Growth of different Euopean broadleaf tree regeneration under different light environment

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Content

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  - Potential natural composition of forest vegetation
  - Species composition, temporal trend, hemeroby
  - Objectives photosynthesis and growth of advanced regenration of broadleaf seedlings under light gradients
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  - Measurements of photosynthesis and growth in 1996/97 and in 2006
  - Effects of amending mineral nutrition

Content (cont.)

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- Results:
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  - photosynthetic performance
  - Increment and growth different species
  - Nutrition, other environmental effects
  - Longerterm effects, remeasurements 2006
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Forests in Austria

forest ecoregions

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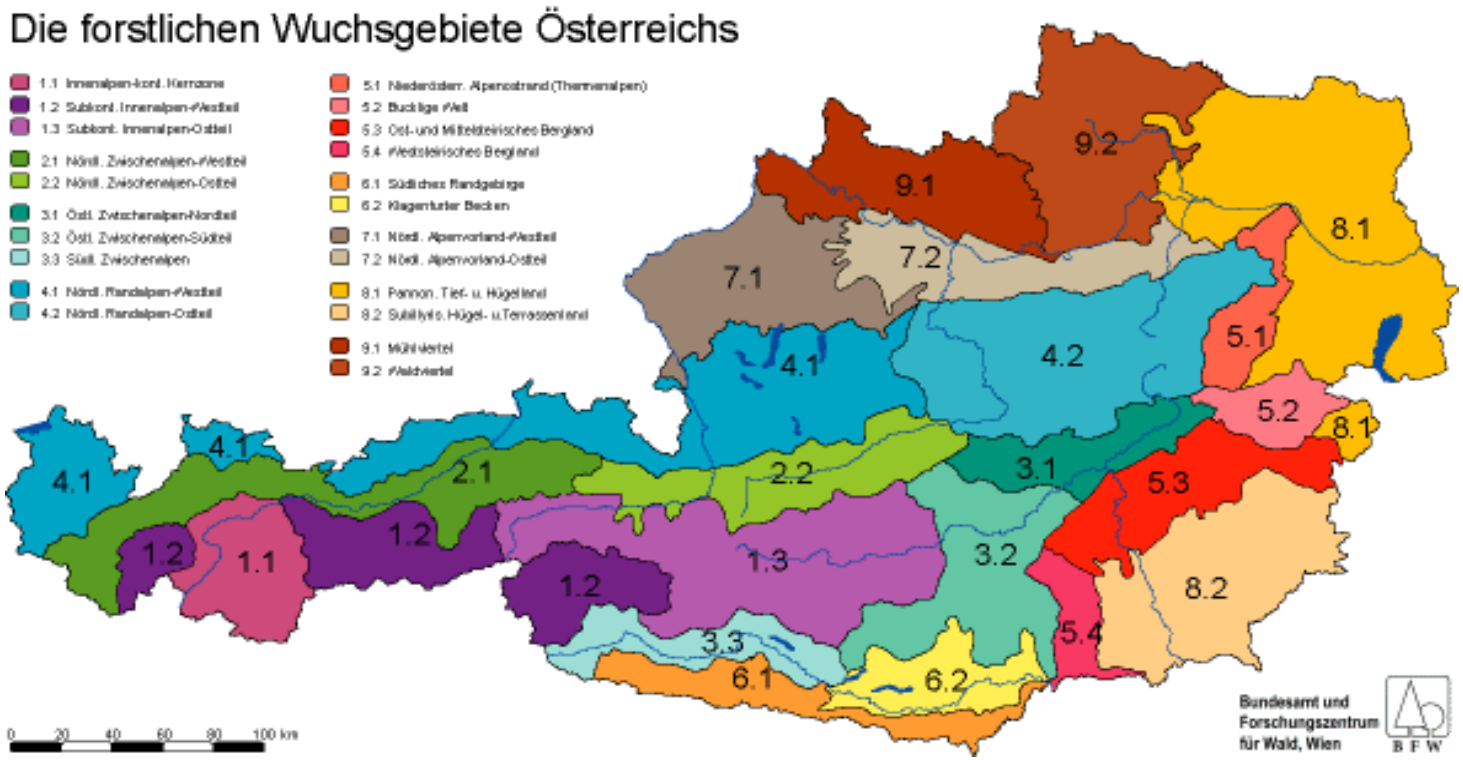

Vertical Forest Vegetation Zonation Eastern Alps (modified by Katzensteiner,2010)

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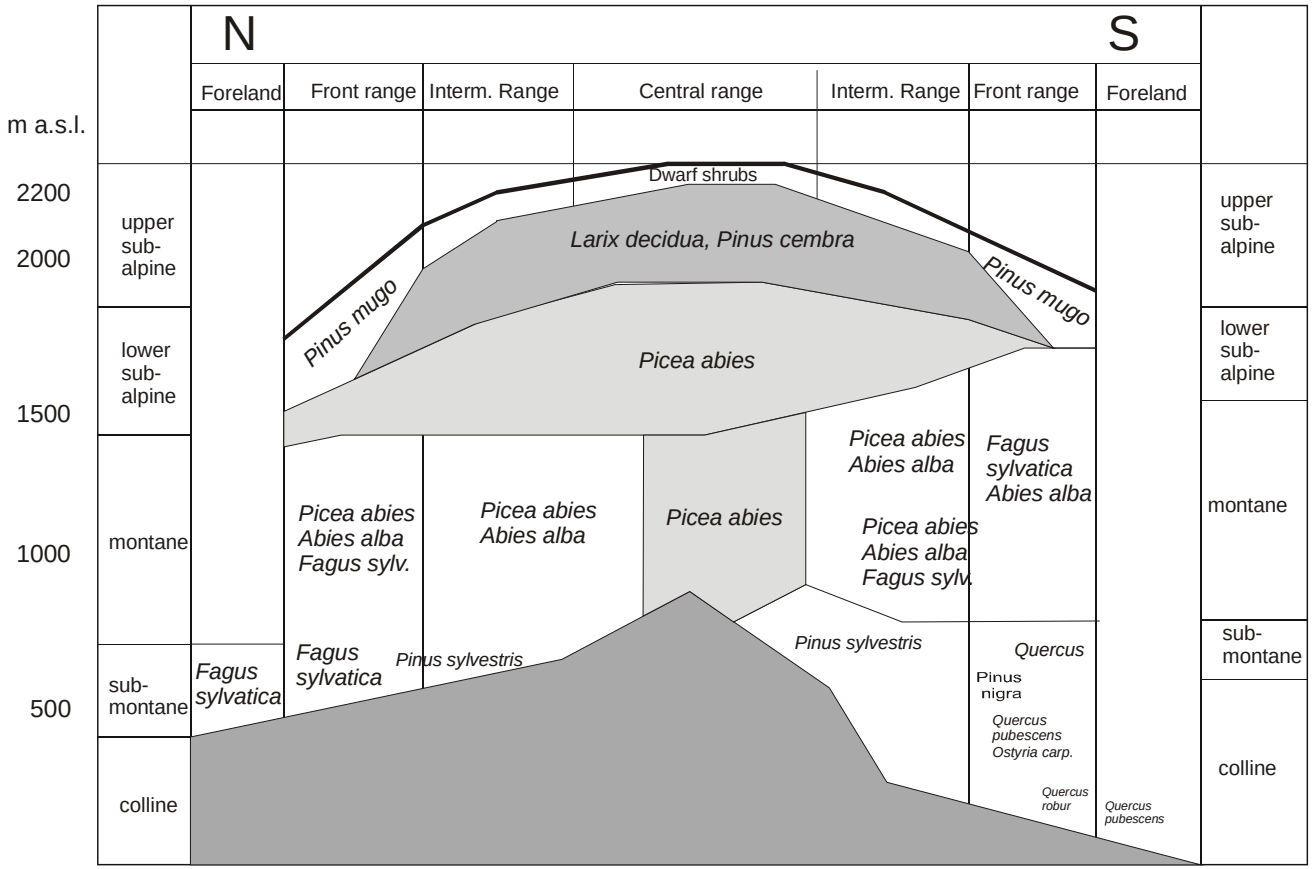
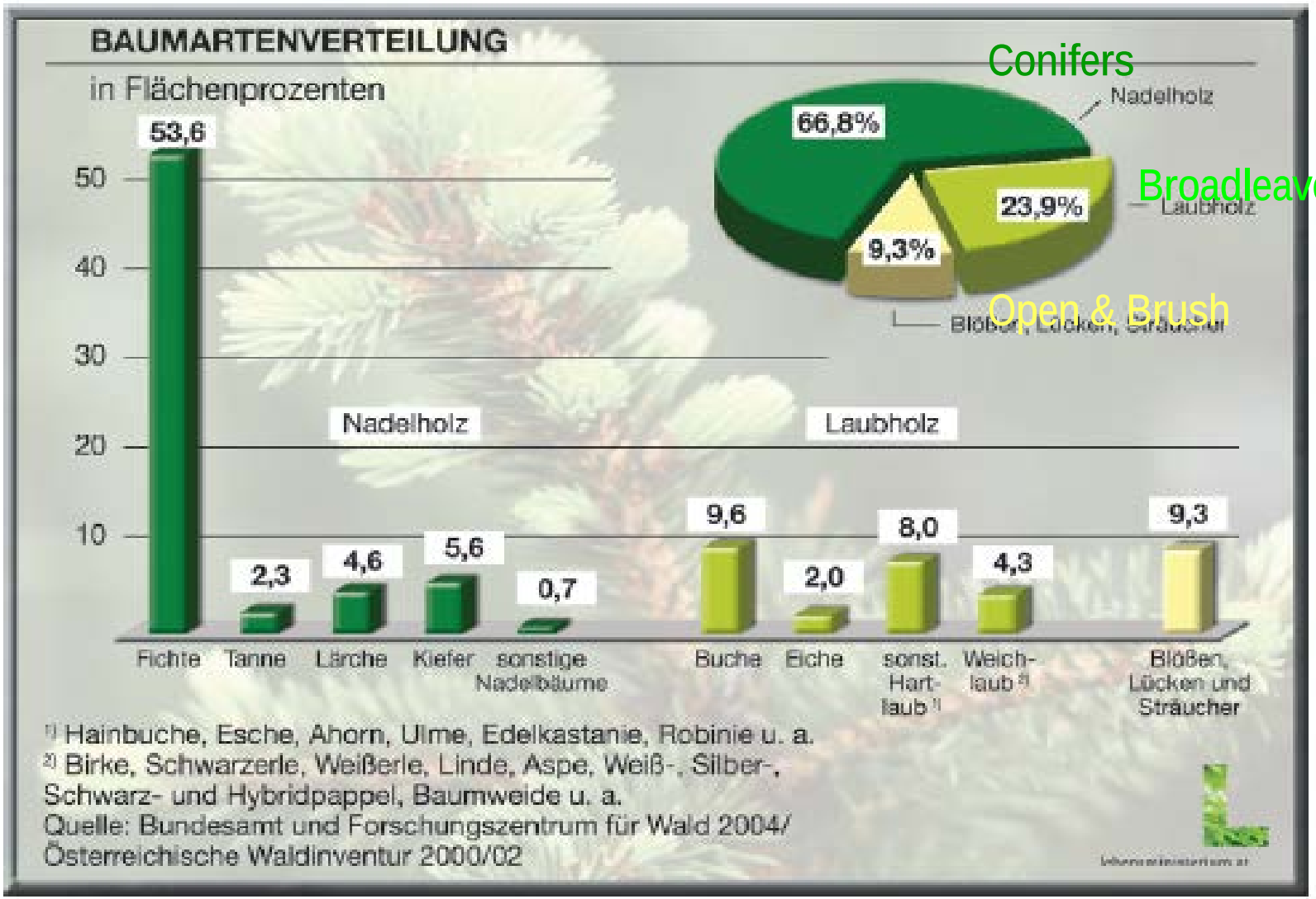
Vertical vegetation zonation



