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The effect of species mixing on tree and stand growth

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http://www.wwk.forst.wzw.tum.de/info/presentations/

Criteria for sustainable forest ecosystem management. Objective hierarchy for the management of municipal forest Traunstein

Criteria for sustainable forest management	Indicators	Weight (%)
Forest resources	timber resources, area of forest, extension of area	20
Health and vitality	stability, fitness, elasticity	17
Productive functions	growth, yield, net return	12
Biological diversity	habitat quality, richness flora/fauna, conservation	10
Protective functions	soil, water, climate, noise, protection	10
Socio-economic functions	employment, recreation, esthetics, proximity to nature	31

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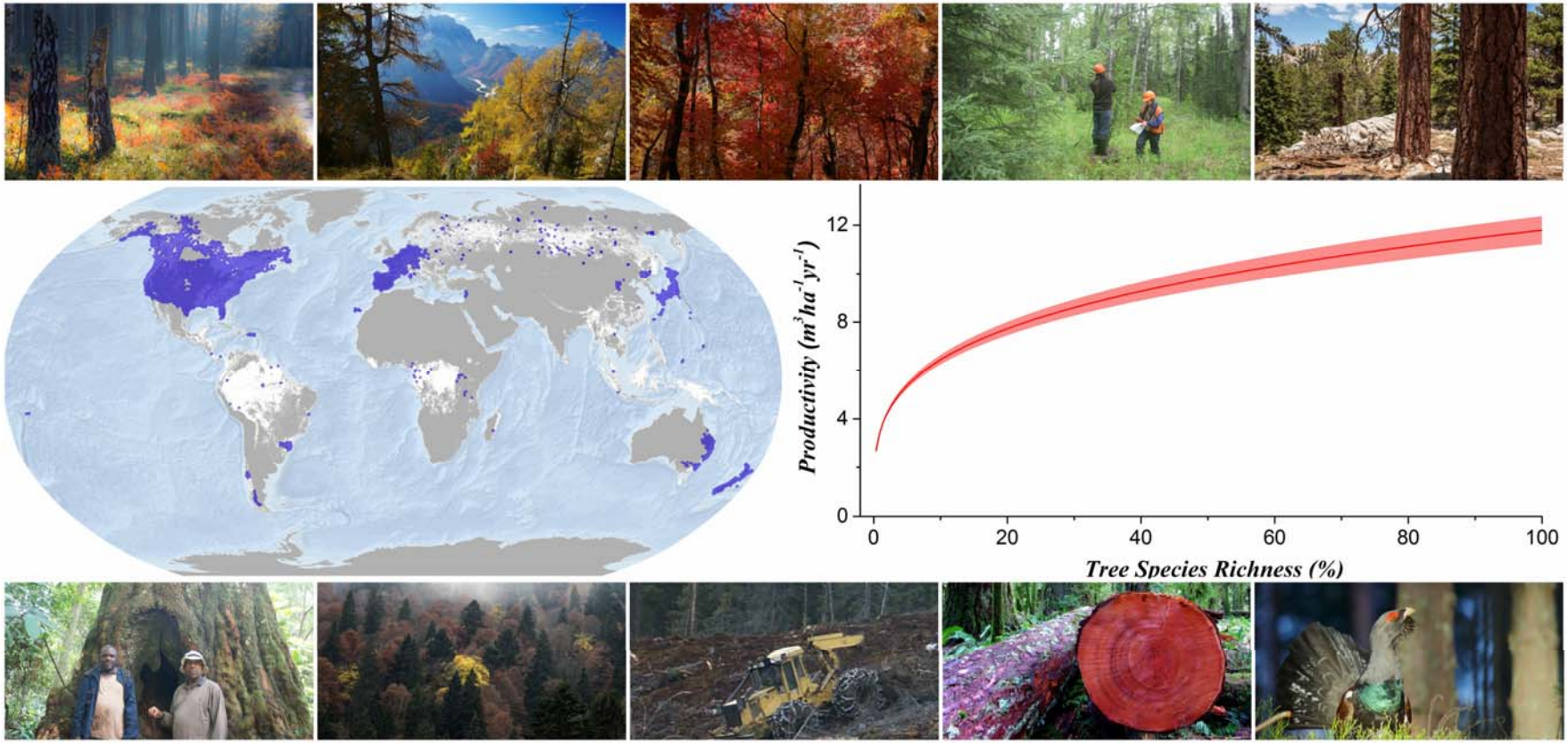
Tree species richness and stand productivity



The steepest curves (α = 0.30) on highly productive sites, the lowest (α = 0.20) on poor sites. Worldwide average α = 0.26

Liang, J. et al. (2016) Positive Biodiversity-Productivity Relationship Predominant in Global Forests, Science, in press

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1 Mixing effects at the stand level

2 Effects on stand density, size distribution stand structure

3 Effects on tree allometry and allocation

Discussion of general patterns

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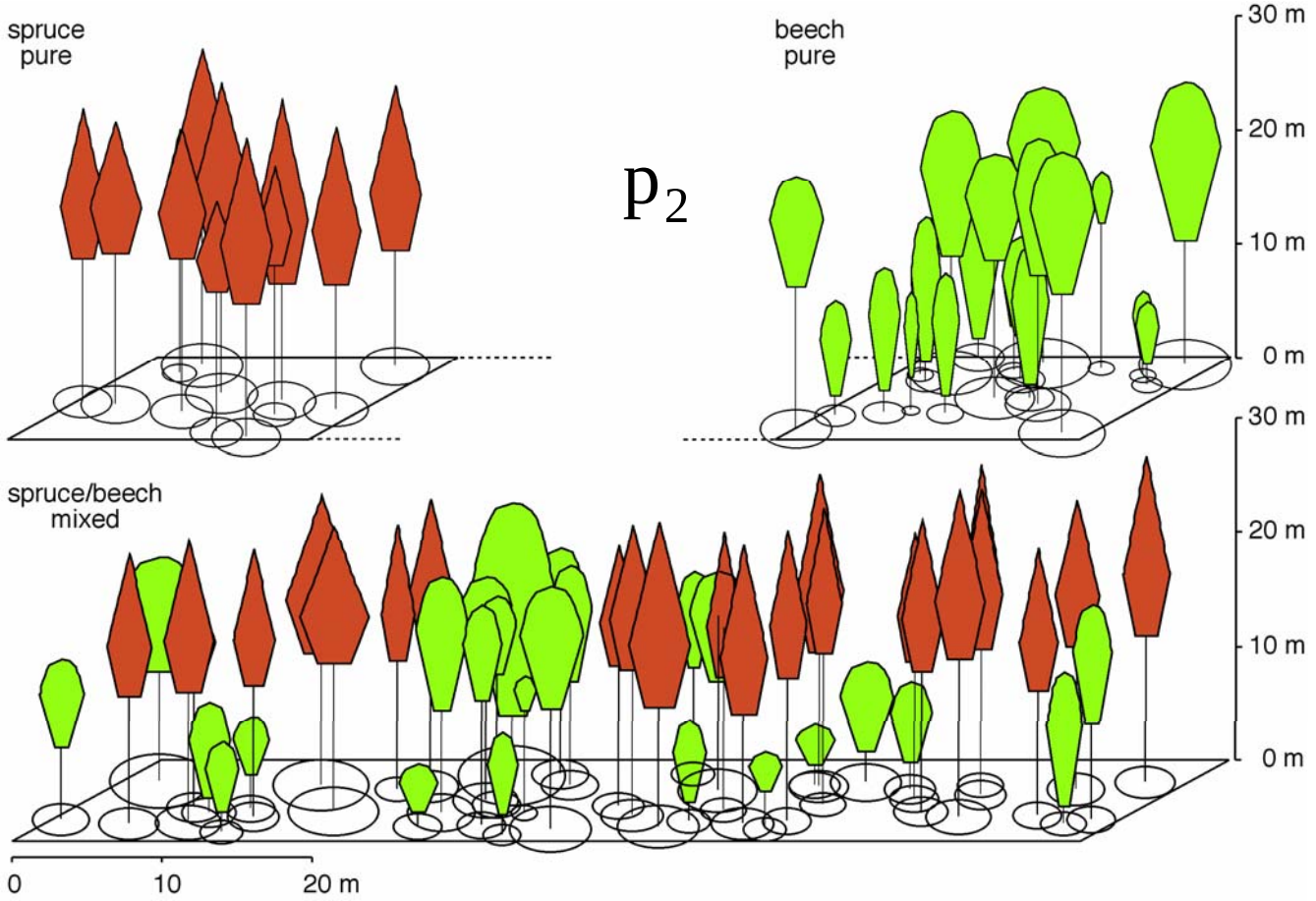
Experimental setup for scrutiny of mixing effects
Zwiesel 111/3,4,5 Bavarian Forest

