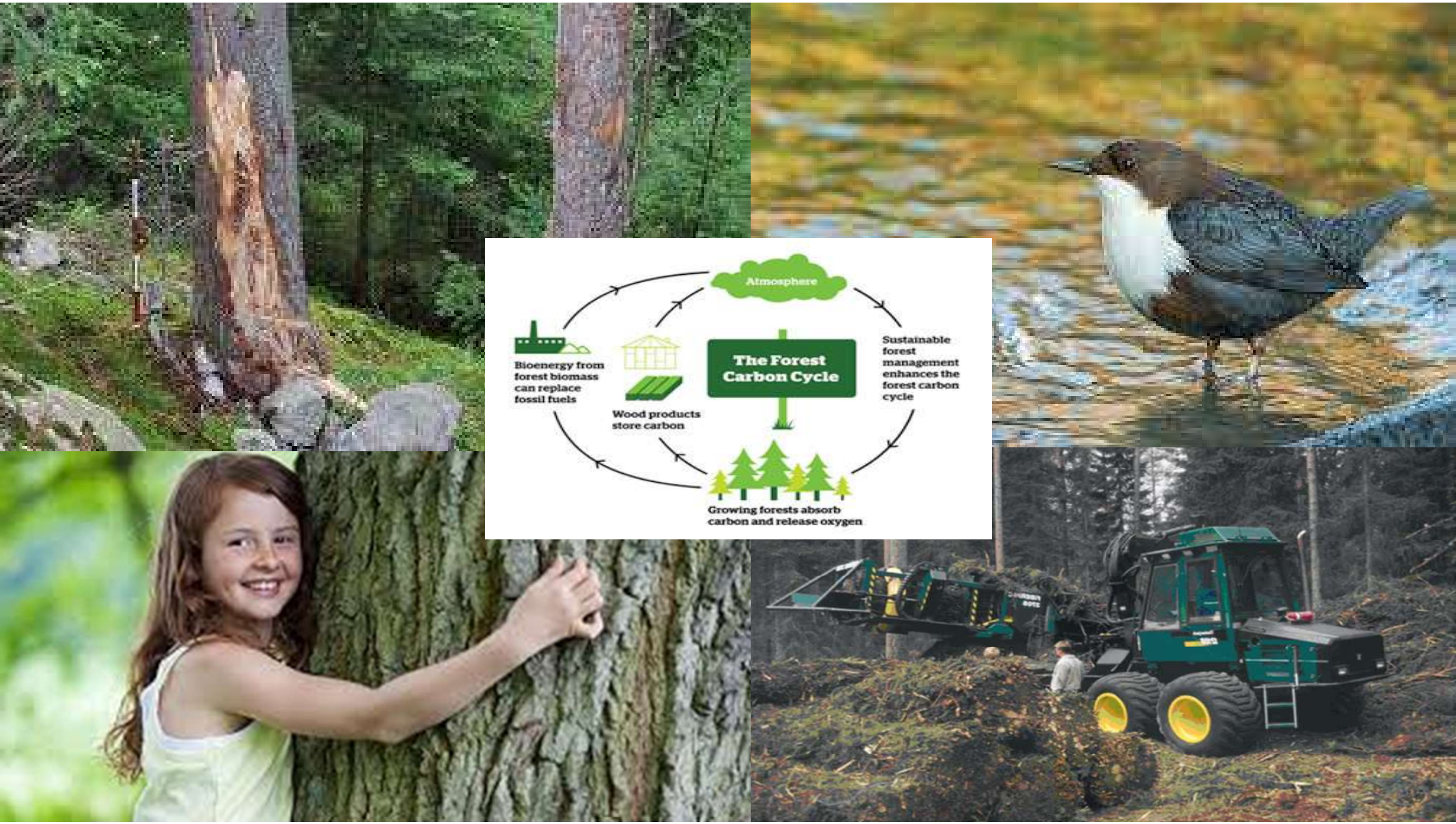
Waldwachstumskunde
Systemanalyse

Forest dynamics. From monospecific to mixed-species stands

Hans Pretzsch

Webinar held on Januar 14th, 2022 in the frame of the Skill-For.Action, Excellent Science, Marie Skłodowska-Curie Innovative Training Networks, GA 956355


Segregation of unmanaged *versus* managed forest areas


Atmosphere
The Forest Carbon Cycle
Bioenergy from forest biomass can replace fossil fuels
Wood products store carbon
Sustainable forest management enhances the forest carbon cycle
Growing forests absorb carbon and release oxygen

Criteria and indicators for sustainable forest ecosystem management

For integrative management 40 European states agreed on the 6 criteria (MCPFE, Helsinki Process):

- **Maintenance of the forest area and stock**
- **Health and vitality**
- **Forest growth, yield, wood production**
- **Biological diversity**
- **Protective functions**
- **Socio-economic functions**

Neerdar, Sauerland, 1959


acid rain CZ


storm Sweden


bark beetle Bavaria


drought Germany


mono-specific
even-aged
mixed-species
even-aged
mixed-species
uneven-aged

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1 Concept of integrative and multiple-functional forest management

