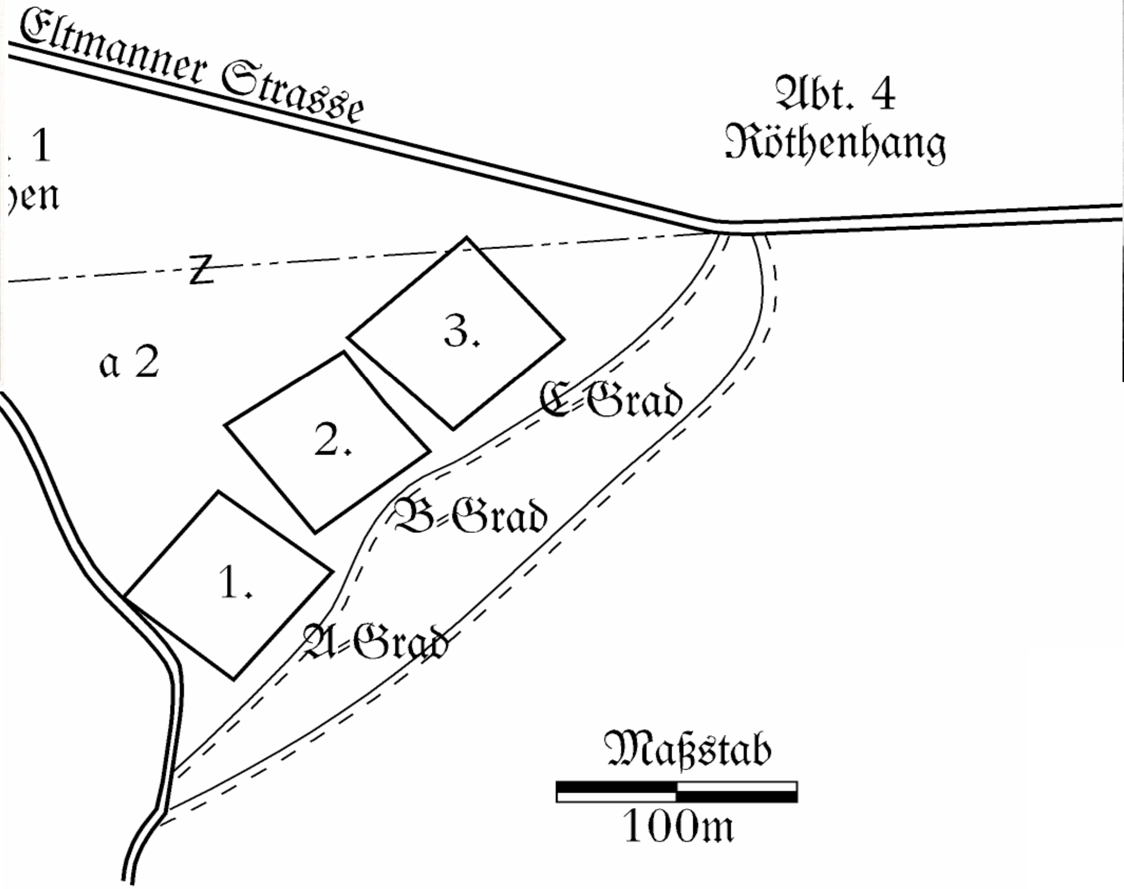
Long-term experiments for unique insights into forest growth dynamics and trends

Hans Pretzsch

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

C. v. Carlowitz
*1645 †1714

Durchforstungsversuch Fabrikschleichach
Situationsplan 1870



B. Danckelmann
*1831 †1901

W. L. Pfeil
*1783 †1859

A. Schwappach
*1851 †1932


A. v. Ganghofer
*1827 †1900
F. v. Baur
1878-1897
R. Weber
1897-1905
V. Schüpfer
1905-1937
K. Vanselow
1937-1951
E. Assmann
1951-1972
F. Franz
1972-1993

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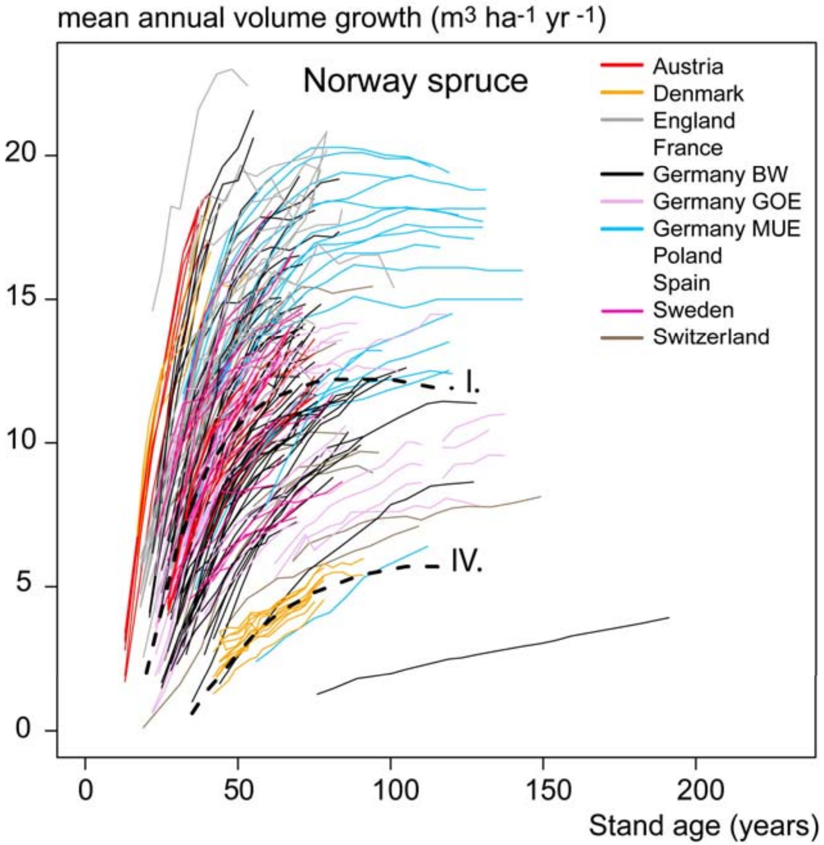
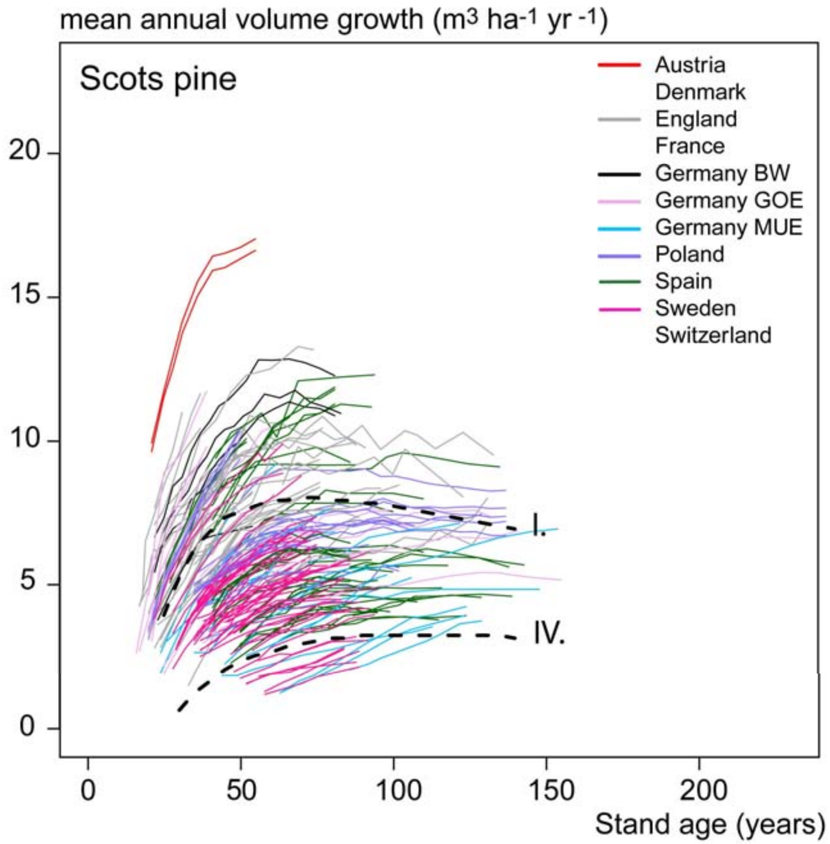
Mean annual volume growth $m^3\ ha^{-1}\ yr^{-1}$ on long-term experiments across Europe since 1860





