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Assessing Felling & Increment in Ireland's NFI

7th Field-Map International User Conference

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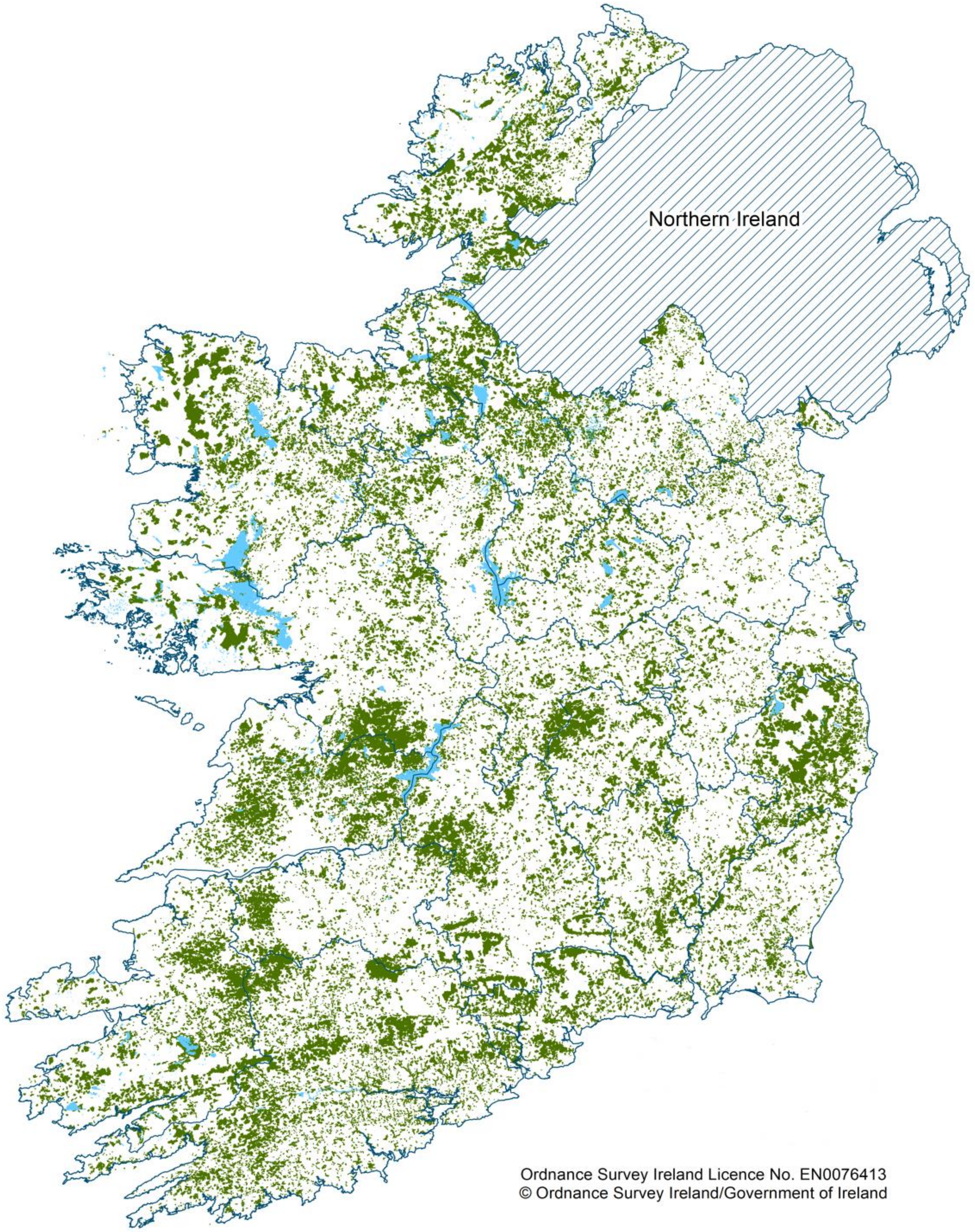
Presentation Overview

- Introduction
- Repeated NFIs and Missing Tree Info.
- Modelling DBH Increment
- Modelling Height Increment
- Results
- Summary

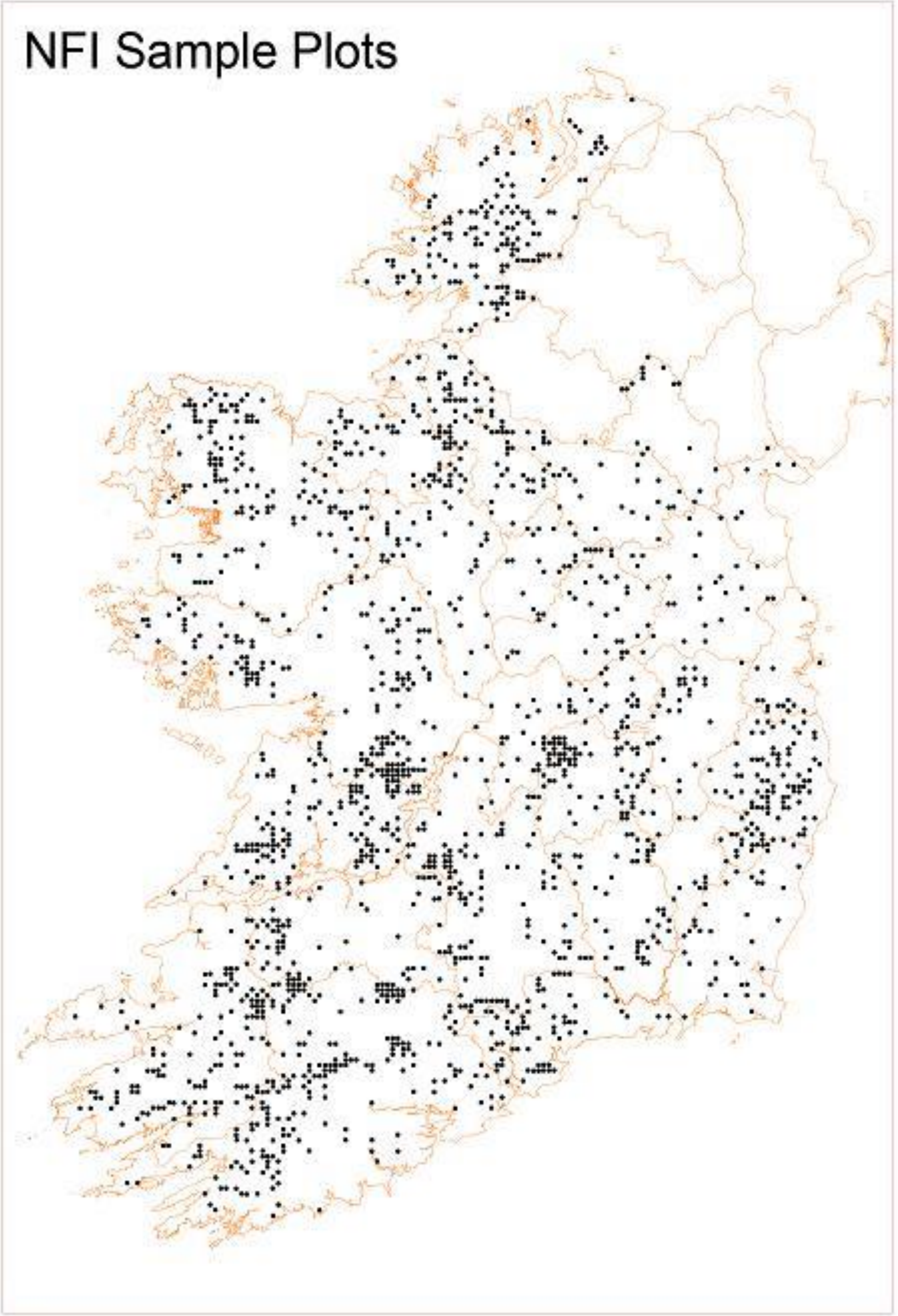
Forestry In Ireland

- 11% forest cover (770,020 ha)
- Over 21,000 owners (85% farmers)
- 12,000 jobs (mainly rural)
- Forestry sector worth €2.3 billion



