Waldwachstumskunde
Systemanalyse

The information potential of crown allometry for tree and stand dynamics

Hans Pretzsch, Technical University Munich/Bavaria Germany

The relevance of tree crowns to

1 tree stability and survival

2 tree growth and tree productivity

3 stand density regulation and growth

4 tree species mixing and growth

5 log and lumber quality

Conclusions

http://waldwachstum.wzw.tum.de/index.php?id=presentations

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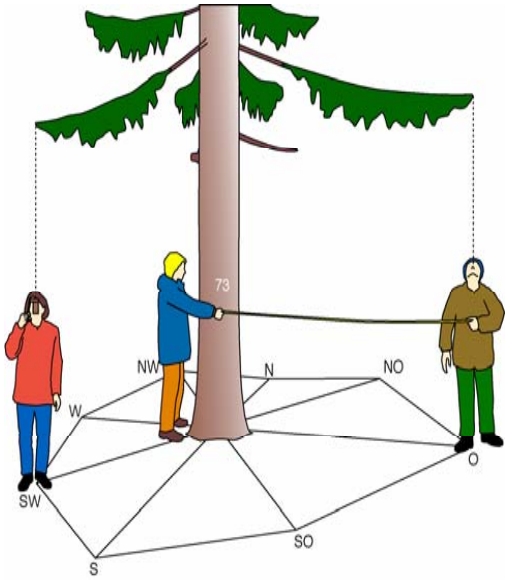
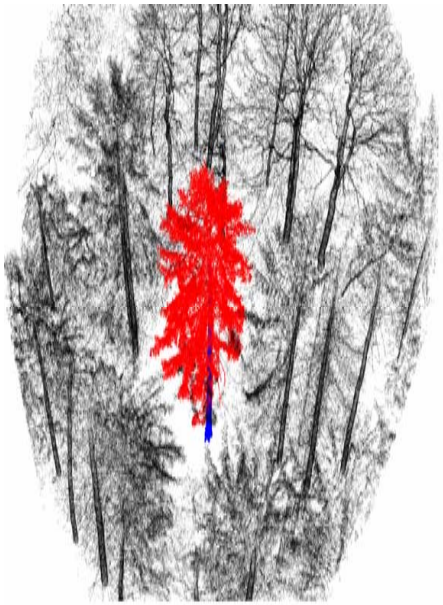
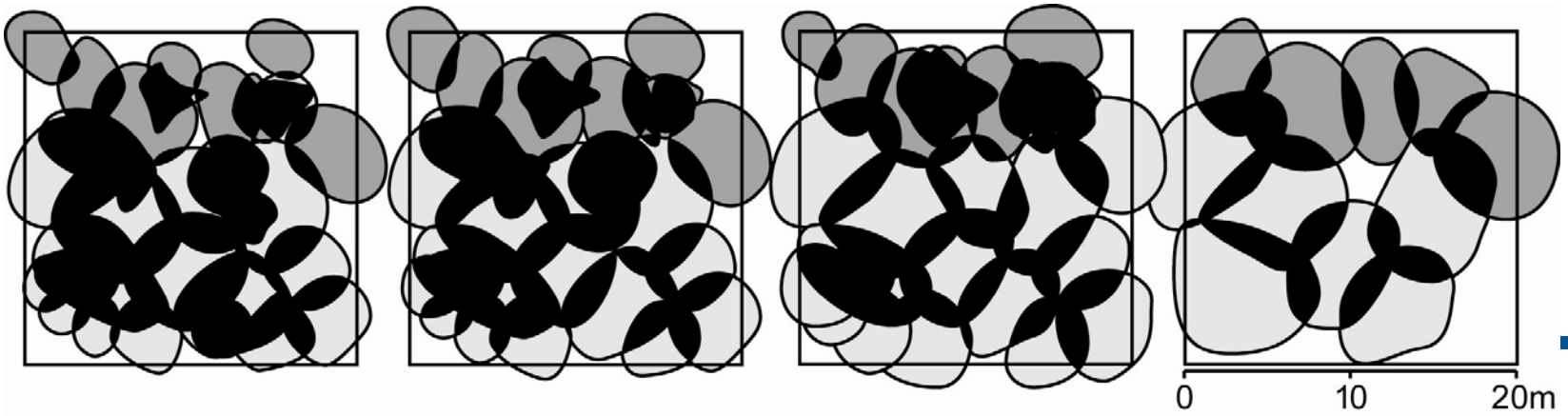
Crown projection area, cpa, measured classically and by TLidar







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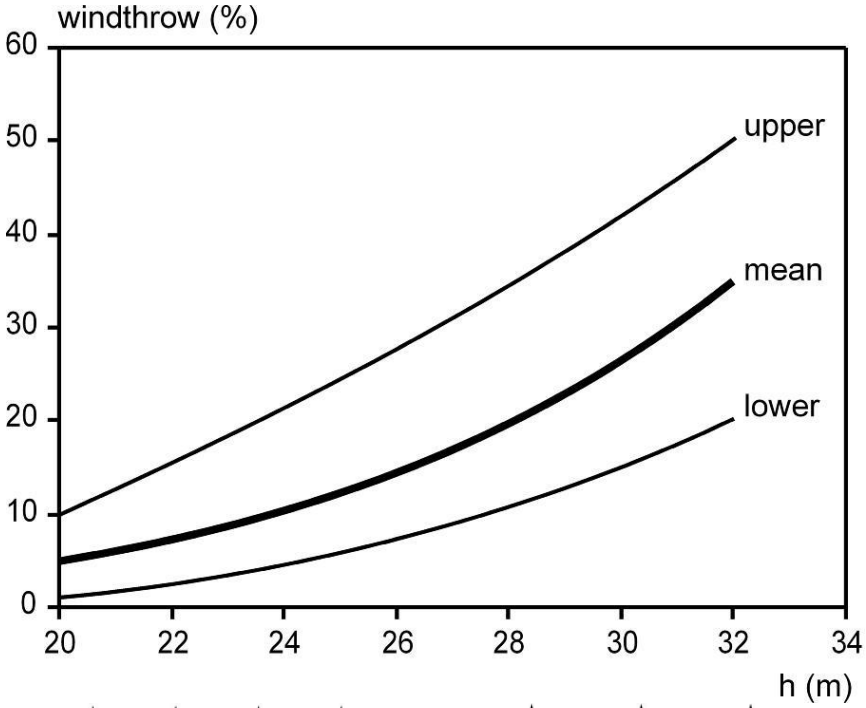
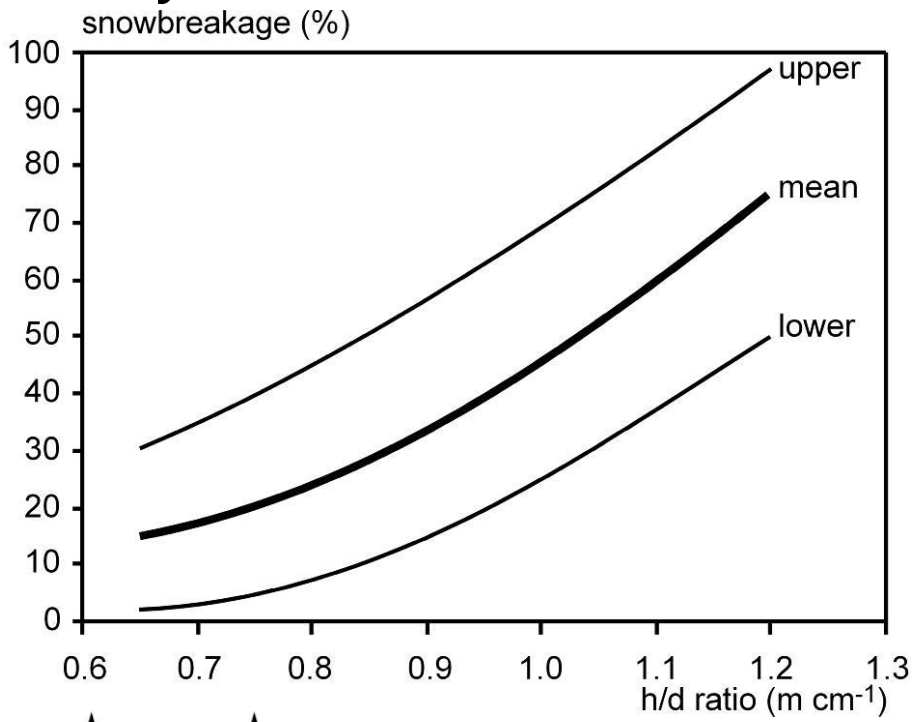
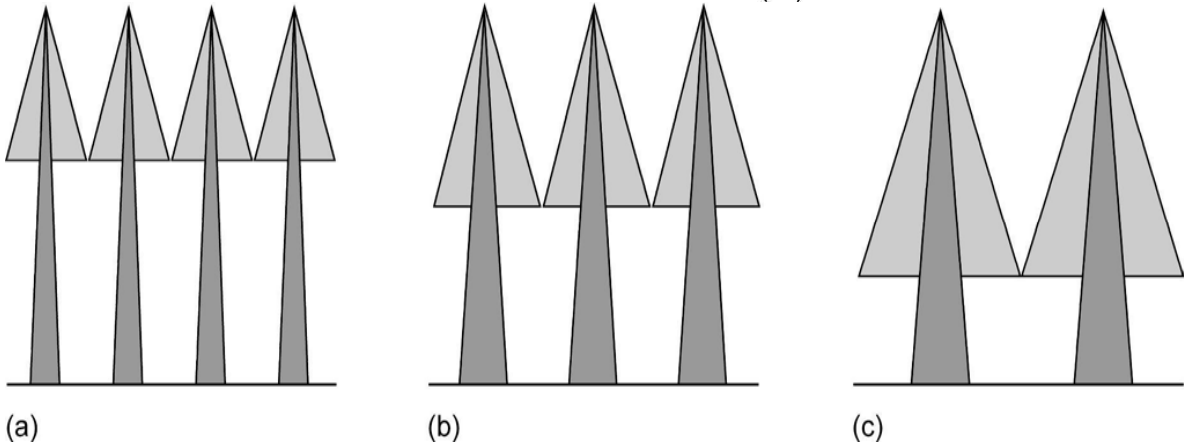
From crown dimensions to stem slenderness, h/d and stem stability







Gardiner (2010, 2013)
Peltola (1999)
Rottmann (1985, 1986)

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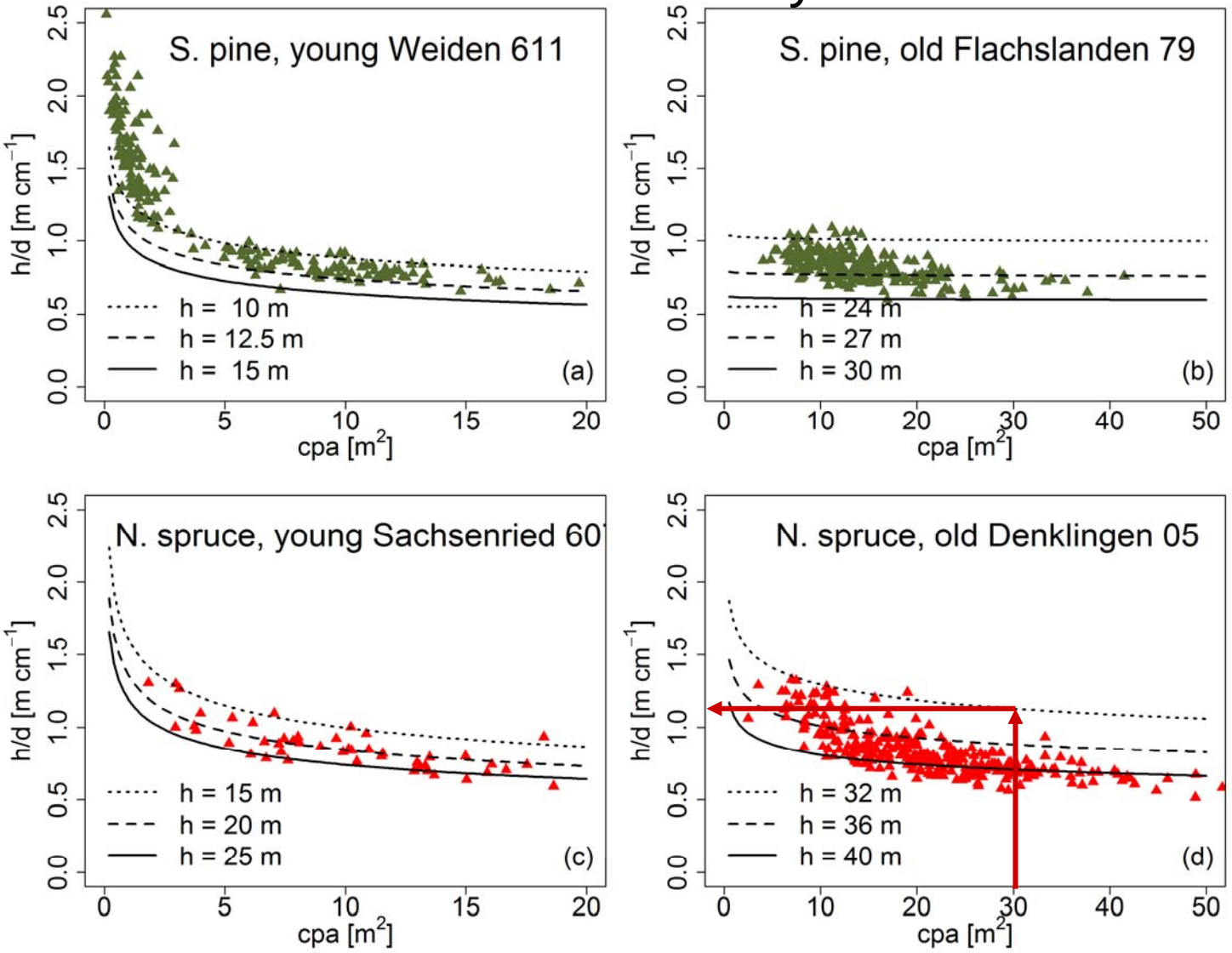
From crown dimension to stem slenderness, h/d and stem stability