Long-term experiments for unique insights into forest growth dynamics and trends

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1 Stand growth acceleration by environmental change
2 Wood density reduced by climate change
3 Increase and stabilization of growth of mixed-species versus mono-specific stands

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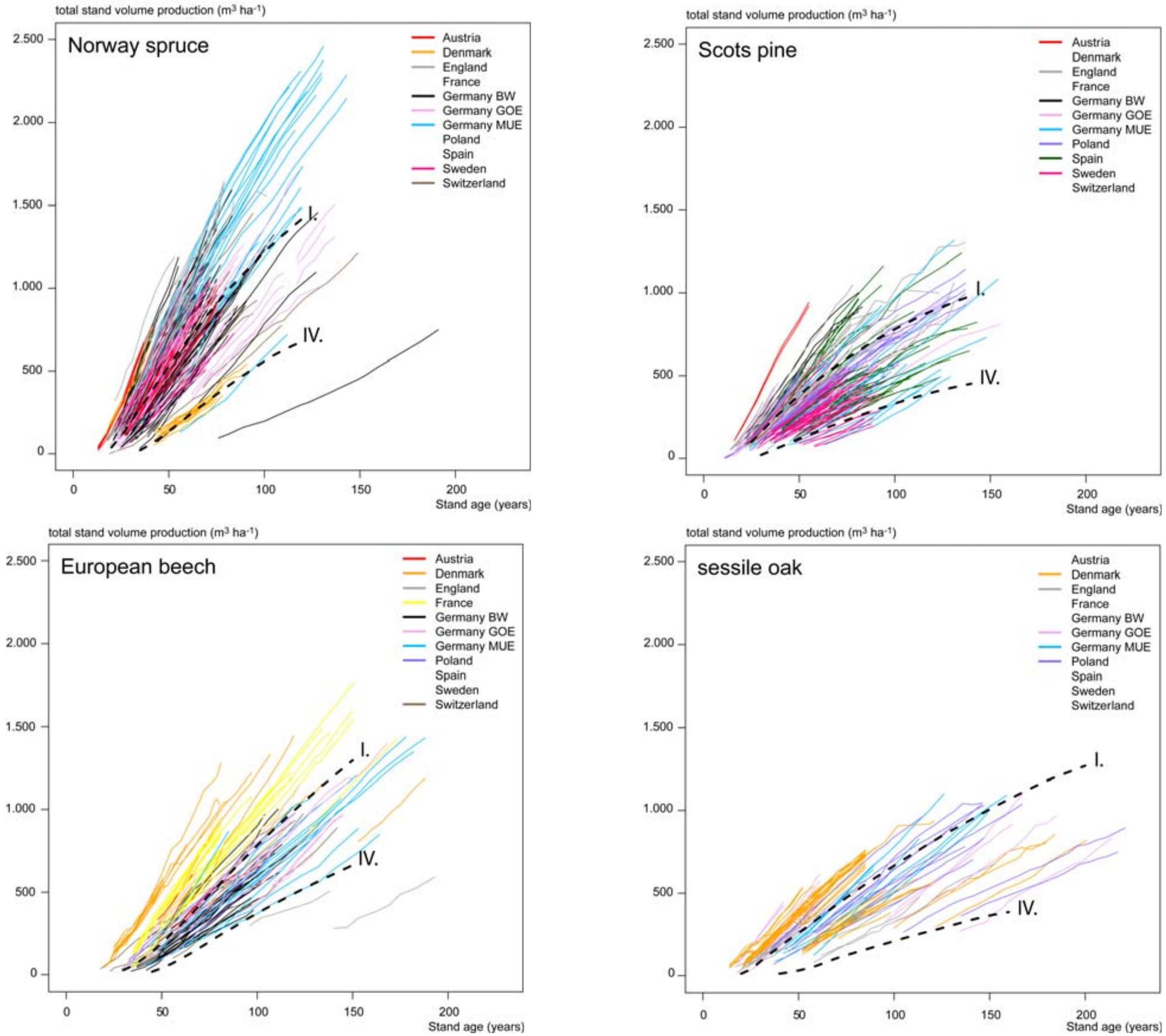
1 Changes of the total stand volume production on 577 long term trials in Europe since 1860



model:
volume growth =
f (age, calender year..)

