Quantitative and qualitative composition of softwood bark polyphenols within and among trees

BARKTANBIO

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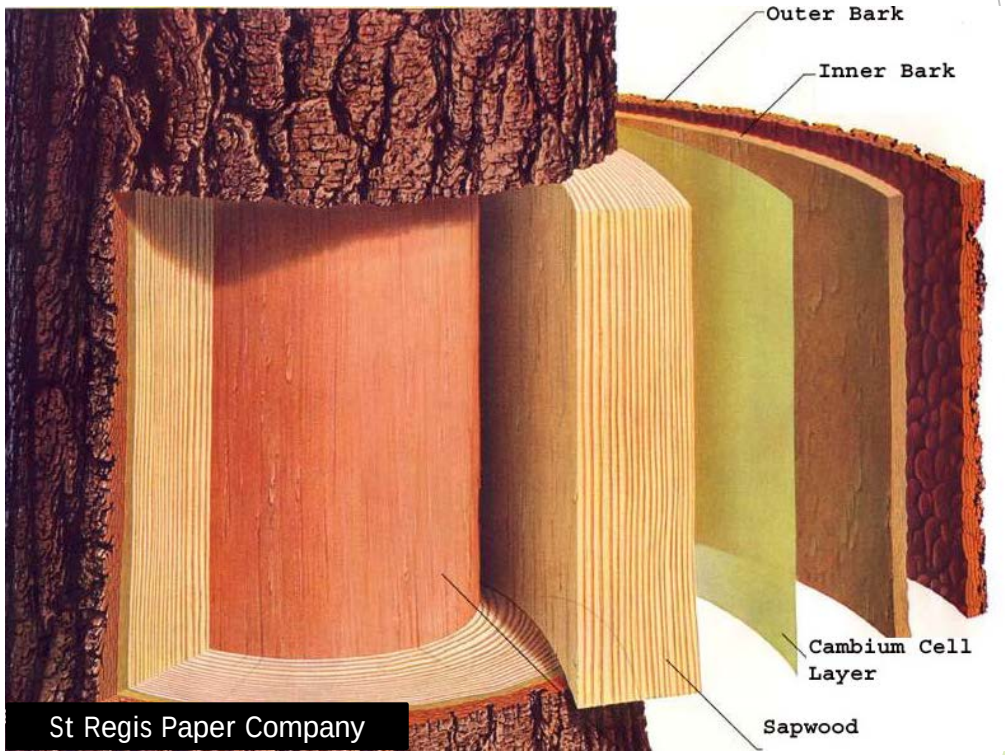
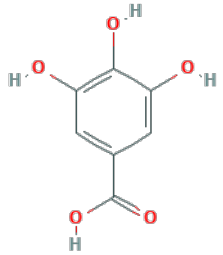
Bark

- Protects against pathogens
- 15% stem volume
- Used for:
  - horticulture (gardens)
  - energy (combustion)
- Extractible polyphenols used in:
  - cosmetics
  - resins, foams and adhesives
- Also contains lignin, polysaccharides and lipids

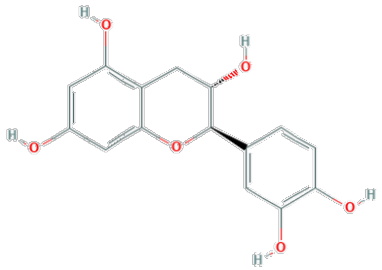


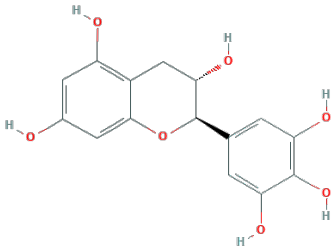
Extractible polyphenols

- Tannins – polyphenolic secondary metabolites
- Hydrolysable
  - esters of gallic acid