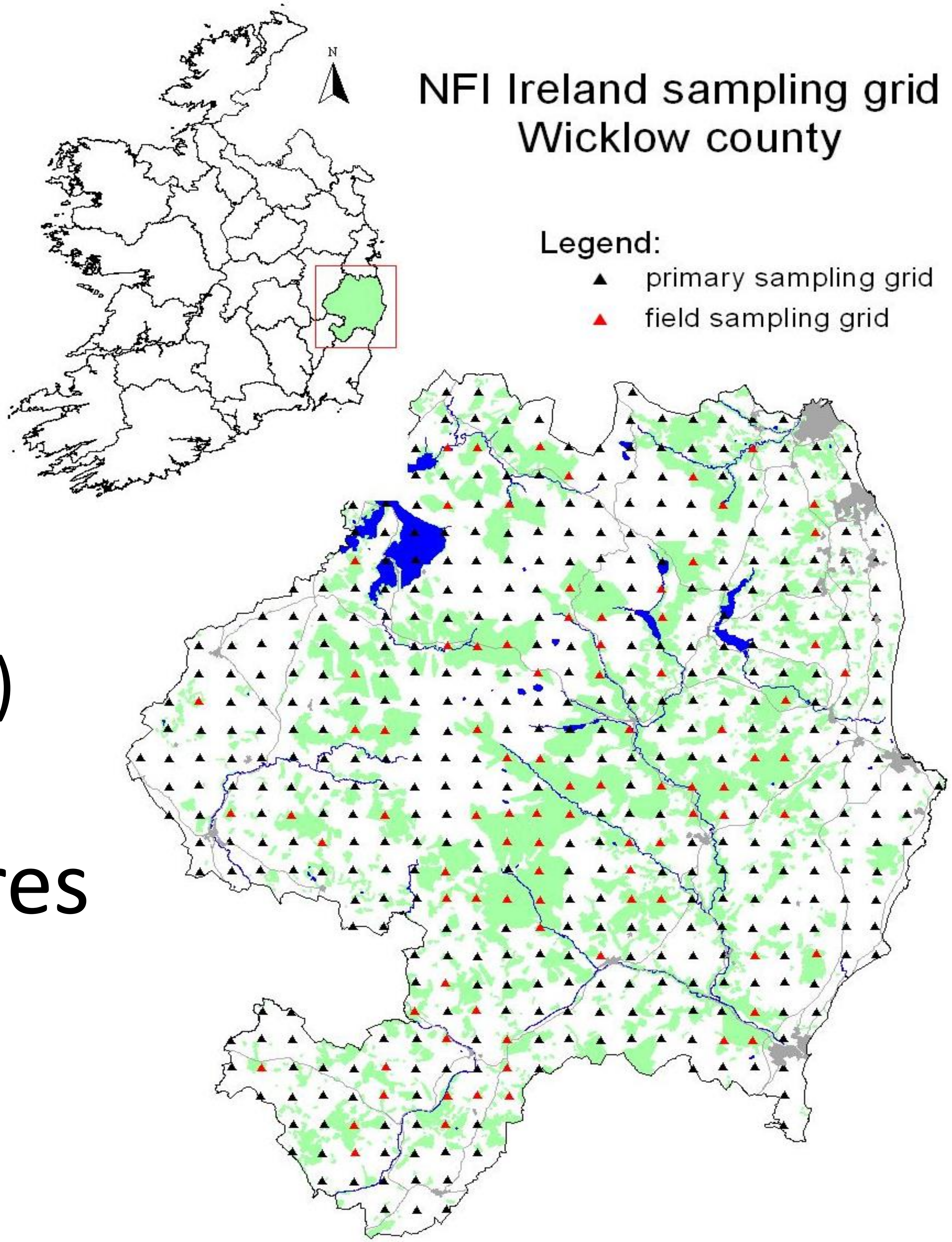
Ireland's NFI

- Operates on a 5 year cycle.
- Managed internally with six contract staff recruited to undertake field-work .
- Permanent forest sample plots
  - NFI 1 (2004-2006) - **1,742** plots
  - NFI 2 (2009 – 2012) - **1,827** plots
  - NFI 3 (2015 – 2017) – **1,923** plots
- Quality control and validation.

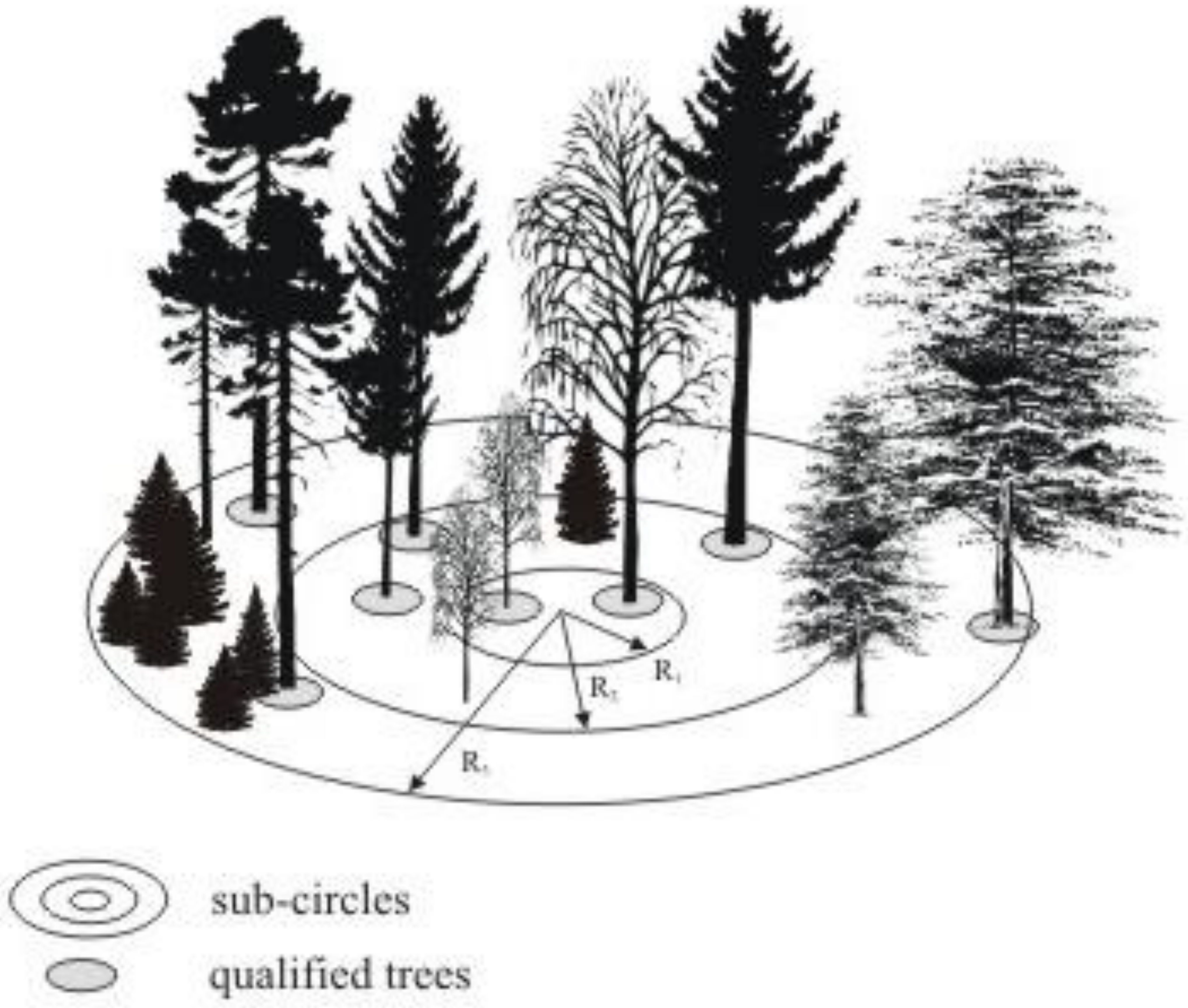


NFI Sampling Frame

- statistical sample survey
- 2 km grid
- 17,423 points (1,923 forest in 2017)
- Each plot represents 400 hectares