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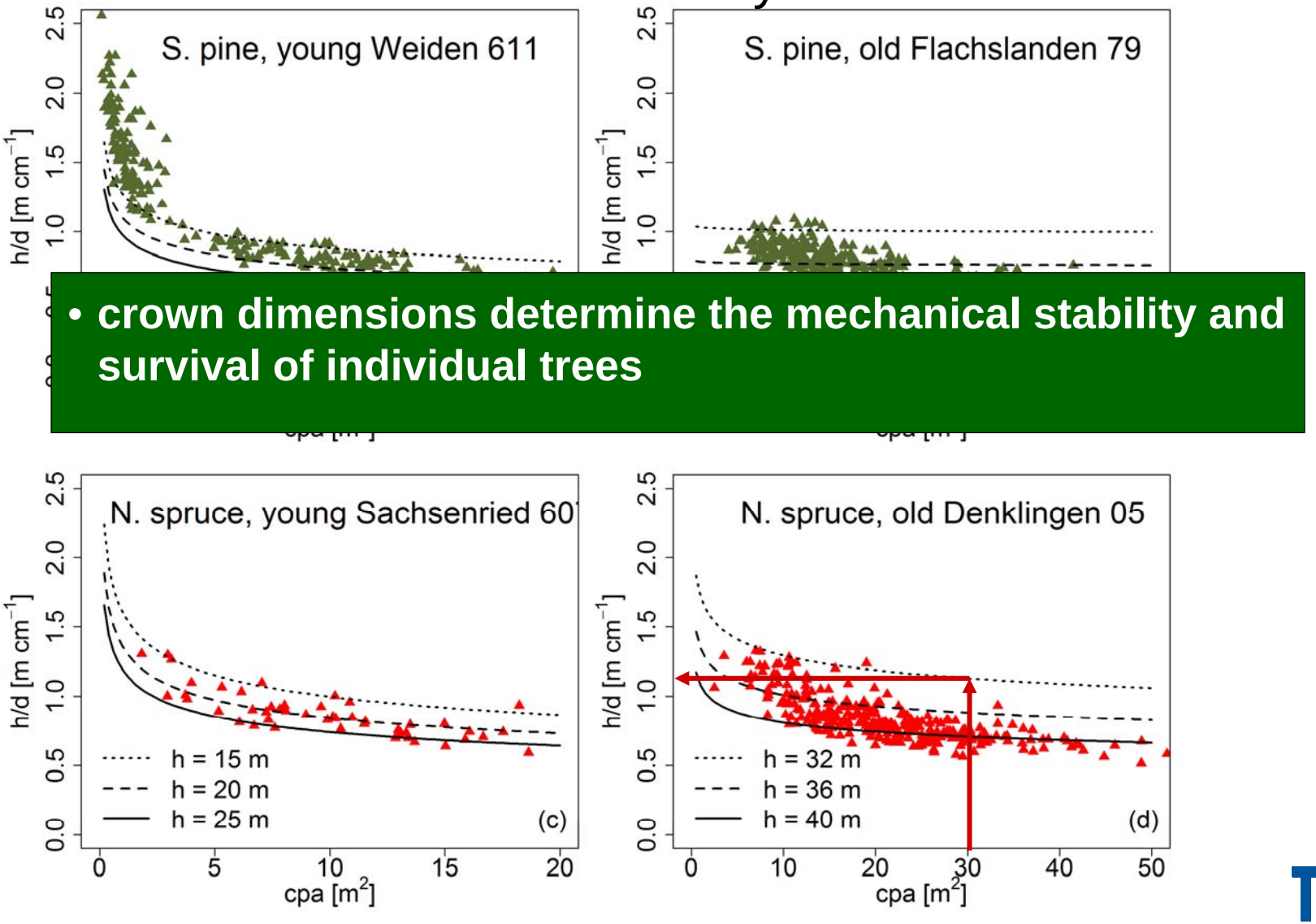
From crown dimension to stem slenderness, h/d and stem stability



- **crown dimensions determine the mechanical stability and survival of individual trees**

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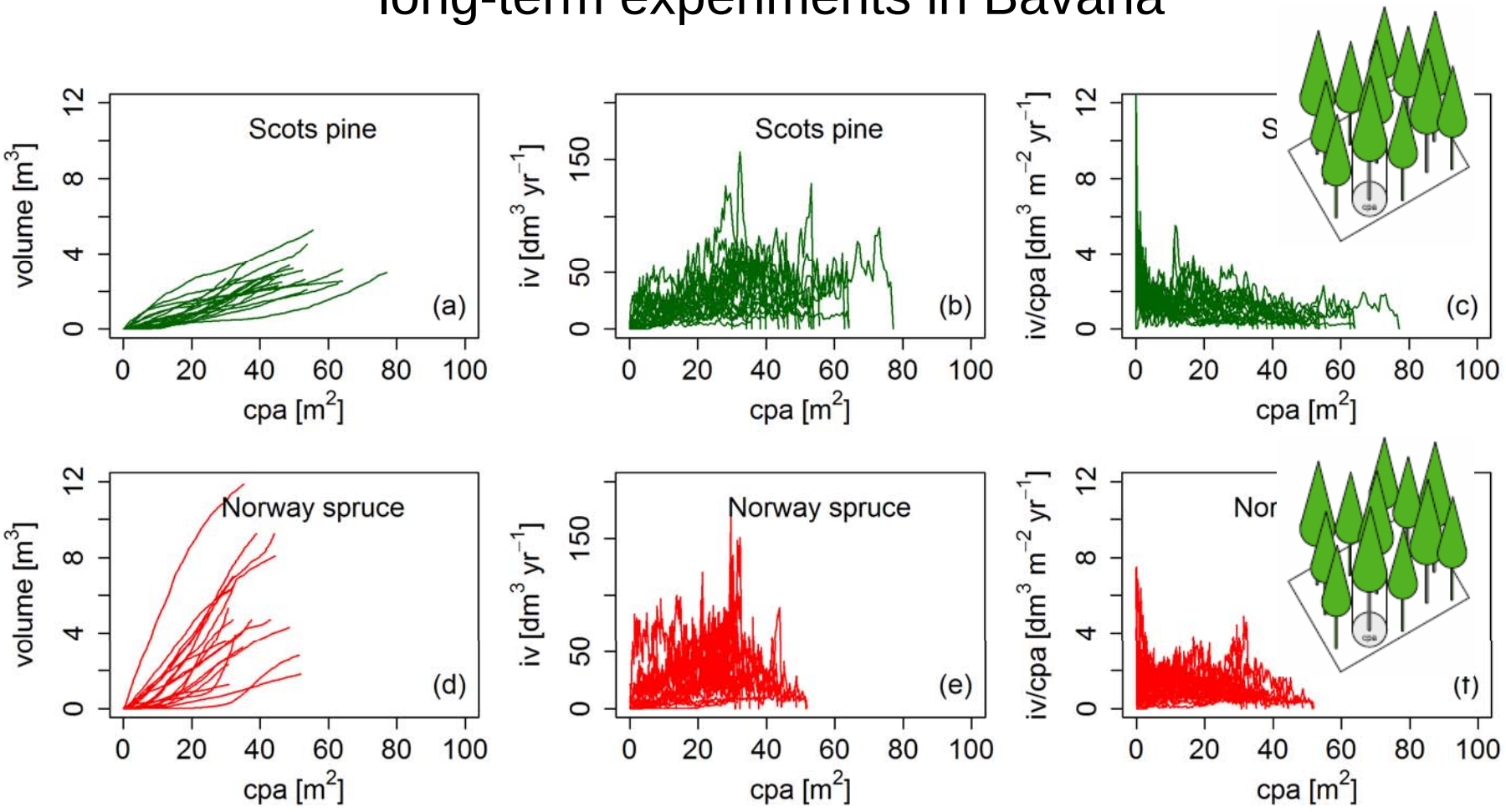
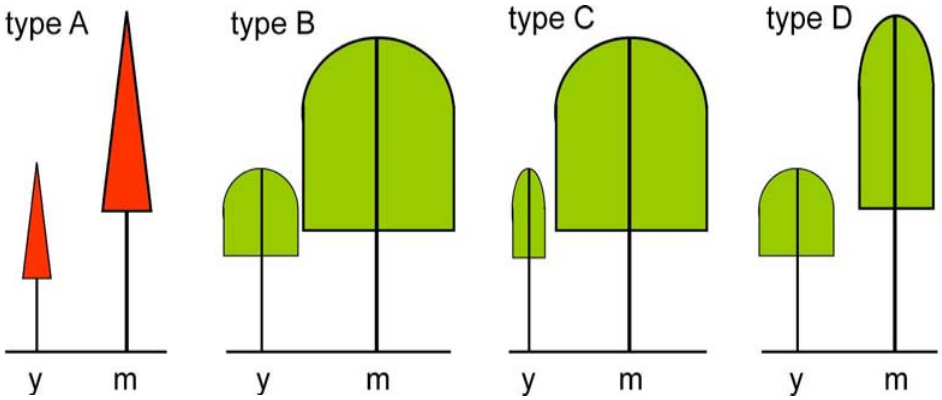
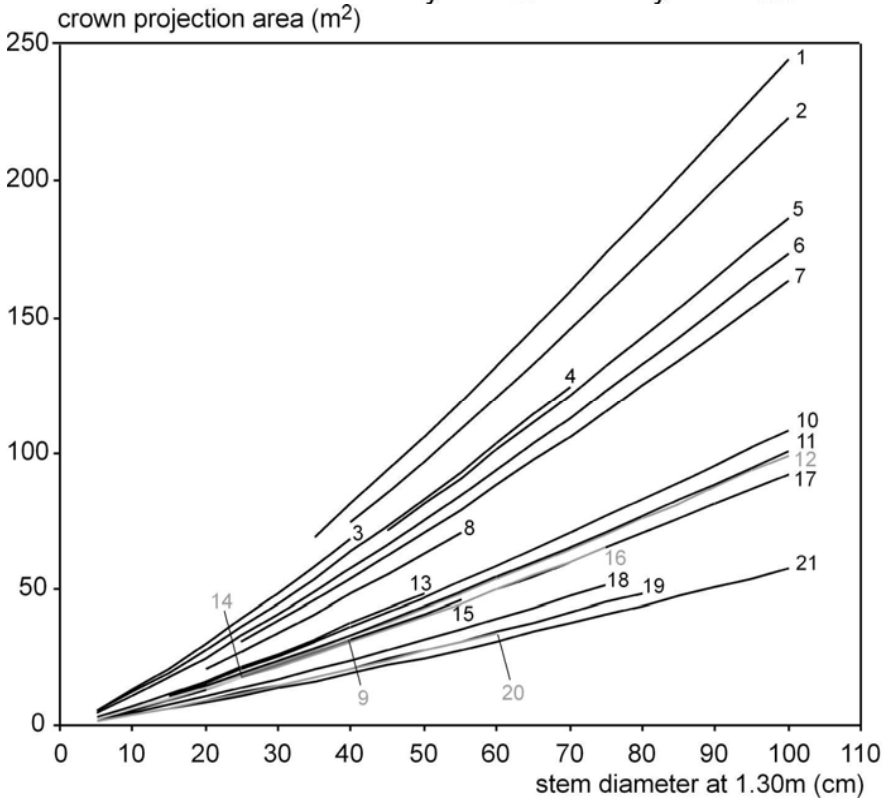
course of v, iv, and iv/cpa of 150-350 years old trees on long-term experiments in Bavaria



cpa - stem diameter allometry of various tree species





[1] *Quercus nigra* L., [2] *Platanus x hispanica* Münchh., [3] *Carpinus betulus* L., [4] *Tilia cordata* Mill.,
[5] *Khaya senegalensis* (Desr.) A.Juss., [6] *Fagus sylvatica* L., [7] *Aesculus hippocastanum* L.,
[8] *Robinia pseudoacacia* L., [9] *Alnus glutinosa* [L.] Gaertn., [10] *Araucaria cunninghamii* Aiton ex. D.Don,
[11] *Pseudotsuga menziesii* [Mirb.], [12] *Abies alba* Mill., [13] *Sorbus aucuparia* L., [14] *Betula pendula* Roth,
[15] *Acer pseudoplatanus* L., [16] *Abies sachalinensis* Mast., [17] *Quercus petraea* [Matt.] Liebl.,
[18] *Pinus sylvestris* L., [19] *Larix decidua* Mill., [20] *Fraxinus excelsior* L., [21] *Picea abies* [L.] Karst.