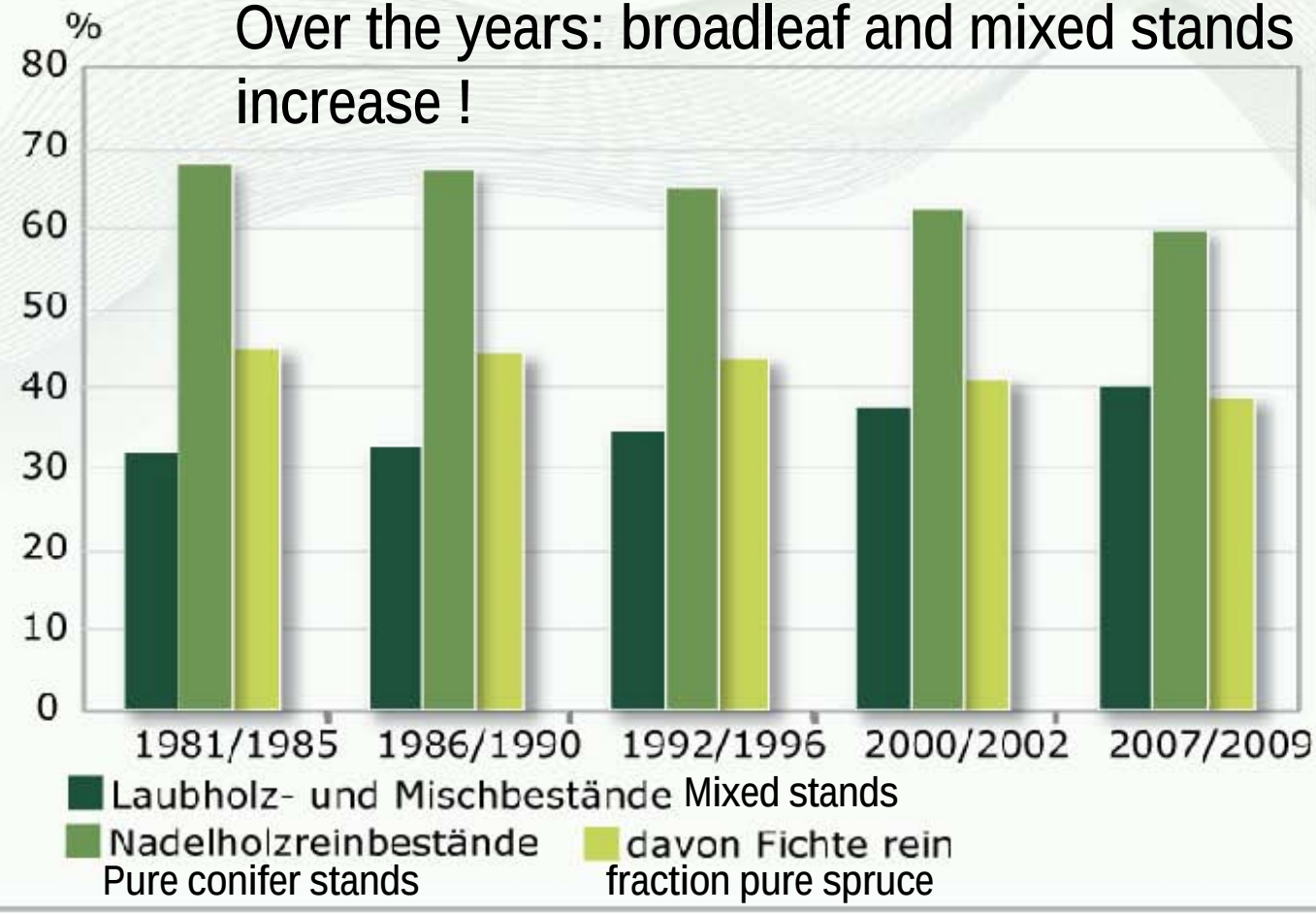
Cross section through the Eastern Alps (modified after Mayer, 1974)

Tree species compostion

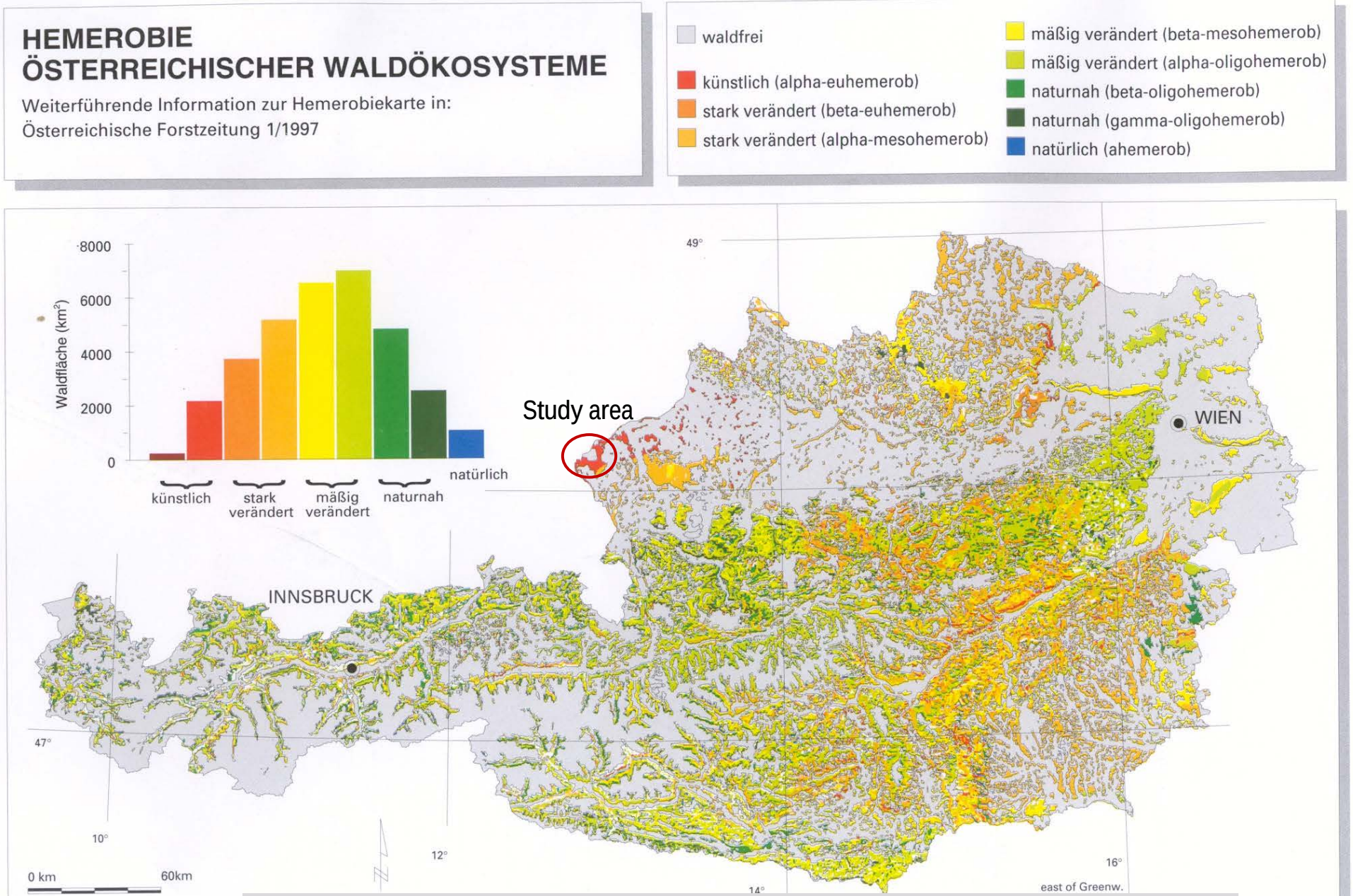


Laubholz- und Mischbestände nehmen zu

Time trend of species mixture 1980 to 2009



Over the years: broadleaf and mixed stands increase !



Naturalness of Austrian Forests (hemeroby)

Background and objectives of this research

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In the lower elevations of Austria, we find many secondary conifer stands which are *not* corresponding with the PNV of the sites

They show very high productivity (yield class)

But they are from age 60 on prone to large scale catastrophic disturbance from wind storms

snow damage

bark beetle infestations

Regeneration of such sites in salvaged clearcuts is

- costly and complicated
- number species for regeneration limited
- competition from grasses&herbs in clearcut

Background and objectives of this research (cont.)

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Therefore an advanced regeneration and conversion of such conifer stands should be tried out before catastrophic breakdowns occur

- utilizing the shading of existing canopies
- suppressing competing ground vegetation
- preventing extreme clearcut climate
- utilizing the production overlapping (old growth & regen.)

Objectives: to evaluate photosynthesis and growth of advanced regeneration of different broadleaf tree species under a light gradient (from inside an old growth conifer stand through the edge into a strip clearcut)

- to evaluate how fertilizer may interact with growth of regen.

Research sites

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Forest Enterprise Castell-Castell, Hochburg/OÖ;
Management unit Holzöster, 95% conifers, 5 % broadleaves
Future stocking should be 20-30% broadleaves and 70 to 80% conifers
Altitude range from 360m to 528m a.sl.
Geology: fluvio-glacial deposits, moraines
Soils: cambisols, podzolic cambisol, podzoloic luvisol (degraded biomass extraction)

Material

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winter 1993/94 strip clearcut (300m x 40m) in
95yr old spruce/pine stand, stand edge W-E
soils degraded podzolic luvisol
April 1996 14 plots each 20m x 70m
planted with beech (Fagus sylvatica) 3 replicates
oak (Quercus petraea) 3 replicates
maple (Acer pseudopl.) 3 replicates
beech fertilized (F. sylvatica) 3 replicates
and one plot of ash (Fraxinus excelsior) and
wild cherry (Prunus avium) planted for comparison
plot orientation was N – S, each plot extending 35 m into the old growth stand and 35m into the clearcut
Seedlings were 2yrs old (oak, cherry & maple) and beech and ash 3yrs,
Planting width 2m by 1m, fertilizer“Magnosol“: organic with15%MgO,
application rate 0.3kg/m2

Material

Location of the sample plots and treatments

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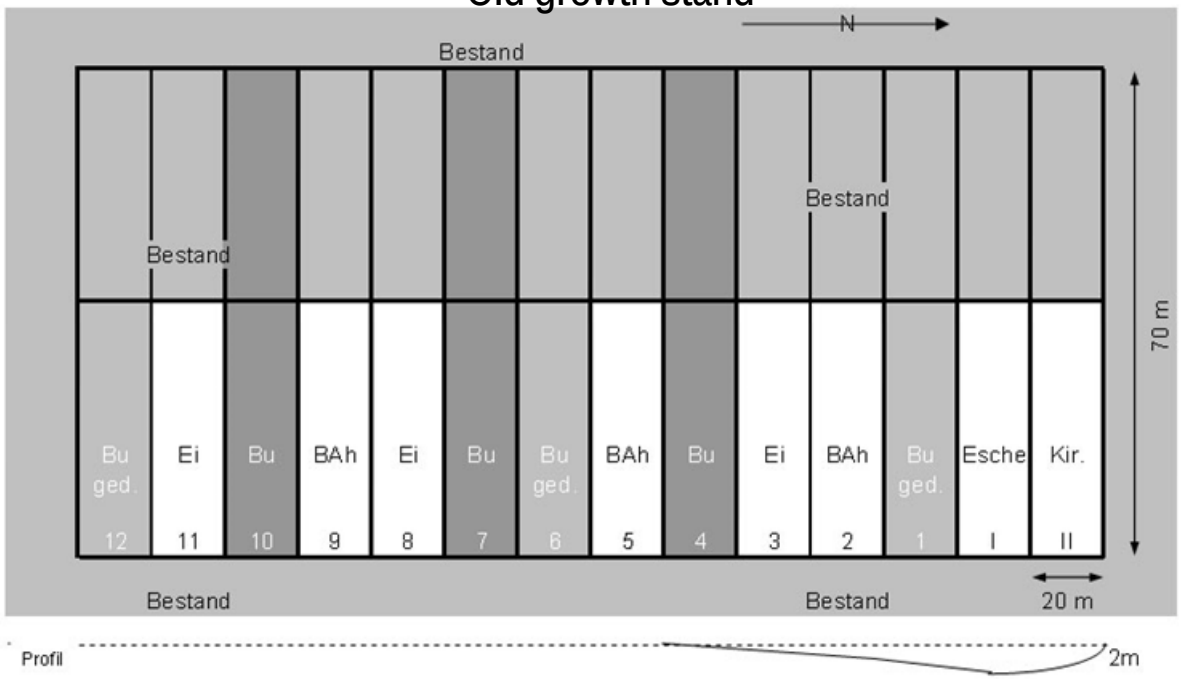
Old growth stand



Strip clearcut

Tree species:

Bu = beech
Bu ged. = beech fertilized
Ei = oak
BAh = sycomore maple
Esche = ash
Kir = wild cherry

Material & Methods

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PAR measured with LI-190SZ quantum sensor
Canopy cover evaluated with LAI 2000 Plant Canopy Analyzer and with Hemiview Photography (Delta-T Devices)
Photosynthesis was measured LI 6400 CO2/H2O Porometer (LICOR Inc.)