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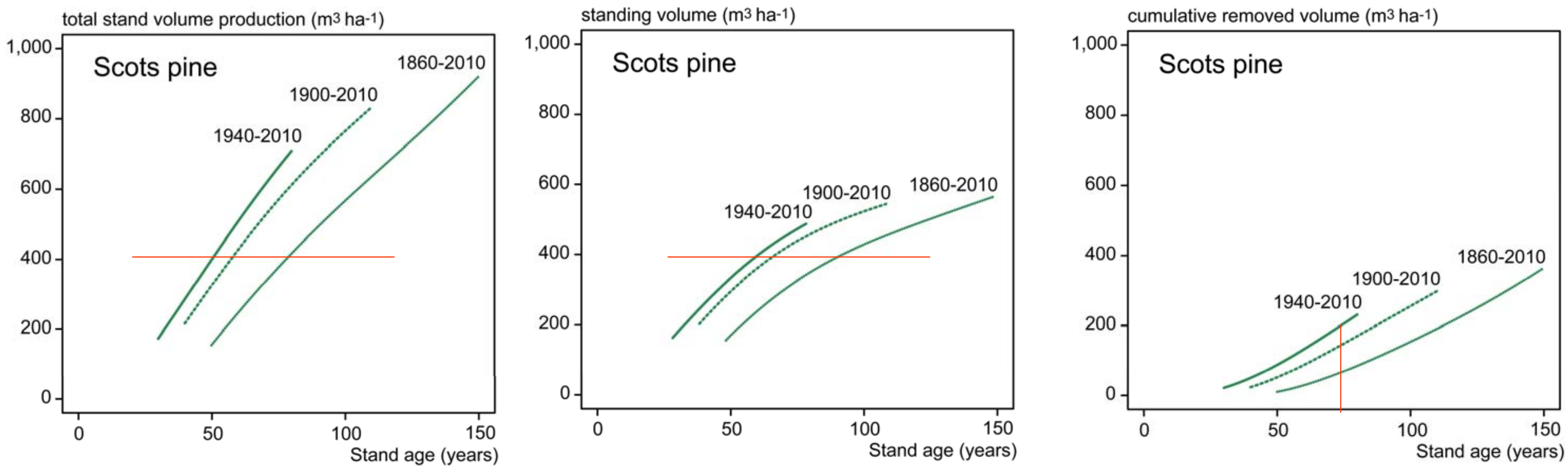
1 Growth trends of Scots pine in Europe



- a given total stand volume production and standing stock is reached 30 years early than 100 years ago
- at the age of 75 intermediate yield is 200 m^3 ha^{-1} while it was just 75 m^3 ha^{-1} 100 years ago,
- this means an increase of intermediate yield by 150 %.

Pretzsch, H. et al. (2018) Maintenance of long-term experiments for unique insights into forest growth dynamics and trends. Review and perspectives, Assmann review series, EFOR

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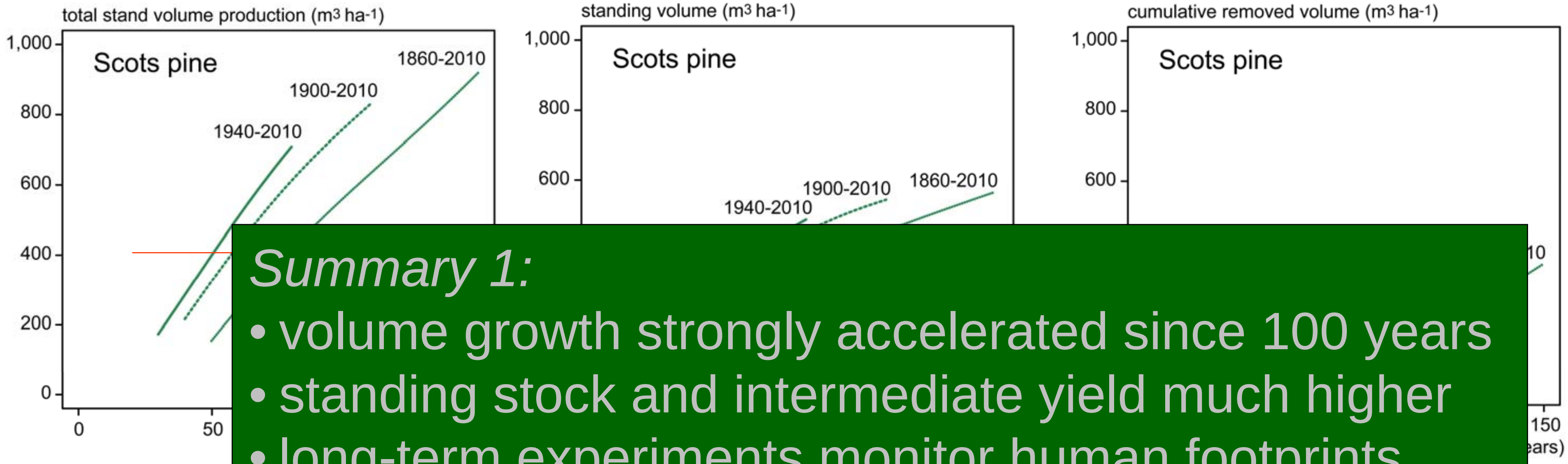
1 Growth trends of Scots pine in Europe



Summary 1:

- volume growth strongly accelerated since 100 years
- standing stock and intermediate yield much higher
- long-term experiments monitor human footprints

- a given total stand volume production and standing stock is reached 30 years early than 100 years ago
- at the age of 75 intermediate yield is 200 m^3 ha^{-1} while it was just 75 m^3 ha^{-1} 100 years ago,
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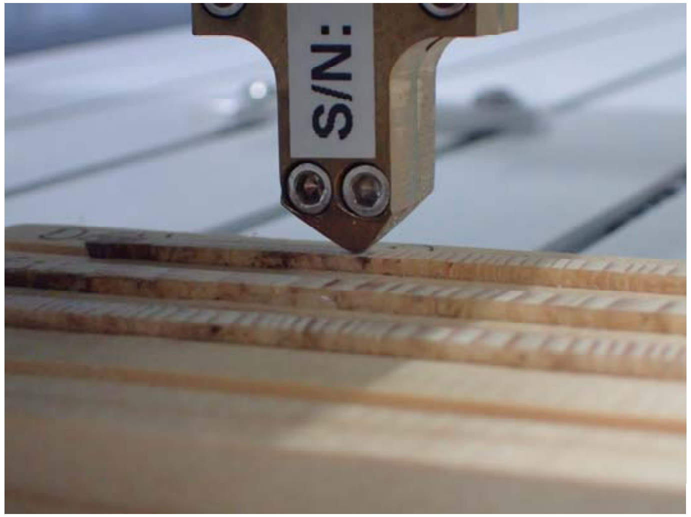
2 Wood density reduced by climate and management

increment core sampling:

sample plots: 41 long-term experiments
species: N. sp (13), S. pi (11), E. beech (8), sess. oak (9)
trees: 392
trees per species: N. sp (127), S. pi (103), E. beech (63), sess. oak (99),
time span: 1870-2016
age: 31-194 years
rings: > 30.000

