Adaptation of silviculture to climate change

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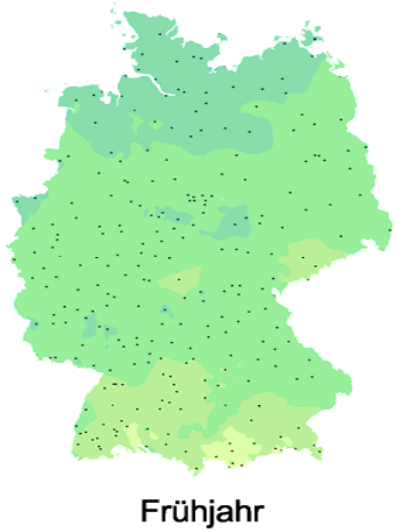
Outline

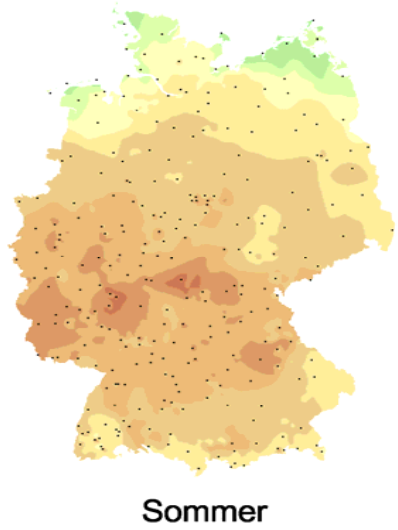
1. CC impacts on forests and vulnerability
2. Silvicultural legacy of Central Europe: Close-to-Nature Silviculture (CNS)
3. Strategies and options of adaptation by silviculture
4. CNS and adaptation principles; conclusions

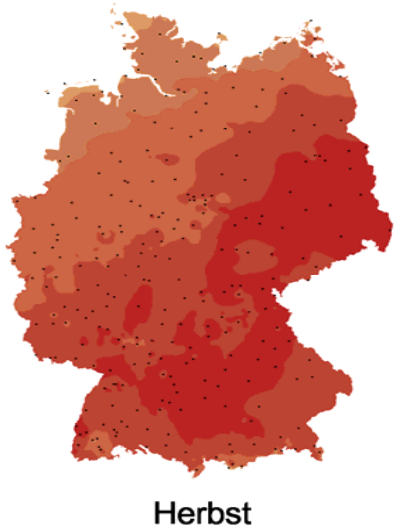
Climate change in Germany: scenarios (A1b)

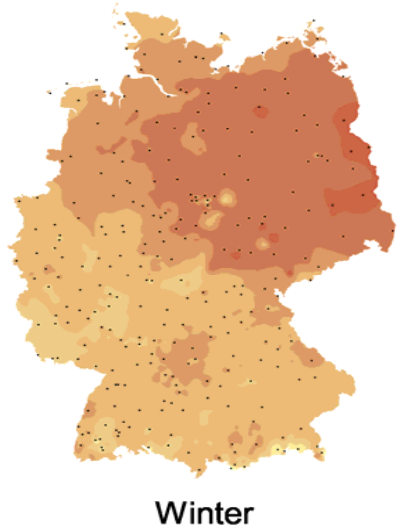
Temperature

Stock (2008), (PIK)





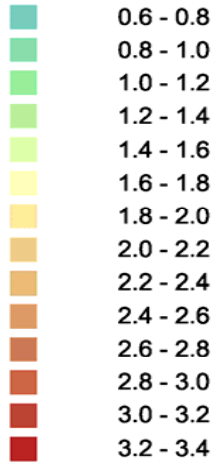




Temperature change

2046/2055-1951/2003

Difference in K



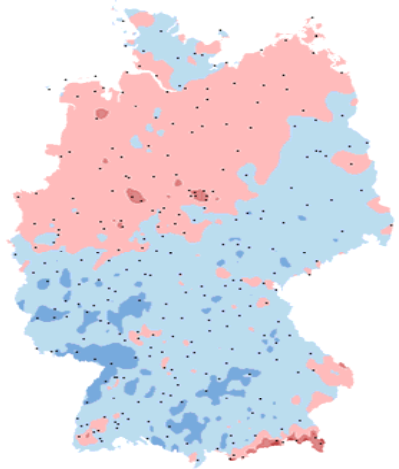
Statement / conclusions:

- Highest temperature increase in autumn and winter
- Extension of vegetation period
- Change of winter and late frost regime

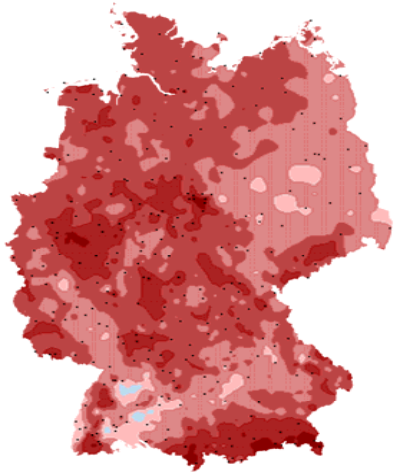
Climate change in Germany: scenarios (A1b)

Precipitation

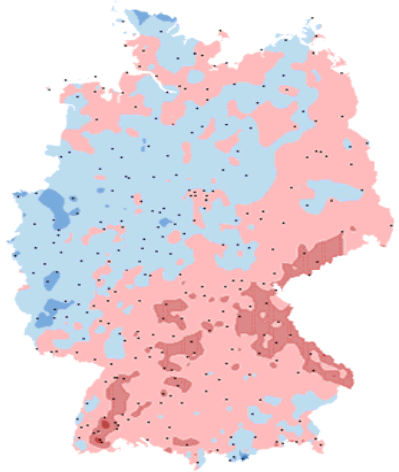
Stock (2008), PIK



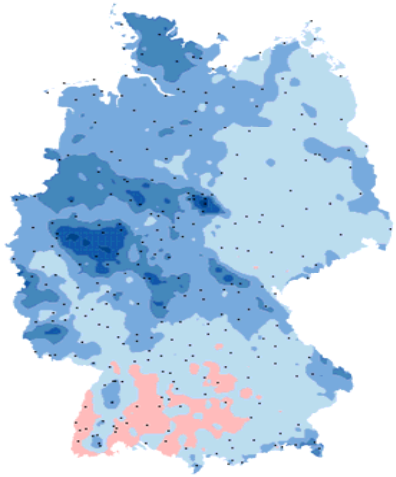
Frühjahr



