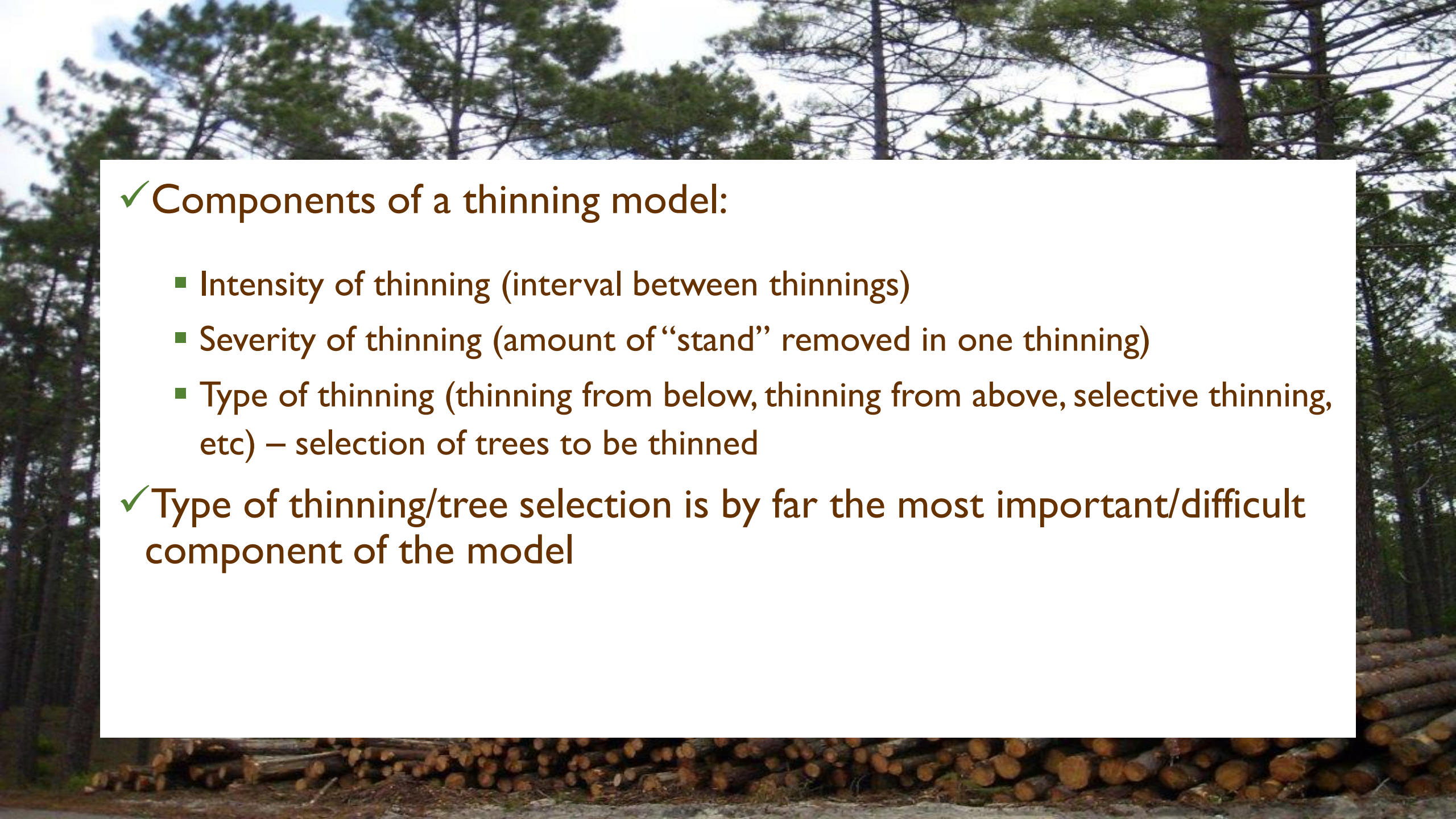
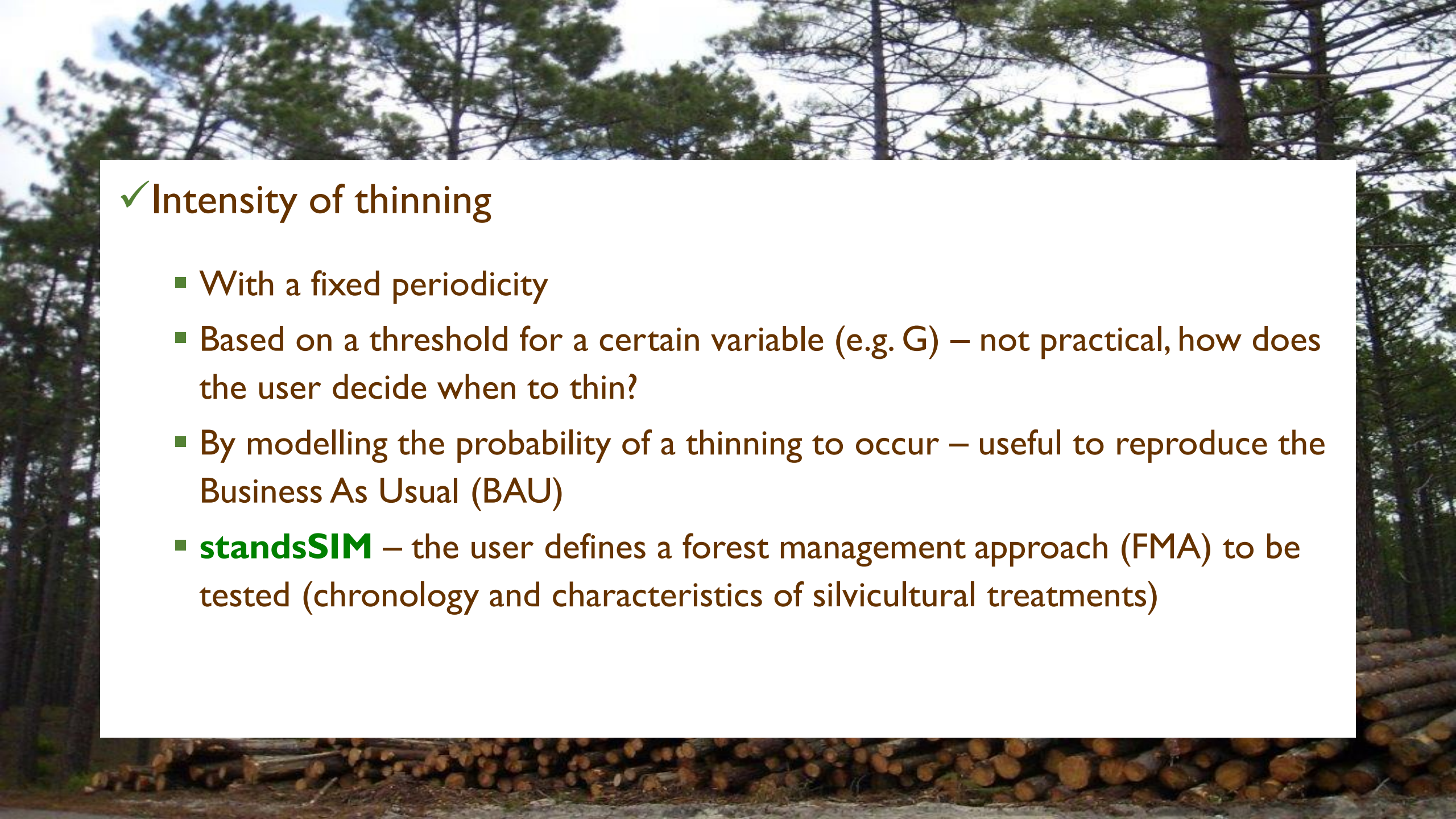
Implementing different thinning types, severities and intensities in stand and regional simulators