Pretzsch & Zenner (2017), Pretzsch (2019)

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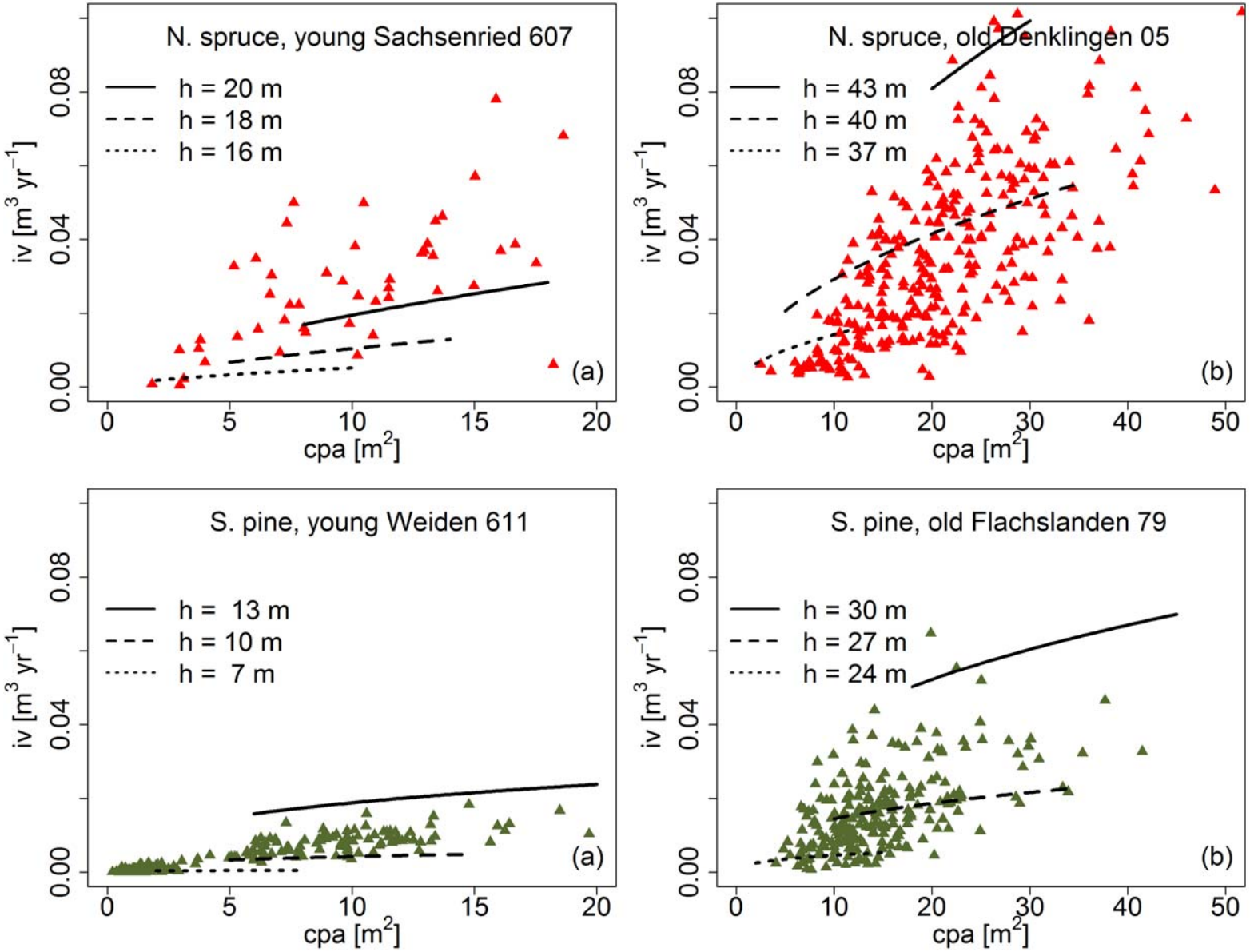
Volume growth, iv, over crown size, cpa



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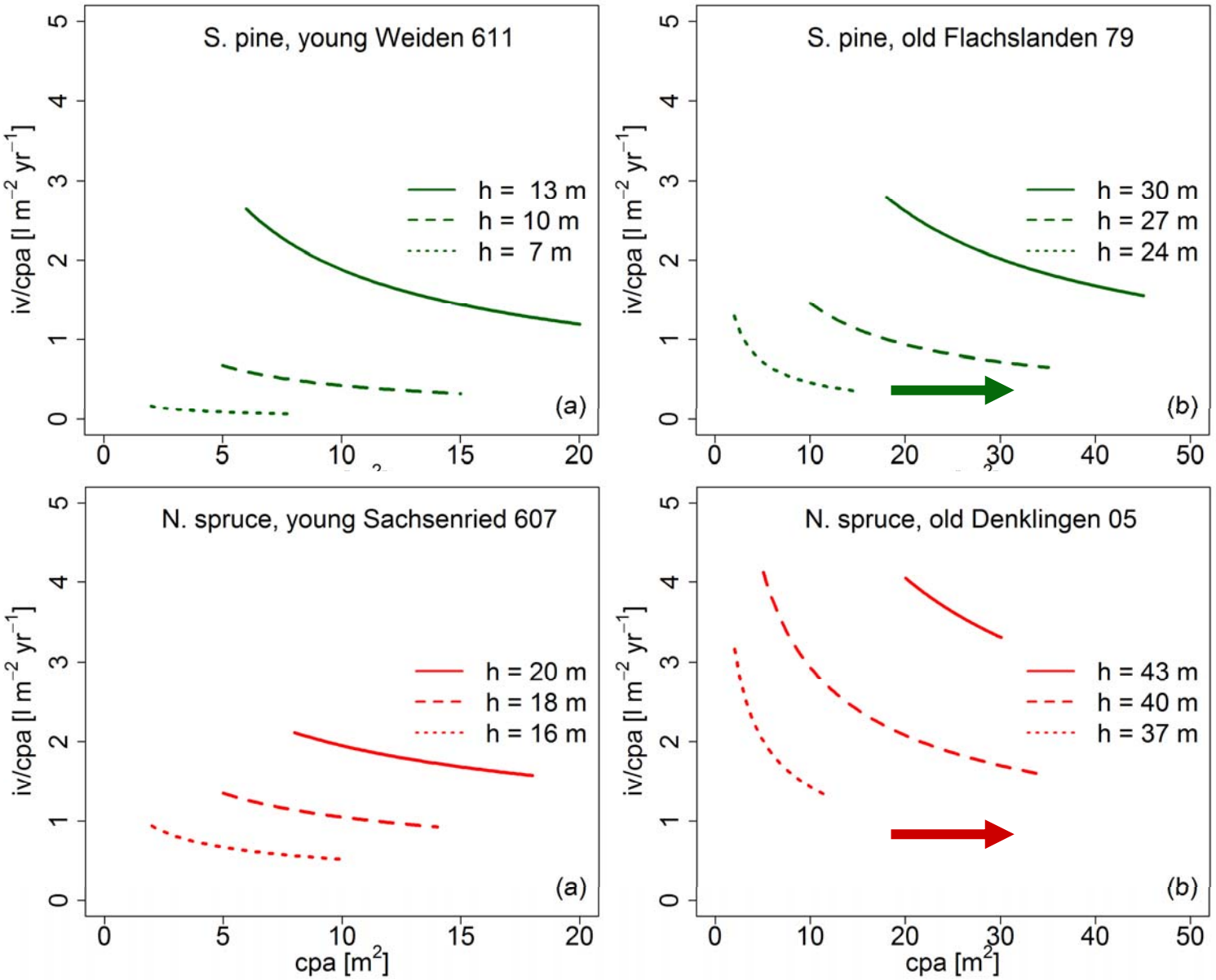
Volume productivity, iv/cpa, over crown size, cpa



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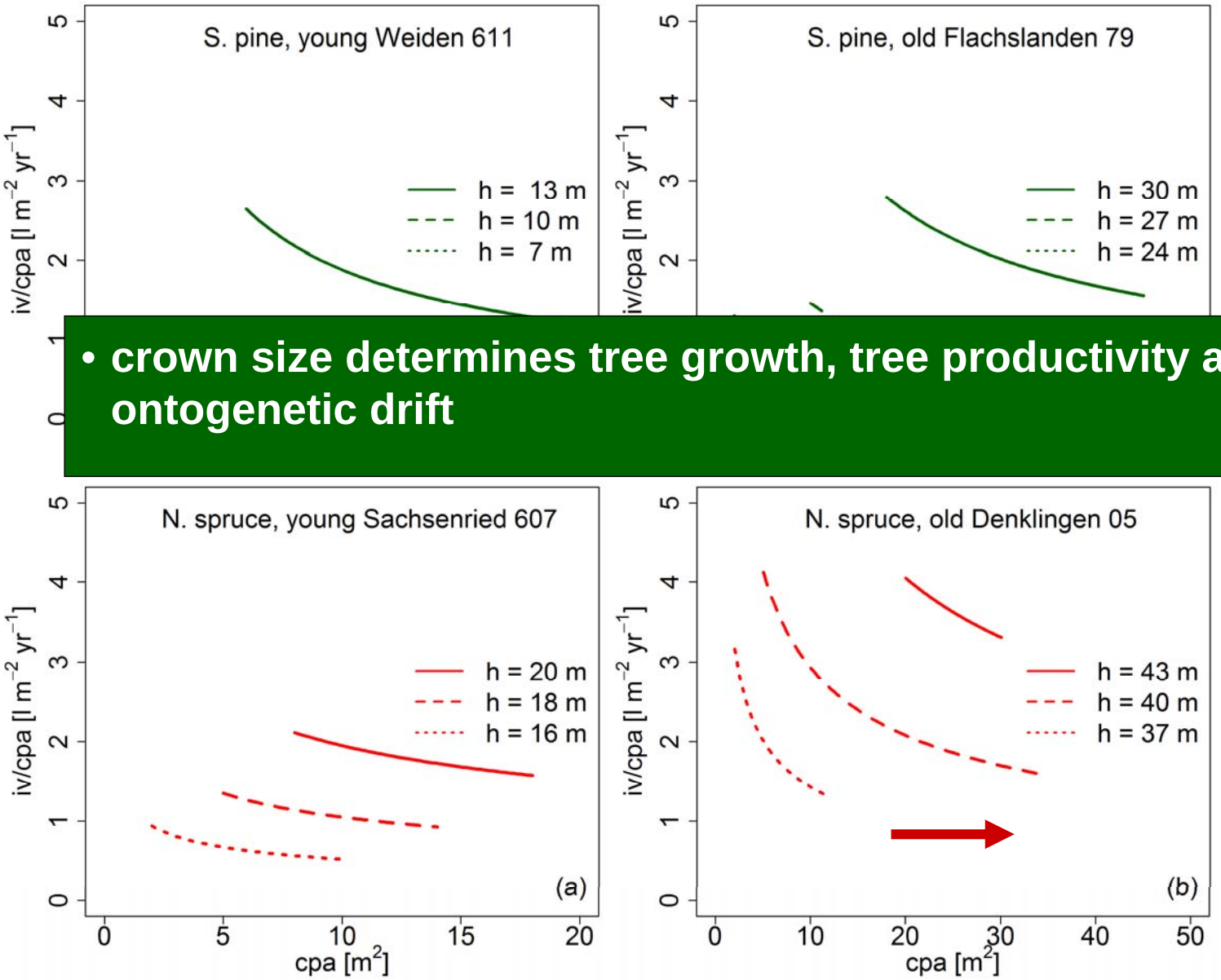
Volume productivity, iv/cpa, over crown size, cpa



