Faculty of Forestry and Wood Technology

7. 10. 2019, Brno

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Forest regeneration after calamity

Mendel University in Brno

The subject of this presentation

1. Silvicultural concepts, theoretical background of regeneration
2. Historical windows - Case study
3. Today - Case study from TFE Křtiny
4. Recommendation and Conclusion

Field:

1) Care about young forest
2) Surprise

1. Disturbances or calamities and forestry

Vivian 1990 – 100 mil. m^3; Lothar 1999 – 155 mil. m^3.

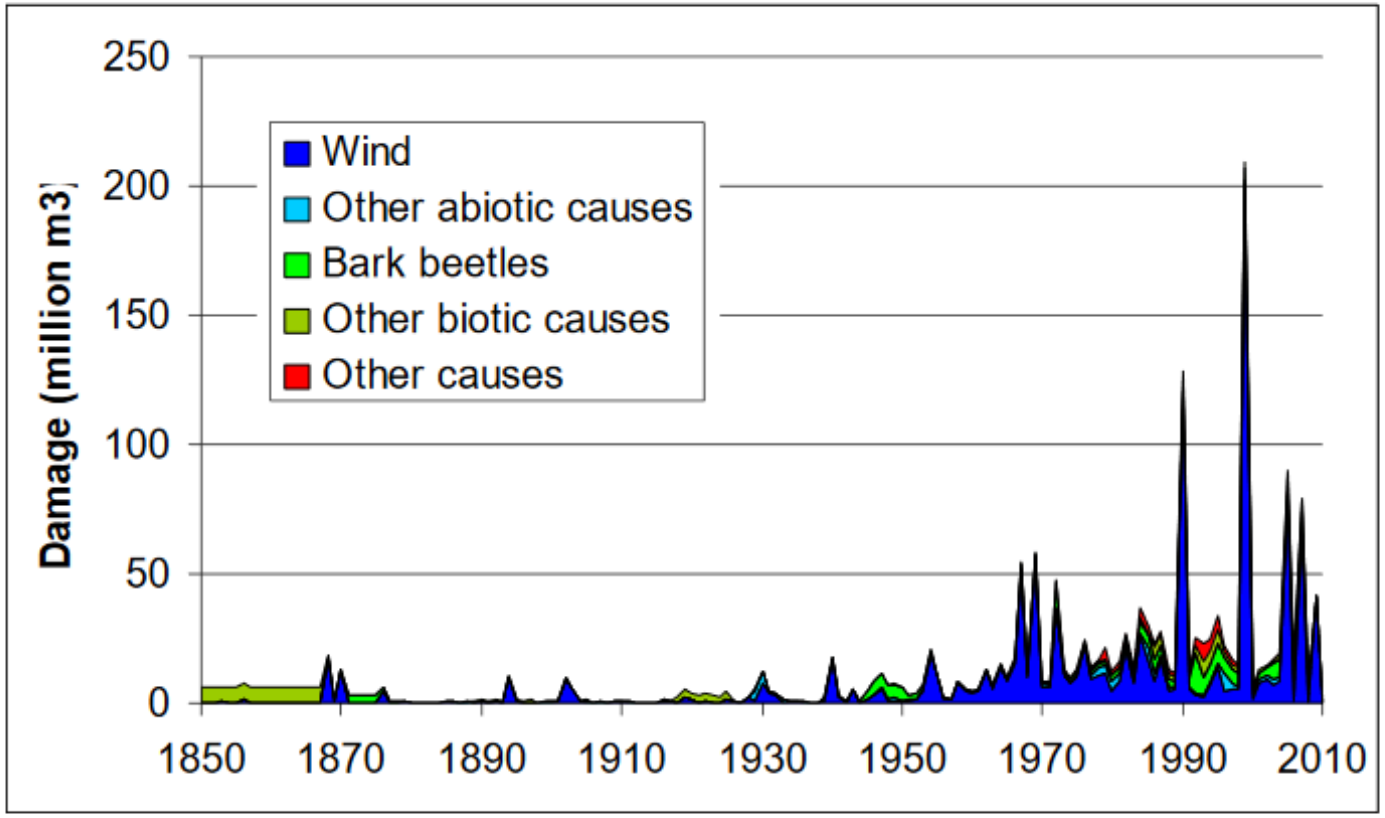


Figure 1a: Total damage due to disturbances in Europe (Schelhaas 2008a). The category "Other causes" includes anthropogenic damage, unidentified causes and mixed causes

1. Disturbances or calamities and forestry

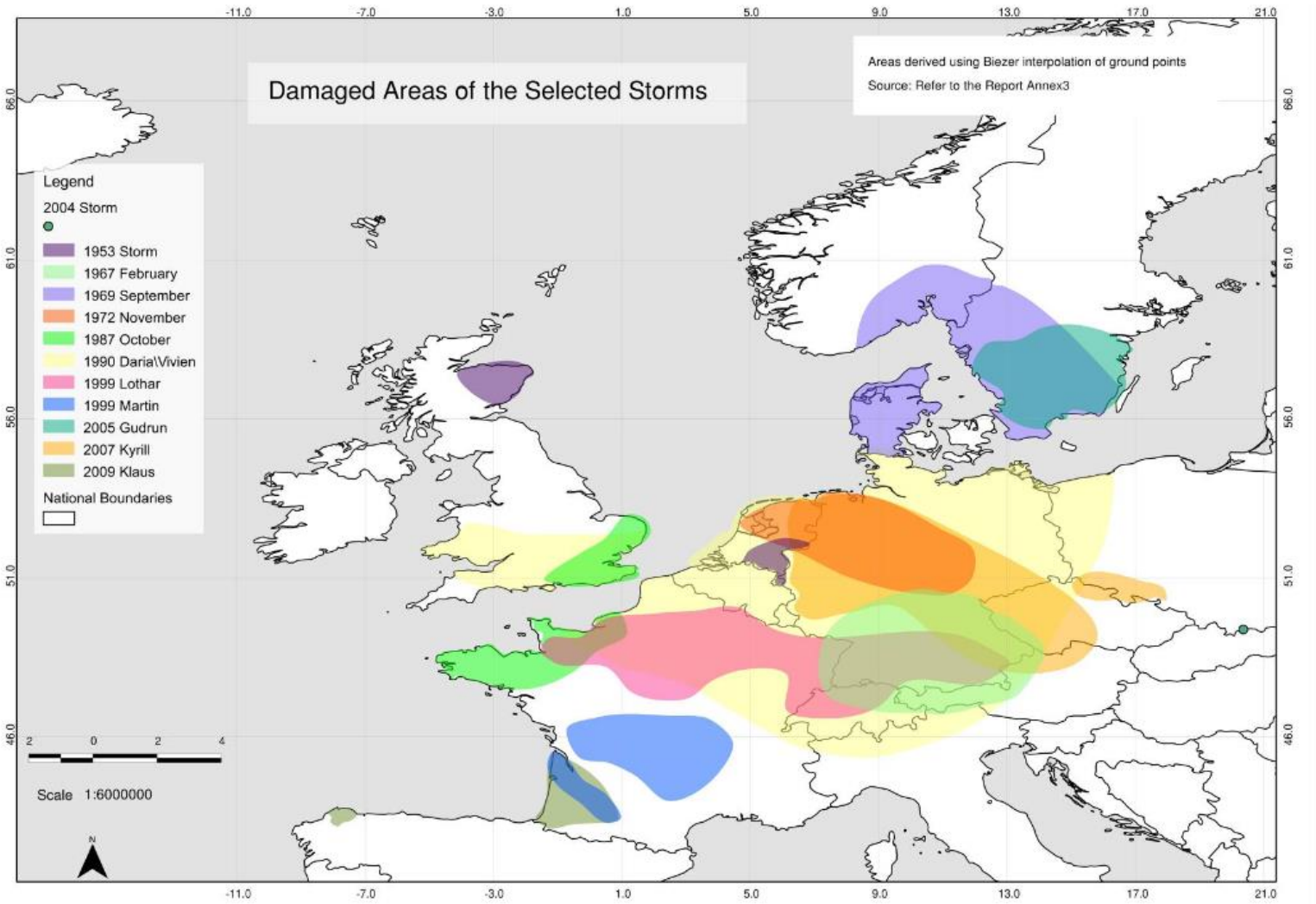


Figure 3b: Estimated areas affected by selected storms. (The areas are derived from reports and publications described in Appendix 3 and are only provided to allow an impression of the impact area and should not be taken as absolutely correct).

1. Disturbances or calamities and forestry

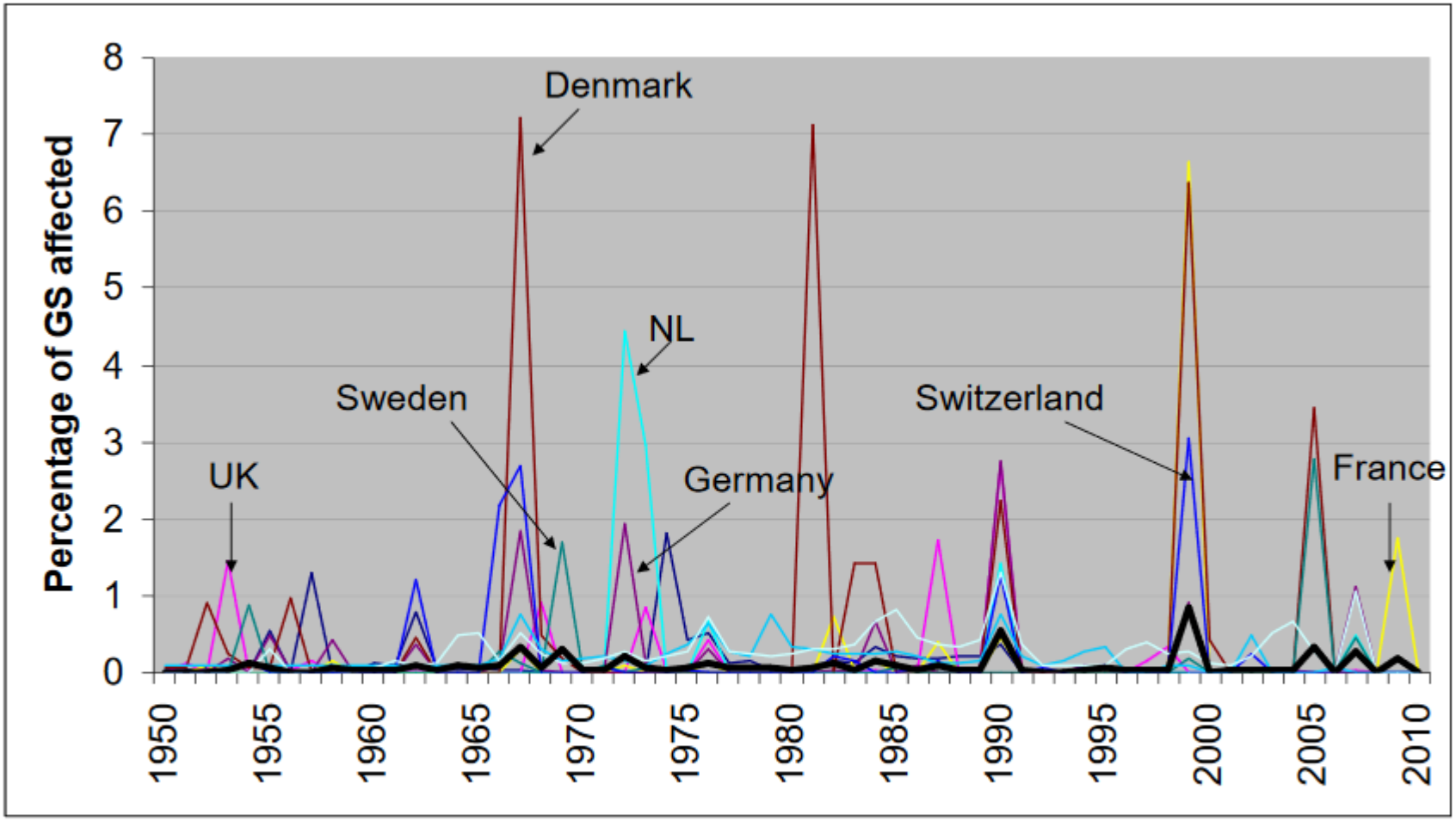


Figure 7: Damage as percentage of growing stock for different countries (adapted from Schelhaas, 2008a).