Growth of seedlings:
diameter was measured with calipers 4cm above root collar, later also at BH
total height and length of the leader shoot was measured with tape and ruler, later with Vertex Hypsometer

Statistical analysis was done with SPSS software package

Research plots in 2006

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nt für Wald- und Boden-
haften

Research Plots 2006

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How height growth was measured in Sept 2006

Results: Photosynthesis and light environment

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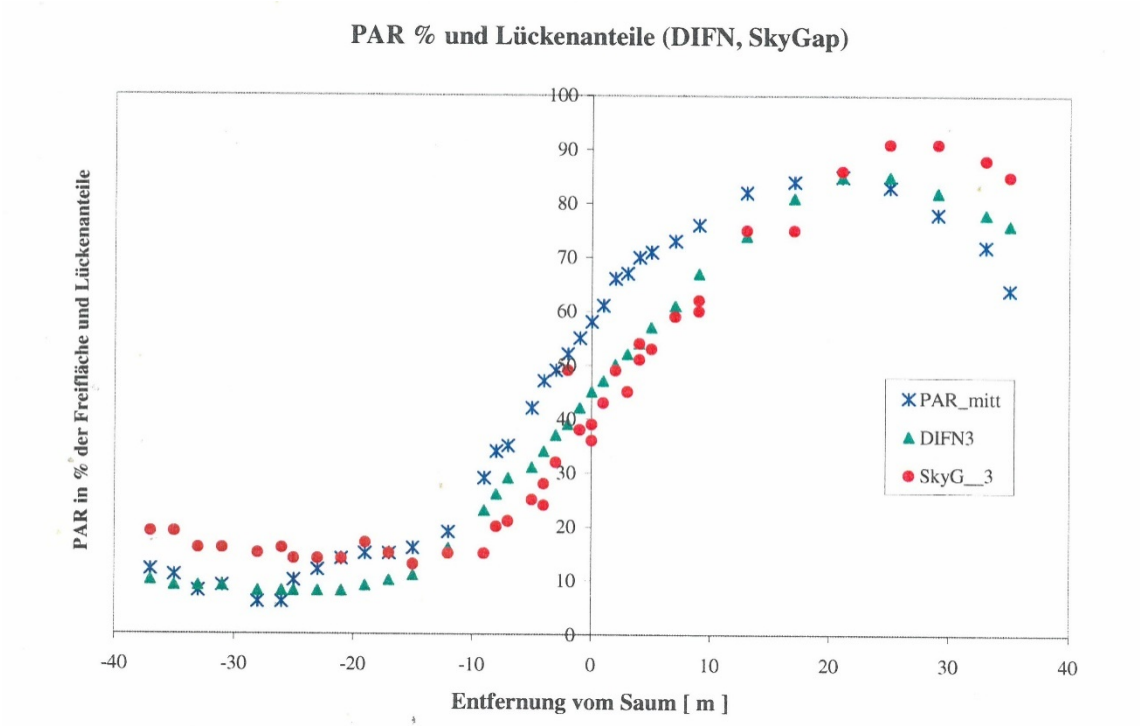

Inside stand in clearcut

Distribution of PAR Diffuse Radiation and Gap fraction
From 35m inside oldgrowth, through the edge 35m into stip clearcut around noon

Results: Photosynthesis and light environment

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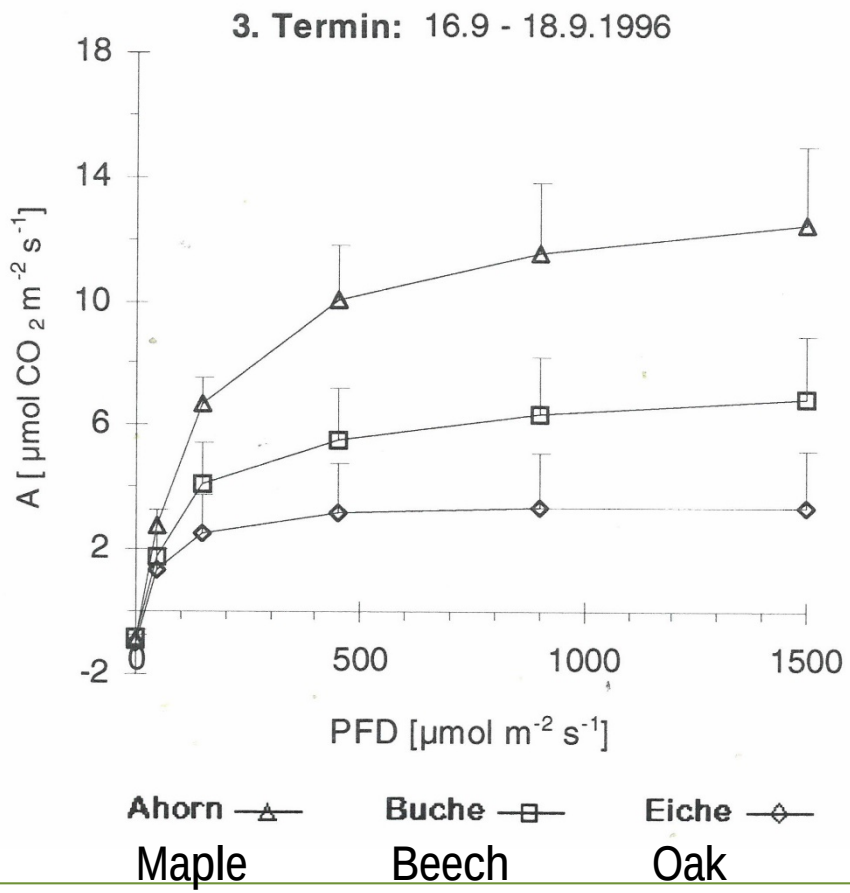

Light saturation curves for photosynthesis of 3 species in the year of transplanting

Results: Photosynthesis and light environment

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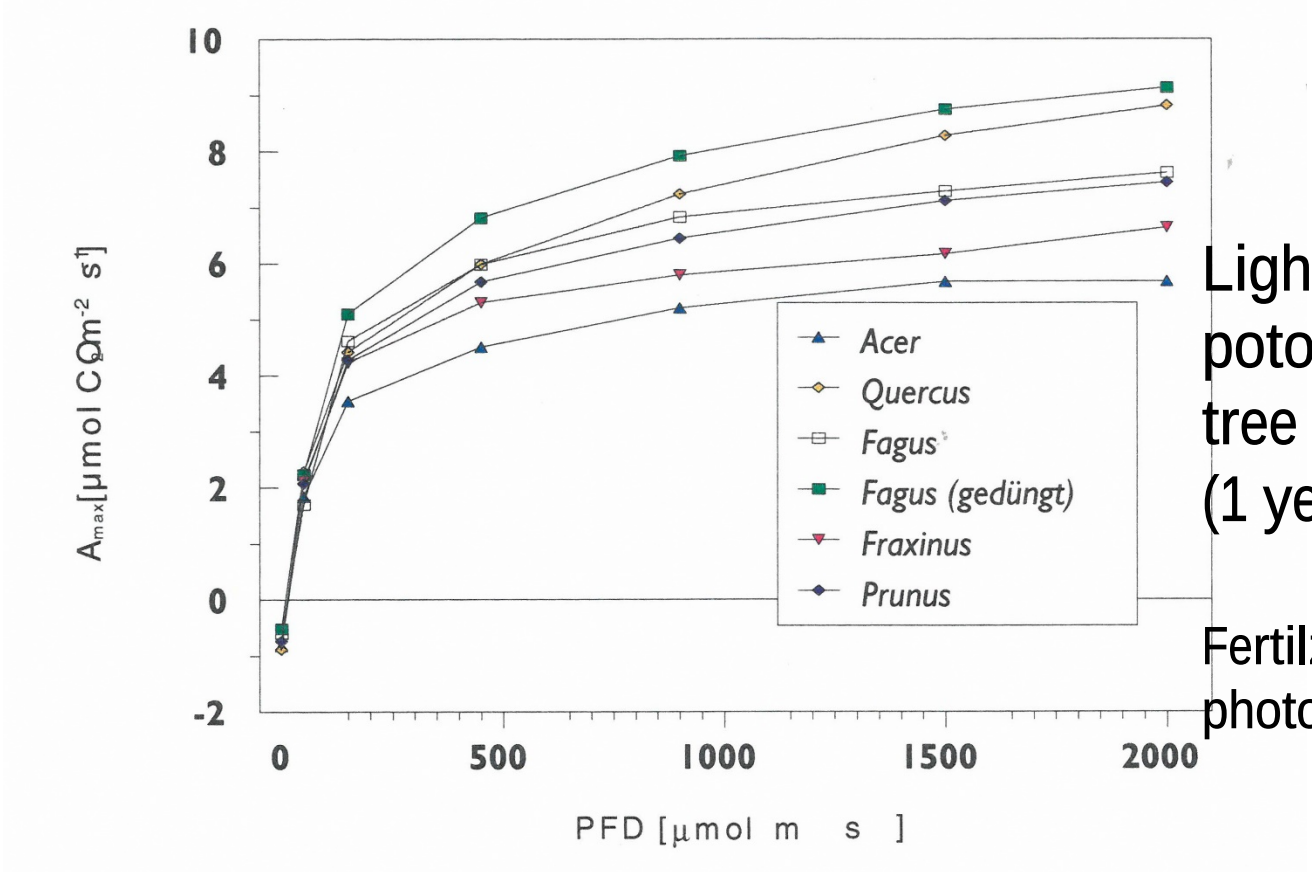

Light saturation curves for potosynthesis 1997 for all tree species
(1 year after transplanting)