- **crown size determines tree growth, tree productivity and ontogenetic drift**

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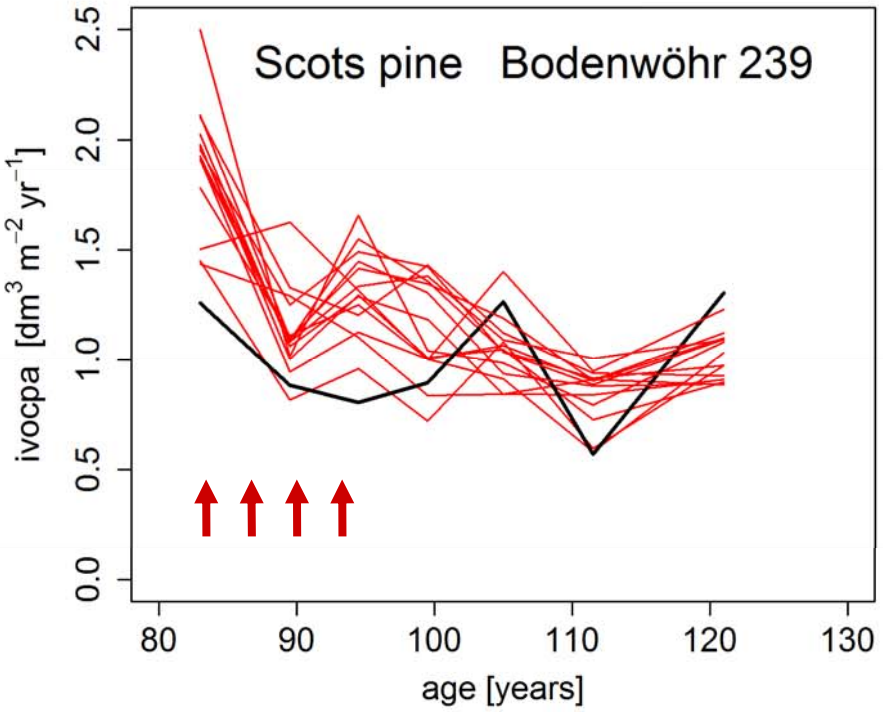
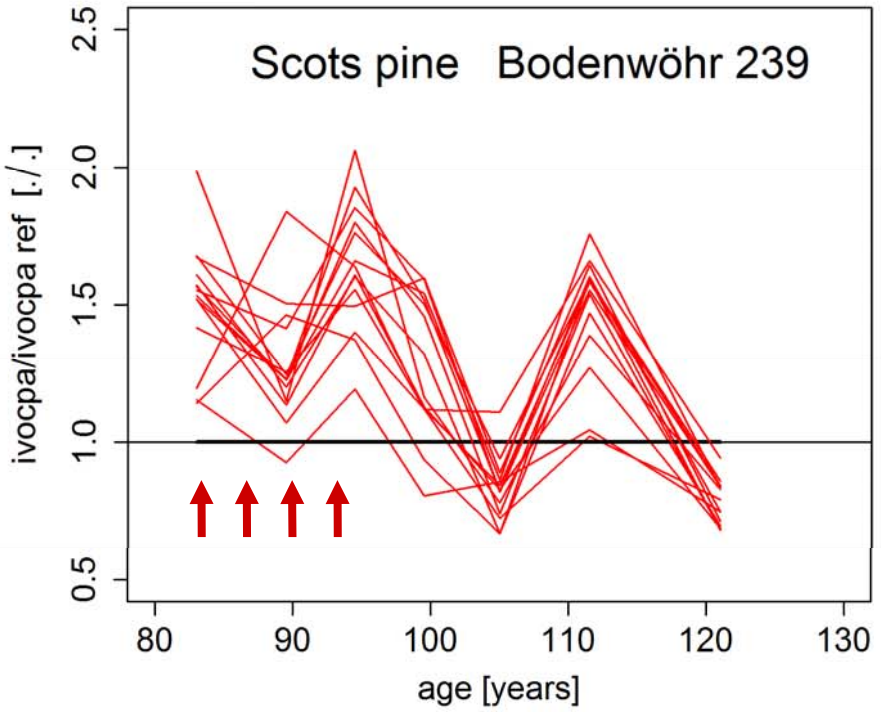
Increase of tree productivity and acceleration of ontogenetic drift by silvicultural measures





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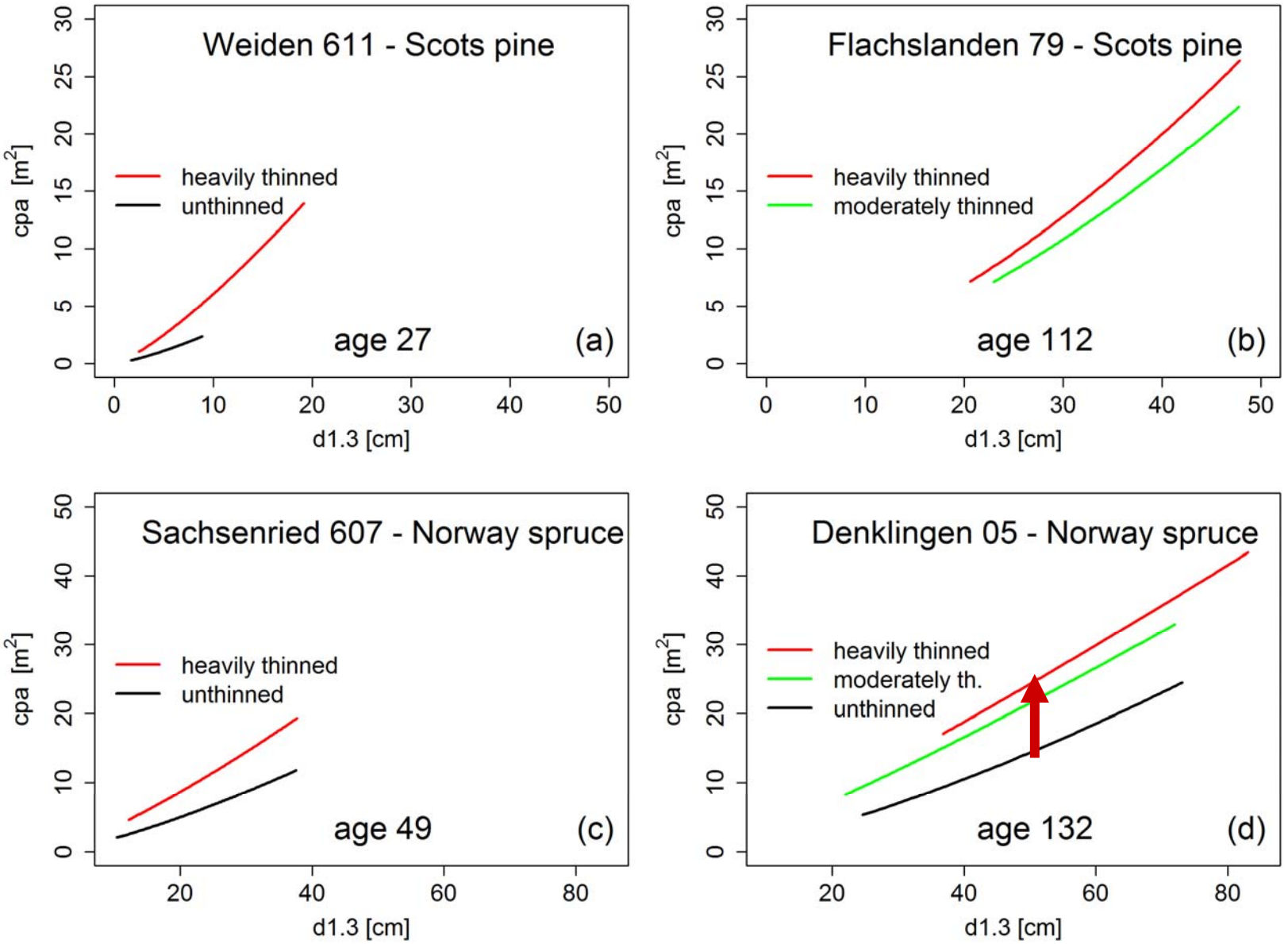
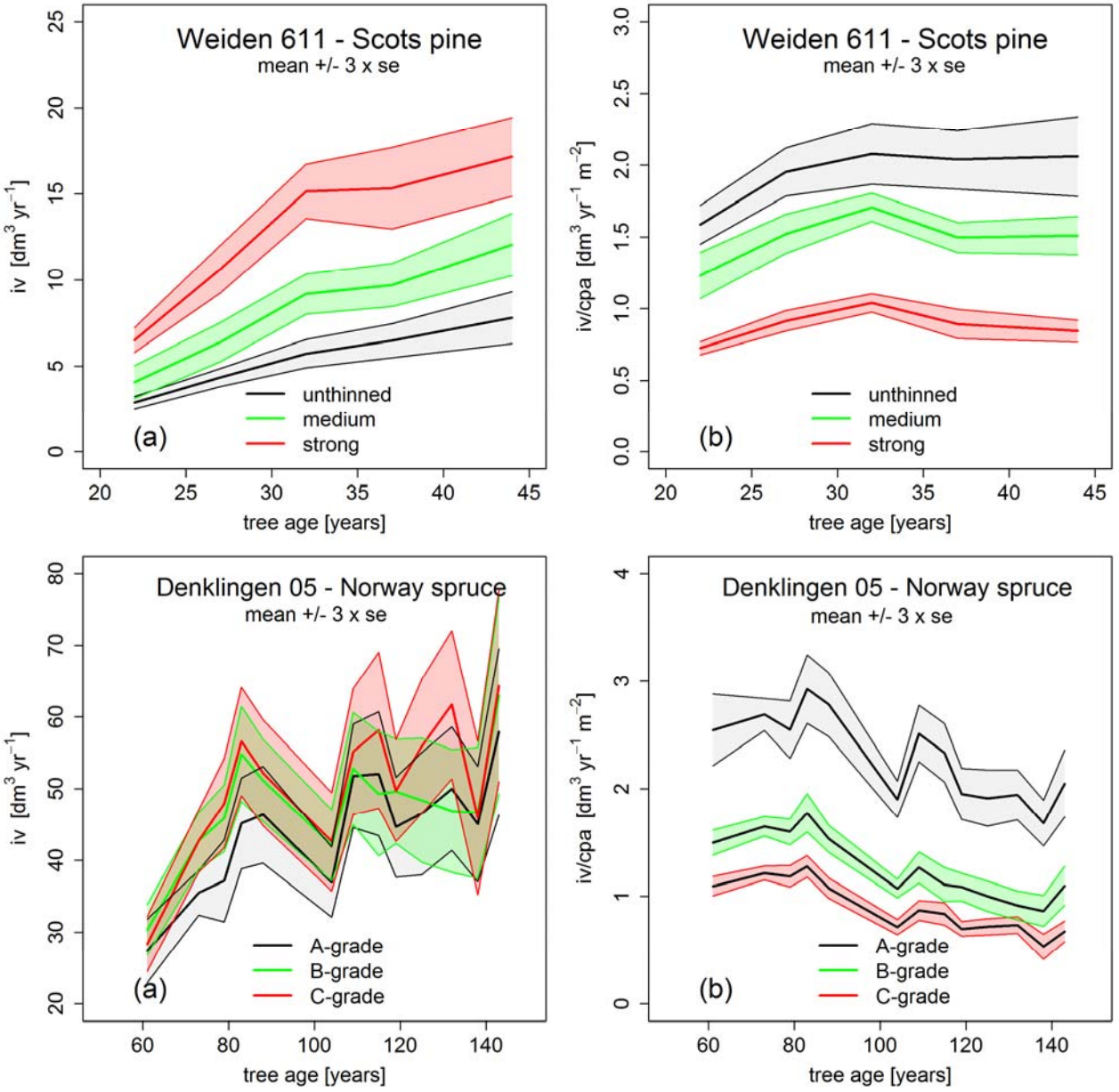
Effect of thinning on the allometry between d and cpa