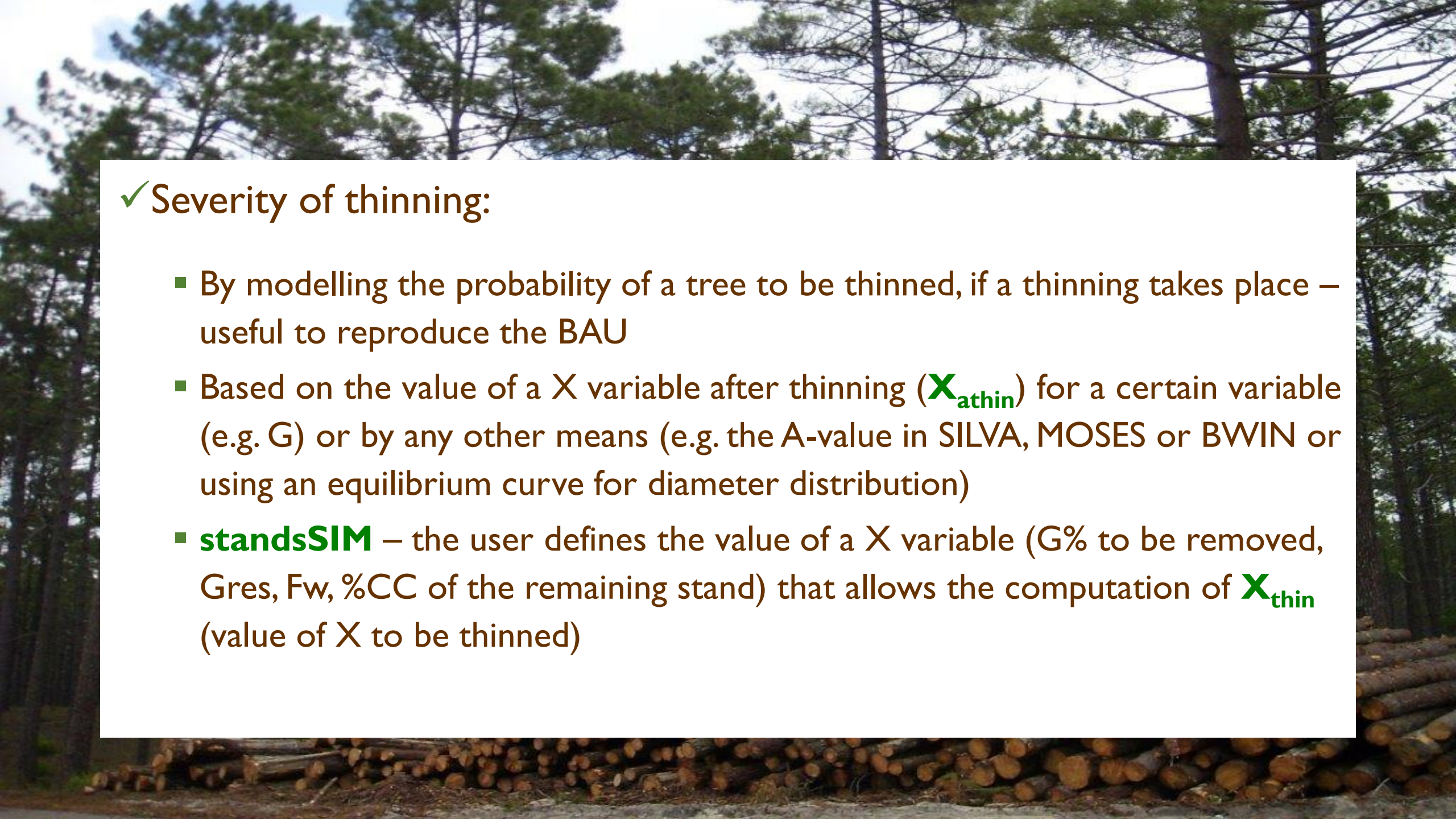


- ✓Components of a thinning model:
  - Intensity of thinning (interval between thinnings)
  - Severity of thinning (amount of "stand" removed in one thinning)
  - Type of thinning (thinning from below, thinning from above, selective thinning, etc) – selection of trees to be thinned
- ✓Type of thinning/tree selection is by far the most important/difficult component of the model



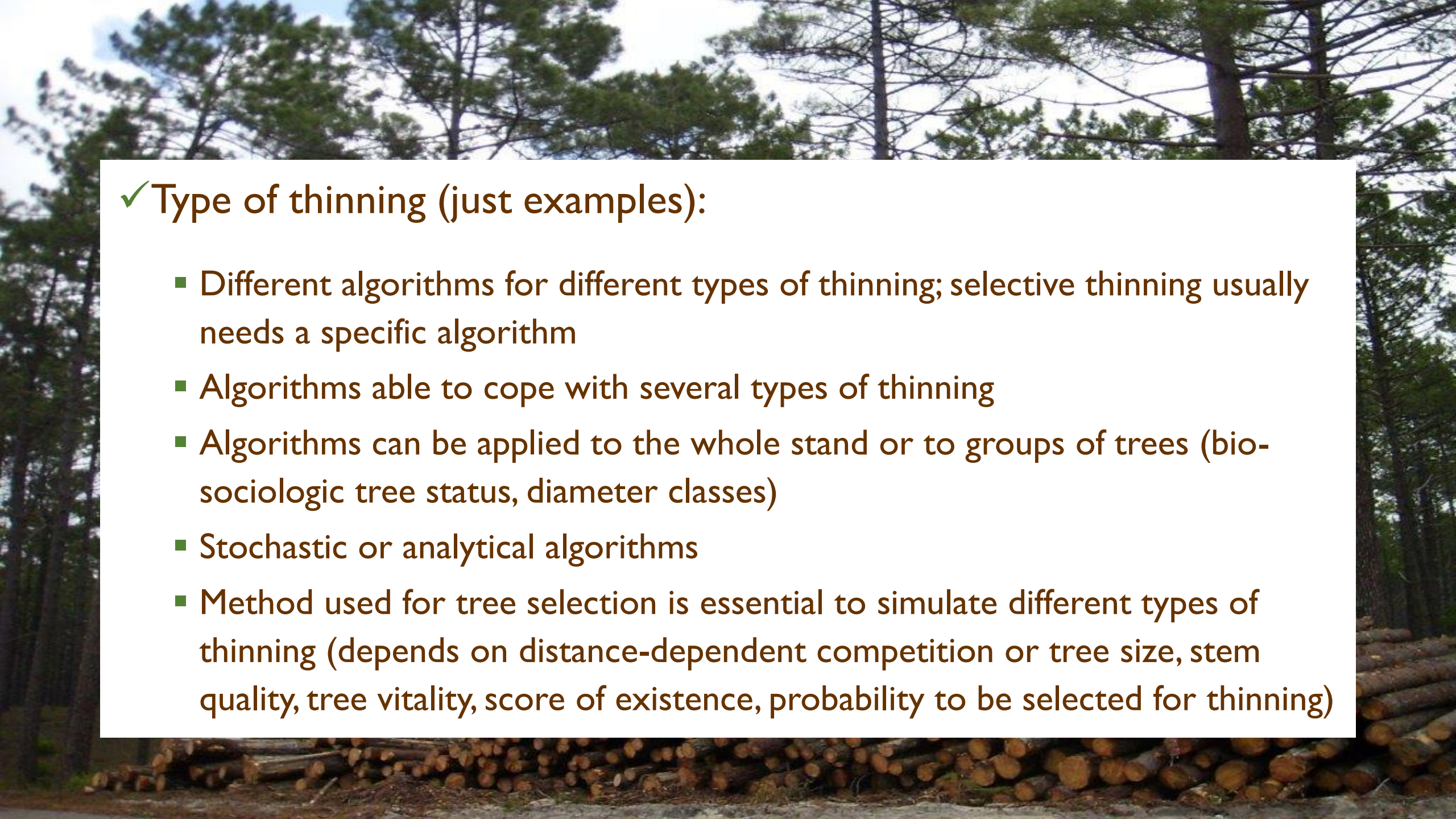
✓Intensity of thinning

- With a fixed periodicity
- Based on a threshold for a certain variable (e.g. G) – not practical, how does the user decide when to thin?
- By modelling the probability of a thinning to occur – useful to reproduce the Business As Usual (BAU)
- **standsSIM** – the user defines a forest management approach (FMA) to be tested (chronology and characteristics of silvicultural treatments)



✓Severity of thinning:

- By modelling the probability of a tree to be thinned, if a thinning takes place – useful to reproduce the BAU
- Based on the value of a X variable after thinning ($\mathbf{X_{athin}}$) for a certain variable (e.g. G) or by any other means (e.g. the A-value in SILVA, MOSES or BWIN or using an equilibrium curve for diameter distribution)
- **standsSIM** – the user defines the value of a X variable (G% to be removed, Gres, Fw, %CC of the remaining stand) that allows the computation of $\mathbf{X_{thin}}$ (value of X to be thinned)

