Waldwachstumskunde
Systemanalyse

From analysing toward managing mixed-species stands

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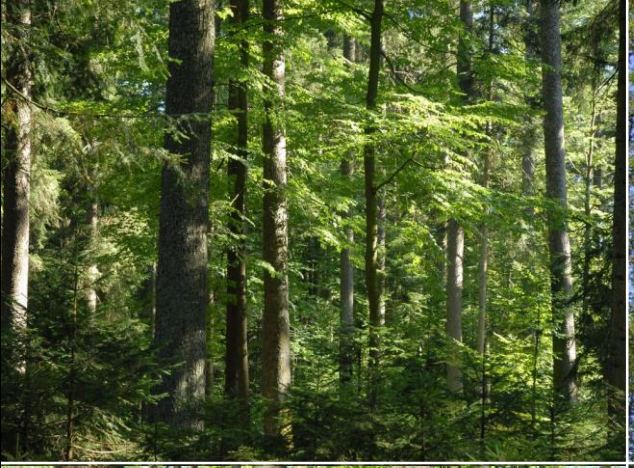
Need for silvicultural guidelines and models for mixed-species stands

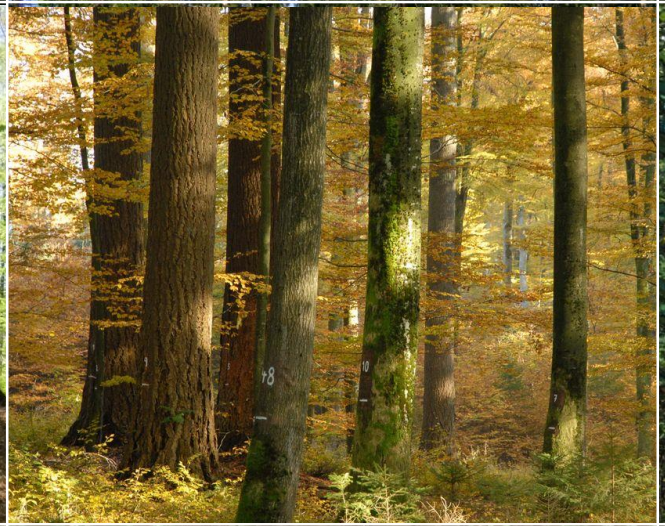
Key mixing effects on tree and stand dynamics

Measures for silvicultural regulation of mixed-species stands

Perspectives

Presentation on the occasion of the XI. Congresso Nazionale SISEF, 10.-13. Oct. 2017,
P. le Aldo Moro, Roma