p_1

p_2

$p_{1,2}$
m_1
m_2



$p_{1,2}$ compared with $p_1 \times m_1 + p_2 \times m_2$

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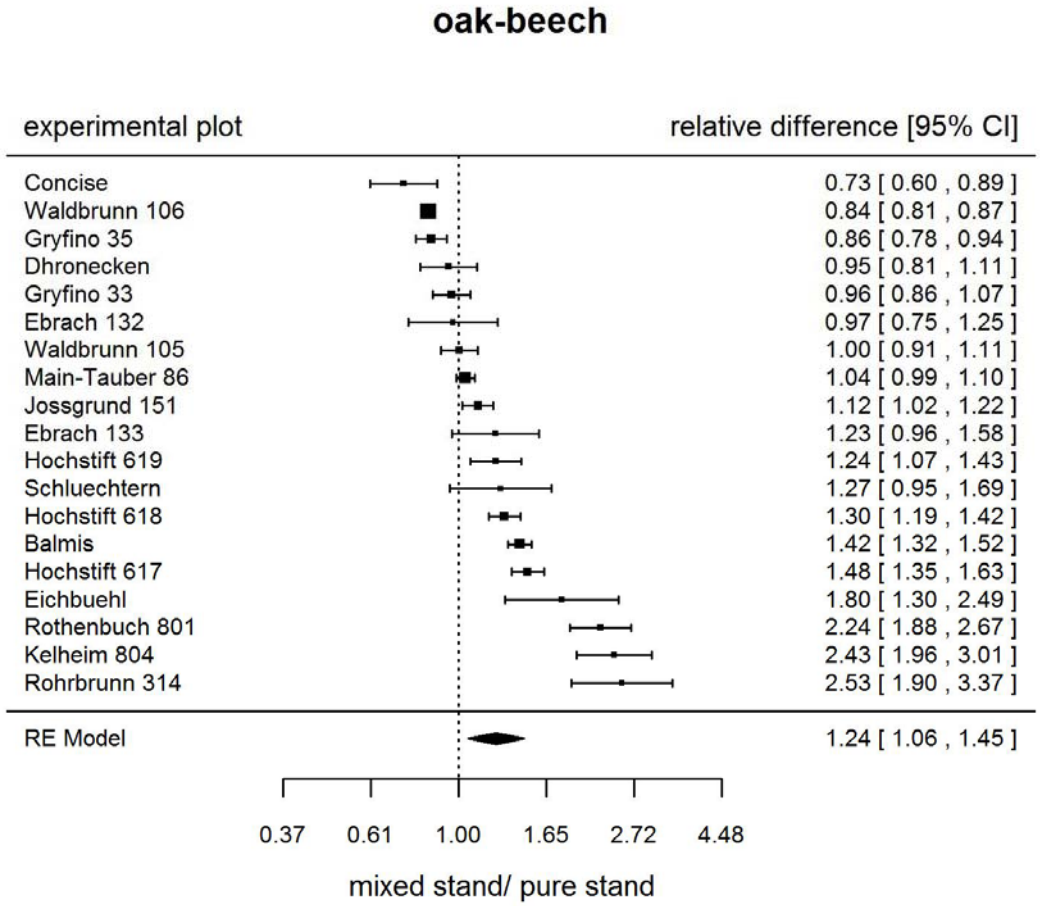
Meta-analysis on overyielding of mixed stands of sessile oak and European beech versus pure stands in Europe based on long-term experiments



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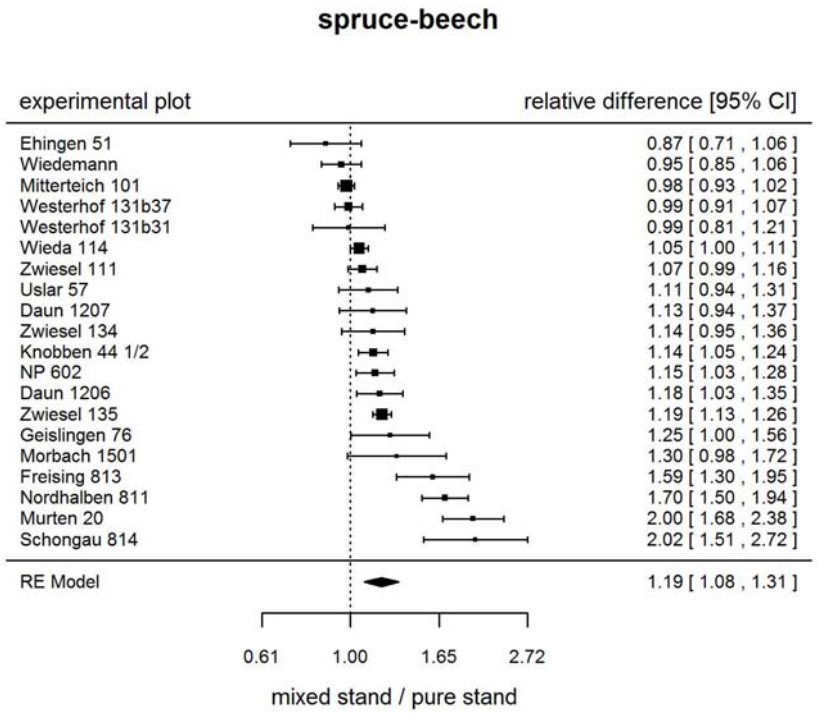
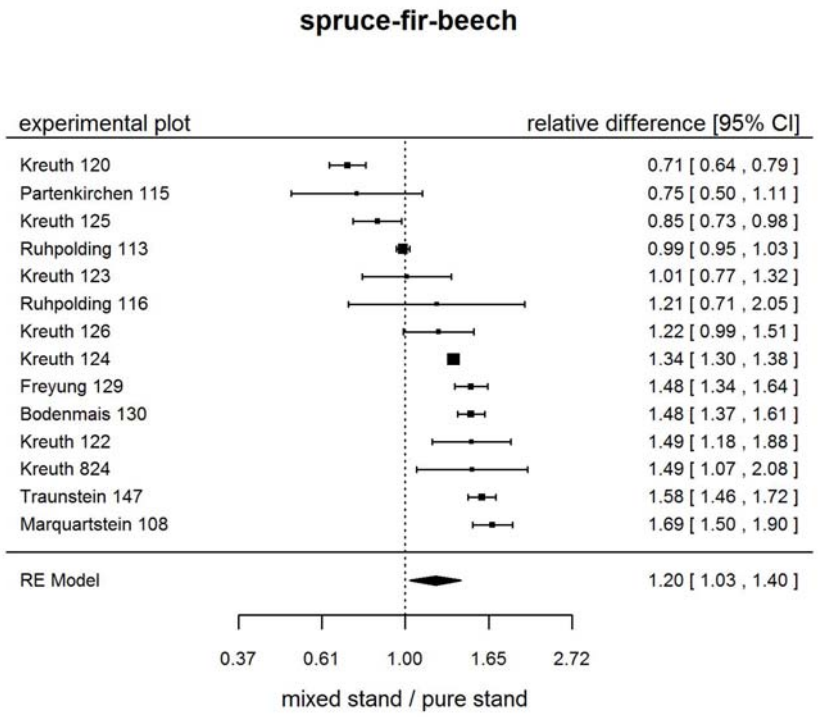
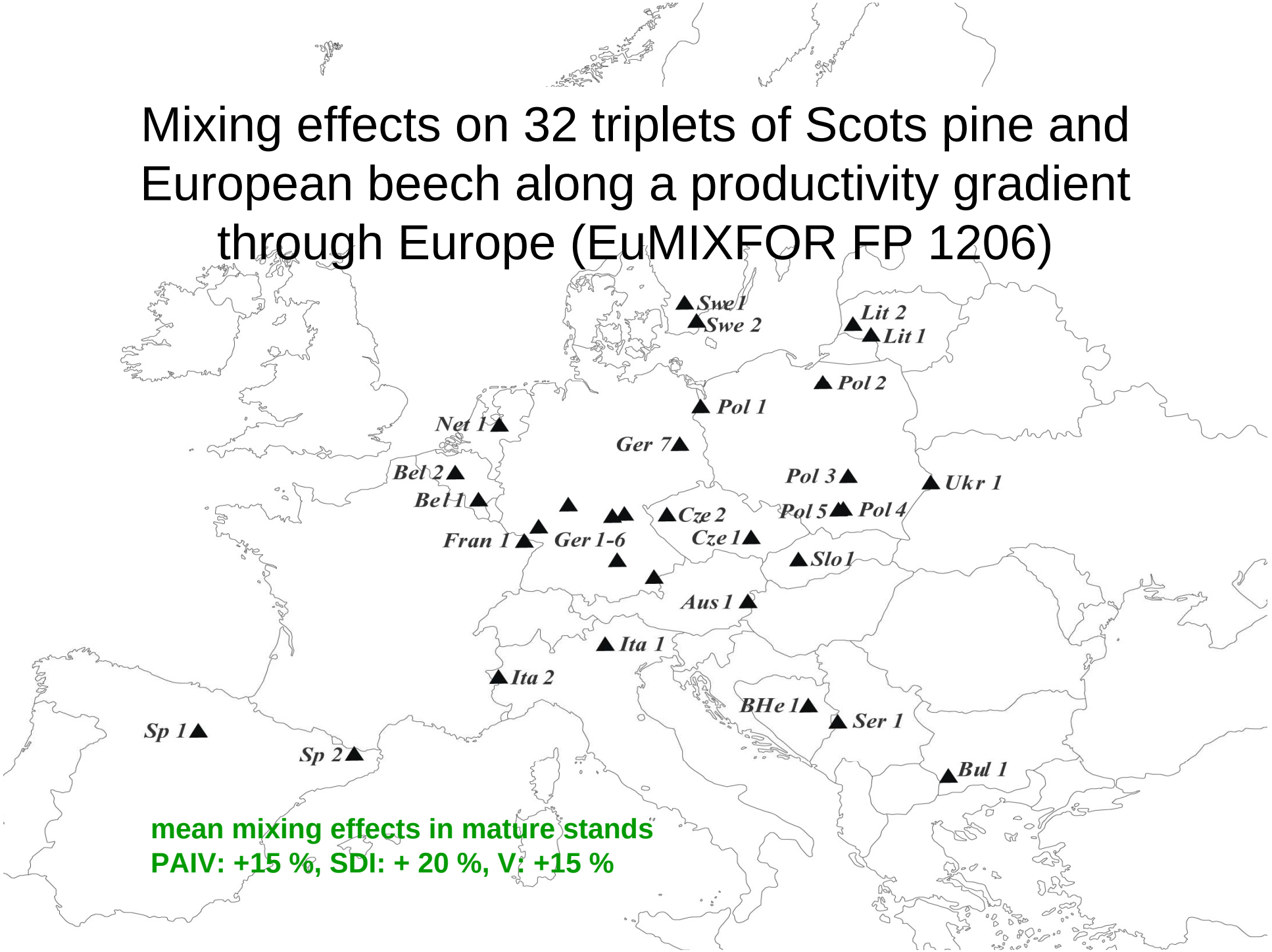
Meta-analysis on overyielding of mixed stands of Norway spruce, European beech, silver fir in Europe based on long-term experiments