tree volume growth, iv, and tree volume productivity, iv/cpa



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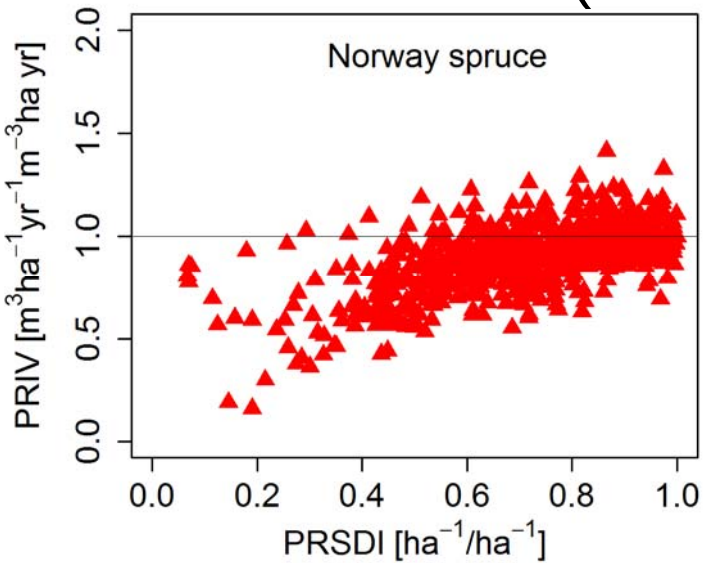
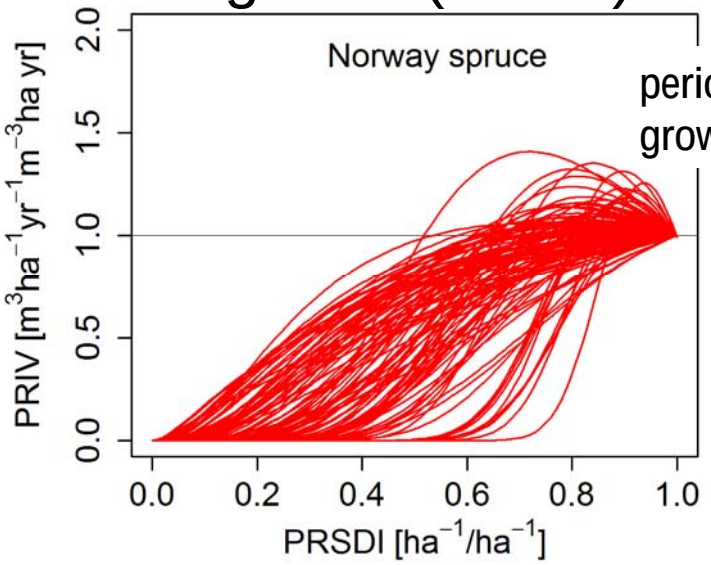
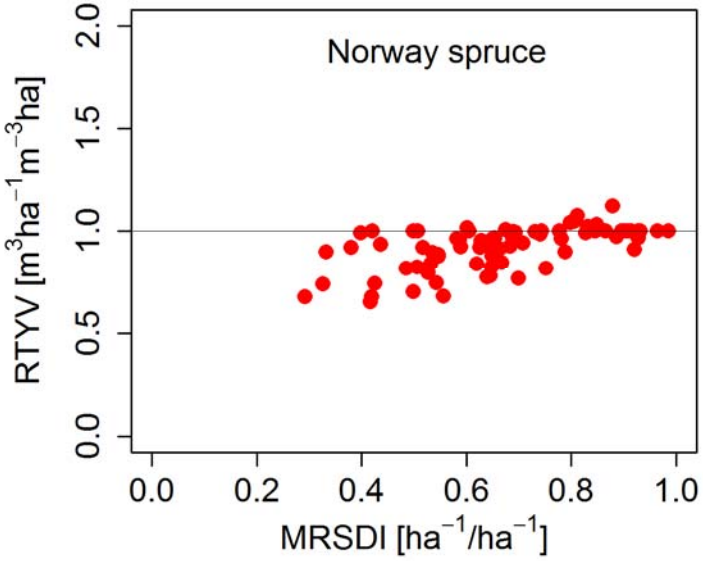
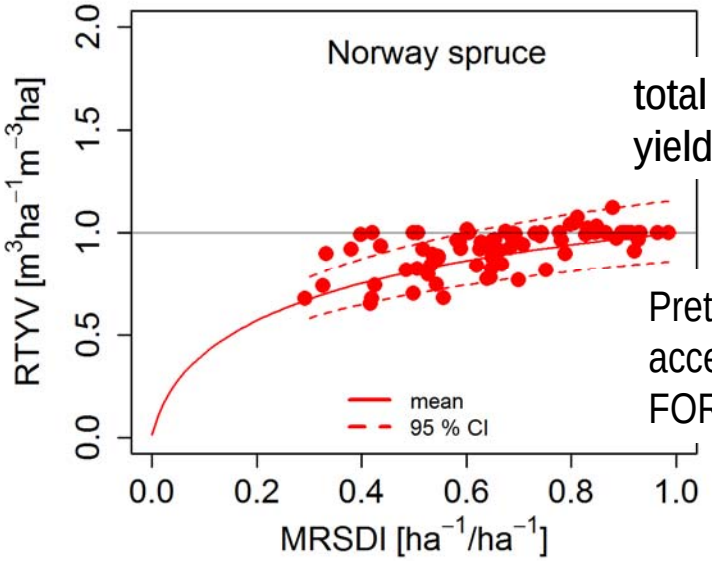
Density - stand growth relationship on 22 th. experiments on the short term (above) and long term (below)





periodical growth





total yield

Pretzsch (2020 accepted) FORECO

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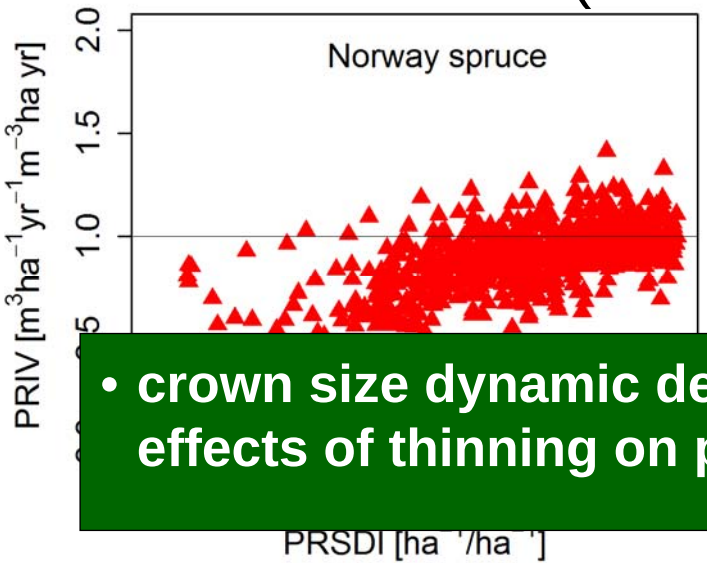
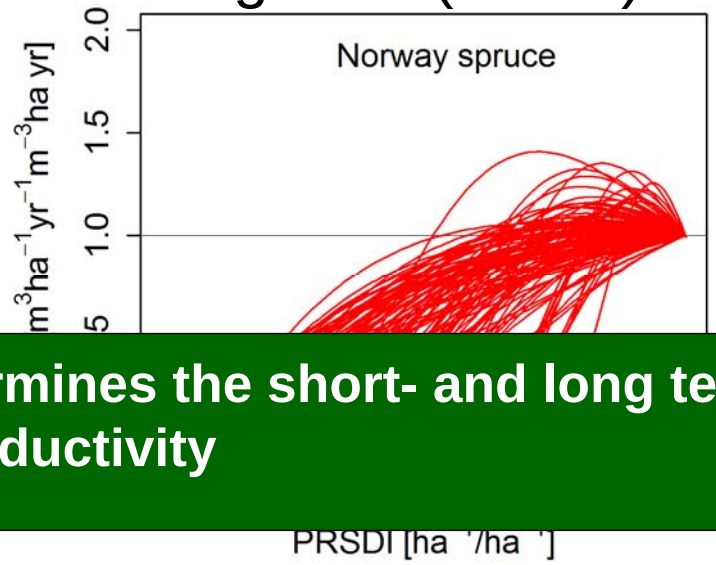
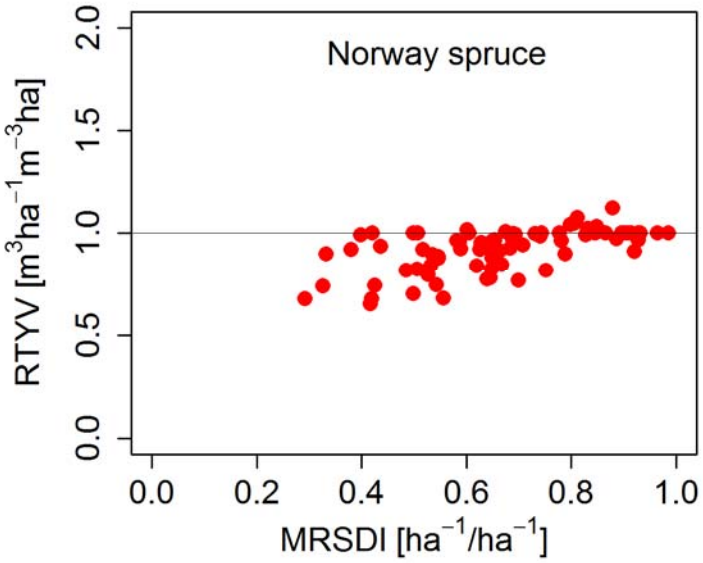
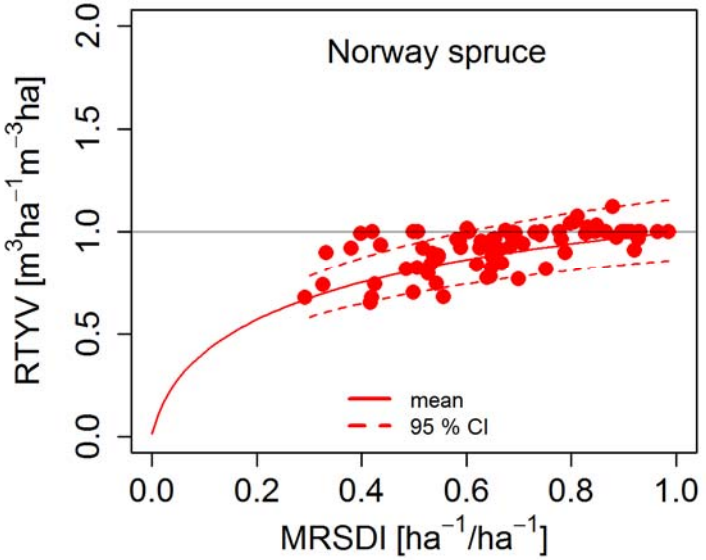
Density - stand growth relationship on 22 th. experiments on the short term (above) and long term (below)





- **crown size dynamic determines the short- and long term effects of thinning on productivity**