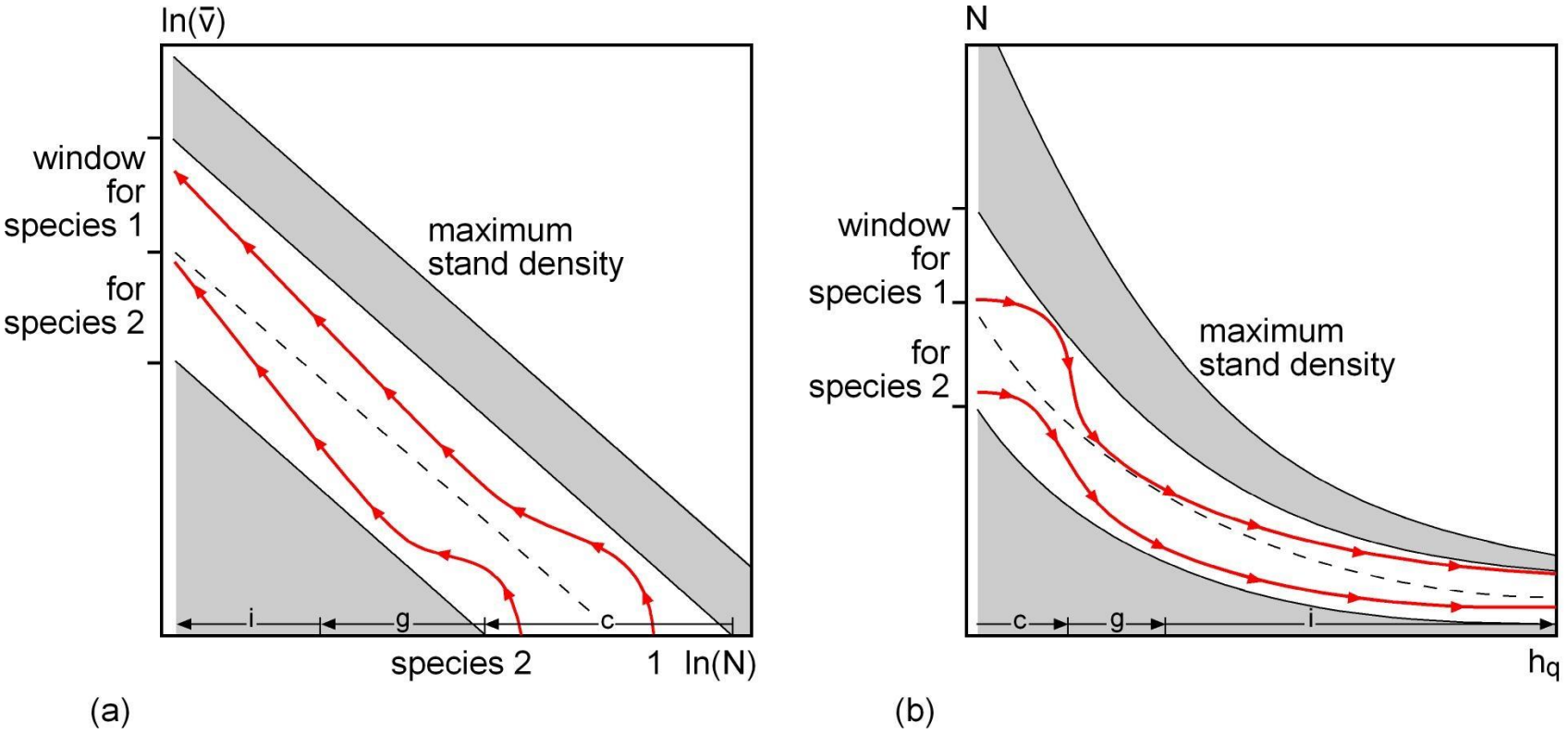




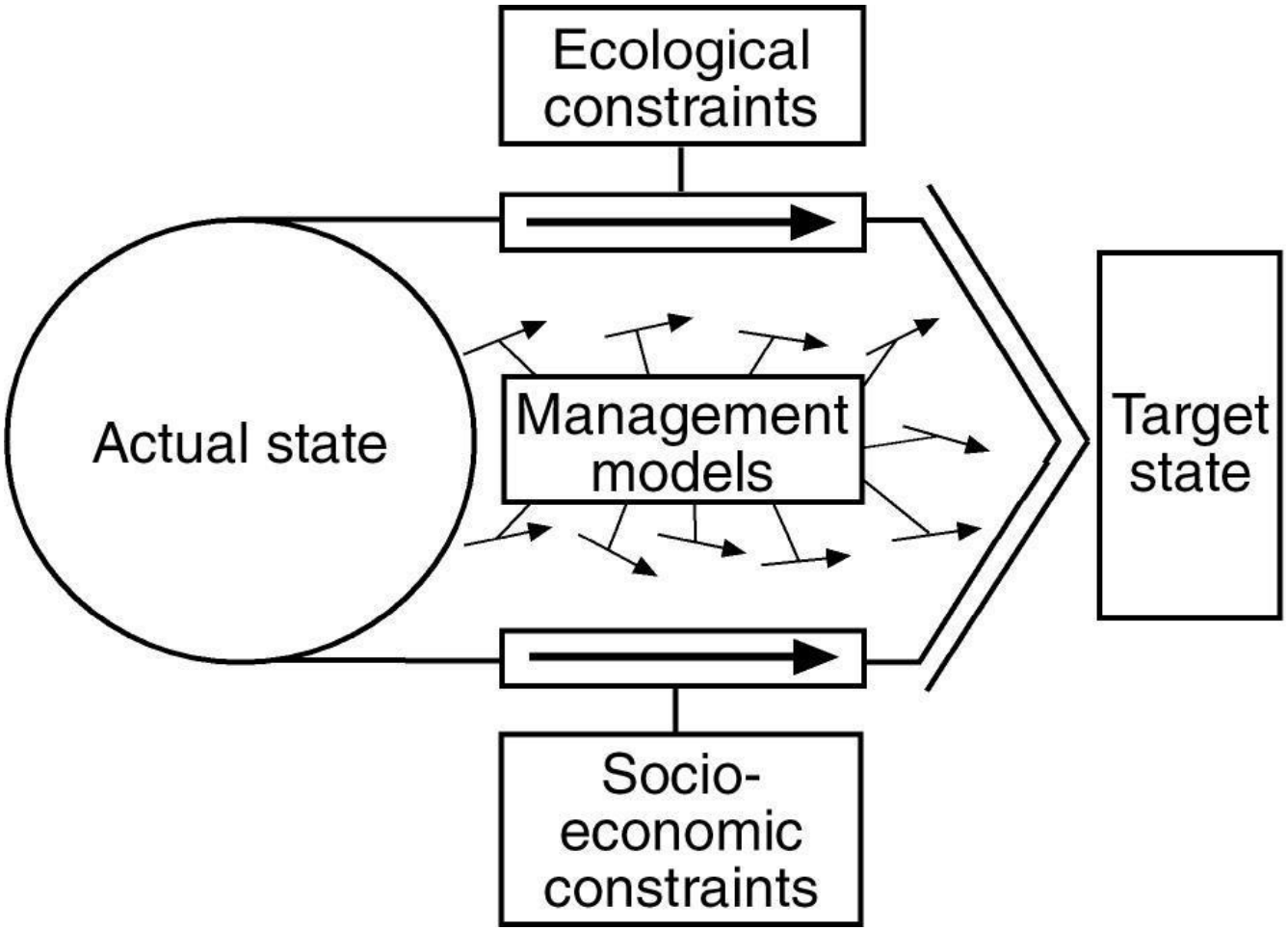

Fotos: Leonhard Steinacker

Guidelines for silvicultural regulation of mixed-species stand can bring the mixing idea onto the ground

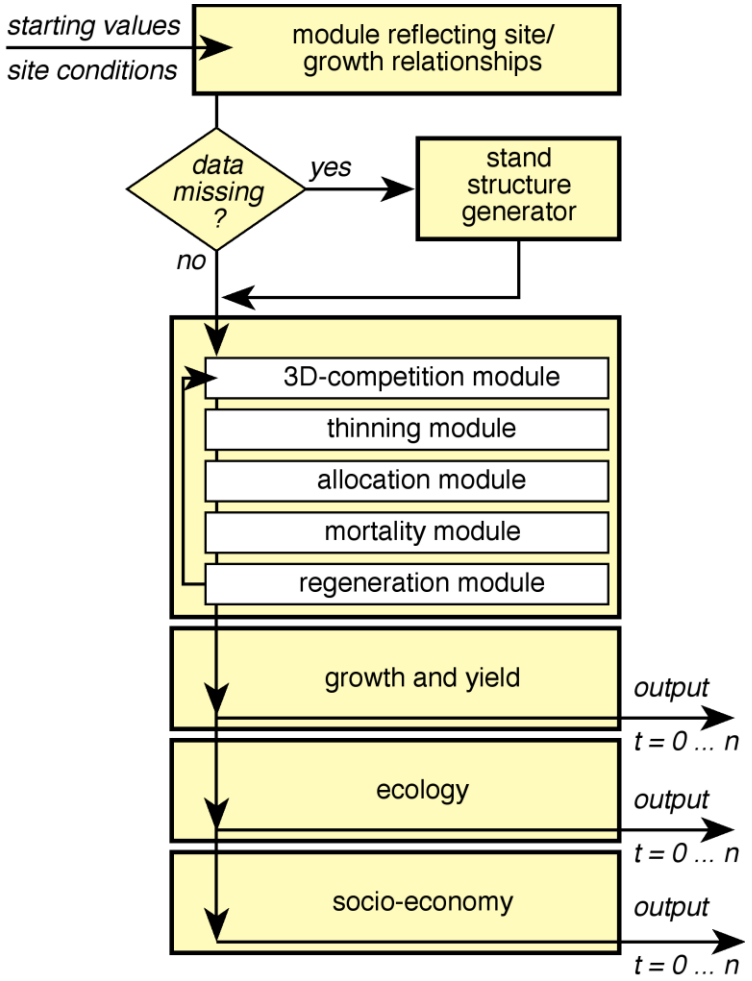


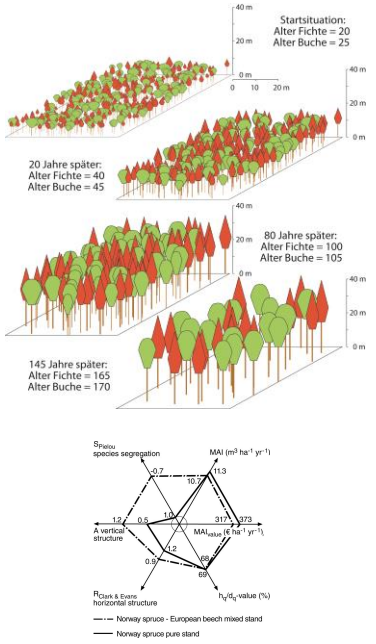
Pretzsch, H and Zenner E (2017) Toward managing mixed-species stands: from parametrization to prescription, Forest Ecosystems, DOI : 10.1186/s40663-017-0105-z

Model application for deriving silvicultural guidelines



SILVA 3.0 as example of a spatially explicit individual tree model for pure and mixed stands





Pretzsch, H., Biber, P. und Dursky, J., 2002: The single tree based stand simulator SILVA. Construction, application and evaluation, Forest Ecology and Management, 162: 3-21