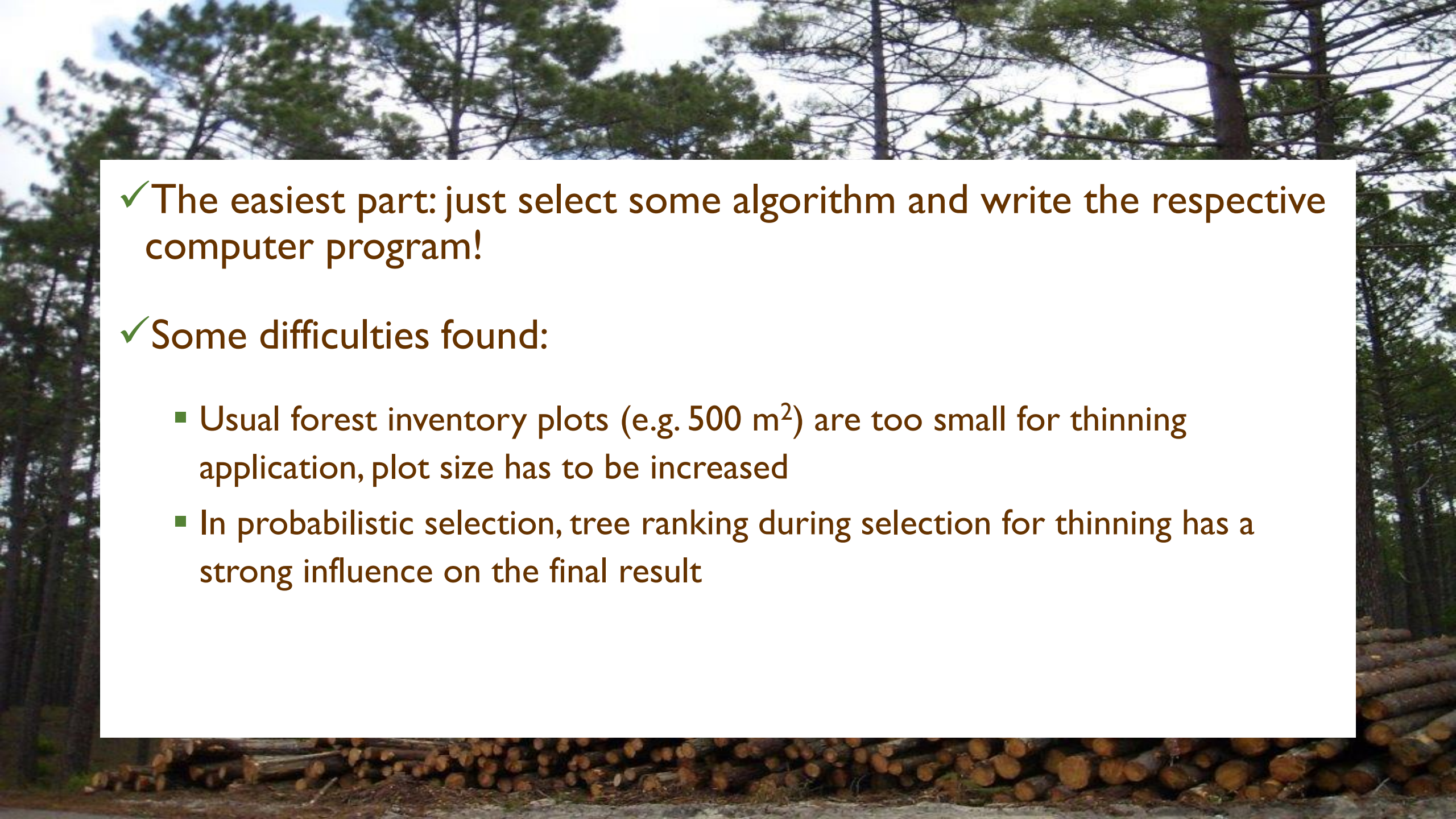


✓Type of thinning (just examples):

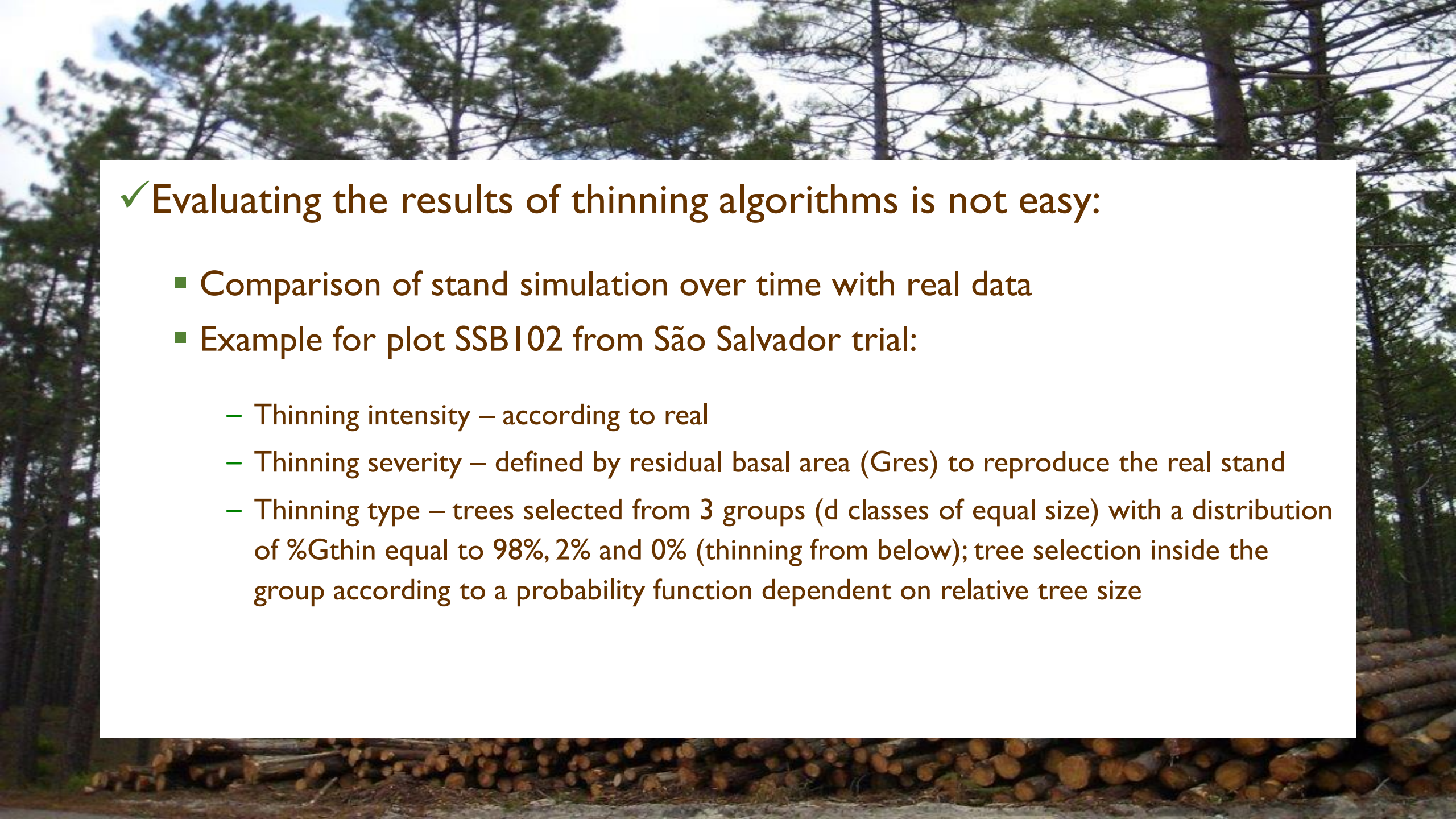
- Different algorithms for different types of thinning; selective thinning usually needs a specific algorithm
- Algorithms able to cope with several types of thinning
- Algorithms can be applied to the whole stand or to groups of trees (bio-sociologic tree status, diameter classes)
- Stochastic or analytical algorithms
- Method used for tree selection is essential to simulate different types of thinning (depends on distance-dependent competition or tree size, stem quality, tree vitality, score of existence, probability to be selected for thinning)

✓Type of thinning (just examples)

- **standsSIM**:
  - no distance-dependent competition index, trees are selected according to:
    1. a thinning index depending on tree size and product quality
    2. a probability function (continuous or discrete)
  - the user defines:
    1. groups of trees (d classes) as well as the % of the total removal of **X** in each group;
    2. an equilibrium curve computed so that %CC is equally distributed per d class;
    3. equilibrium curve defined by number of trees/ha per d class
    4. Other being implemented