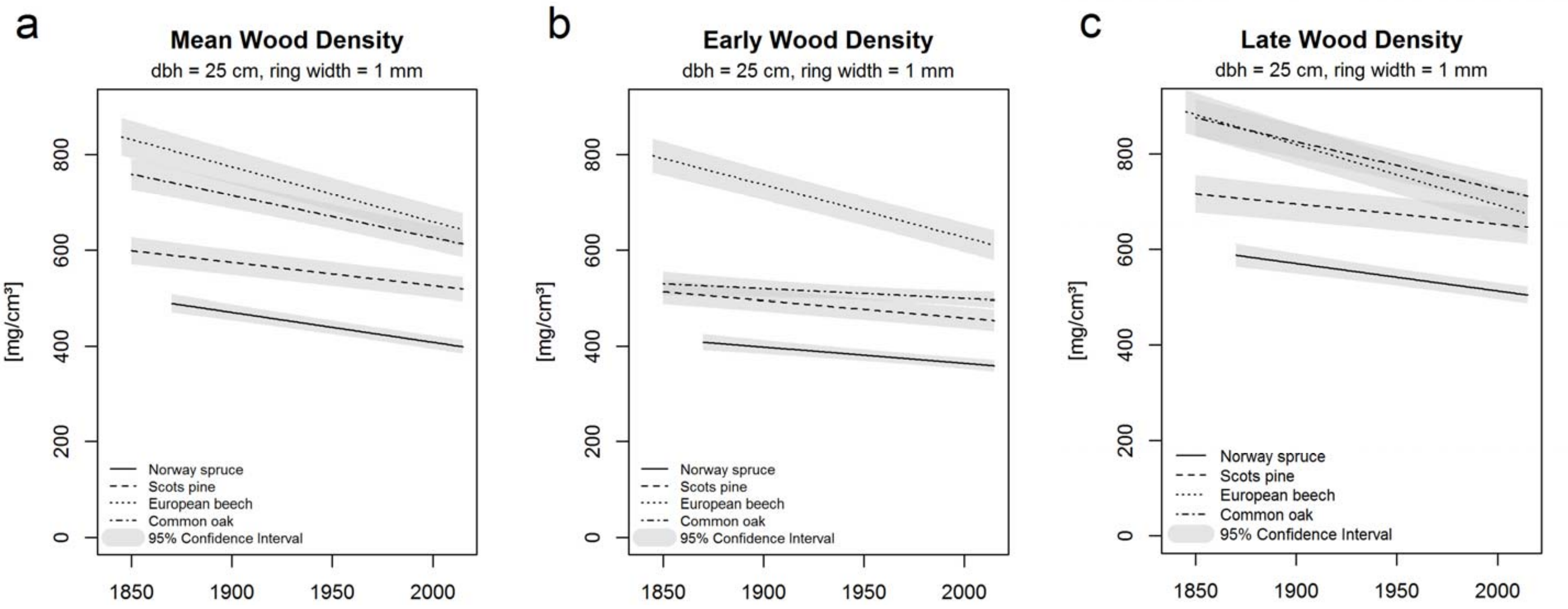
LIGNOSTATION, high frequency wood densitometry



model
wood density = f (tree size, ring width, calender year..)

Pretzsch, H et al. (2018) Wood density reduced while wood volume growth accelerated in Central European forests since 1870, Forest Ecology and Management, 429: 589-616

2 Wood density reduced by climate and management



Species	Mean wood density		Early wood density		Late wood density	
Norway spruce	−7.7%	(2.5)	−1.7%	(2.3)	−4.2%	(2.5)
Scots pine	−5.4%	(3.4)	−4.8%	(3.4)	−4.5%	(3.9)
European beech	−11.2%	(3.8)	−10.8%	(3.4)	−12.1%	(4.4)
sessile oak	−11.8%	(3.1)	−1.3%	(2.5)	−10.6%	(3.5)

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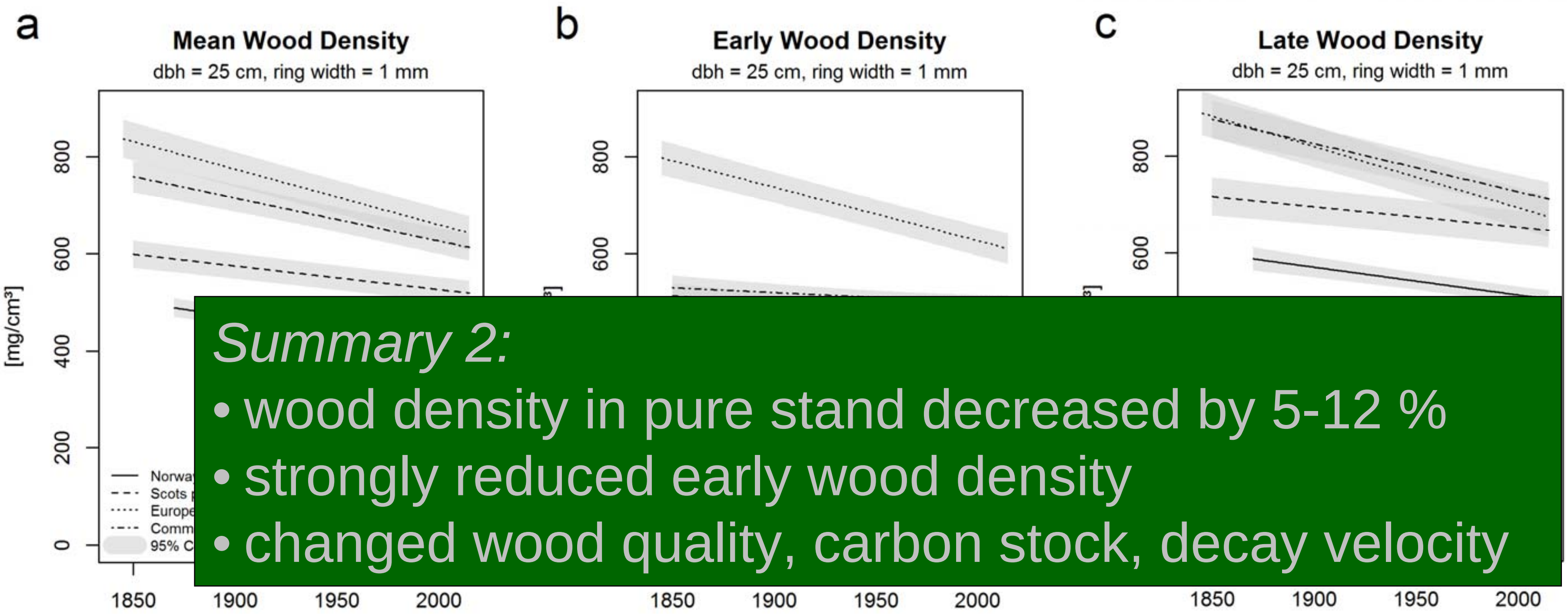
2 Wood density reduced by climate and management



Summary 2:

- wood density in pure stand decreased by 5-12 %
- strongly reduced early wood density
- changed wood quality, carbon stock, decay velocity