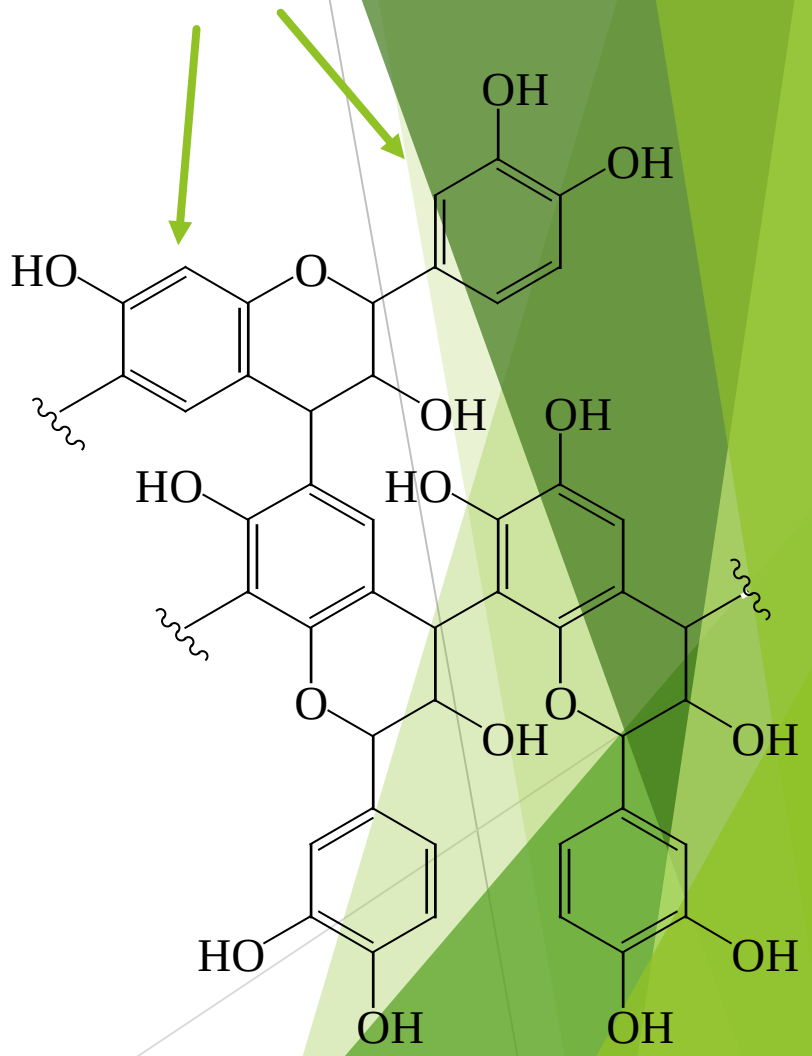


- Condensed
  - proanthocyanidins (catechin and epicatechin)
  - prodelphinidins (gallocatechin)