2 Shift from mono-specific to more complex forest stands. Resilience, resistance, recovery

3 Dynamic and management of mixed species stands. Three challenges
3.1 Competition regulation by spatial or temporal separation
3.2 Species-specific growing space provision
3.3 Density regulation

4 Transitioning from monocultures to selection forest

5 Summary and perspectives

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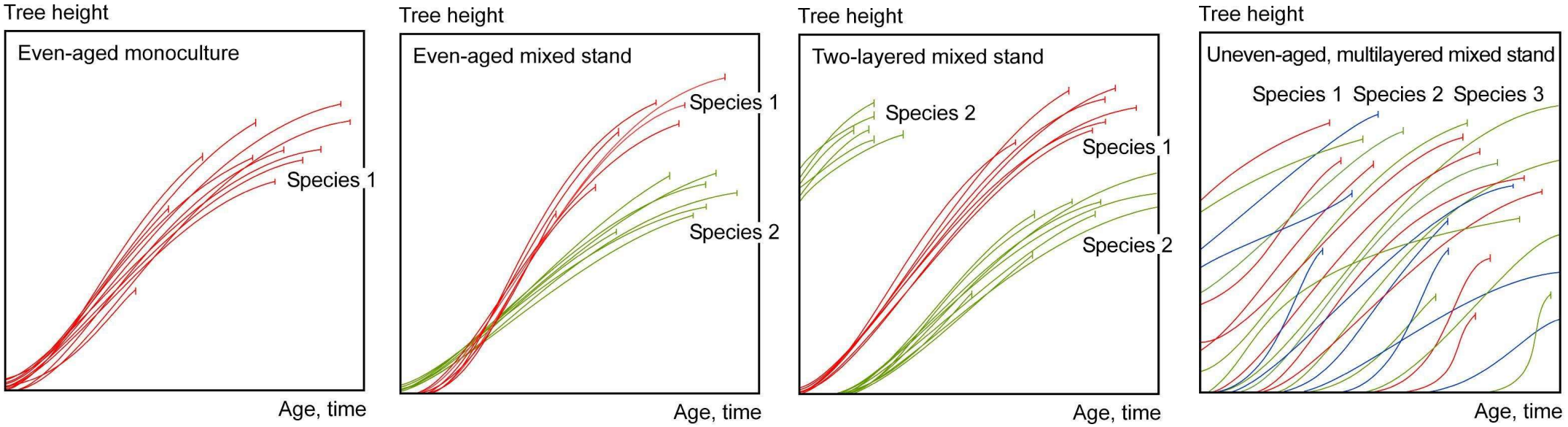
Tree trajectories in (a) mono-specific stands and (b-d) different mixtures