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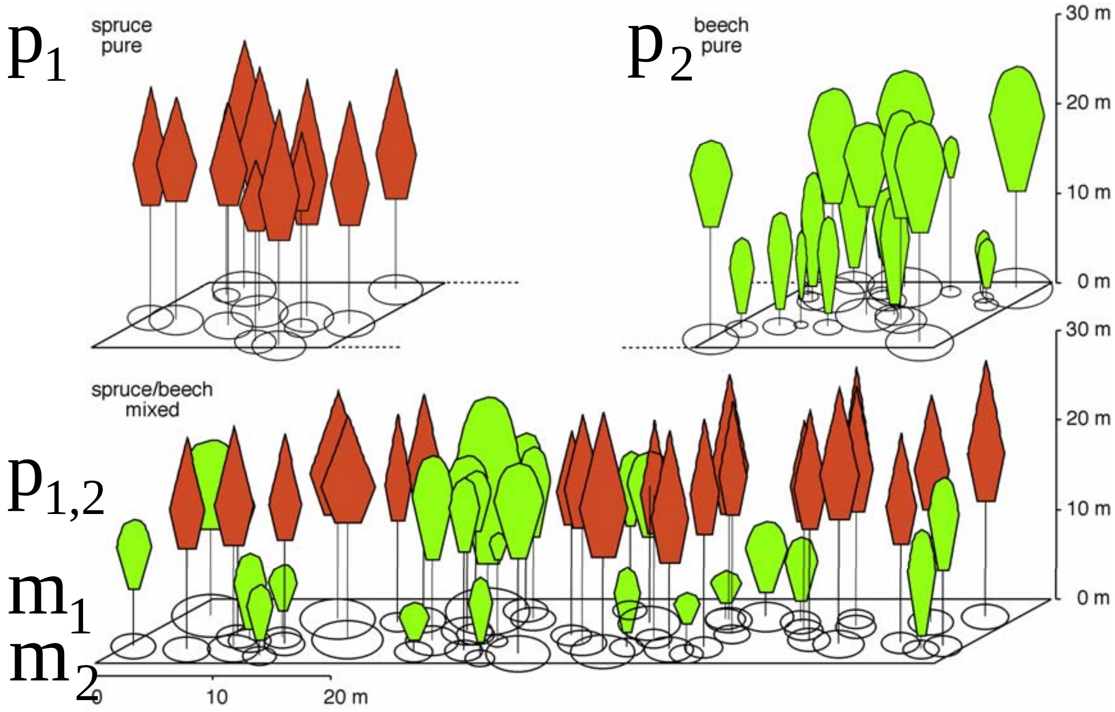
3 Experimental setup for scrutiny of mixing effects Zwiesel 111/3,4,5 Bavarian Forest



$$\text{relative productivity} = p_{1,2}/(p_1 \times m_1 + p_2 \times m_2)$$

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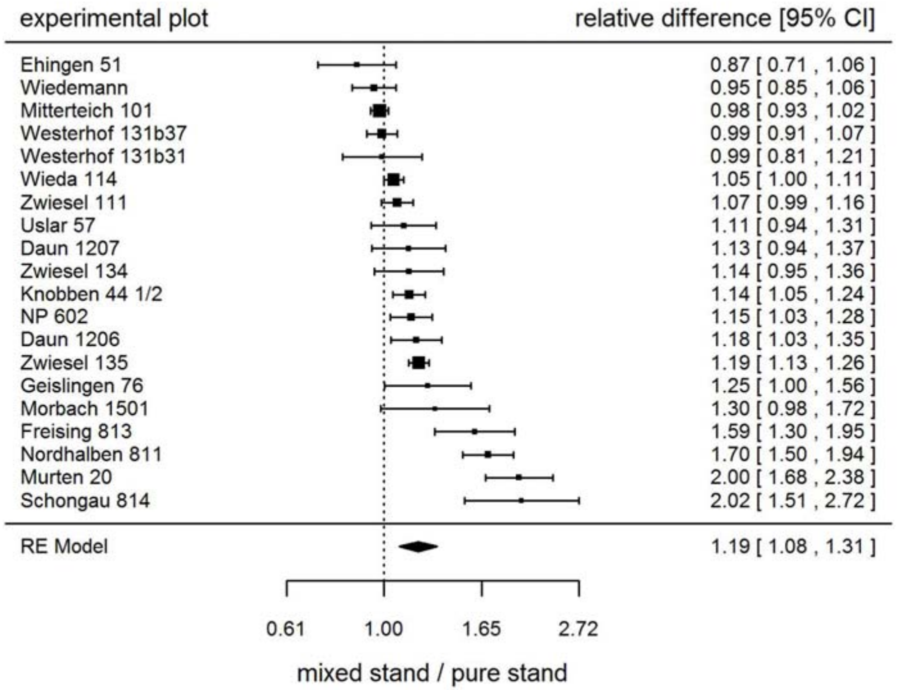
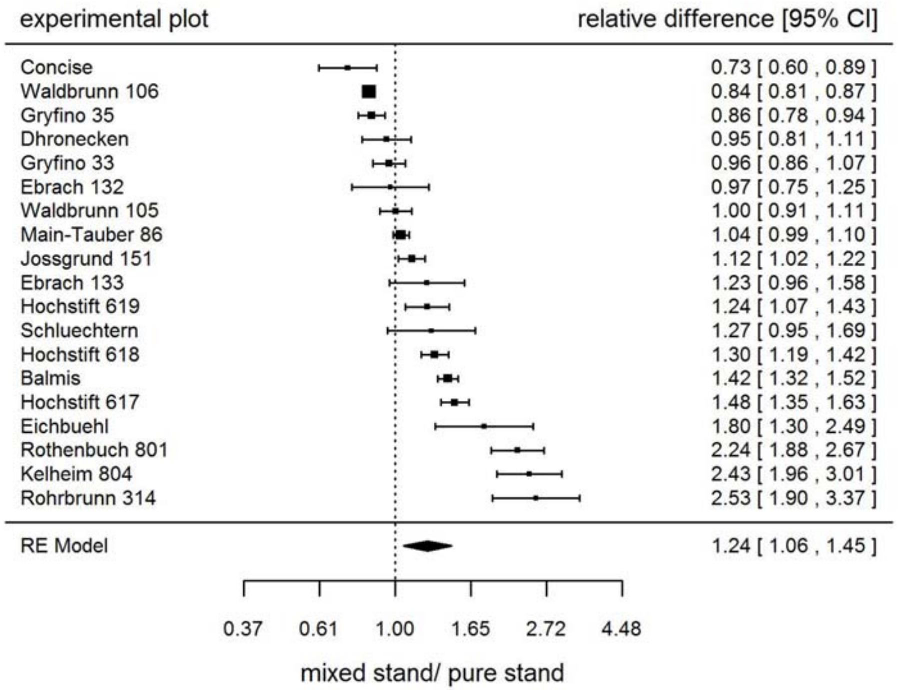
3 Meta-analyses of overyielding in mixed vs. pure stands

spruce-beech



oak-beech



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 (± SE) in %	21 (± 3)	30 (± 9)	20 (± 3)	11 (± 8)	21 (± 11)	25 (± 6)	13 (± 6)	
corr. factor	1.10	1.20	1.10	1.10	1.20	1.20	1.10	1.10

Jactel et al. (2018), Pretzsch, Forrester and Bauhus (2017), Liang, J. et al. (2016)