Fertilzed beech has highest photosynthetic efficiency

Photosyntehsis and the light environment

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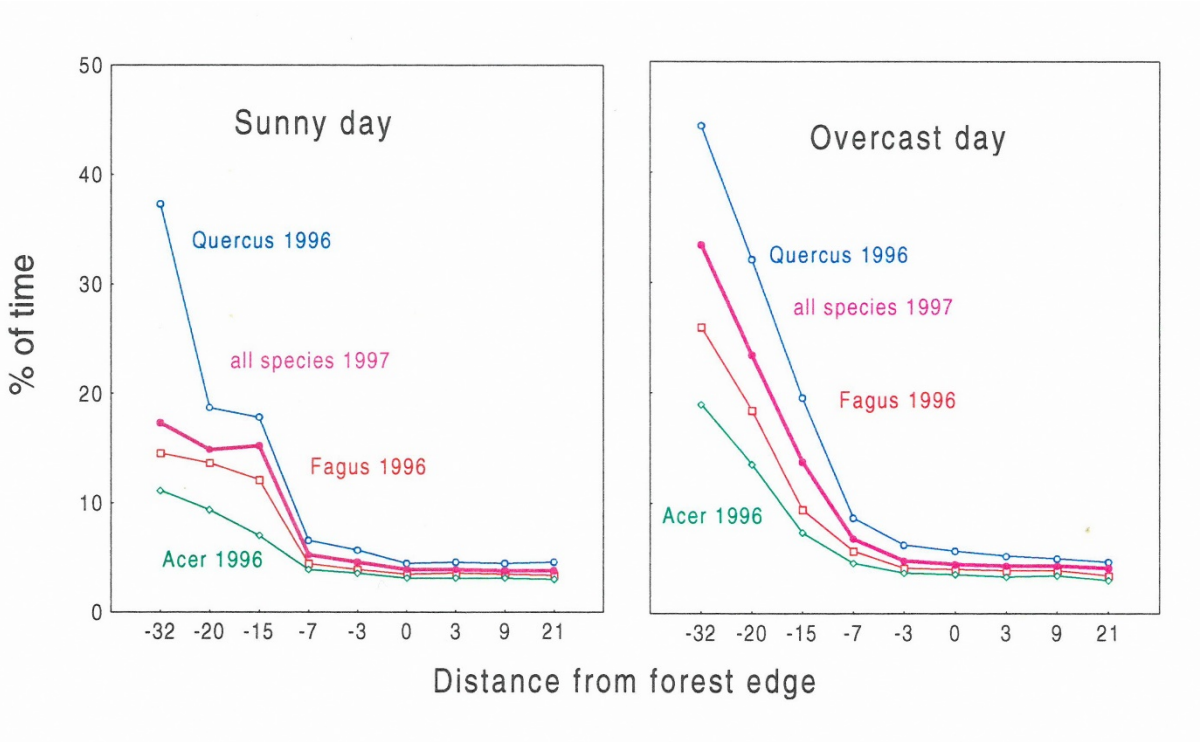

Percentage of time when light flux density was at/below the photosynthetic compensation point inside or outside the edge of oldgrowth forest (no net C-gain)

Maple 1996 best adapted to shade inside old growth canopy!

Overall Increment of tree species 1996 and 1997

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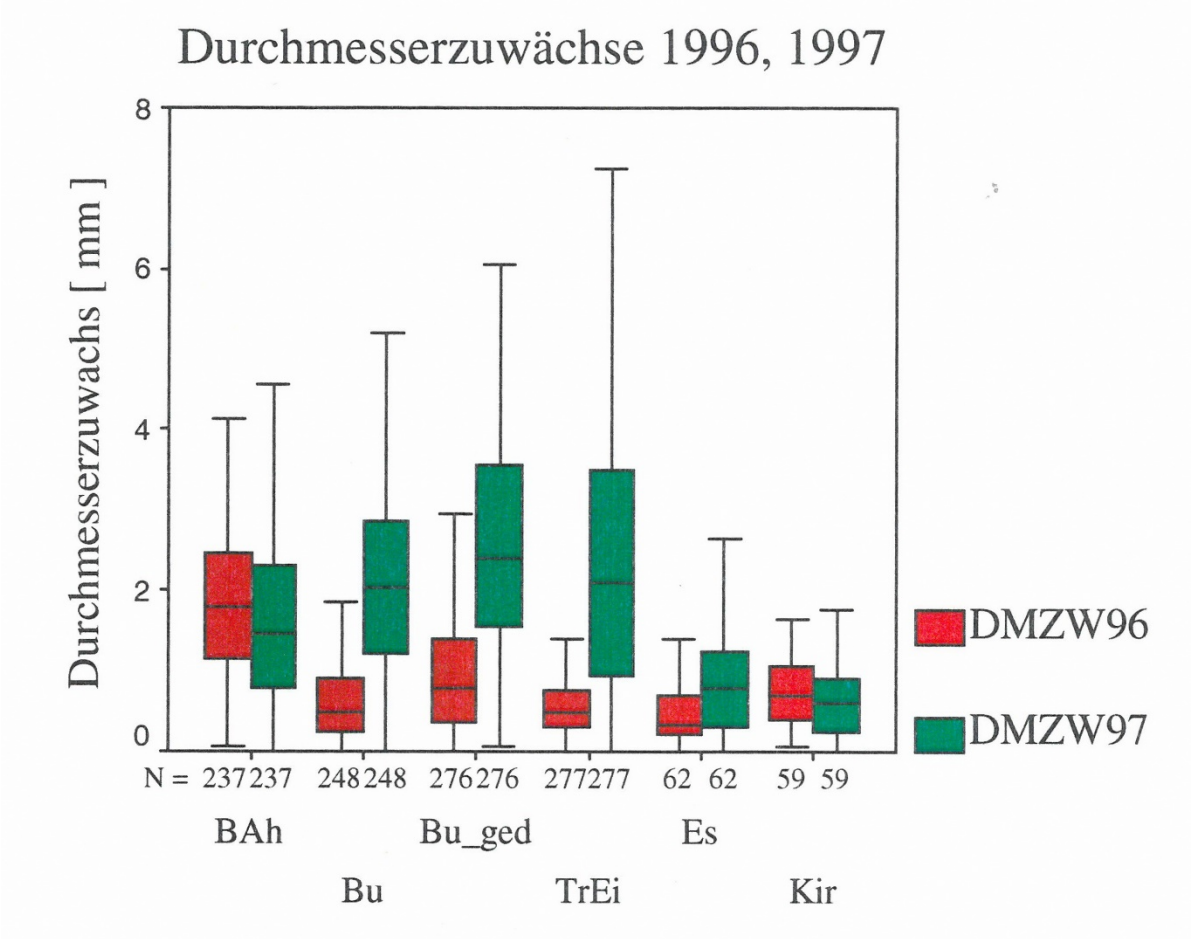

Diameter increment for all tree species planted

DMZW96 = diameter increment 1996 (mm)
DMZW97 = diameter increment in 1997 (mm)
BAh ... Maple
Bu ..... Beech
Bu_ged..... Beech fertilized
TrEi ..... Oak
Es ..... Ash
Kir.....Cherry

Overall Increment of tree species 1996 and 1997

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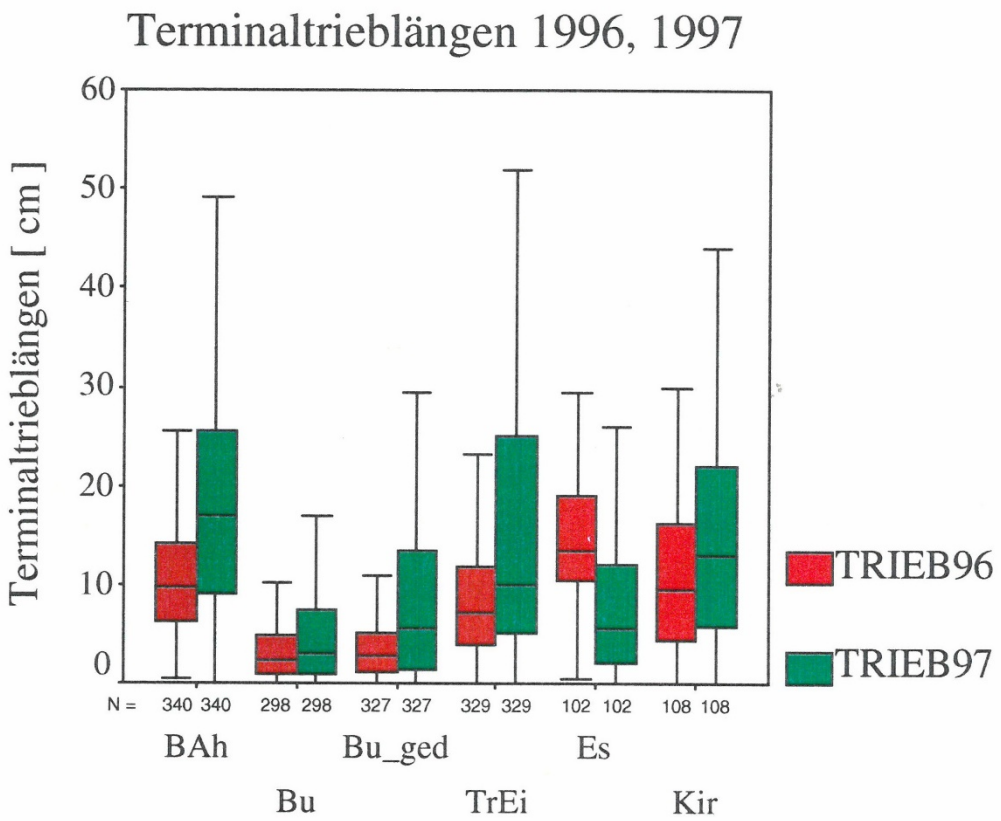

Terminal shoot increment for all tree species planted

TRIEB96 = shoot increment 1996 (cm)
TRIEB97 = shoot increment 1997 (cm)
BAh ... Maple
Bu ..... Beech
Bu_ged..... Beech fertilized
TrEi ..... Oak
Es ..... Ash
Kir.....Cherry

Overall Increment of tree species 1996 and 1997

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		DMZW96	DMZW97	TRIEB95*	TRIEB96	TRIEB97
Eiche	Mittel	0,54	2,35	32,49	8,27	17,23
	Median	0,45	2,0	32,0	7,0	10,0
Ahorn	Mittel	1,85	1,84	55,05	11,28	20,15
	Median	1,8	1,45	54,5	9,6	17,0
Buche	Mittel	0,66	2,02	39,02	3,3	5,38
	Median	0,5	1,92	40,0	2,3	3,0
Buche ged.	Mittel	0,94	2,39	37,93	3,47	8,27
	Median	0,8	2,25	38,5	2,8	5,5
Esche	Mittel	0,55	0,85	119,46	14,55	8,0
	Median	0,4	0,75	120,25	13,75	5,5
Kirsche	Mittel	0,87	(0,81)	88,18	10,91	15,48
	Median	0,8	0,6	87,0	9,5	13,0

*Die Vegetationsperiode 1995 verbrachten die Voranbaupflanzen noch im Pflanzgarten.