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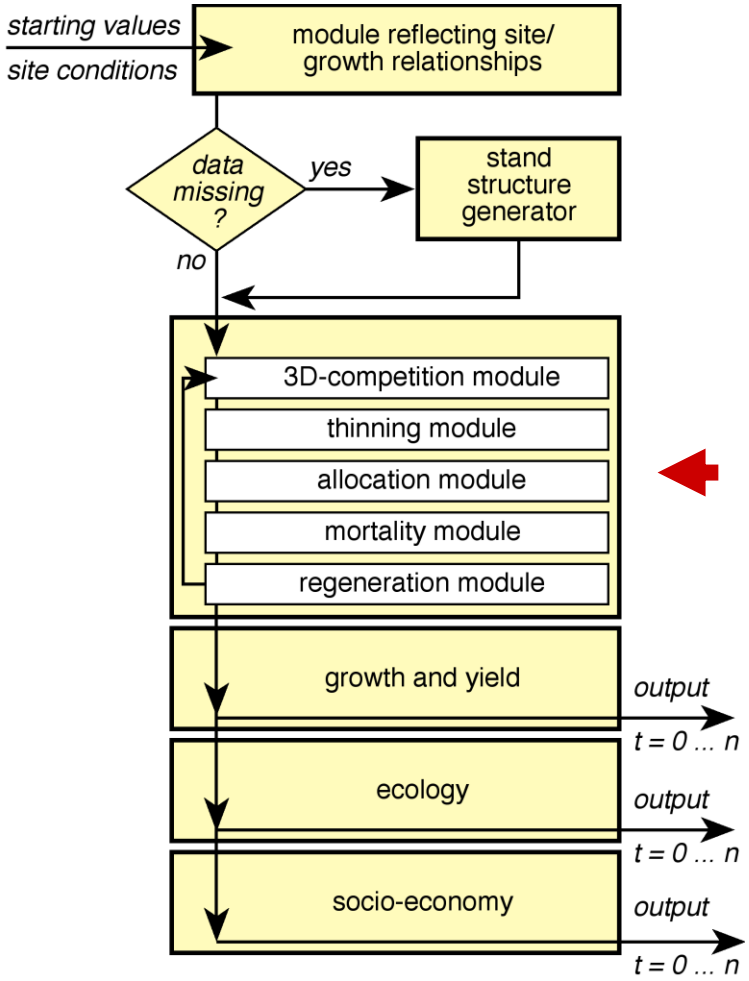

Integration of mixing effects on growth, structure, mortality

Extension of the algorithms for silvicultural regulation

Pretzsch, H., Biber, P. und Dursky, J., 2002: The single tree based stand simulator SILVA. Construction, application and evaluation, Forest Ecology and Management, 162: 3-21

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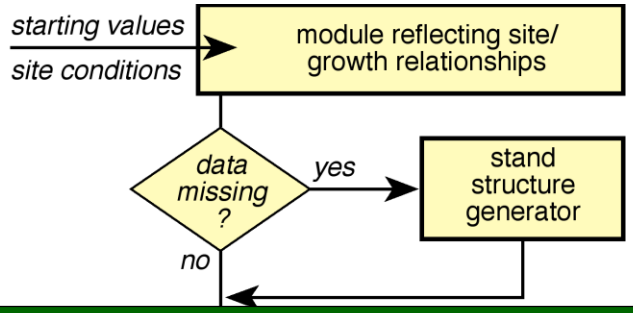
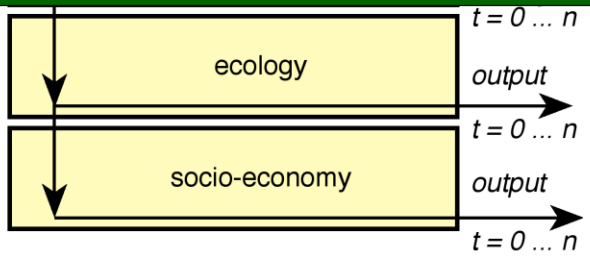


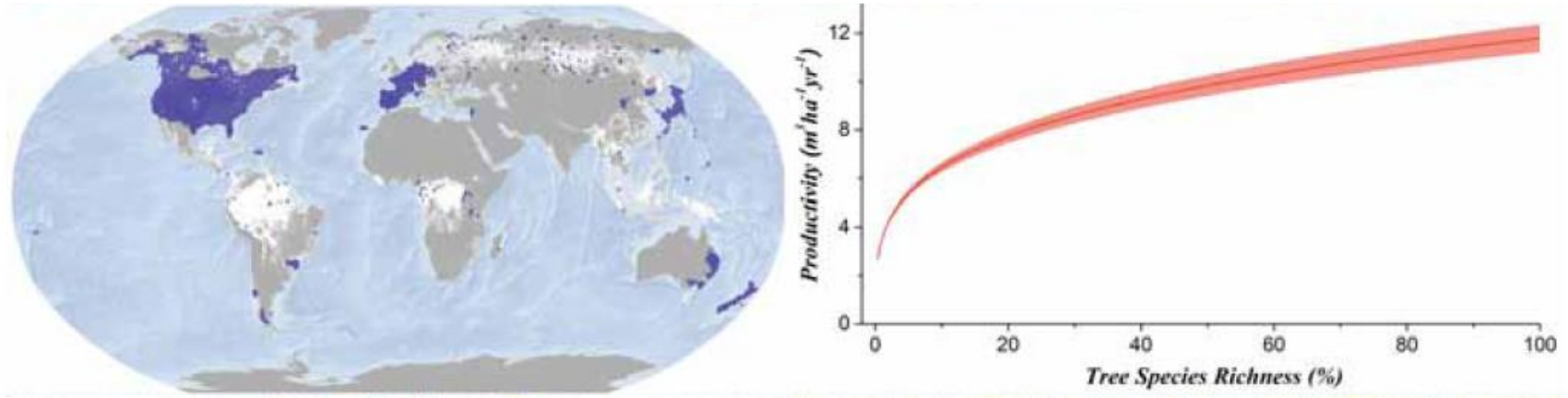
challenge

- quantitative silvicultural guidelines needed
- models should reflect mixing effects
- models should comprise algorithms for regulating tree species mixtures



Pretzsch, H., Biber, P. und Dursky, J., 2002: The single tree based stand simulator SILVA. Construction, application and evaluation, Forest Ecology and Management, 162: 3-21

Mixing effects on productivity. Inventory data worldwide and experiments in Central Europe