Sommer



Herbst



Winter

Precipitation change

2046/2055-1951/2003

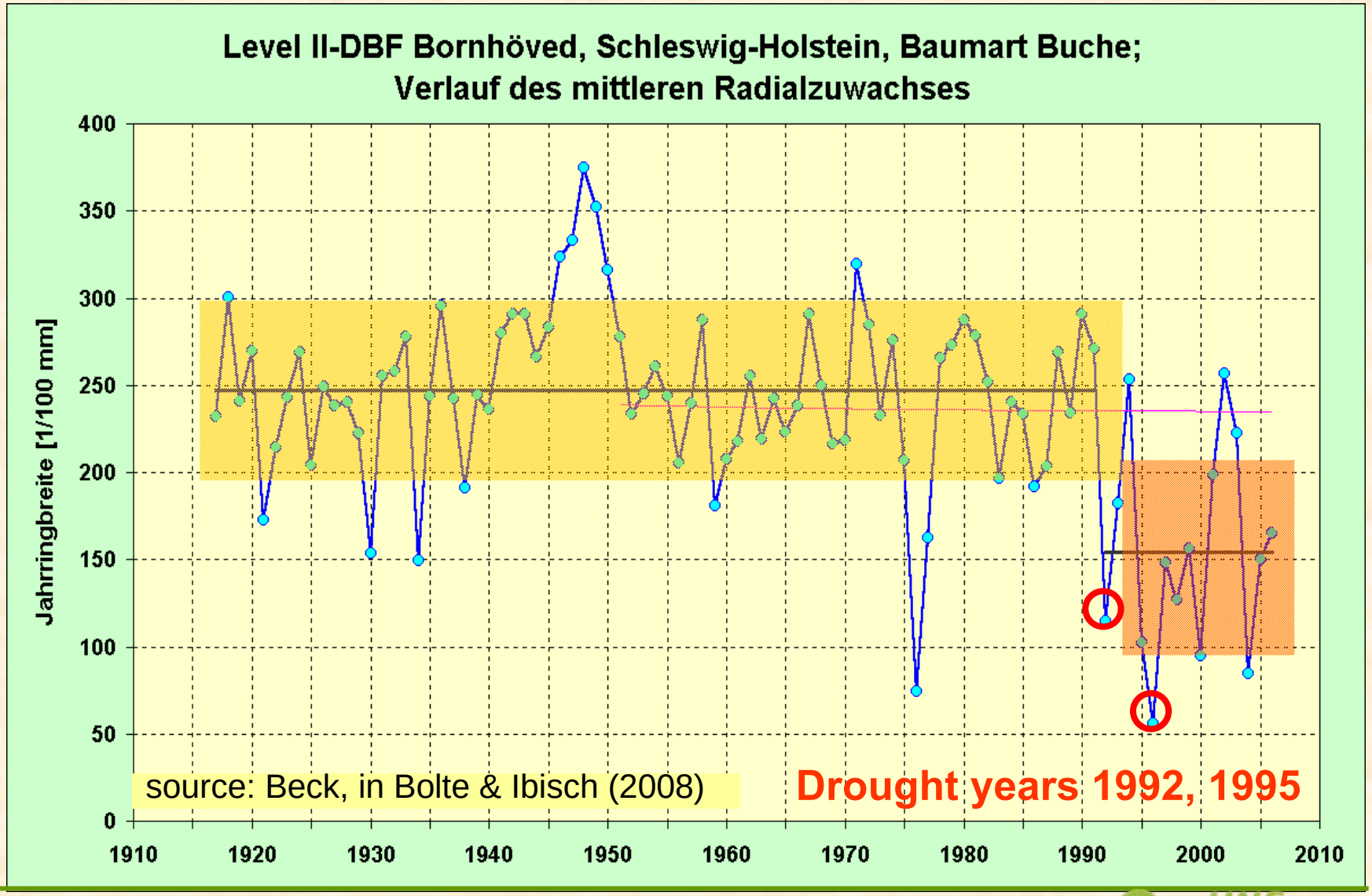
Difference in mm

-125 -	-75
-75 -	-50
-50 -	-25
-25 -	0
0 -	25
25 -	50
50 -	75
75 -	125
>	125

Statement / conclusions:

- Disparate distributions intensified
- Less continuous rain, more intense rain
- Less in summer, more in winter