Mittel = mean
Median = median

TRIEB 95 shoot increment before transplanting

DMZW96 = diameter increment 1996 (mm)
DMZW97 = diameter increment in 1997 (mm)
TRIEB96 = shoot increment 1996 (cm)
TRIEB97 = shoot increment 1997 (cm)
Eiche ..... Oak
Ahorn ... Maple
Buche ..... Beech
Buche_ged..... Beech fertilized
Esche ..... Ash
Kirsche.....Cherry

Increments of individual species along a light gradient (1997)

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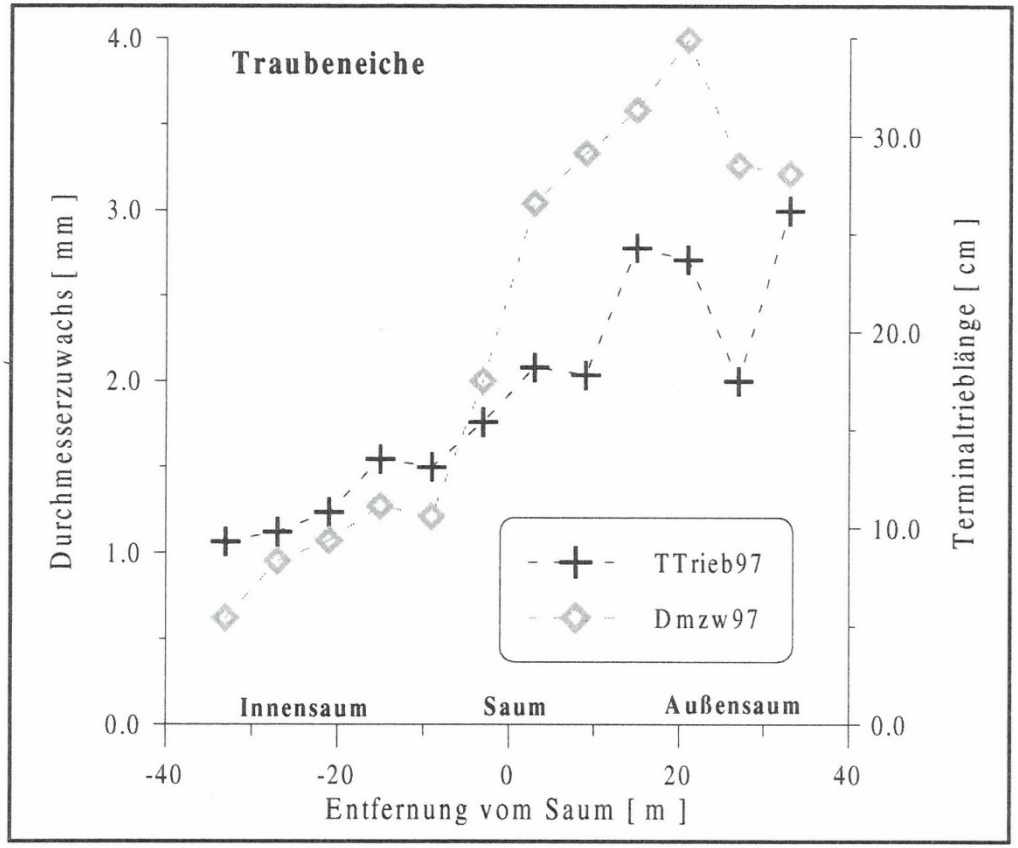

Inside edge outside

Oak (*Quercus petraea*) shoot and diameter increment

TTrieb97 = terminal shoot increment 1997 (cm)
Dmzw97 = diameter increment 1997 (mm)

Increments of individual species along a light gradient (1997)

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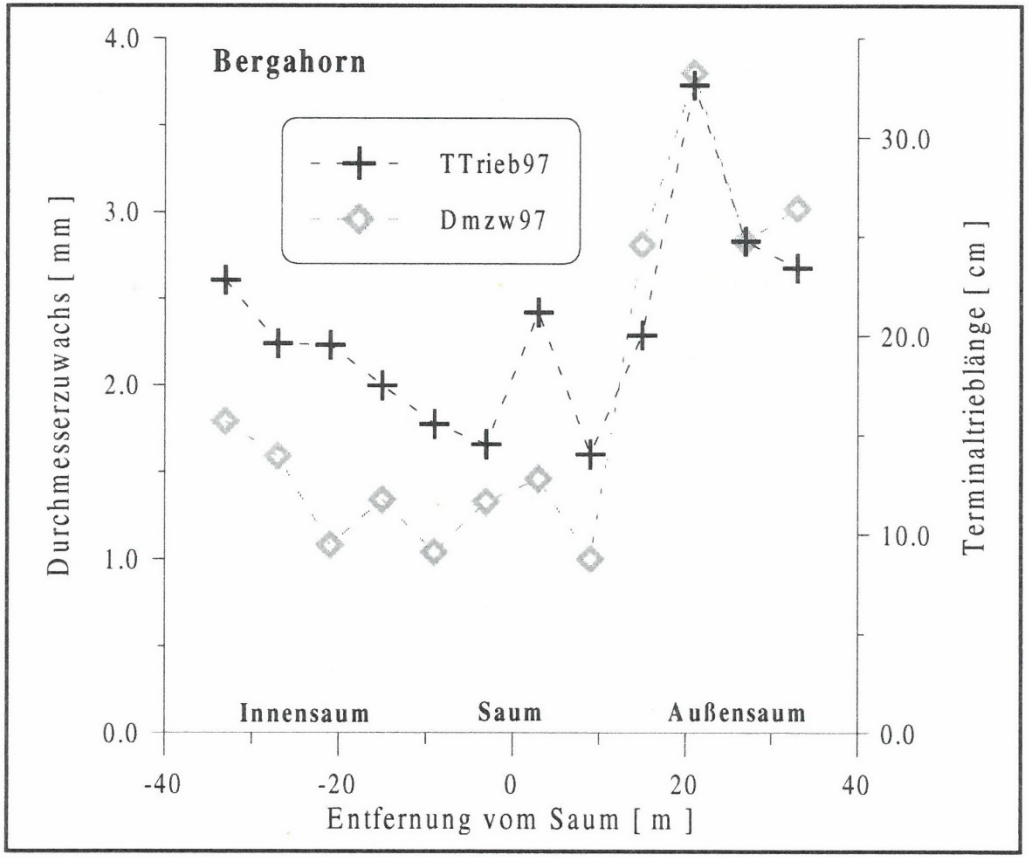

Inside edge outside

Maple (*Acer pseudoplatanus*) shoot and diameter increment

TTrieb97 = terminal shoot increment 1997 (cm)
Dmzw97 = diameter increment 1997 (mm)

Increments of individual species along a light gradient (1997)

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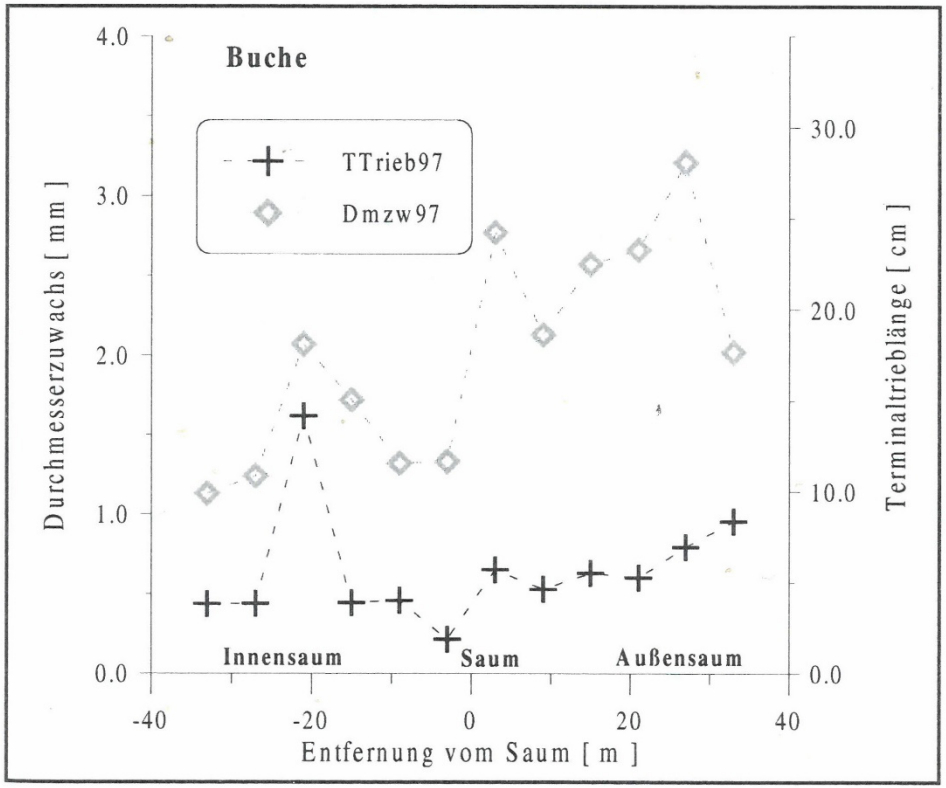

Inside edge outside

Beech (*Fagus sylvatica*) shoot and diameter increment

TTrieb97 = terminal shoot increment 1997 (cm)
Dmzw97 = diameter increment 1997 (mm)

Increments of individual species along a light gradient (1997)

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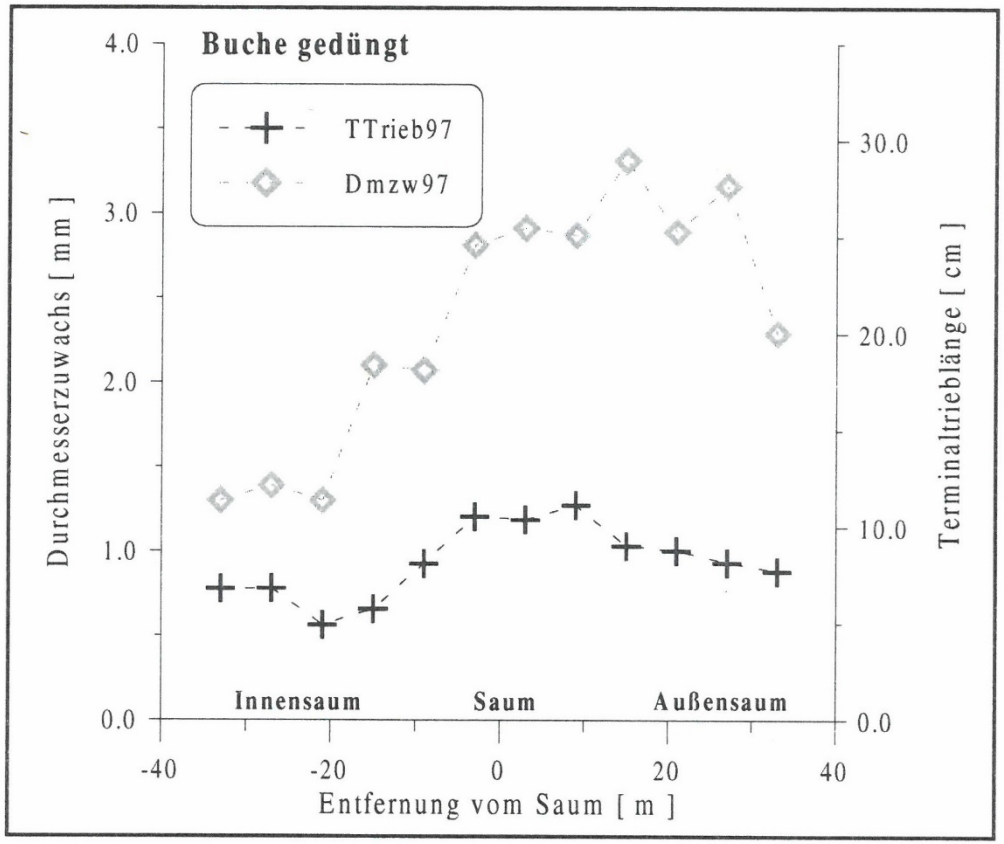

Inside edge outside

Fertilized Beech (*Fagus sylvatica*) shoot and diameter increment

TTrieb97 = terminal shoot increment 1997 (cm)
Dmzw97 = diameter increment 1997 (mm)

Increments of individual species along a light gradient (1997)

