Waldwachstumskunde
Systemanalyse

Contribution of functional ecology to forest management

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


establishment


thinning


regeneration


transformation

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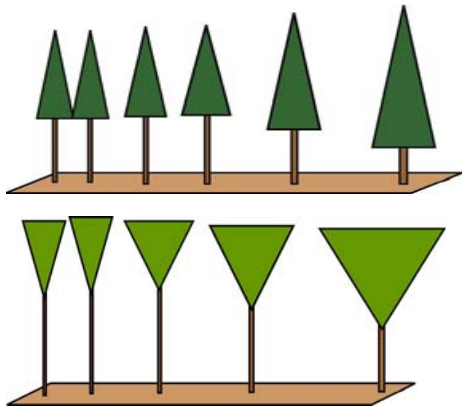
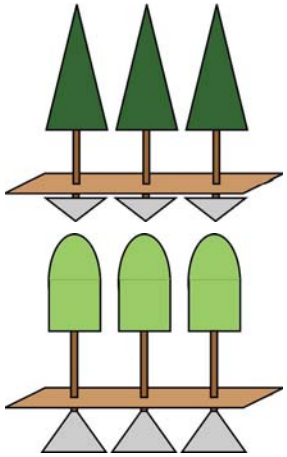
Structural and functional characteristics of tree species

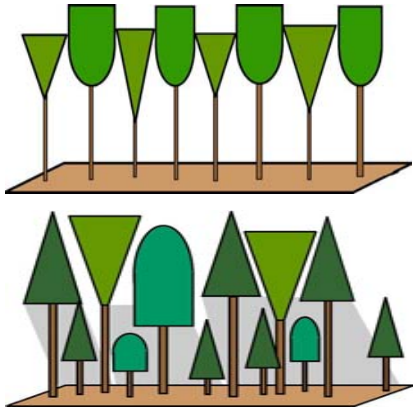
inplastic - plastic



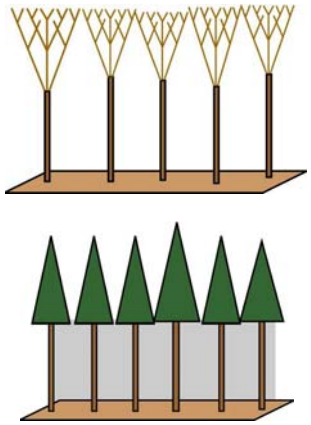
shallow – deep rooting



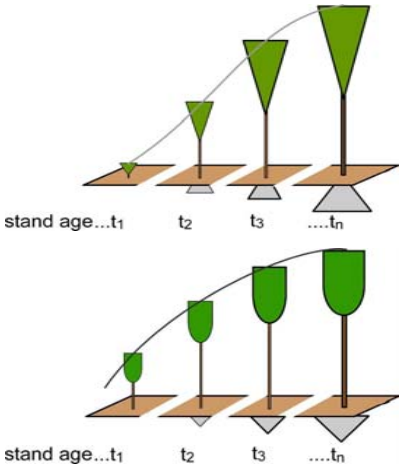
light demanding - shade tolerant



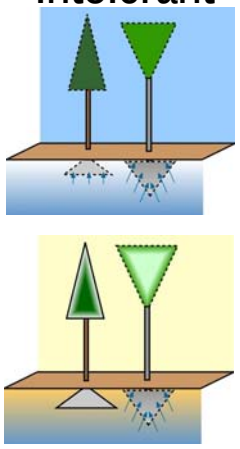
seasonal - evergreen



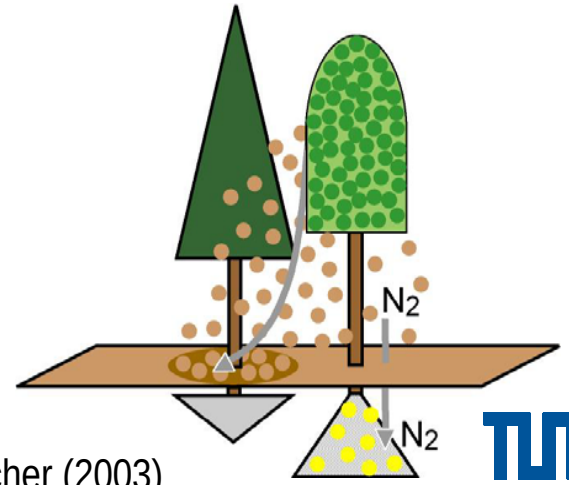
slow - fast growing



drought tolerant-intolerant



N-fixing - non N-fixing



Ammer (2018), Pretzsch et al. (2017), Ellenberg and Leuschner (2010), Larcher (2003)

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1 Functional characteristics considered by forest management

2 Functional characteristics and mixing effects

3 From understanding to silvicultural design and guidelines

Next steps

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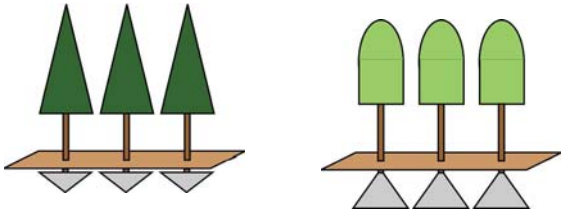
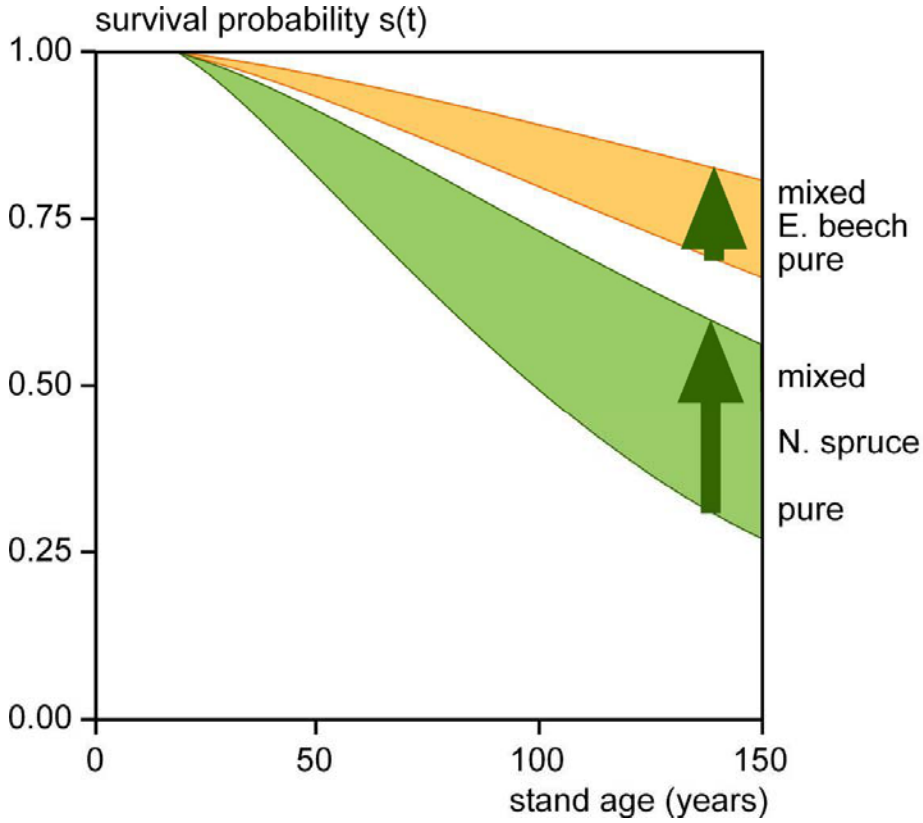
Rooting depth: Selection of species with wind stability



wind stability: oak > beech > pine > spruce



Brandl et al. (2018)
Griess and Knoke (2011)

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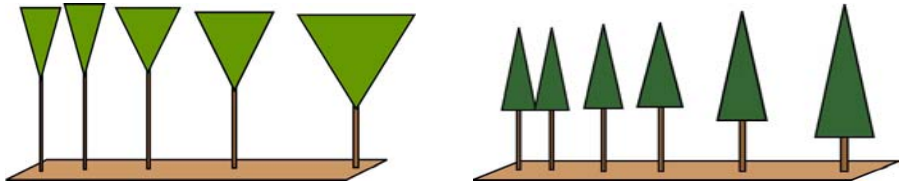
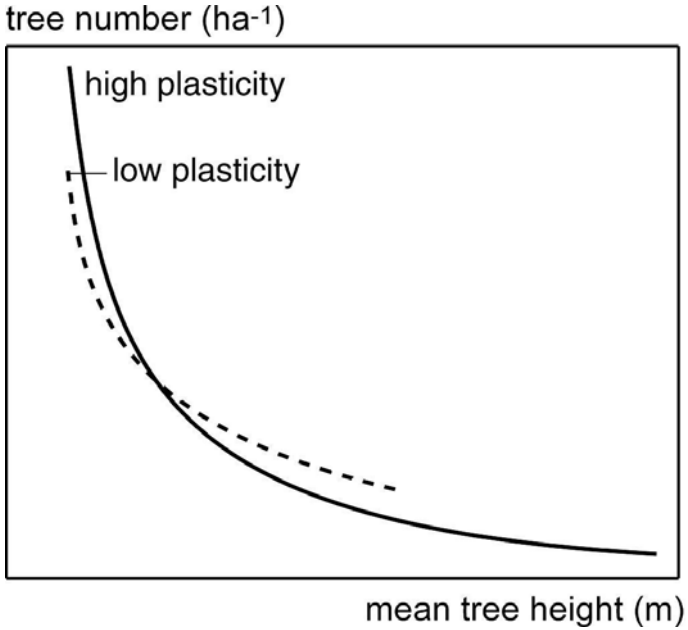
Morphological plasticity: consequences for spacing



m. plasticity: beech > oak > pine > spruce



initial density: s. oak (20,000 ha^{-1}) >
E. be. > S. pi > N. sp > D-fir (1,000 ha^{-1})
crop trees: s. oak (60 ha^{-1}) vs.
N. sp. (400 ha^{-1})