1. Disturbances or calamities and forestry

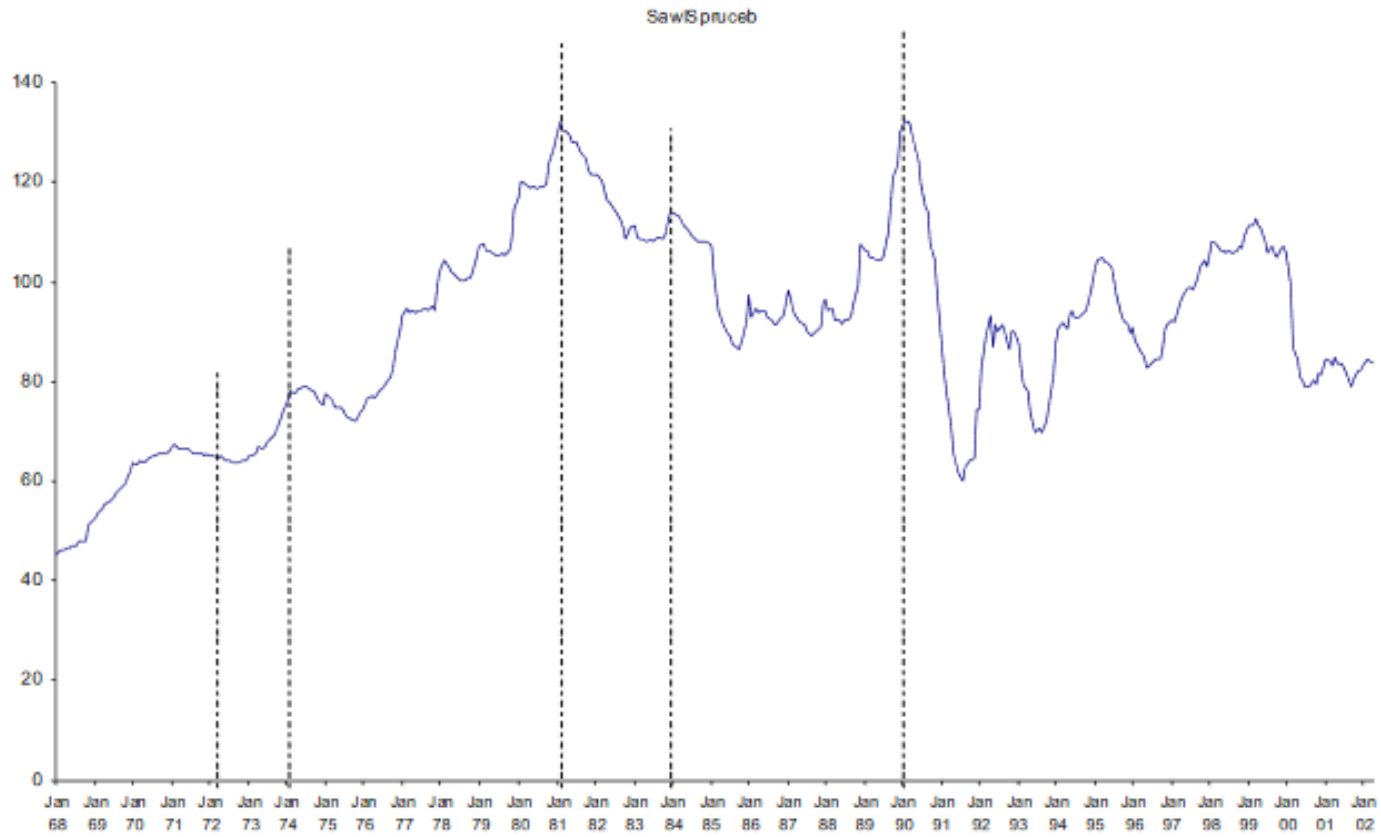
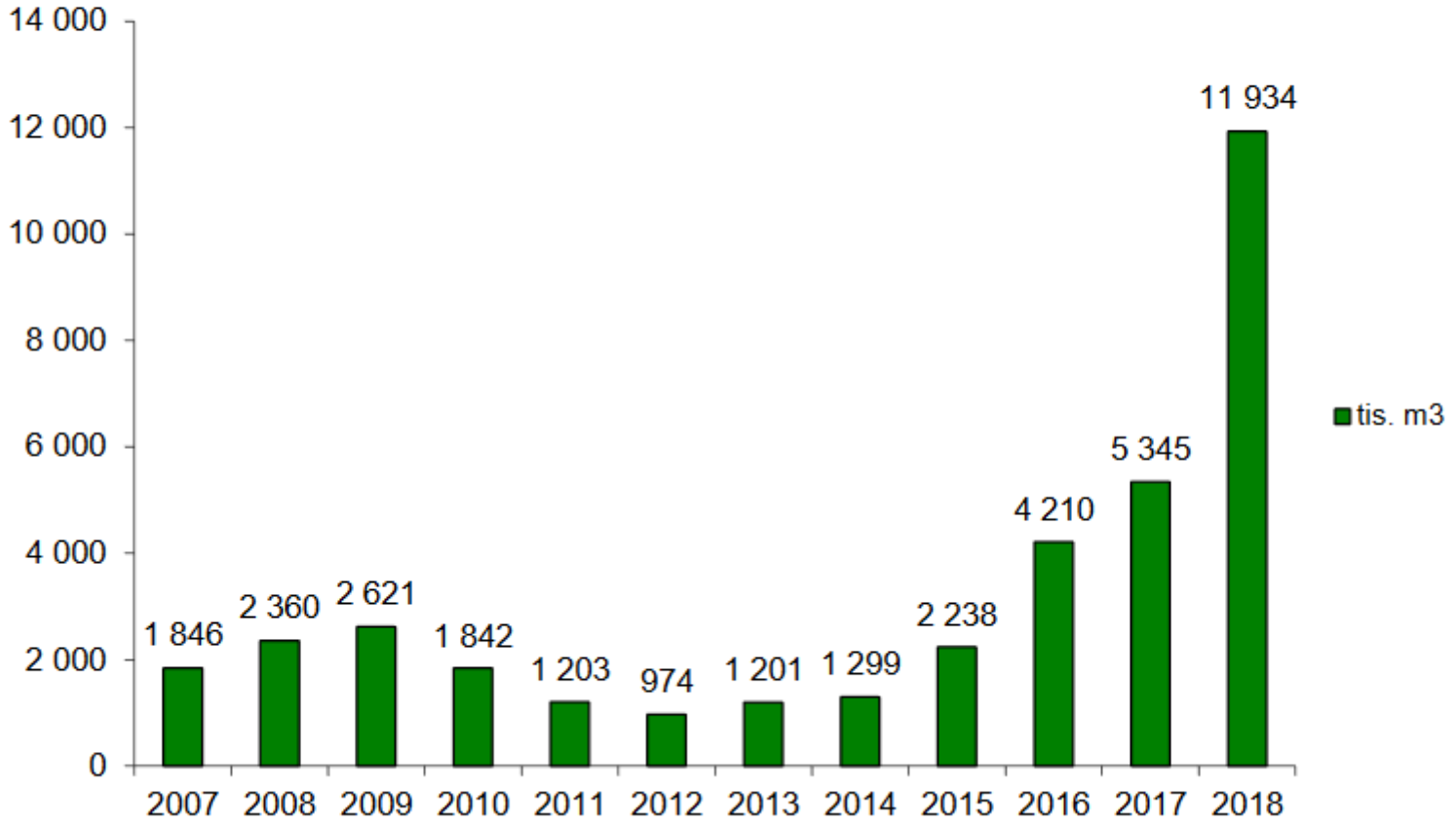


Figure 2: Prices for Norway spruce from 1968 until 2002 in Germany illustrating the drop in price following storms in 1972, 1974, 1981, 1984 and 1990. (Data courtesy of Marc Hanewinkel, Forest Research Institute of Baden-Wuerttemberg.)

1. Disturbances or calamities and forestry

Graf 1.6.3.2.1
Evidovaný objem smrkového kůrovcového dříví vytěženého v letech 2007 až 2018 (tis. m^3)



Sanitary (bark beetle) logging in the Czech Republic

Situation in the Czech Republic

Nejvyšší hodnoty těžby dřeva v historii ČR (tis. m^3 b. k.)