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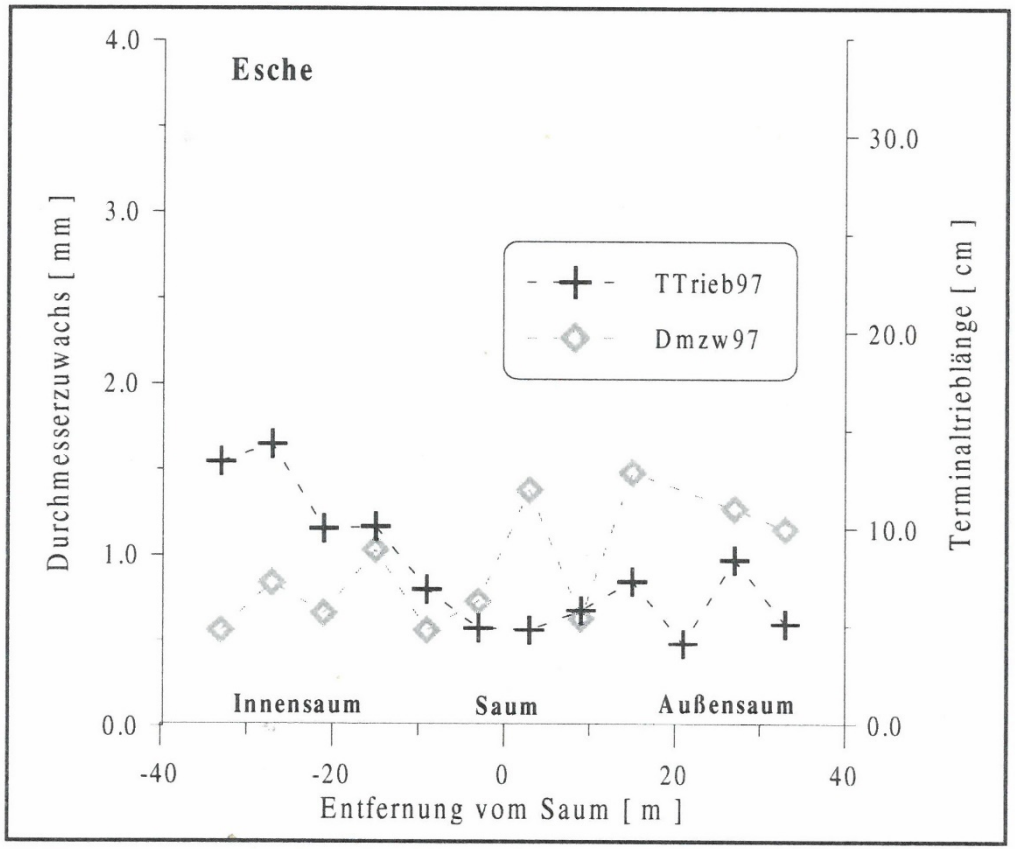

Inside edge outside

Ash (*Fraxinus excelsior*) shoot and diameter increment

TTrieb97 = terminal shoot increment 1997 (cm)
Dmzw97 = diameter increment 1997 (mm)

Increments of individual species along a light gradient (1997)

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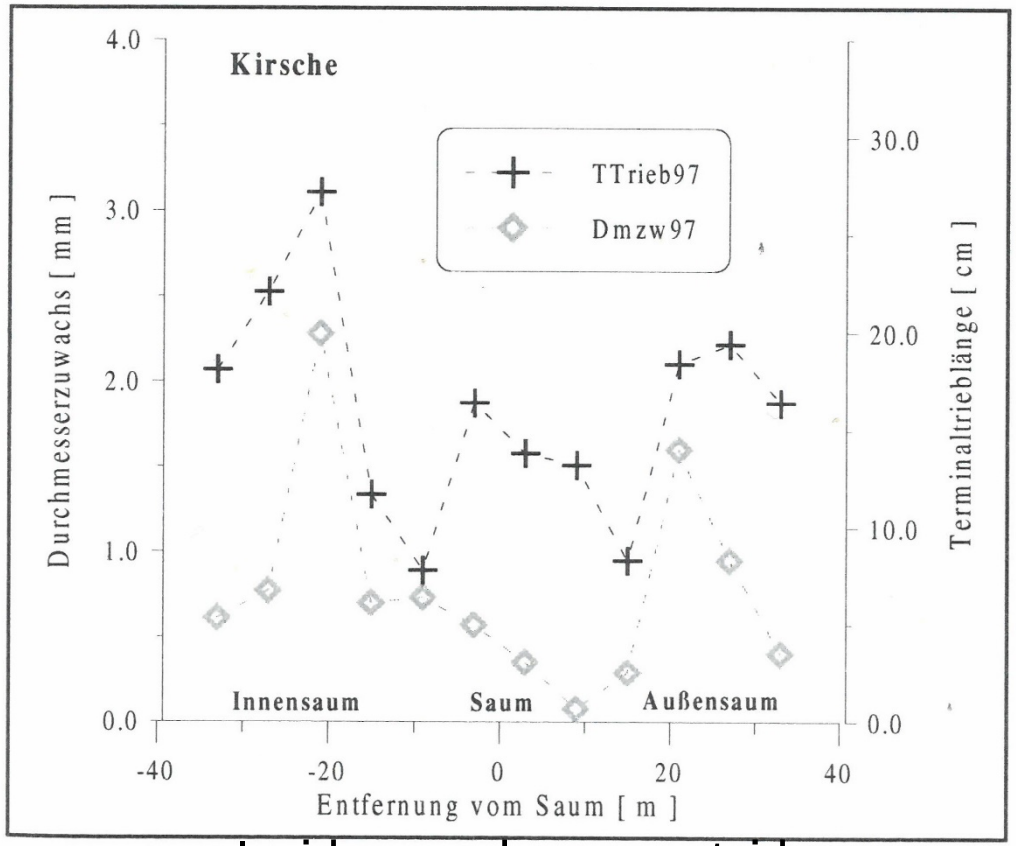

Inside edge outside

Cherry (*Prunus avium*) shoot and diameter increment

TTrieb97 = terminal shoot increment 1997 (cm)
Dmzw97 = diameter increment 1997 (mm)

Analysis of Growth and Increments and Response to light gradients short term effects

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Generally most tree species show in the year after transplantation postive effects upon diameter and terminal shoot increment, only the species Ash and Cherry show a trend towards either depressed shoot or diameter increment

Maple and oak and cherry show the best overall growth performance in 1997, where maple exhibits the least sensitivity towards decreasing light inside from the edge the oldgrowth stand

Oak increment reacts very strict with decreasing light flux densities

Beech, ash and cherry seem also to hampered by nutritional and other problems from site climatology

Effects of nutritional improvements in beech

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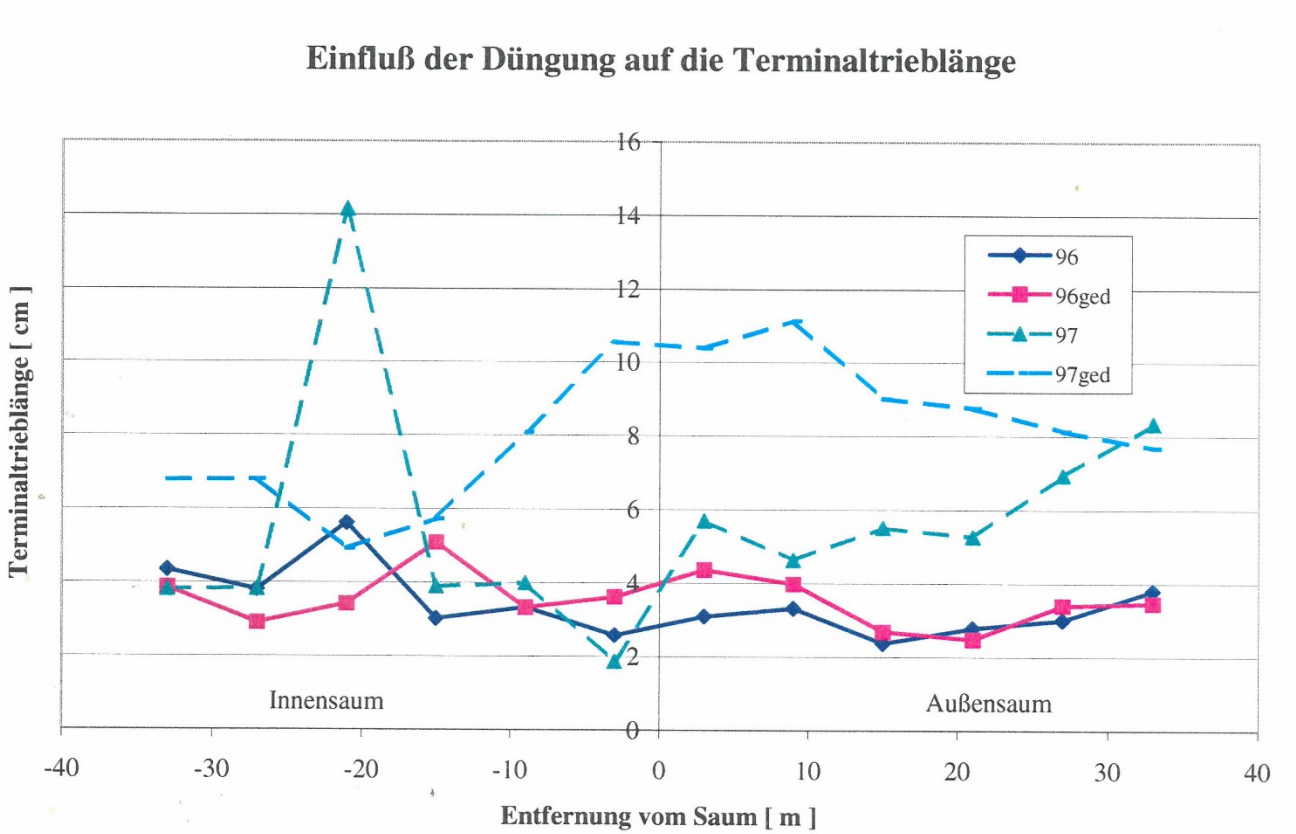

Inside edge outside

Terminal shoot increment 96 and 97 for beech and Mg-fertilized beech

97 postive reponse

Effects of nutritional improvements in beech

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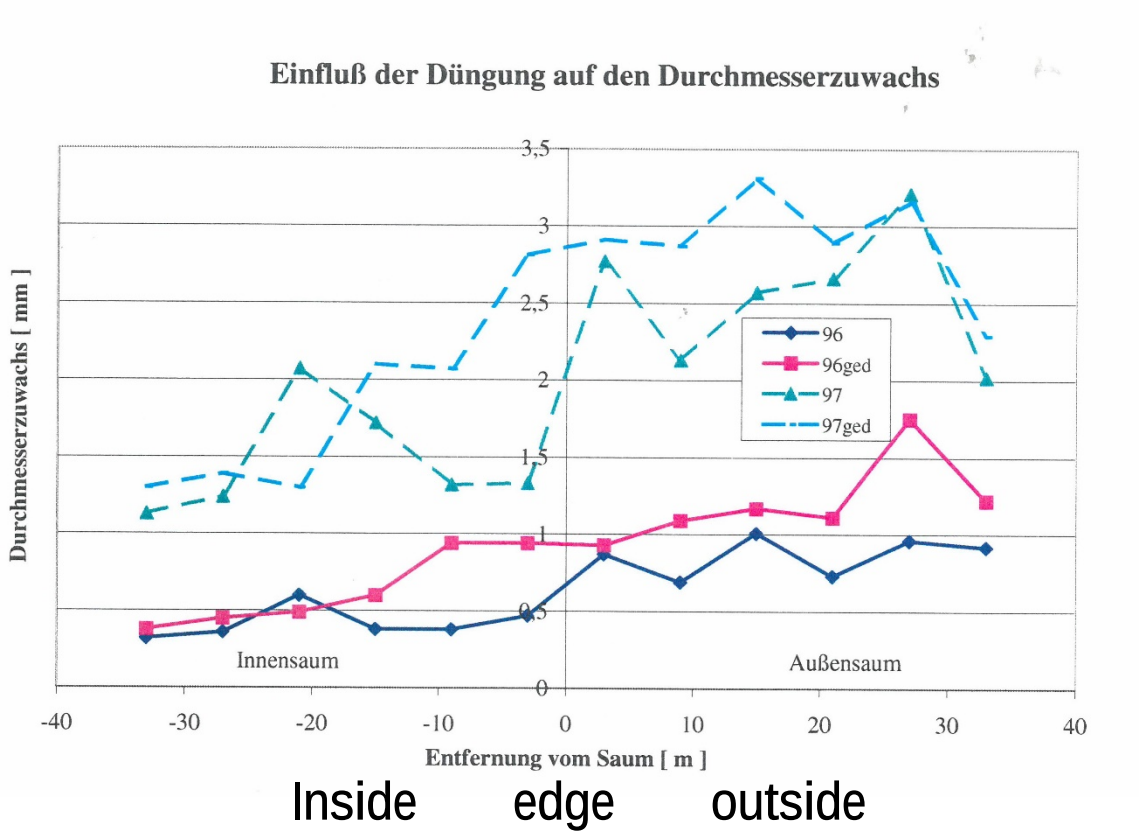