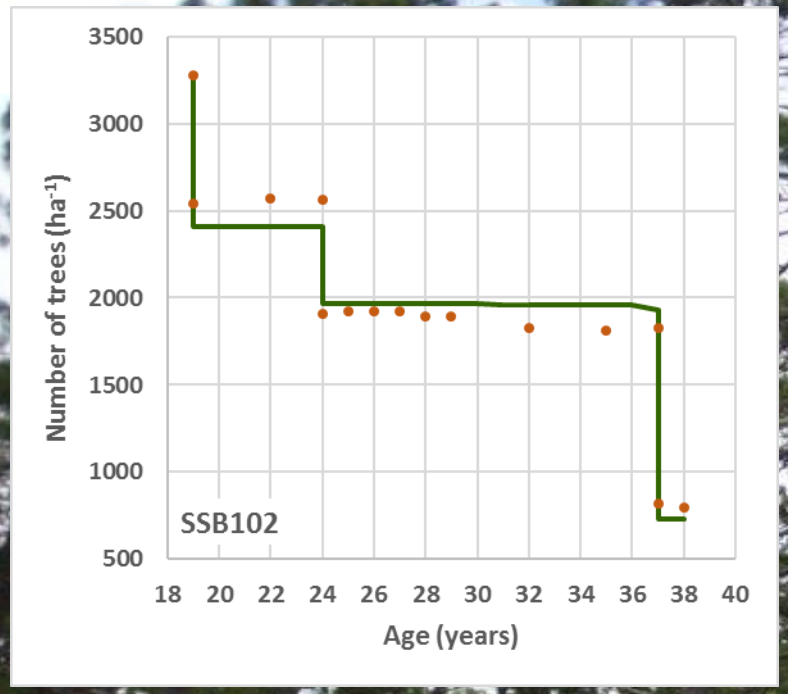


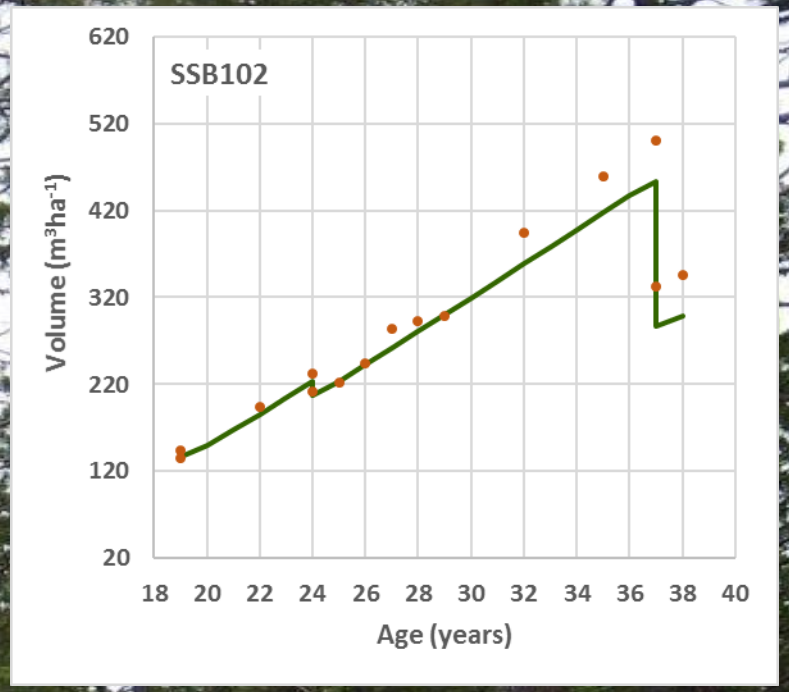
- ✓The easiest part: just select some algorithm and write the respective computer program!
- ✓Some difficulties found:
  - Usual forest inventory plots (e.g. 500 m^2) are too small for thinning application, plot size has to be increased
  - In probabilistic selection, tree ranking during selection for thinning has a strong influence on the final result

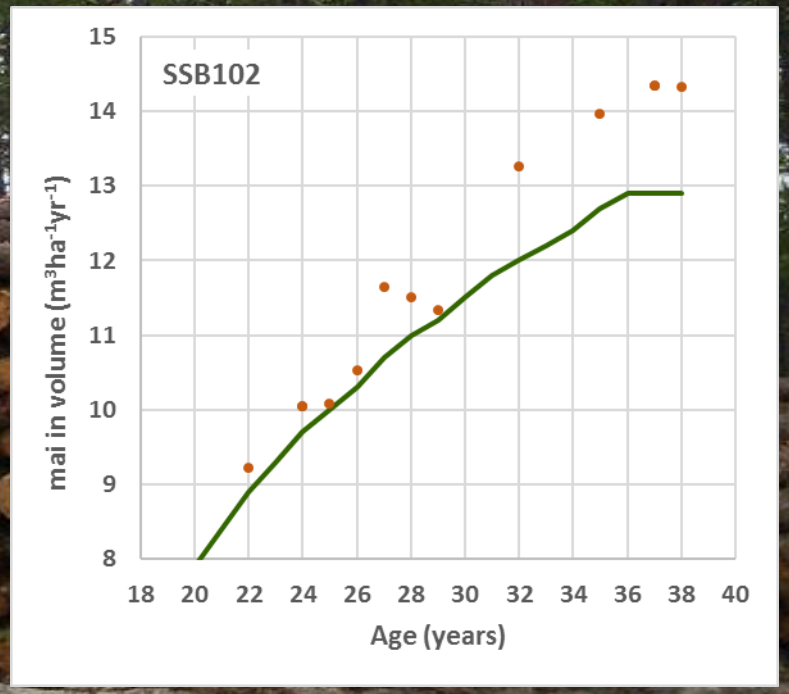


✓Evaluating the results of thinning algorithms is not easy:

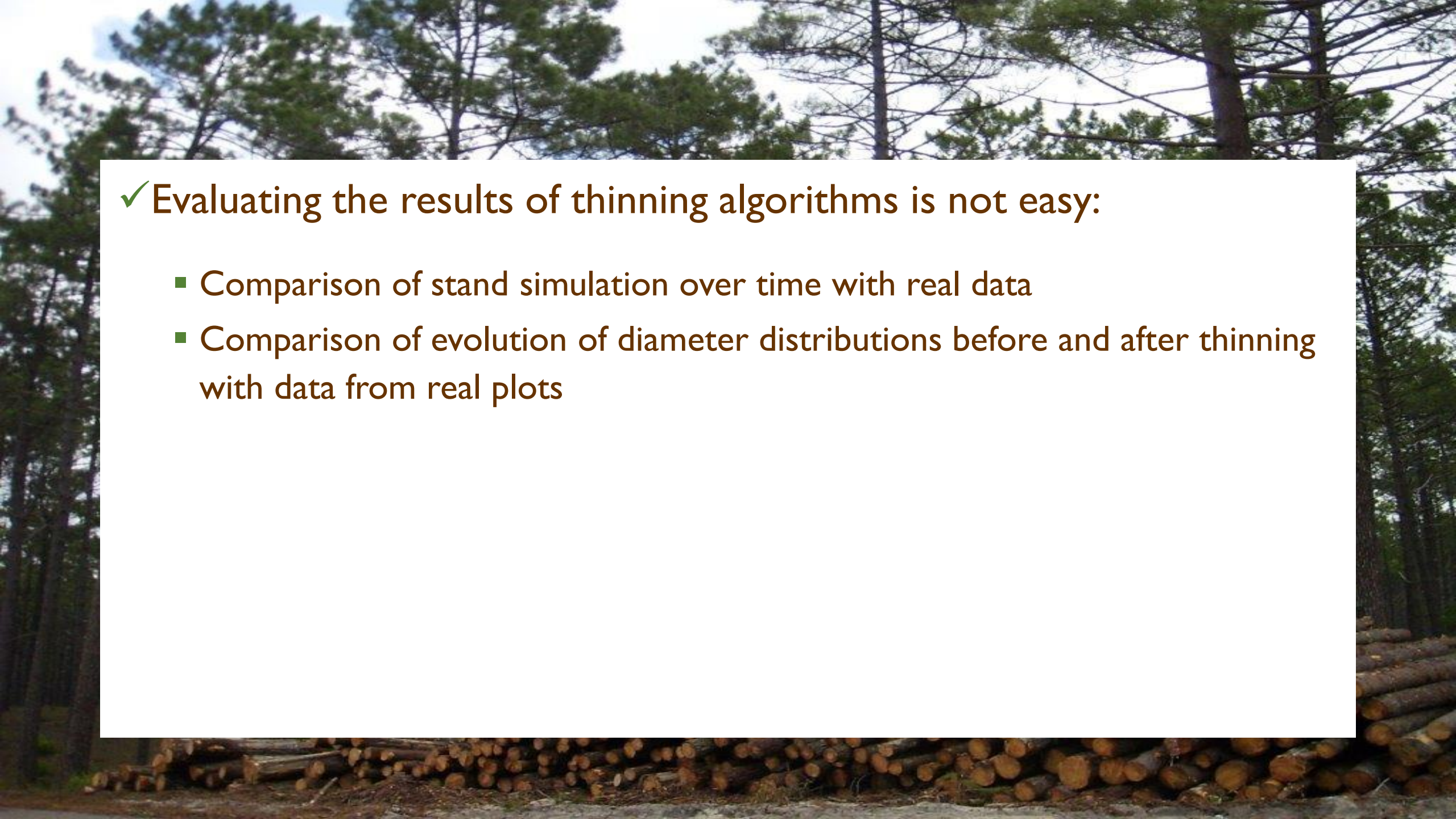
- Comparison of stand simulation over time with real data
- Example for plot SSB102 from São Salvador trial:
  - Thinning intensity – according to real
  - Thinning severity – defined by residual basal area (Gres) to reproduce the real stand
  - Thinning type – trees selected from 3 groups (d classes of equal size) with a distribution of %Gthin equal to 98%, 2% and 0% (thinning from below); tree selection inside the group according to a probability function dependent on relative tree size