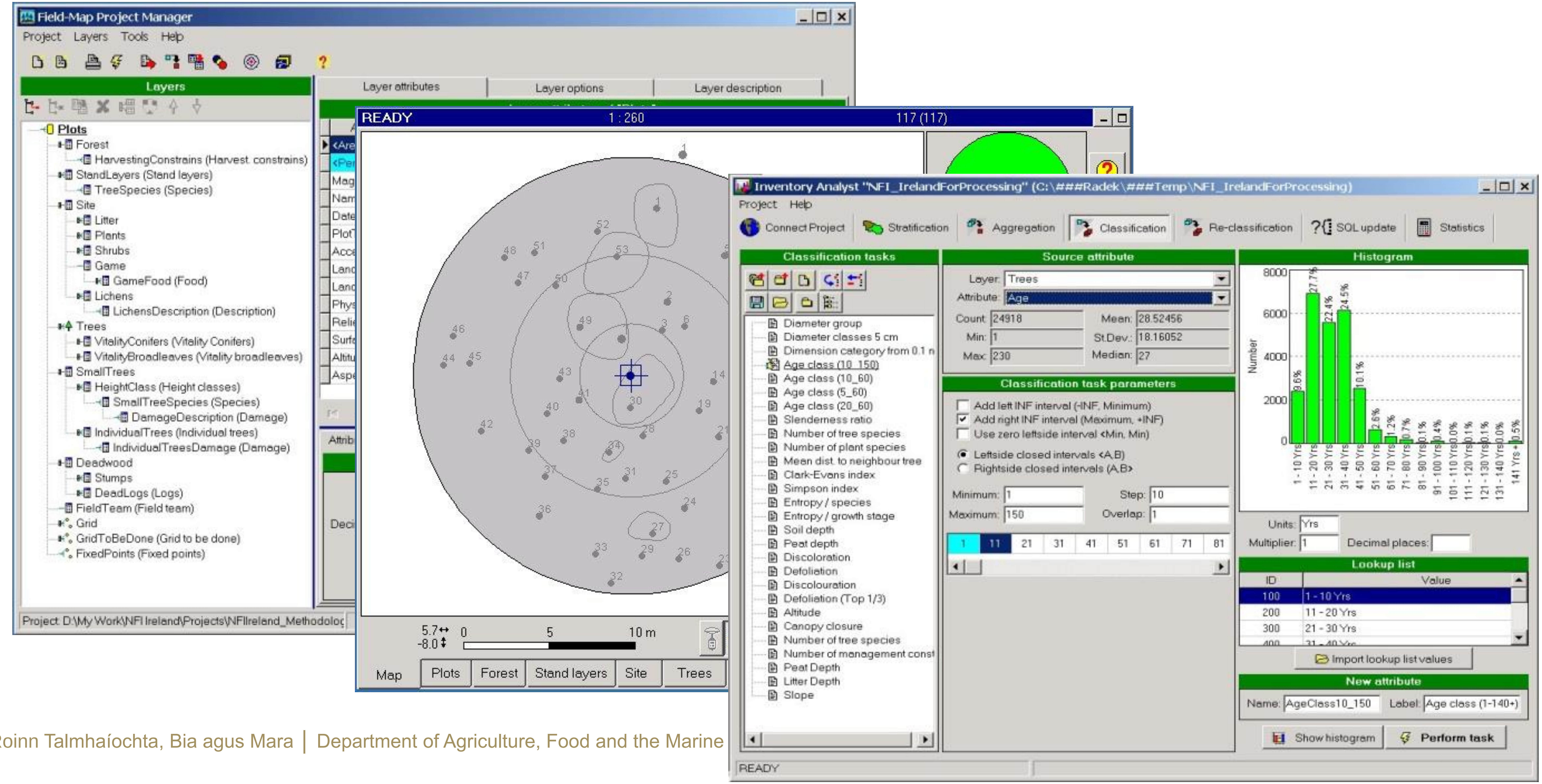


NFI Plot Design

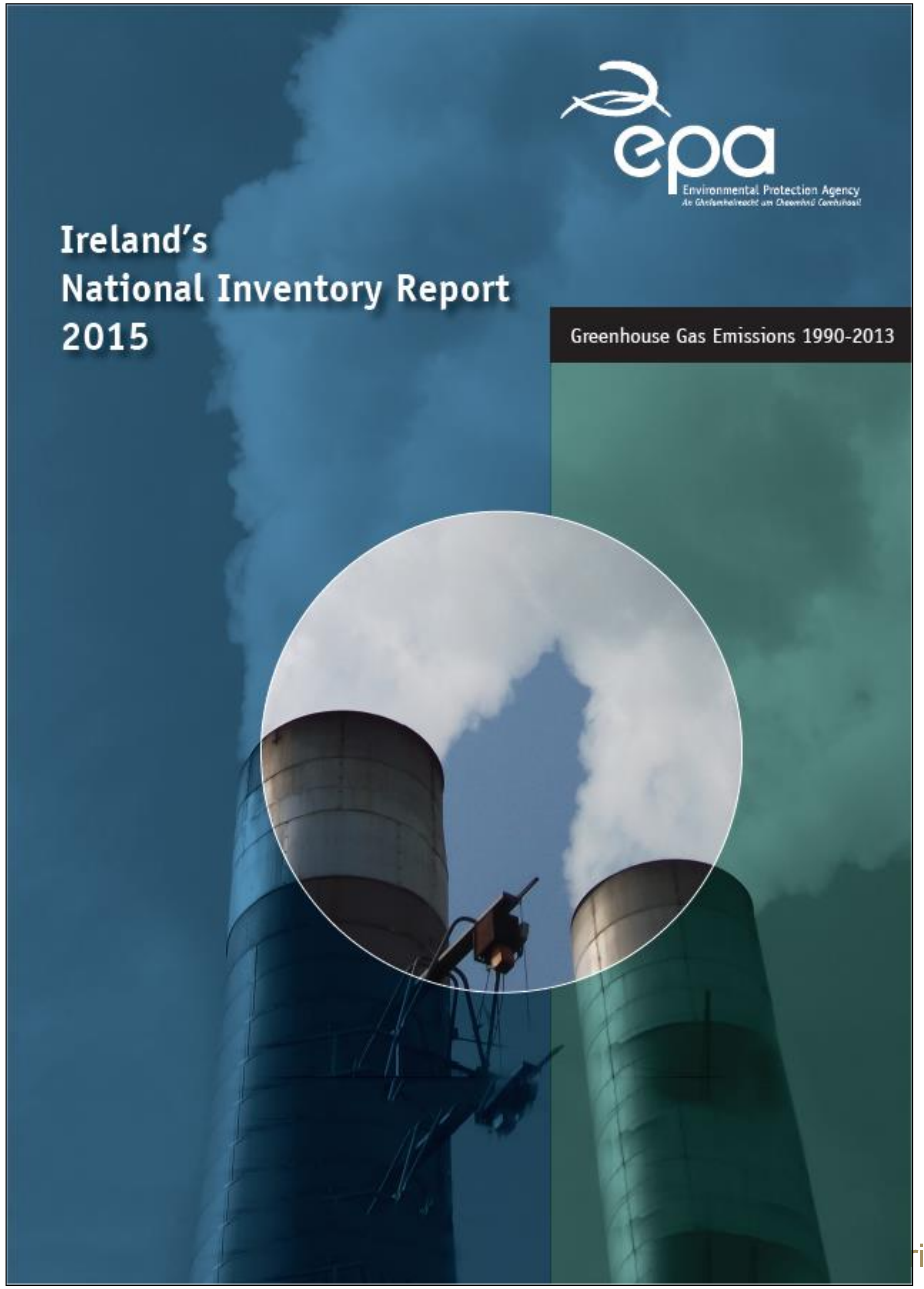


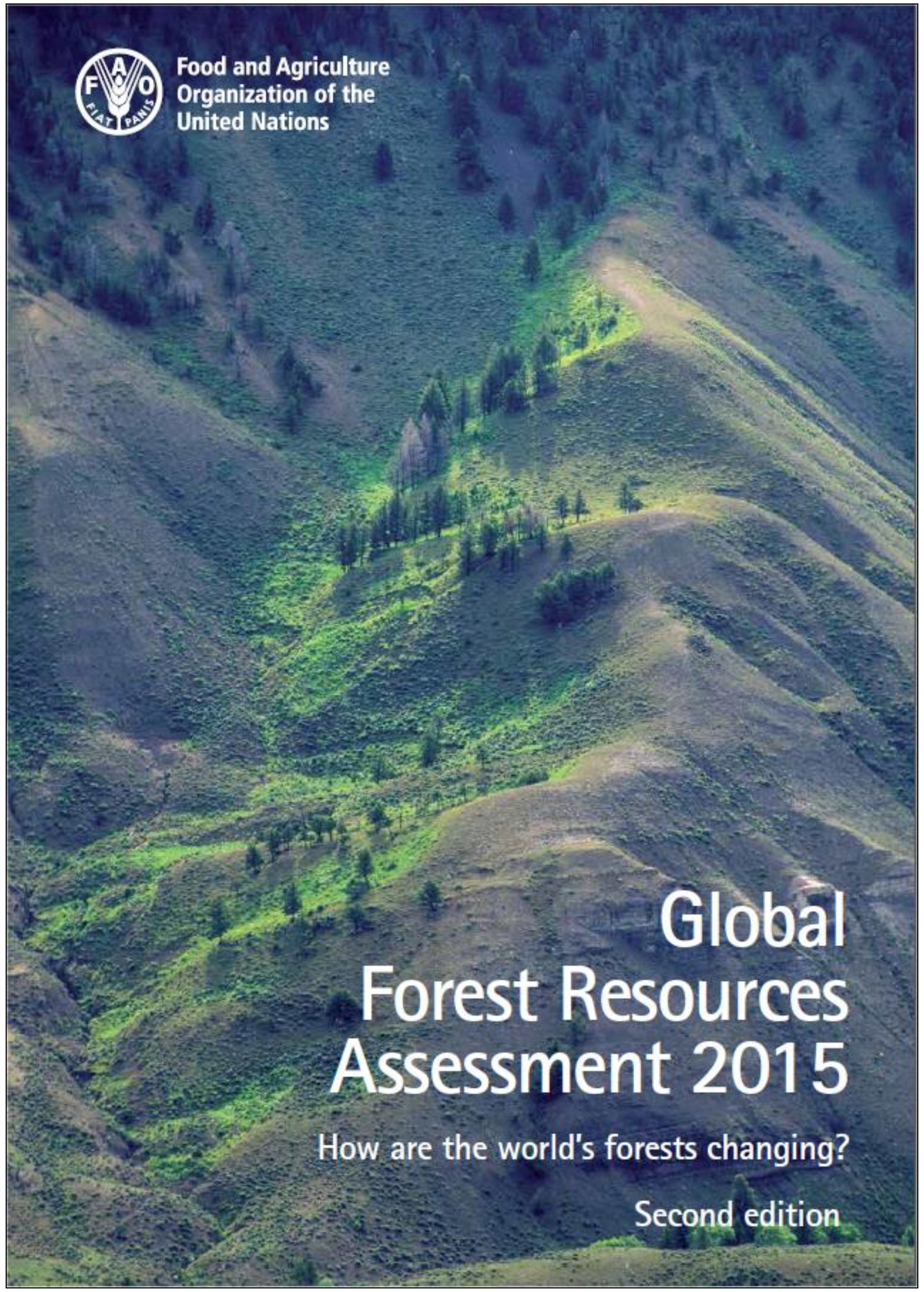
	R_1	R_2	R_3
Sub-circle radius (m)	4.00	7.00	12.62
Sub-circle area (m^2)	50.3	153.9	500.0
Threshold Dbh (mm)	70	120	200