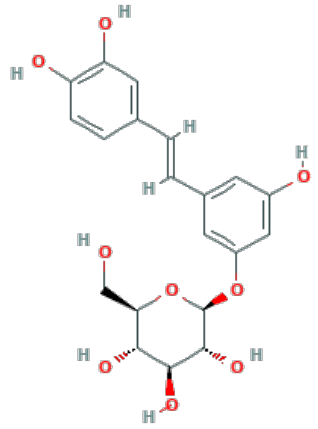


Aromatic rings absorb in UV

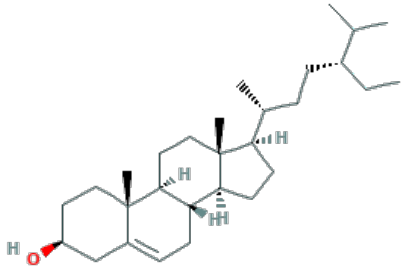


Other extractible compounds

- Stilbene glycosides
  - e.g. astringin
  - other polyphenolic glycosides



- Lipophilic compounds
  - e.g. fatty acids, terpenoids and sterols

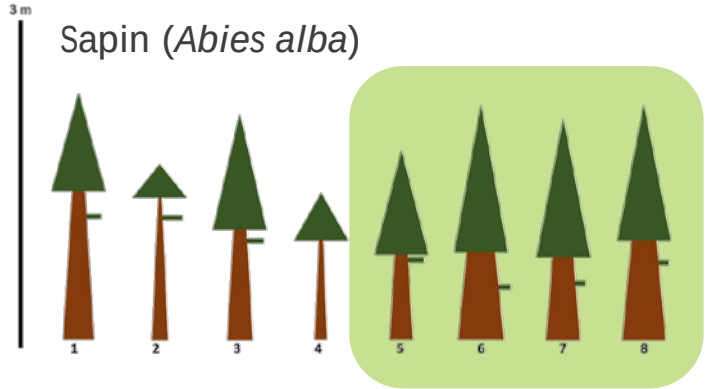


- Lignin and polysaccharides

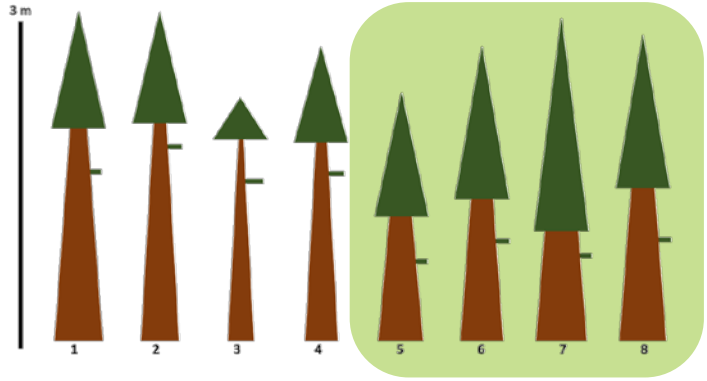
Species and trees

- Thinned more frequently
- Lower final stand density

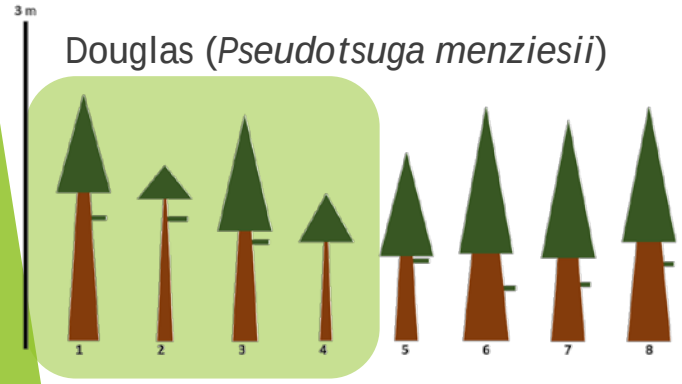
Sapin (*Abies alba*)



Epicea (*Picea abies*)



Douglas (*Pseudotsuga menziesii*)



Samples: (13)

30 cm above the ground

80 cm above the ground

130 cm above the ground

Mid-height

Diameter 20 cm

First green branch

Base of the crown

Diameter 10 cm

} with and without branches

Extraction protocol

Bark

↓

Milling

↓

Extraction

↓

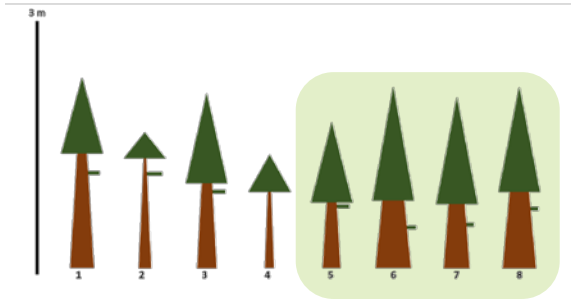
Quantitative & qualitative analyses

Dionex ASE

LC-MS (UV)