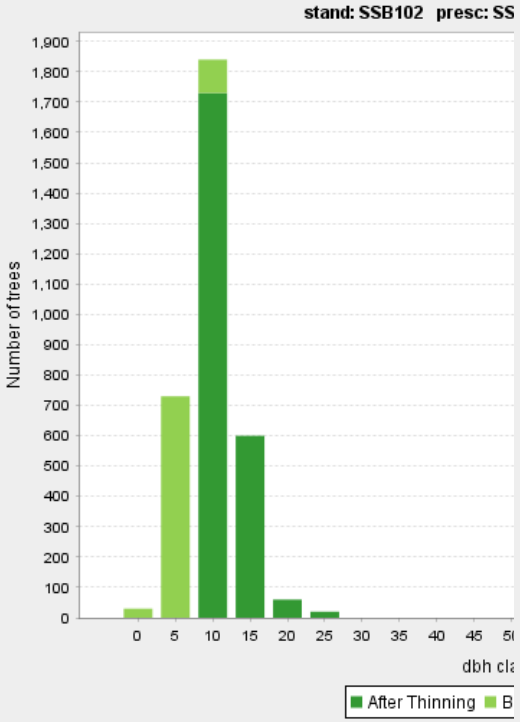
V harvested: 142.3 m^3
NPV: -2718 euros
EAA: -207 euros

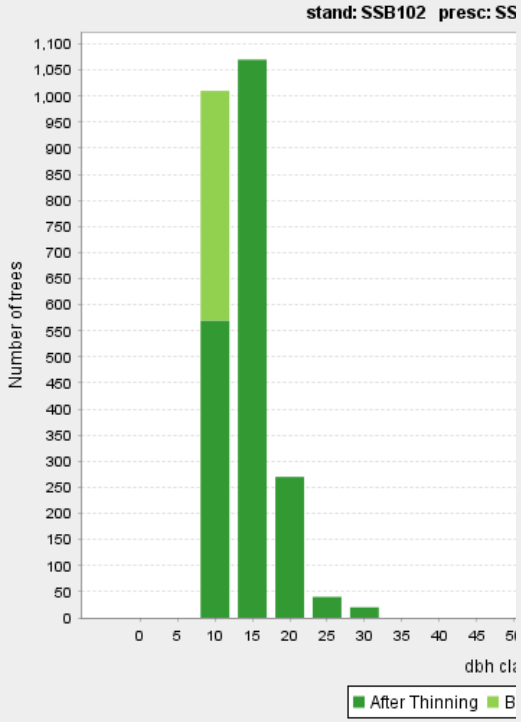


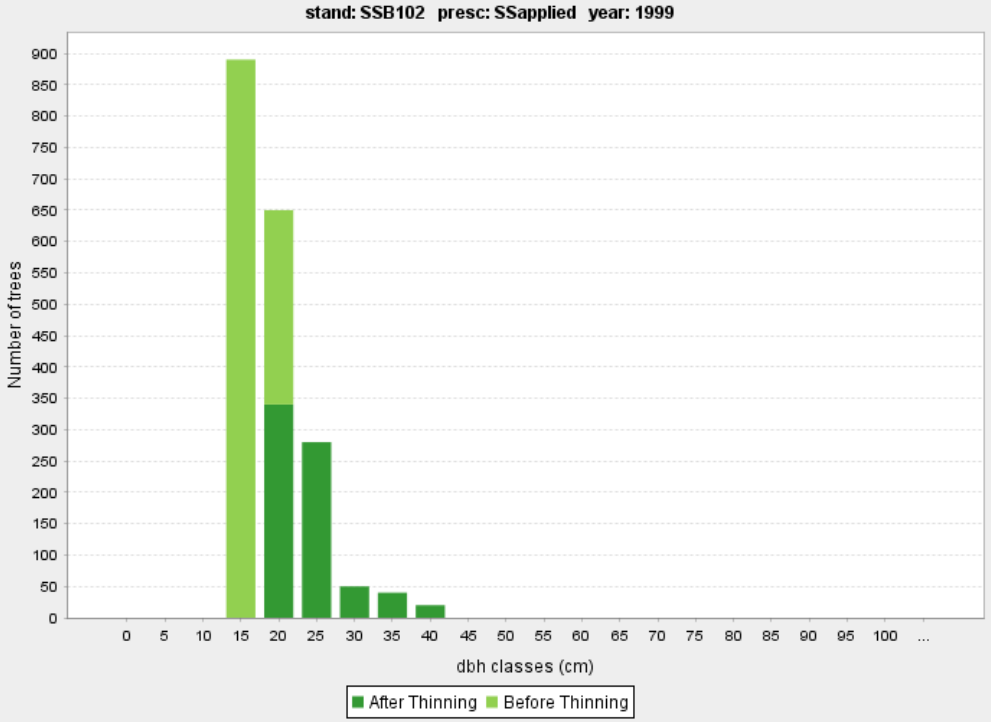
- ✓Evaluating the results of thinning algorithms is not easy:
  - Comparison of stand simulation over time with real data
  - Comparison of evolution of diameter distributions before and after thinning with data from real plots