NFI Technology



International Reporting Obligations





Overview of the main NFI results 2006-2017

	2006	2012	2017
Total Forest Area (ha)	697,842	731,652	770,020
Mean Basal Area (m^2/ha)	20.2	25.3	27.5
Mean Growing stock (m^3/ha)	112	148	170
Growing stock (million m^3)	71.9	97.5	116.5
Gross Increment Volume (million m^3 yr^{-1})	not available	7.69	8.53
Gross Fell Volume (million m^3 yr^{-1})		3.62	4.90

Repeated NFI cycles and Missing Tree Information

Missing Information

- First cycle Dbh & Ht unknown e.g. ingrowth trees.
- Second cycle Dbh & Ht unknown e.g. harvested trees.
- Dbh data is present for both cycles

Third cycle tree information available

Tree Dbh/Ht Availability	Tree Category	Relevant for increment?	Number of Trees	
			Per Category	Sub-total
Dbh/Ht Unknown in previous cycle	new plot tree	Yes	957	13,047
	ingrowth	Yes	11,763	
	omitted by mistake	Yes	327	
Dbh/Ht Unknown in current cycle	living to lying dead	Yes	284	5,950
	harvested tree	Yes	5,139	
	deforestation (living last cycle)	Yes	64	
	deforestation (dead last cycle)	No	13	
	standing dead tree cut	No	218	
	measured by mistake	No	134	
	standing dead to lying dead	No	98	
Dbh/Ht known in both cycles	no change	Yes	23,873	24,554
	standing dead to living (Lazarus tree)	Yes	3	
	living to standing dead	Yes	340	
	standing dead current and previous cycle	No	338	
		Total Number of Trees		43,553

Plot Status

Plot Status	Description
no change	Plot location has not changed
new plot	Afforestation since previous cycle
new plot, forest missed in previous NFI	Existing forest being assessed for the first time.
Forest/FOA previous NFI, should have been NF	Problem with classification of land-use category in previous cycle
Forest previous NFI, should have been FOA	
FOA prev NFI, should have been Forest	
centre located, Forest to FOA	Change in land-use category
centre located, FOA to Forest	
GO moved in forest, due to new OA	A new generated origin is being created for the plot.
GO move error previous NFI, return to GO	
GO should have moved previous NFI, move GO	
Deforestation	Land-use category change to non-forest, trees no longer present
inaccessible	Not possible for field-team to reach plot for assessment

Estimating annual increment data

- Trees assessed in both the 2nd and 3rd cycle (i.e. no change) provide total increment.

- Plot may get surveyed at different times of the year from one cycle to the next.

- Growing season is not equal to the calendar year.

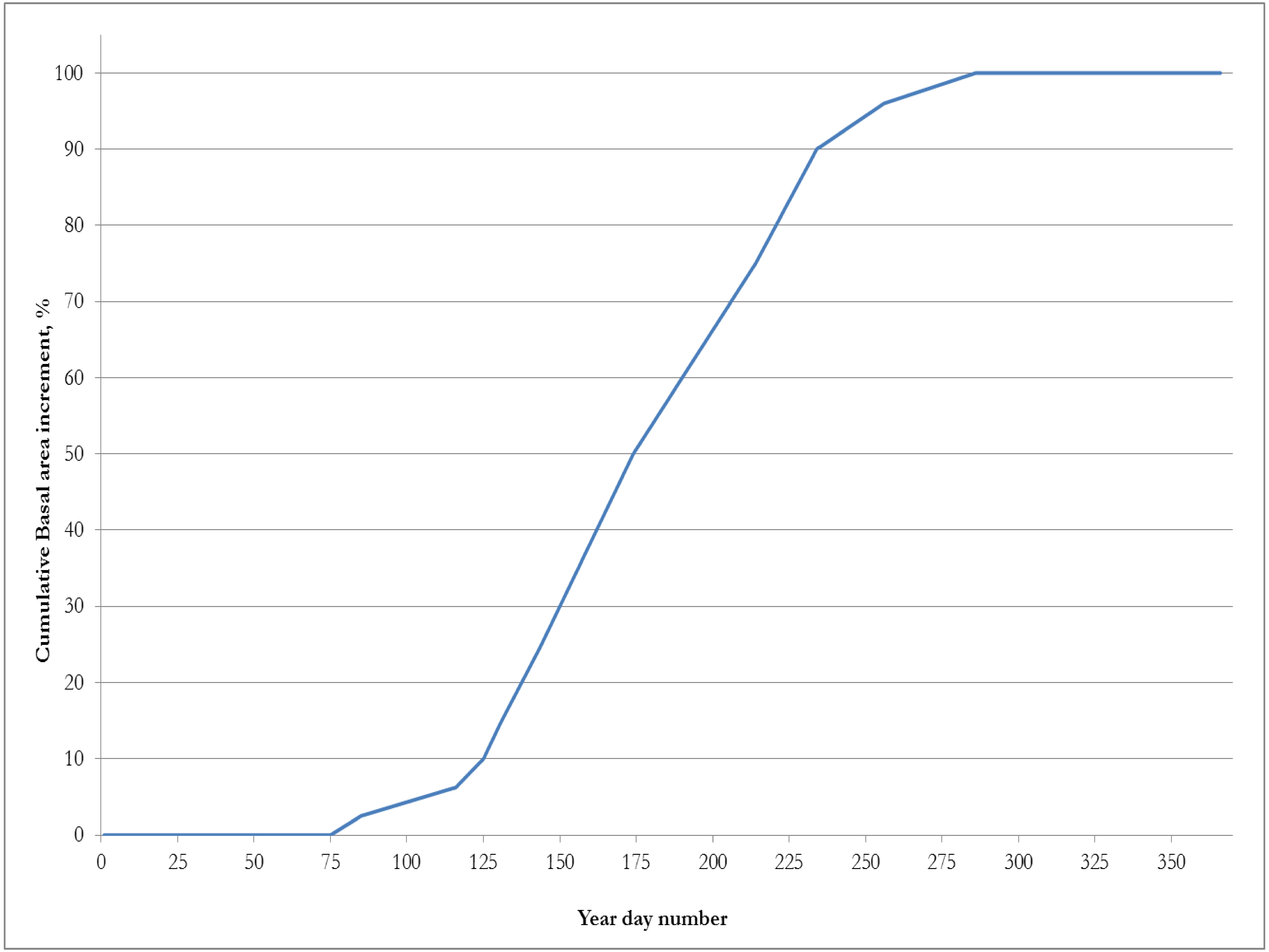
- Use the plot survey dates based to calculate the increment period for individual plots.

Calculating increment period

- Growth period
  16th Mar - 19th Oct.

- Phenology data used to model the cumulative increment over the growing season.

- Total increment is divided by the increment period to give annual increment.



Adjusting the increment period

- Trees that have died between cycles i.e. ‘harvested tree’, ‘living to standing dead’ and ‘living to lying dead’.

- The increment period is adjusted to take into account the period of time from when the tree died and the assessment date.

- Growth period adjustment is estimated from:
  - management records or
  - in the field by assessing tree or stump decomposition.