Mixing effects on 32 triplets of Scots pine and European beech along a productivity gradient through Europe (EuMIXFOR FP 1206)



mean mixing effects in mature stands
PAIV: +15 %, SDI: + 20 %, V: +15 %

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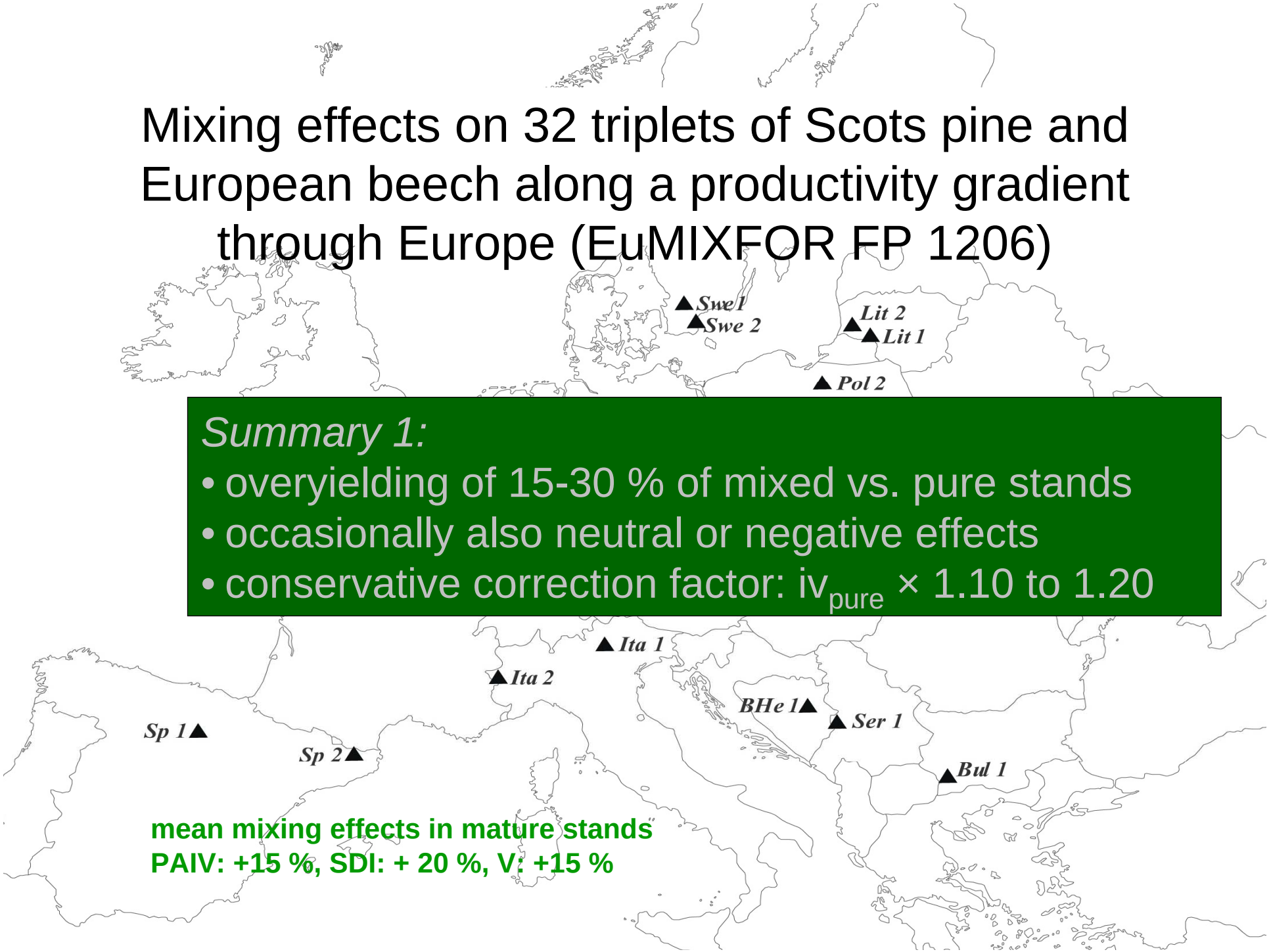

Summary 1:

- overyielding of 15-30 % of mixed vs. pure stands
- occasionally also neutral or negative effects
- conservative correction factor: iv_{pure} × 1.10 to 1.20

