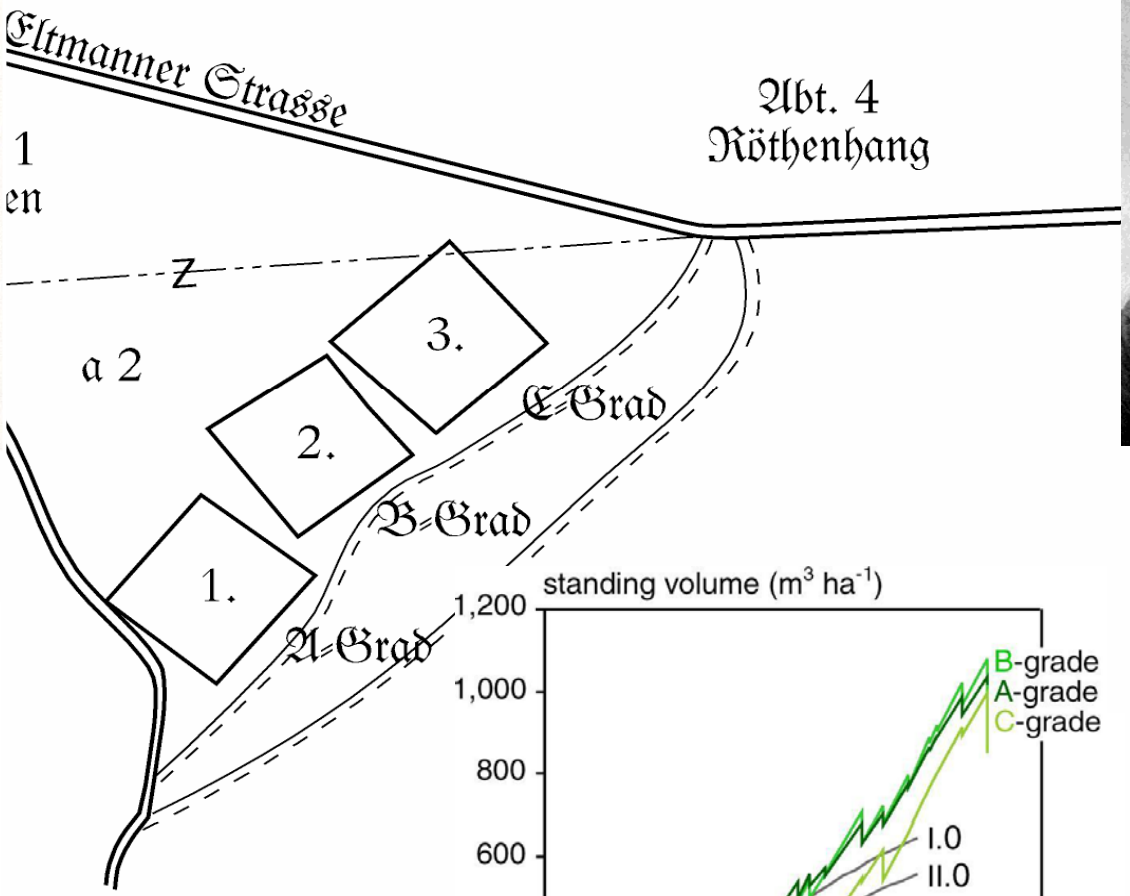
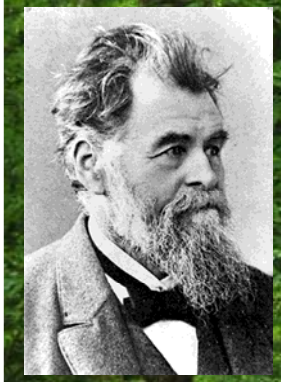
C. v. Carlowitz
*1645 †1714