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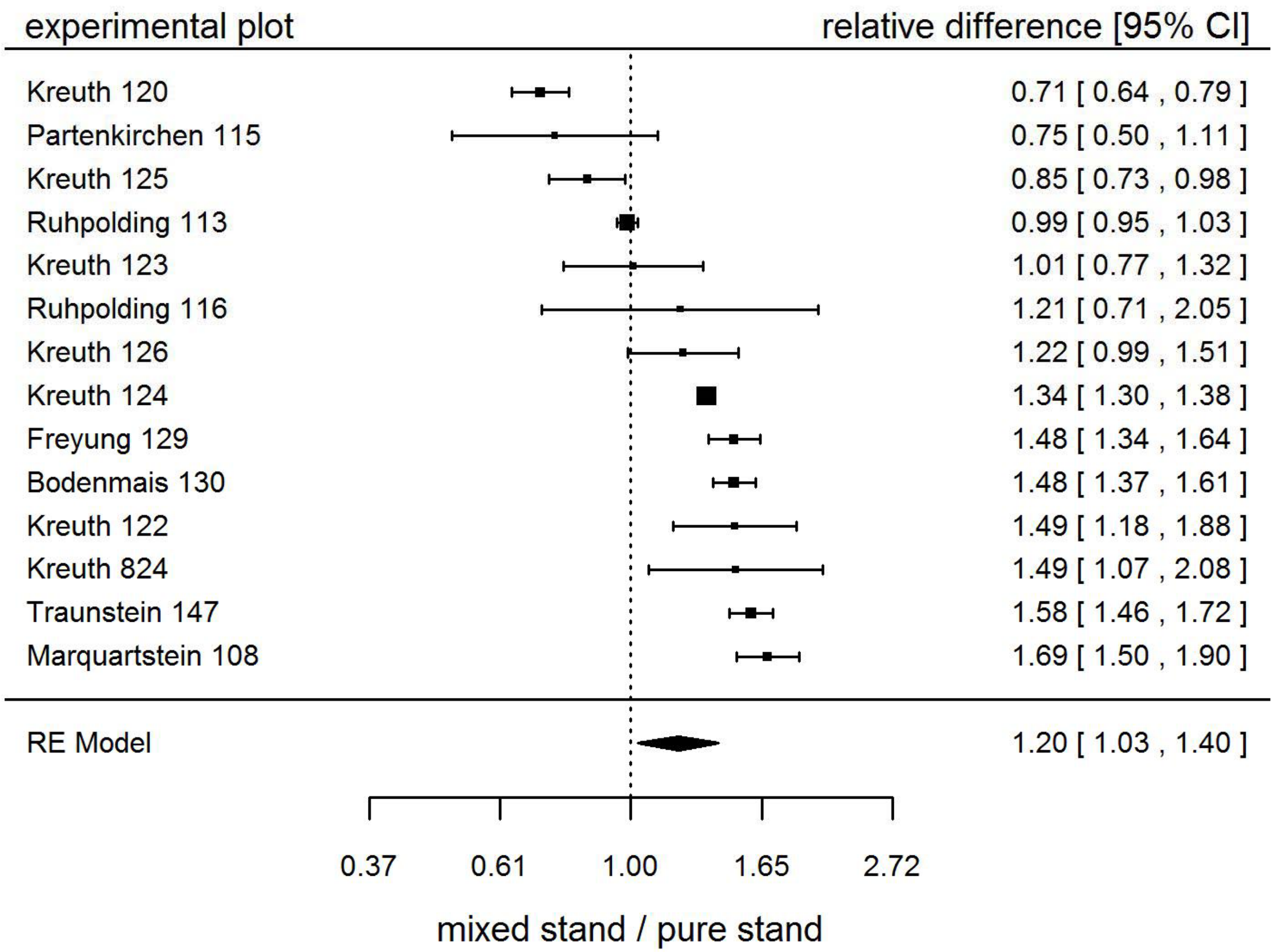
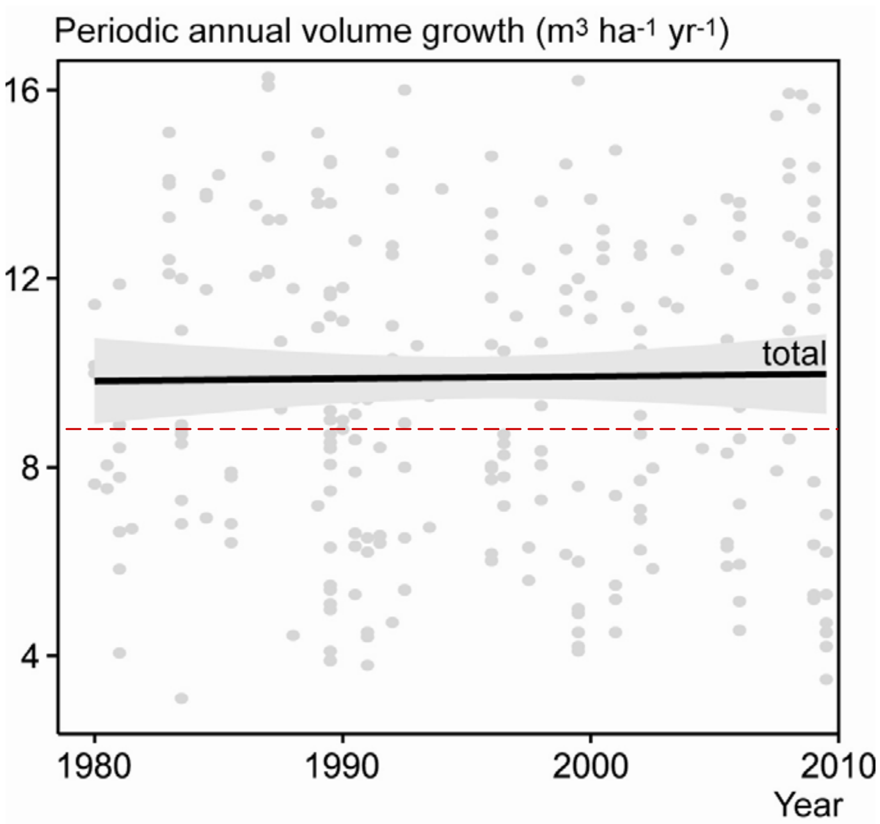
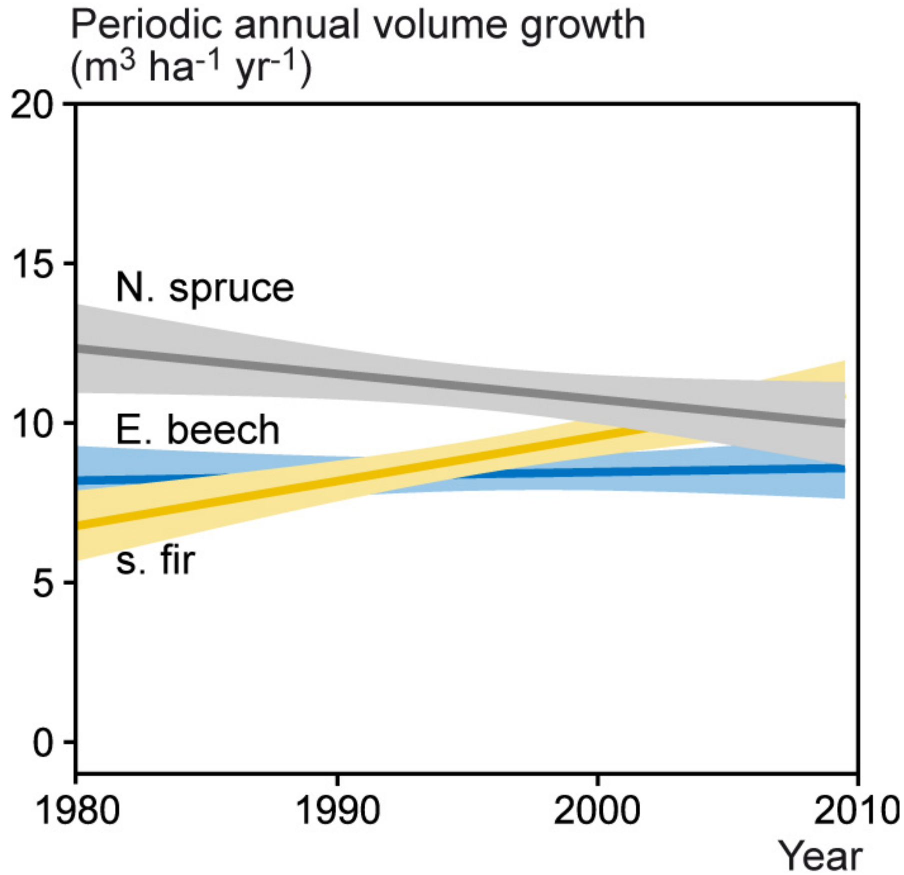
Meta-analysis on overyielding of mixed stands of spruce-fir-beech in Europe based on long-term experiments