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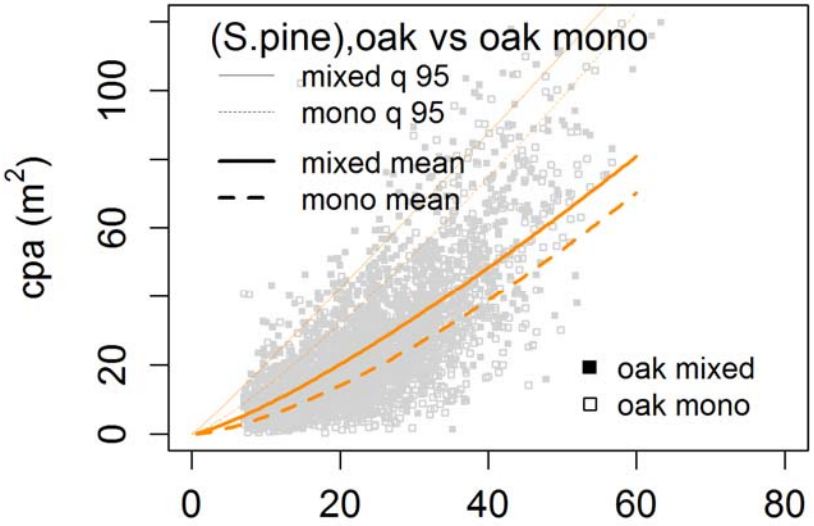
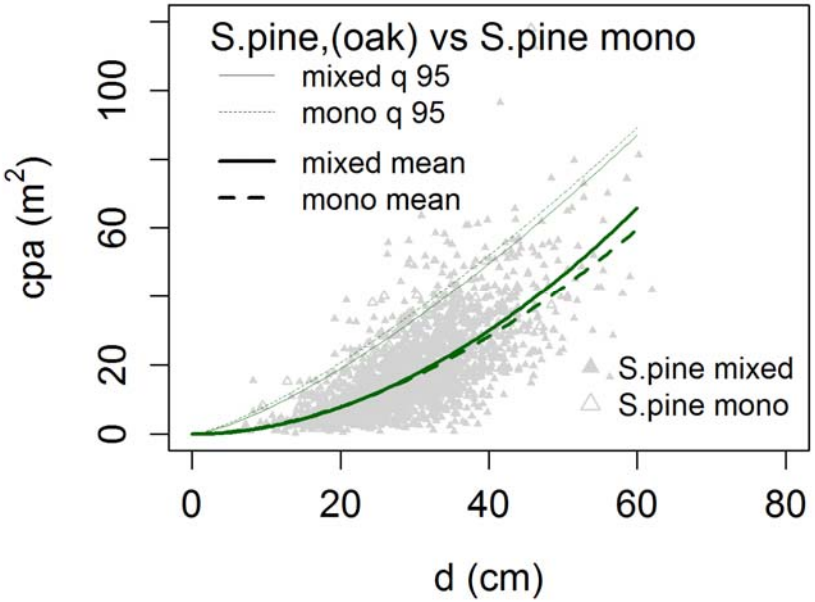
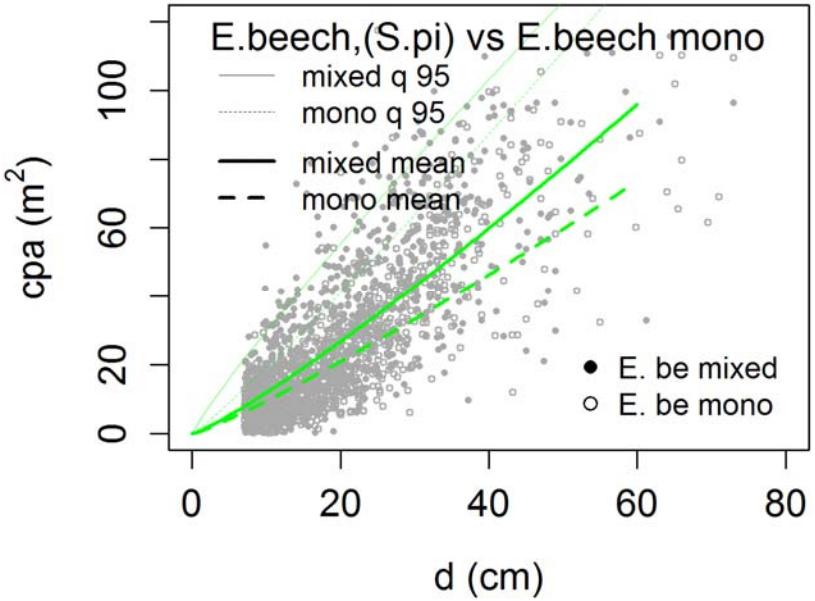
cpa-d allometry in mixed vs. monospecific stands







Pretzsch et al. (2019) Stand growth and structure of mixed-species and monospecific...EJFR

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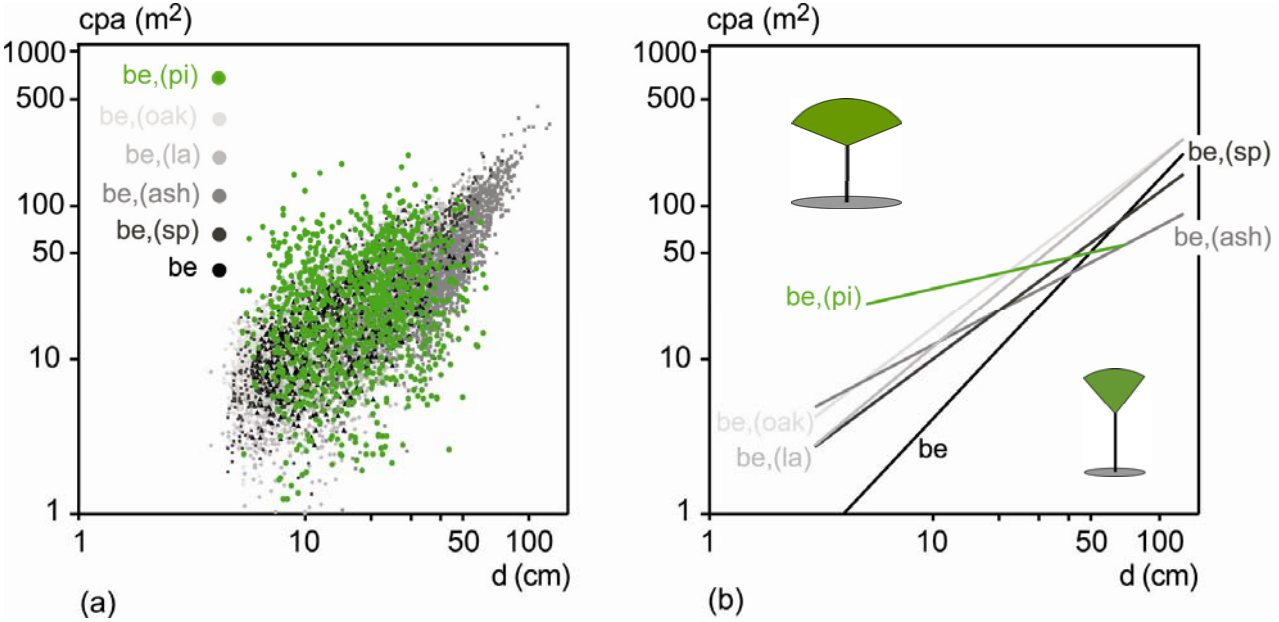
Allometry between crown projection area and stem diameter of European when growing in mono-specific versus mixed stands



S. pine
s. oak
E. ash
E. larch
N. spruce
E.beech

Pretzsch, H. (2014) Canopy space filling and tree crown morphology...
FORECO, 327: 251-264.

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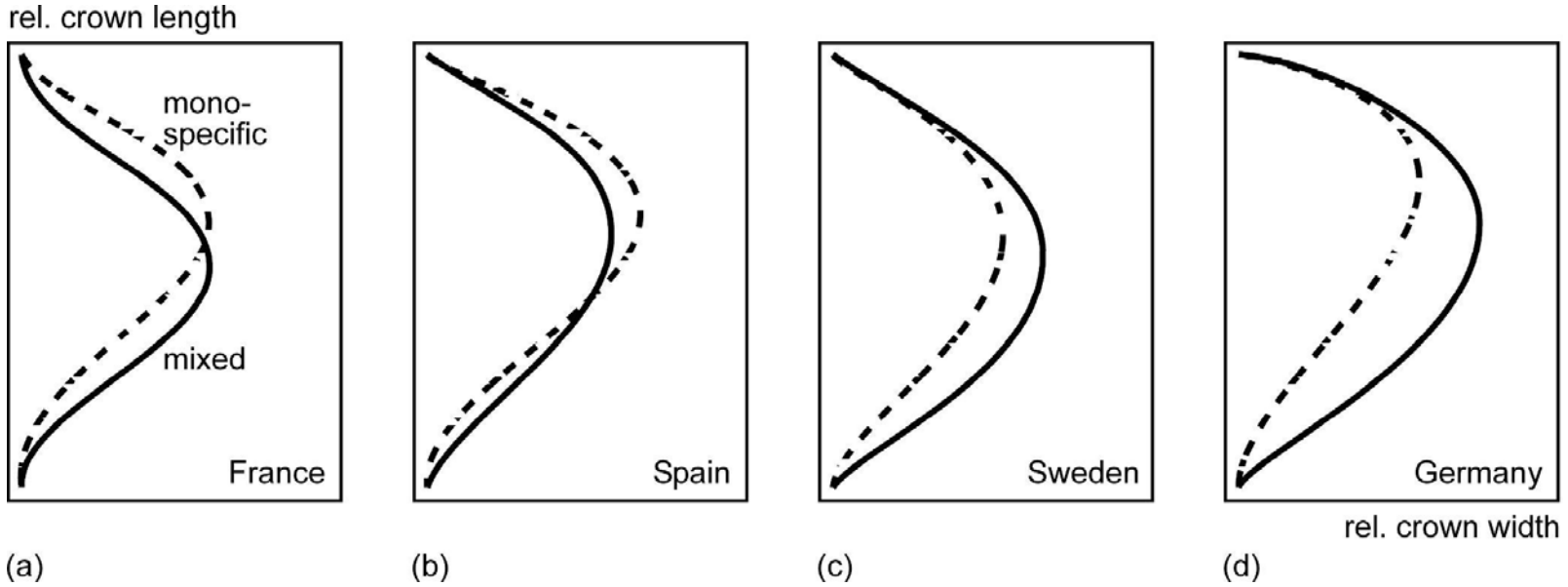
Modification of the crown profile of European beech by mixing with Scots pine on triplets across Europe



Barbeito et al. (2017) Terrestrial laser scanning reveals differences in crown structure.....FORECO

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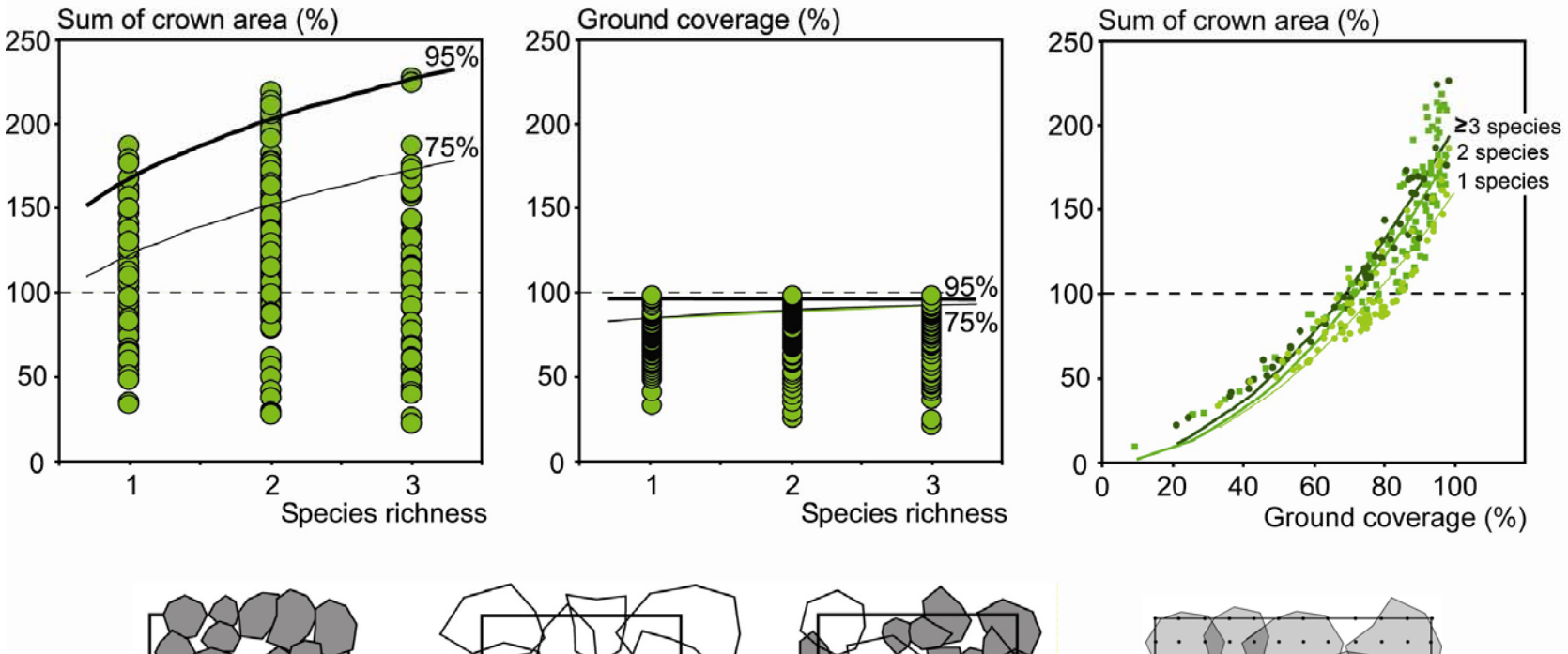
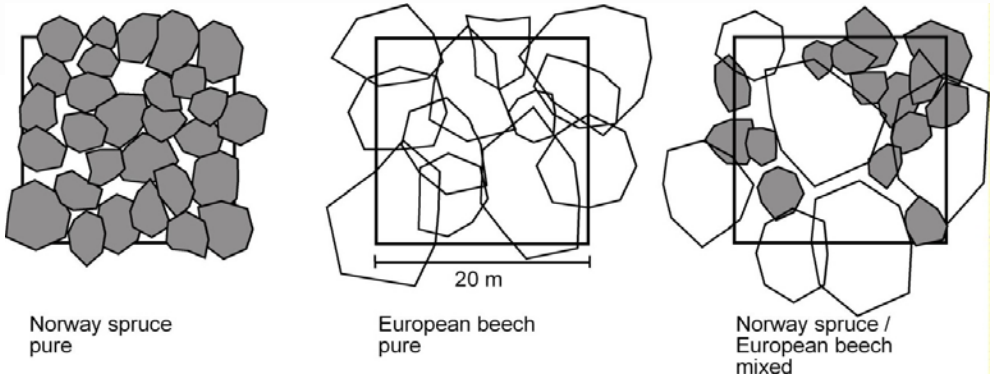
Denser canopy space filling in mixed stands: higher sum of crown area and ground coverage analysed on 253 plots





Pretzsch, H. (2014) Canopy space filling and tree crown morphology in mixed-species stands compared with monocultures. Forest Ecology and Management, 327: 251-264.