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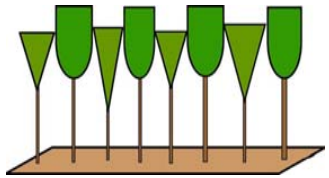
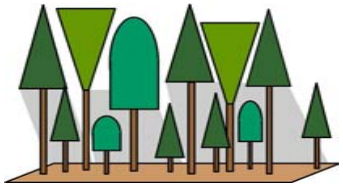
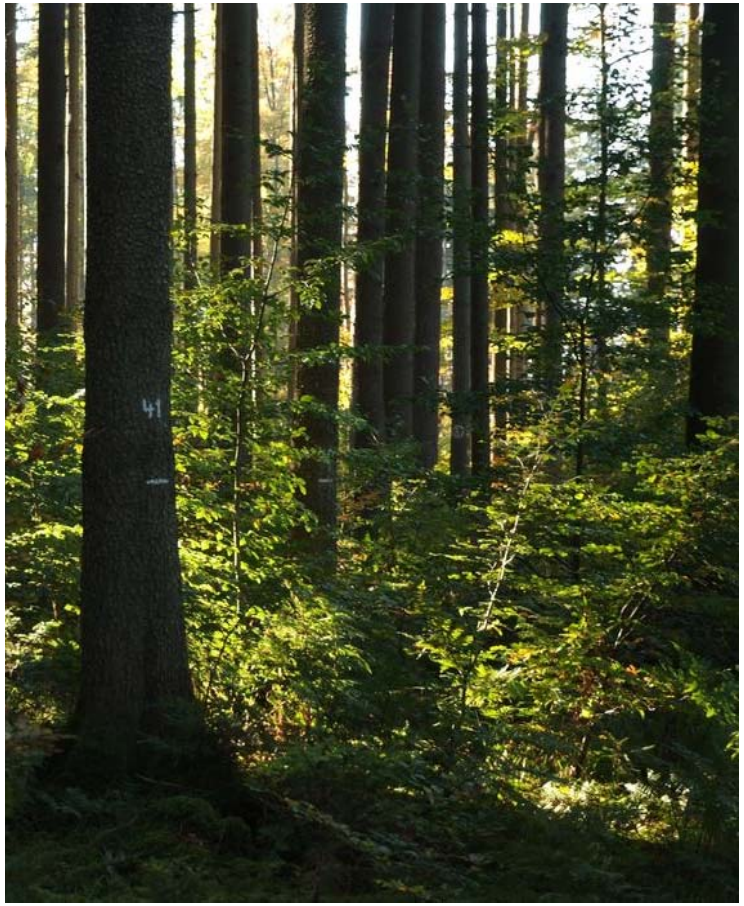
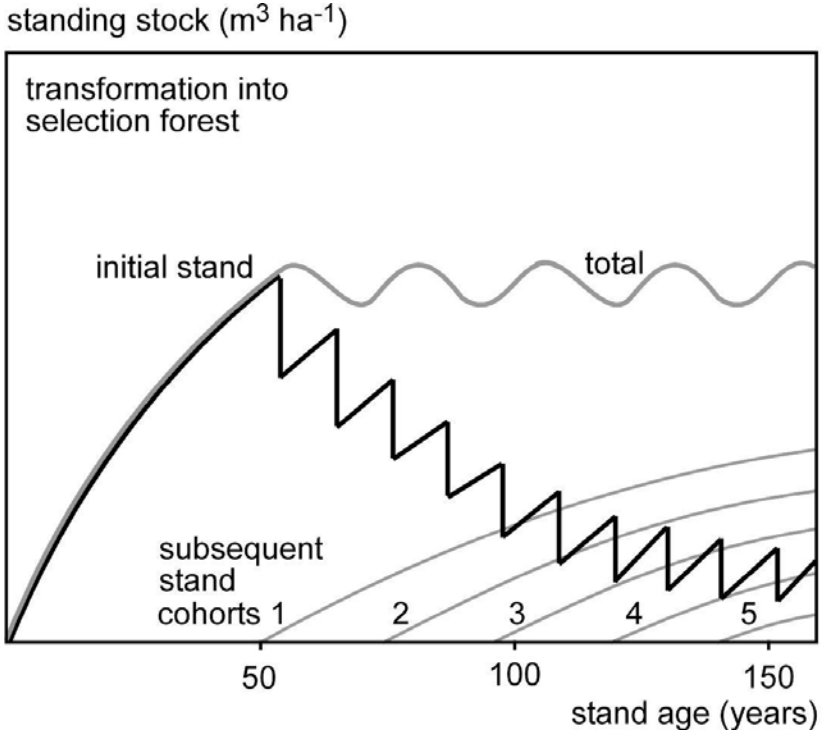
Shade tolerance, advanced planting, under-planting





shade tolerance: E.beech > fir > N. spruce > oak > pine





Pretzsch et al. (2018)

Summary 1:

- structural and functional tree characteristics are deeply engraved in forest practitioners‘ experience
- since centuries species selection, spacing, thinning advanced planting etc. are based on s-f characteristics
- focus on mono-specific stands

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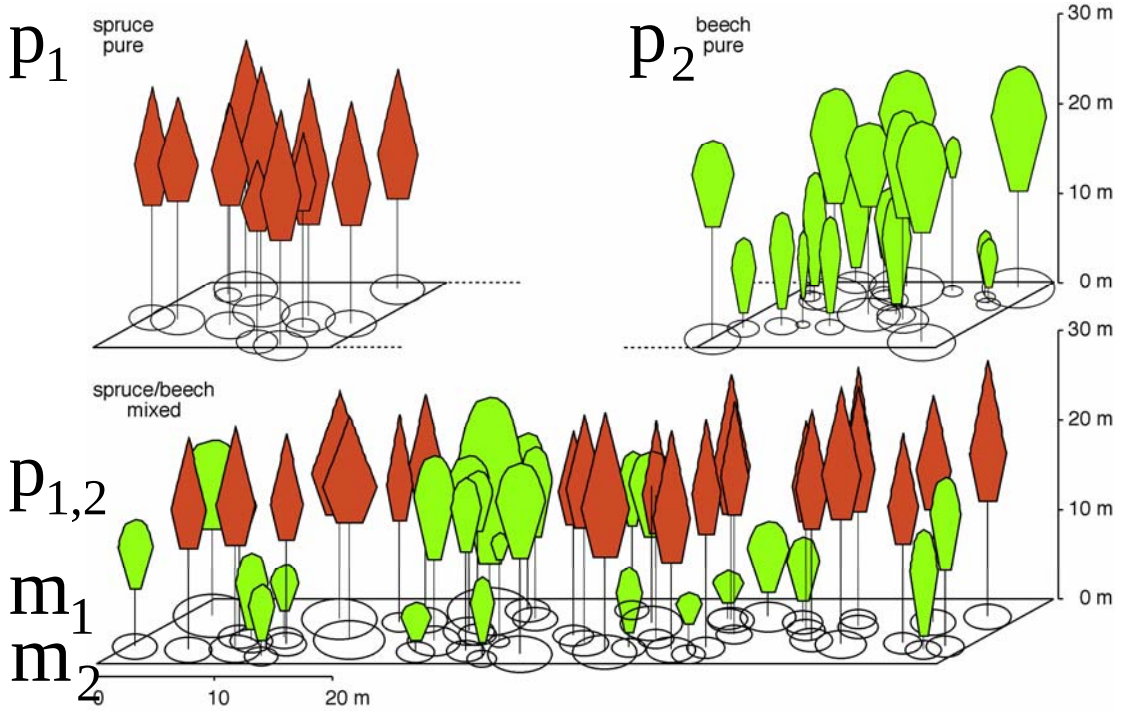
Experimental setup for scrutiny of mixing effects Zwiesel 111/3,4,5 Bavarian Forest



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

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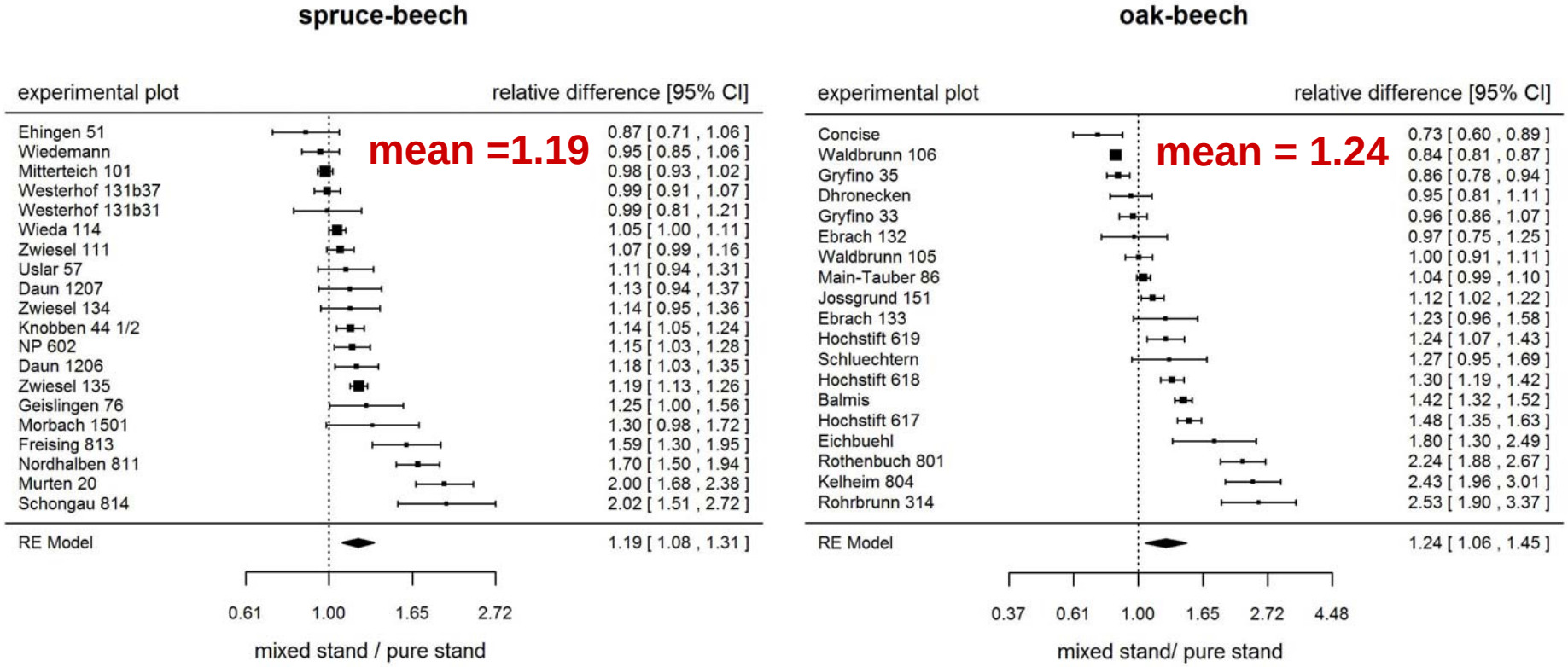
Meta-analysis on overyielding of mixed stands of Norway spruce/European beech and s oak and E. beech on long-term experiments



Pretzsch, Forrester and Bauhus (2017)

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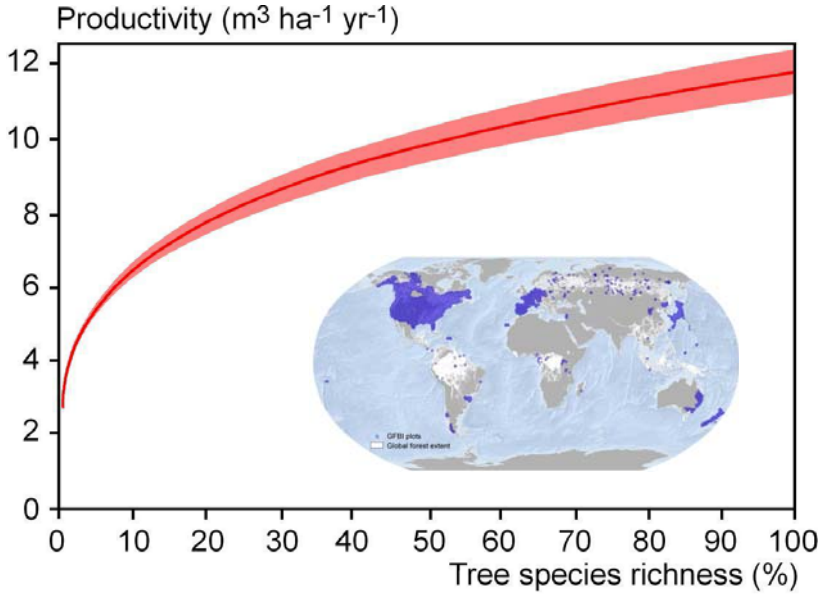
Mixing effects on productivity of forests in Central Europe and worldwide

overyielding ordered by light demand:

	S. pi.	E. la.	s.oak	N.sp.	D-fir	E.be.
S. pi.	1					
E. la.		1				
s. oak	1.08		1			
N. sp.	1.21	1.21		1		
D-fir				1.13	1	
E. be.	1.30	1.25	1.20	1.21	1.11	1

Pretzsch (2016) Ertragstafel-Korrekturfaktoren für Umwelt- und Mischunsgeffekte, AFZ Der Wald, 14/2016: 47-50



Liang, J. et al. (2016) Positive Biodiversity-Productivity Relationship Predominant in Global Forests, Science, 354 (6309), aaf8957

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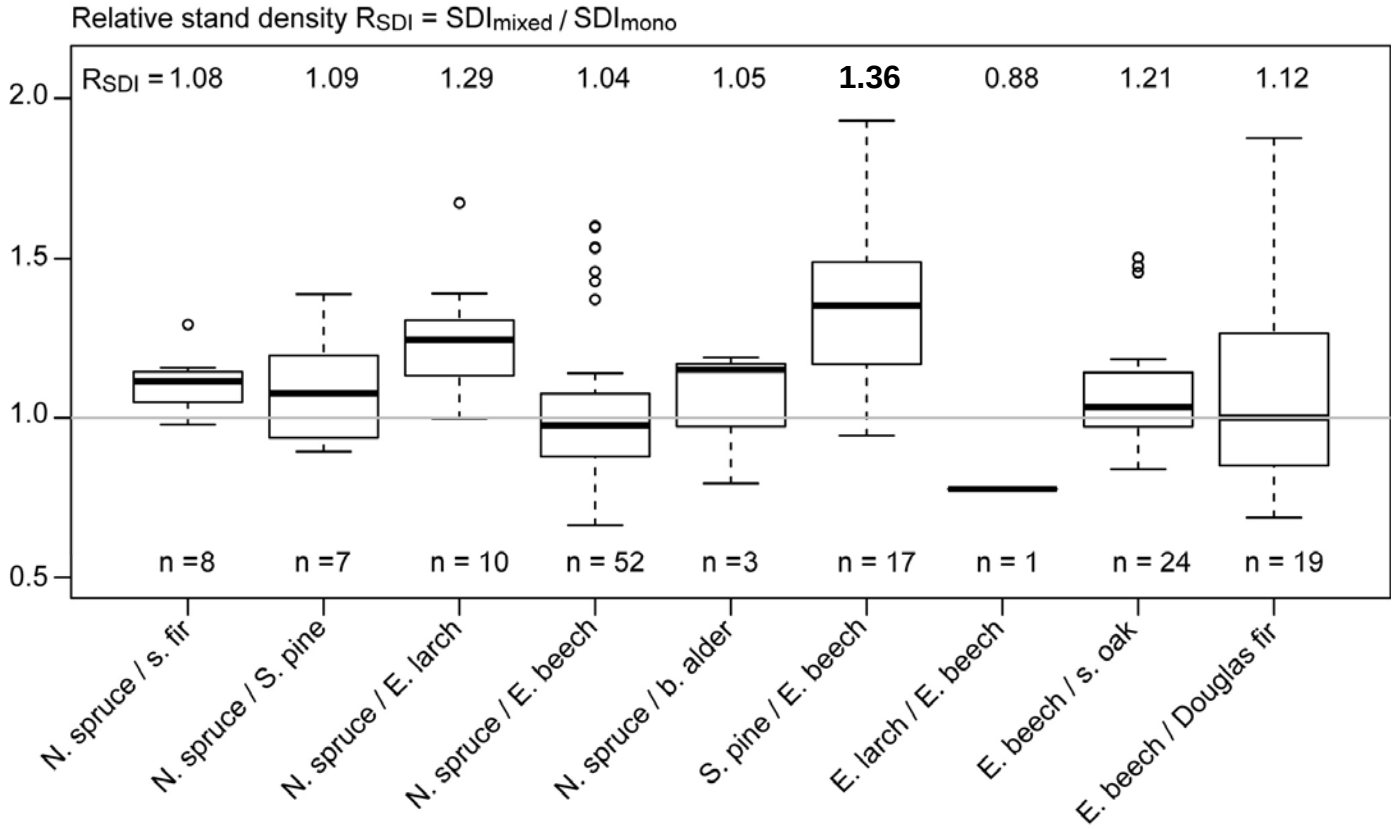
Stand density (SDI) of mixed-species stands versus monocultures on long-term experiments in Central Europe



Pretzsch, H., Biber, P. (2016) Tree species mixing can increase maximum stand density. Canadian Journal of Forest Research, DOI: 10.1139/cjfr-2015-0413

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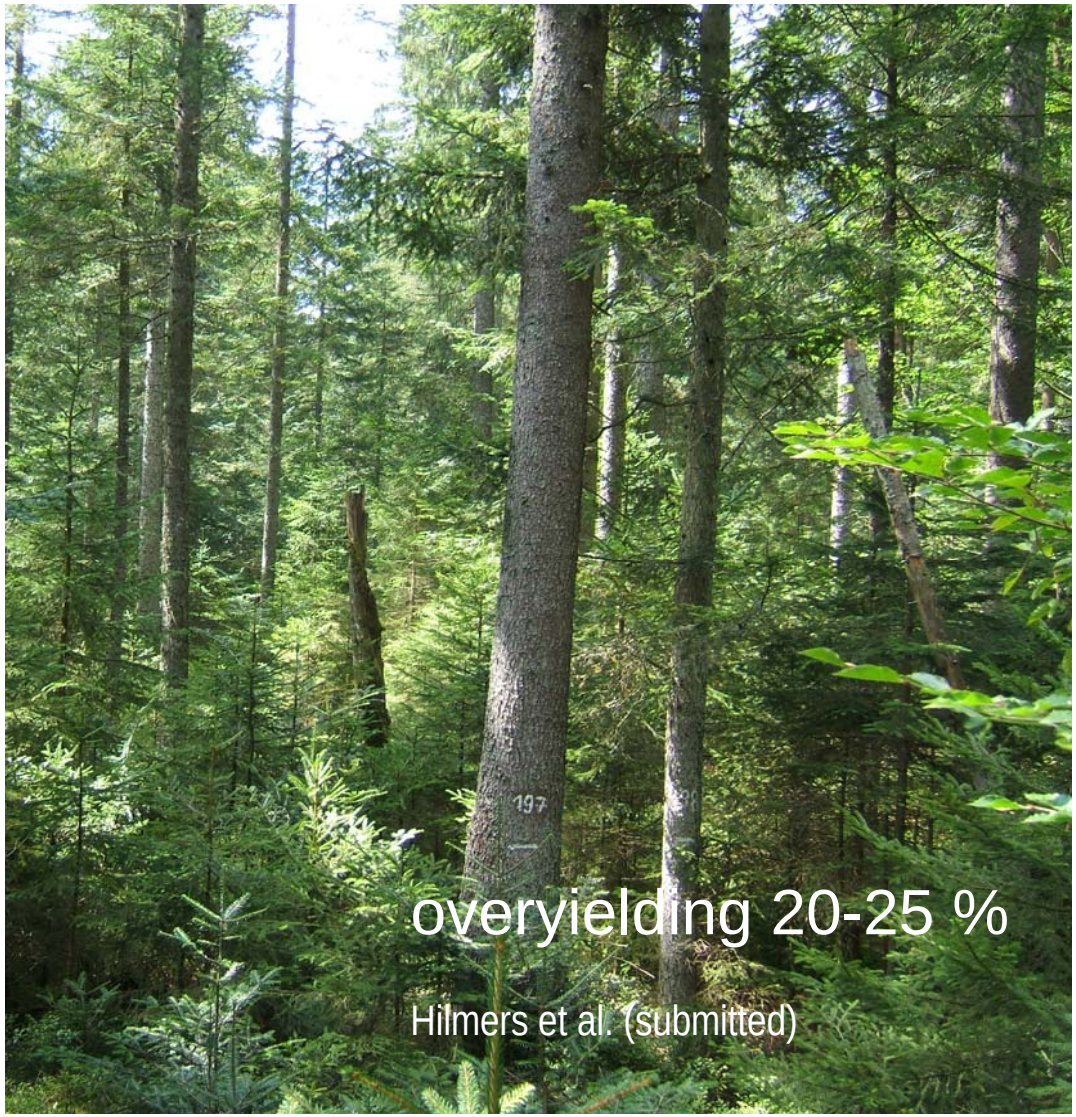
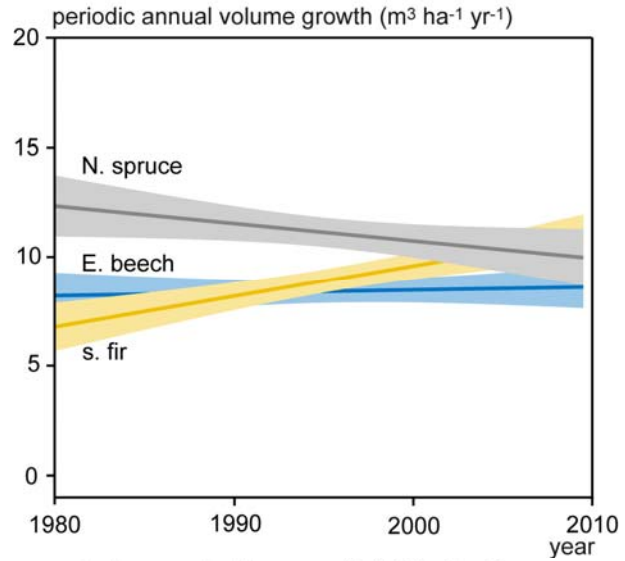
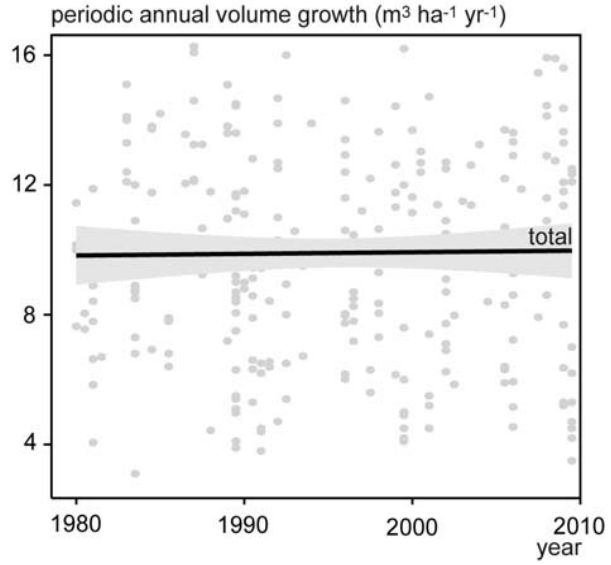
Overyielding and growth stability of the n=105 CLIMO study # 1 spruce-fir-beech stands