mean mixing effects in mature stands
PAIV: +15 %, SDI: + 20 %, V: +15 %

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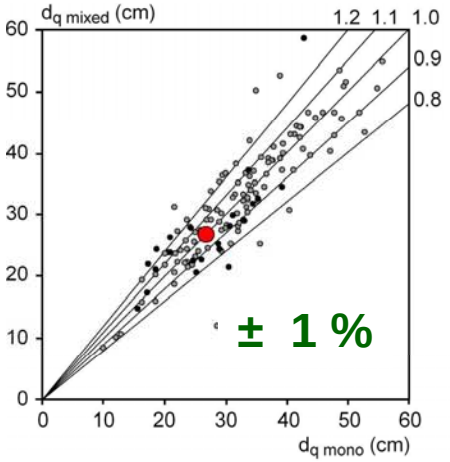
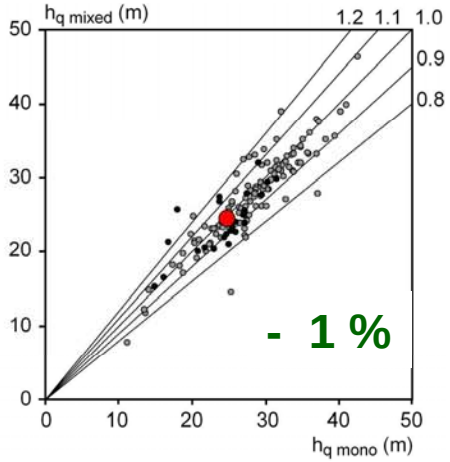
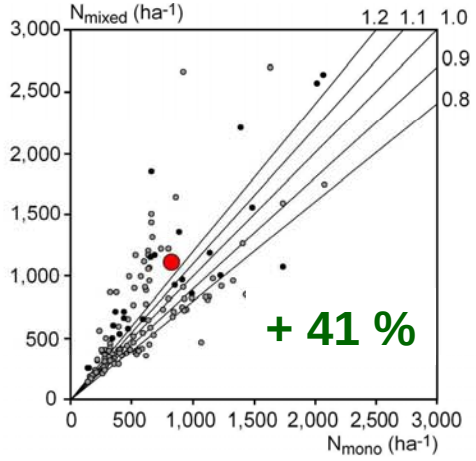
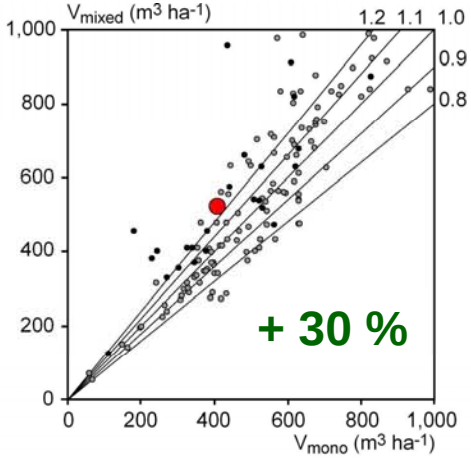
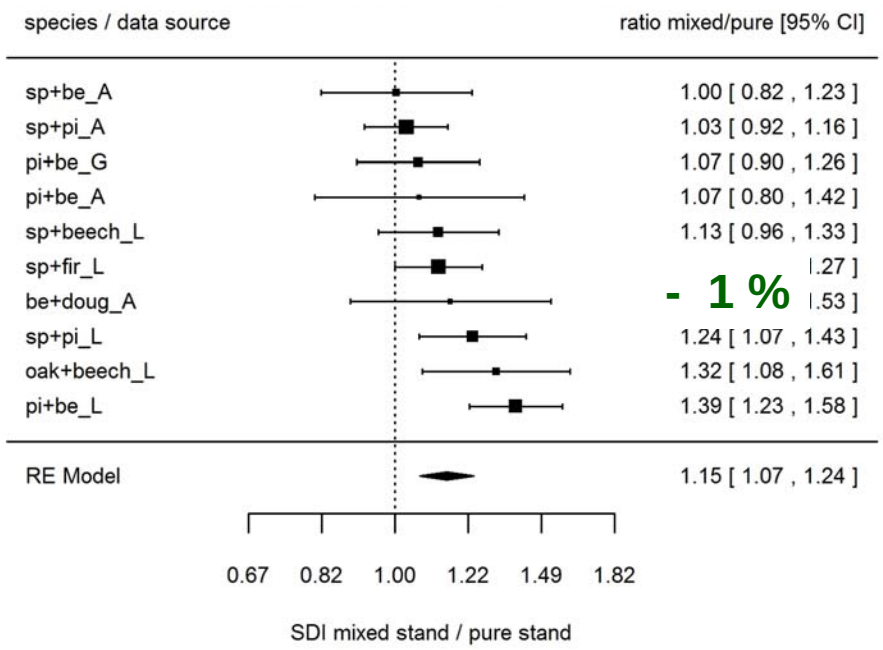
Mixing increases tree number and standing volume rather than mean tree diameter or height



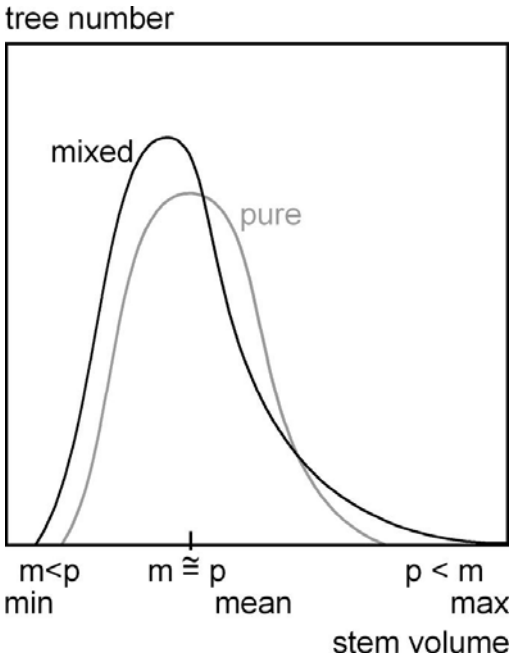


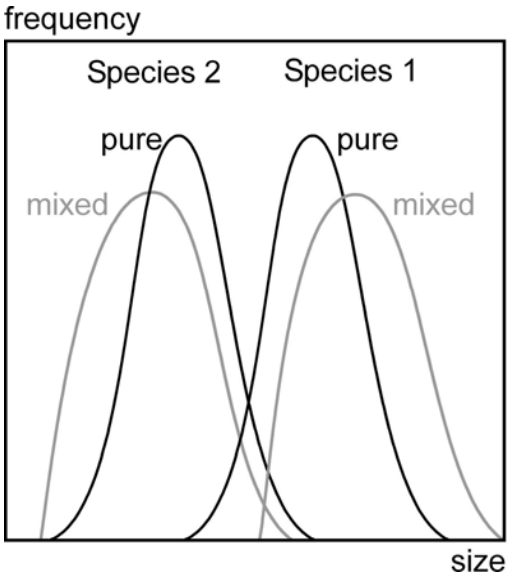






More trees, wider size range, stronger right-skewness in mixed stands; often species 1 ahead, species 2 behind the pure stand





Pretzsch, H., Schütze, G. (2014) Size-structure dynamics of mixed versus pure forest stands, Forest Systems, 23(3):560-572.

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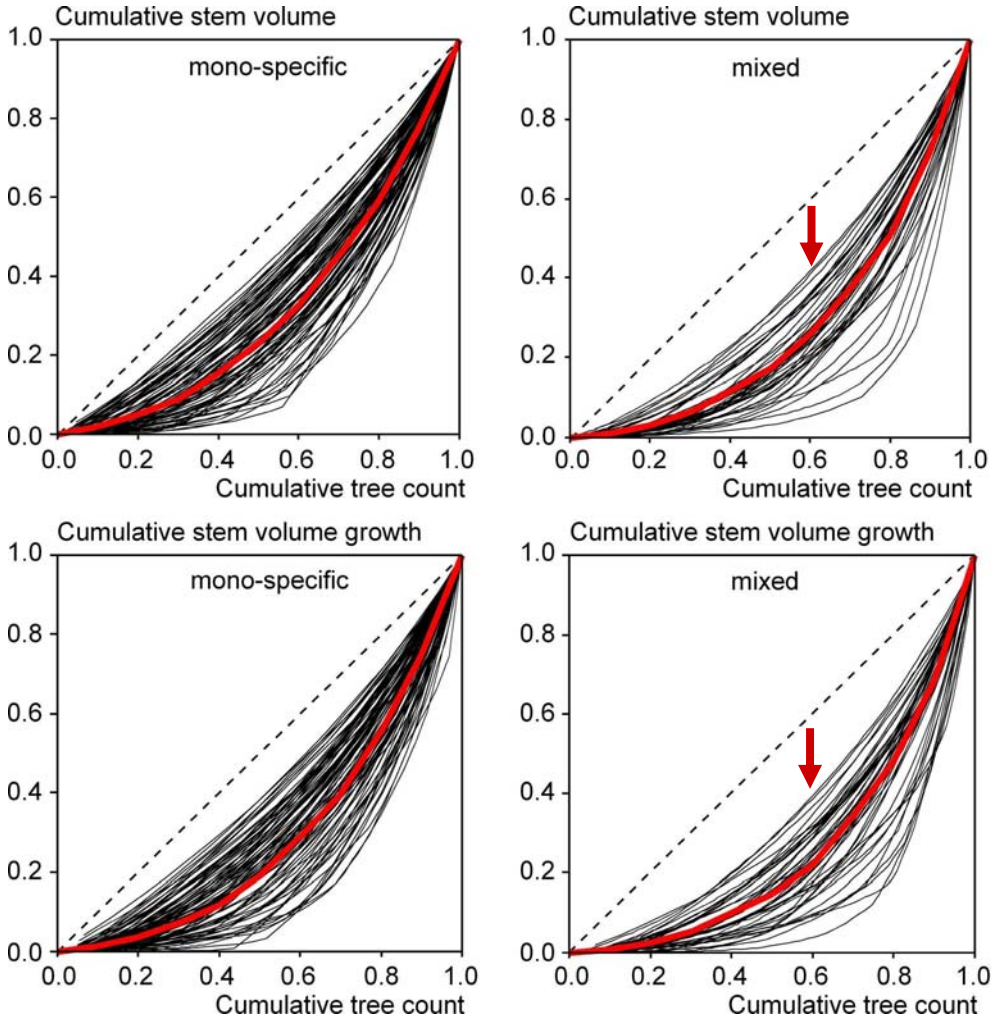
Cumulative distribution of stem volume (above) and stem growth (below) over cumulative tree count (Lorenz-curve Gini-coefficient)