B. Danckelmann
*1831 †1901

W. L. Pfeil
*1783 †1859

A. Schwappach
*1851 †1932



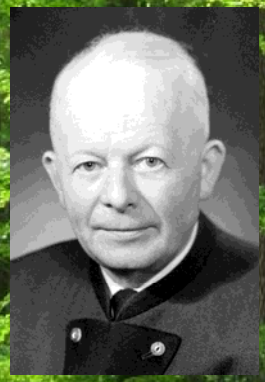
A. v. Ganghofer
*1827 †1900

F. v. Baur
1878-1897

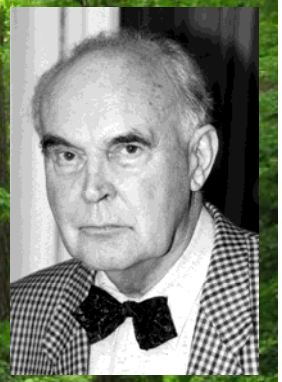
R. Weber
1897-1905

V. Schüpfer
1905-1937

K. Vanselow
1937-1951



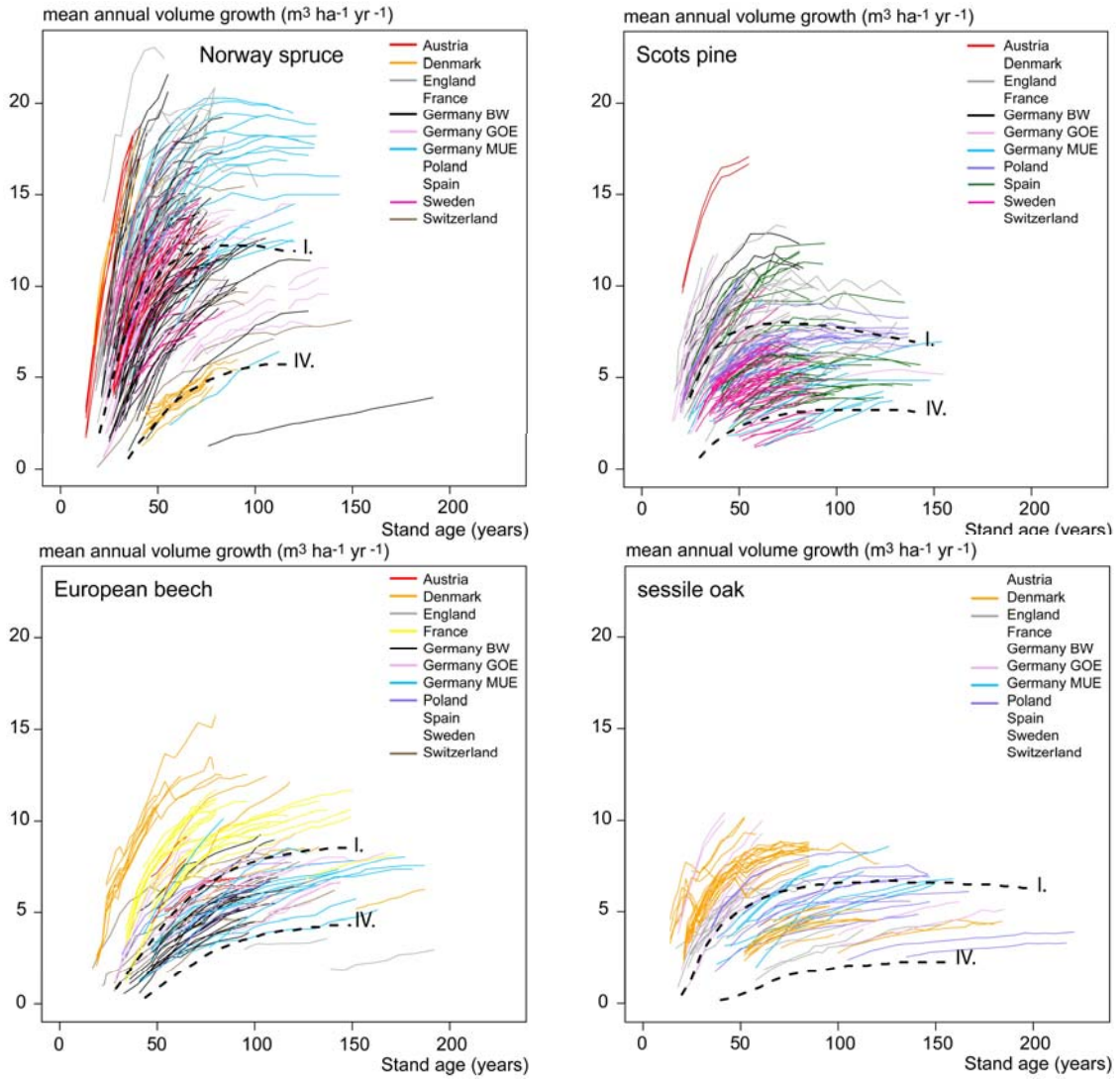
E. Assmann
1951-1972



F. Franz
1972-1993

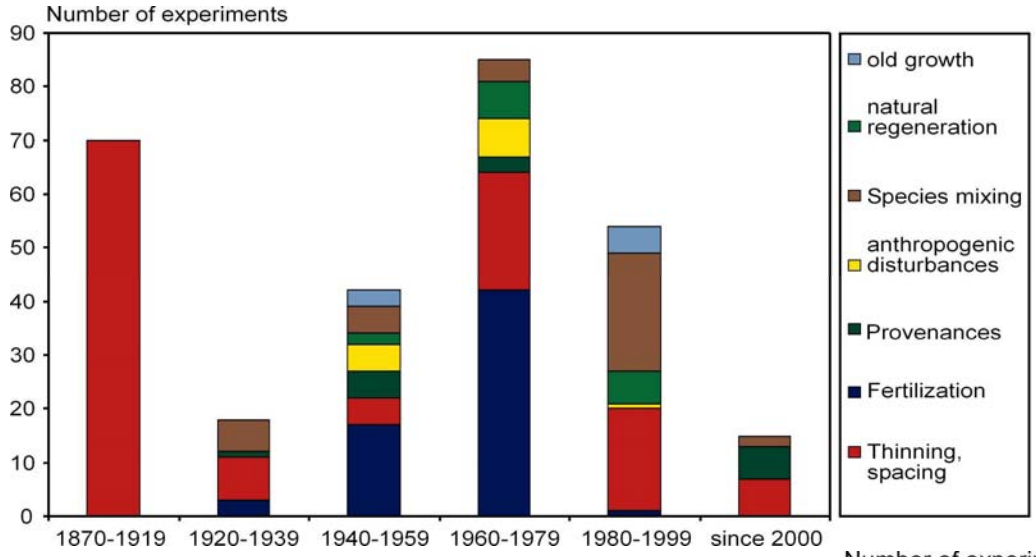
Waldwachstumskunde
Systemanalyse

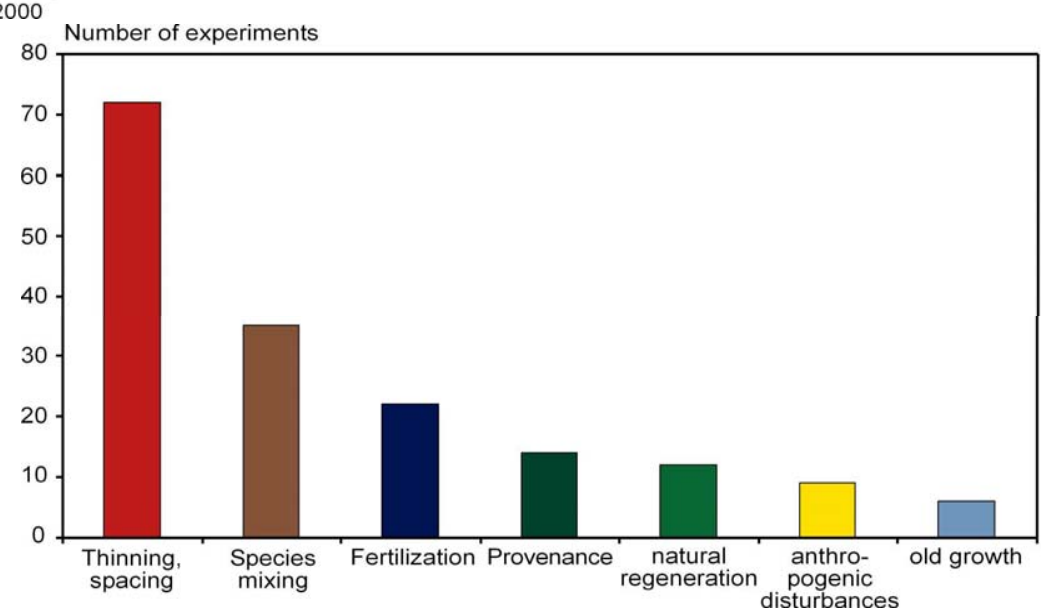
Mean annual volume growth $m^3\ ha^{-1}\ yr^{-1}$ on long-term experiments across Europe since 1860



Waldwachstumskunde
Systemanalyse

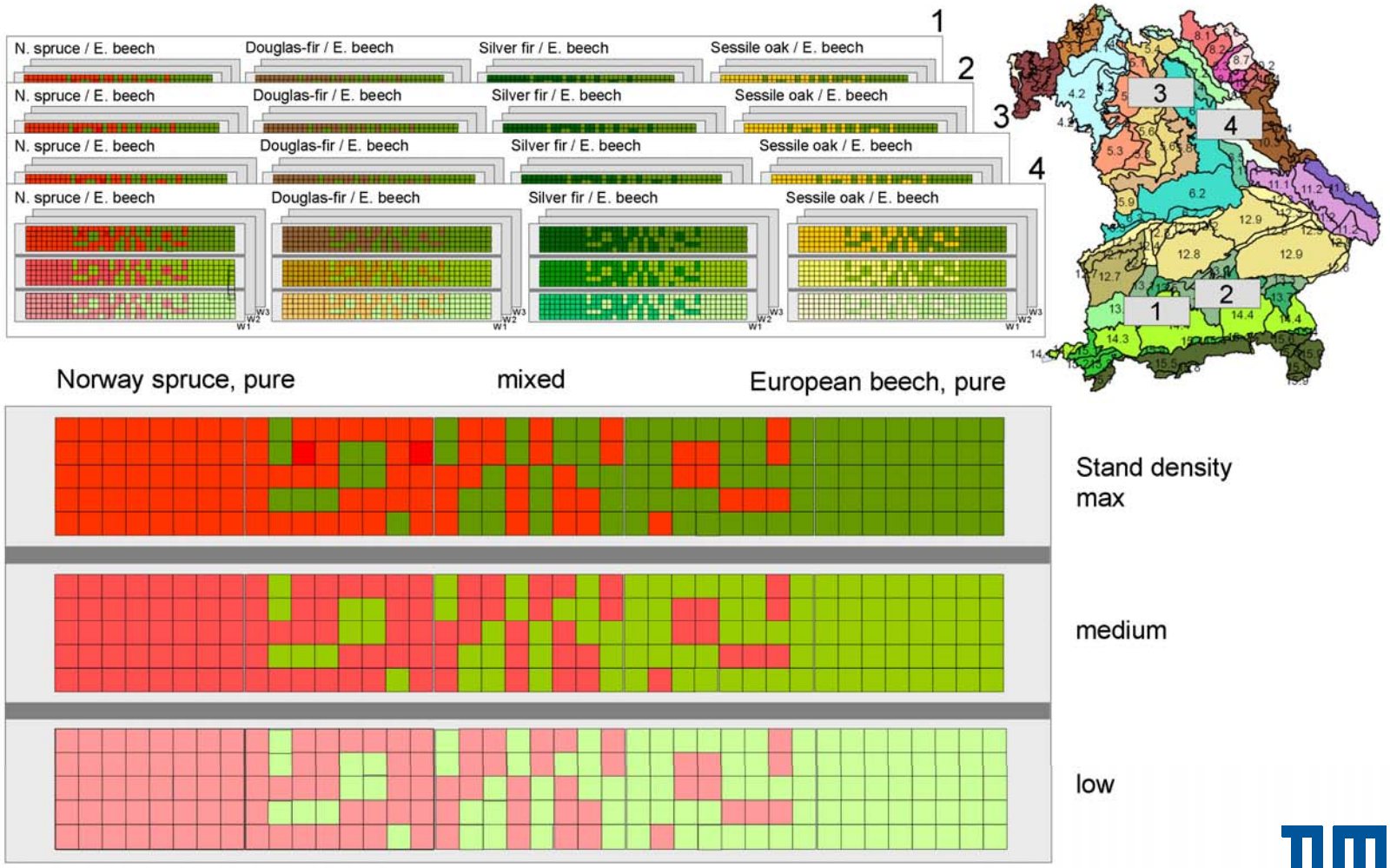
Time of establishment and main questions of long-term experiments in Bavaria





Waldwachstumskunde
Systemanalyse

Establishment of a new generation of species mixing experiments from 2017-2023 on about 120 ha with factors: species, site conditions, mixing patern, stand density



Waldwachstumskunde
Systemanalyse

Long-term experiments in forests. Essential for facts on stand dynamics and evidence of human influence

Hans Pretzsch
Chair for Forest Growth and Yield Science
Technical University of Munich
http://waldwachstum.wzw.tum.de/index.php?id=presentations

1 Tradeoff between thinning effects on tree size growth and stand volume production

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Self-thinning variant on the long-term thinning experiment in Norway spruce FFB 612, South Bavaria, Germany

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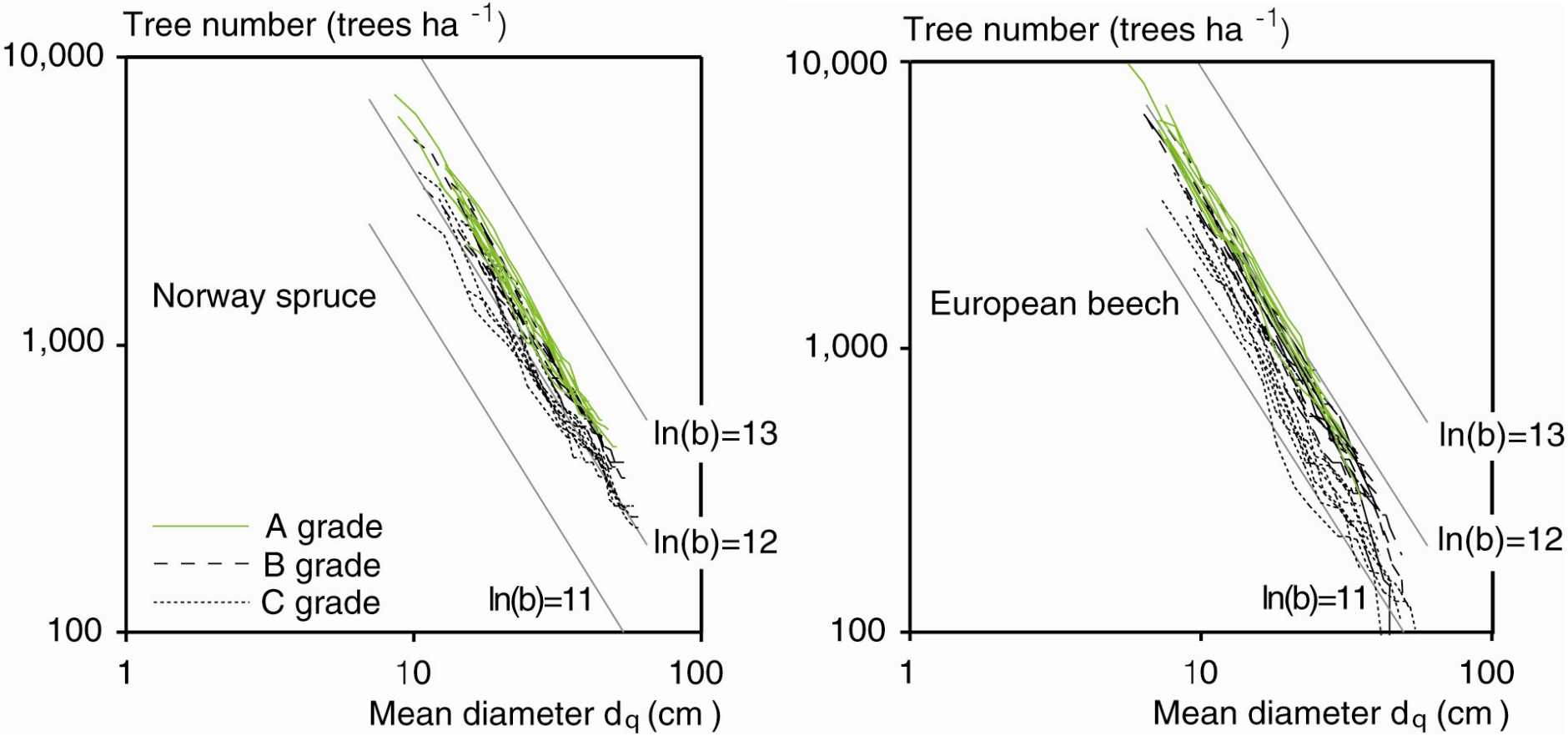
Revelation of self-thinning lines (green) on long-term thinning experiments with different treatment variants