Rok	Těžba dřeva				
	celkem	v tom		z toho nahodilá těžba dřeva	na 1 ha lesních pozemků (m^3 b. k./ha)
		jehličnaté dřeviny	listnaté dřeviny		
2018	**25 689**	24 213	1 476	23 013	9,61
2017	**19 387**	17 735	1 652	11 743	7,26
2007	**18 508**	17 278	1 230	14 885	6,98
2006	**17 678**	16 118	1 560	8 027	6,67
2016	**17 617**	15 924	1 693	9 399	6,60

http://www.silvarium.cz/lesnictvi/nahodila-tezba-v-roce-2018-v-cr-23-milionu-kubiku

95 % of sanitary logging in case of conifer species

1. Disturbances or calamities and forestry

Disturbaces/Calamities

Disturbance – more about biology

- kill, uprooted, breaking trees or group of trees
- change in source and growing space availability
- natural or human events

Calamity – more about human thinking about forest

1. Theoretical background of regeneration

deforestation

reforestation

afforestation

natural forest expansion/ forest reversion

1) Silvicultural concepts and regeneration methods

1. Silvicultural concepts - regeneration methods and sustainability

Two concepts:

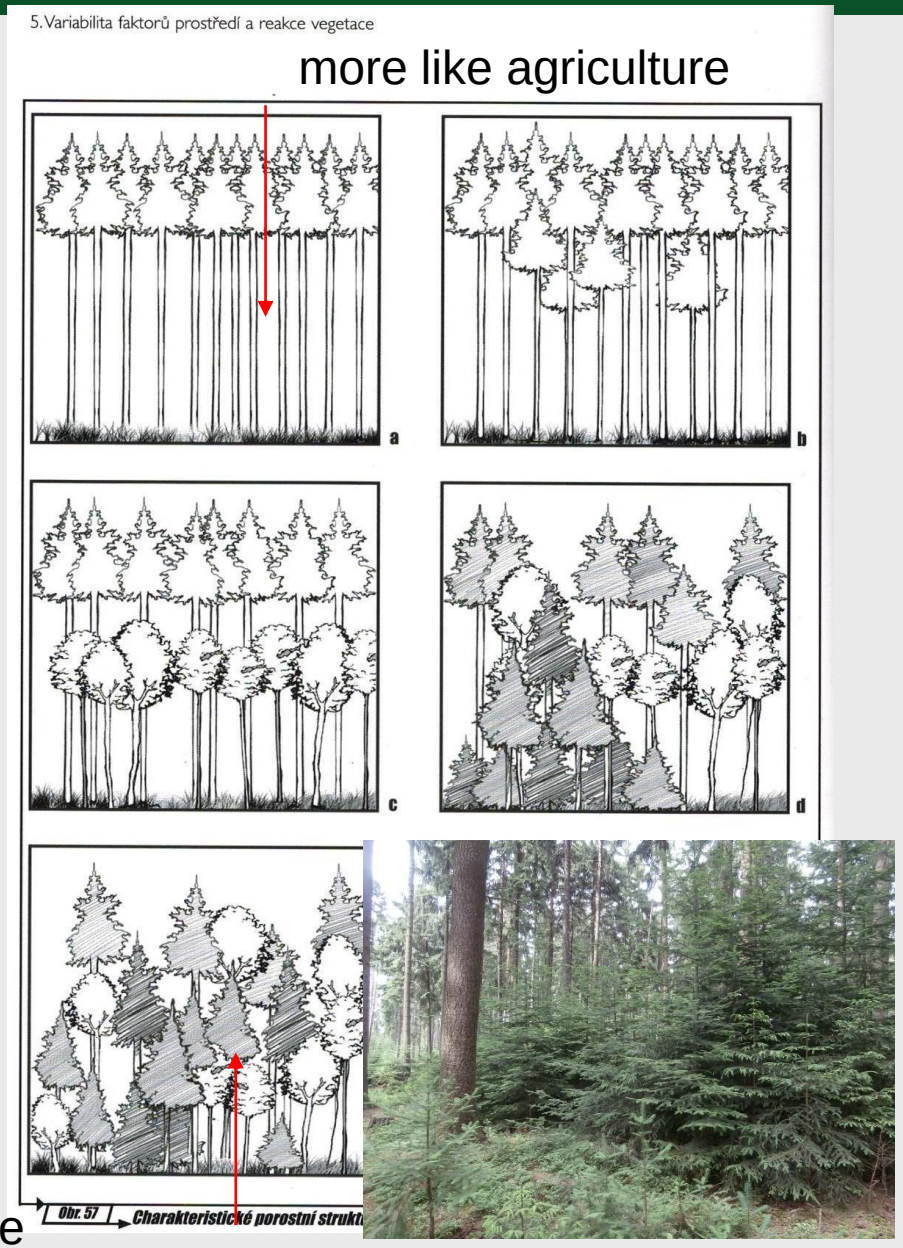
conventional × alternative

Forest – agricultural lands/nature-close forestry

1) Silvicultural concepts and regeneration methods

Results of silvicultural methods

- Stands structure
- Stability
- Biodiversity
- Economy



more nature

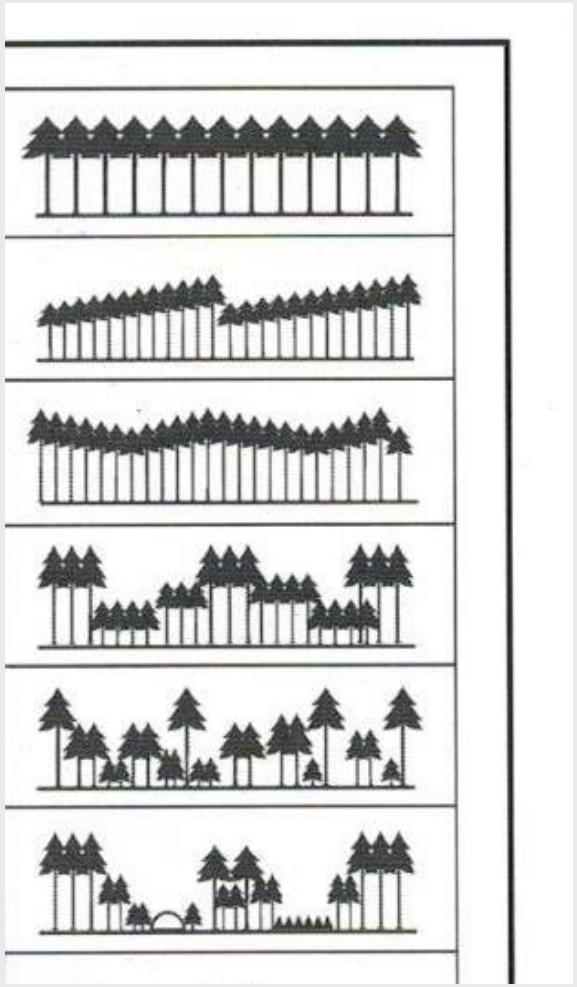
Differences between silvicultural and regeneration methods

More artificial

- clearing: clearcutting

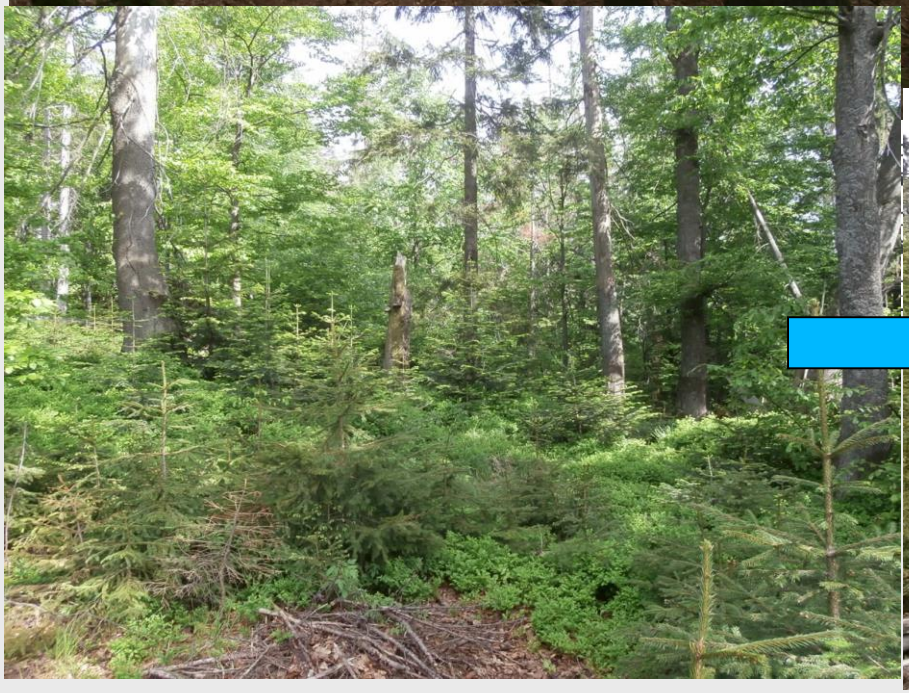
More natural

- shelter: shelter wood, single-selection system



1) Silvicultural concepts and regeneration methods

Stability and results of disturbance:

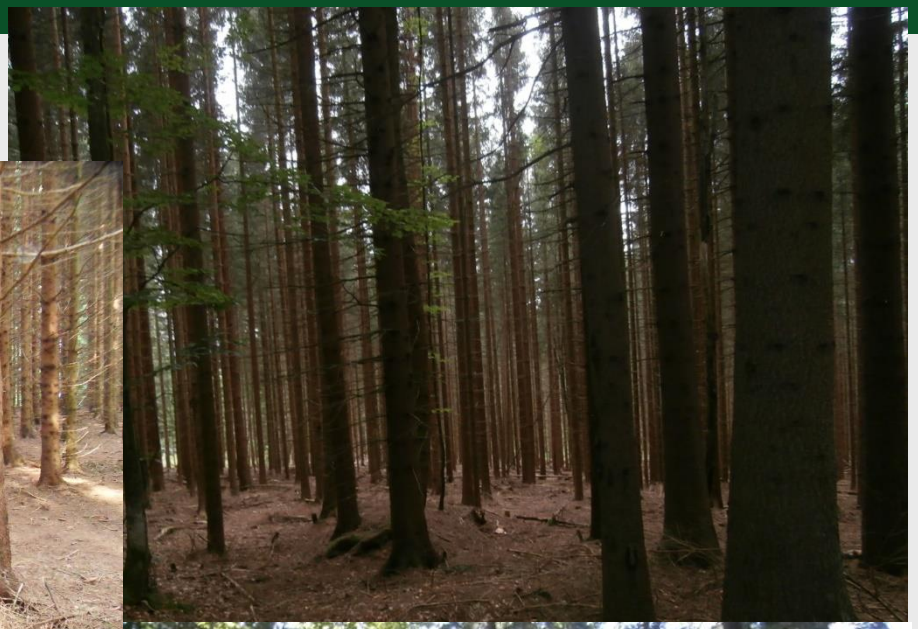


Clearing – ecologic problems

- erosion
- climatic extremes
- soil degradation
- carbon

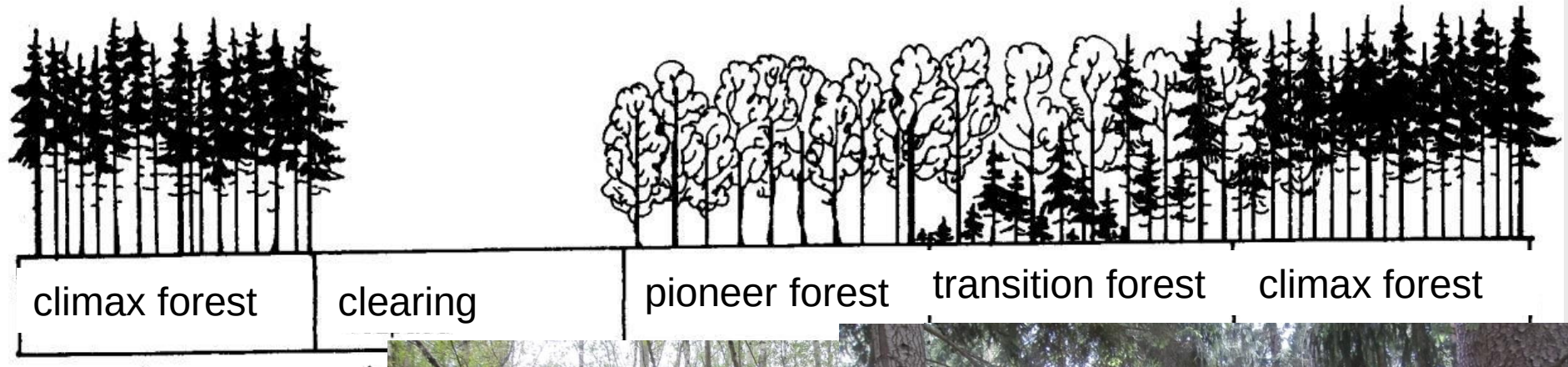
1) Silvicultural concepts and regeneration methods

…and what we want?