G_v mono= 0.35

G_v mixed= 0.45

G_{iv} mono= 0.39

G_{iv} mixed= 0.46

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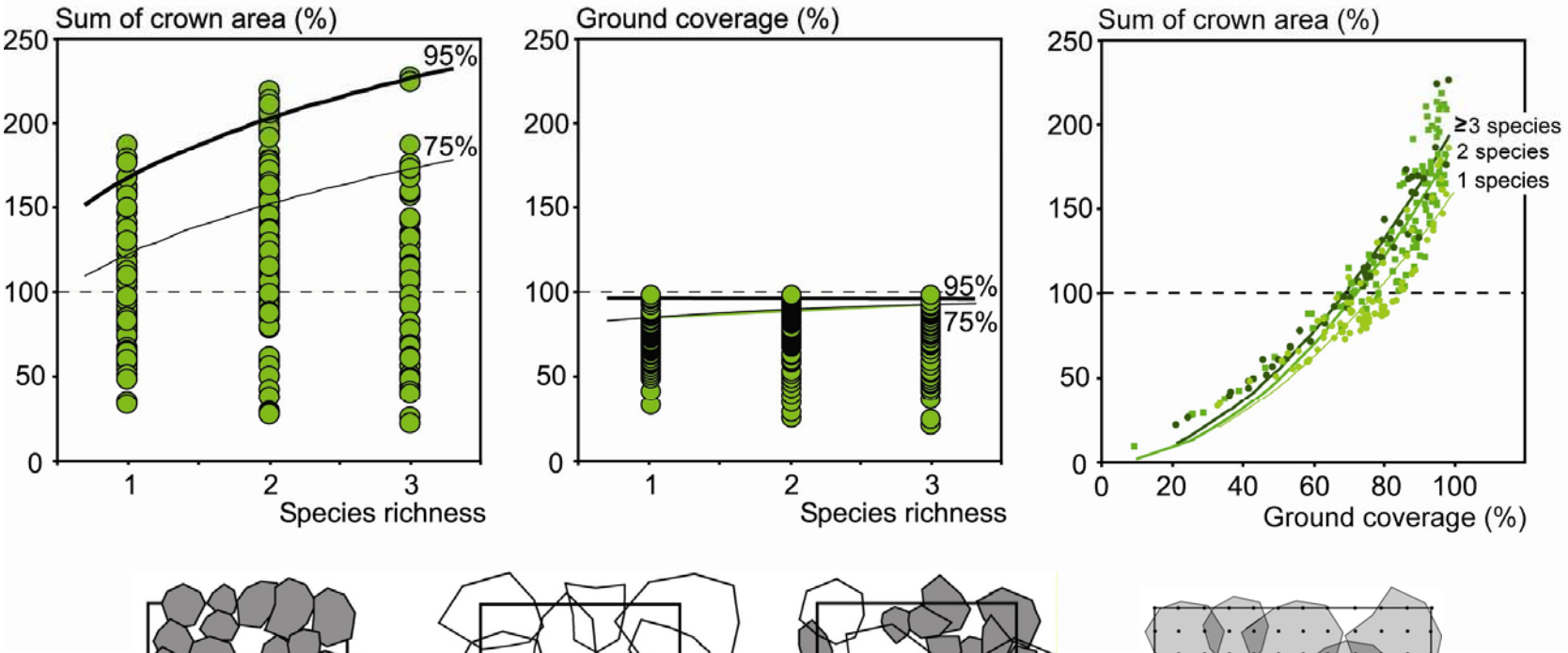
Denser canopy space filling in mixed stands: higher sum of crown area and multiple ground coverage



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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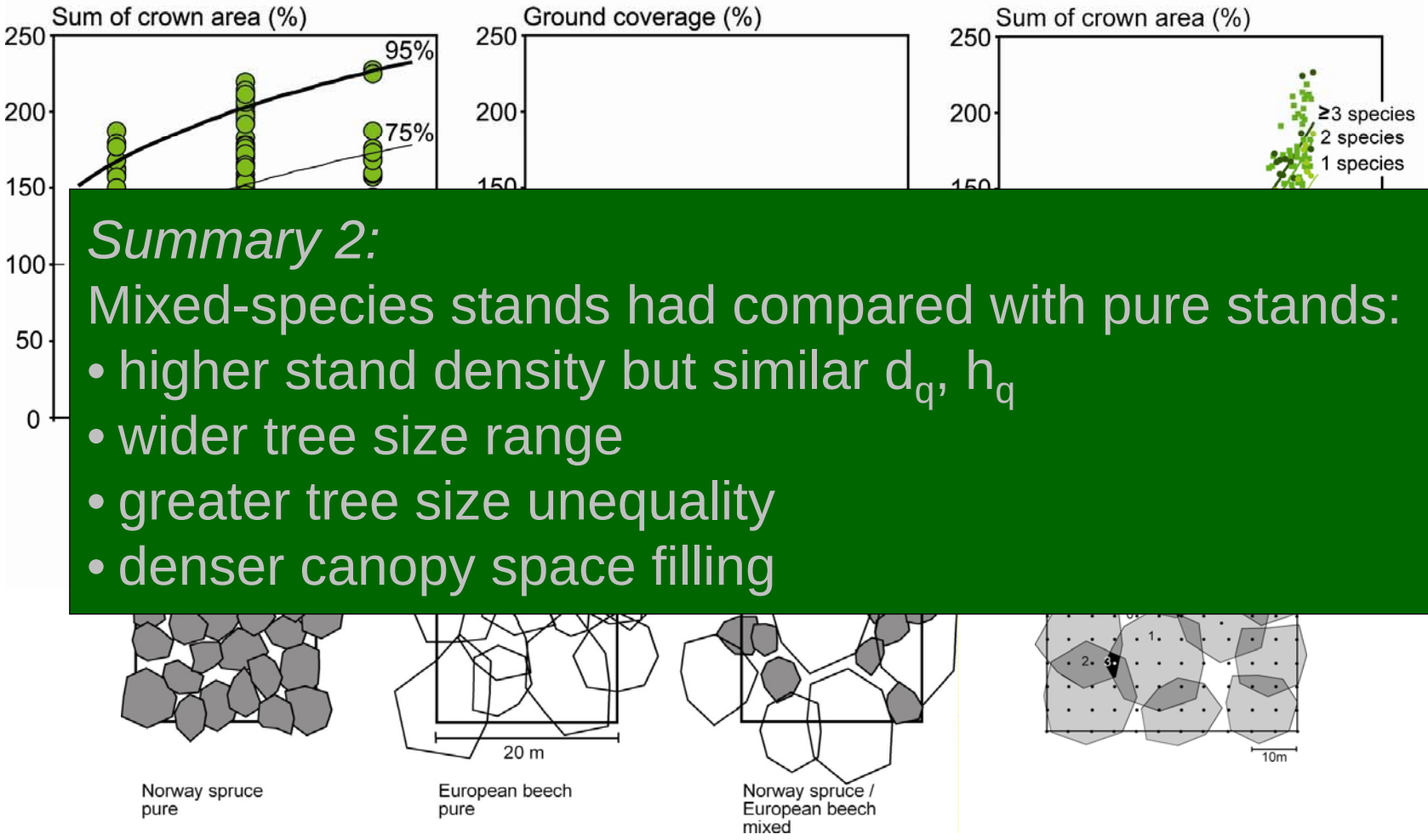

Summary 2:

Mixed-species stands had compared with pure stands:

- higher stand density but similar d_q, h_q
- wider tree size range
- greater tree size unequality
- denser canopy space filling