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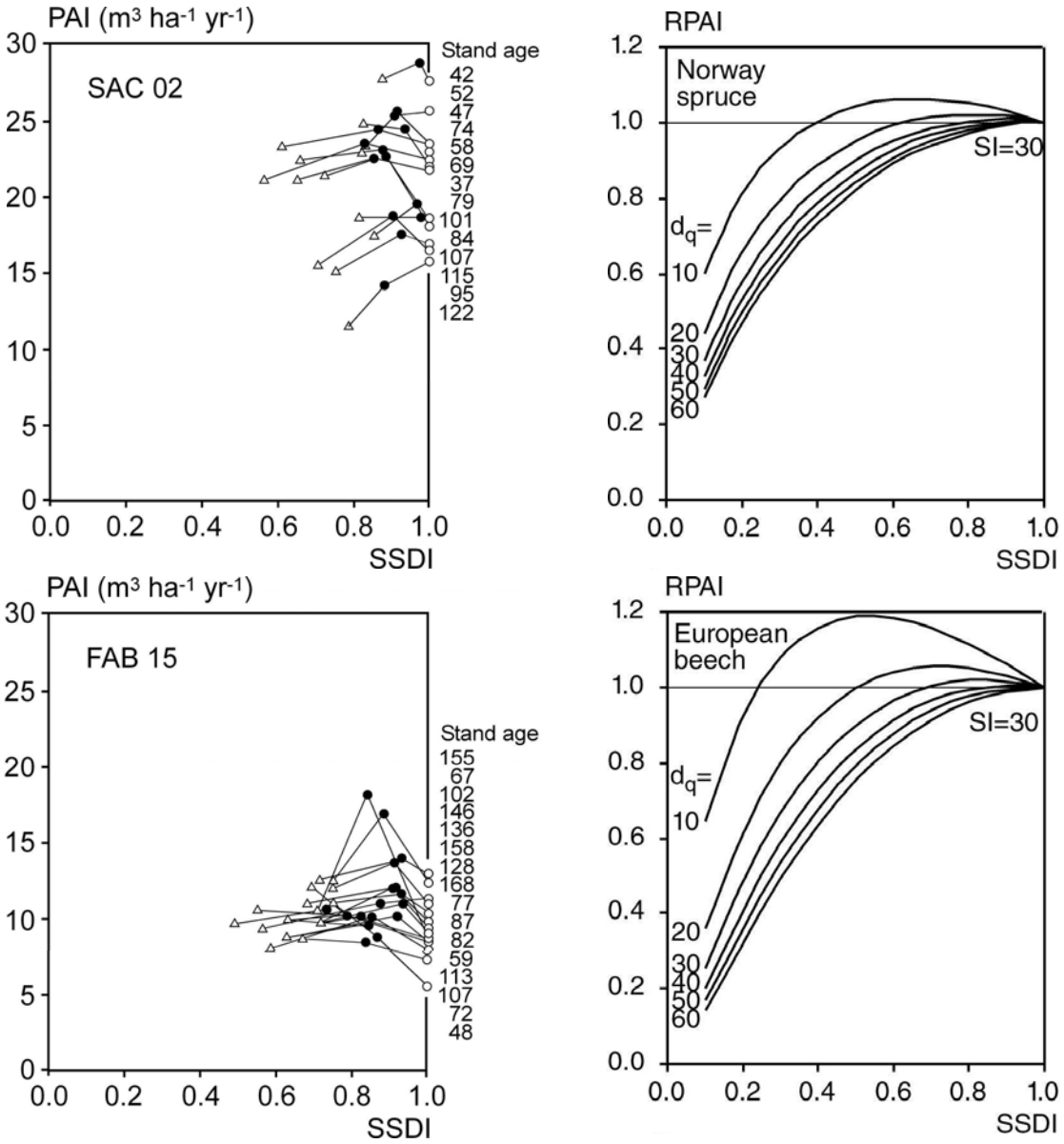
Systemanalyse

From thinning trials to density-productivity relationships



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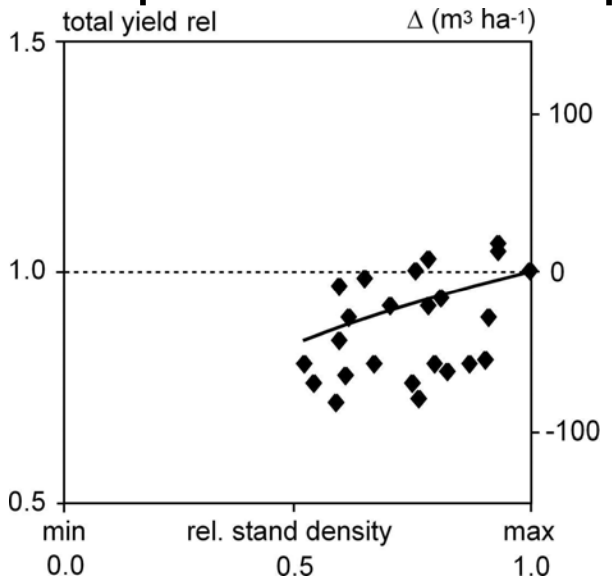
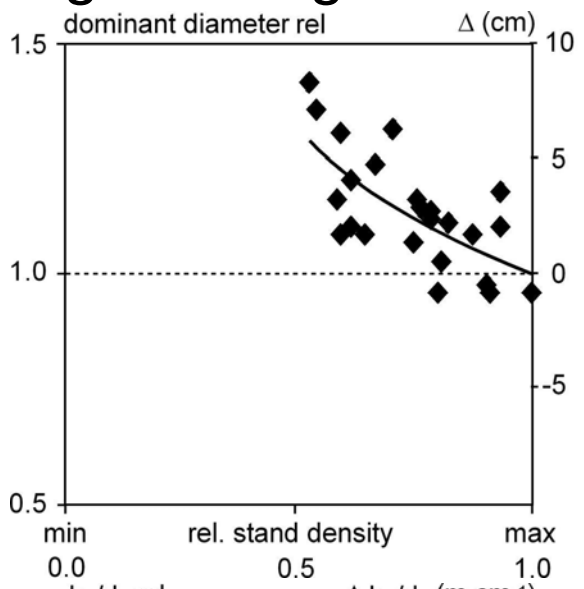
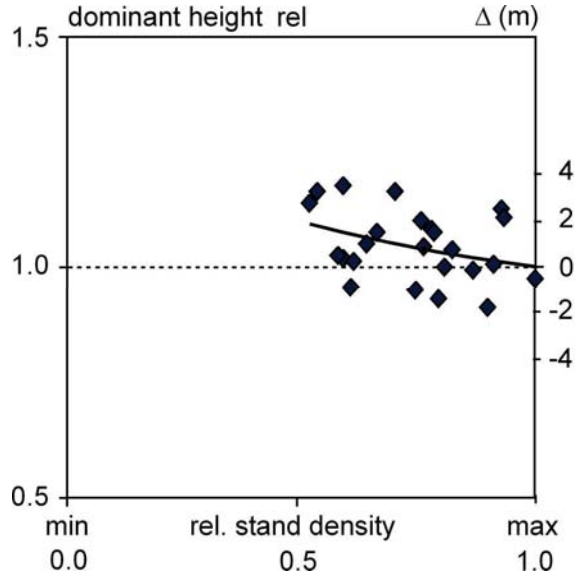
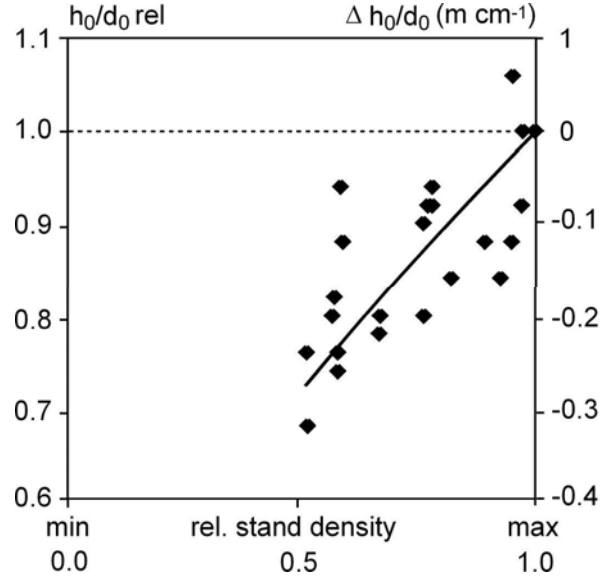
Tradeoff between stand productivity and mean tree growth on Scots pine combined spacing-thinning trial WEI 611