Inside edge outside

Diameter increment 96 and 97 for beech and Mg-fertilized beech

Overall slightly positive relationship with light gradient 1997 little enhancement of diameter increment of fertilized beech

Mortality and other environmental effects

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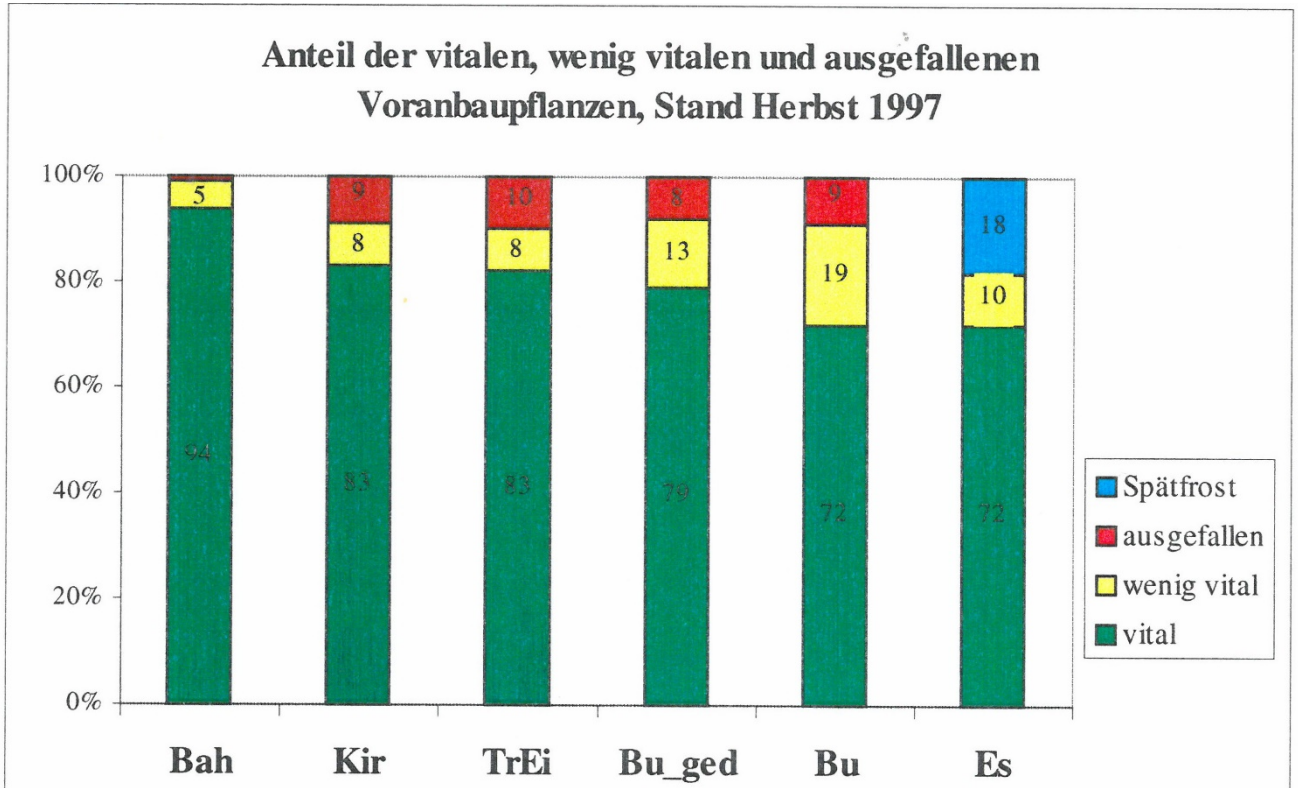
Percentage, vital, less vital, dead and frost damaged seedlings in Fall 1997



Bah ... Maple
Kir.....Cherry
TrEi ..... Oak
Bu_ged..... Beech fertilized
Bu ..... Beech
Es ..... Ash

Late frost
Dead
Less vital
Vital

Maple least transplanting problems, Ash transplanting & frost problems !

Effects on ash establishment along environmental gradient

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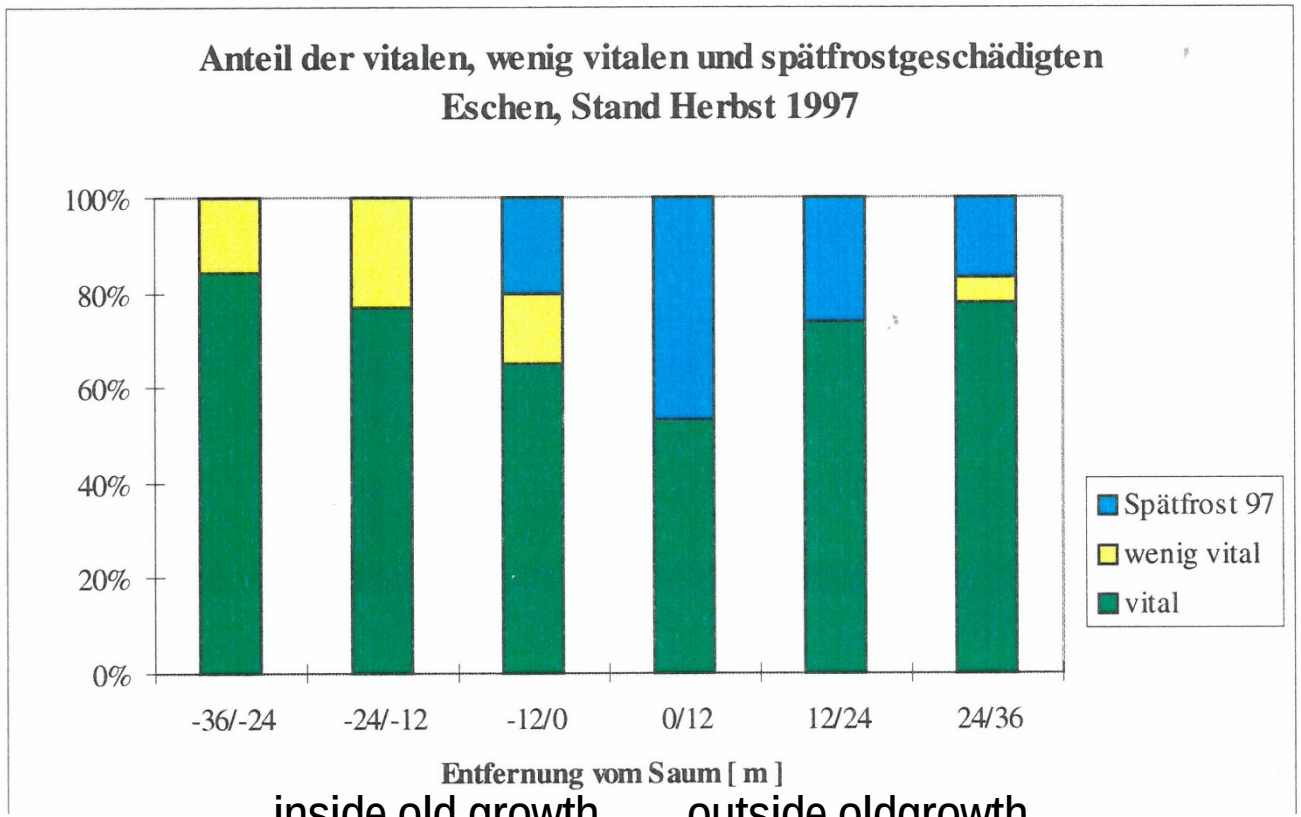
Percentage of vital, less vital and frost damaged ash; fall 1997



frost damage 97
less vital
vital

inside old growth outside oldgrowth

Oak mortality and establishment along environmental gradient

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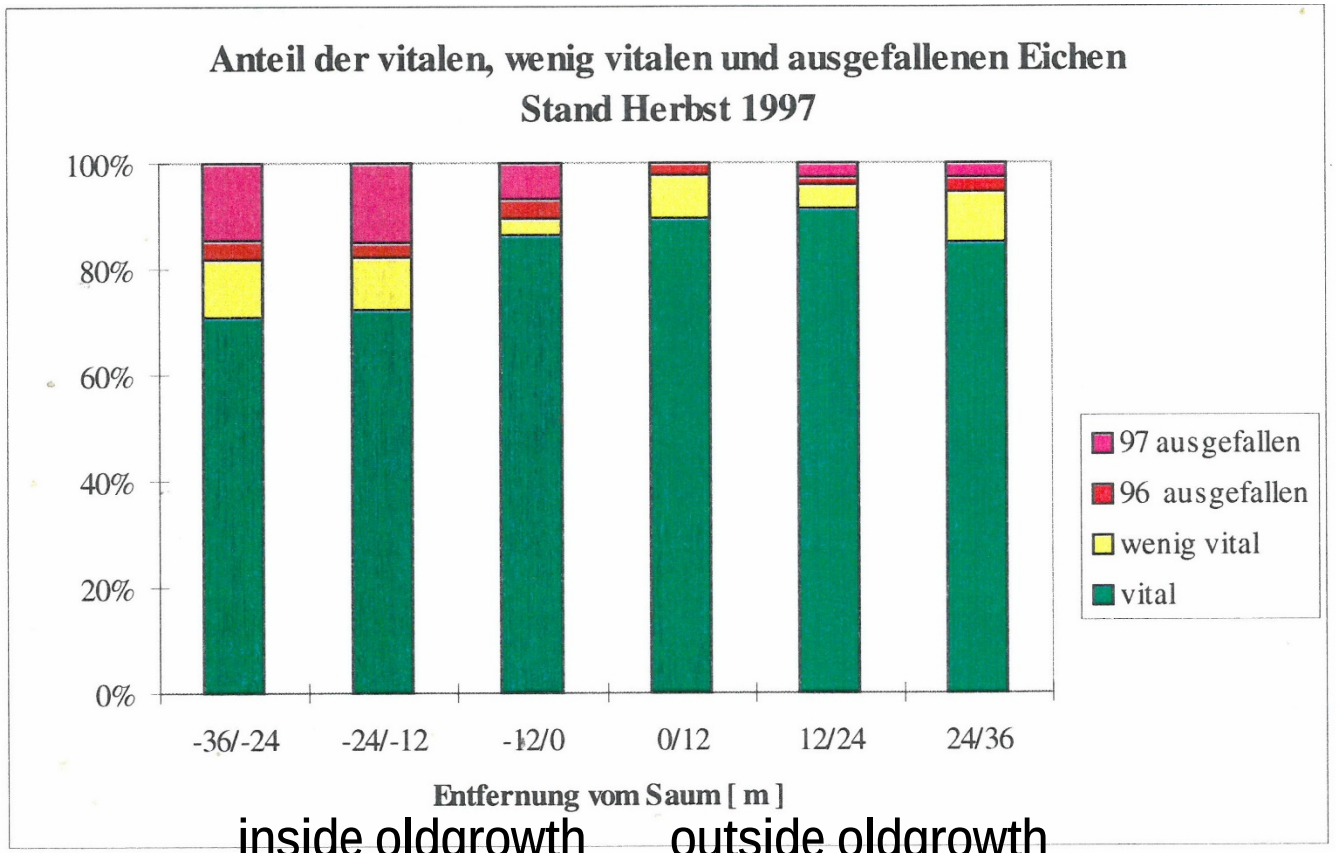
Percentage of vital, less vital and dead oak seedlings; fall 1997