Calamity chance for forest transformation

Natural process in a forest



Examples of position pioneer tree species in temperate (nature – virgin) forest

Badínský virgin forest – Slovakia

Protected from 1913, 30,75 ha

Natural conditions: fir – beech zone

(700 – 780 m, 5 °C, 850 mm)

1947 wind calamity- 5 ha clearing:

- 5 years after young willow stand,
- 10 years after: willow 89 %, 6 % beech, 3 % fir, 2 % birch, aspen, elder.
- 20 years after: transition forest – beech, fir, maple – begins to prevail
- 30 years after: willow mortality under beech pressure

Disturbance in virgin forest

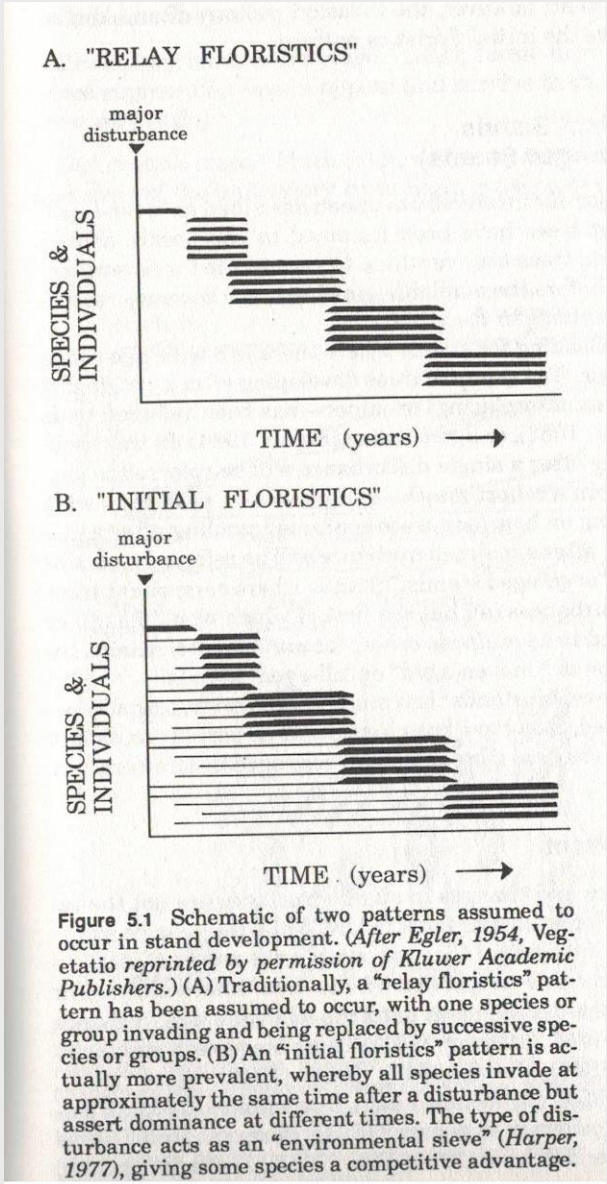
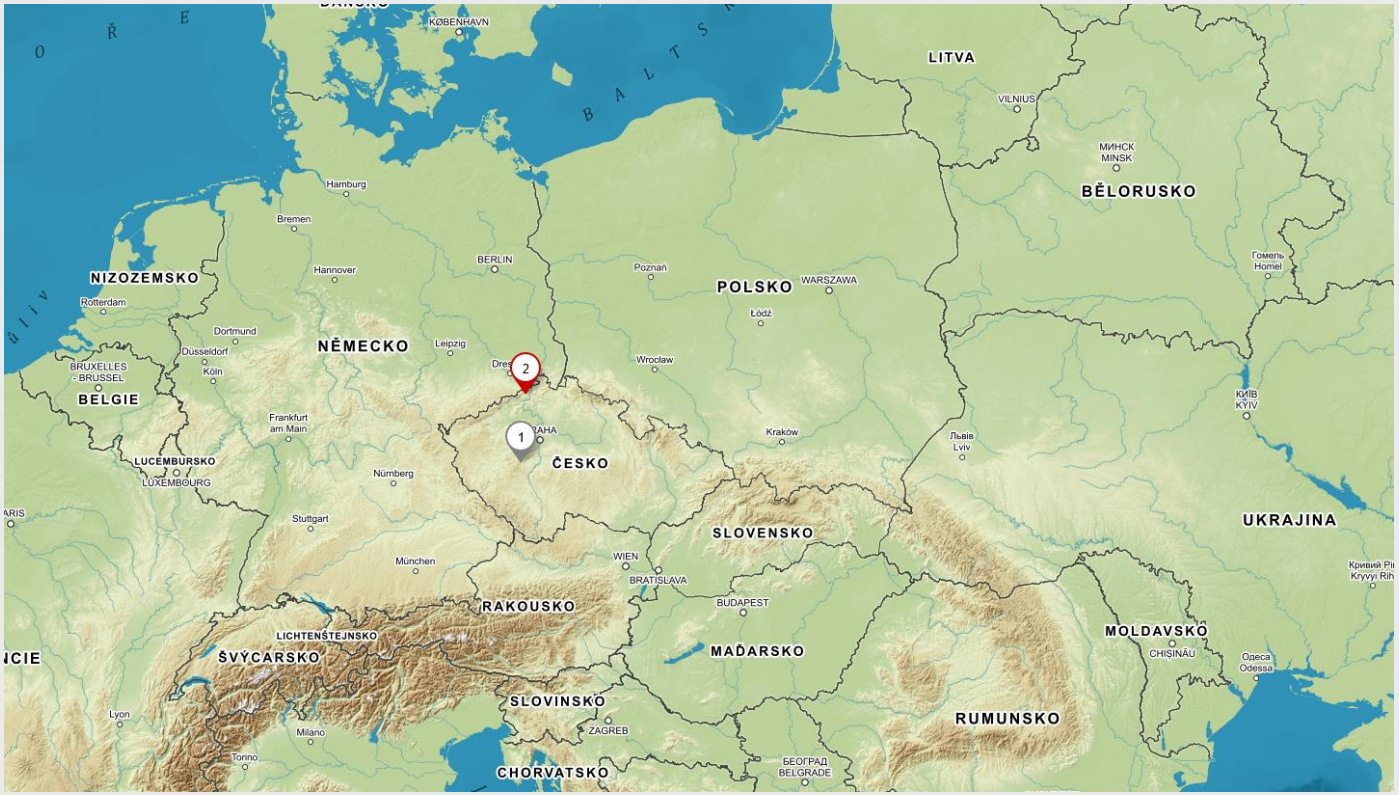


Figure 5.1 Schematic of two patterns assumed to occur in stand development. (*After Egler, 1954,* Vegetatio *reprinted by permission of Kluwer Academic Publishers.*) (A) Traditionally, a "relay floristics" pattern has been assumed to occur, with one species or group invading and being replaced by successive species or groups. (B) An "initial floristics" pattern is actually more prevalent, whereby all species invade at approximately the same time after a disturbance but assert dominance at different times. The type of disturbance acts as an "environmental sieve" (*Harper, 1977*), giving some species a competitive advantage.

A) Change species during time

B) Presence of all genus; only change in dominance

2. Historical examples



1) Křivoklátsko – from 1950
2) Krušné hory (Ore mountains) – from 1970

2. Historical experiences:

Křivoklátsko – Zakopal (1955, 1958, ...)

Natural conditions: dry region (precipitation 500 mm), heavy clay soils;

spruce: 1813 – 0%; 1932 – 55 %

Calamity: beky nun 1918 - 22; snow, wind 39 - 41, draught - 1947)

Cleaning – more than 80 ha;

Extreme climate, weed - *Calamagrostis*;

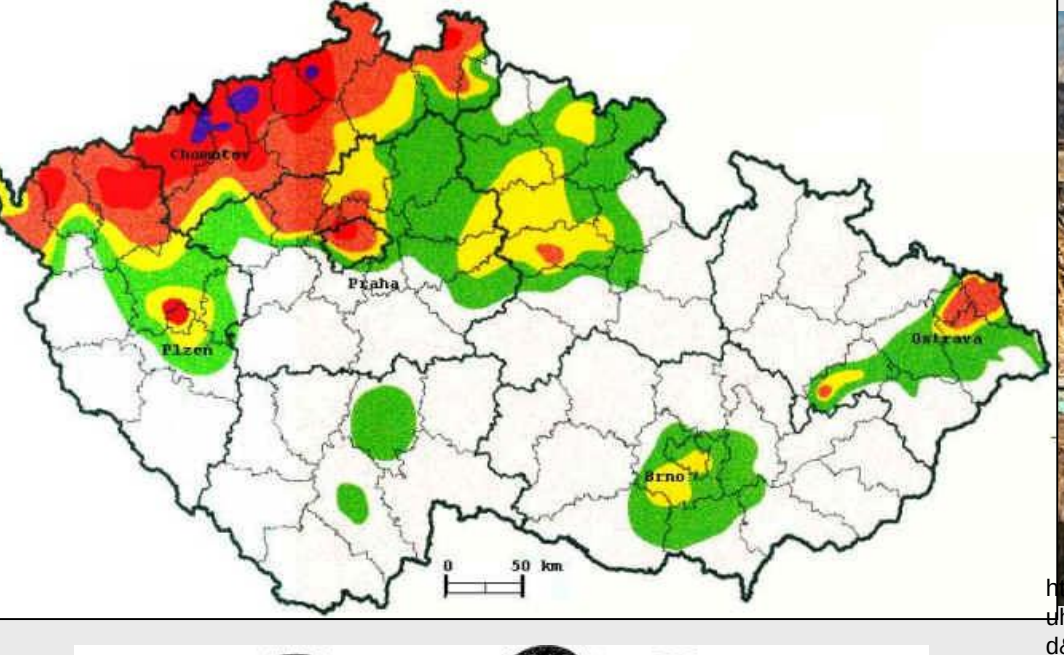
- artificial regeneration (planting): more species (pine, oak, spruce)
- success only birch – natural regeneration, seeding, planting