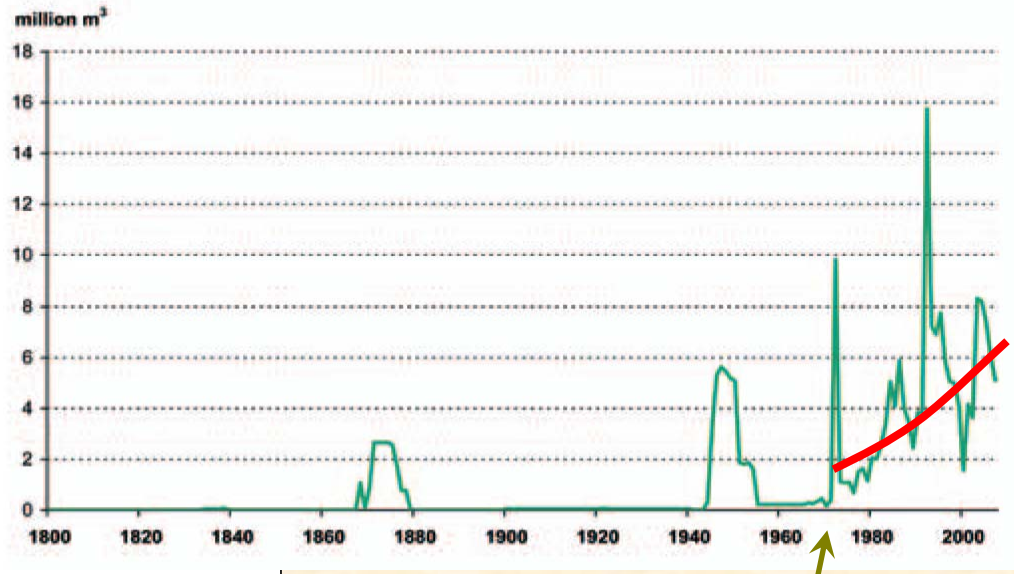
Response: *1) growth*

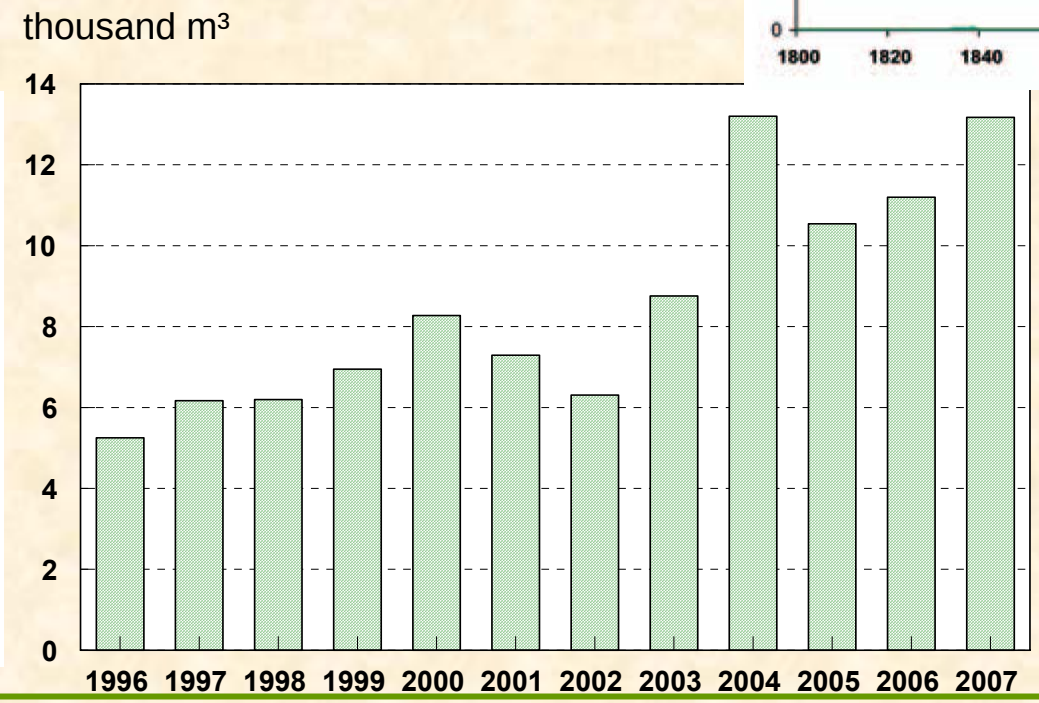


Response: *2) salvage cutting*

Salvage cutting in Europe since 1850 due to storm damage…

Dobbertin & DeVries (2008)