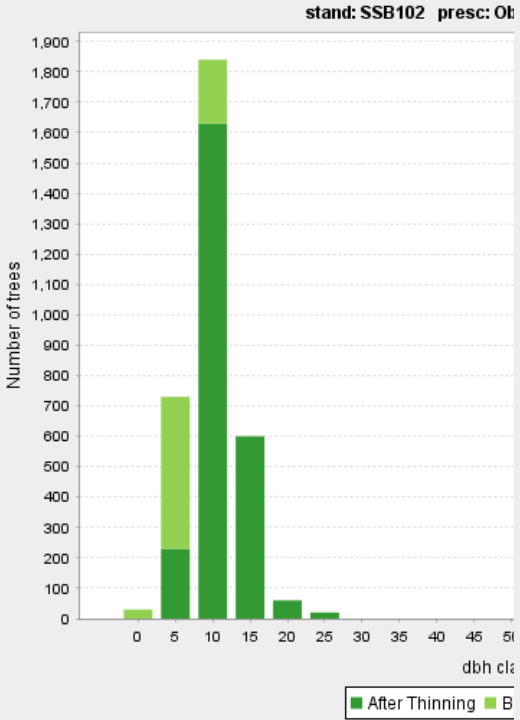
Simulated

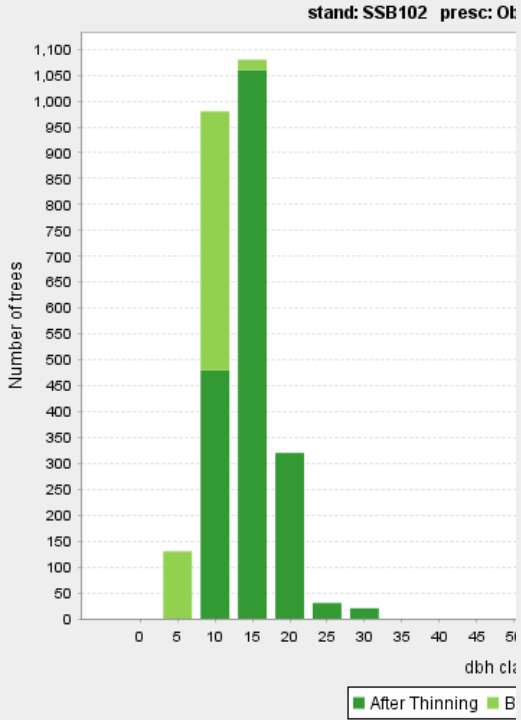
Observed

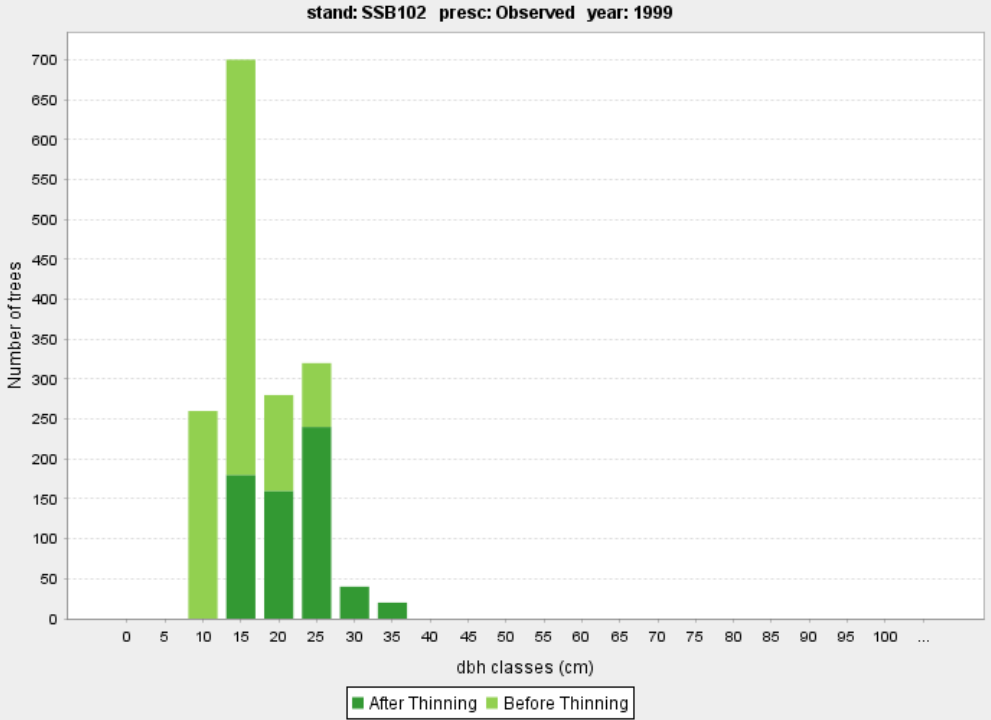


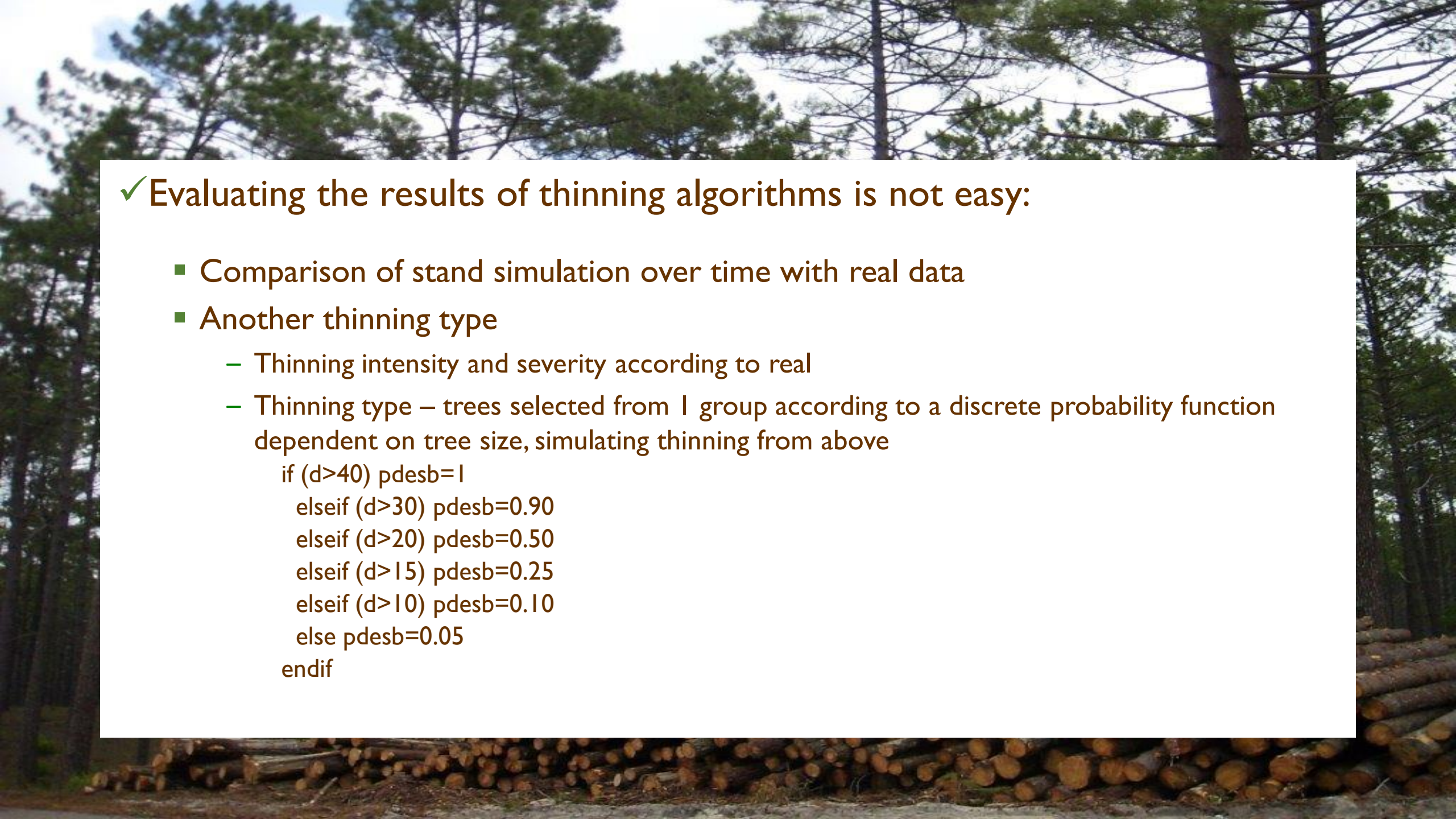








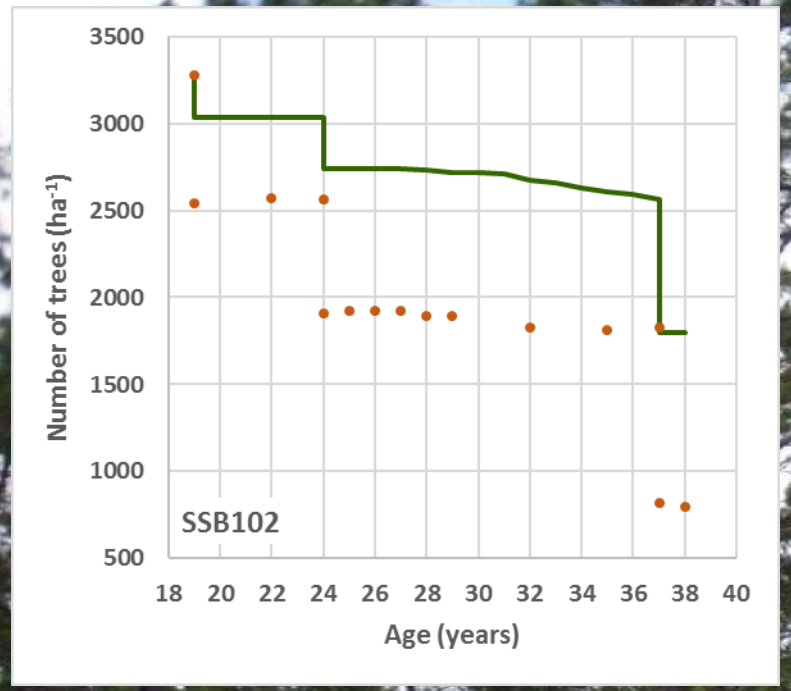


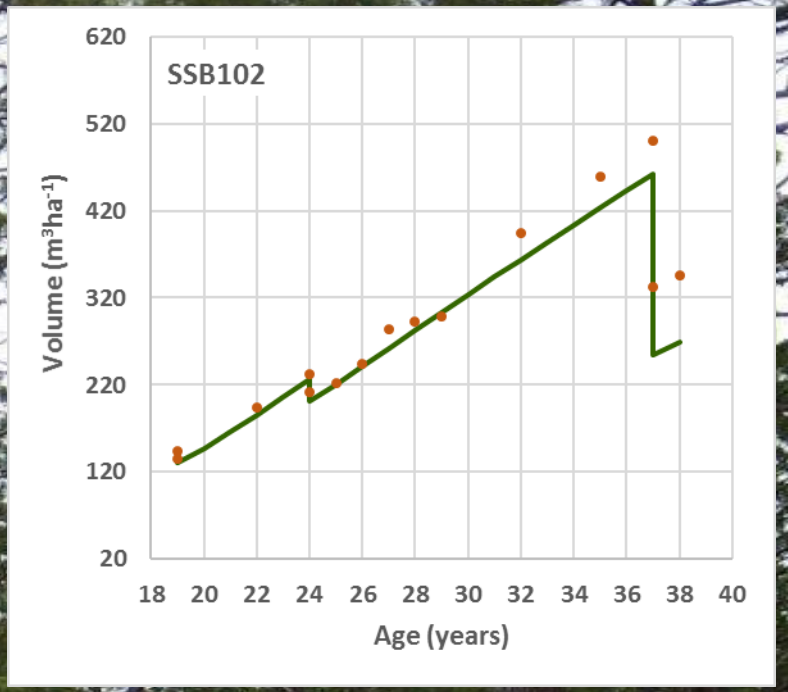


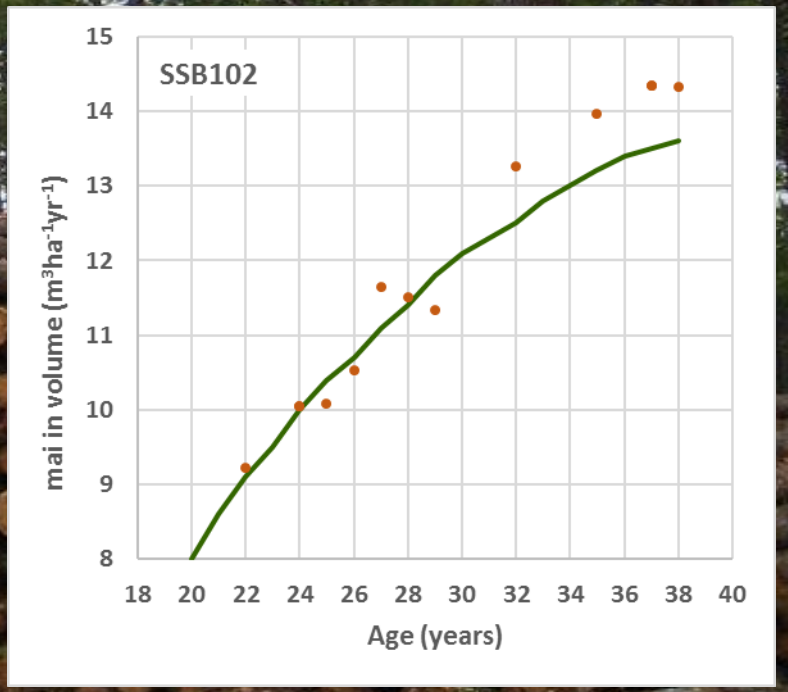
✓Evaluating the results of thinning algorithms is not easy:

- Comparison of stand simulation over time with real data
- Another thinning type
  - Thinning intensity and severity according to real