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

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

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

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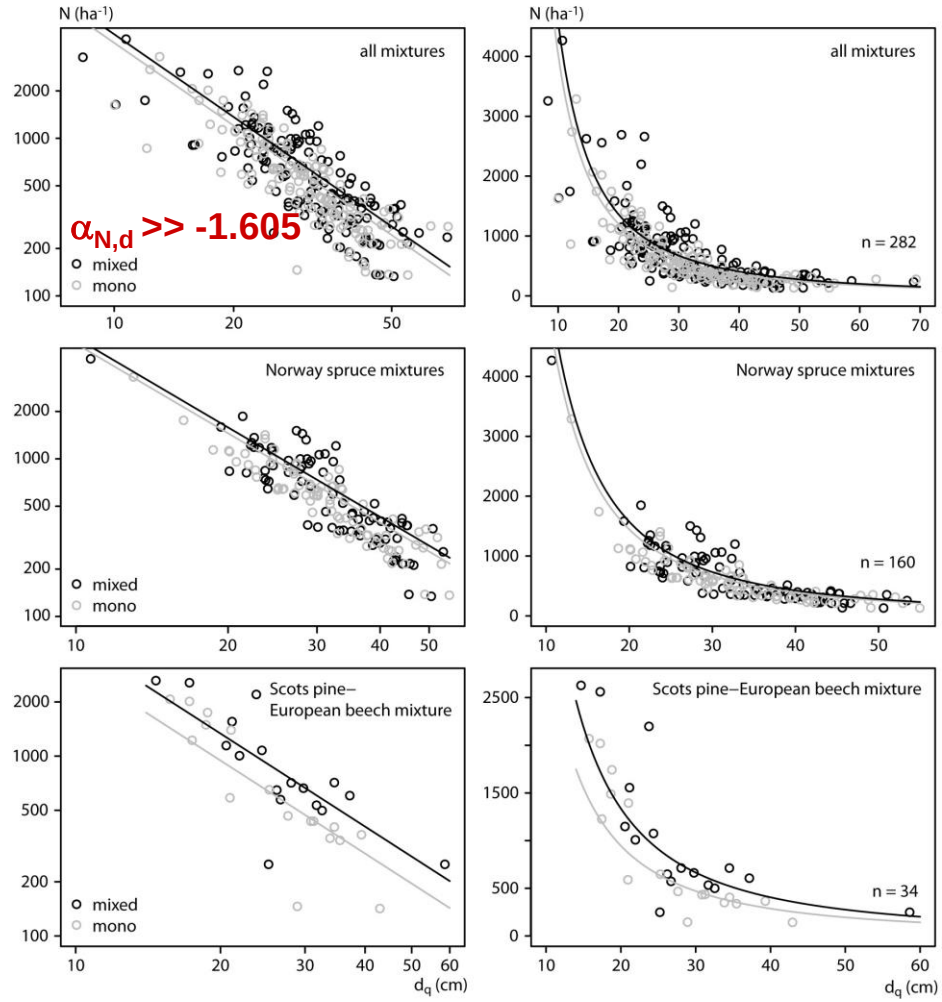
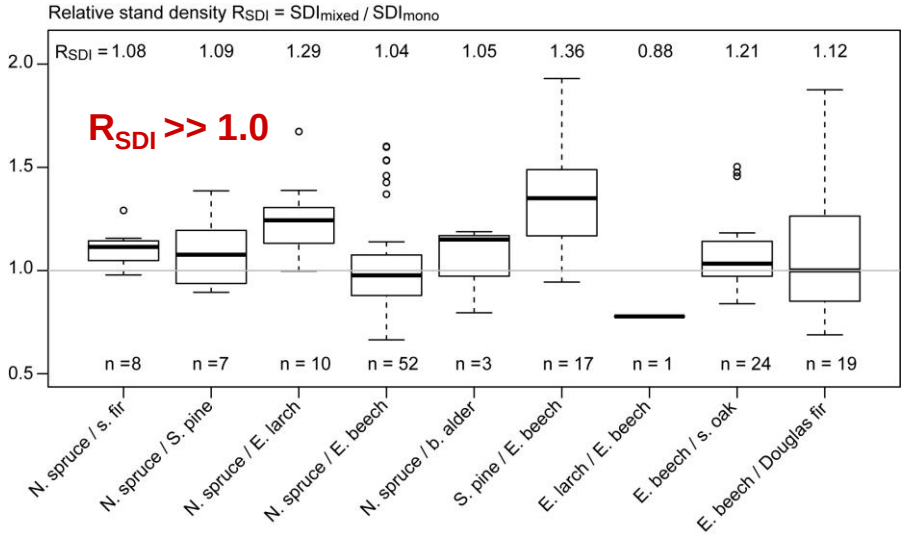
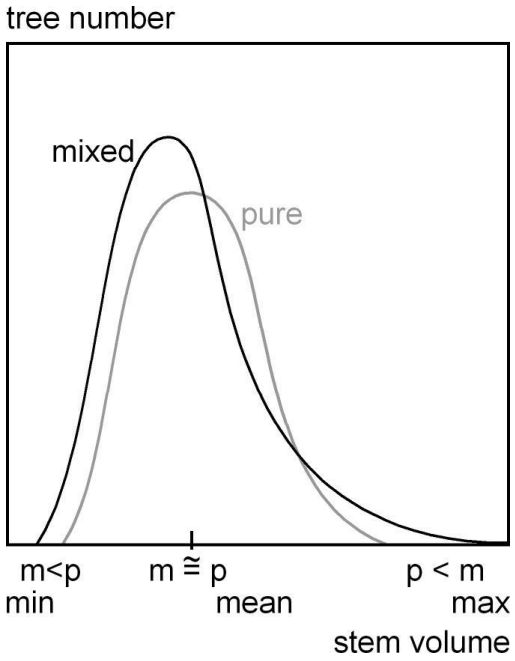
Effect of tree species mixing on stand density represented by self-thinning line and SDI

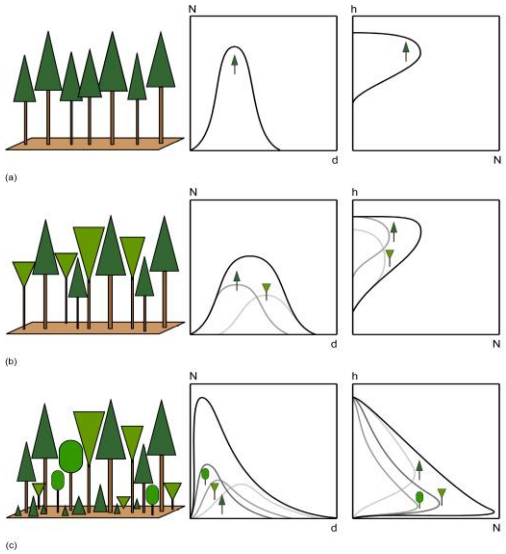


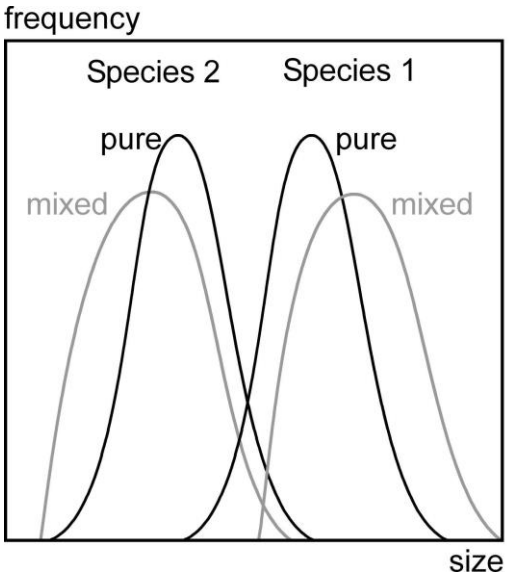


Pretzsch H, Forrester D, Bauhus J (2017)
Mixed-species forests.
Ecology and Management,
Springer, Berlin, 653 p

Wider size range, stronger right-skewness in mixed stands; more vertical heterogeneity, often species 1 ahead, species 2 behind