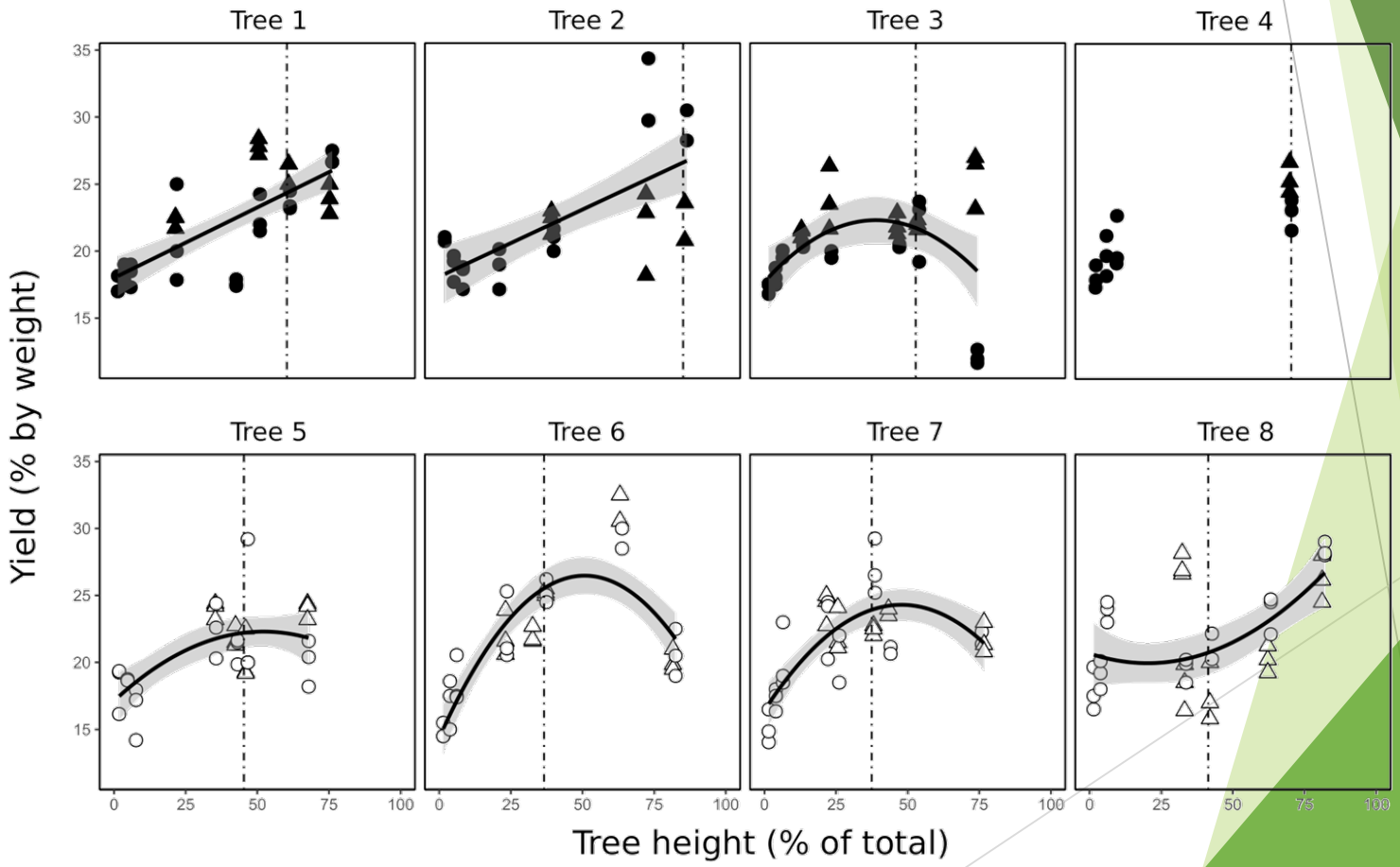
Yield (%) = dry extract mass/dry bark mass ×100