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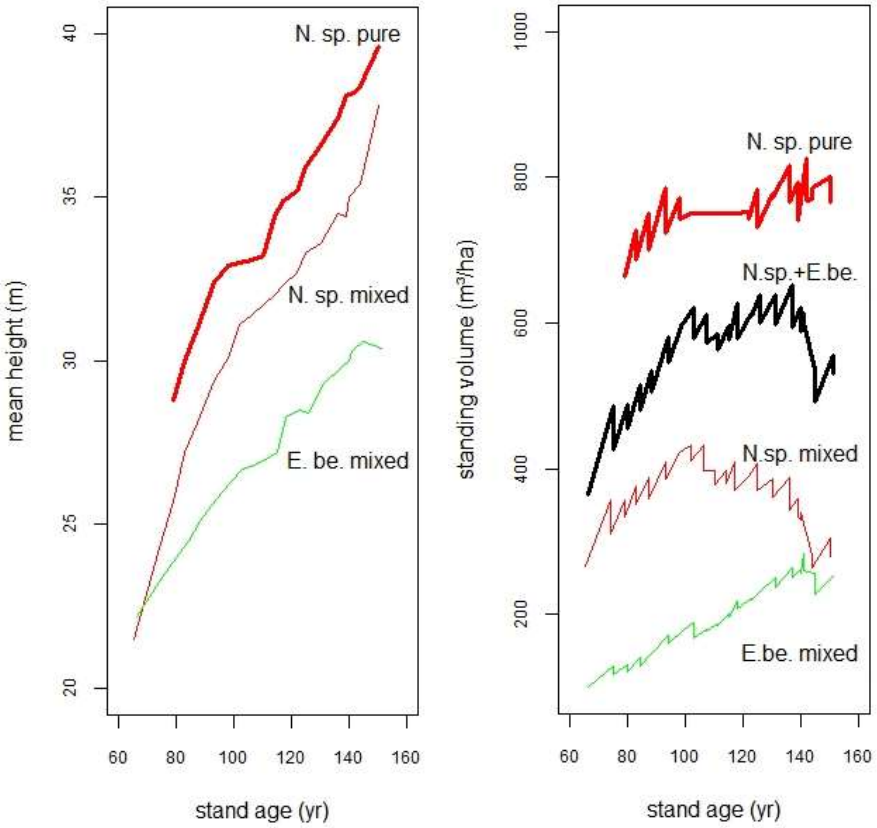
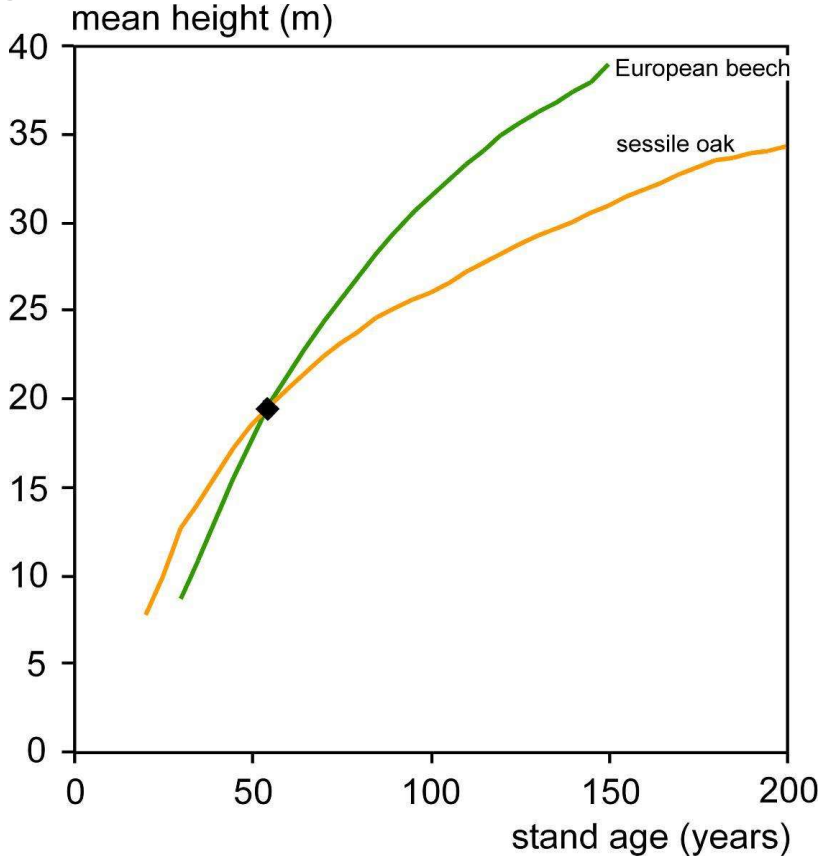
3.1 Maintenance of species mixing, avoidance of demixing. Examples: N. spruce and E. beech Oderhaus/Harz and E. beech s. oak/Steigerwald

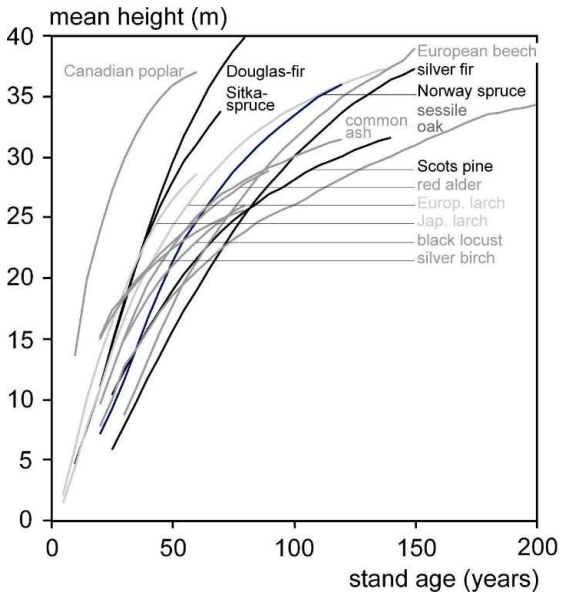


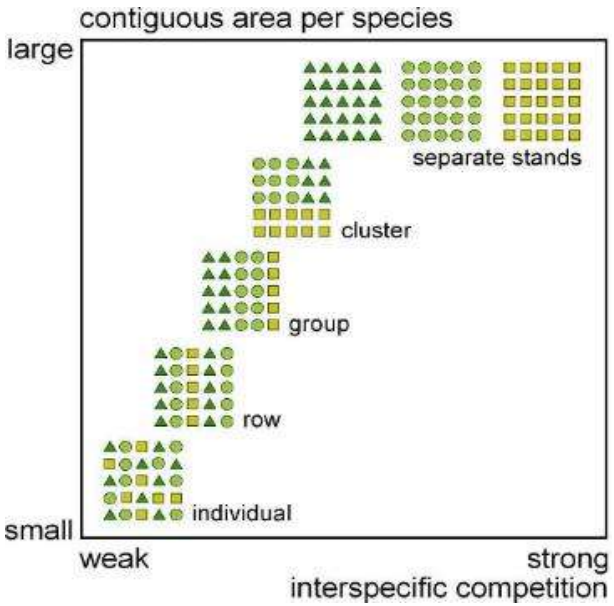
Lüpke v. B. and Spellmann, H (1997),
Pretzsch and Zenner (2017)