Modelling DBH Increment

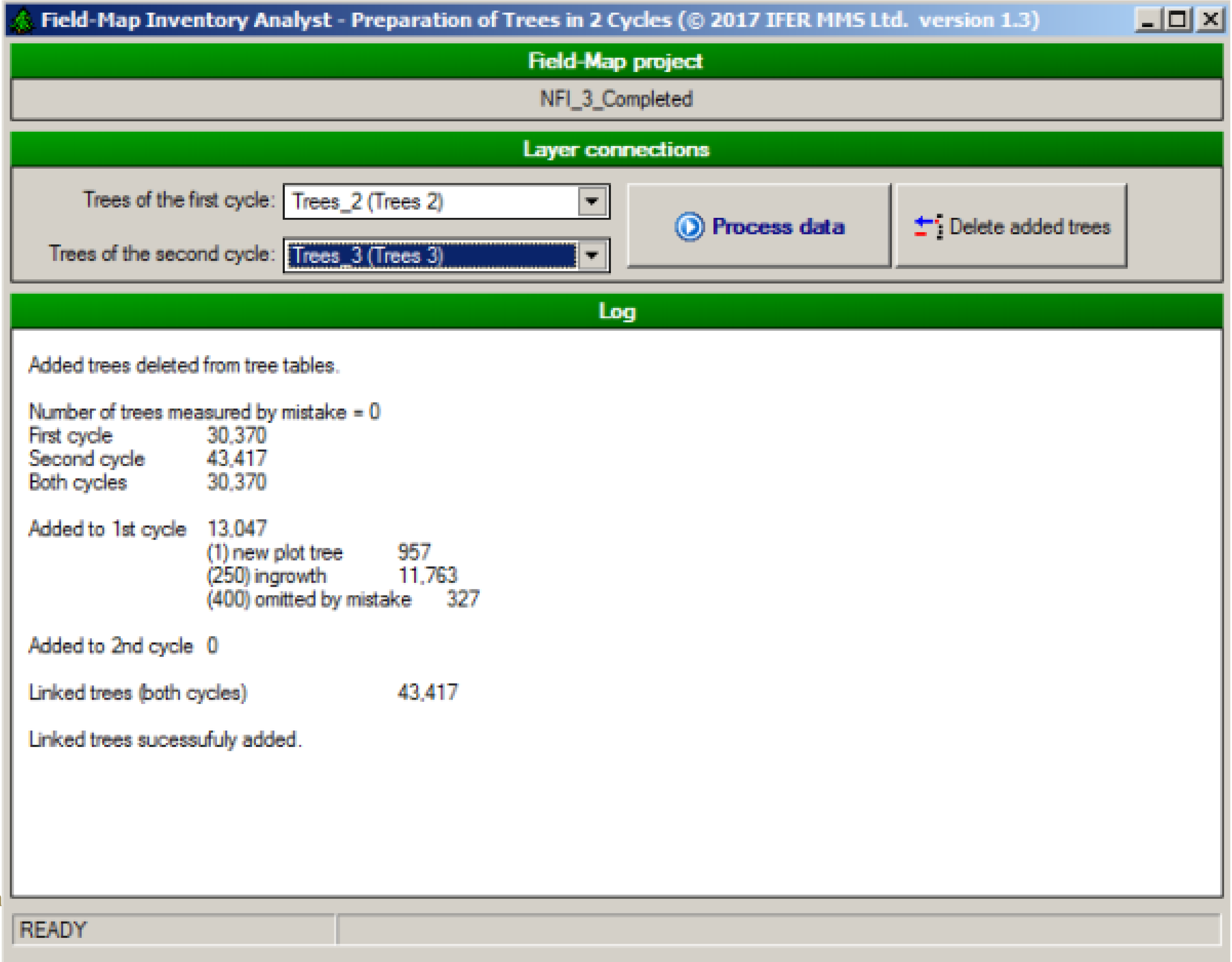
kNN Modelling Process Overview

- K nearest neighbour (kNN) non-parametric modelling is used to estimate the missing Dbh values.
- The model compares each tree which has no Dbh (e.g ingrowth, harvested trees) with all other trees that have a Dbh value, and uses predefined attribute information to find a tree that will be most similar in terms of the attribute data supplied.
- The kNN Dbh modelling is an iterative process, which aims to select the model with the lowest Root Mean Squared Error .
- Integrated software developed by IFER.

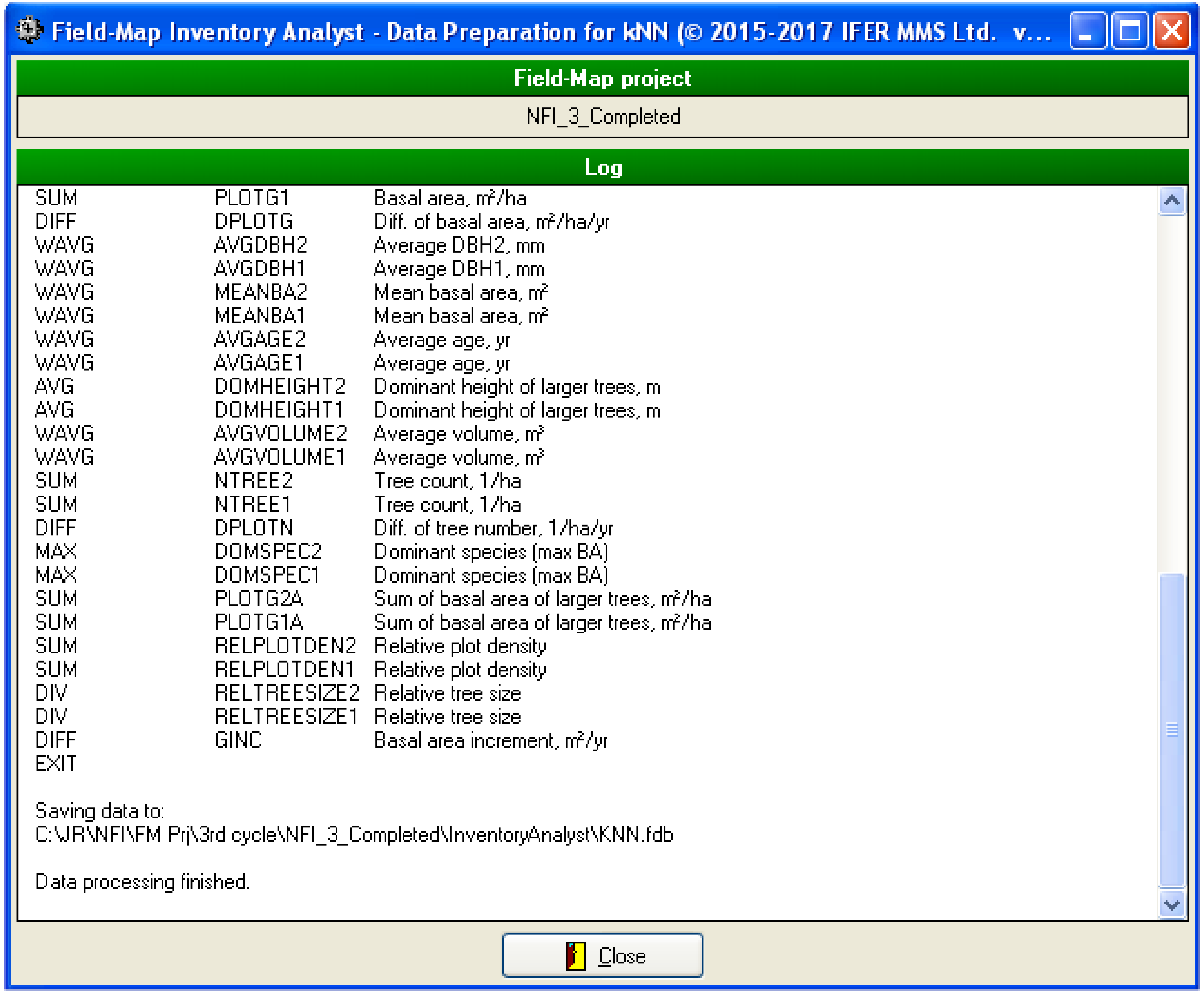
kNN Modelling Stages

- Stage 1 - Evaluate core variables for modelling (i.e. IDPlots, Species, DBH, Height, Age)
- Stage 2 – Evaluate addition of other variables to the best model from stage 1. (e.g. Mean basal area, Sum of BA of larger trees)
- Stage 3 - Evaluate the combination of the variables from the best model in stage 2.
- Stage 4 - Evaluate the parameter exponent weight.
- Stage 5 - Evaluate the variable weights.
- Stage 6 - Evaluate the number of nearest neighbours to use in final model

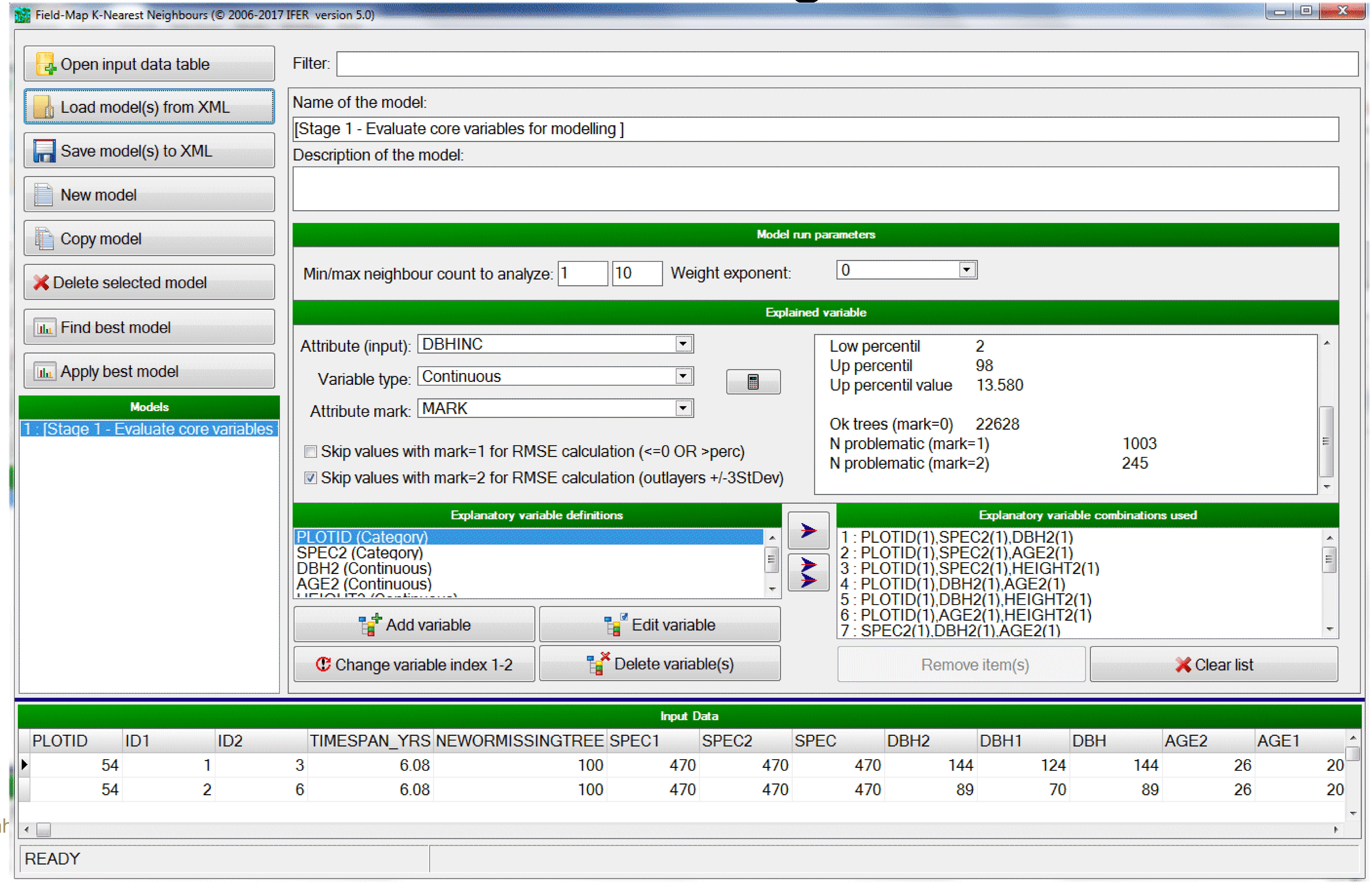
FM Tools - Prepare trees for modelling in previous cycle