  - Thinning type – trees selected from 1 group according to a discrete probability function dependent on tree size, simulating thinning from above

```
if (d>40) pdesb=1
  elseif (d>30) pdesb=0.90
  elseif (d>20) pdesb=0.50
  elseif (d>15) pdesb=0.25
  elseif (d>10) pdesb=0.10
  else pdesb=0.05
endif
```



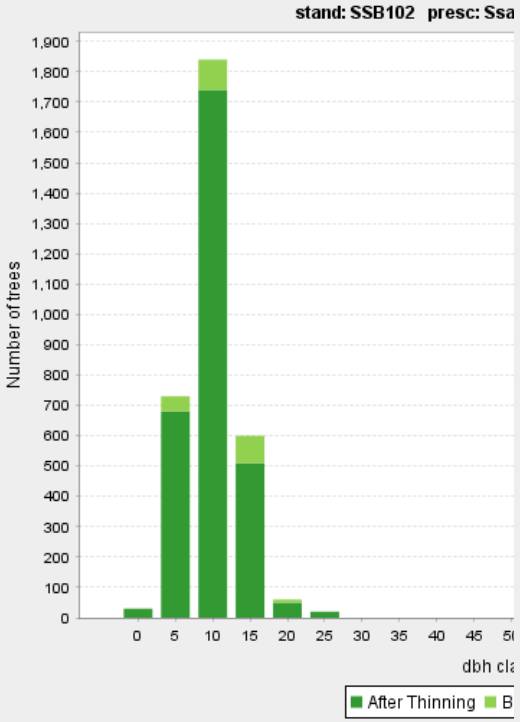


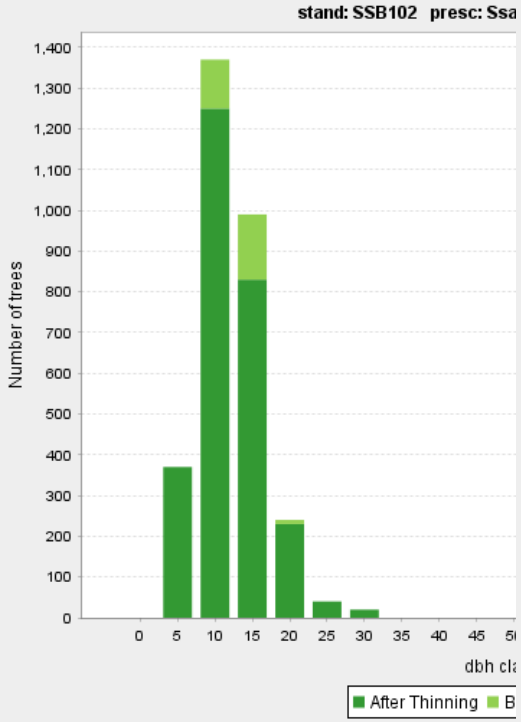


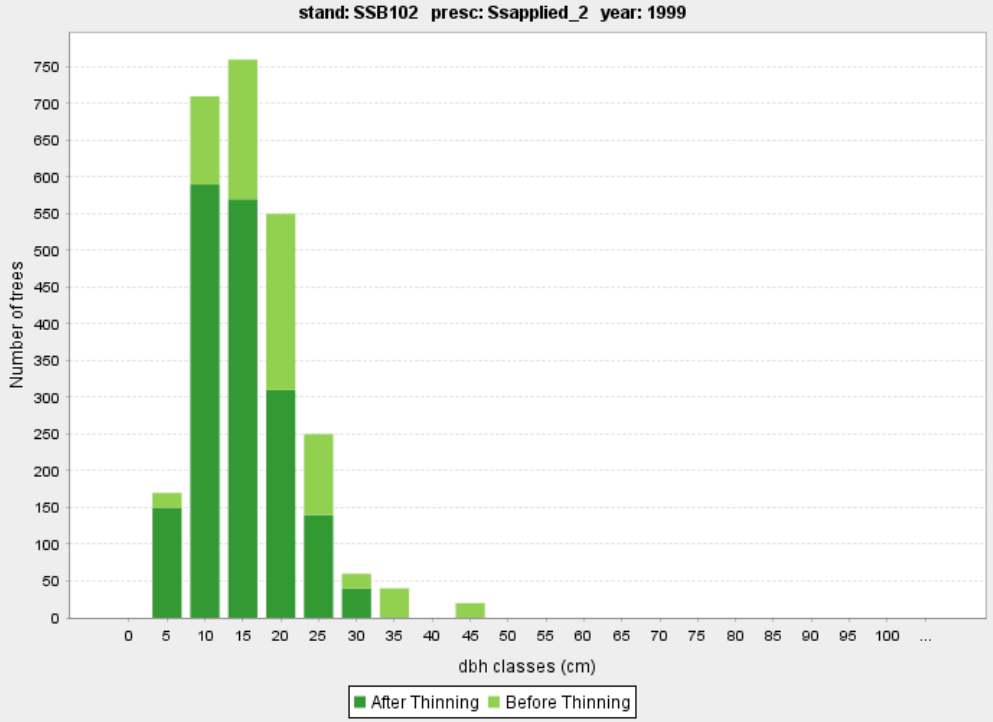
V harvested: 208.8 m^3
NPV: 2535 euros
EAA: 193 euros