Sapin, EtOH:H_2O



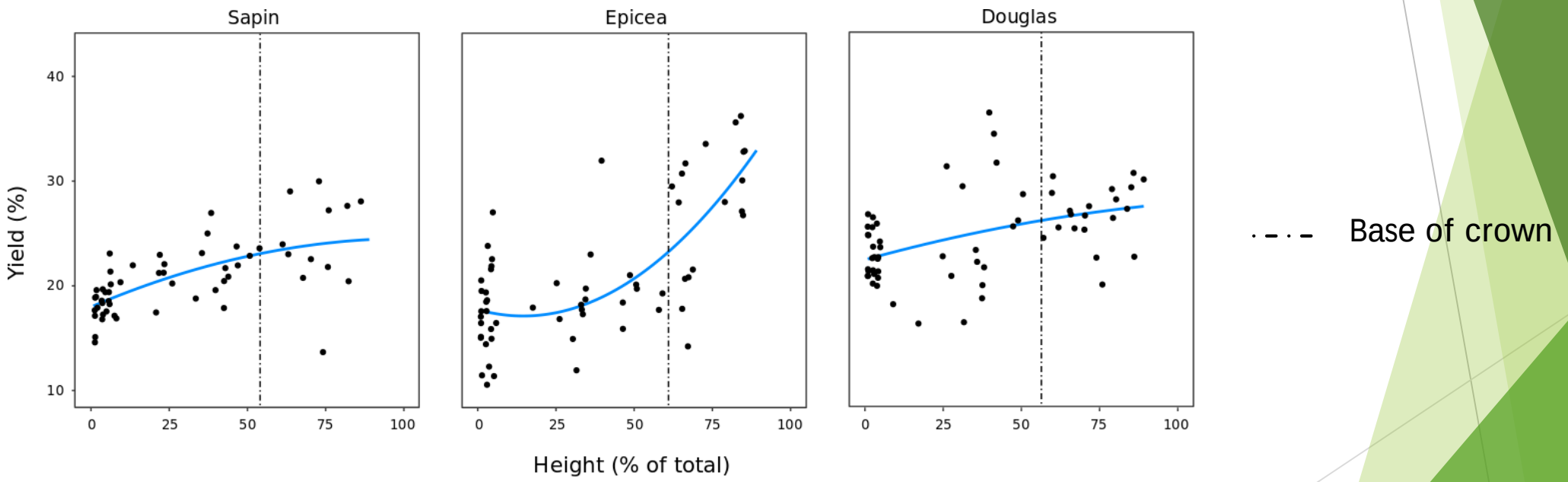
Without branches
With branches
Base of crown

- Yield increased with height, towards the base of the crown
- Max yield was often close to the base of the crown
- No clear trend for the presence of branches
  - For Epicea and Douglas, branch presence was significant



Without branches, EtOH:H_2O

- Yield generally increases with height
  - Relationship form is species-dependent
- For Sapin and Douglas, there is little yield increase after the base of the crown

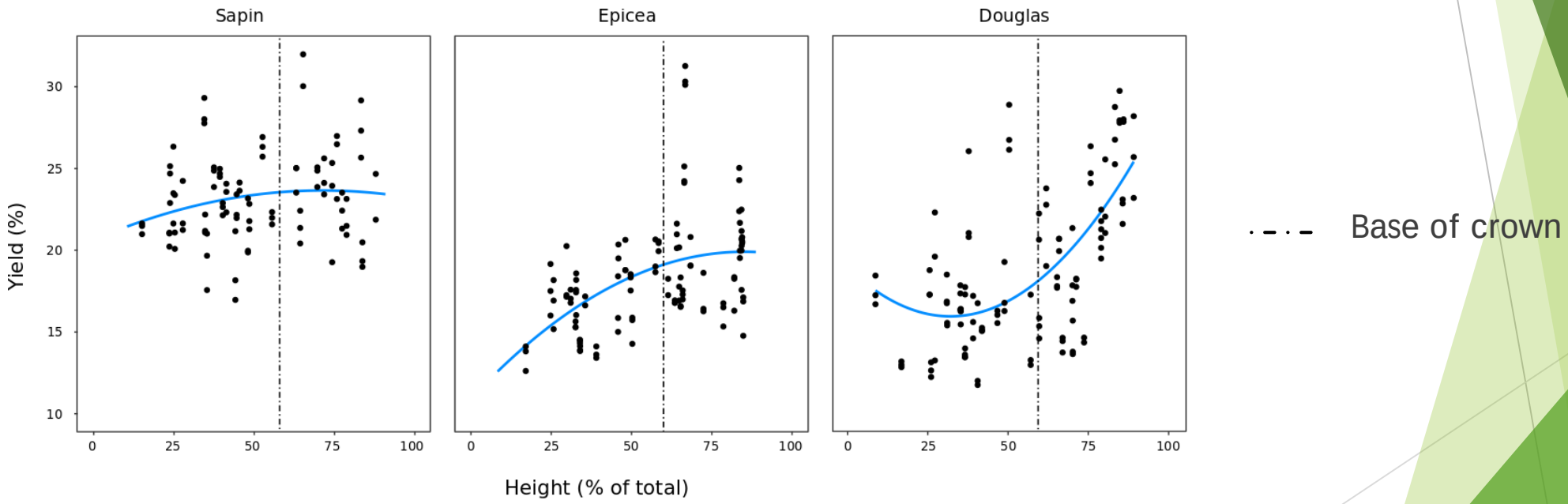


Fixed effects: Species * % Total height²
Random effect: Tree height (m) (AIC: 1012 vs 1080)
Thinning program was not significant

