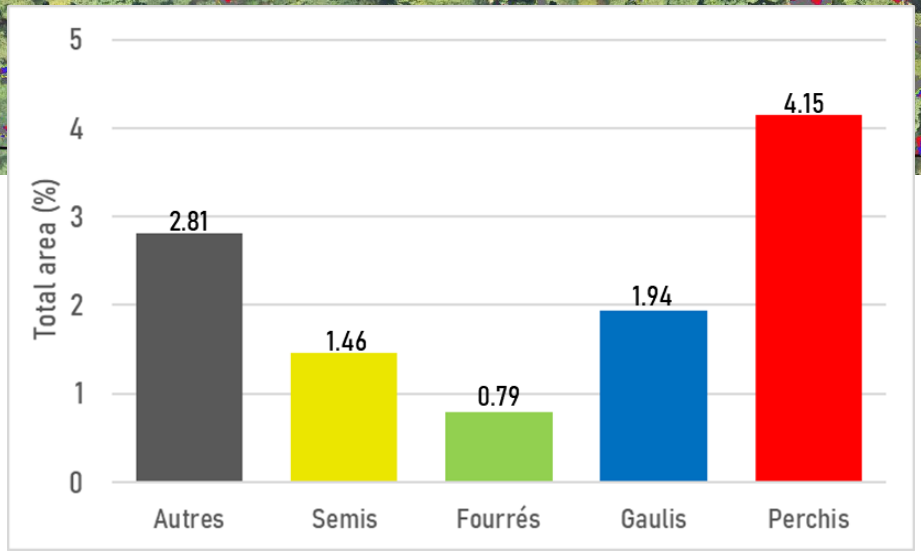


% regenerated area

< 50%

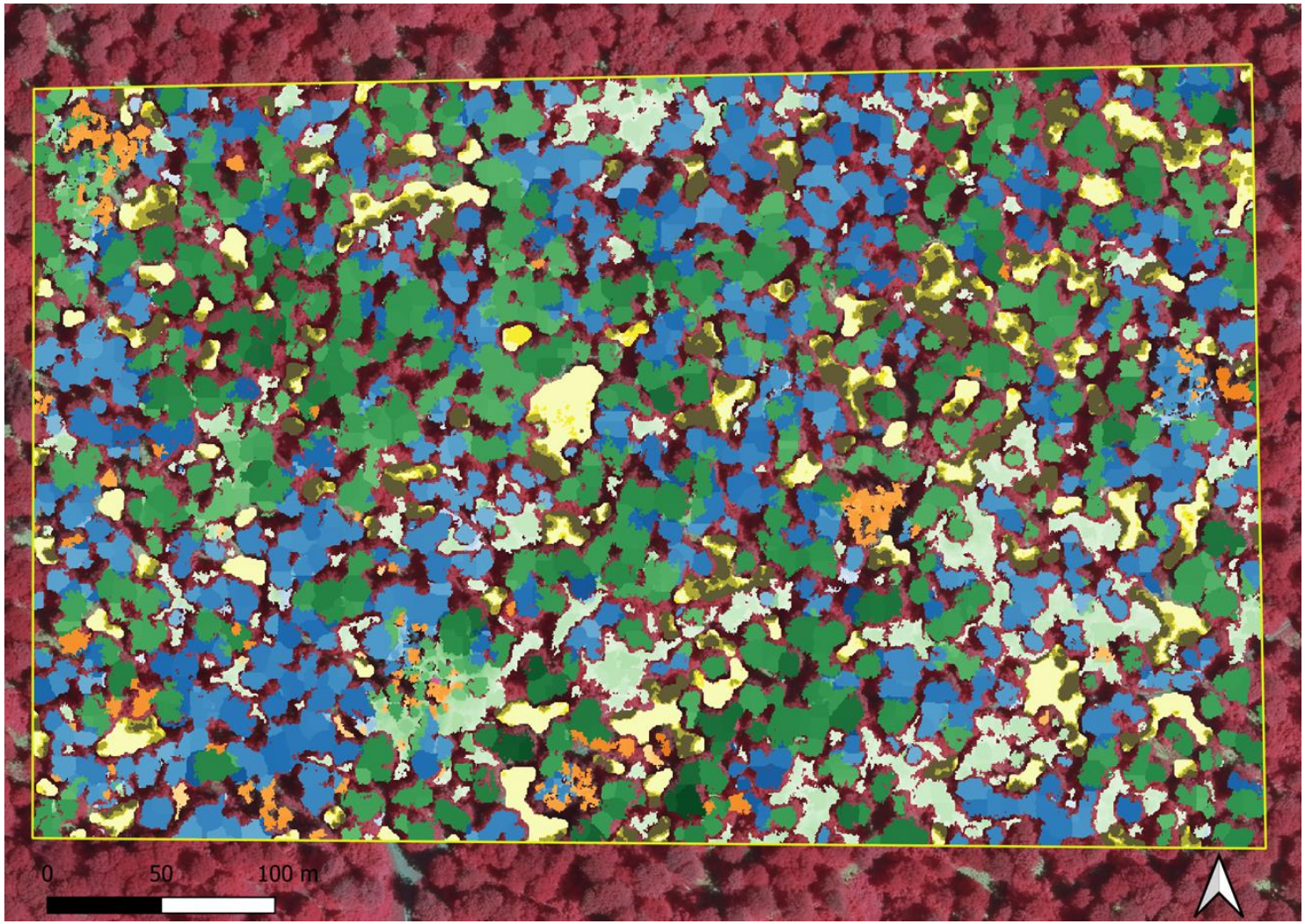
>= 50%





# Overall mapping





Thank you !

# VALORISATION DU LIDAR AÉRIEN POUR LA CARACTÉRISATION DES PEUPLEMENTS FORESTIERS FEUILLUS IRRÉGULIERS MÉLANGÉS

Séminaire télédétection forestière

4 juin 2020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Regiowood II

Interreg Grande Région | Großregion

Wallonie