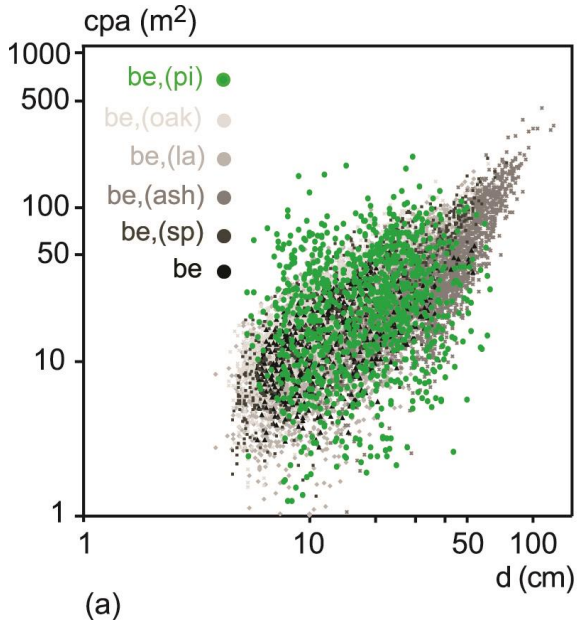


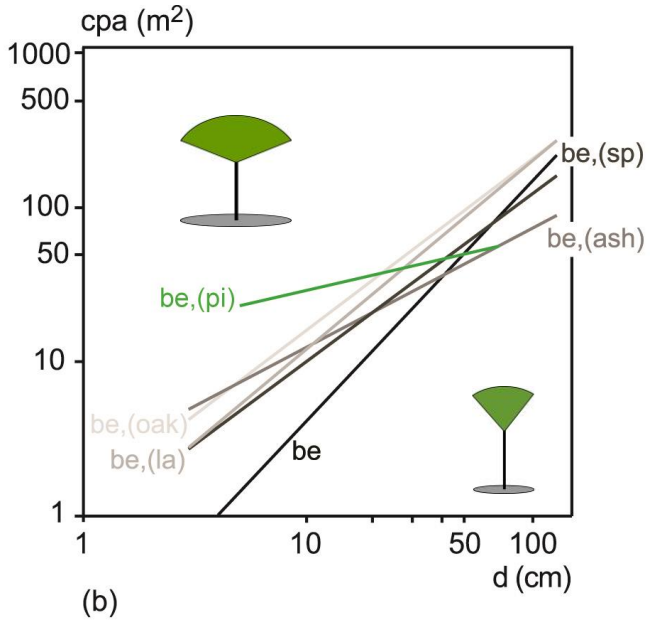




Pretzsch, H., Schütze, G. (2014) Size-structure dynamics of mixed versus pure forest stands, Forest Systems, 23(3):560-572.

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

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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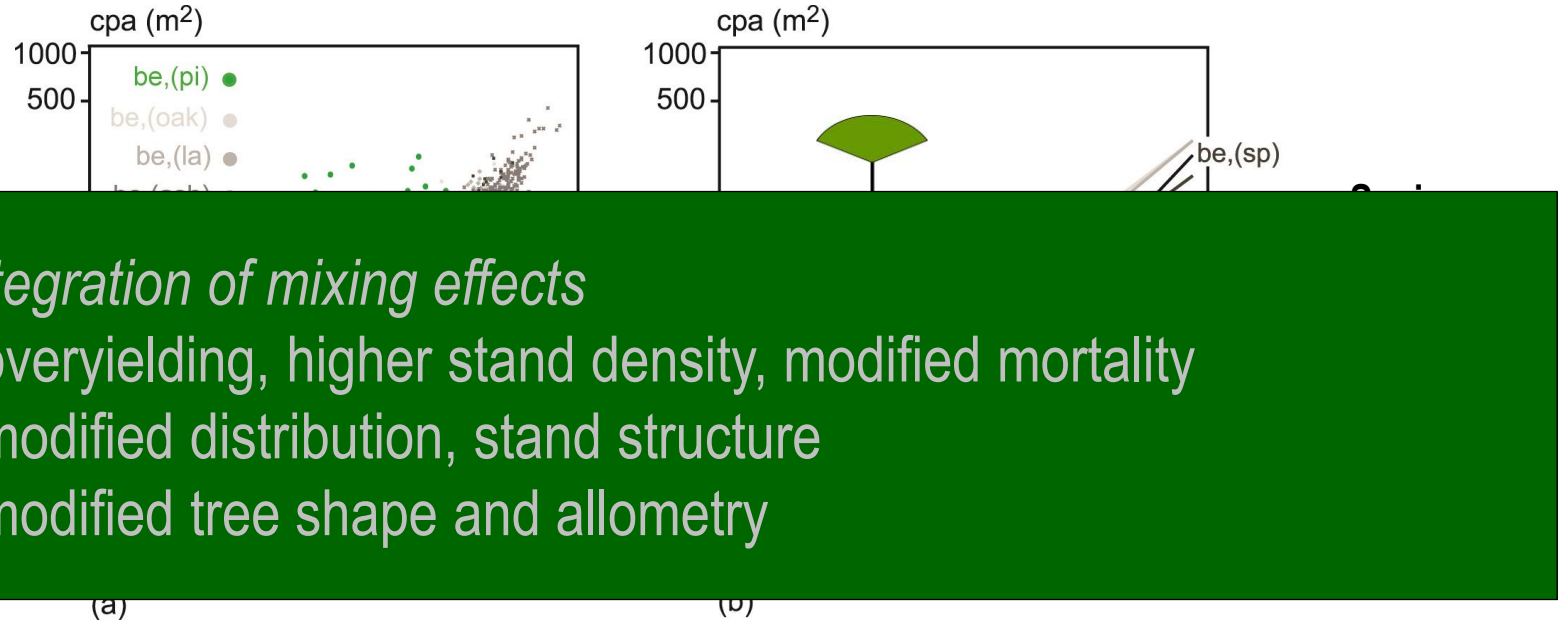

Integration of mixing effects

- overyielding, higher stand density, modified mortality
- modified distribution, stand structure
- modified tree shape and allometry

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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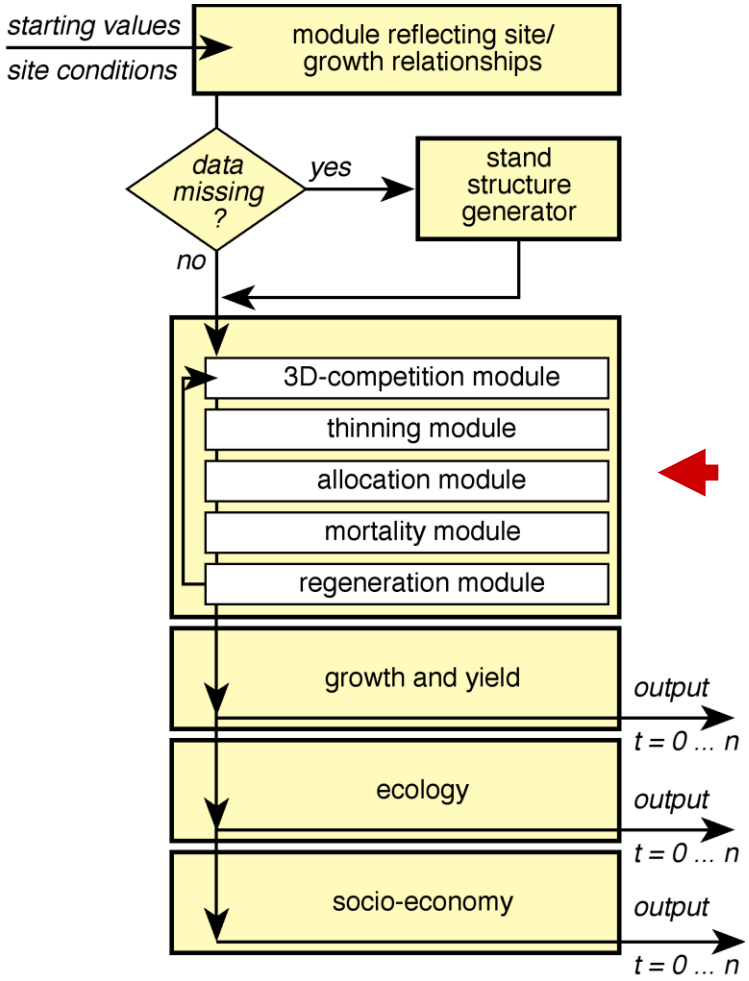