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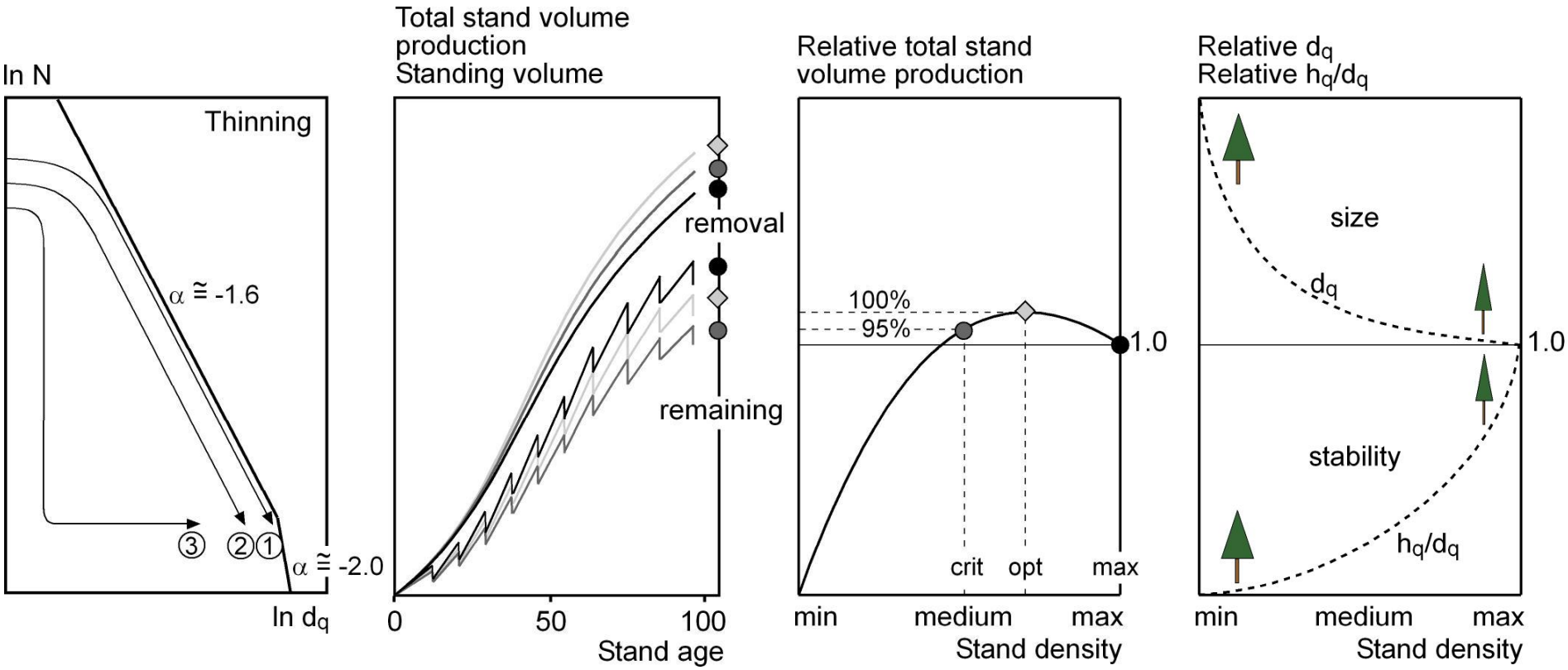
Long-term experiments record self-thinning, remaining *and* removal stand, total production, density-productivity relationship, and tradeoff between stand and mean tree




161
160

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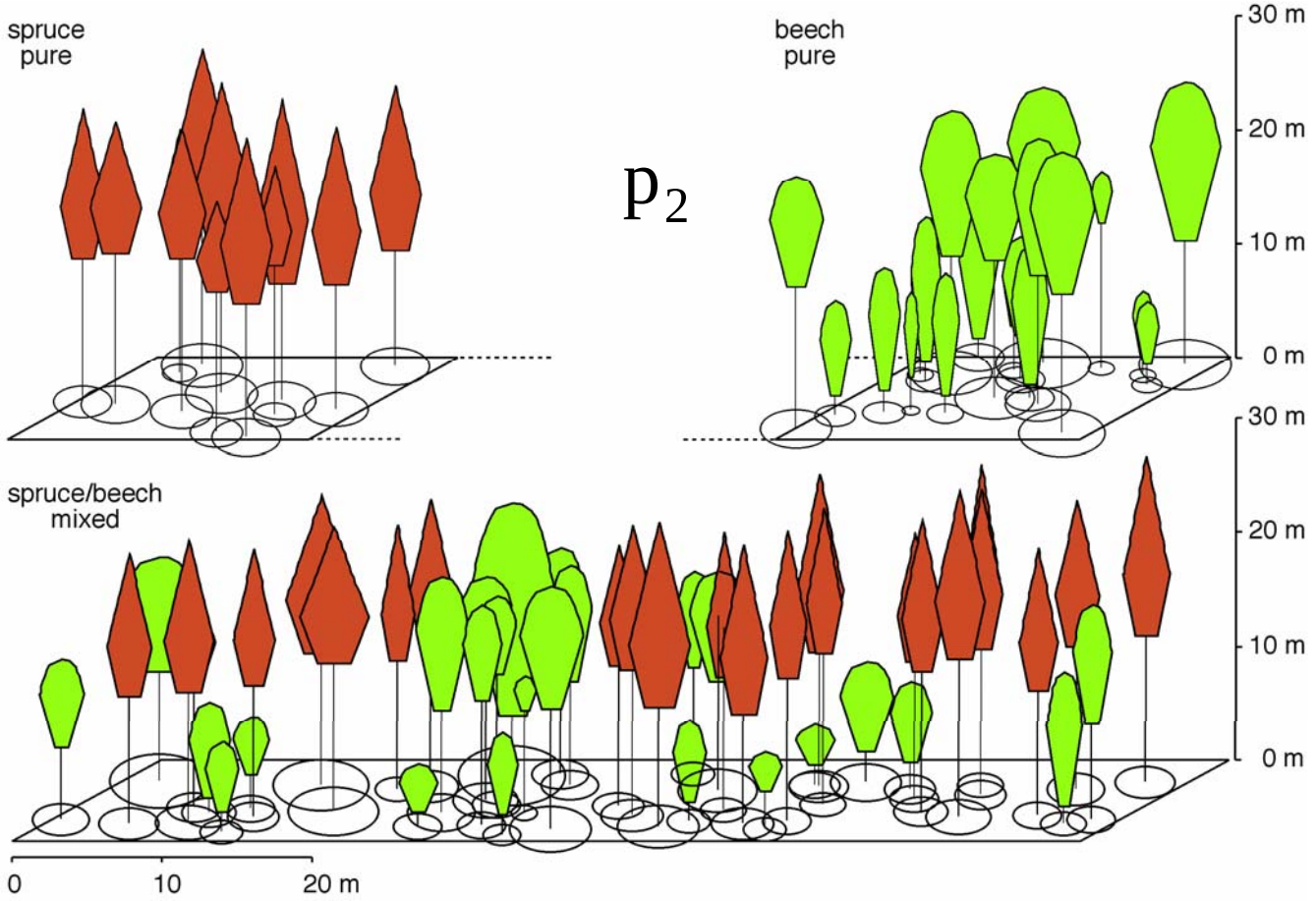
Experimental setup for scrutiny of mixing effects
Zwiesel 111/3,4,5 Bavarian Forest

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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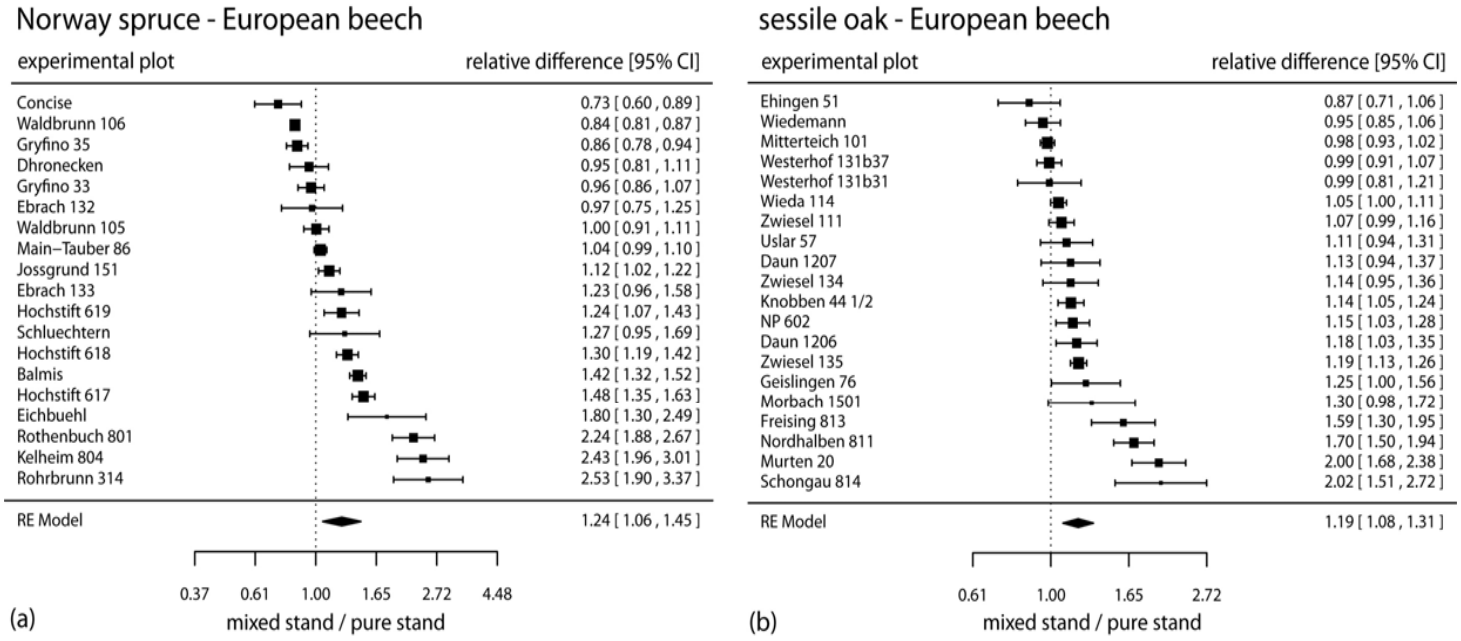
Systemanalyse