Random effects which did not improve model:
- Tree
- DBH (similar to total height)

With branches, EtOH:H_2O

- Relationship form is still species-dependent
  - Similar for Sapin, but opposite coefficients for Epicea and Douglas
- Douglas had large quantities of resin in higher samples

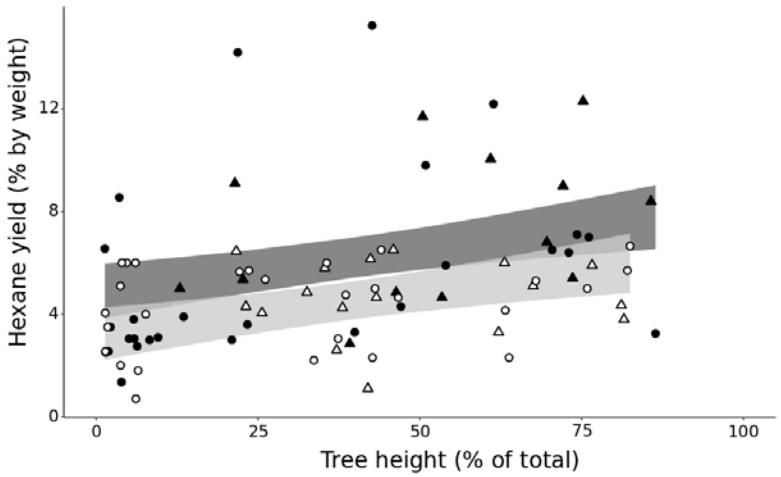


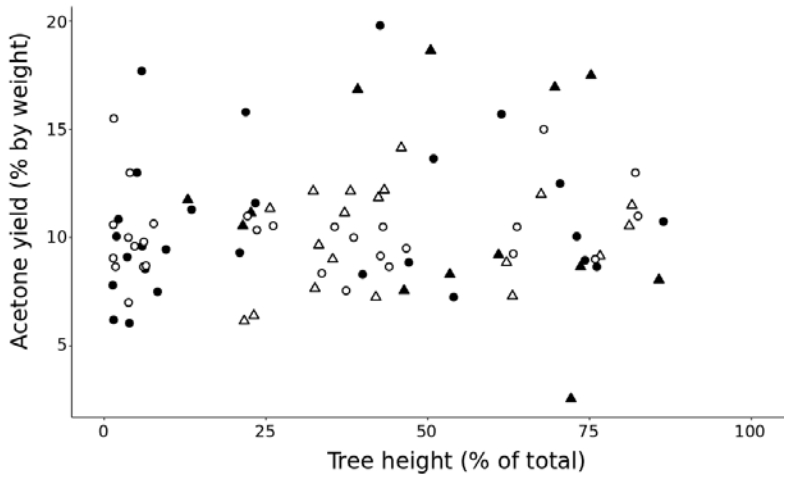
Fixed effects: Species * % Total height²
Random effect: Tree height (m) (AIC: 1648 vs 1746)
Thinning program was not significant

Random effects which did not improve model:
- Tree
- DBH (similar to total height)