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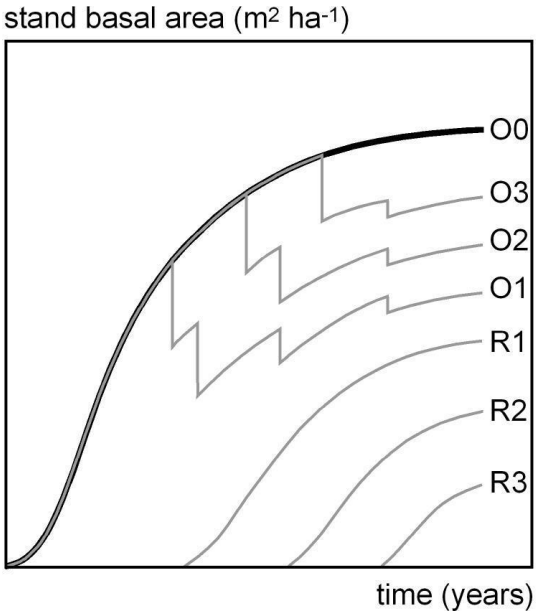
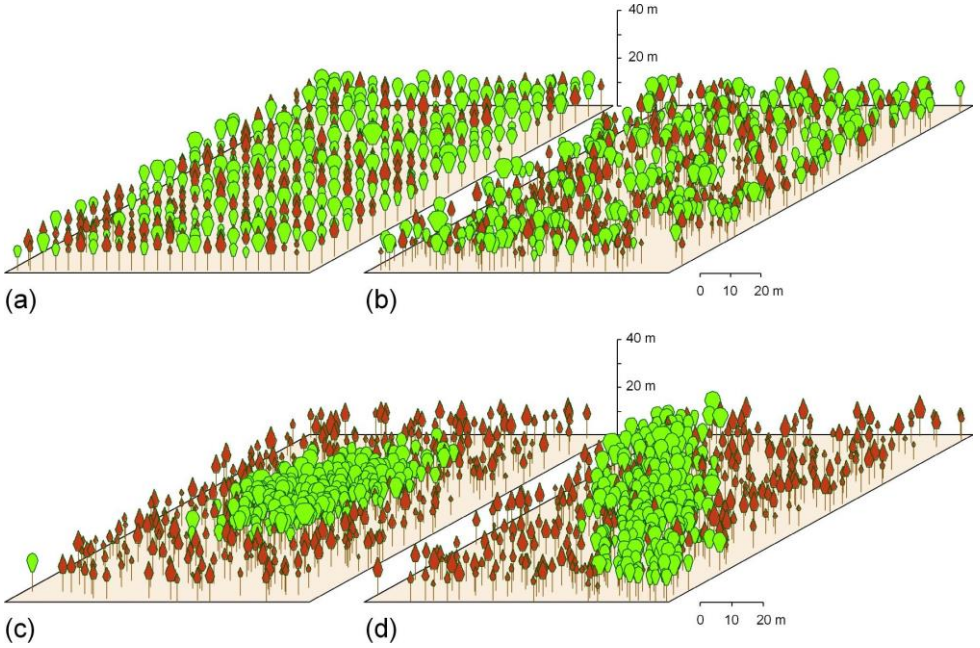
Extension of the algorithms for silvicultural regulation

Pretzsch, H., Biber, P. und Dursky, J., 2002: The single tree based stand simulator SILVA. Construction, application and evaluation, Forest Ecology and Management, 162: 3-21

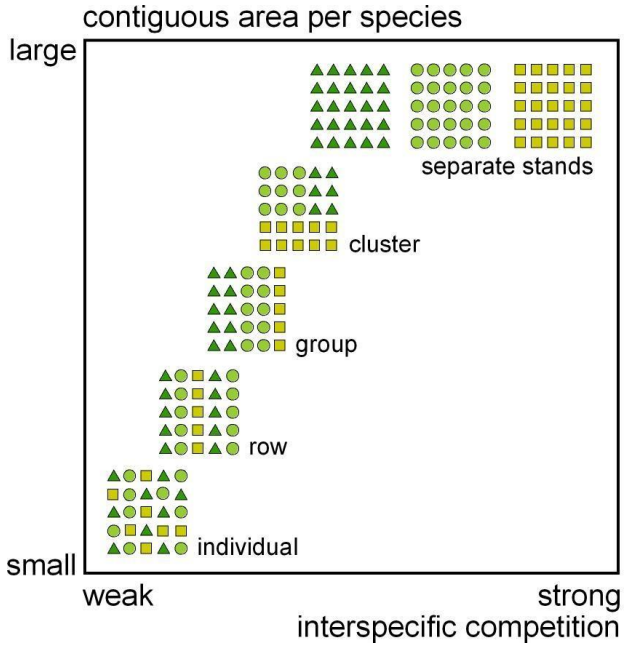
Rules and algorithms for initiating the regeneration depending on the density of the overstorey

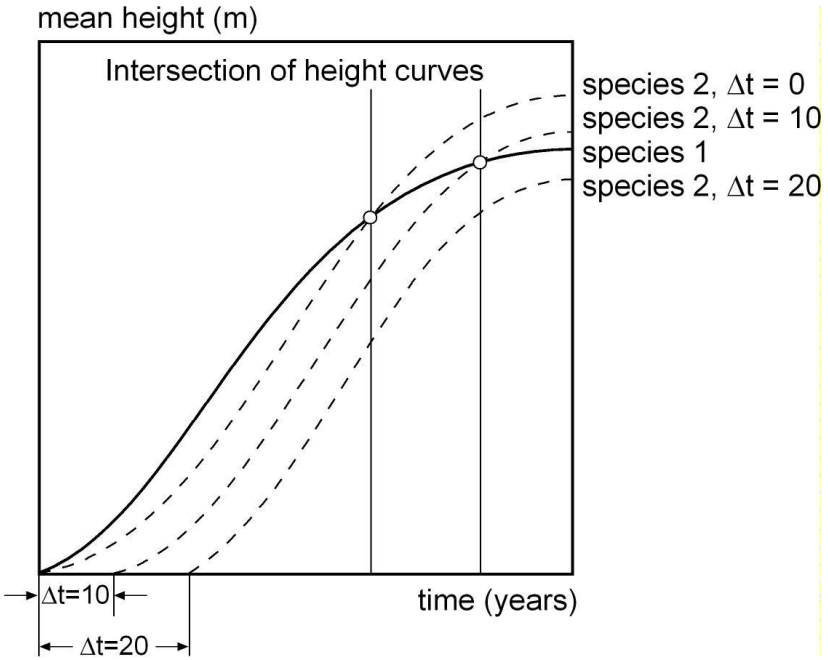




Pretzsch H, Forrester D, Bauhus J (2017) Mixed-species forests. Ecology and Management, Springer, Berlin, 653 p

Rules and algorithms for regulation of competition by spatial or temporal separation