Meta-analyses of overyielding in mixed vs. pure stands

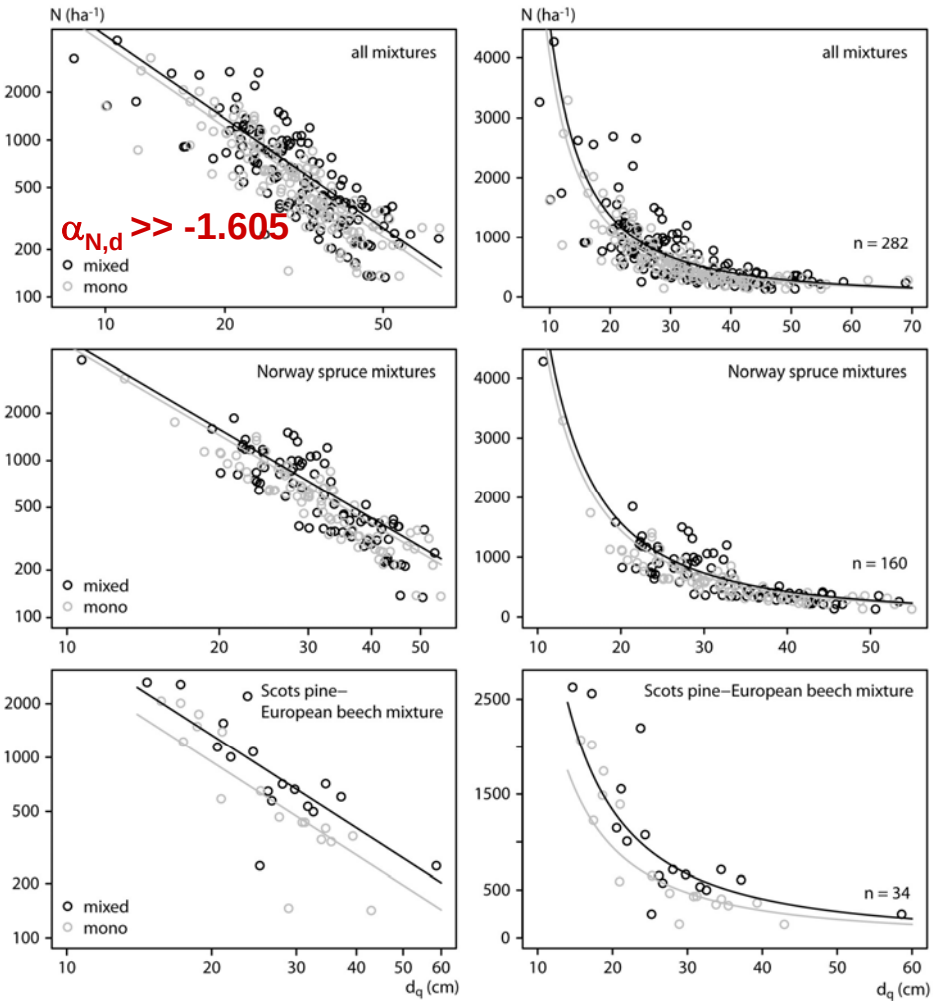


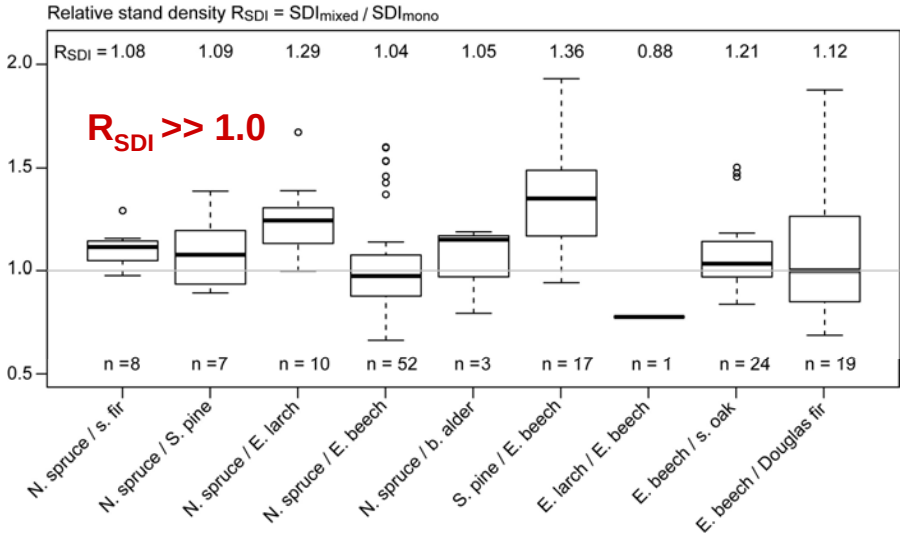
Species combination	N. sp/ E. be	S. pi/ E. be	s. oak/ E. be	E. be/ D-fir	S. pi/ N. sp	E. la/ N. sp	N. sp/ s. fir	mean
overyielding	21	30	20	11	21	25	13	
(± SE) in %	(± 3)	(± 9)	(± 3)	(± 8)	(± 11)	(± 6)	(± 6)	
corr. factor	1.10	1.20	1.10	1.10	1.20	1.20	1.10	1.10

Pretzsch, Forrester, Bauhus (2017) Mixed-species forests. Ecology and management, Springer, Berlin, 653 p

Waldwachstumskunde
Systemanalyse

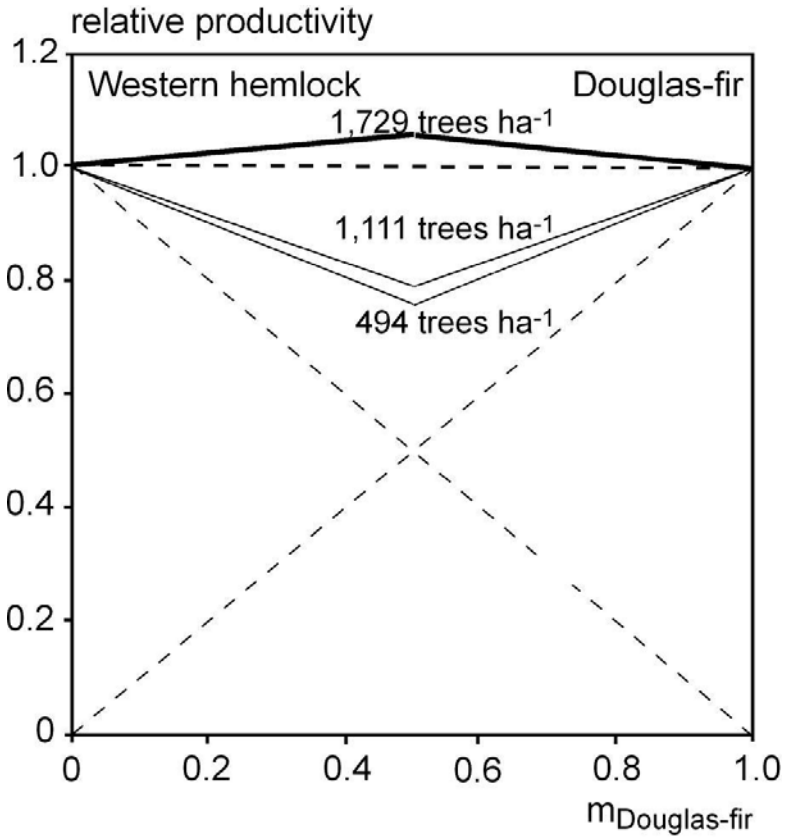
Effect of tree species mixing on stand density represented by self-thinning line and SDI