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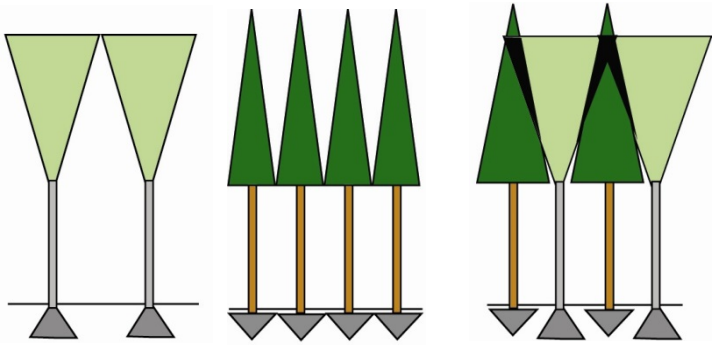
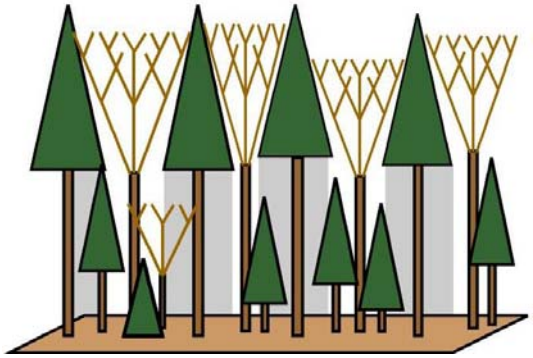
Beneficial combinations of s-f characteristics above ground

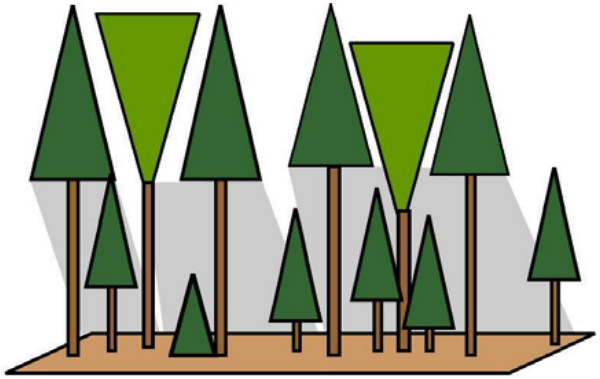
Morphological complementarity



Temporal asynchronity



complementary light ecology



Ammer Ch (2018) Diversity and forest productivity in a changing climate, New Phytologist
Pretzsch, H, Forrster, D, Bauhus, J (2017) Mixed-species Forests, Springer, Berlin, 653 p

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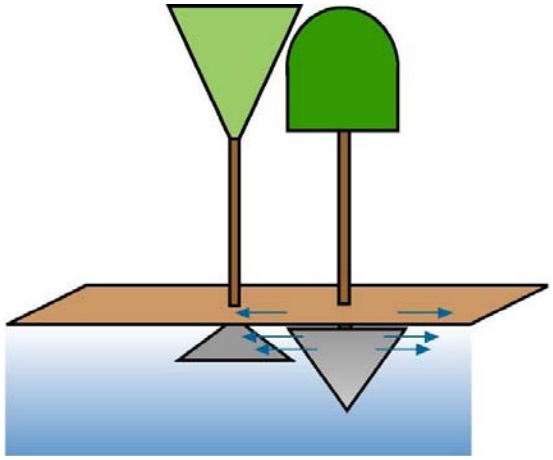
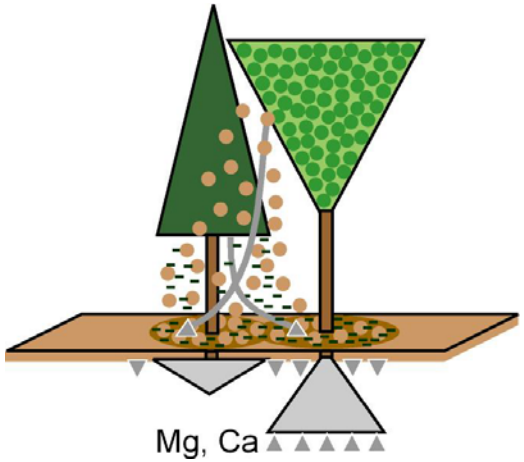
Beneficial combinations of s-f characteristics below ground

hydraulic redistribution



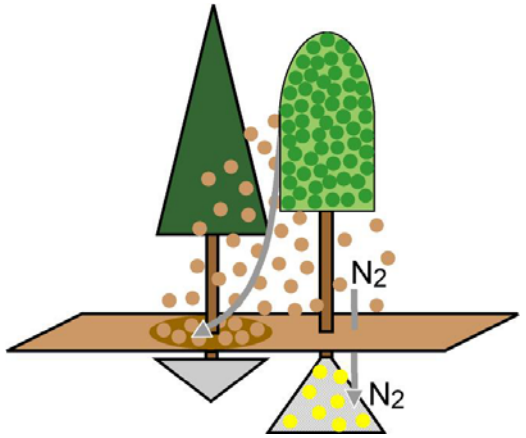
e.g. Prieto et al. 2012

nutrients upward transport

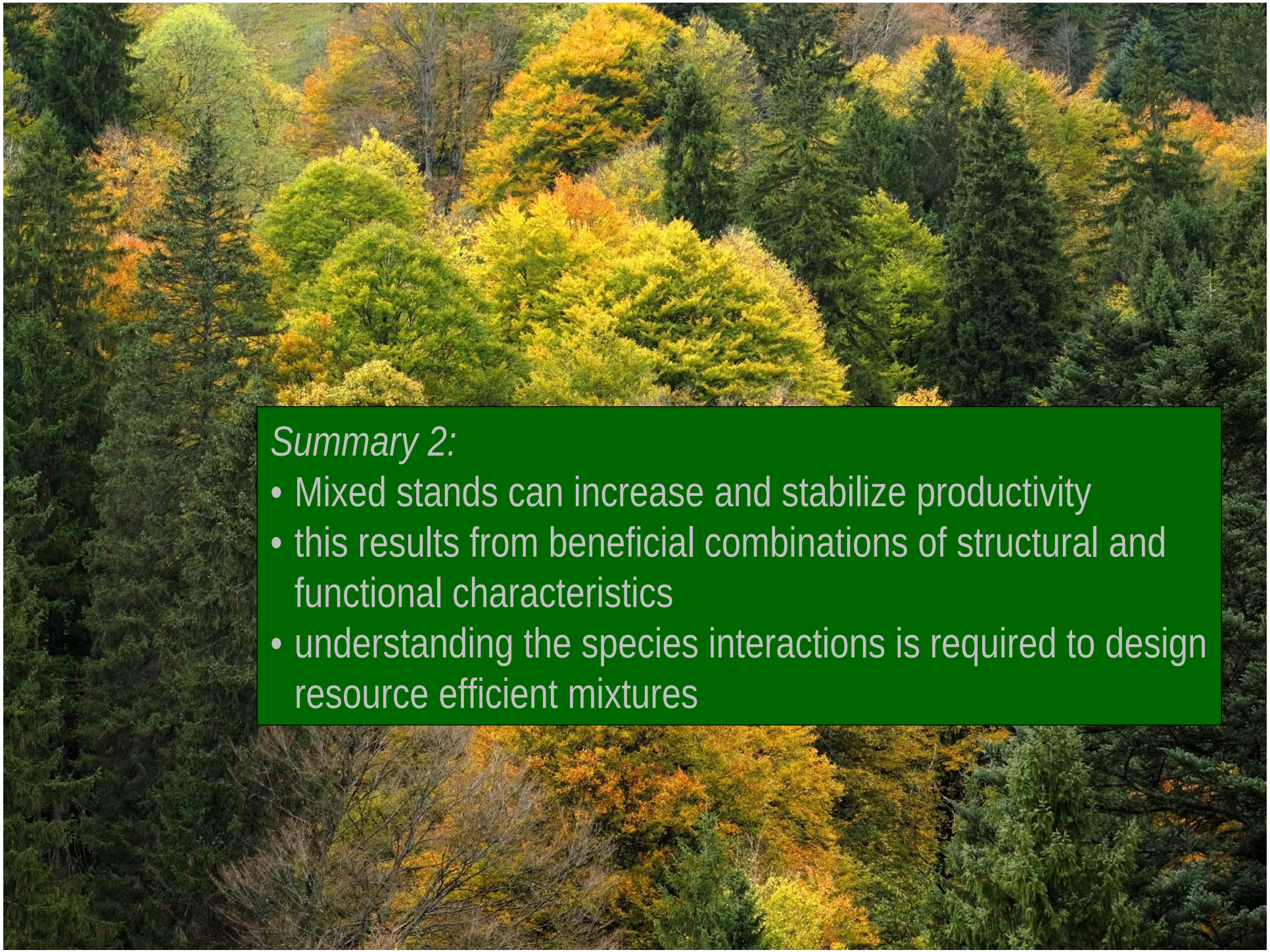


e.g. Rothe, Binkley (2001)

atmospheric N_2 fixation



e..g. Forrester et al. 2007, 2007



Summary 2:

- Mixed stands can increase and stabilize productivity
- this results from beneficial combinations of structural and functional characteristics
- understanding the species interactions is required to design resource efficient mixtures