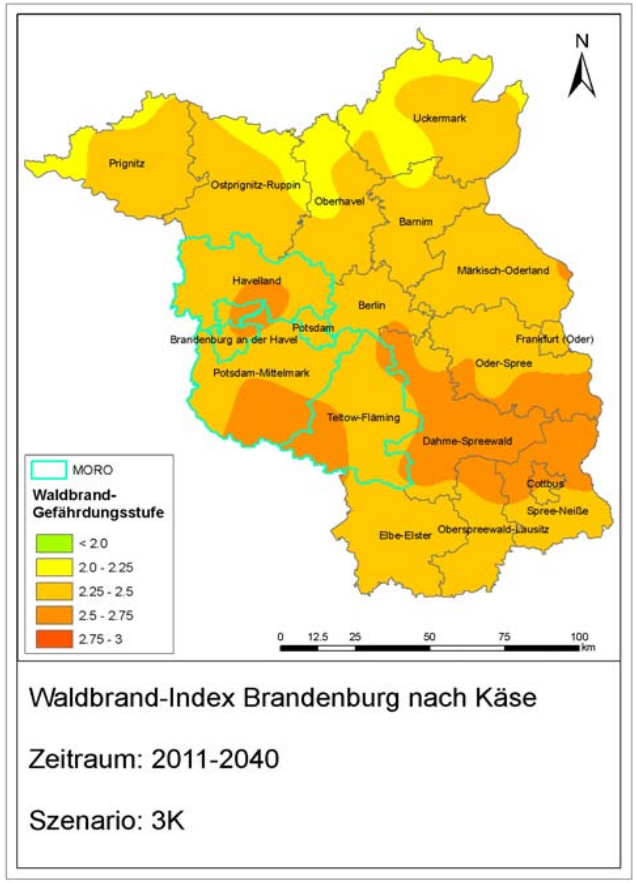


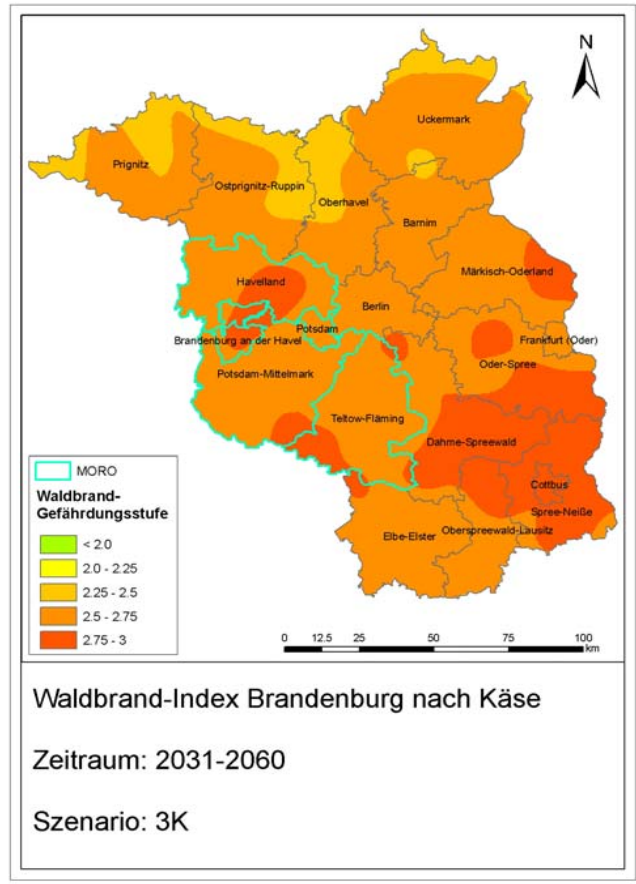
…and oak ‘decline’ in Brandenburg

Möller (2008)

HNE Eberswalde
Hochschule für nachhaltige Entwicklung (FH)