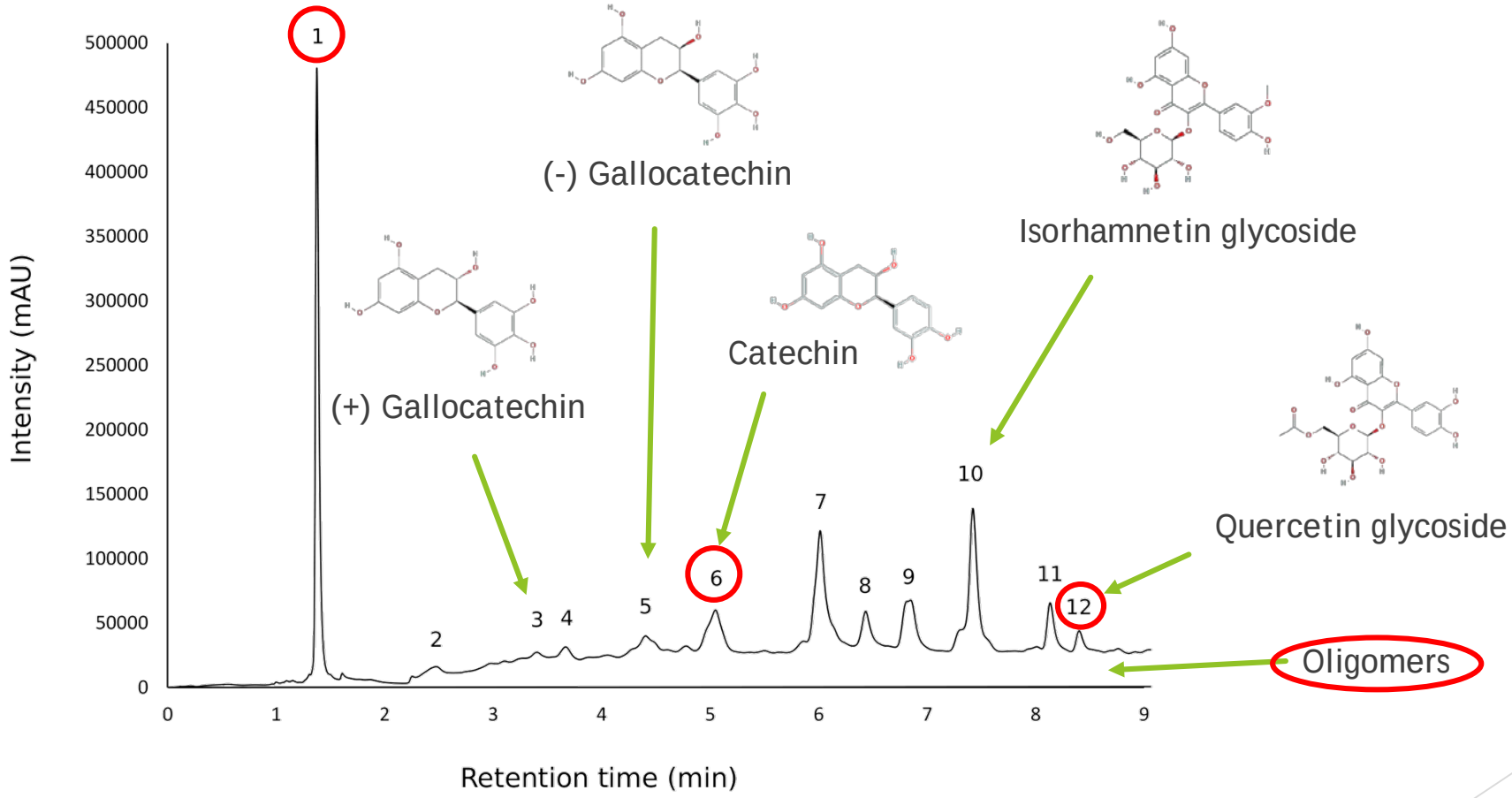
Sapin, lipophilic extractibles

- Successive extractions with solvents increasing in polarity to extract lipophilics
- Only hexane extracts (least polar) had a significant relationship with height
  - Extra thinning (light grey) decreased mean hexane yield by 1.7 %





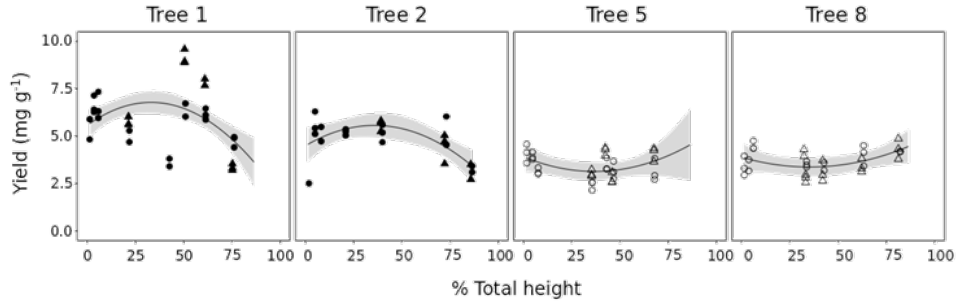
Sapin, EtOH:H_2O compounds – UV (280 nm)