2. Historical experiences - Křivoklátsko:

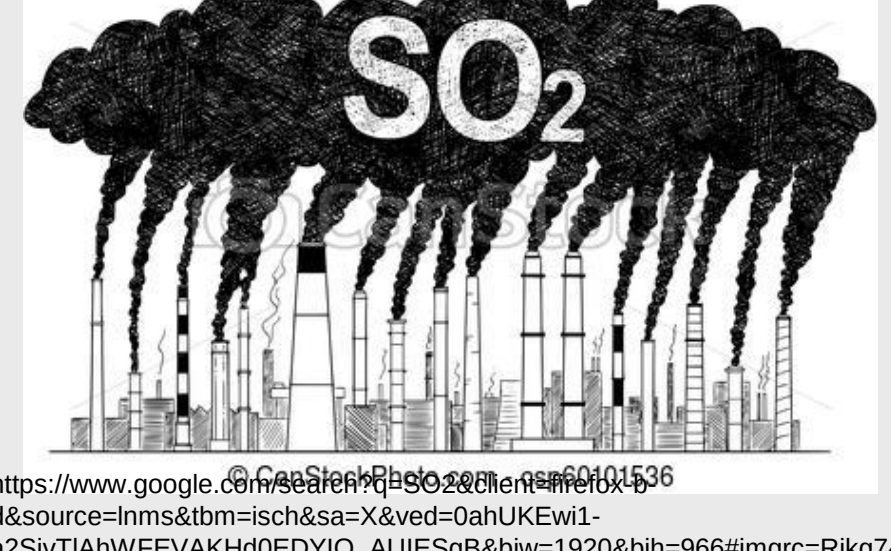
Birch:

- can tolerate climatic extremes
- improved soil conditions
- create conditions for more sensitive species

2. Krušné hory Mts.

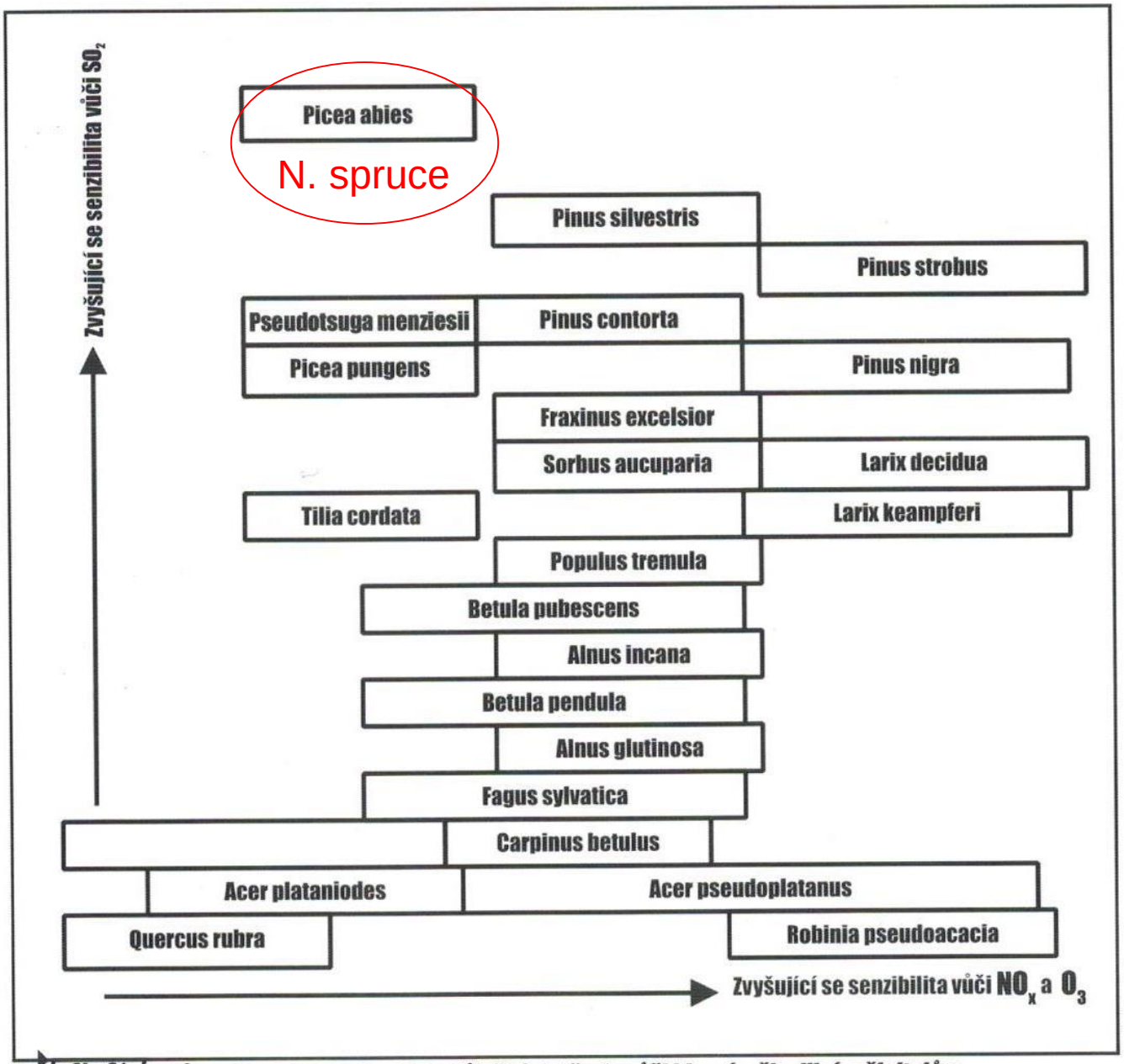


https://www.google.com/search?q=t%C4%9B%C5%BEba+hn%C4%9Bd%C3%A9uhl%C3%AD&client=firefox-b-d&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiSxJOyifTlAhVQLFAKHWUkBQgQAUIESgB&biw=1920&bih=966#imgrc=_1k0_IUw-sG1VM:

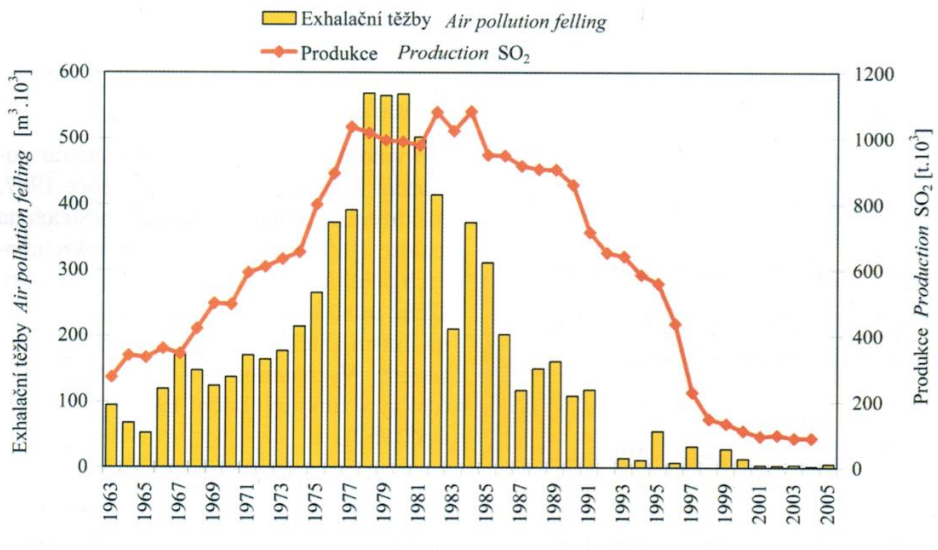


https://www.google.com/search?q=SO2&client=firefox-b-d&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi1-a2SivTlAhWFEVAKHd0EDYIQ_AUIESgB&biw=1920&bih=966#imgrc=Rikg74YJ7E8NgM:

https://www.google.com/search?q=tepeln%C3%A9+elektr%C3%A1rny=firefox-b-d&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjf553difTlAhWMUlAKcYQ_AUIESgB&biw=1920&bih=966#imgrc=eJN7Mamnko05iM:



Obr. 81 *Úroveň senzibility lesnicky důležitých dřevin vůči hlavním škodlivým činitelům (SO_2, NO_x a O_3) – (Thomasius 1989).*



Obr. 4.1: Vývoj emisí oxidu siřičitého v severozápadních Čechách a úrovně exhalačních těžeb v Krušných horách (dle údajů ČHMÚ a VÚLHM)
Development of SO_2 production in the North-western Bohemia and amount of air-pollution felling in the Krušné hory Mts. (according to data of CHMI and FGMRI)

Obr. 1.3: Shrnování svrchních půdních vrstev buldozerem v 80. letech min. století

Obr. 2.3: Vytvořené liniové valy na lokalitě Špičák v 80. letech min. století

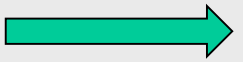
https://lesycr.comint.cz/wp-content/uploads/2016/12/revitalizace-valu-7-lvs-web.pdf

Species selection

Non native introduced spruce

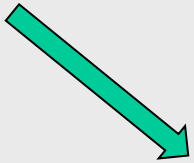
(*Picea pungens* Engelm.)

- Tolerat to air pollutions
- tolerat to soil
- light demanding
- tolerate to grazing



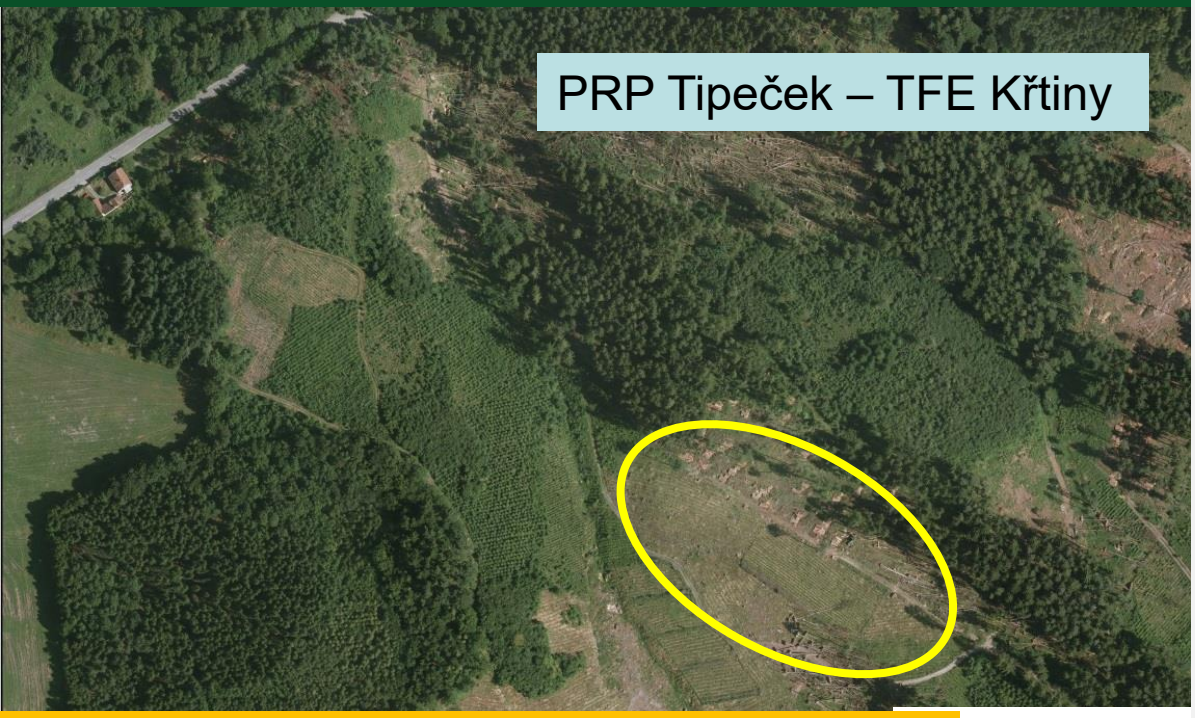
- slow grow
- damaged by fungi and insect
- frost damage
- negative impact on soil