Response: *3) fire risk*



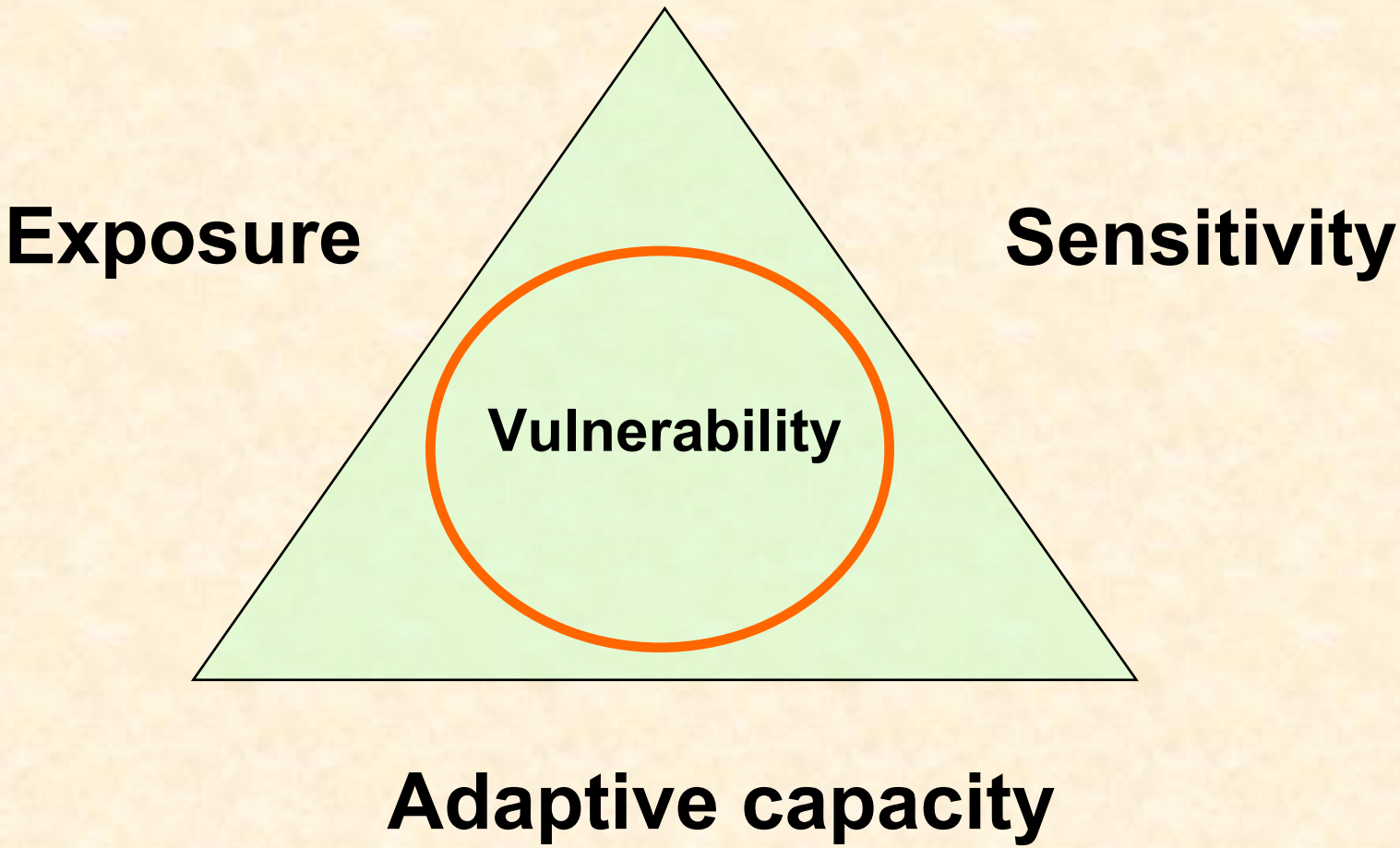


1961-1990 2011-2040 2031-2060

Forest fires in Brandenburg (data acc. to Forest Service):

∅ 1992-2005: 267 ha (514 fires/a)

Components of ecosystem vulnerability



Vulnerability: tree species and regions

Categories of climate risk regions in Germany (CRAMER et al. 2005, *www.waldundklima.net*)

high	moderate	low
• Northeastern Germany • Southeastern basin and hill landscape • Valley of the river Rhine • Pre-Alps	• West German lowland basins • Central mountain ranges and Harz • Erzgebirge, Thüringen and Bavarian forest • Mountain ranges left and right of the river Rhine • Alps • Bavarian hill landscape	• Northwest German lowlands

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1. CC impacts on forests and vulnerability
2. **Silvicultural legacy of Central Europe: Close-to-Nature Silviculture (CNS)**
3. Strategies and options of adaptation by silviculture
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Alfred Möller (1860 – 1922), Eberswalde

…introduced and promoted the concept of ‚permanent forest‘ (continuous-cover forestry) in Germany


Ge
ove
Close-to-nature-silviculture, since 1980

Close-to-nature silviculture (CNS)

elements

- Promotion of the natural and/or site-adapted tree species composition, often based on the assumed potential natural vegetation,
- Promotion of mixed and ‘structured’ forests,