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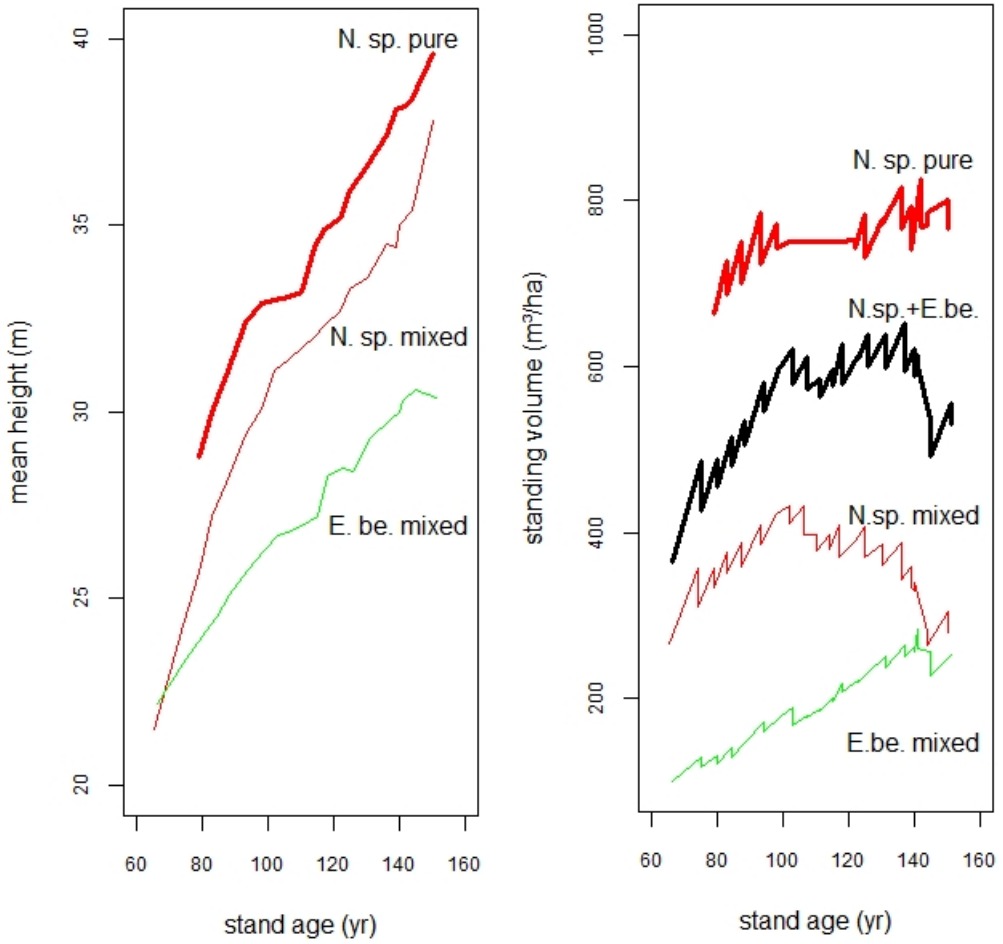
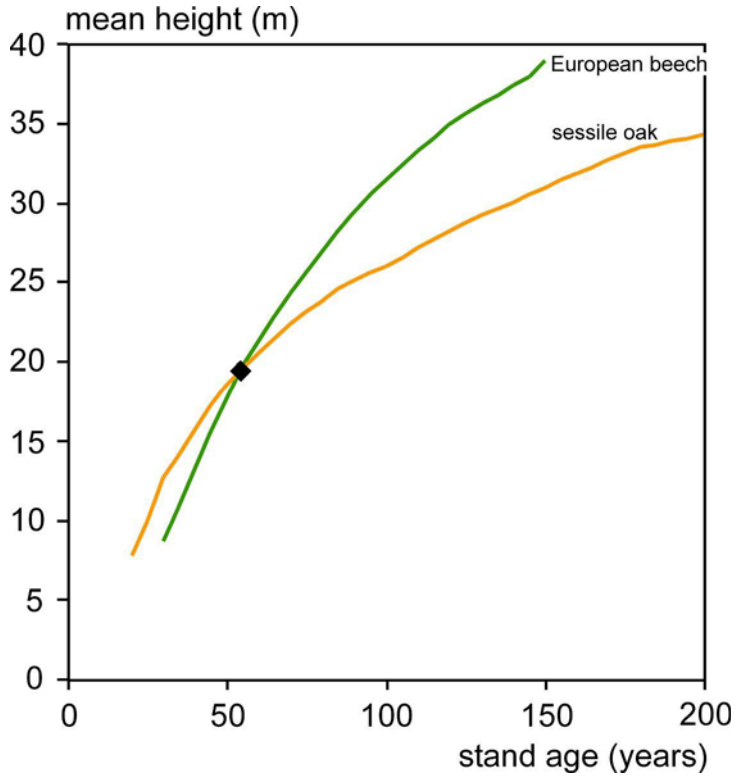
Problematic mixtures: N. spruce and E. beech Oderhaus/Harz and E. beech s. oak/Steigerwald





Lüpke v. B. and Spellmann, H (1997),
Pretzsch and Zenner (2017)

Pretzsch (2018)

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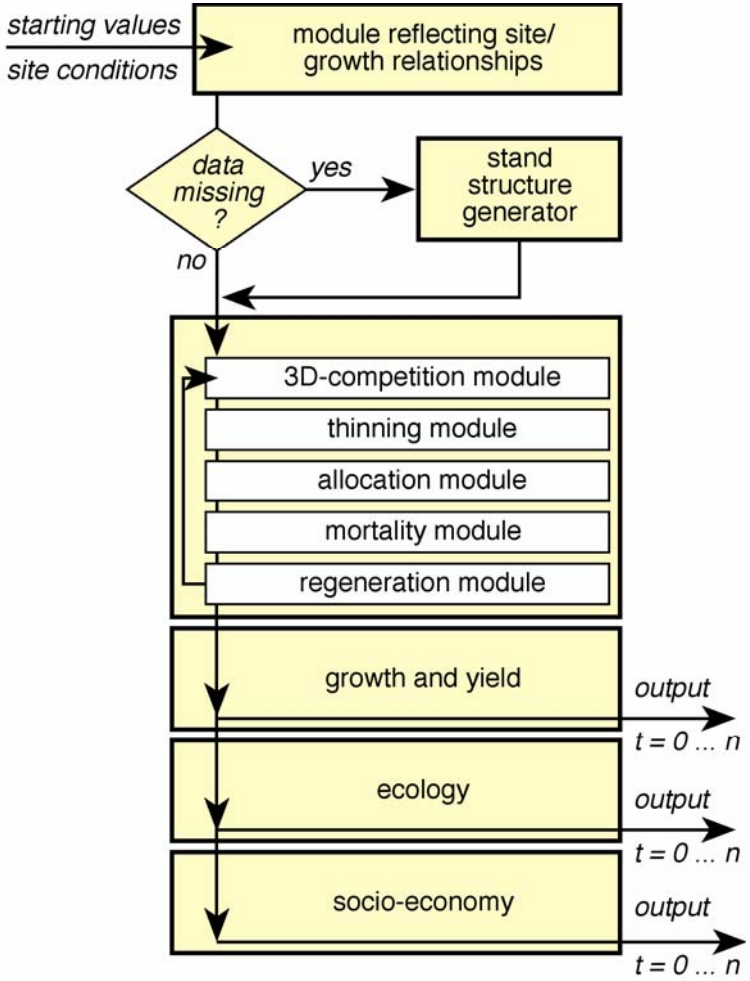
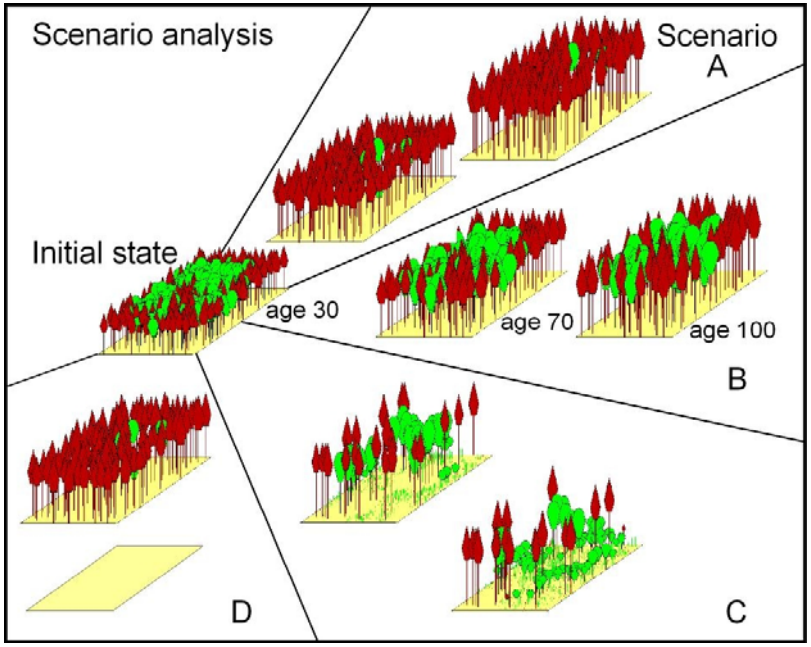
Models for the design of mixed stands: SILVA as example of a spatially explicit individual tree model





Pretzsch, Biber, Dursky (2002)

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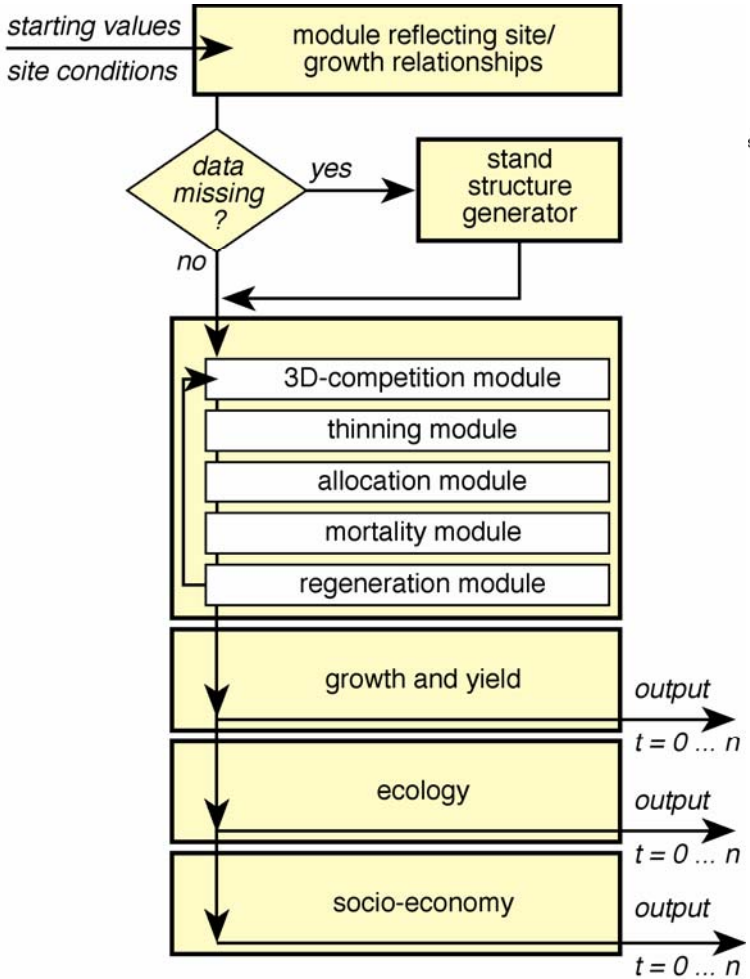
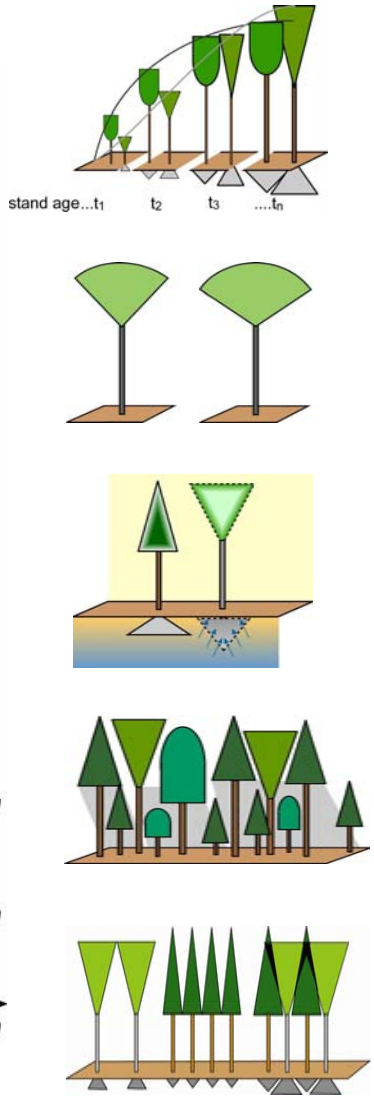
Consideration of mixing effects in models