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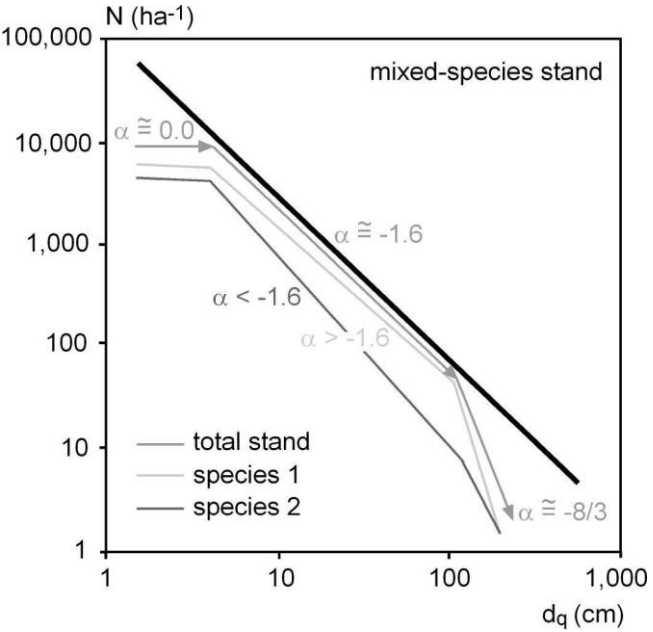
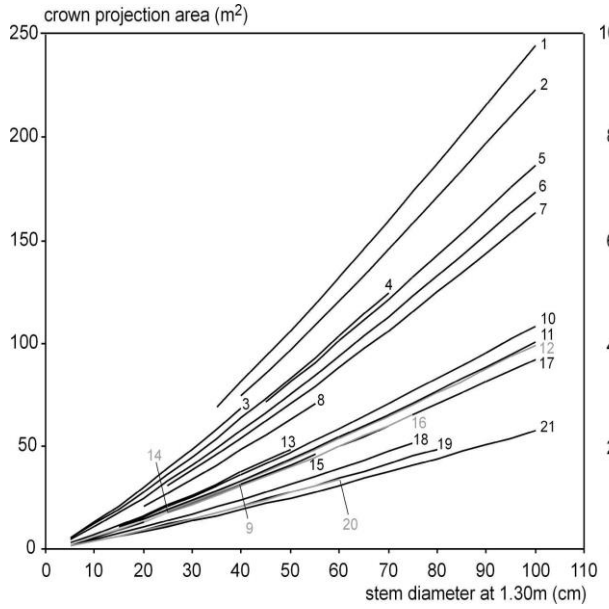
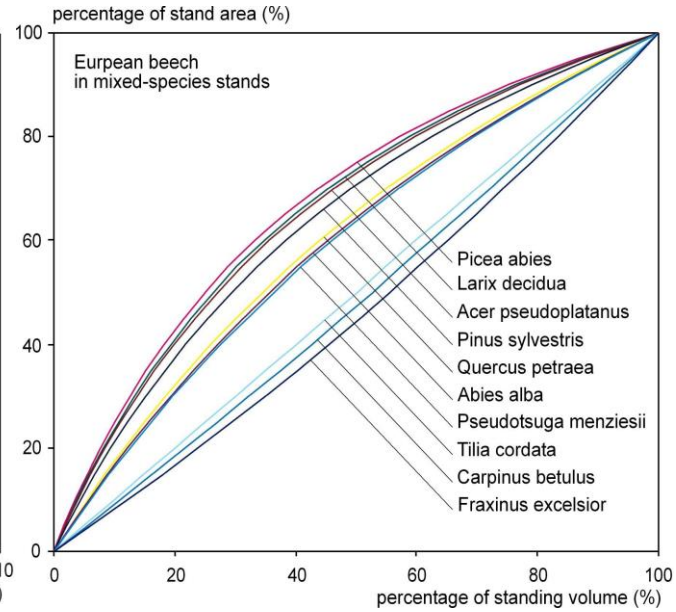
Rules and algorithms for regulation of stand density and species-specific mixing proportions







[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.

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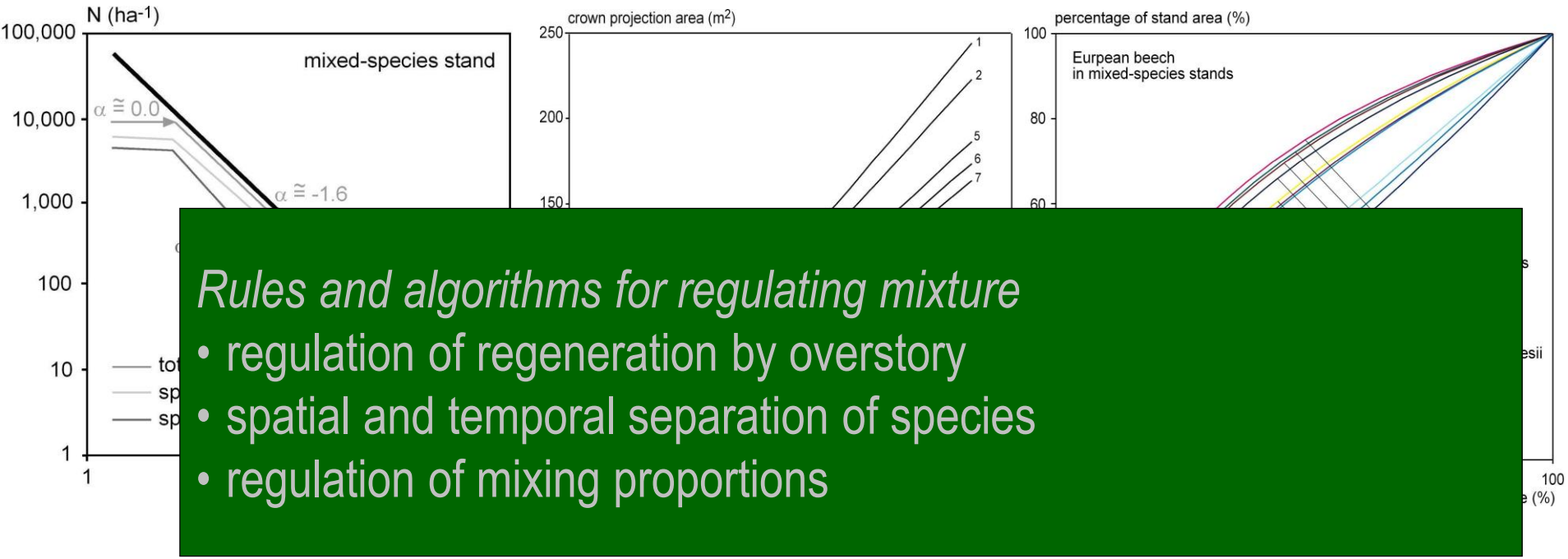
Rules and algorithms for regulation of stand density and species-specific mixing proportions