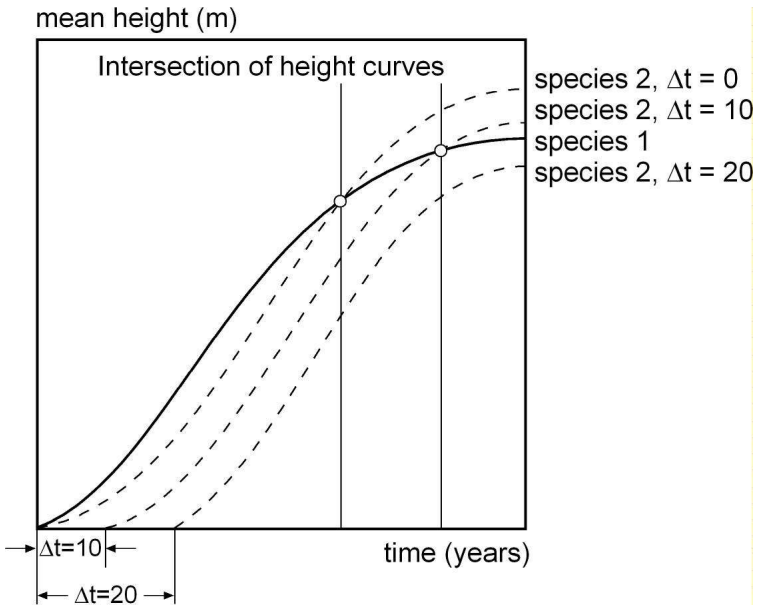


Pretzsch (2018)

3.1 Maintenance of species mixing, avoidance of demixing. Intersection of height curves, spatial or temporal segregation







Pretzsch and Zenner (2017)

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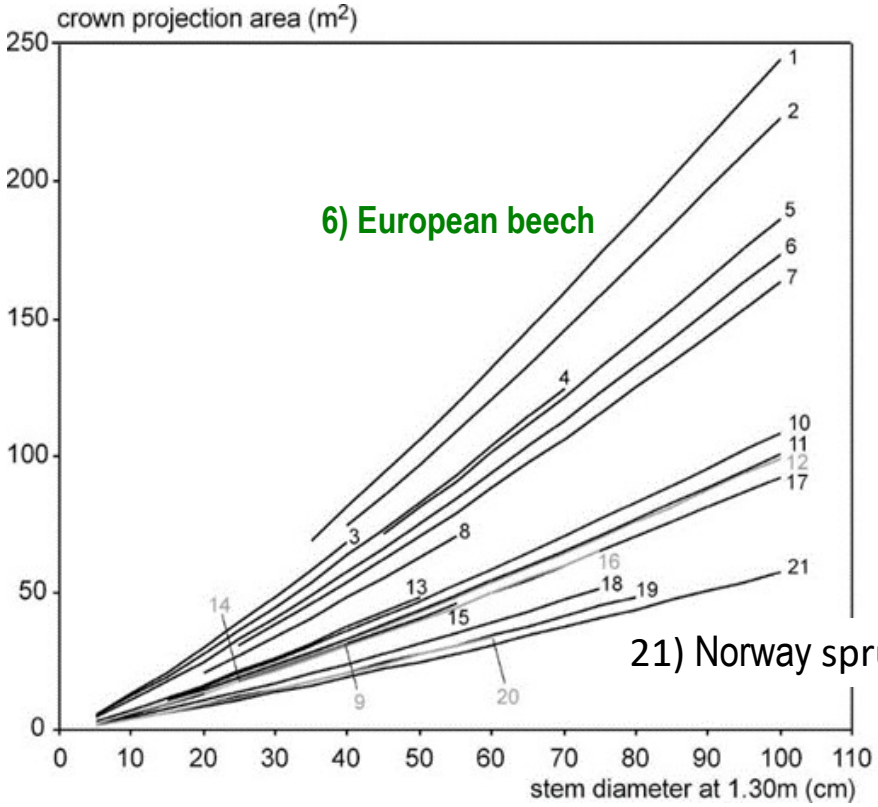
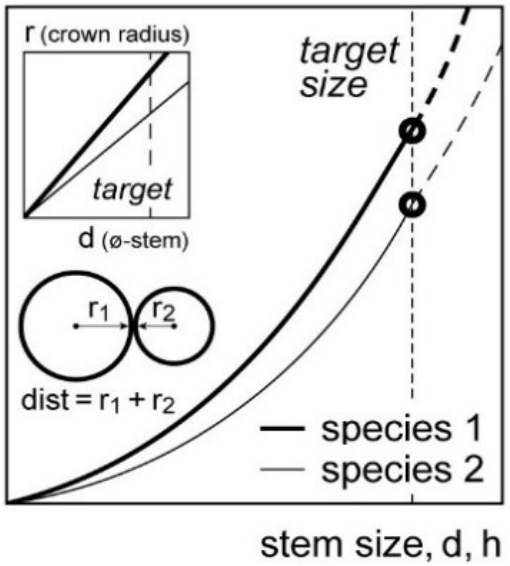
3.2 Species-specific growing space provision.
Crown allometry, growing space requirement, tree numbers