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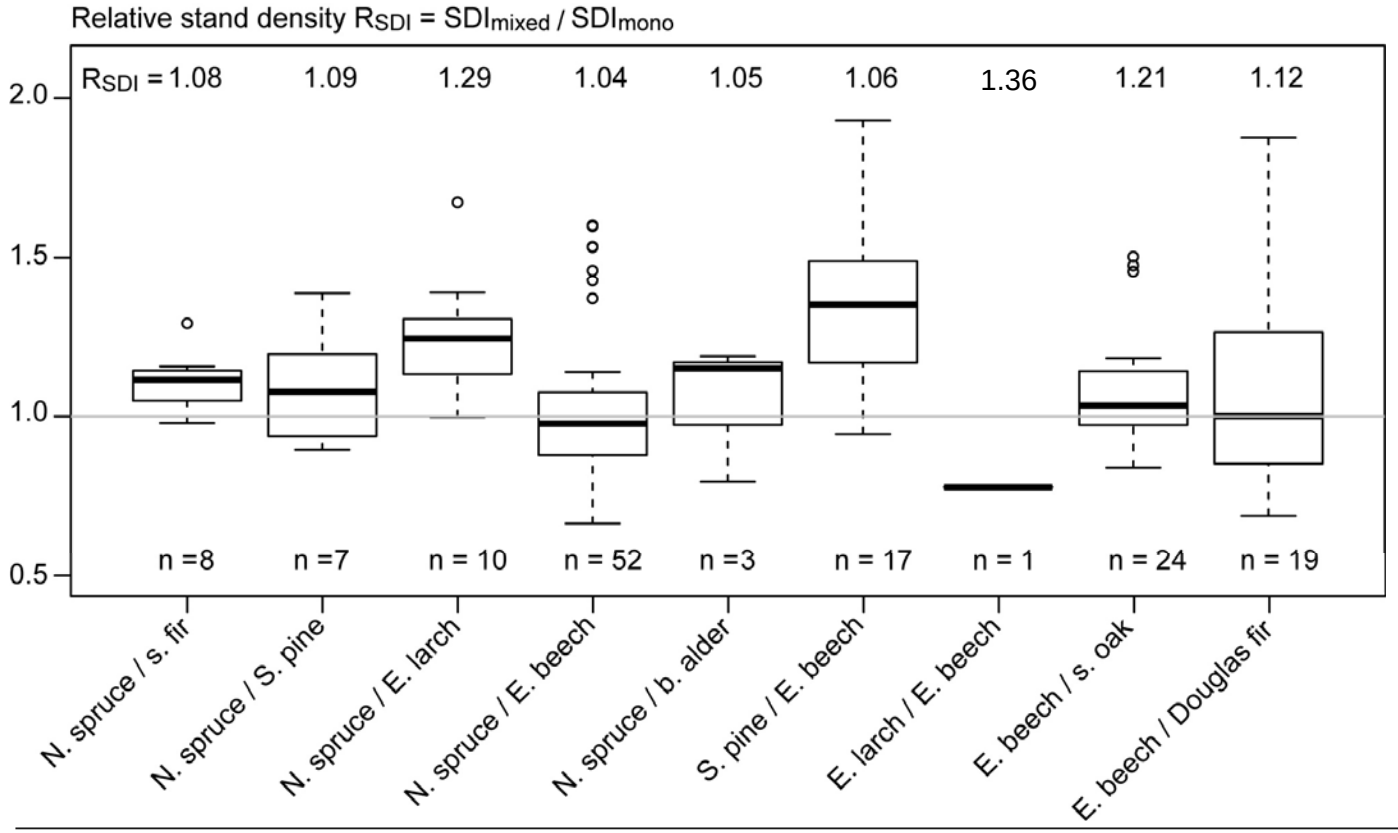
Stand density (SDI) and rel. productivity of mixed- versus monospecific stands on long-term experiments in Europe

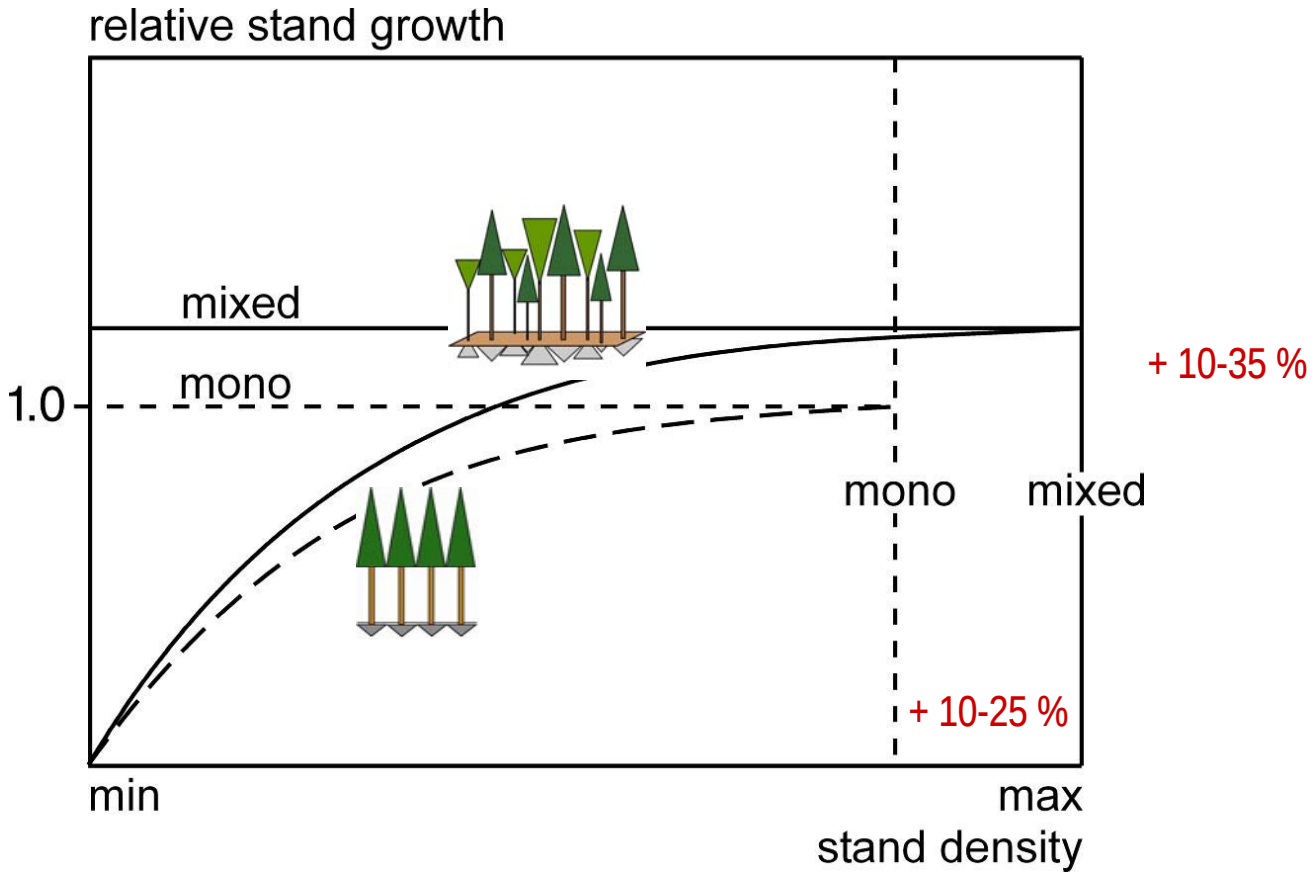


Pretzsch, H., Biber, P. (2016) Tree species mixing can increase .. CJFOR

Pretzsch (2016) Korrekturfaktoren AFZ Der Wald, 14/2016: 47-50

Species combination	N. sp/ E. be	S. pi/ E. be	s. oak/ E. be	E. be/ D-fir	S. pi/ N. sp	E. la/ N. sp	N. sp/ s. fir	mean
overyielding	21	30	20	11	21	25	13	
(± SE) in %	(± 3)	(± 9)	(± 3)	(± 8)	(± 11)	(± 6)	(± 6)	
corr. factor	1.10	1.20	1.10	1.10	1.20	1.20	1.10	1.10

Stand density growth – relationship in mixed versus monospecific forest stands



Pretzsch (2016) AFZ Der Wald, 14/2016: 47-50

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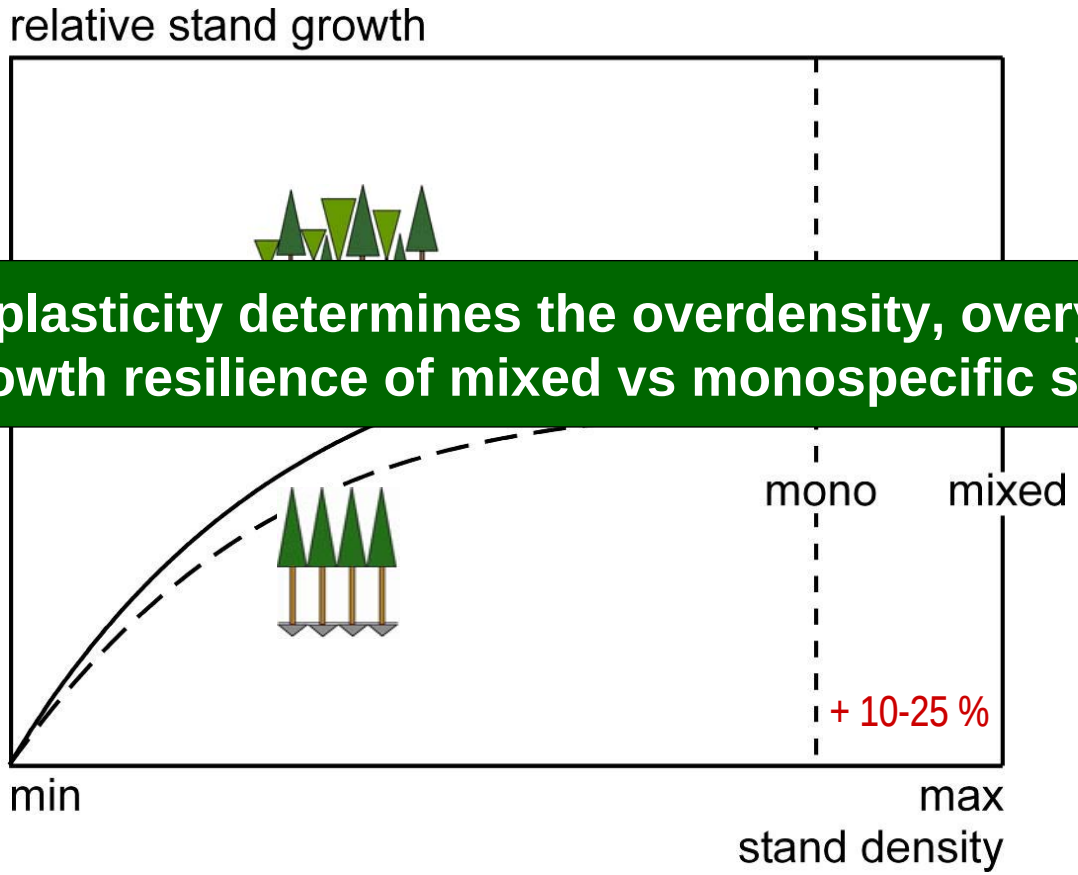
Stand density growth – relationship in mixed versus monospecific forest stands



- **crown plasticity determines the overdensity, overyielding, and growth resilience of mixed vs monospecific stands**