Krušné Hory – 8000 ha,



Method - substitution forest tree species stands

3. Case study from present



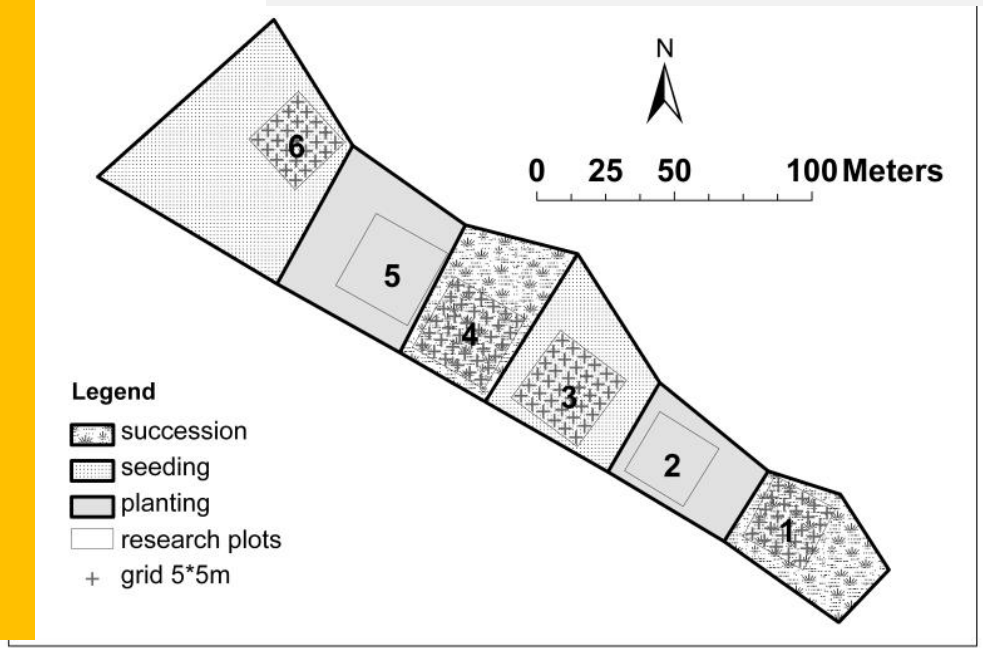
- The original forest: 100 years old, spruce, closed canopy
- Wind-thrown area of about 1.5 ha links up immediately with young forest stands and forms a complex of non-established stands stretching over an area of 6 ha.
- The predominating Forest Site Complex: fresh Oak-Beech

1) Artificial regeneration of **spruce** and **beech (oak, lime, larch)** – "planting"

2) Establishment of a preparatory stand by seeding of **birch** – "sowing"

3) Variant left **without human intervention** – "succession"

two repetitions: 900 m^2 (30×30 m) and 625 m^2 (25×25 m)




2010


2010


2011


2012


Artifical regeneration - 2018
beech


2016 – succession

2017 – birch seeding

- Succession

2017 – 10 000 pcs/ha (Birch)

average DBH 2.3 cm

height: + 4 m

- Artificial regeneration

2010 – 7 800 pcs/ha (10 000 beech; 4 000 spruce)

2017 – 4 800 pcs/ha

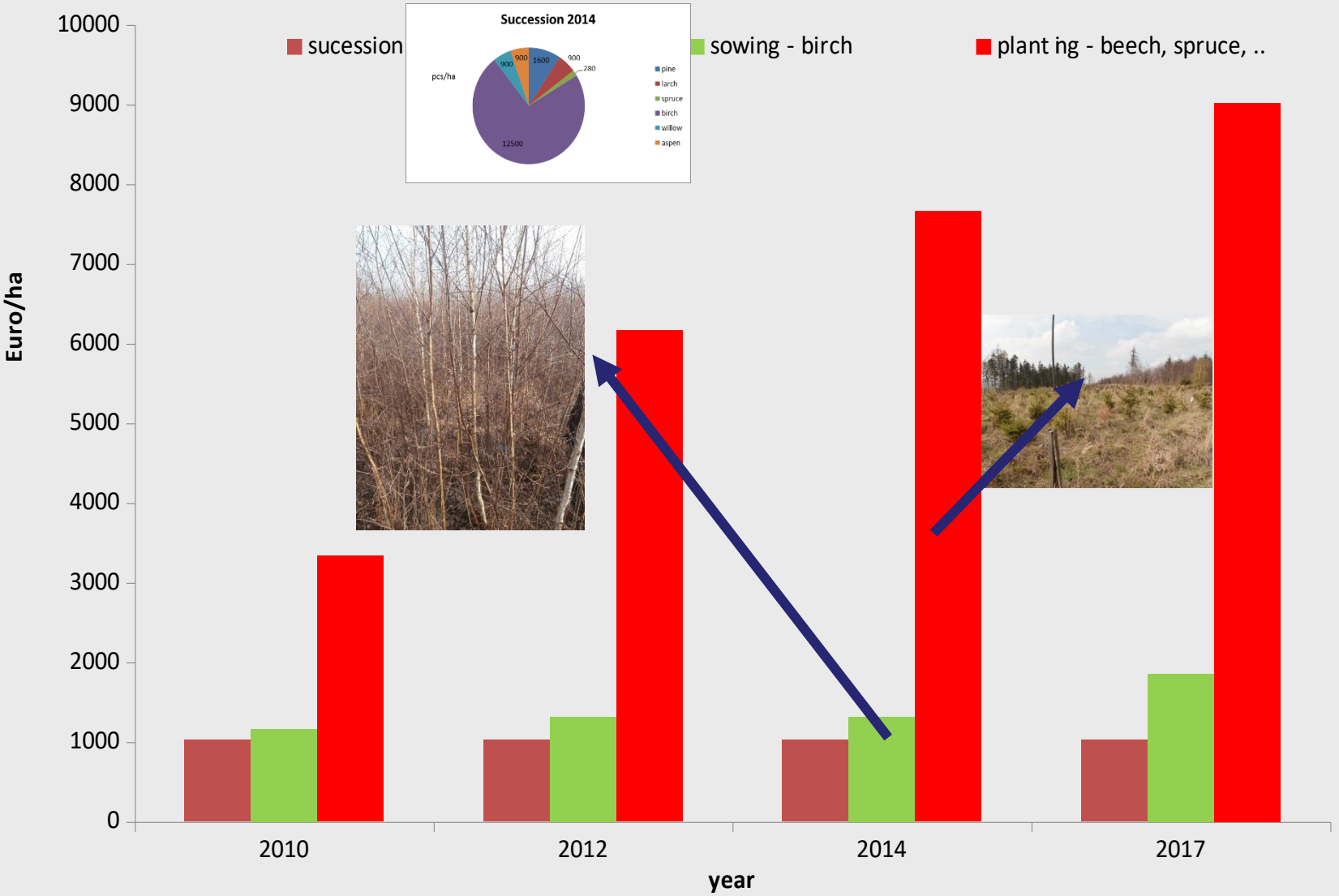
height: spruce – 182 cm

beech – 81 cm

Succes of succession

Seeding – denser (50 000 psc/ha) and regular regeneration

Regeneration cost

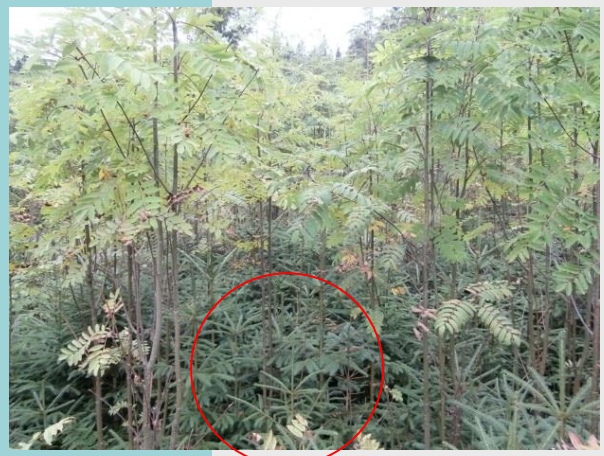


How to create diverse and stable forest – recommendation

How do we manage pioneer stands?