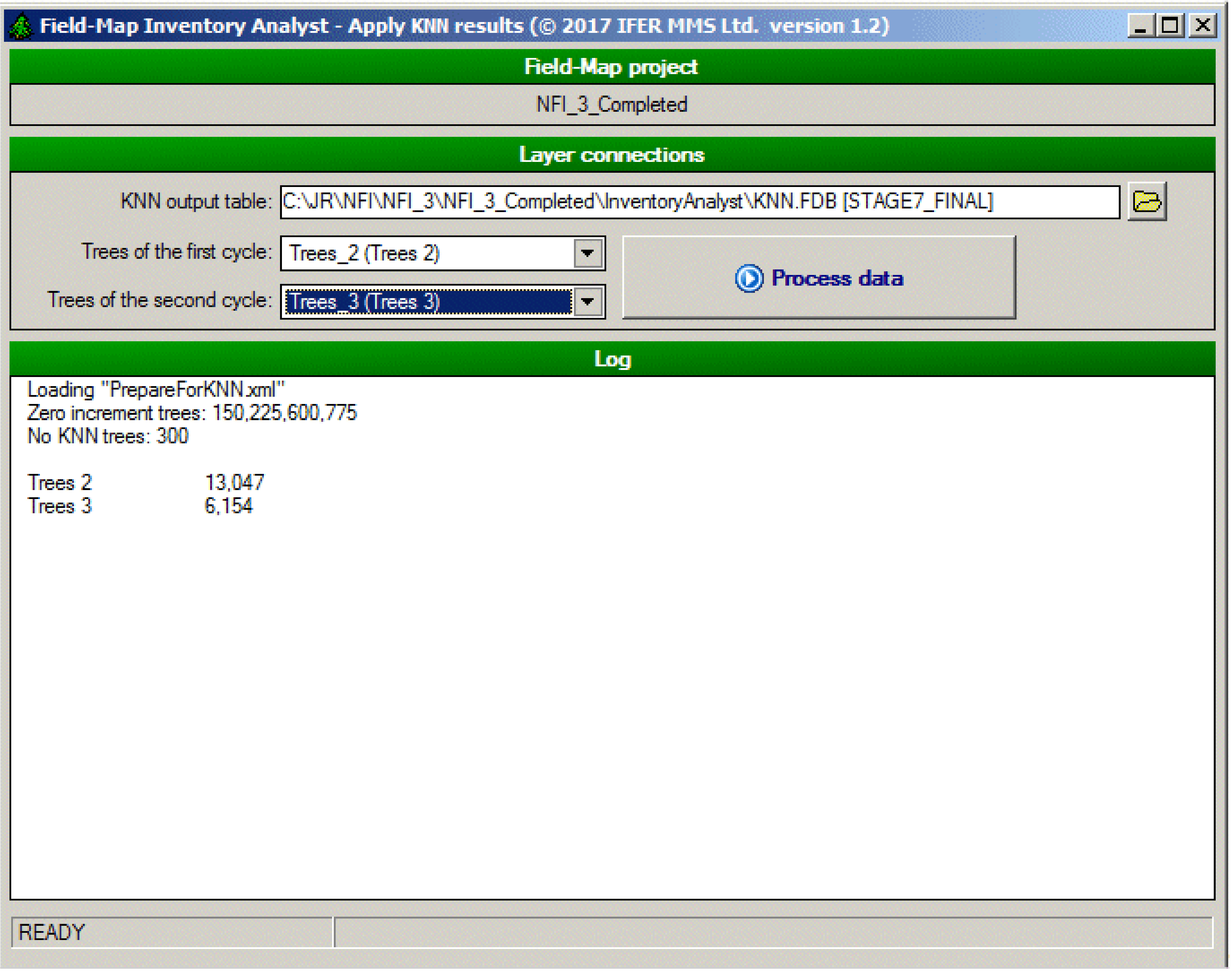
FM Tools - Calculate attributes required for kNN modelling



FM Tools - kNN Modelling of Dbh Increment



FM Tools - Applying the kNN DBH Increment results



Final Model Selected

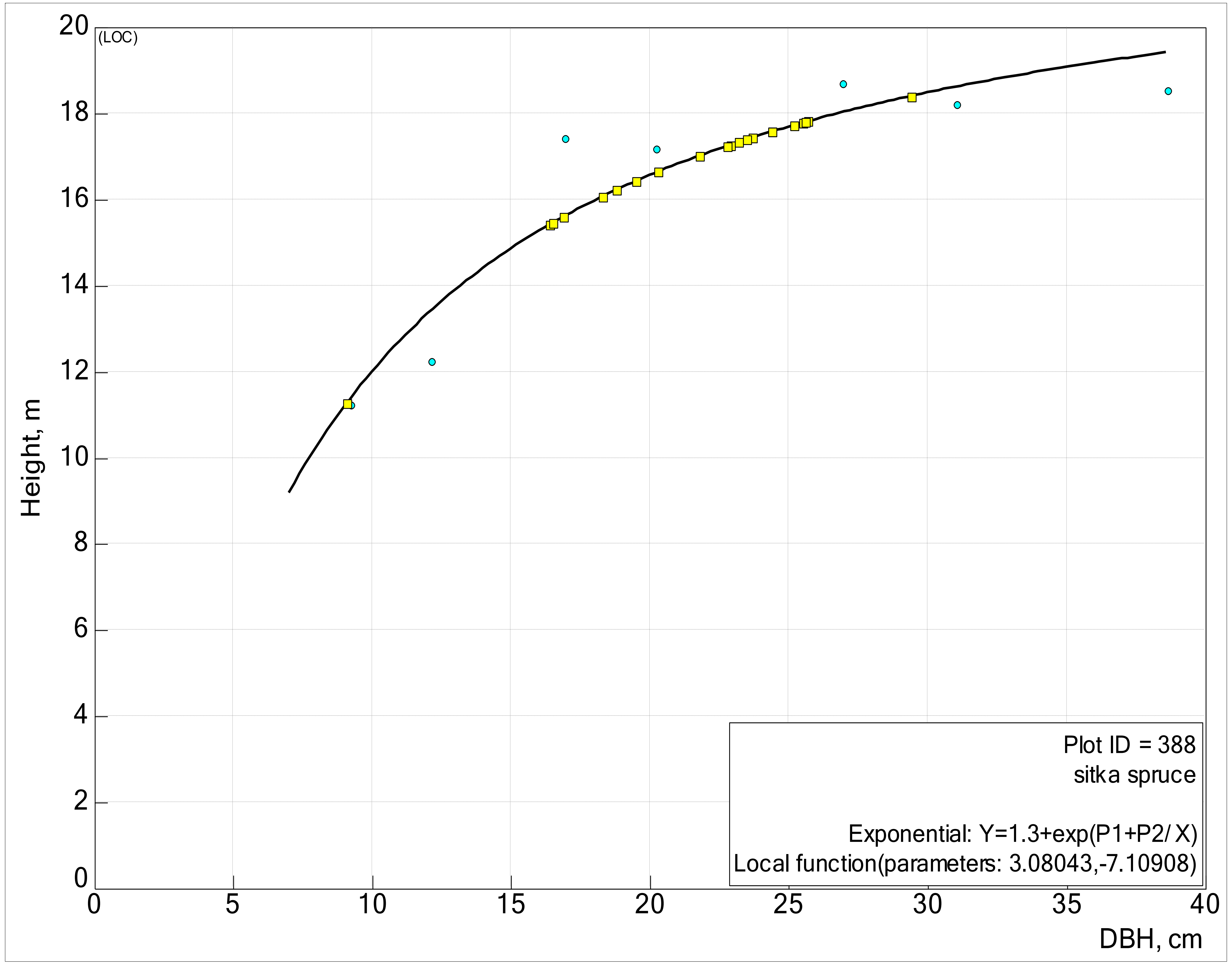
- Final Model Variables (Weight=1)