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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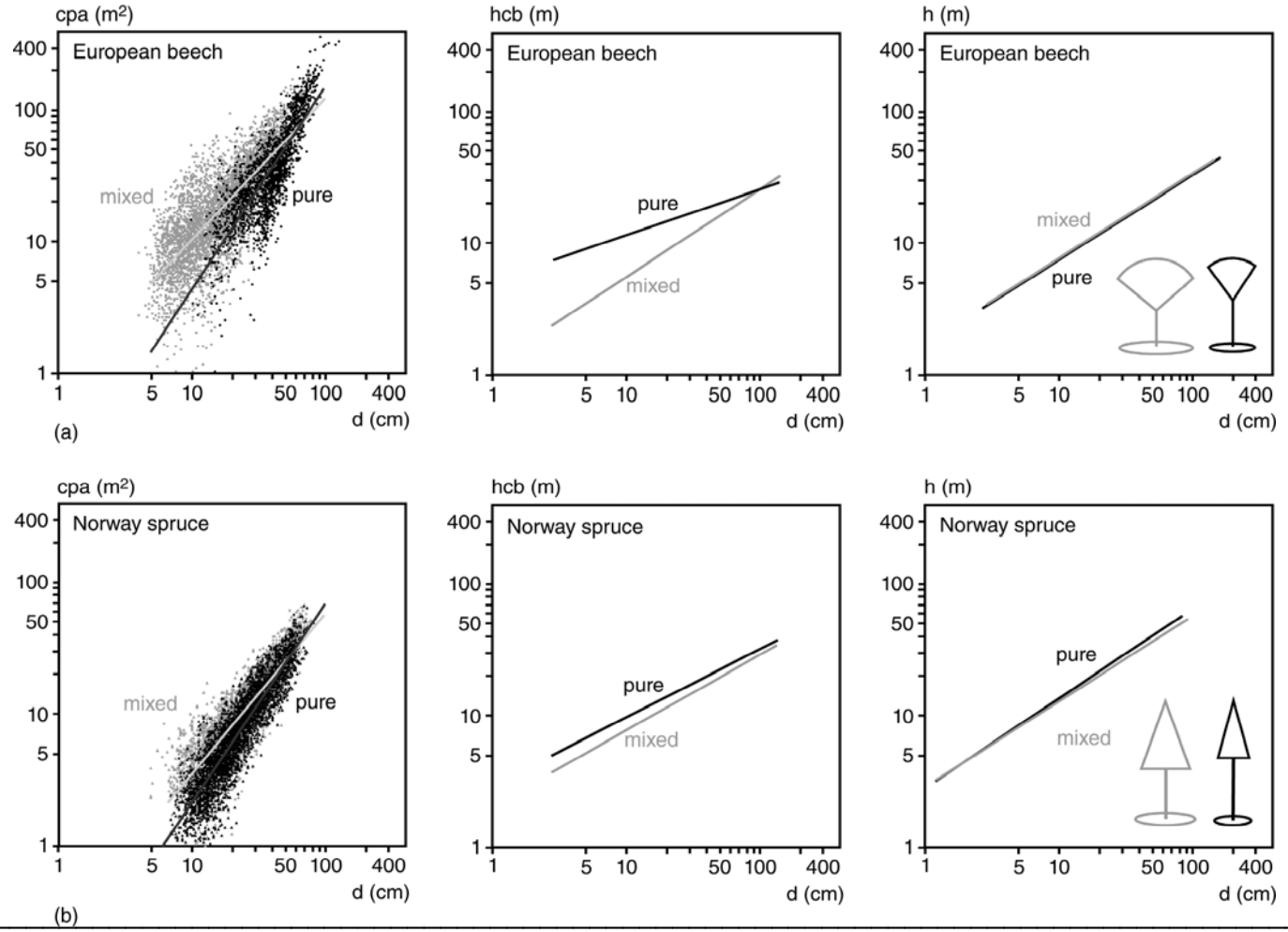
Effect of species mixing on the crown allometry of European beech and Norway spruce



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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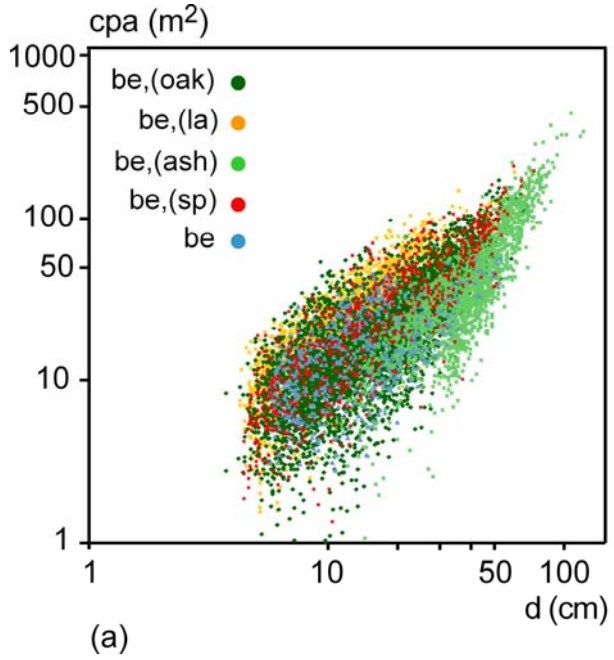
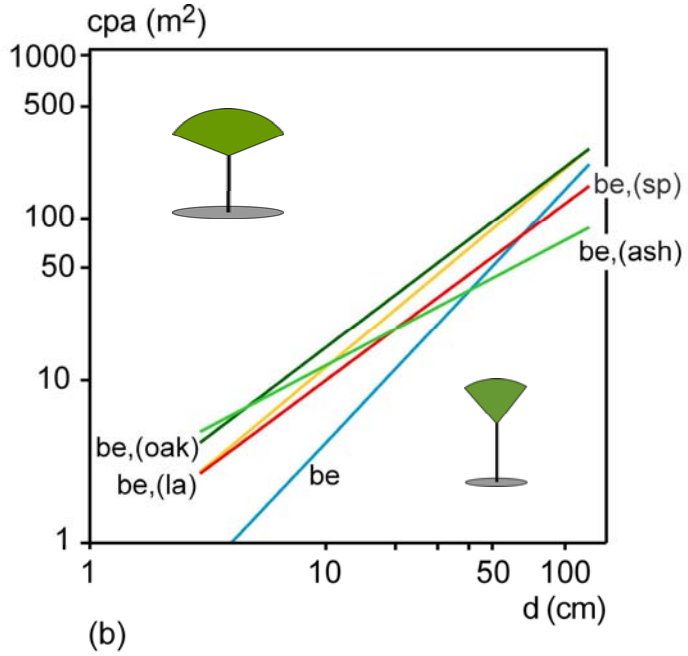
Allometry between crown projection area and stem diameter of European in pure stands and when mixed with other tree species





s. oak
E. ash
E. larch
N. spruce

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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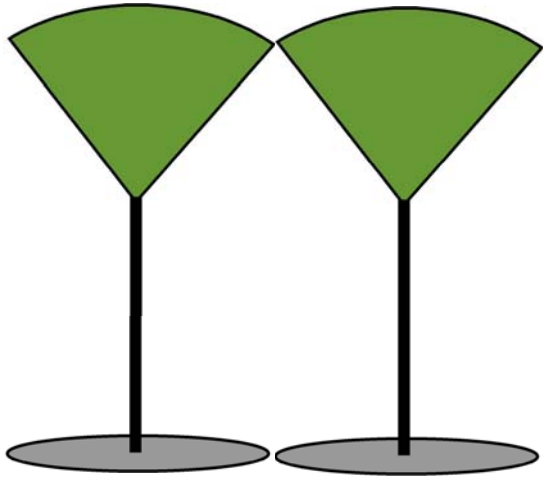
Morphological differences in intra- vs. inter-specific environment despite of equal biomass

beech/beech



branch number
19 vs. 36

branch length
4.8 m vs. 4.3 m

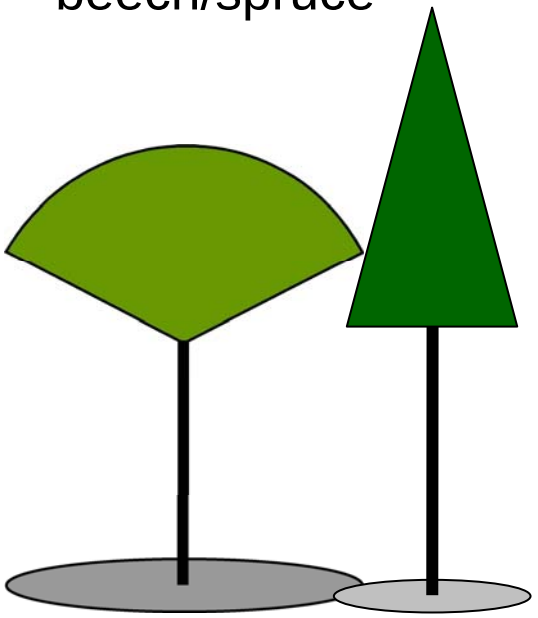
branch angle
139° vs. 128°

branch straightness
96 vs. 94

stem inclination
2° vs. 3.5°

crown volume
25 m^3 vs. 59 m^3

beech/spruce



Bayer, Seifert, Pretzsch (2012) Structural crown properties of Norway spruce and European beech in mixed versus pure stands revealed by terrestrial laser scanning, Trees, DOI: 10.1007/s00468-013-0854-4