- Silvicultural (economic) aim
- Pioneer forest first steps
- Climax species

Presence of climax species



- pioneer stand as preparatory stands

Wide range of silvicultural treatments

Without presence of climax species

- pioneer stand as the aim of economic utilization

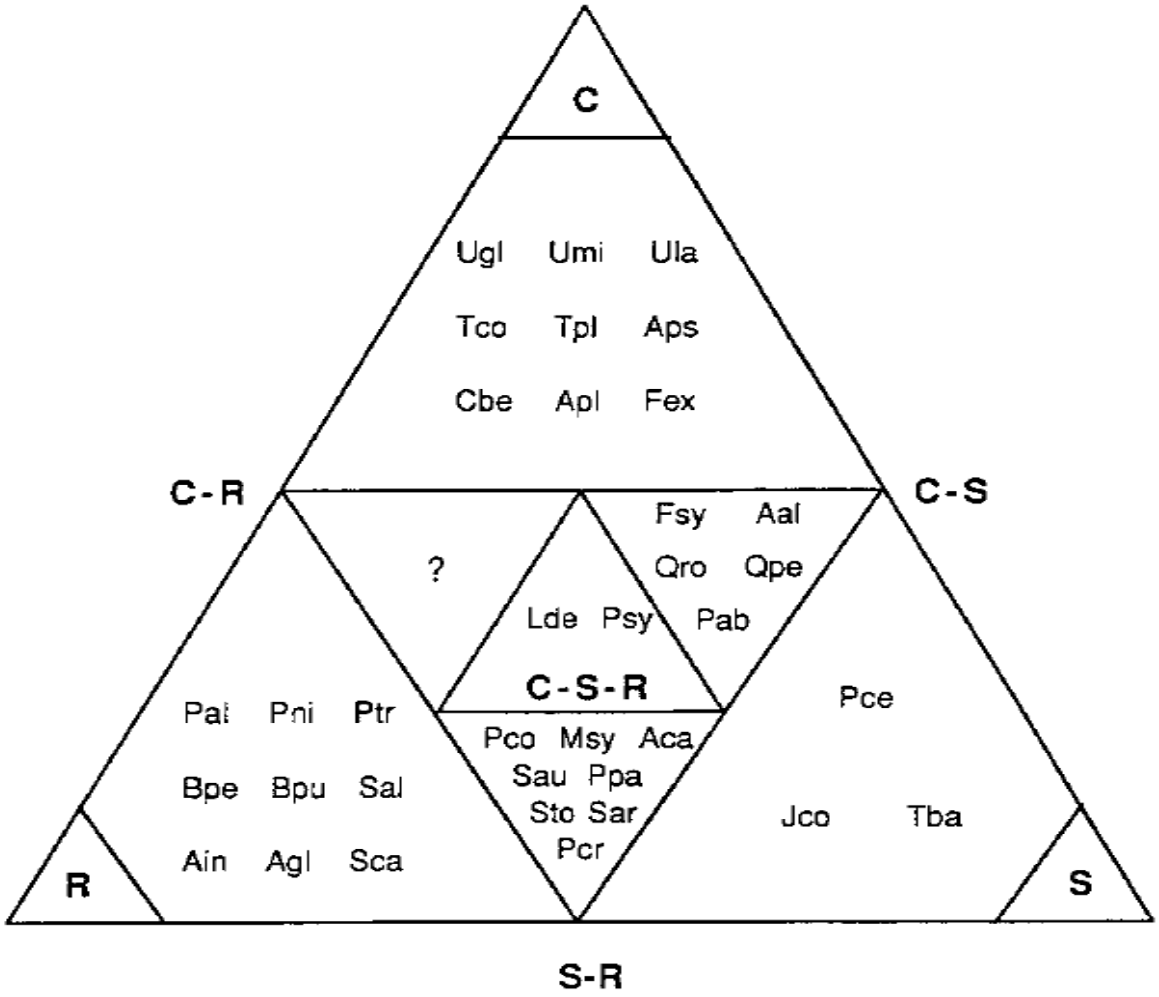


Fig. 4. Application of the triangular model of Grime (1977, 1979) as a basis for classification of life-history strategies of major European tree species: R, ruderals; C, competitors; S, stress tolerators; S–R, stress-tolerant ruderals; C–S, competitive ruderals; C–R, competitive ruderals; C–S–R, competitive stress-tolerant ruderals. See text for further explanations.

Pioneer species / *Pioneer forest*

Species:

-Betula sp.; Populus sp.;

-Alnus sp.; Salix sp.;

- (Larix sp.; Pinus sp.; Sorbus aucuparia., Picea abies)

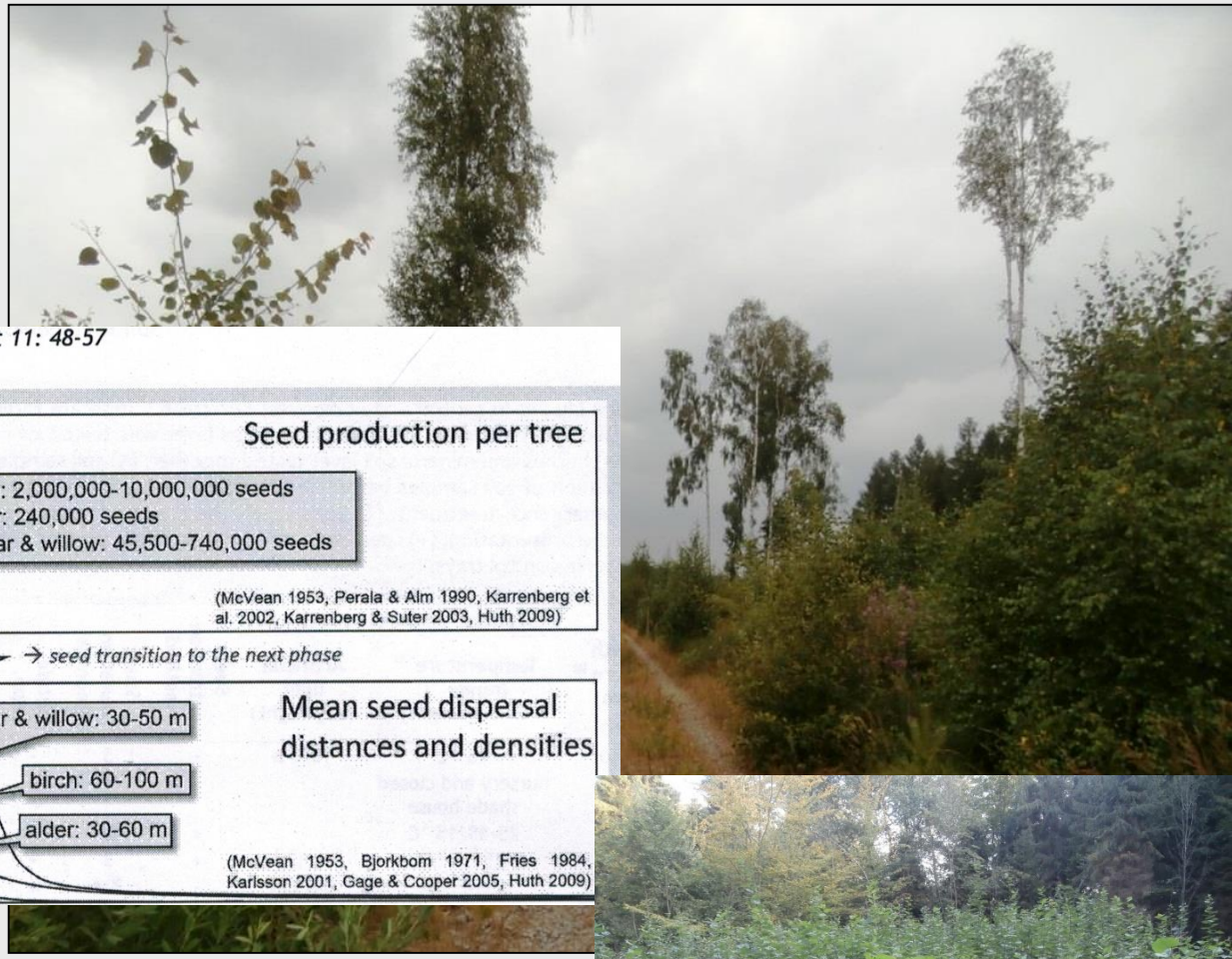
Properties:

- Sunlight
- Easy to regenerate
- Tolerant to climatic extremes
- Fast growth
- Short lifespan

- *Short duration of pioneer stands in natural conditions (forest) due to competition of climax species and short lifespan*

Prerequisites of natural regeneration of pioneer species

Presence of mature trees - distance:
- 2 times the height
- more in case of aspen



Soil substrates
- mineral
- humus

Soil banks:
rowen, birch

Vegetative regeneration
- aspen

Artificial regeneration of pioneers:

Species selection:

- Natural conditions

 - More water:

 Alnus glutionosa

 Betula pubescens

 Salix alba

- Rich or degraded soil:

 Populus tremula

Spacing: losser 2.000 pcs/ha

Artificial regeneration of birch - patch seeding:

1 year old

3 years old

Lower cost, easy to regenerate, regular distribution patterns

Seed amounts:

patch:

1 patch – 1.6 g

spacing: 2×2 – 2 500 patches/ha

- 4 kg/ha

whole area:

seeding: 20 – 40 kg/ha

Forest continuity – introduced of climax species:

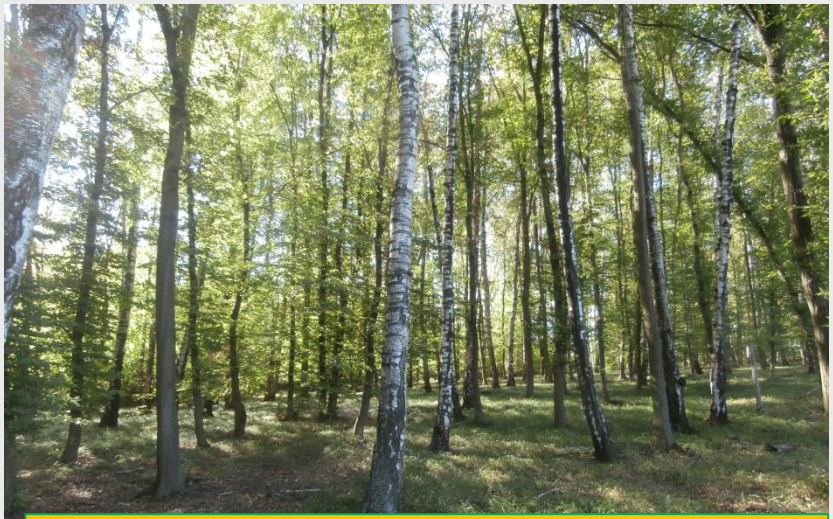
- Release of natural regeneration
- Artificial regeneration: small scale regeneration (strips, gaps, underplanting)

Silviculture of pioneer stands

Release of natural regeneration within pioneer stands

Biomas (energetic utilization) – rotation period 20 years

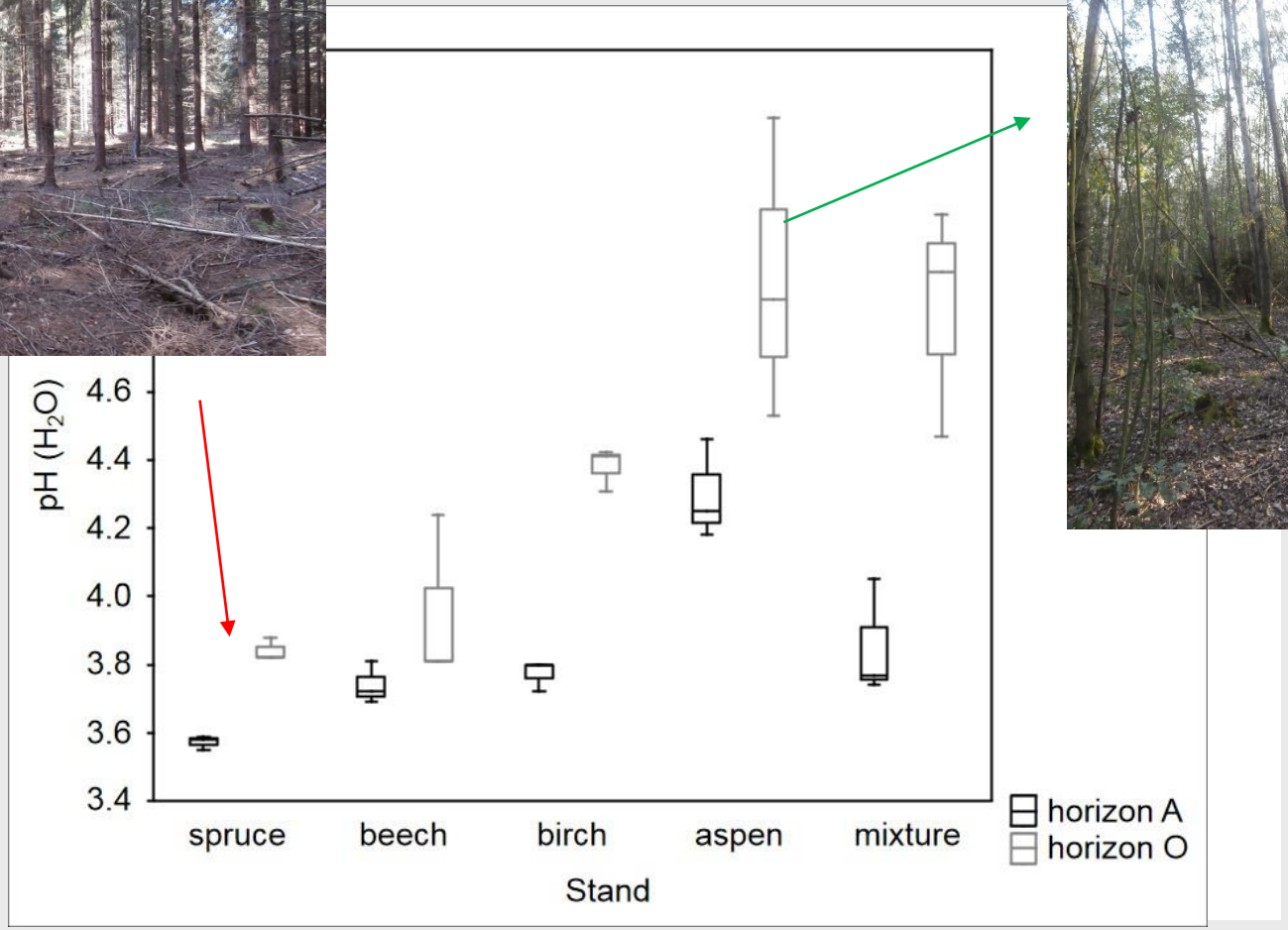
The same time regeneration of pioneer and climax species