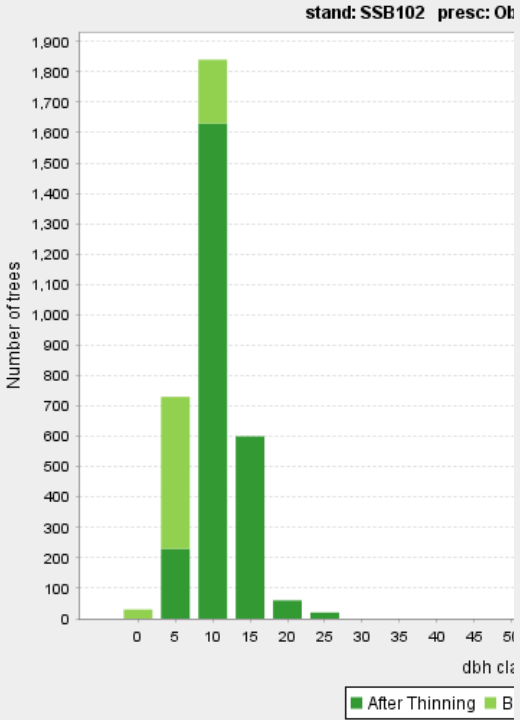
Simulated

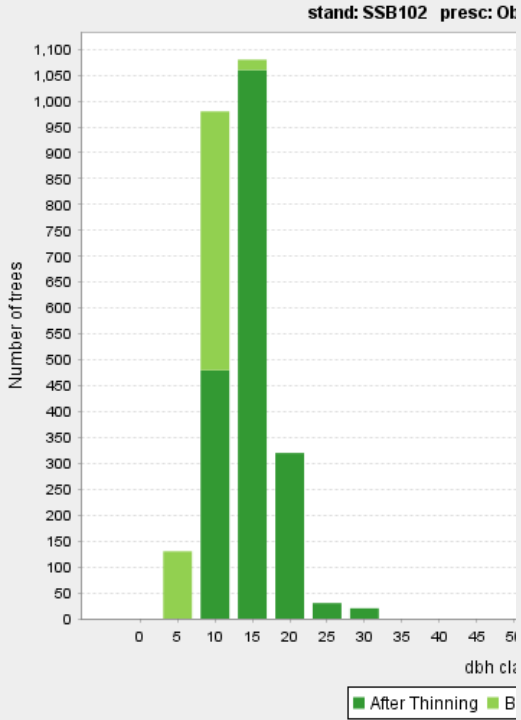
Observed

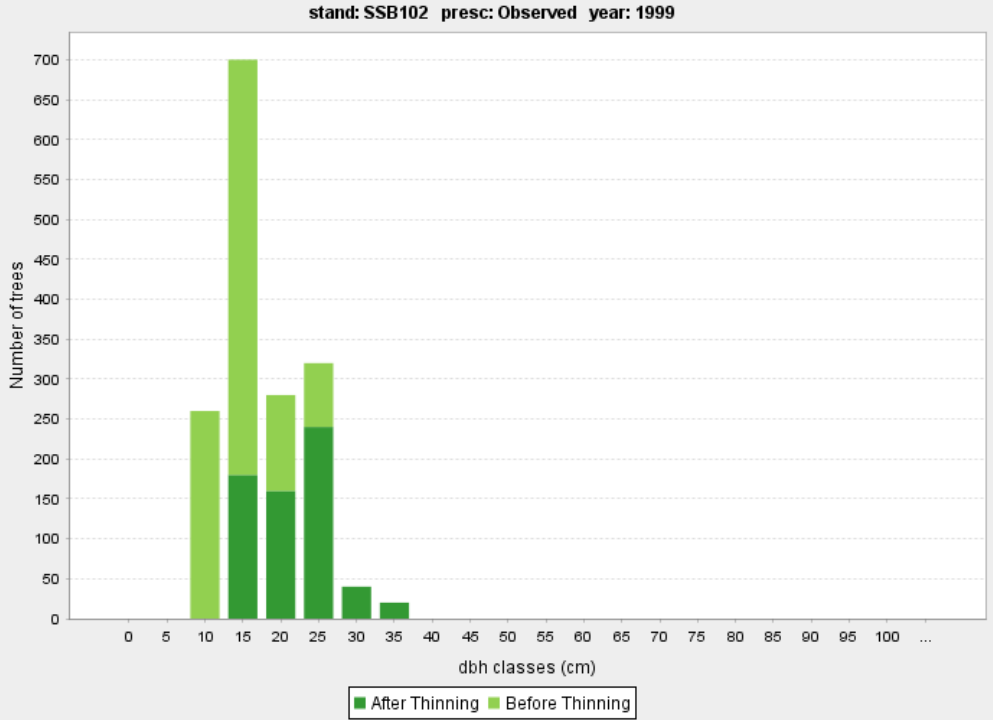


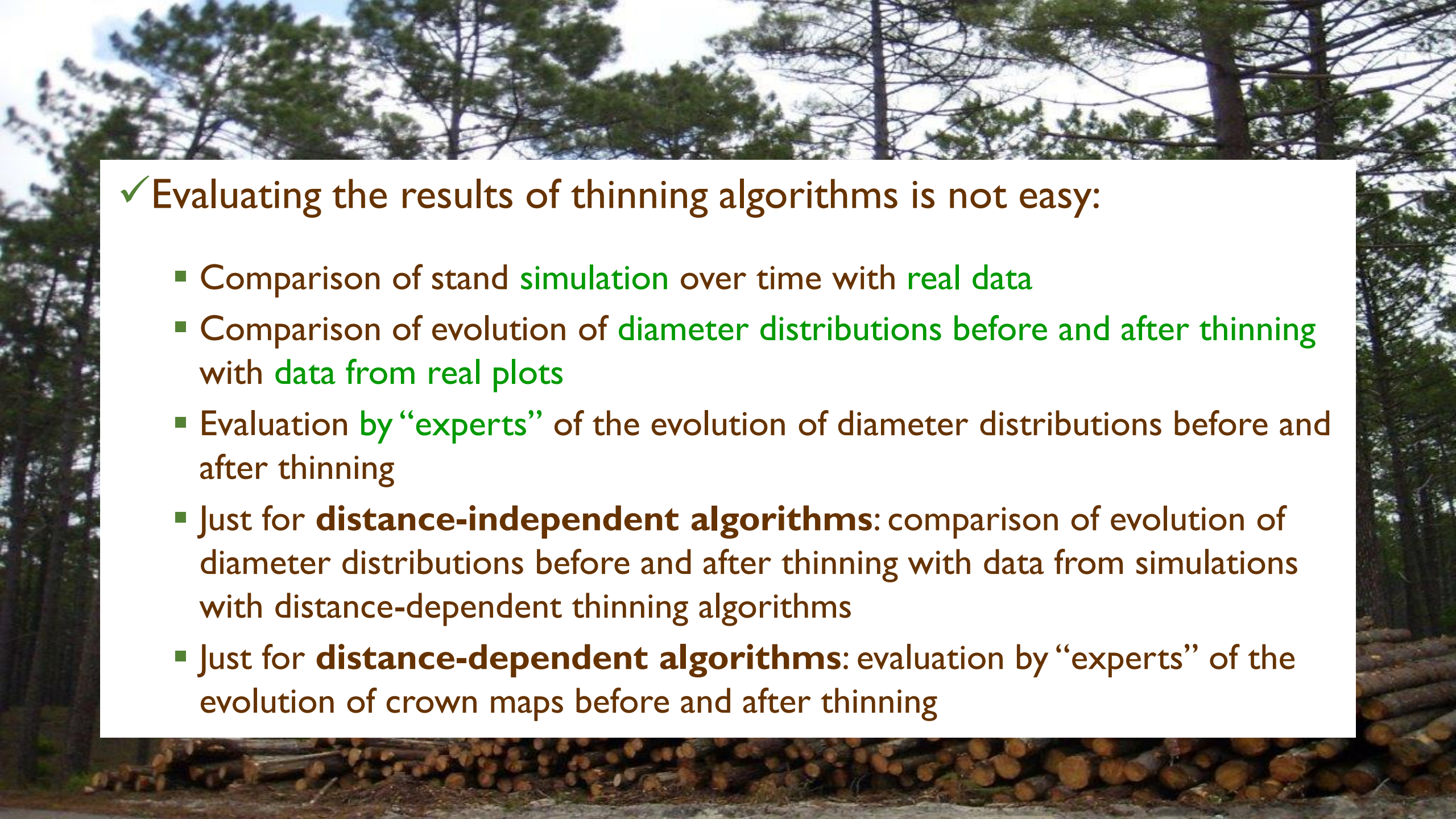












✓Evaluating the results of thinning algorithms is not easy:

- Comparison of stand simulation over time with real data
- Comparison of evolution of diameter distributions before and after thinning with data from real plots
- Evaluation by "experts" of the evolution of diameter distributions before and after thinning
- Just for **distance-independent algorithms**: comparison of evolution of diameter distributions before and after thinning with data from simulations with distance-dependent thinning algorithms
- Just for **distance-dependent algorithms**: evaluation by "experts" of the evolution of crown maps before and after thinning


The End!!