Plot ID, Species, Dbh, Age, Basal area (m^2/ha), Rank of tree by DBH

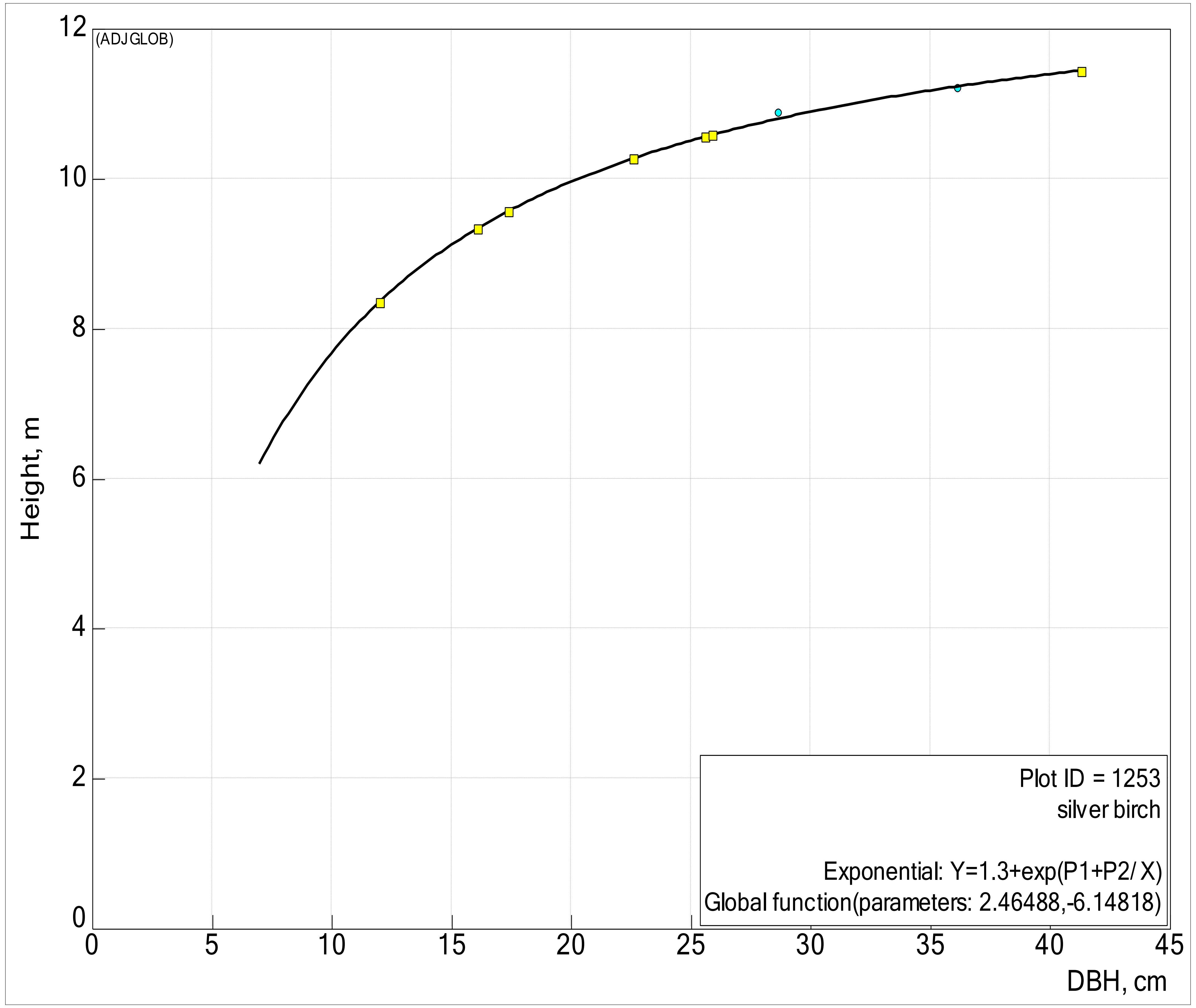
- Parameter exponent weight of 1 uses an inverse distance weighted average of the *k*-nearest multivariate neighbours
- Number of neighbours = 13
- Average annual Dbh increment (mm) = 5.0 (RMSE = 2.1 mm)
- Using the modelled annual Dbh increment values and the increment period the missing tree Dbh data are generated.

Modelling Height Increment

Modelling Tree Height



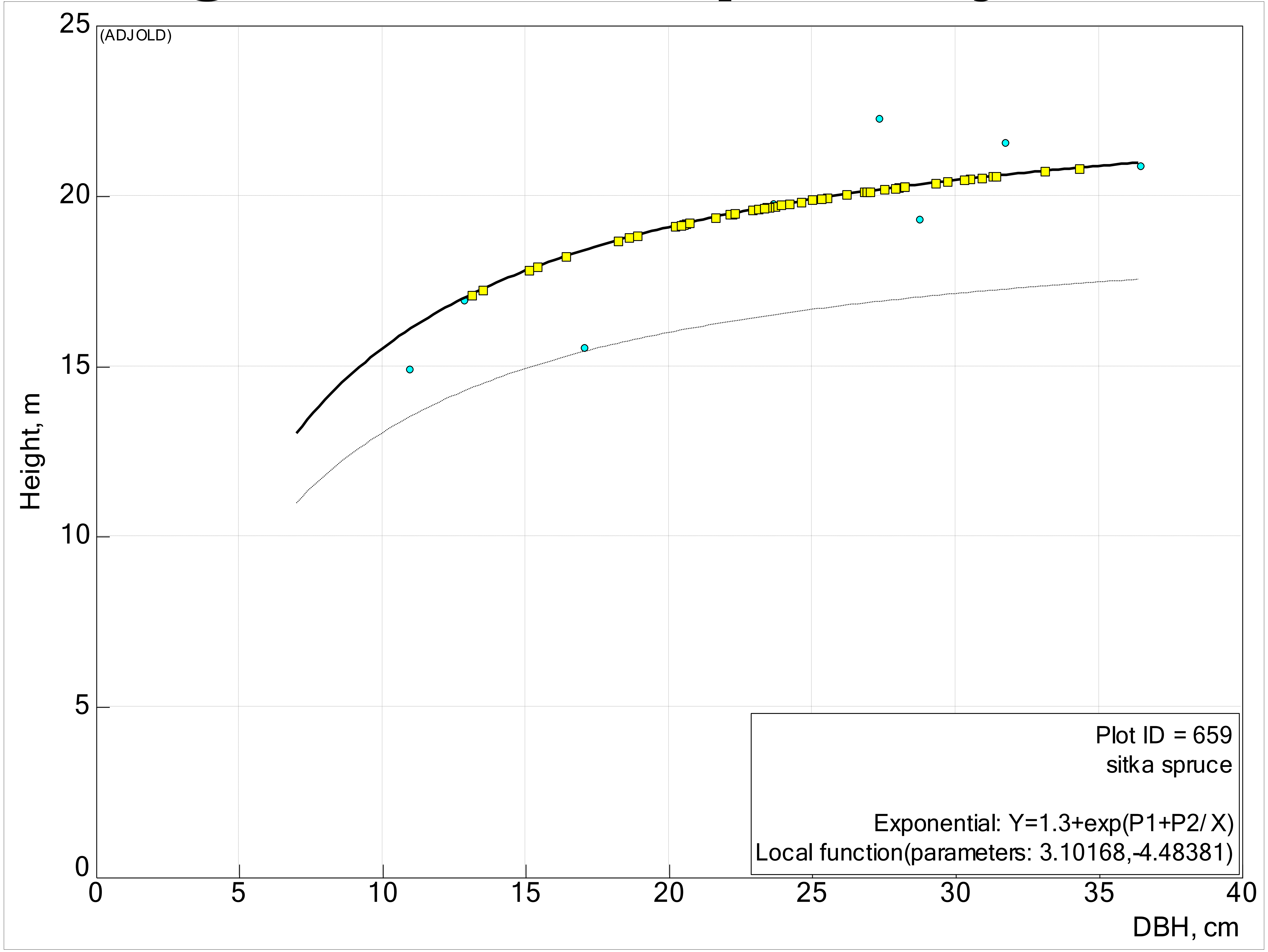
Dbh-height model for an individual plot.



Global Dbh-height model adjusted for an individual plot.