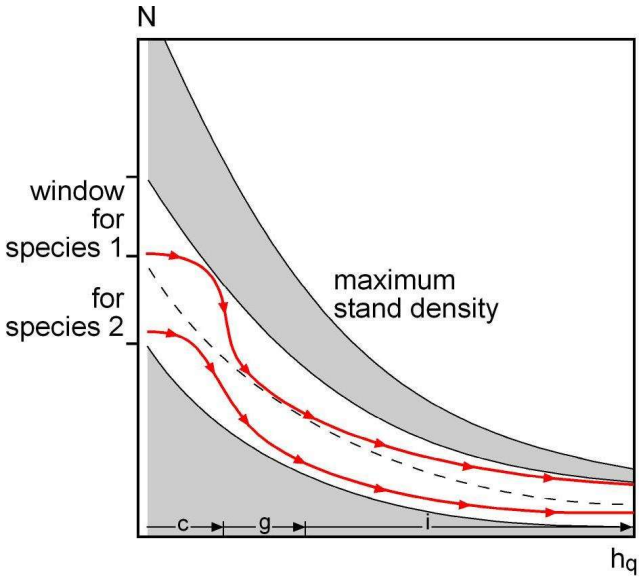


[1] *Quercus nigra* L., [2] *Platanus x hispanica* Münchh., [3] *Carpinus betulus* L., [4] *Tilia cordata* Mill., [5] *Khaya senegalensis* (Desr.) A.Juss., [6] *Fagus sylvatica* L., [7] *Aesculus hippocastanum* L., [8] *Robinia pseudoacacia* L., [9] *Alnus glutinosa* [L.] Gaertn., [10] *Araucaria cunninghamii* 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.

3.2 Species-specific growing space regulation.
Distance regulation, target tree number, guide-curves mixing specific

crown projection area



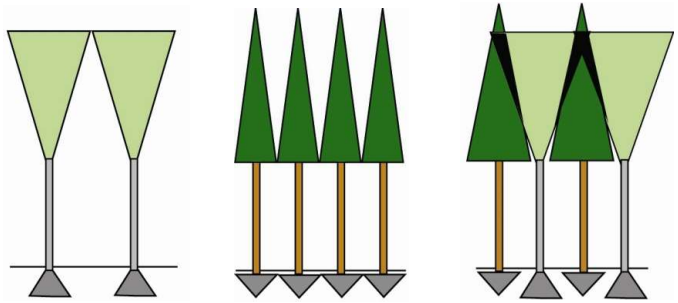


equivalence coefficents

species 2 \ species 1 d(cm)	10	20	30	40	50
10	**1.3**	**0.4**	**0.2**	**0.1**	**0.1**
20	**4.7**	**1.5**	**0.8**	**0.5**	**0.3**
30	**7.2**	**2.3**	**1.2**	**0.7**	**0.5**
40	**10.1**	**3.2**	**1.7**	**1.0**	**0.7**
50	**26.5**	**8.4**	**4.3**	**2.7**	**1.9**

3.3 Stand density regulation.
Competition reduction, facilitation can improve packing density, overyielding

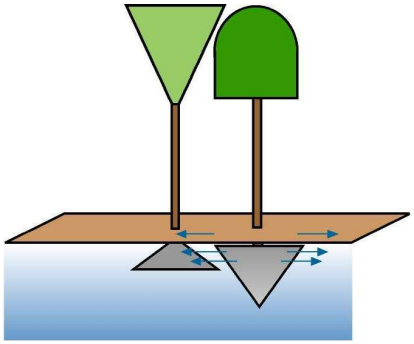
morphological complementarity



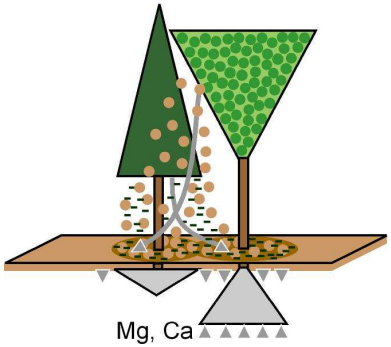
complementary light ecology

Ammer Ch (2018)
Pretzsch, H, Forrester, D, Bauhus, J (2017)