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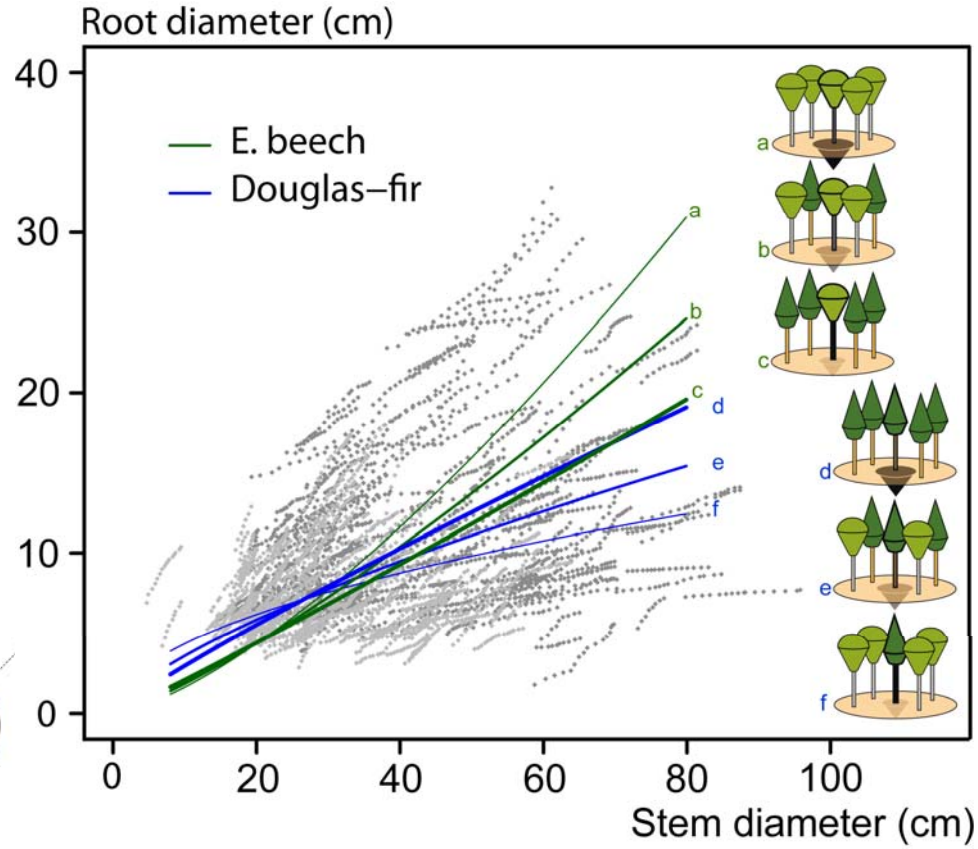
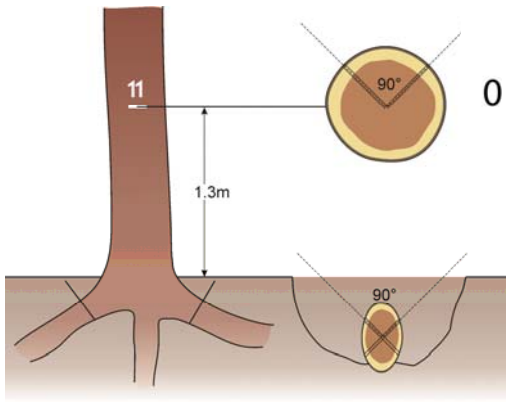
Enhancement of shoot in relation to coarse root growth in mixed compare with mono-specific stands of European beech and Douglas-fir





Thurm et al. (in review)

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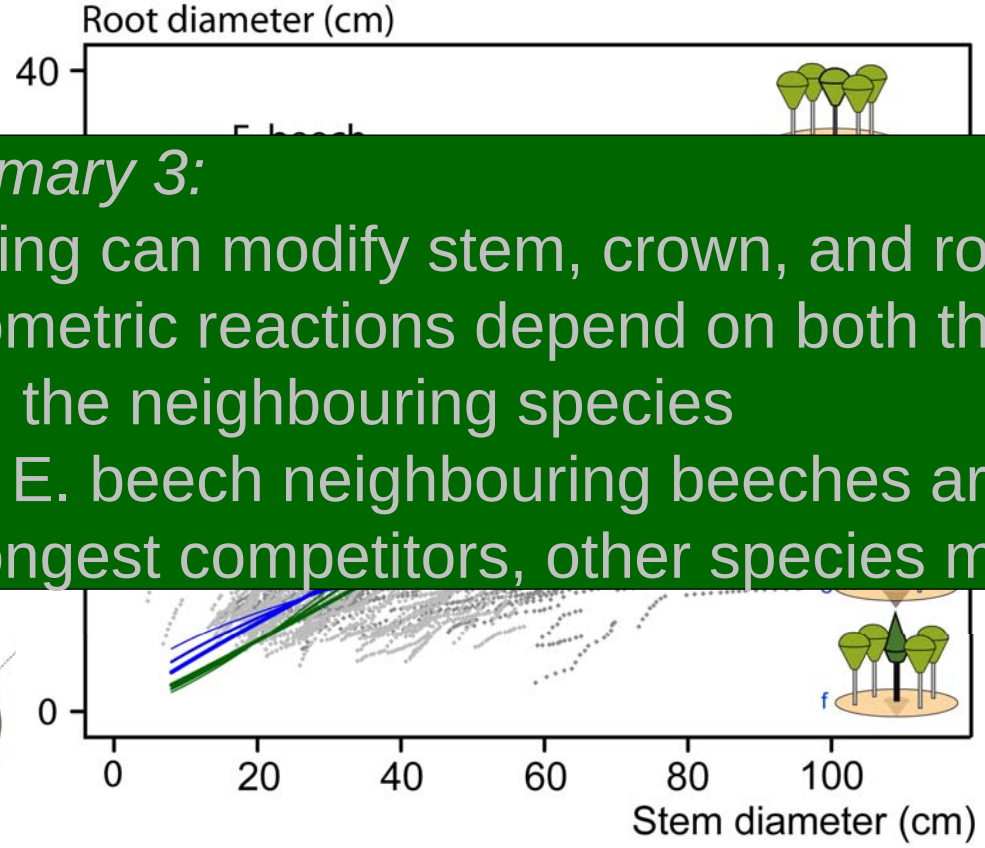
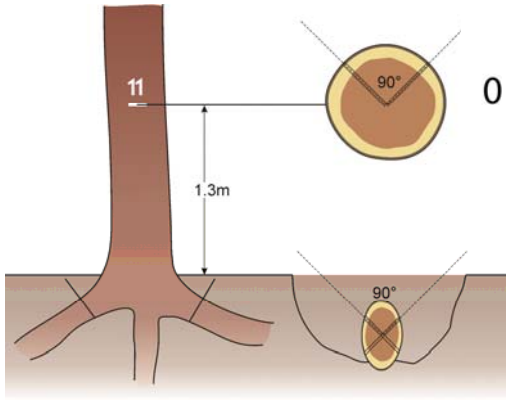


Summary 3:

- Mixing can modify stem, crown, and root allometry
- Allometric reactions depend on both the tree species and the neighbouring species
- For E. beech neighbouring beeches are most strongest competitors, other species mean relieve



Thurm et al. (in review)

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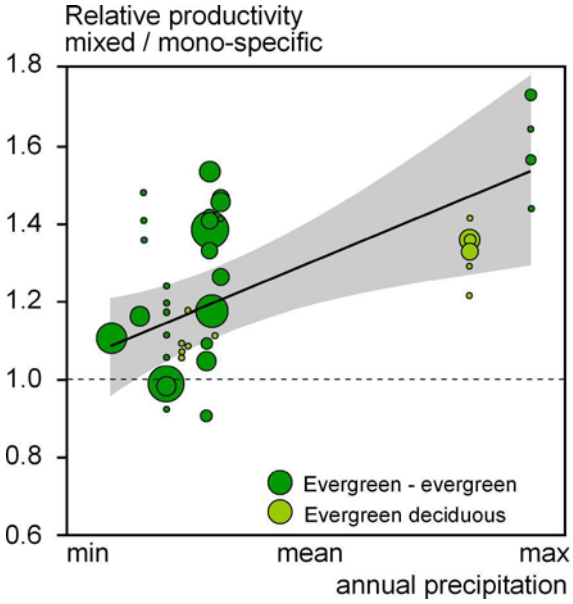
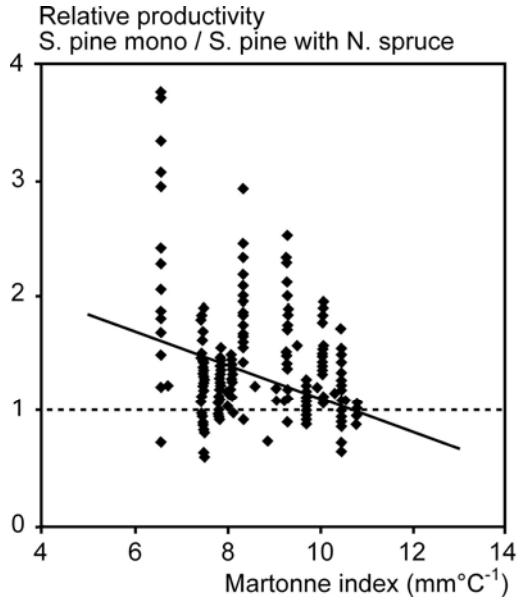
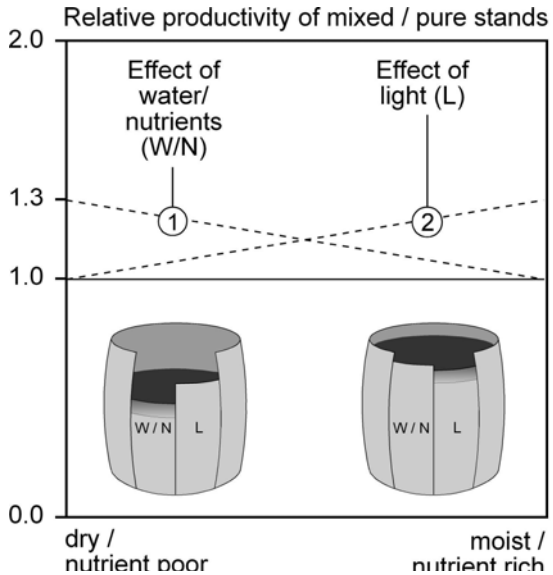
Discussion. Mixing effect and site conditions