Modelling tree heights in subsequent cycles

If at least 20% of the same trees have been resampled for height in the current cycle and the heights have not decreased then the original model is adjusted for the height increase

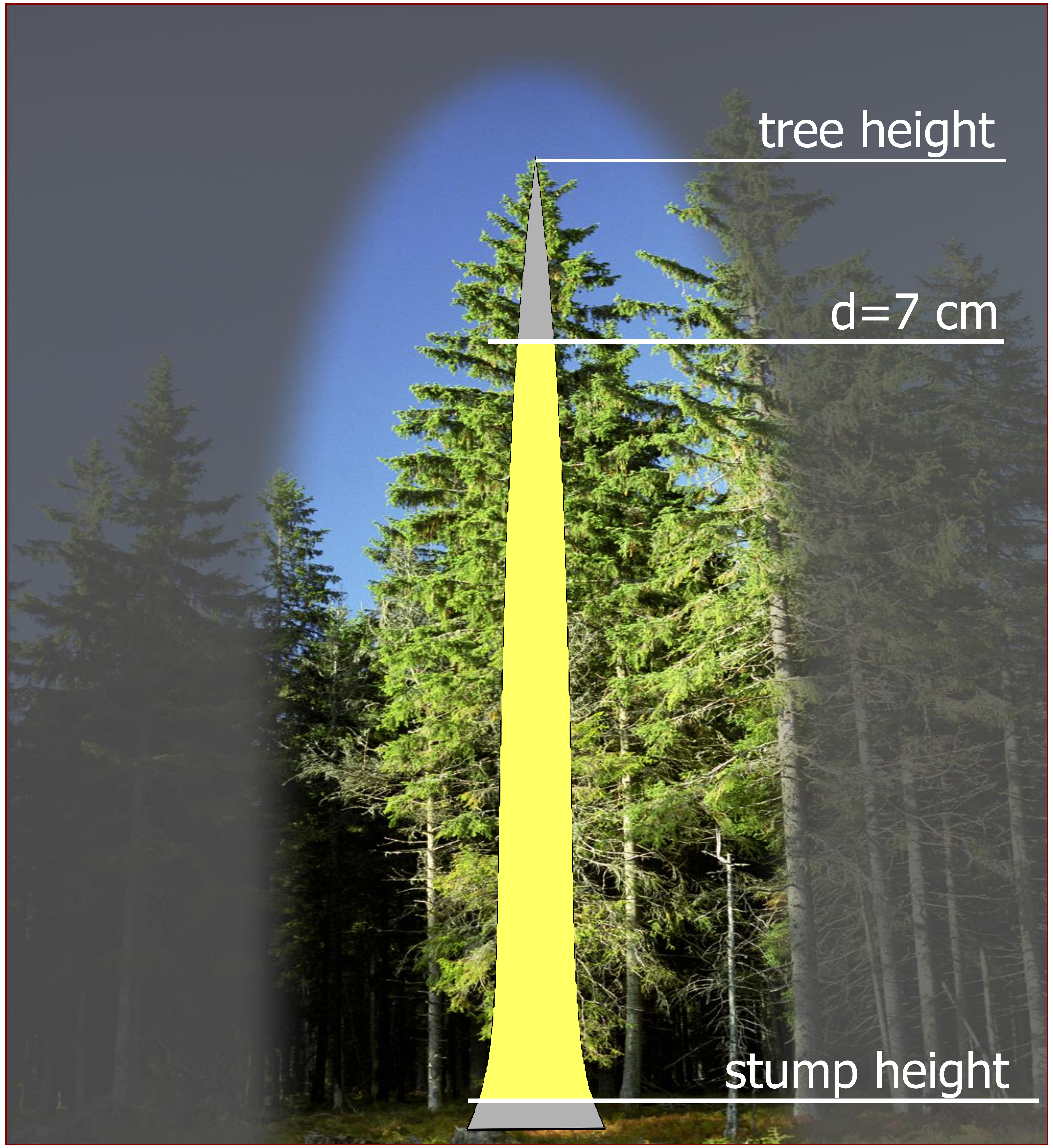


Results

Estimating Volume

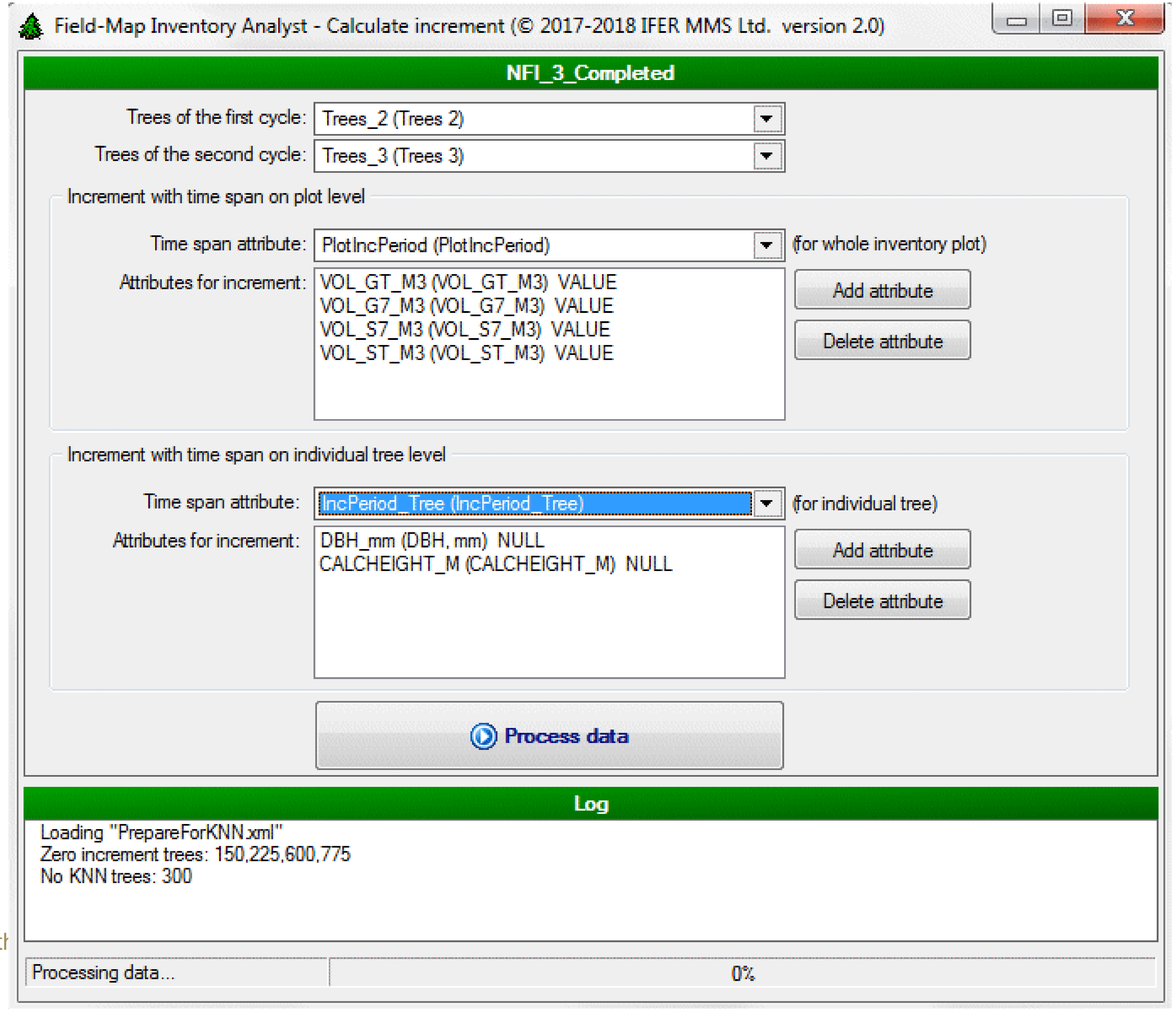
- Unknown Dbh & Ht data in first & second cycle is calculated.

- Using the DBH and Height information tree volume is calculated as normal using Ireland's stem profile equations.



Generate Annual Increment and Harvest Data

- Using the values from the current and previous cycle, annual estimates are generated for:
    - Dbh/Ht/Vol increm.
    - Harvest volume.



Increment Volume

Tree type	Annual volume increment (S7)		
	thousands m^3	(α=0.05)	%
new plot tree	24.9	(0.0 – 55.5)	0.3
no change	5,592.8	(5,323.2 – 5,862.5)	65.4
standing dead to living (Lazarus tree)	0.1	(0.0 – 3.2)	0.002
felled tree	567.9	(510.2 – 625.6)	6.7
ingrowth	2,250.5	(2,144.1 – 2,356.8)	26.4
living to standing dead	8.4	(0.0 – 18.7)	0.1
omitted by mistake	59.3	(39.4 – 79.2)	0.7
living to lying dead	21.4	(15.1 – 27.7)	0.3
deforestation (living last cycle)	6.6	(6.1 – 7.2)	0.08
Total	8,532.0	(8,185.4 – 8,878.6)	100.0

Felled Volume

Harvest type	Annual harvest volume (S7)		
	thousands m^3	($\alpha = 0.05$)	%
1st thin	644.7	(554.0 – 735.4)	13.2
2nd thin	313.2	(233.7 – 392.8)	6.4
subsequent thin	226.3	(123.1 – 329.6)	4.6
clearfell	3,711.2	(3,341.7 – 4,080.7)	75.8
Total	4,895.5	(4,335.6 – 5,455.3)	100.0

Summary

Summary

- Subsequent cycle requires new attributes at plot an tree level describing change.
- kNN approach presents a novel way to estimate Dbh increment for NFI.
- New Field-Map suite of tools provides an integrated approach to undertake this work.

Further Information

- Thomas Gschwantner, Adrian Lanz, Claude Vidal, Michal Bosela, Lucio Di Cosmo, Jonas Fridman, Patrizia Gasparini, Andrius Kuliešis, Stein Tomter & Klemens Schadauer. 2016. Comparison of methods used in European National Forest Inventories for the estimation of volume increment: towards harmonisation. Annals of Forest Science Volume 73 Number 4 807-821

- Stein Michael Tomter, Andrius Kuliešis & Thomas Gschwantner. 2016. Annual volume increment of the European forests—description and evaluation of the national methods used. Annals of Forest Science Volume 73 Number 4 849-856

- Andrius Kuliešis, Stein M. Tomter, Claude Vidal & Adrian Lanz. 2016. Estimates of stem wood increments in forest resources: comparison of different approaches in forest inventory: consequences for international reporting: case study of European forests. Annals of Forest Science Volume 73 Number 4 857-869

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Thank you
& Any questions?

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