Growth stability of the n=105 CLIMO study 1 spruce-fir-beech stands

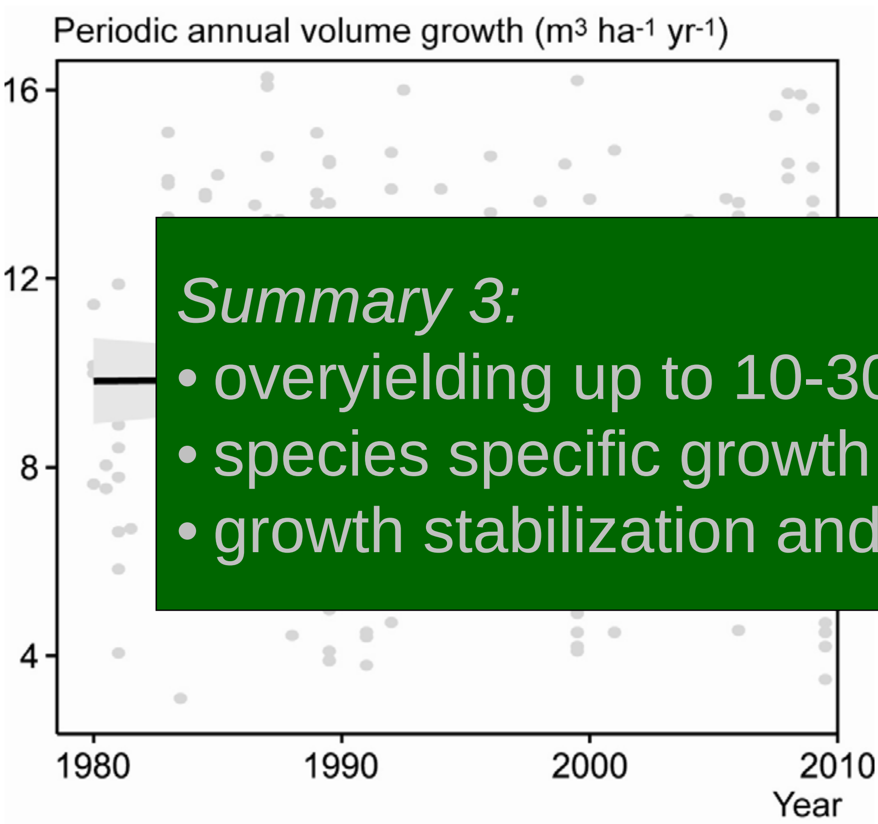


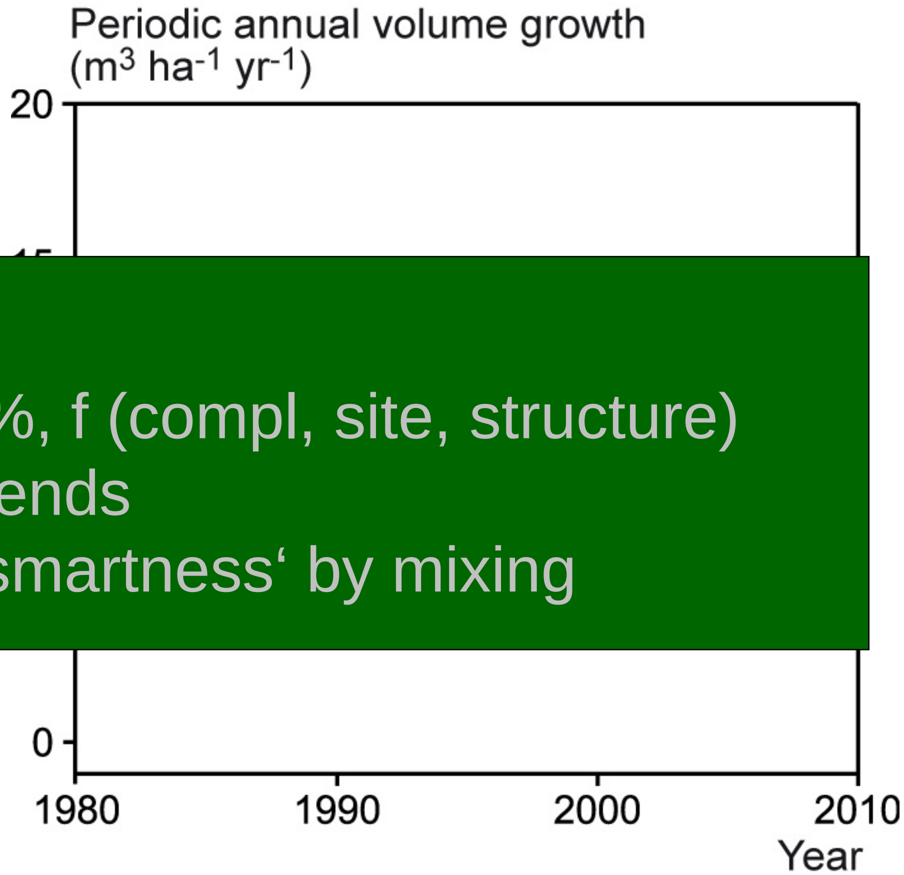


yield table + 20 %

Hilmers, T et al. (in preparation) Productivity of mountain mixed forests in Europe, Forestry