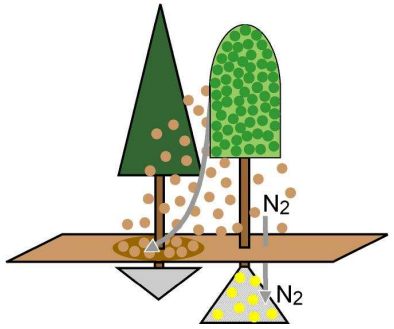
hydraulic redistribution



nutrients upward transport

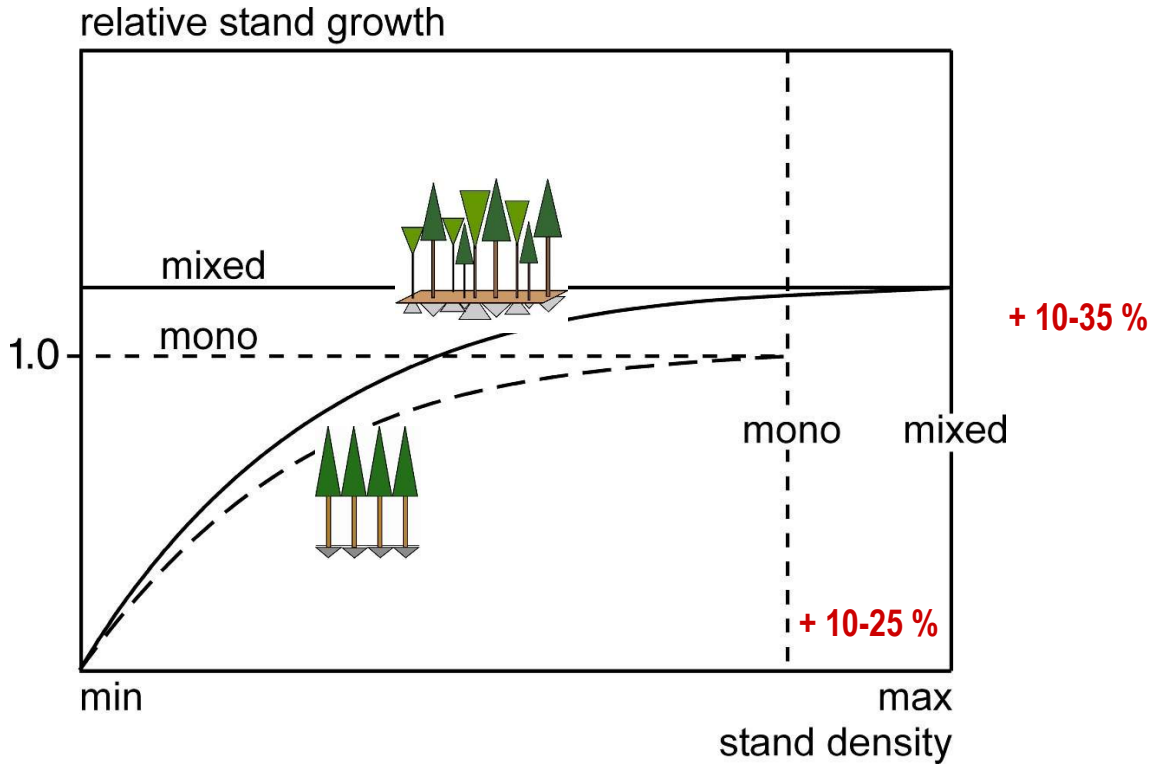


atmospheric N_2 fixation



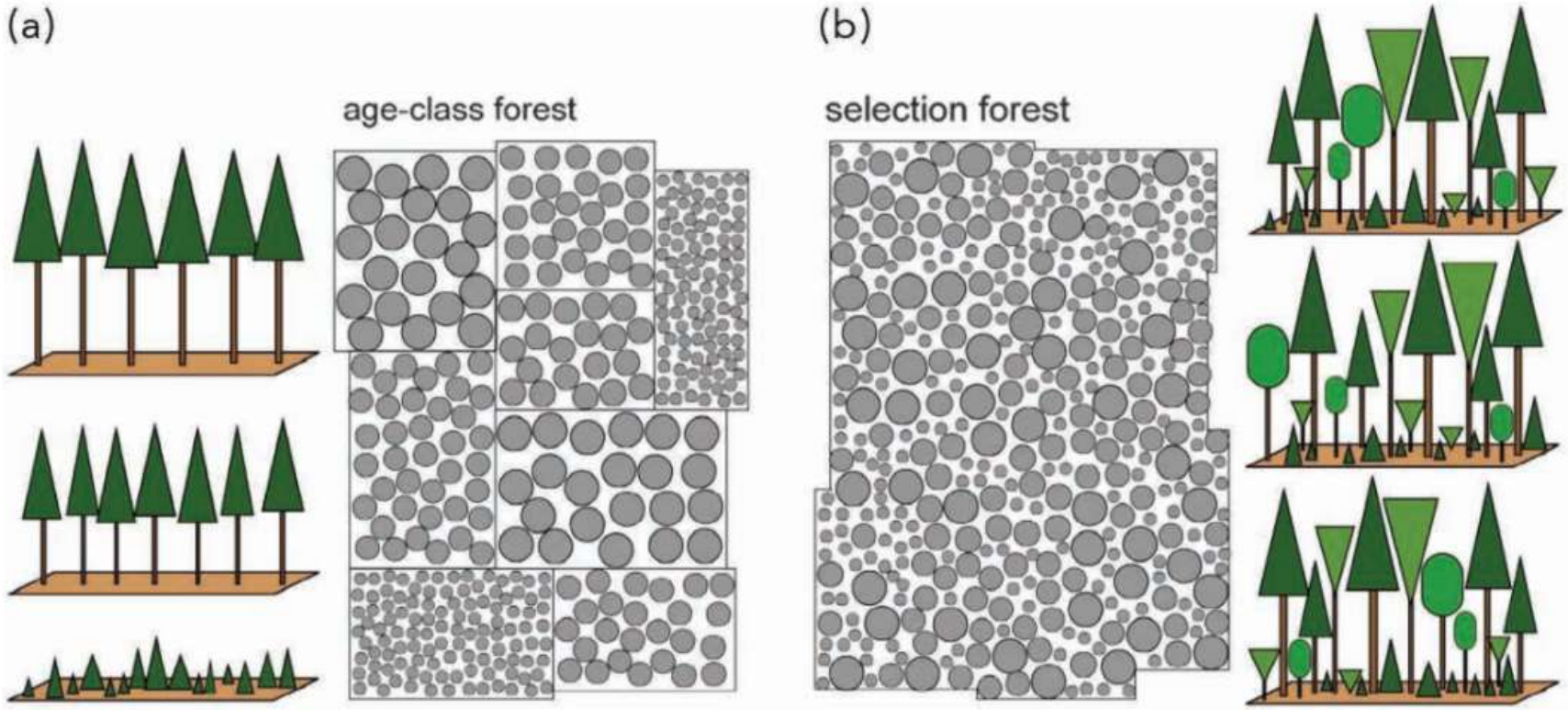
Prieto et al. (2012)
Rothe, Binkley (2001)
Forrester et al. (2007, 2007)