dead 97
dead 96
less vital
vital

inside oldgrowth outside oldgrowth

Overall height growth for the different tree species in fall 2006

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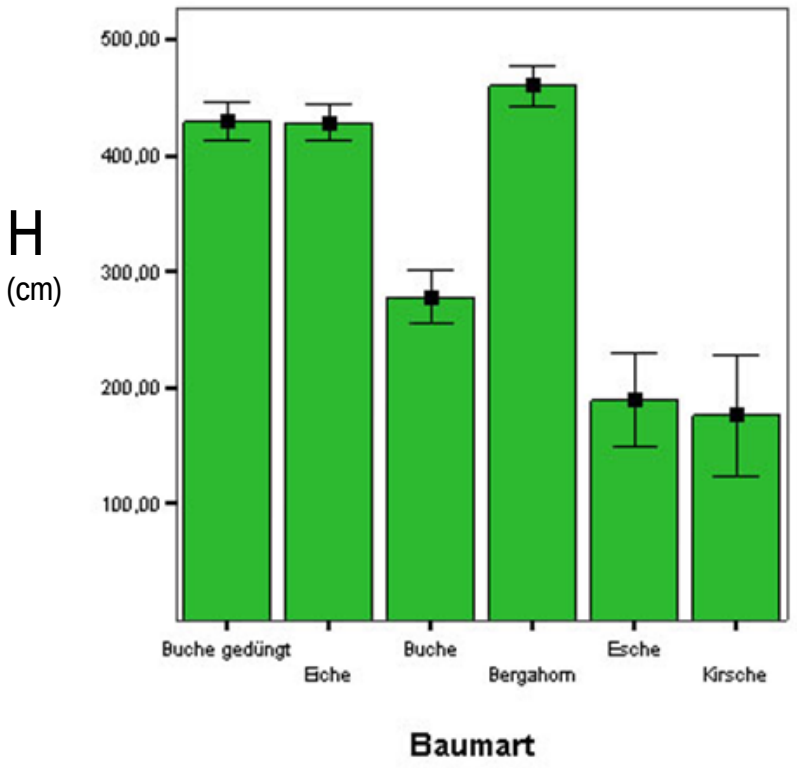

Baumart = tree species
Buche gedüngt = beech fertilized
Eiche = oak
Buche = beech
Bergahorn = maple
Esche = ash
Kirsche = cherry

Overall diameter (DBH) growth for different tree species, fall 2006

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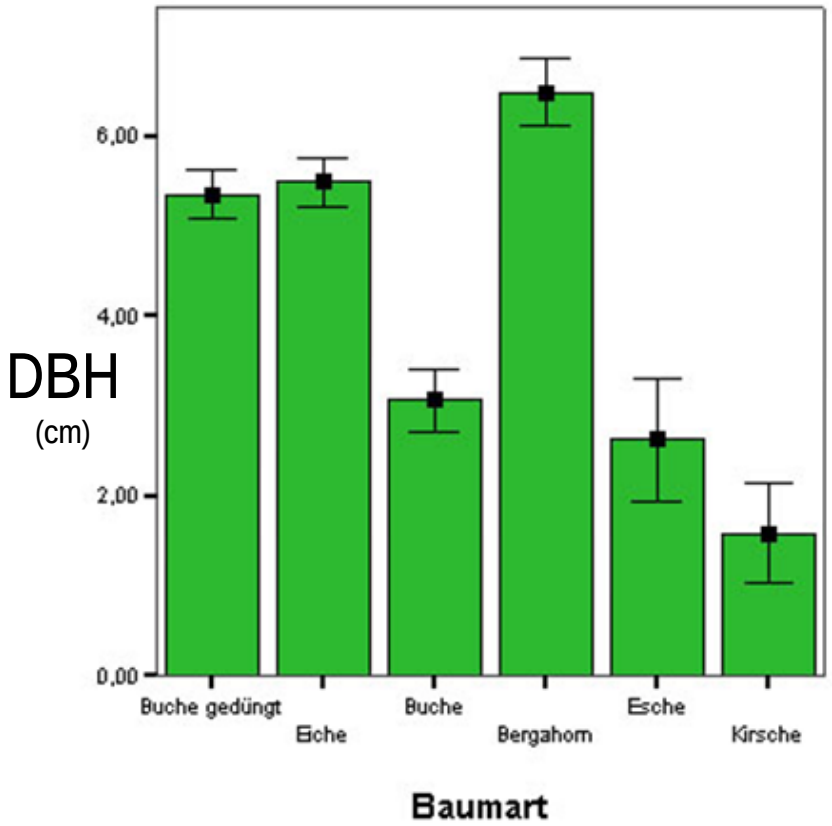

Baumart = tree species
Buche gedüngt = beech fertilized
Eiche = oak
Buche = beech
Bergahorn = maple
Esche = ash
Kirsche = cherry

Diameter (DBH) growth of different tree species along a light gradient, fall 2006

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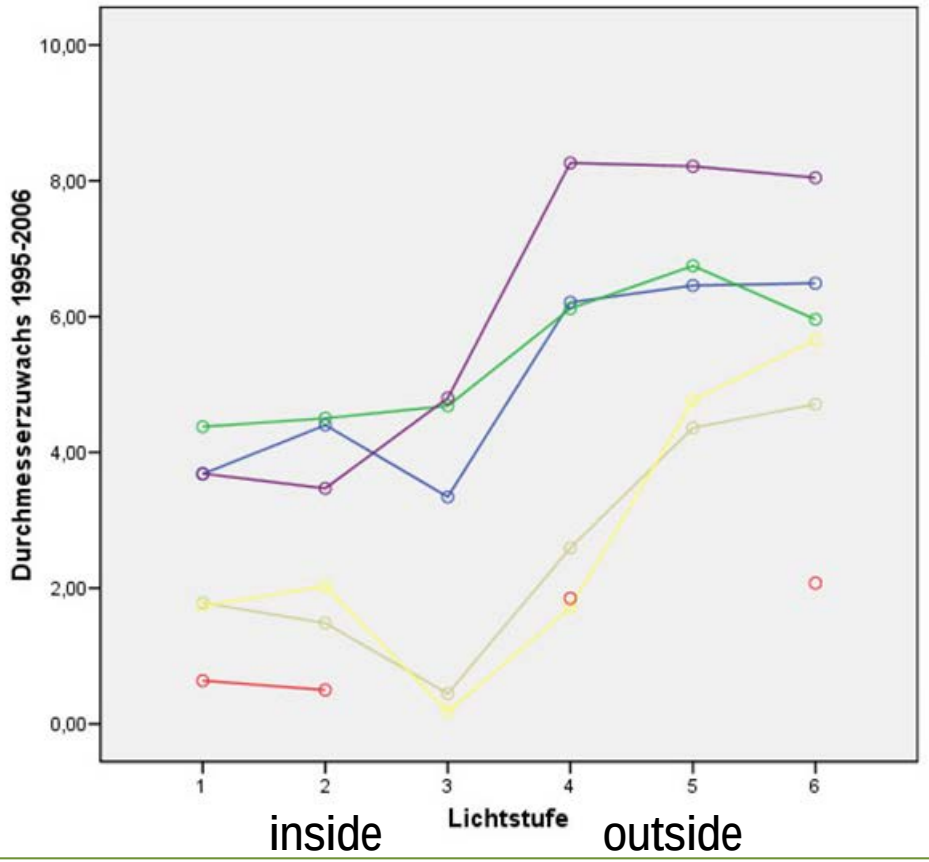

Tree species
Beech fertilized
Oak
Beech
Maple
Ash
Cherry

DBH increment quite responsive to increasing light, best maple , oak fertilzed beech
Ash and cherry may be better off when base nutrition is ameliorated

Height growth of different tree species along a light gradient, fall 2006

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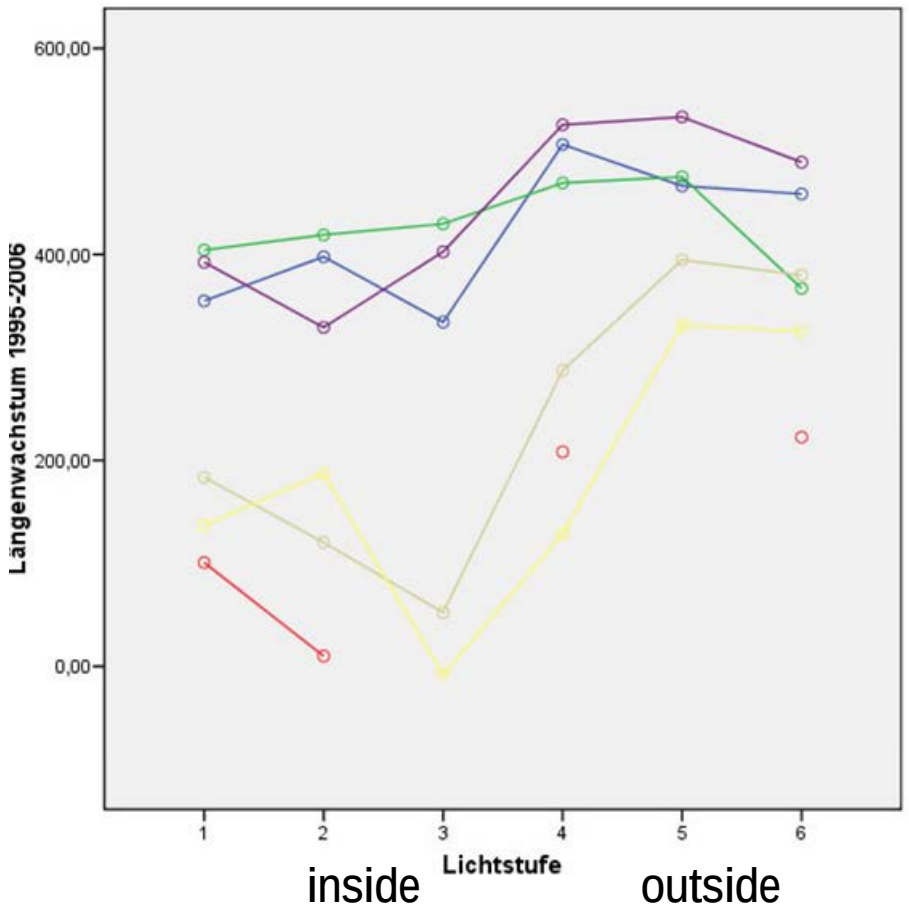

Tree species
Beech fertilized
Oak
Beech
Maple
Ash
Cherry

Height growth the best performances with maple, beech fertil. and oak, little light response, best growth closer to edge of old growth
Lesser performance beech, ash and cherry, strong light dependance (may be nutrients)

Summary
some short facts

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- secondary conifer stands on degraded natural broadleaf forest sites are a problem in Austrian forestry
- transforming these stands with advanced planting of broadleaf tree species after strip clearcutting may a practical method, which creates also a variable light environment
- photosynthetic performance under such light gradients may change in the years after transplanting, Mg fertilizer improved performance of beech, while maple was falling back.
- but after all maple was the least affected by limited light conditions
- in shortterm (97) shoot growth performance oak, maple &cherry were superior
- oak showed in 97 for both diameter and shoot increment a very strict postive relationship with light flux density, while other species wer not so clear

Summary
some short facts

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- Mg fertilzer in beech did not only improve increment but als vitality and survival
- mortality in oak increased with decreasing light (into the old growth stand, while ash had the highest frost damage close to the edge of oldgrowth
- longer term growth performance (2006) excluding mortality, showed that maple, fertilized beech and oak were the best performers concerning height and diameter growth, while ash and cherry were no good
- growth under a light gradient showed a maximum for the best 3 species a maximum 1 or 2 steps before maximum light flux density (may indicate → environmental conditions /litter decomposition)
- ash und cherry are the least fit for advanced planting of broadleaves

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THANK YOU FOR YOUR ATTENTION !

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