Growth stability of the n=105 CLIMO study 1 spruce-fir-beech stands



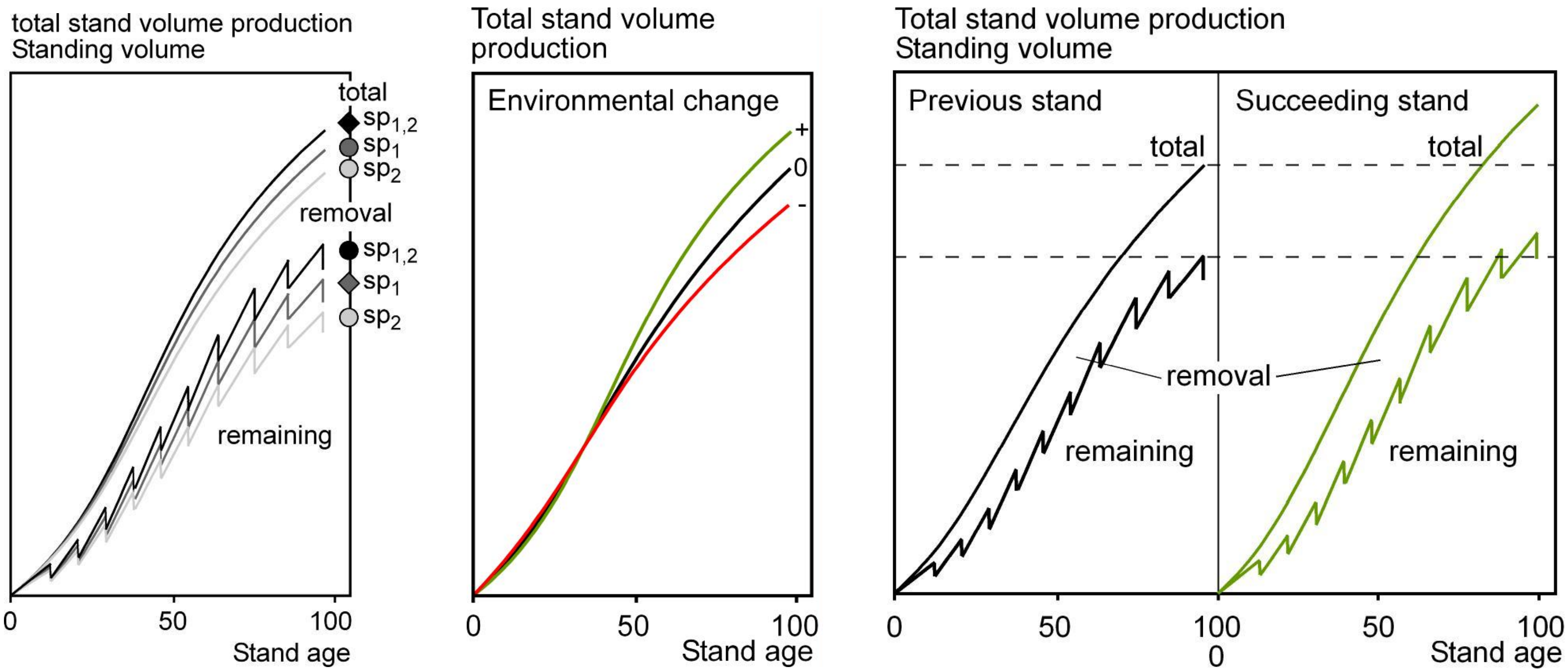


Summary 3:

- overyielding up to 10-30 %, f (compl, site, structure)
- species specific growth trends
- growth stabilization and ‘smartness‘ by mixing

Hilmers, T et al. (in preparation) Productivity of mountain mixed forests in Europe, Forestry

Unique stand information just from long-term experiments: total production, stand history, growth trends



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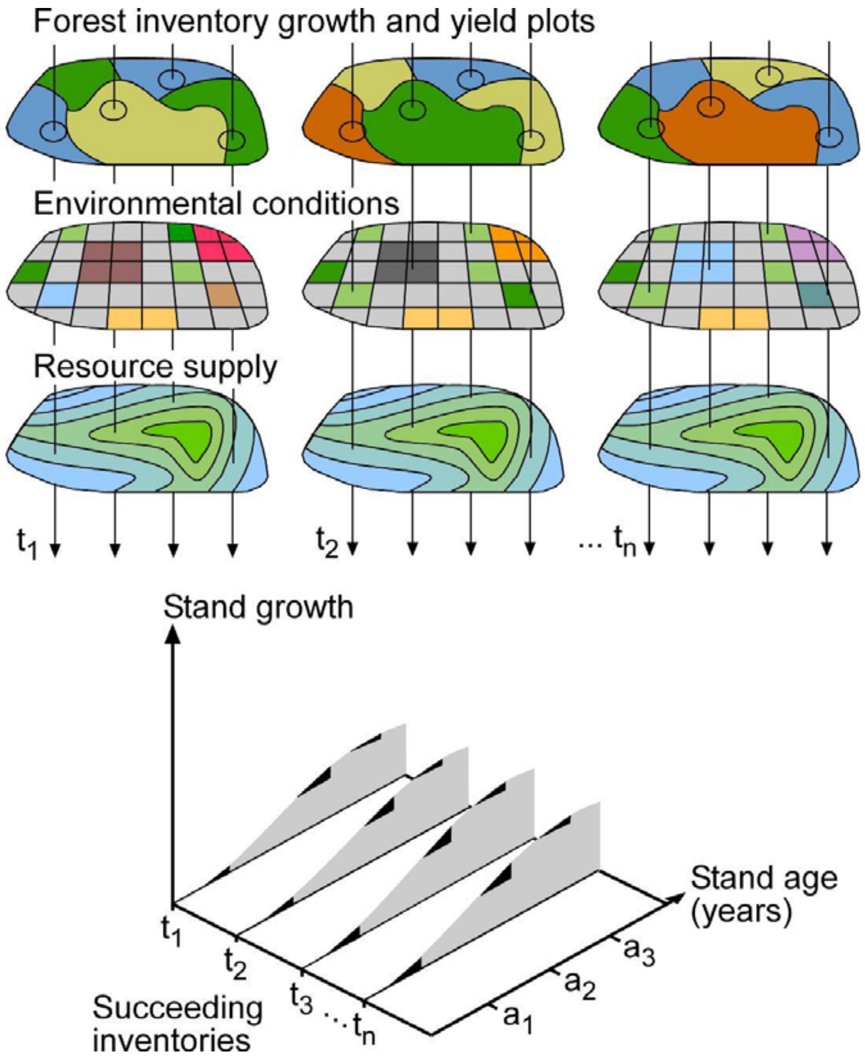
Space for time assumption. Use of inventory data



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

according to MCPFE, 2000, 2009

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COST CLIMO

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Slovenia, Sweden, Switzerland, Spain, and others

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