Pretzsch, Biber, Dursky (2002)



- species- and site-specific growth velocity

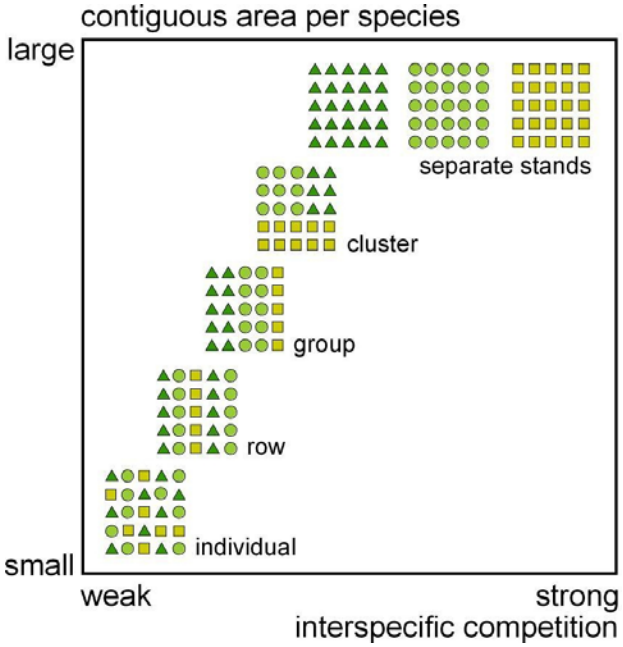
- crown shape
- stem shape
- wood density
- wood quality

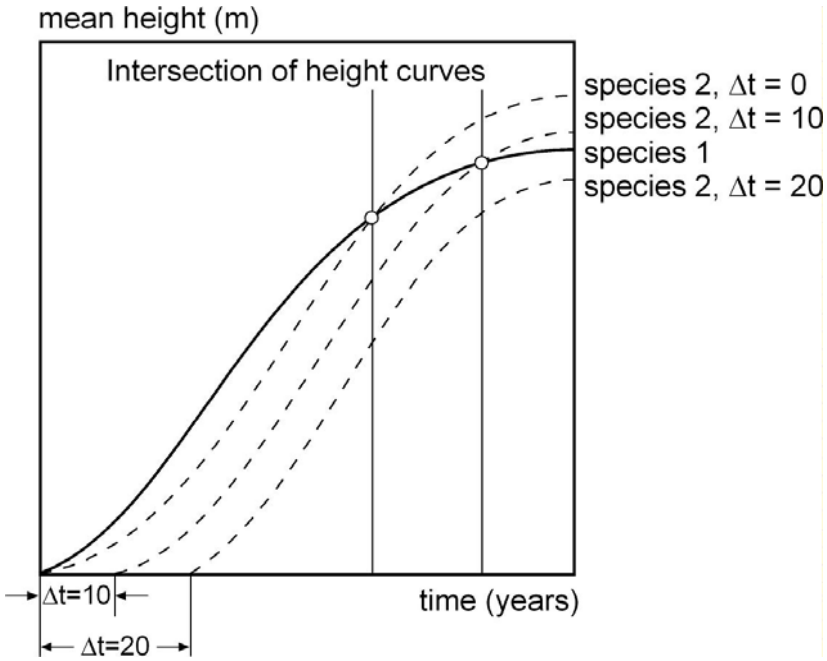
- potential growth
- growth under competition
- growth under facilitation
- growth under drought

- shade tolerance

- packing density
- mortality
- yield level

Integration of mixing regulation algorithms in models, e. g. for spatial or temporal separation





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

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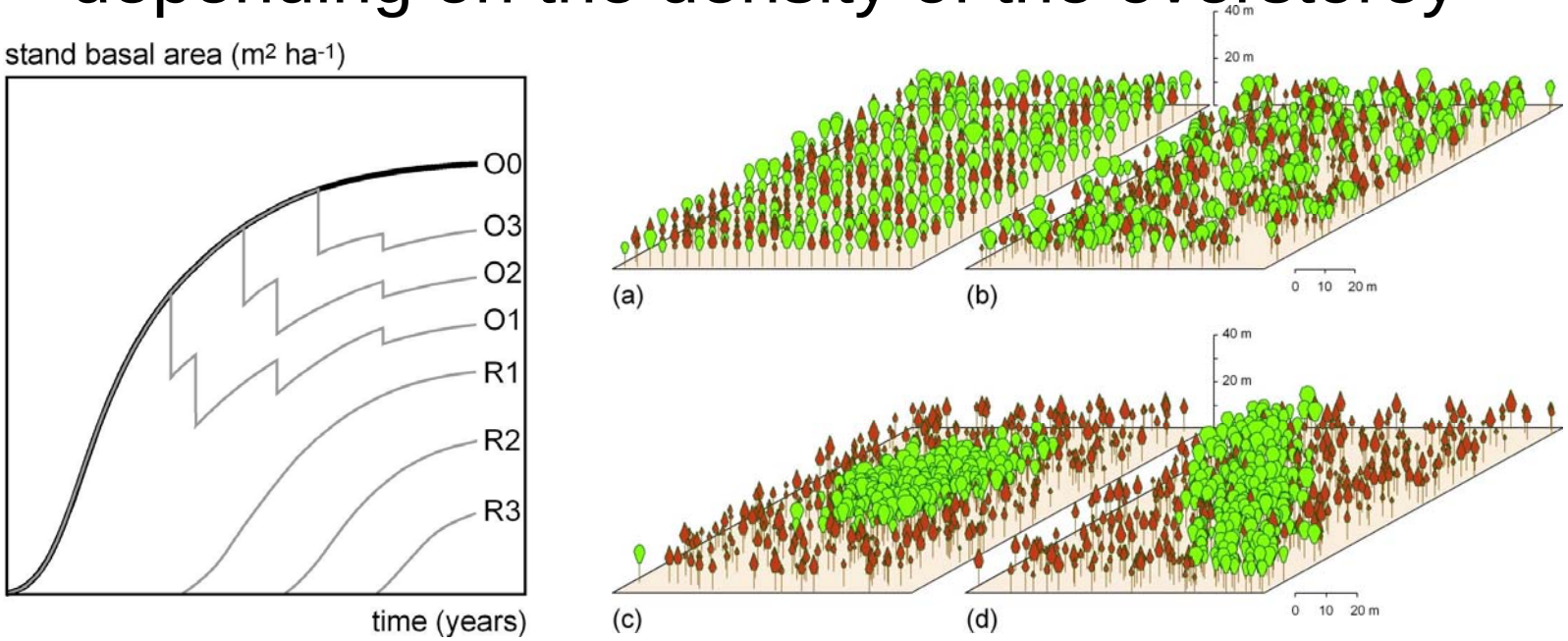
Integration of mixing regulation algorithms in models, e. g. for initiating the regeneration depending on the density of the overstorey



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

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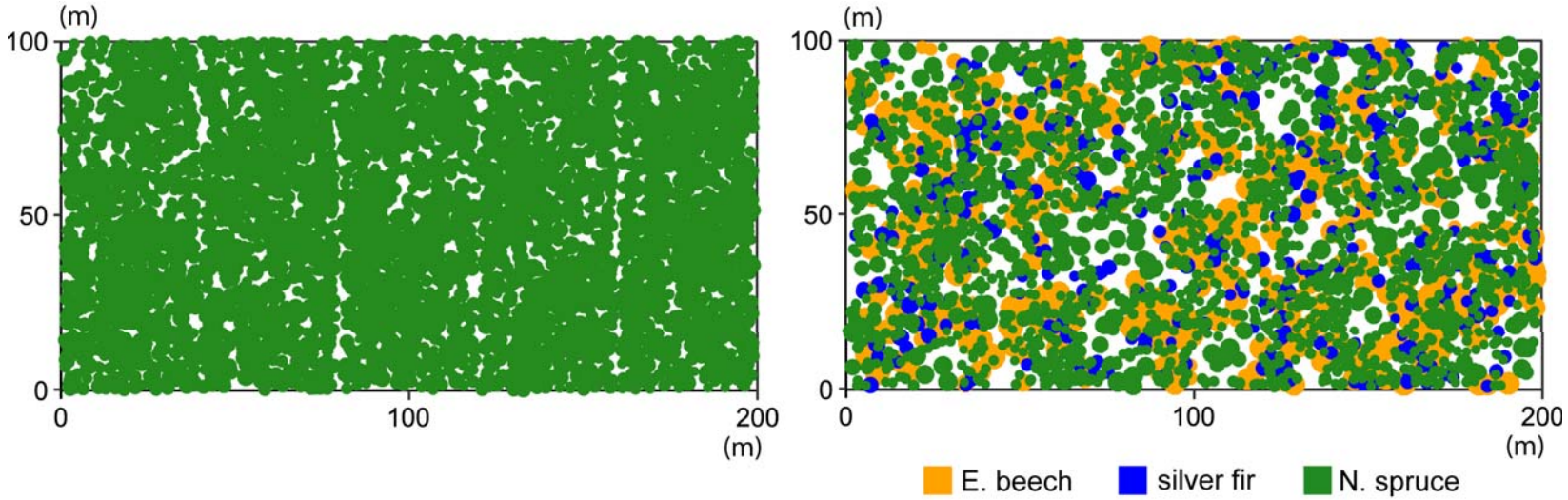
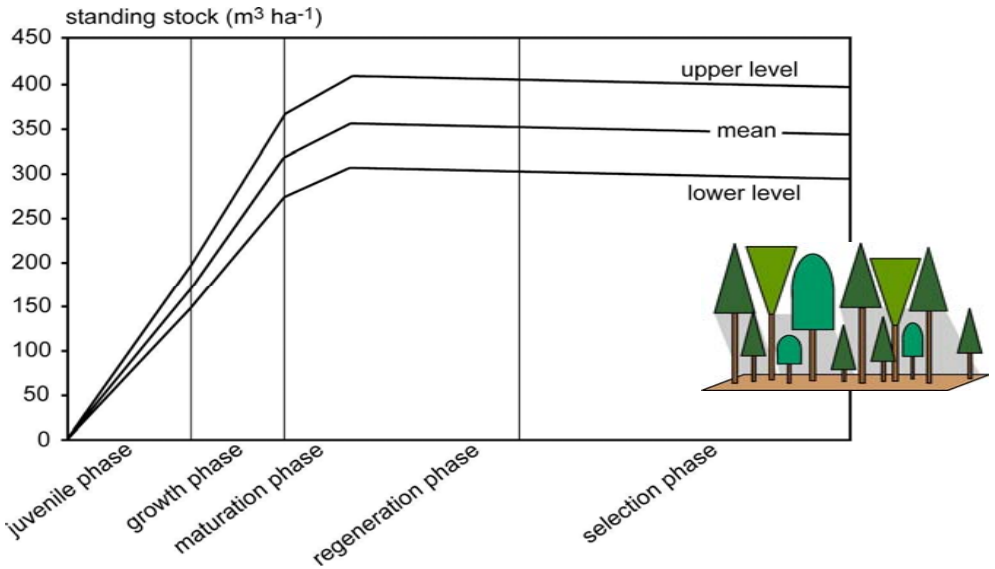
Scenario analyses and guidelines for transformation of mountain monocultures to close-to-nature stands