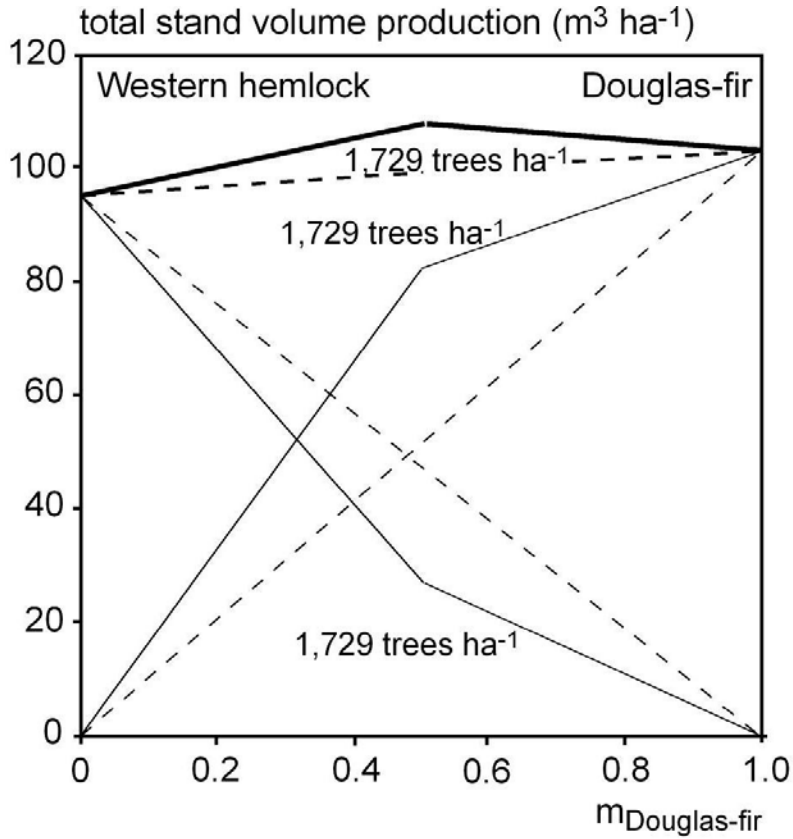




Pretzsch H, Forrester D, Bauhus J (2017)
Mixed-species forests.
Ecology and Management,
Springer, Berlin, 653 p

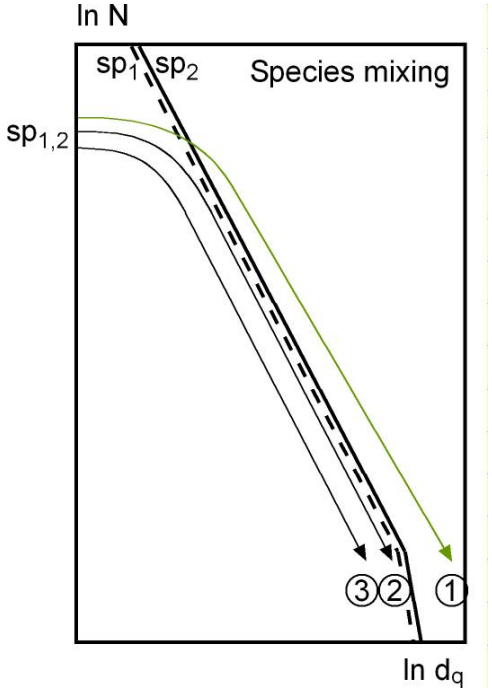
Mixing effects in terms of overyielding can emerge from stand density and can be eliminated by thinning

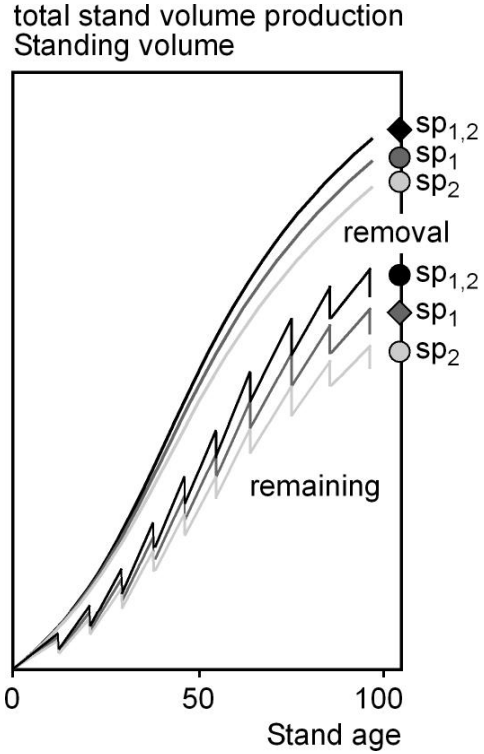


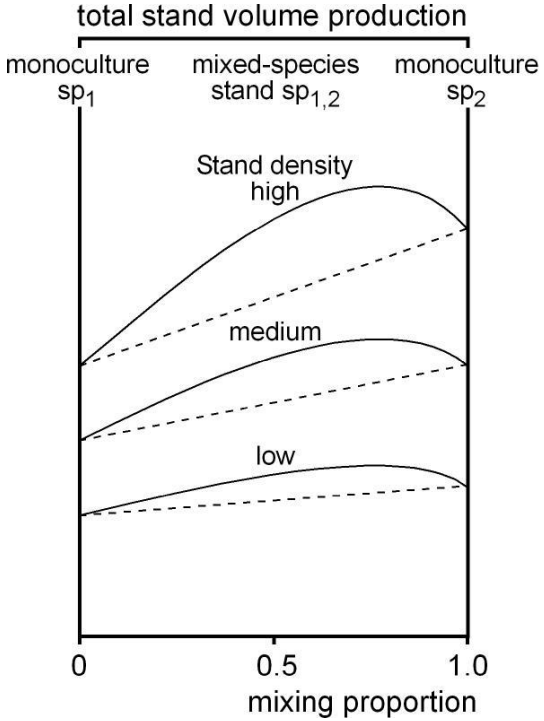


Amorosos and Turnblom (2006) Comparing productivity of pure and mixed Douglas-fir and western hemlock plantations, Canadian Journal of Forest Research 36:1484-1496

Long-term mixing experiments can reveal the effect of mixing on stand density, remaining and removal stand, and any overyielding in total production







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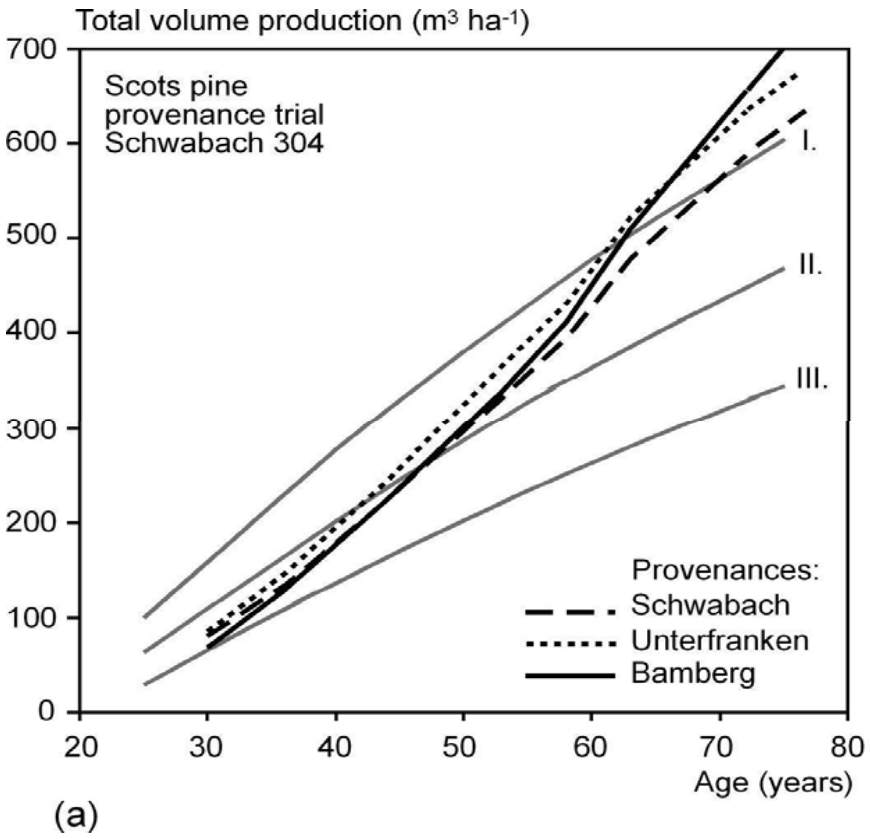
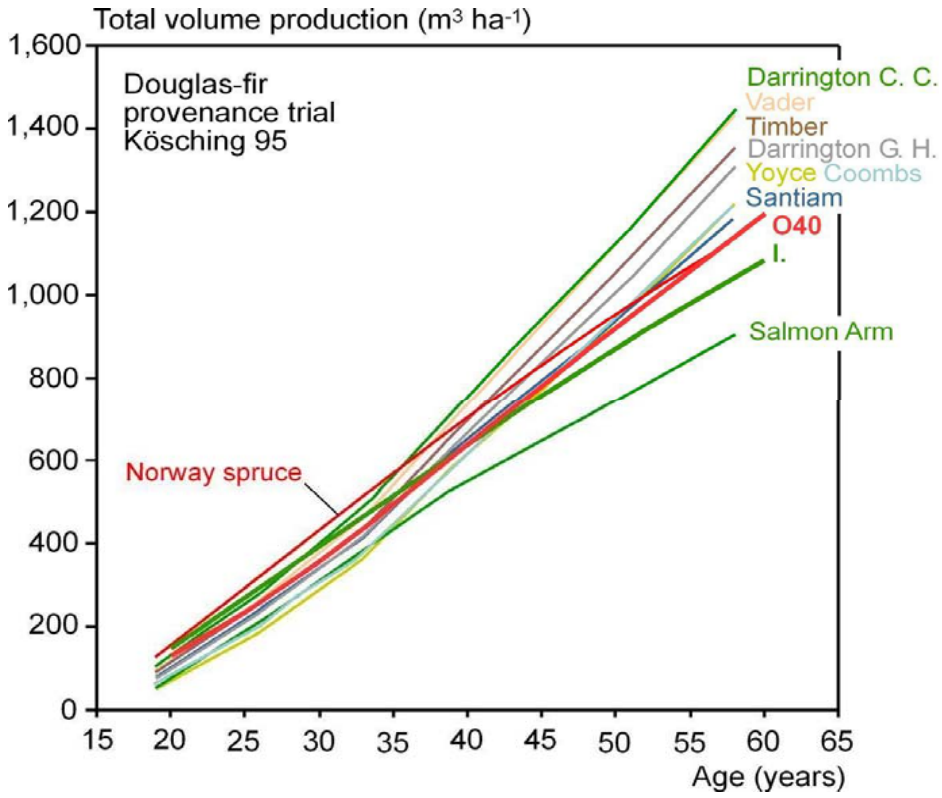
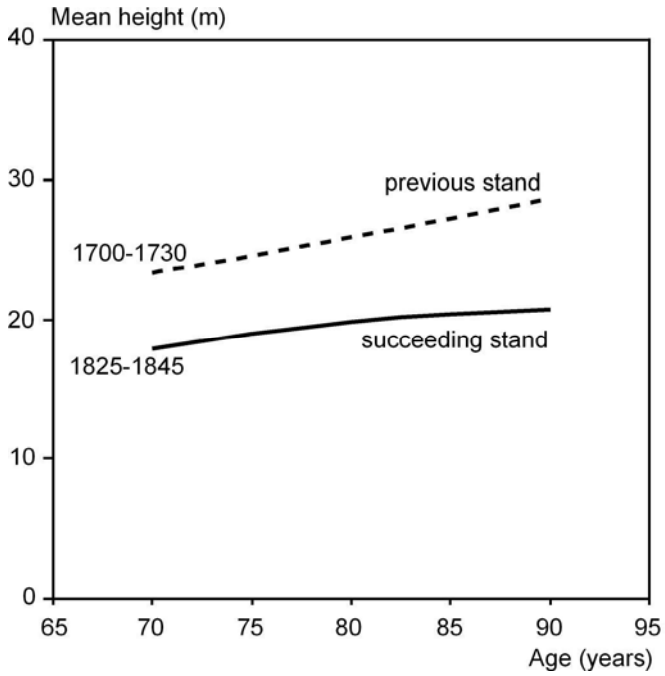
Changes in the ranking and growth of different Scots pine provenances on long-term trials in Bavaria