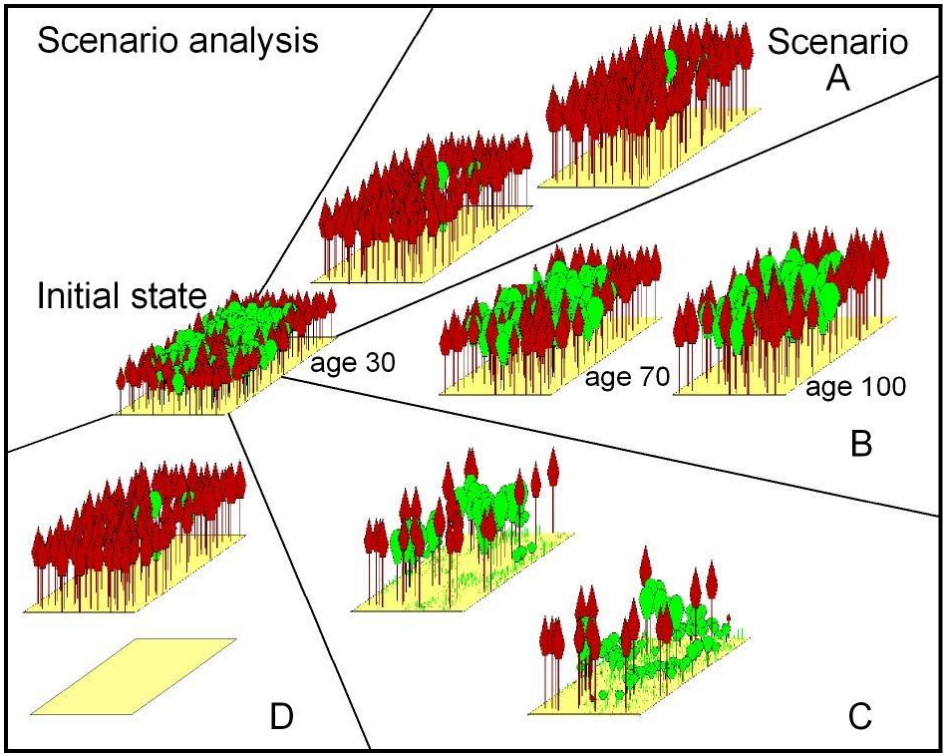


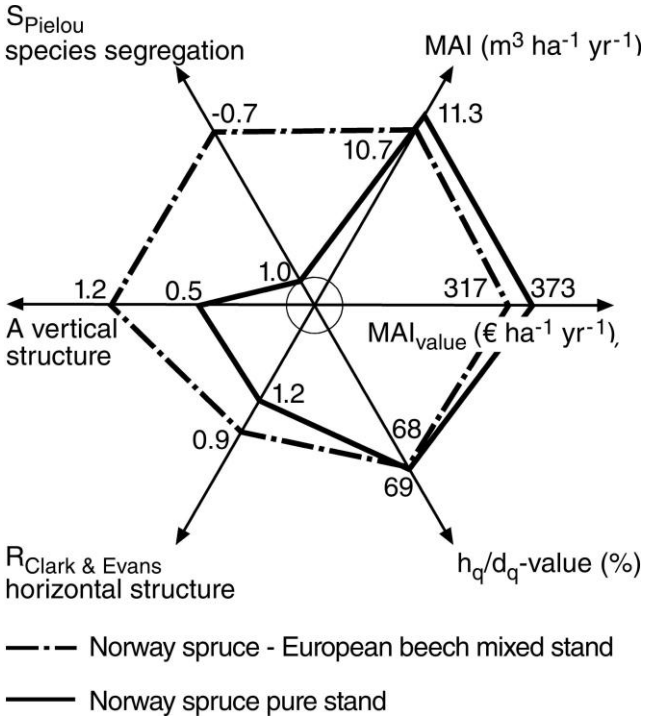
Rules and algorithms for regulating mixture

- regulation of regeneration by overstory
- spatial and temporal separation of species
- regulation of mixing proportions

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

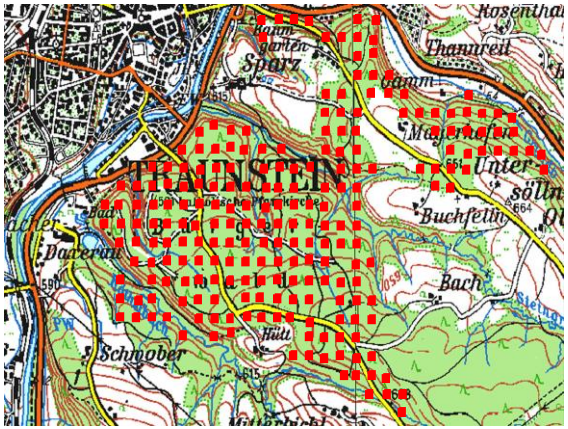
Silvicultural guidelines derived by models and scenario analyses



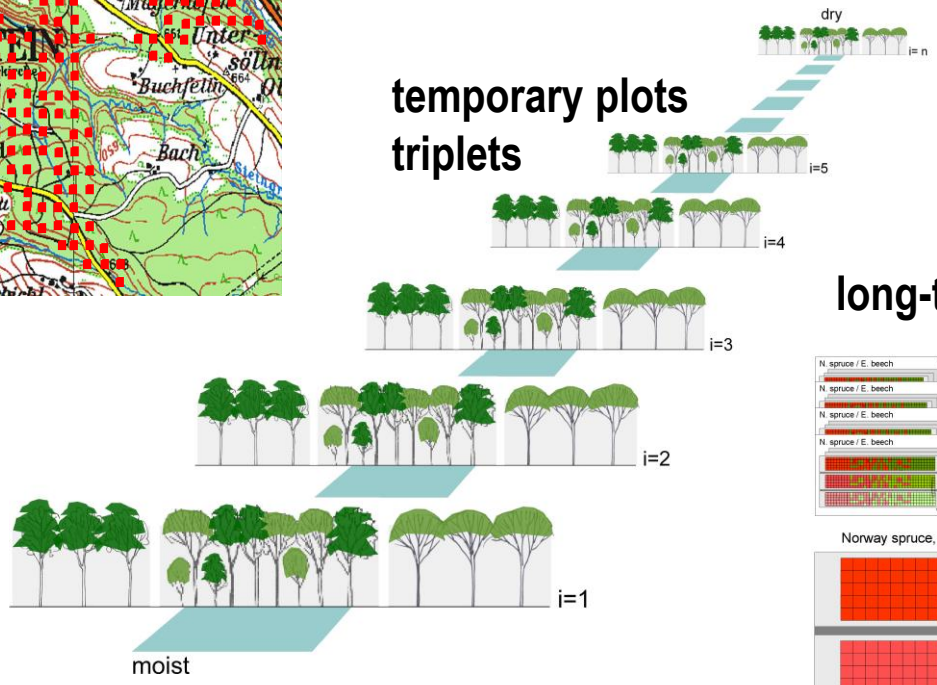


Data base: From forest inventories to temporary plots and long-term experiments

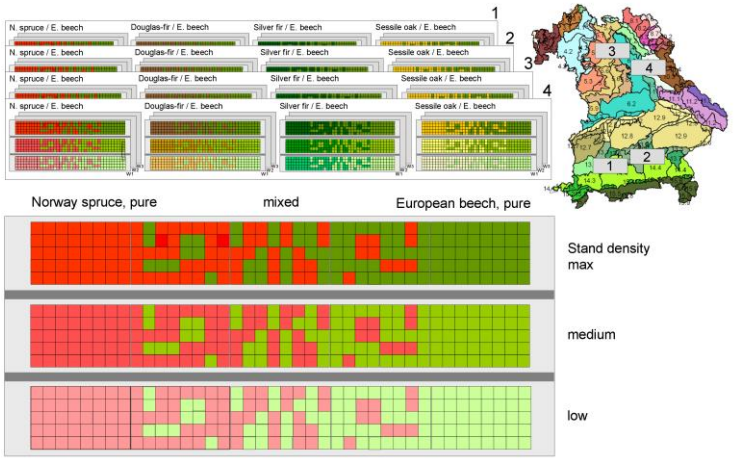
forest inventories



temporary plots triplets



long-term experiments



Summary and conclusions

- quantitative **silvicultural guidelines** may bring the mixed-species stands paradigm on the ground
- silvicultural guidelines require **models for scenario analyses**
- models should consider **mixing effects** and **silvicultural prescriptions**
- development and parameterization may be based on **inventory data** and **temporary plots** or triplets
- further substantiation requires **long-term experiments** for various species combinations, mixing patterns, treatments

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