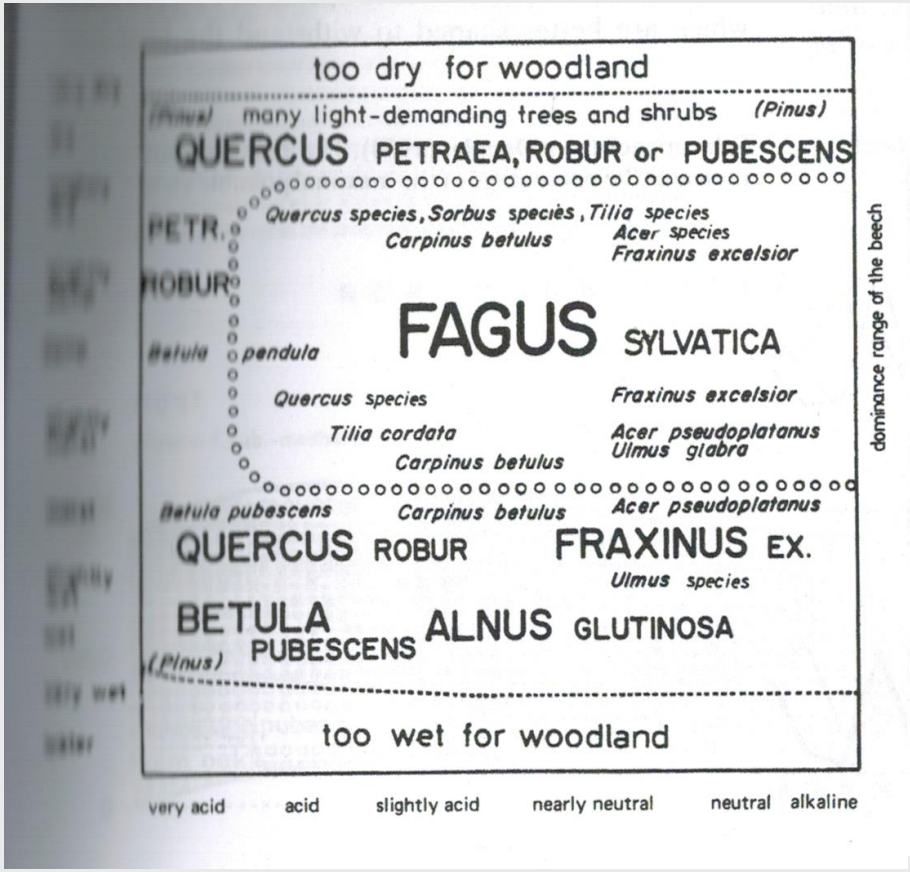
Production of high volume timber of pioneer – rotation period 50 years

Sustanability for 21st century

Long term productivity – keeping soil quality



Climax species selection



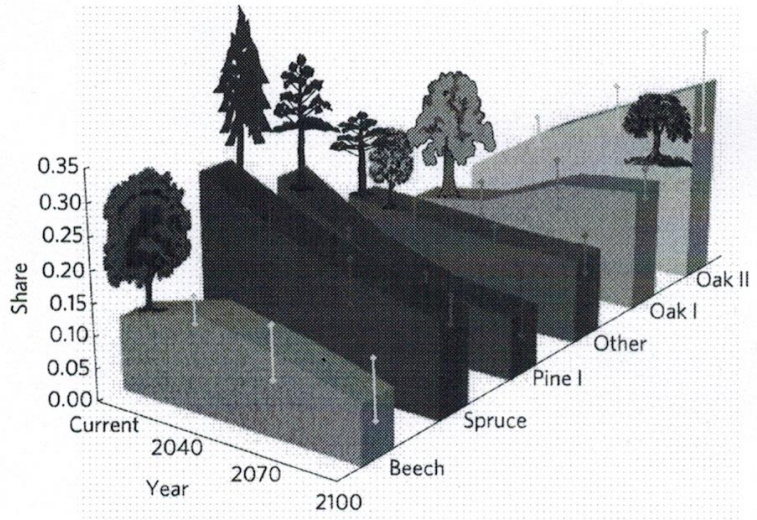


Figure 3 j Development of the share of the area of major tree species in Europe under scenario A1B until 2100. The relative size of the icons approximately corresponds to the relative height of mature trees of the species groups. The tree species group labelled 'Other' includes Pine II, Birch and Other spp. from Figs 1 and 2. The bars reflect the standard deviation resulting from four different model realizations of scenario A1B (see Supplementary Tables S5 and S6).

H. Ellenberg – vegetation ecology of Central Europa

Hanewinkel et al. Climate change may cause severe loss in the economic value of European forestland

Group planting

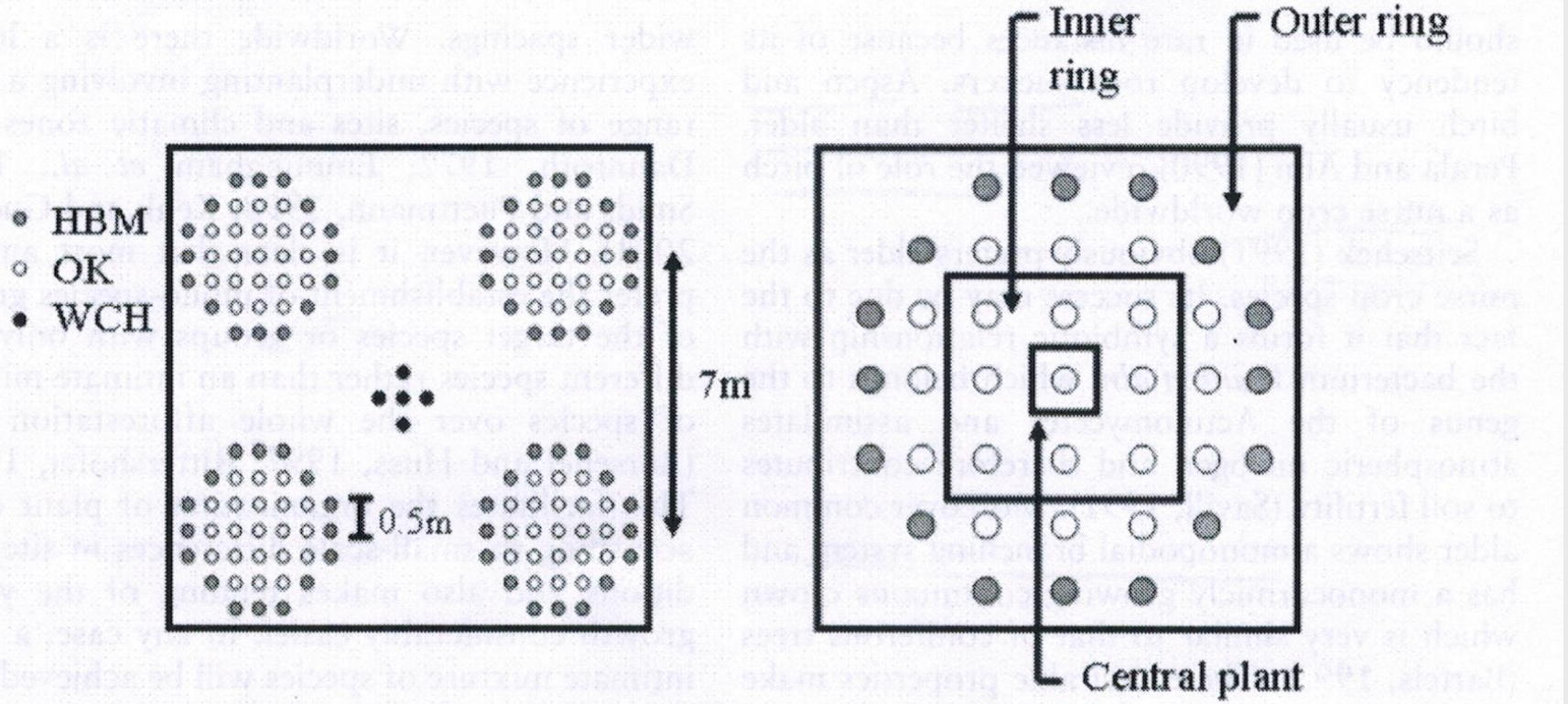


Figure 5. Design of a so-called 'oak-nest-planting'. On the left-hand side the arrangement of oak-nests on the afforestation area. On the right-hand side a detailed aspect of the arrangement of plants in one nest. Key to species codes: HBM = hornbeam, OK = oak, WCH = wild cherry (gean).

převzato Pommerening, Murphy 2004

Afforestation agriculture land

Ecologic problems:

- **Large areas – climatic conditions of clearing – not forest soil conditions**
- Compacted layer at 30 – 50 cm
- the absence of soil microflora and microfauna
- higher trophy and lower acidity of these soil

Trees growth:

- increased occurrence of rot especially in conifers (spruce)
- more branching and lower wood quality
- damage by animals and climatic extremes

Silviculture recommendation:

- species selection – pioneers, broadleaves
- shorter rotation period
- next generation

Conclusion:

- Disturbances (calamities) part of forestry and forest management
- Calamity – economic losses but chance for transformation
- Forest sensitivity – disturbance agents and forest structure
- Eliminate disturbance – diverse forest structure (multi-age silviculture)
- First steps towards diverse forest – wider using of pioneer species and diversity regeneration treatments

Thank you for your attention