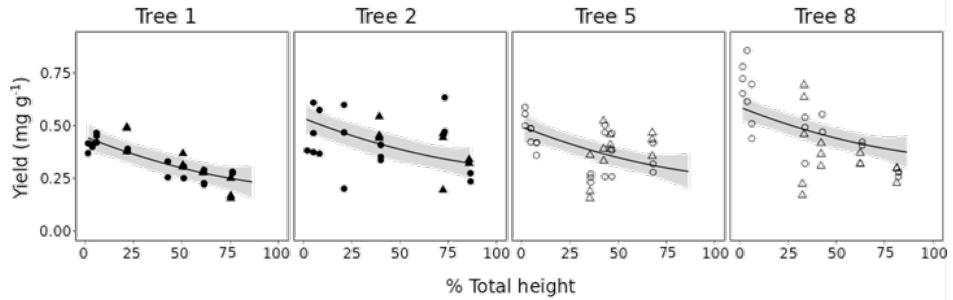
Quantification of identified compounds

- Few compounds increase with % total height
  - Increase in Sapin yield is due to non-UV visible compounds
- Difference in relationship form among trees is not consistent between managements

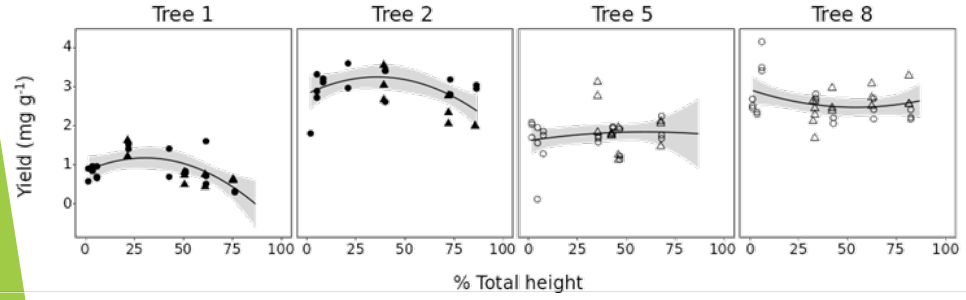
Peak 1



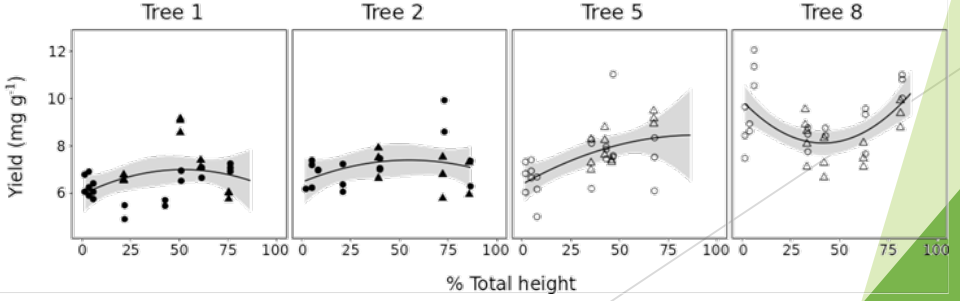
Quercetin glycoside



Catechin



Oligomeric tannins



Conclusions

- Within one species the relationship between yield and height can differ among trees
- In general:
  - Sapin has higher extractive yield above the crown, but more polyphenolics below the crown
  - Epicea and Douglas also have higher extractive yields above the crown
- Bark volume above the crown is lower than at the base of the tree
  - The bark at the base of the tree may be more value, despite the lower yield
- It is important to characterise the compositional variability of extracts to determine their potential for valorisation

Merci!

Est-ce que vous-avez des questions?