Pretzsch (2016) AFZ Der Wald, 14/2016: 47-50

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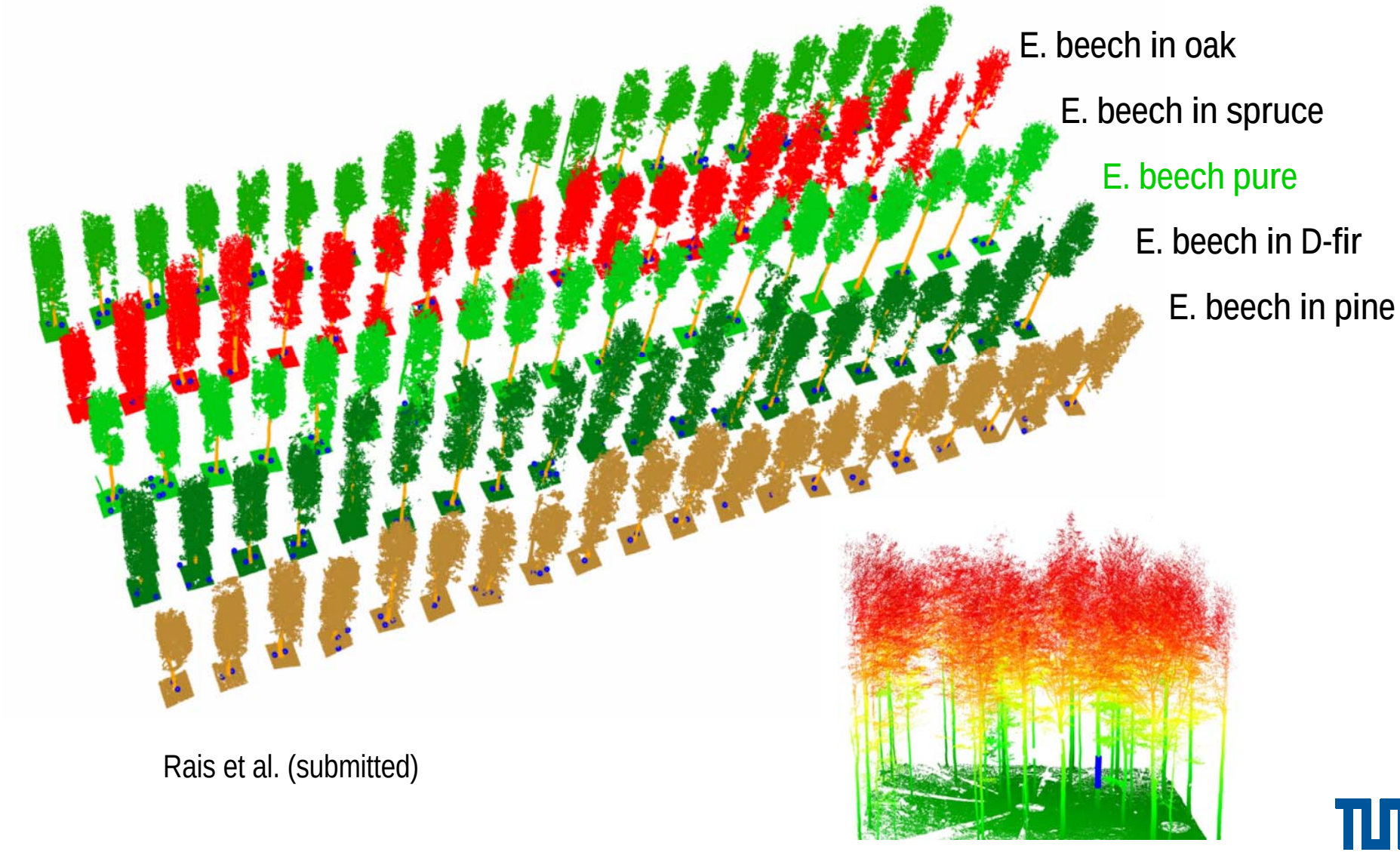
Scan of crown structure and analysis of wood quality of E. beech in mixed vs monospecific stands



Rais et al. (submitted)

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Stress waves analyses for log and lumber quality analyses of E. beech in mixed vs monospecific stands

Rais et al. (2020) European beech log and lumber grading... Holzforschung

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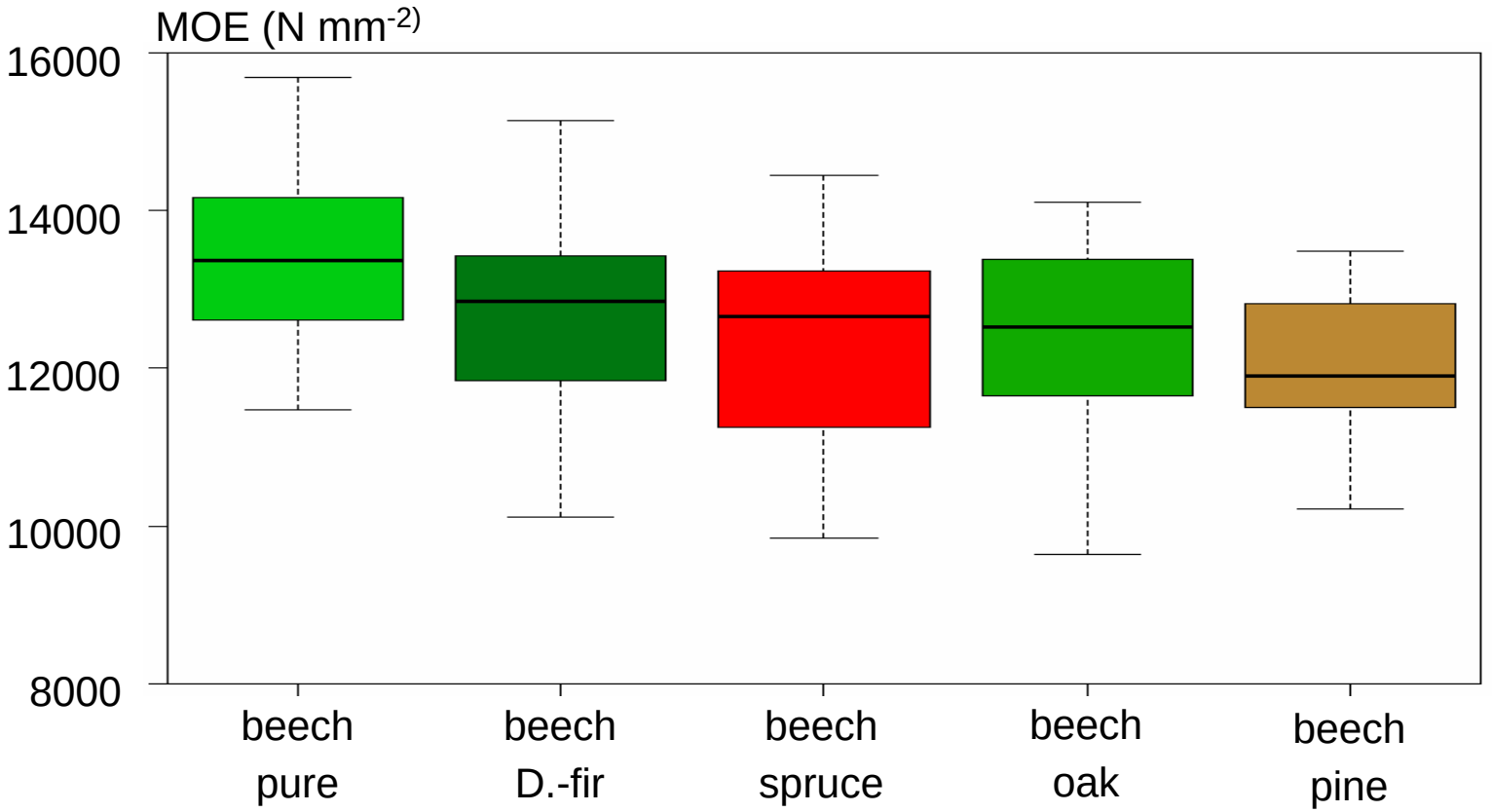
Decrease of log MOE of E. beech by tree species mixture



Rais et al. (2020)

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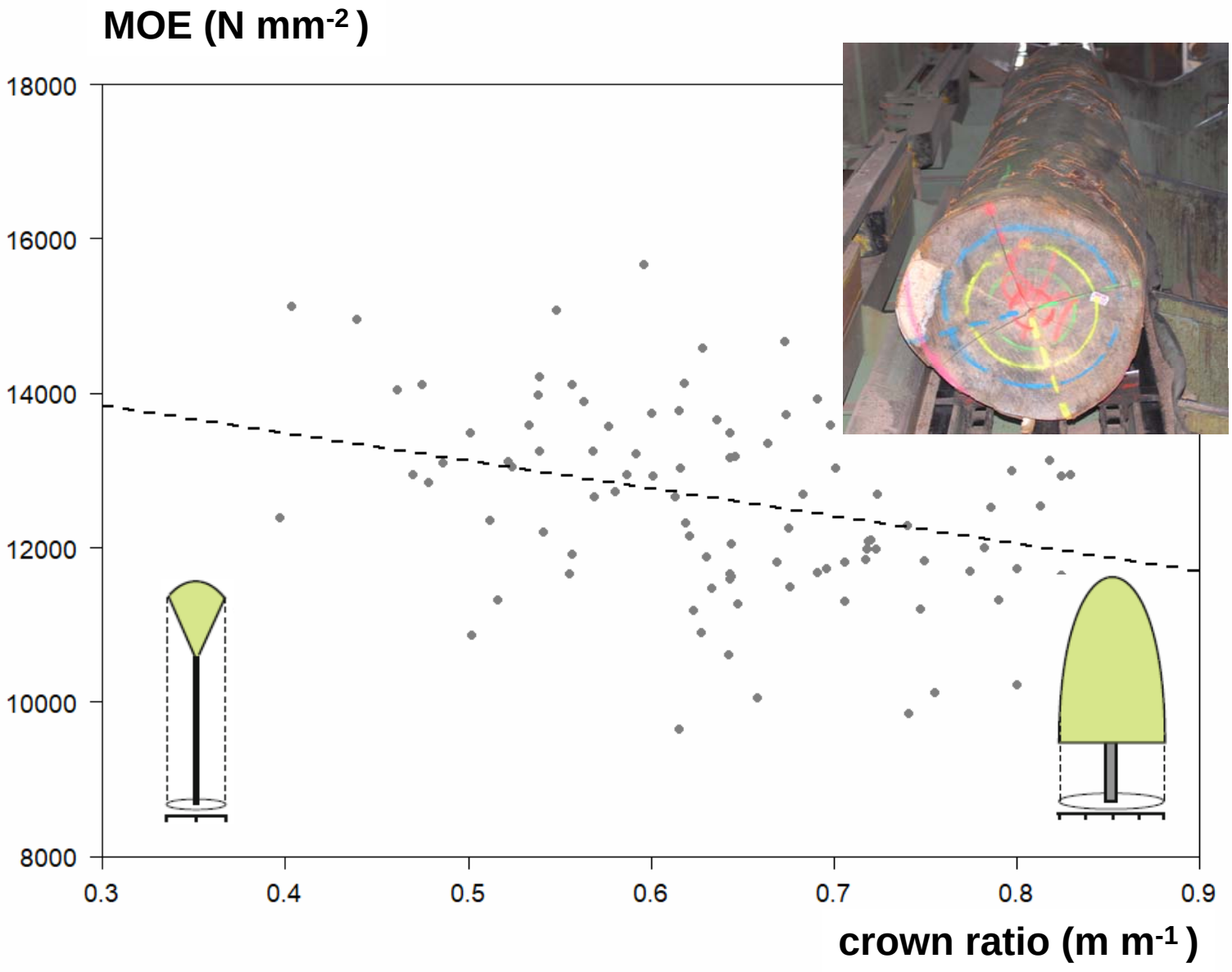
Module of elasticity of round wood logs of E. beech



- crown morphology can be modified by mixing and determine log and lumber quality

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Conclusions and perspectives

- crowns are pivot for many ecosystem functions and services and tradeoffs e.g. between productivity vs size, stability vs quality
- so far mainly used for monitoring or inventories, 3D crown measurement should become standard in long-term experiments
- 3D time series of crown responses (e.g. to thinning, gap cuts, borders) allow revelation of general rules and model parameterization
- crown information (e.g. cpa, cl, transparency, fractal dim) is becoming essential for trees beyond forests. Urban trees highly relevant for people.


Thanks for funding by
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EU (REFORM, CLIMO, CARE4C)
MStELF, MStU, BaySF
Thanks to the REFORM and CLIMO partner institutions for providing data
http://waldwachstum.wzw.tum.de/index.php?id=presentations