3.3 Stand density regulation. Overyielding10-35%, overdensity 10-25%



Pretzsch (2016) AFZ Der Wald, 14/2016: 47-50

Concept and pattern of age-class forest (a) and selection forest (b)



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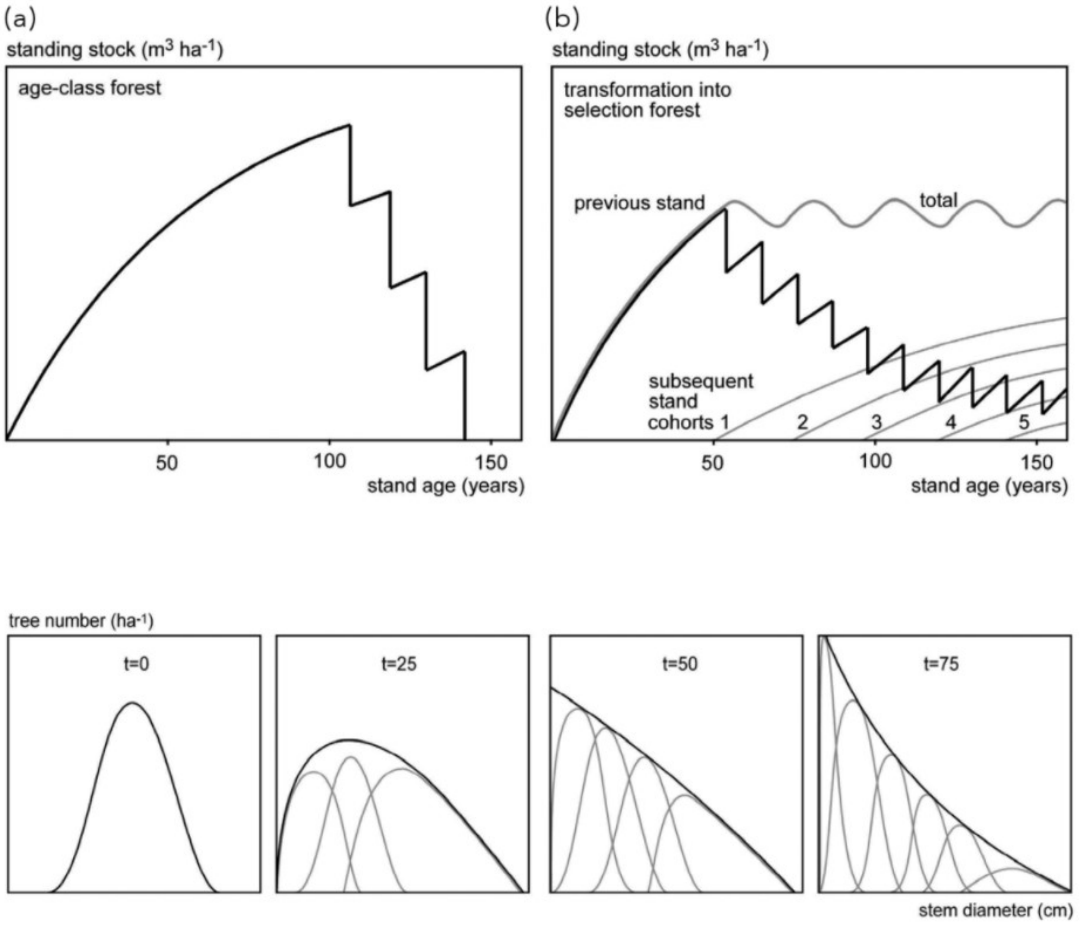
4 Transitioning to continuous-cover-forestry, selection forest. From normal to exponential size distribution