Gritti et al. (2016)



Bielak et al. (2015)



remedy of the limiting factor

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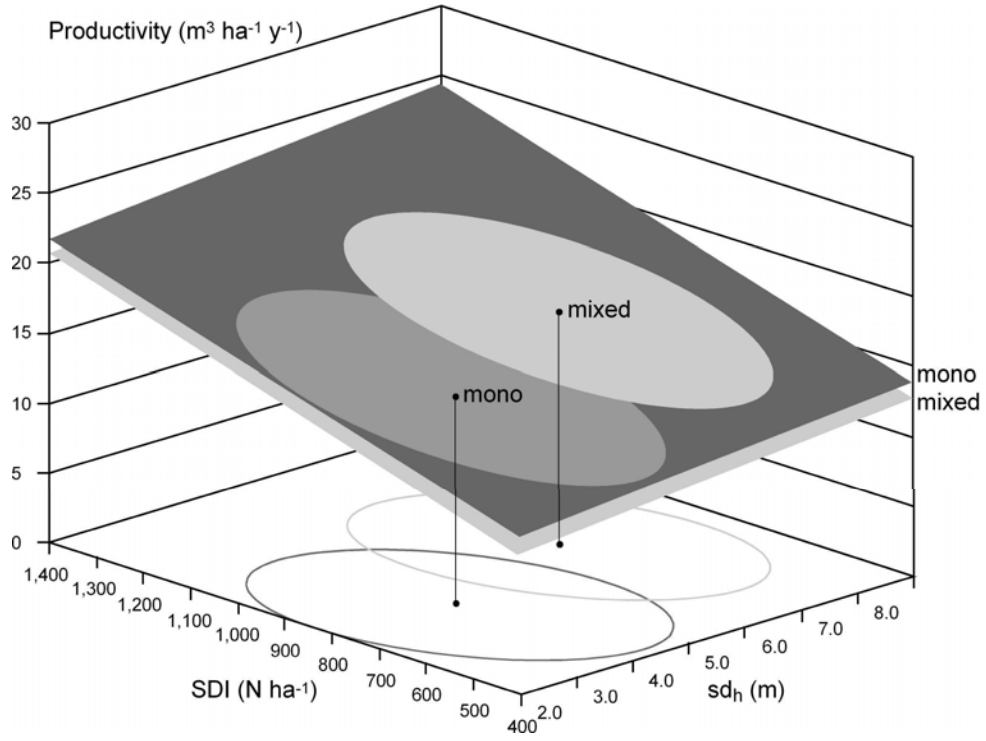
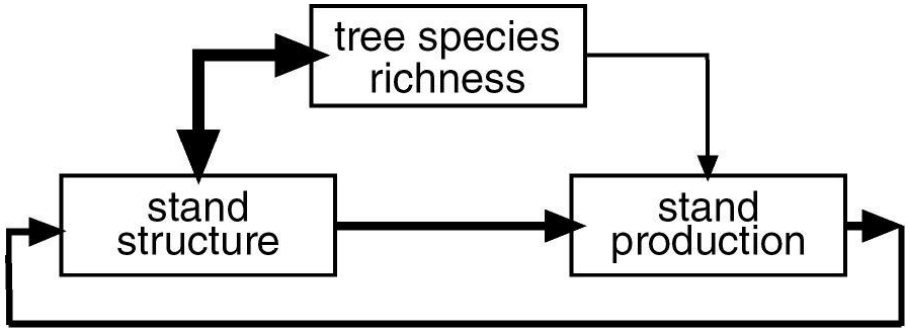
Discussion. Mixing effect and structure





Danescu et al. 2016, Pretzsch et al. 2016

structural heterogeneity drives mixing effect

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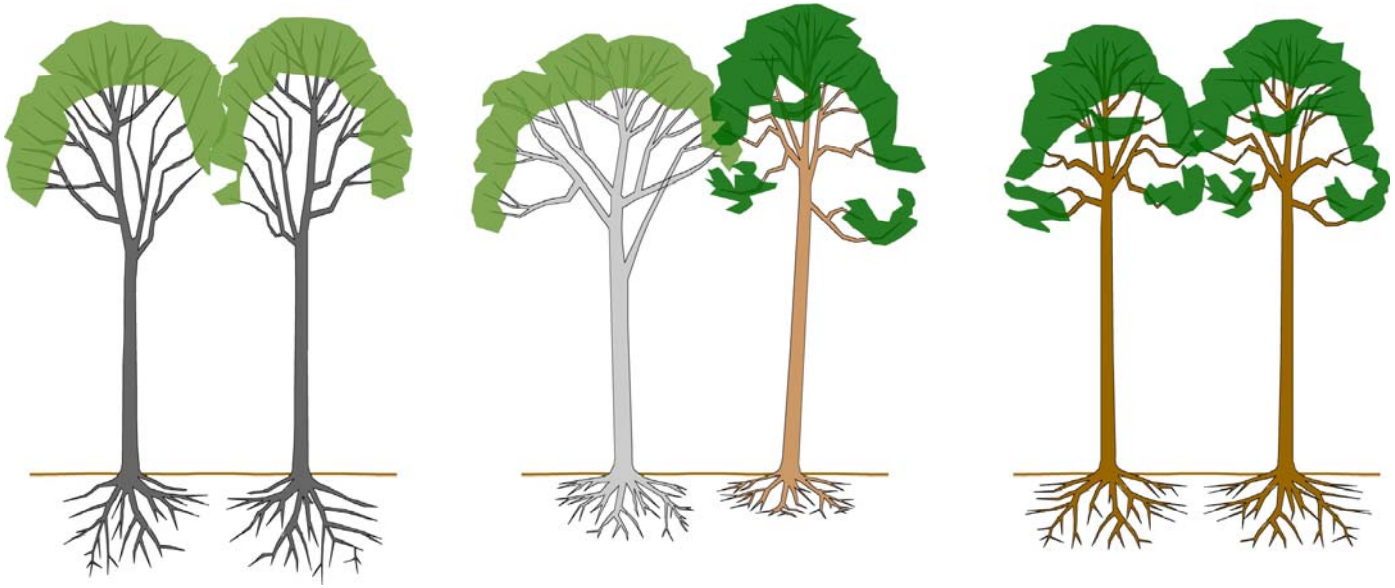
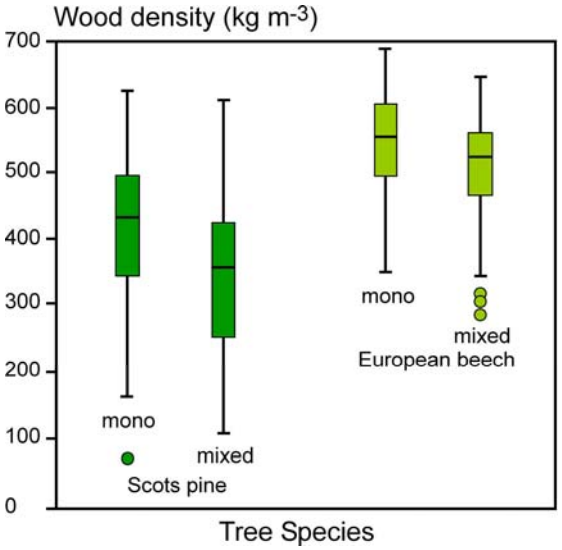
Discussion. Mixing effect and matter allocation





Zeller et al. submitted
Pretzsch et al. 2016

matter partitioning disguises mixing effect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EU EuMIXFOR COST FP1206
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