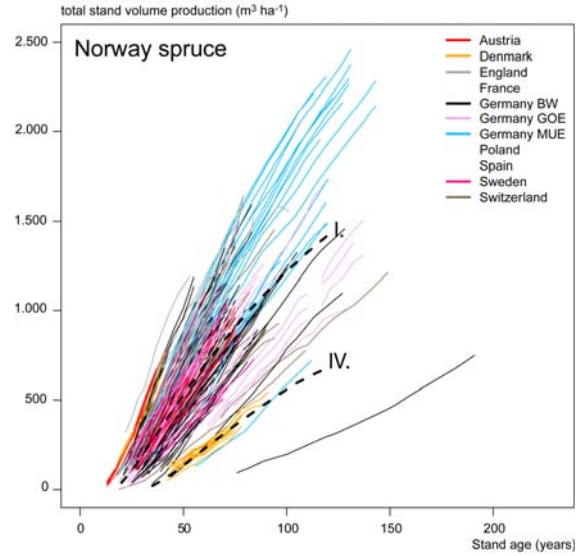
Degradation in the site fertility by repeated cultivation of Norway spruce in Saxonia revealed by long-term survey

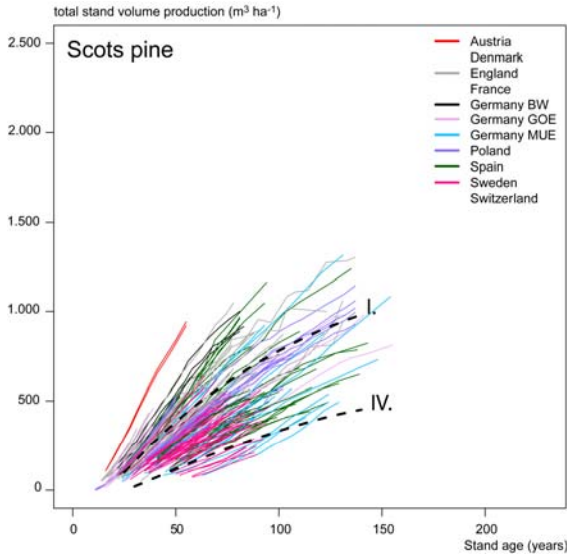


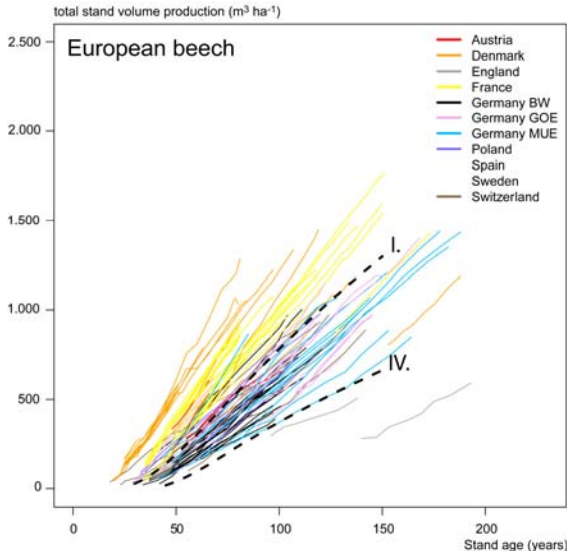
Wiedemann E (1923, p 157, Tab. 1)

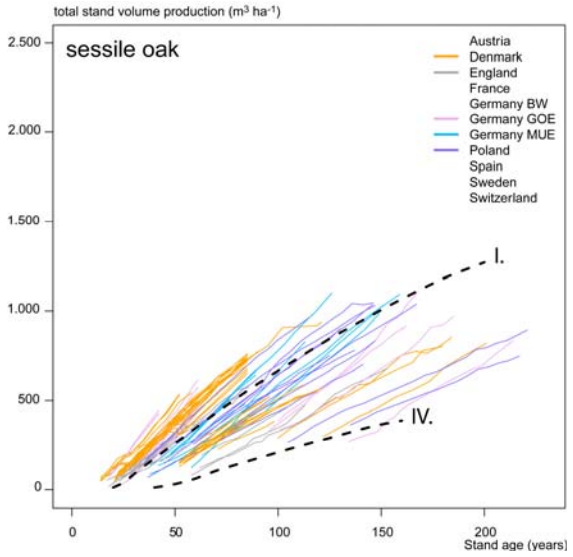
Waldwachstumskunde
Systemanalyse

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









Waldwachstumskunde
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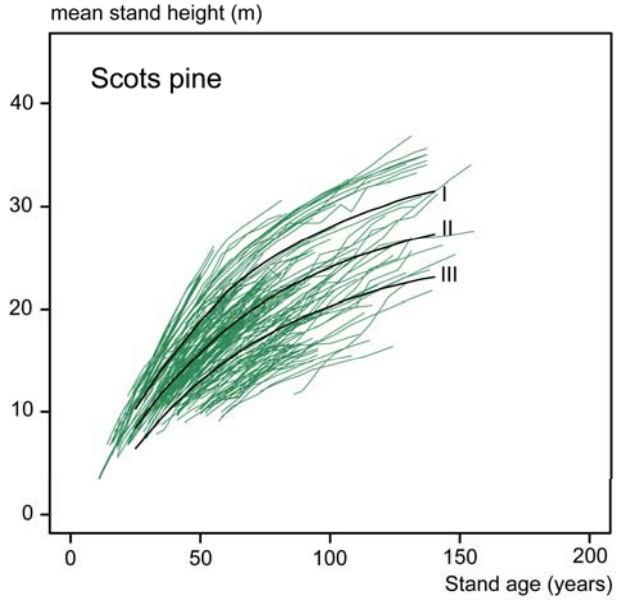
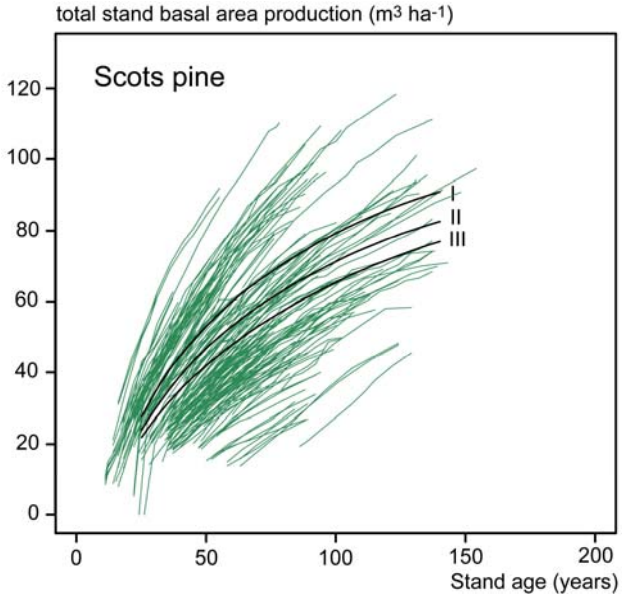
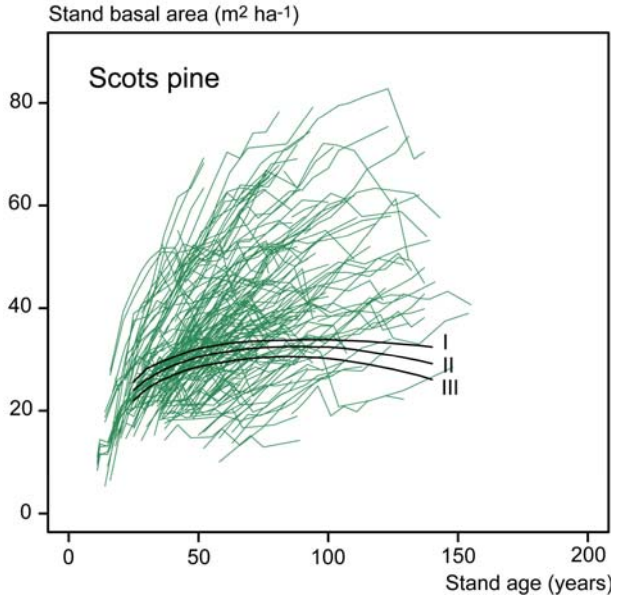
Growth trends of height, basal area production and stand basal area of Scots pine since 1860