BaySF (2018)

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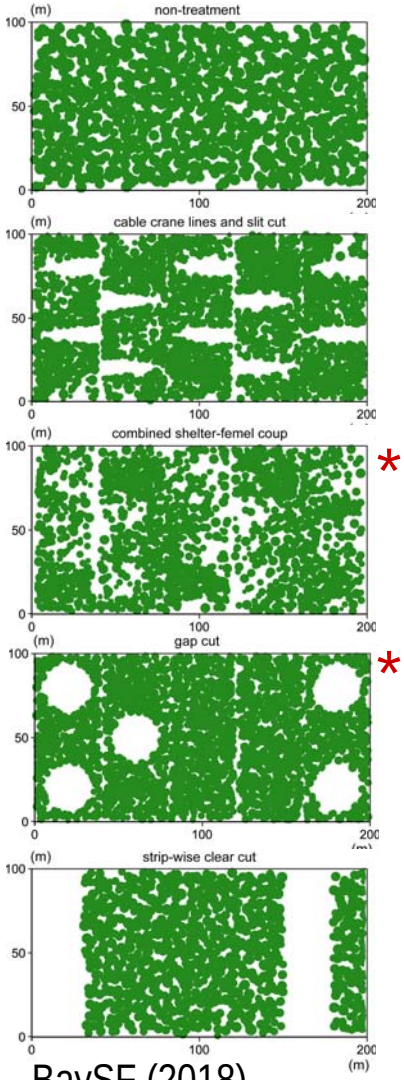
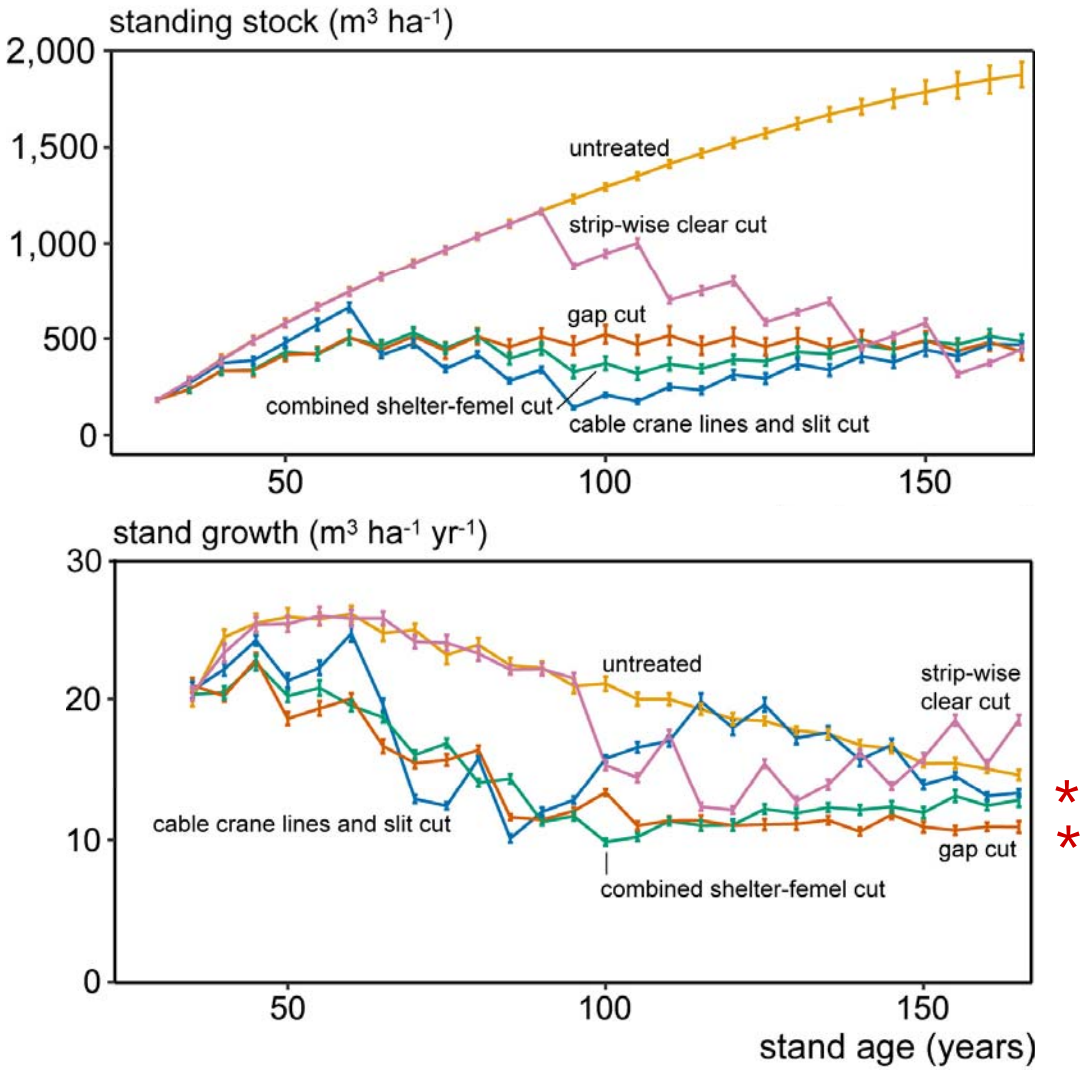


BaySF (2018)



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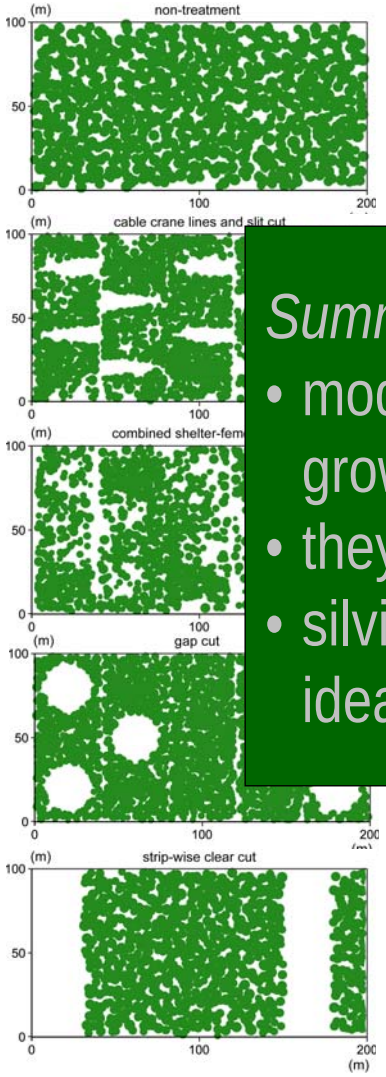

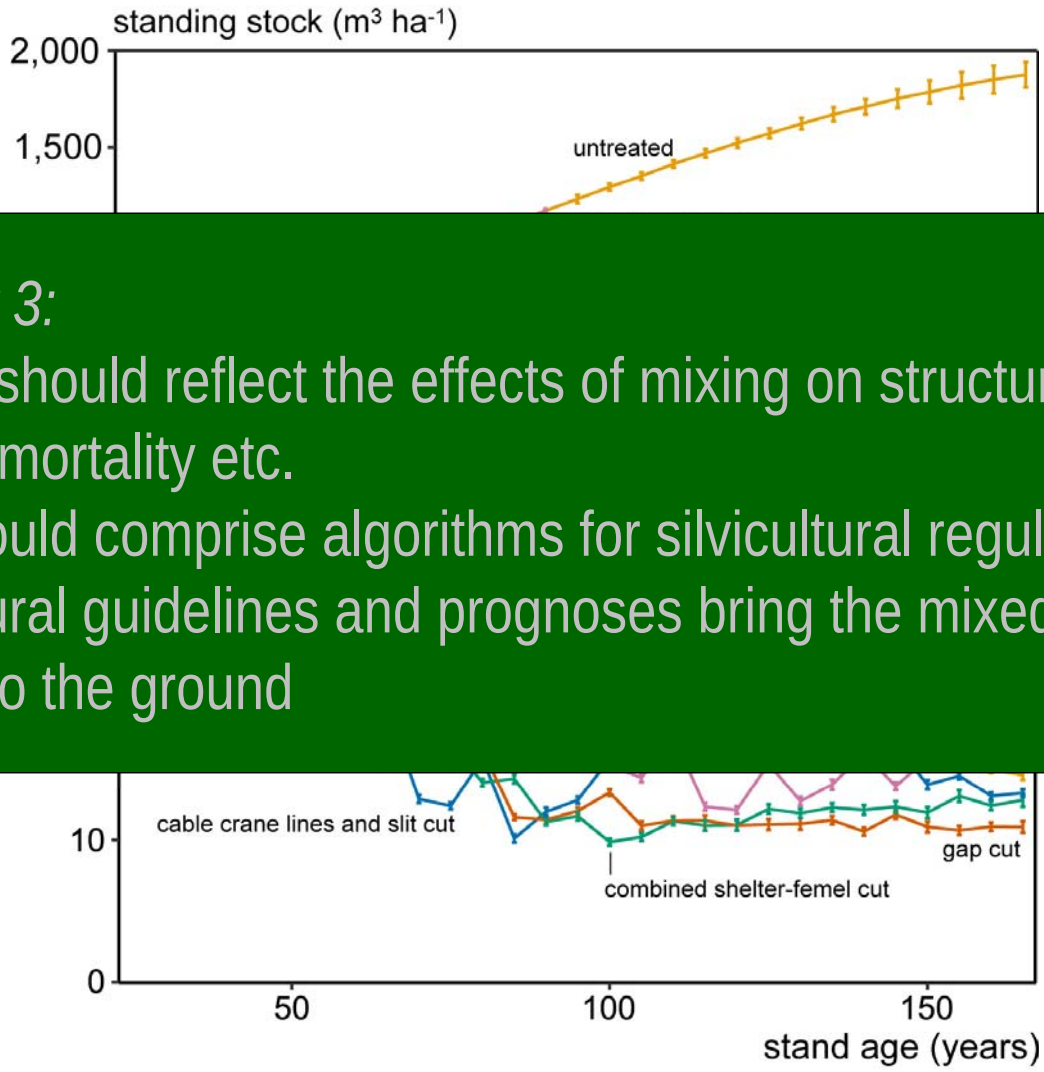

Summary 3:

- models should reflect the effects of mixing on structure, growth, mortality etc.
- they should comprise algorithms for silvicultural regulation
- silvicultural guidelines and prognoses bring the mixed stand idea onto the ground

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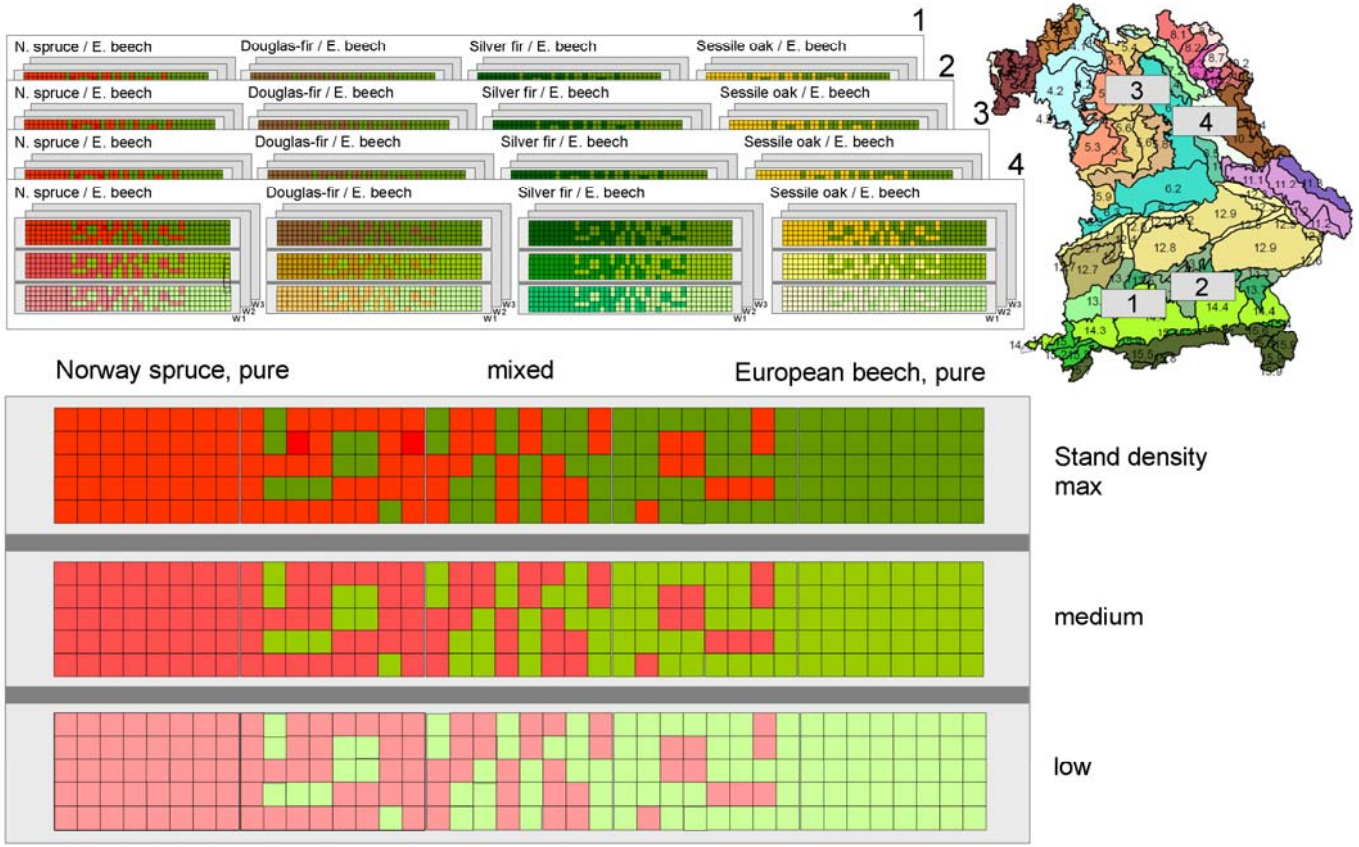
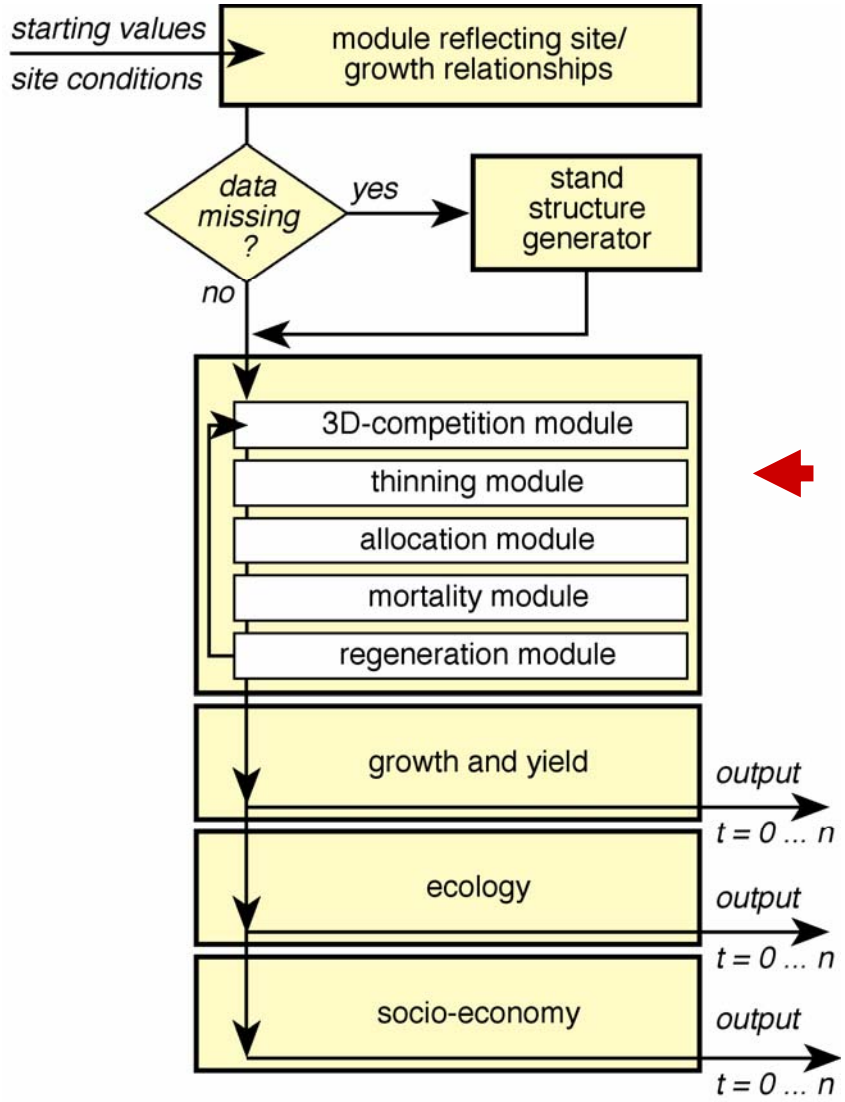
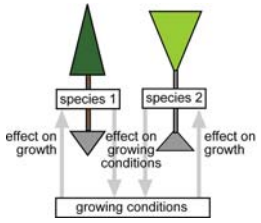
Long-term experiments for data acquisition, model parameterization, teaching and training

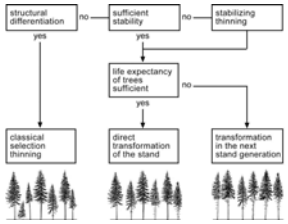


Further development of simulation models for transfer from understanding to design and prognoses





- Integration of mixing effects on growth, structure, mortality
- Extension of the algorithms for silvicultural regulation



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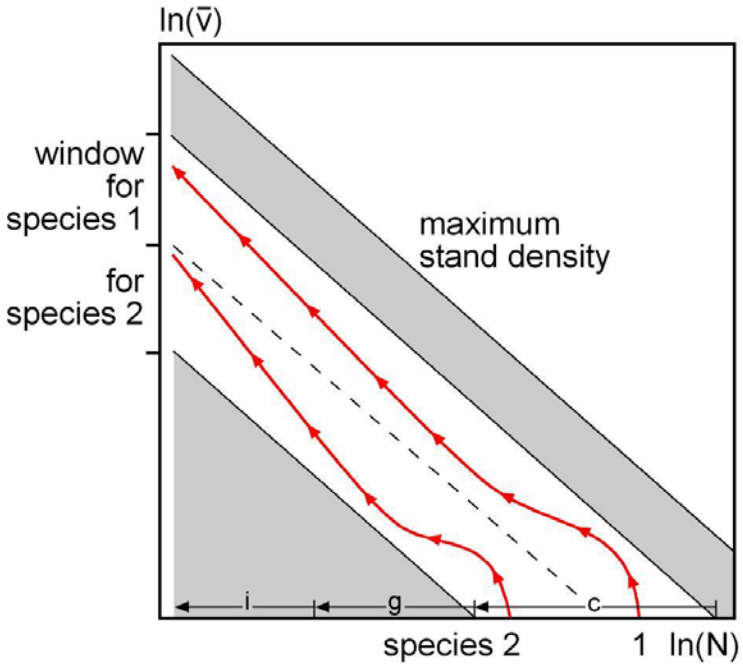
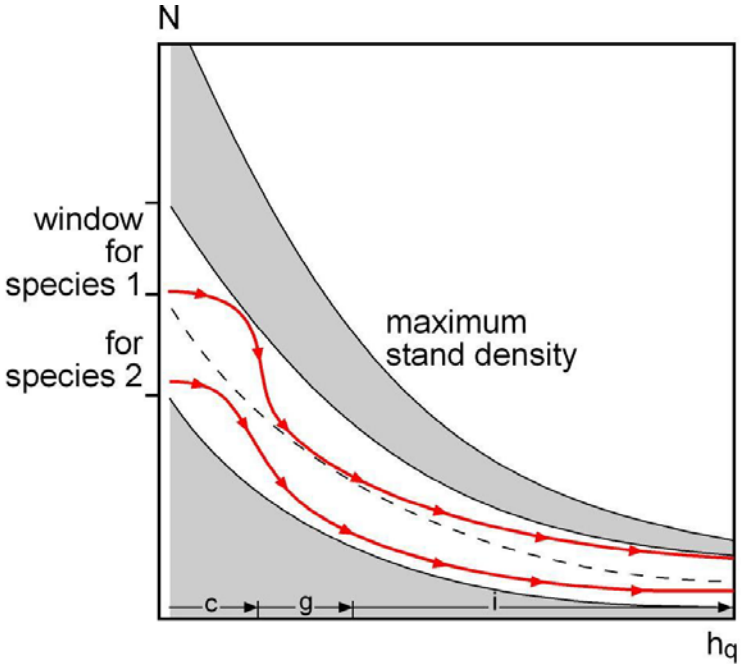
Systemanalyse

Development of simple guidelines for the silvicultural regulation of mixed-species stands





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