Pretzsch (2019)

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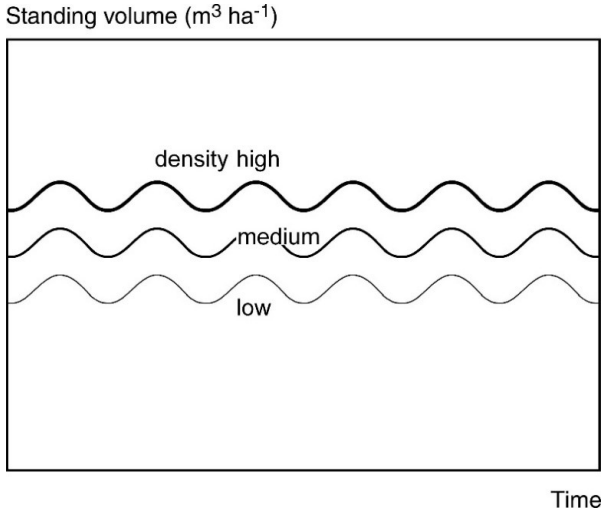
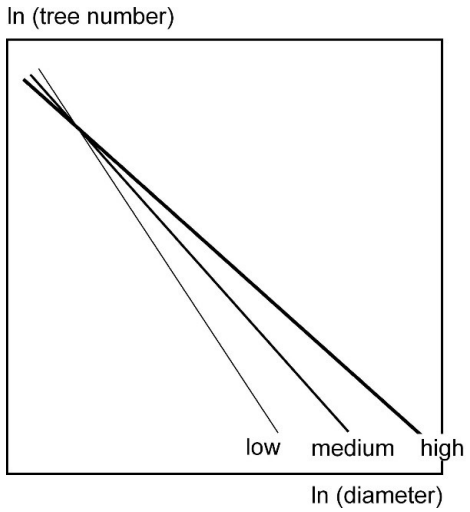
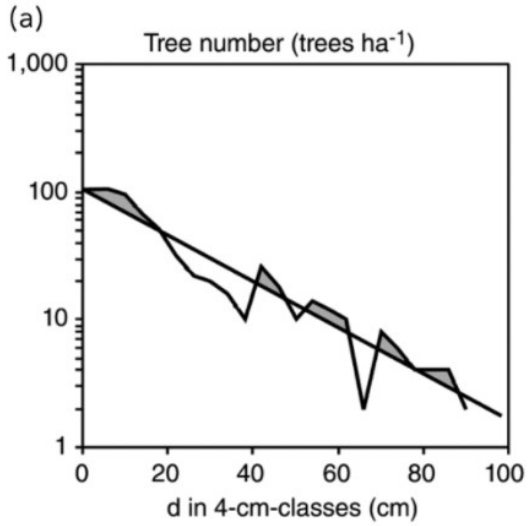
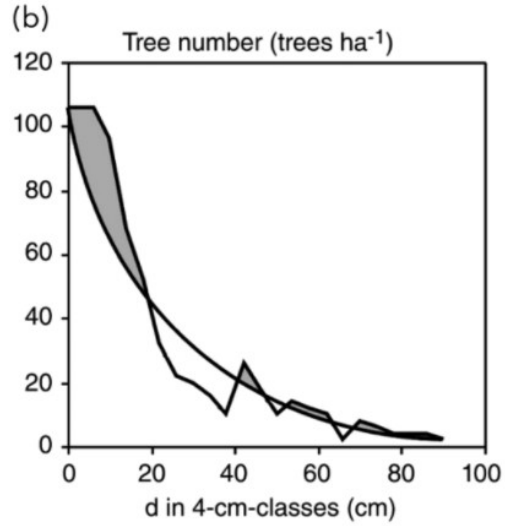
Selection forest.
Steady state of standing volume and diameter distribution
= f(site conditions and target diameter









Pretzsch (2019)

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5 Summary and perspectives

Starting points: Integration versus segregation; multifunctionality versus wood dominance

Complex forests contribute to higher stability and better provision of forest functions and services…

… but more complex forests also require advanced silviculture prescriptions

However, forest ecosystems are so valuable, they deserve smart management options…

…contribute by your PhD study.

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Picture credits

Slide 2: photos L. Steinacker, H. Pretzsch
Slide 3: photos BFW, Wien, Österreich; LBV, Bayern; waist-up-Porträt, racorn; BMEL;
FVA, Baden-Württemberg
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Slide 10: graphs von Lüpke and Spellmann (1997), Pretzsch and Zenner (2017), Pretzsch (2018)
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Slide 12: photo L. Steinacker, graph Pretzsch
Slide 13: graphs Pretzsch et al. (2021)
Slide 14: graphs Pretzsch et al. (2018), Pretzsch, H, Forrester, D, Bauhus, J (2017)
Slide 15-16: Pretzsch (2016)
Slide 17-19: graphs Pretzsch (2000), Pretzsch (2019)

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References. Selected own publications refering to the topic

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