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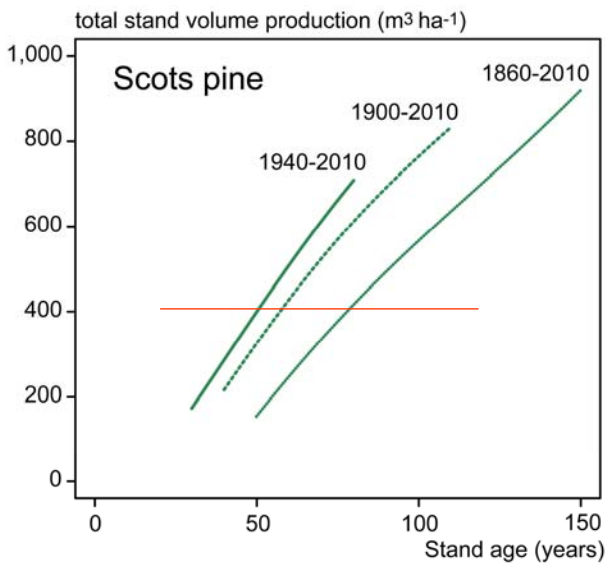
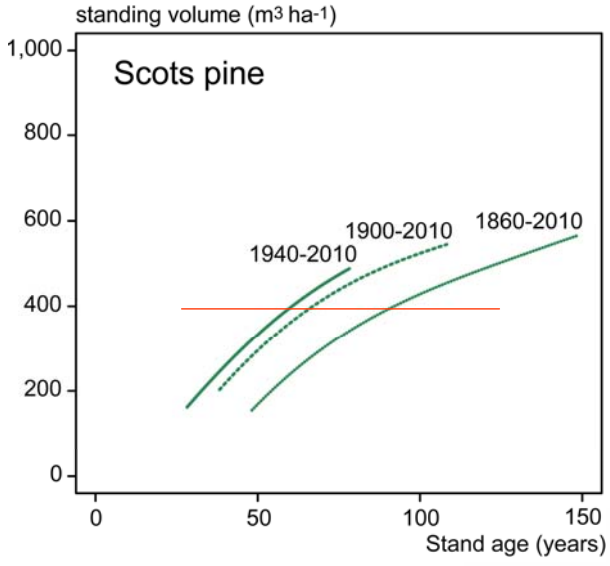
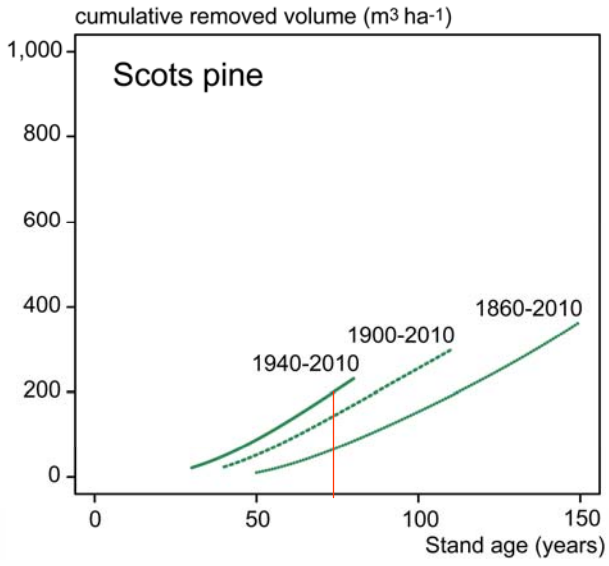
Growth trends of Scots pine in Europe







- a given total stand volume production and standing stock is reached 50 years early than 100 years ago
- at the age of 75 intermediate yield is 200 m^3 ha^{-1} while it was 75 m^3 ha^{-1} 100 years ago,
- this means an increase of intermediate yield by 150 %.

Scots

NORMAL YIELD TAI

Age	MAIN CROP After Thinning							Yield	
	Number of Trees	Top Height feet	Mean BHQG ins.	Basal Area sq. ft. q. g.	Volume (h. ft.) to top diameter o.b. of 3 inches	7 inches	9 inches	Number of Trees	Mean BHQ ins.
15	1650	27½	2¾	86	750	—	—	—	—
20	765	36	3½	65	1020	—	—	885	3
25	478	44	4¾	71	1380	120	—	287	4
30	333	51	6	80	1830	610	95	145	5
35	250	57½	7¼	90	2330	1500	580	83	6¼
40	199	63½	8½	100	2840	2350	1420	51	7½
45	166	69	9¾	110	3350	3015	2270	33	8¾

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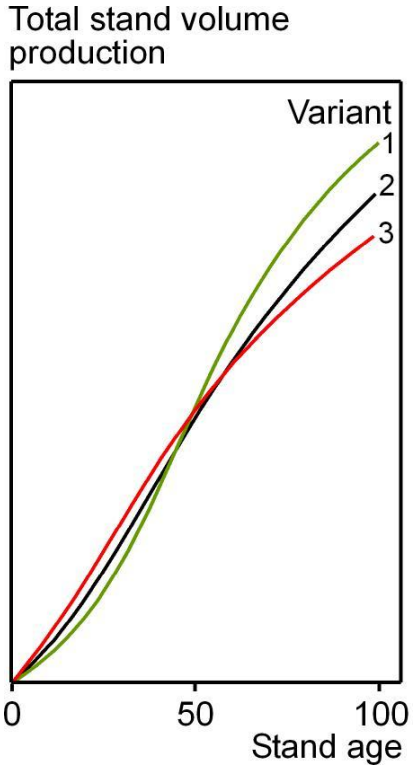
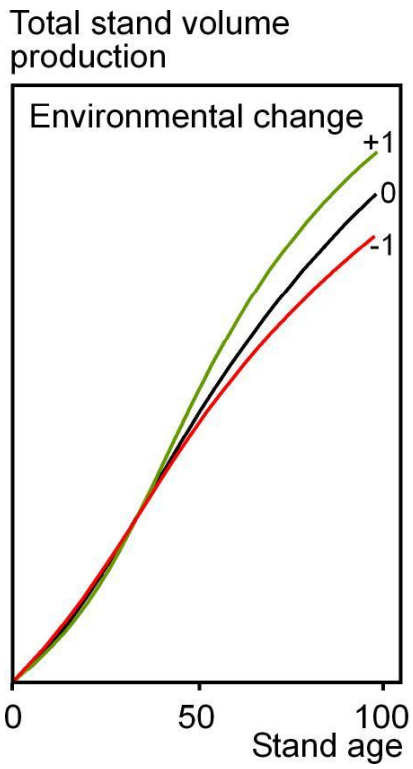
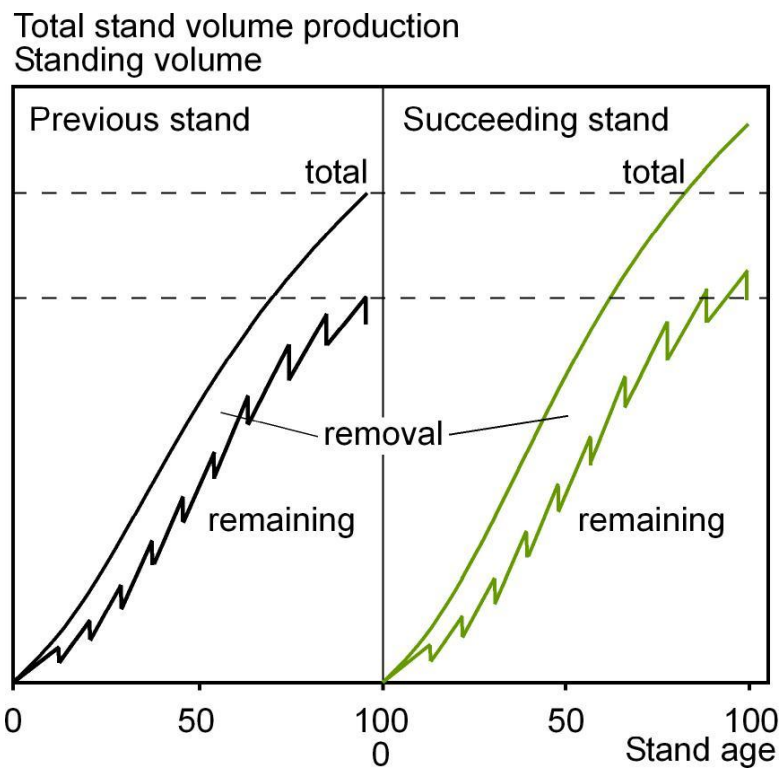
Long-term experiments document growth trends, environmental changes, human impact on forests







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Systemanalyse

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DFG
MStELF, MStU, BaySF

Thanks for provinding data to
partner institutions in Sweden, Denmark,
England, Poland, France, Germany
Austria, Switzerland, Italy, Spain, and others

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