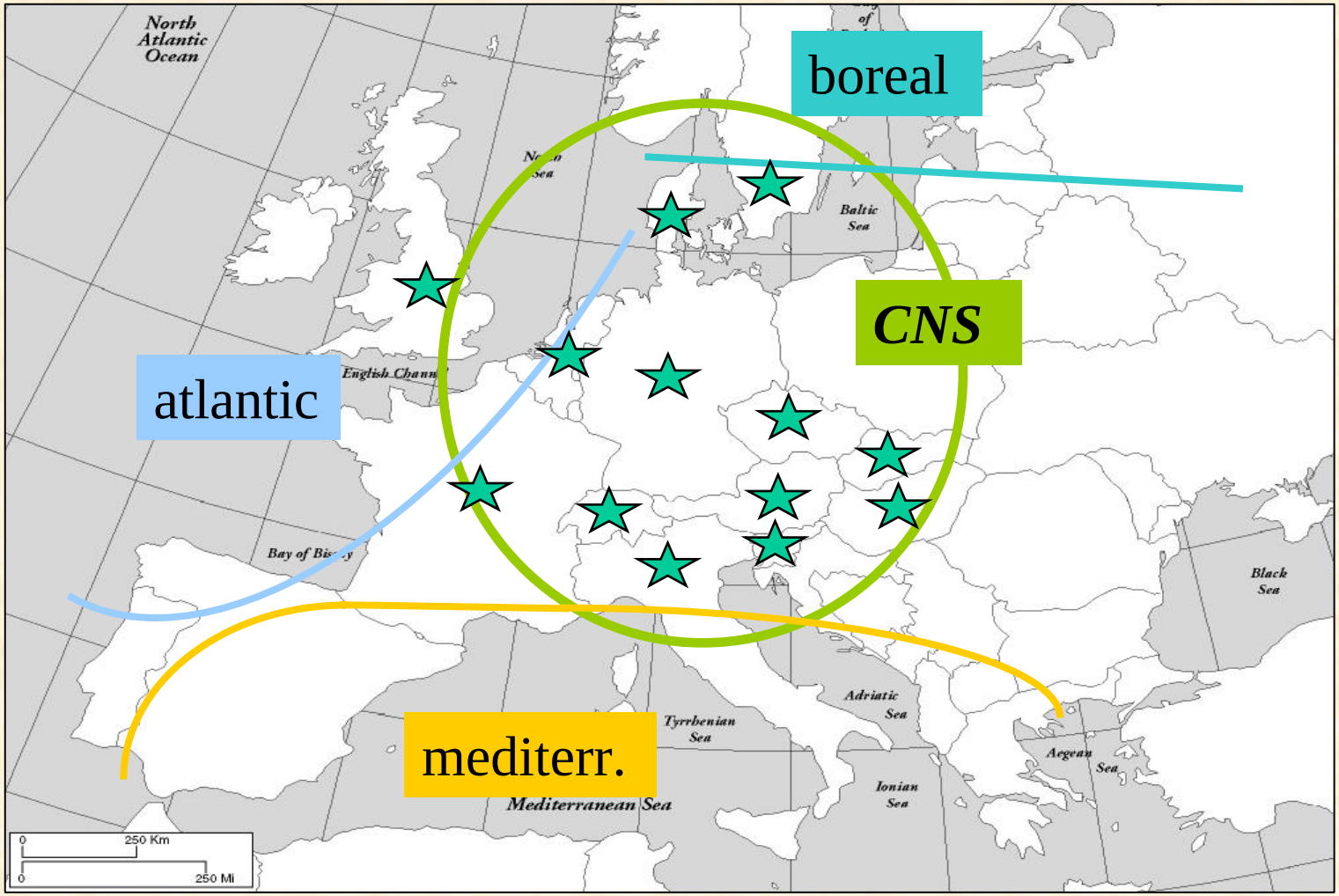
E.g. Silvicultural programme of Brandenburg 2004, principle 1:

‚…resilience of forests through more complex stand structures, mixed stands and long-term natural regeneration…’

- *Broad programme!*

CNS

extension



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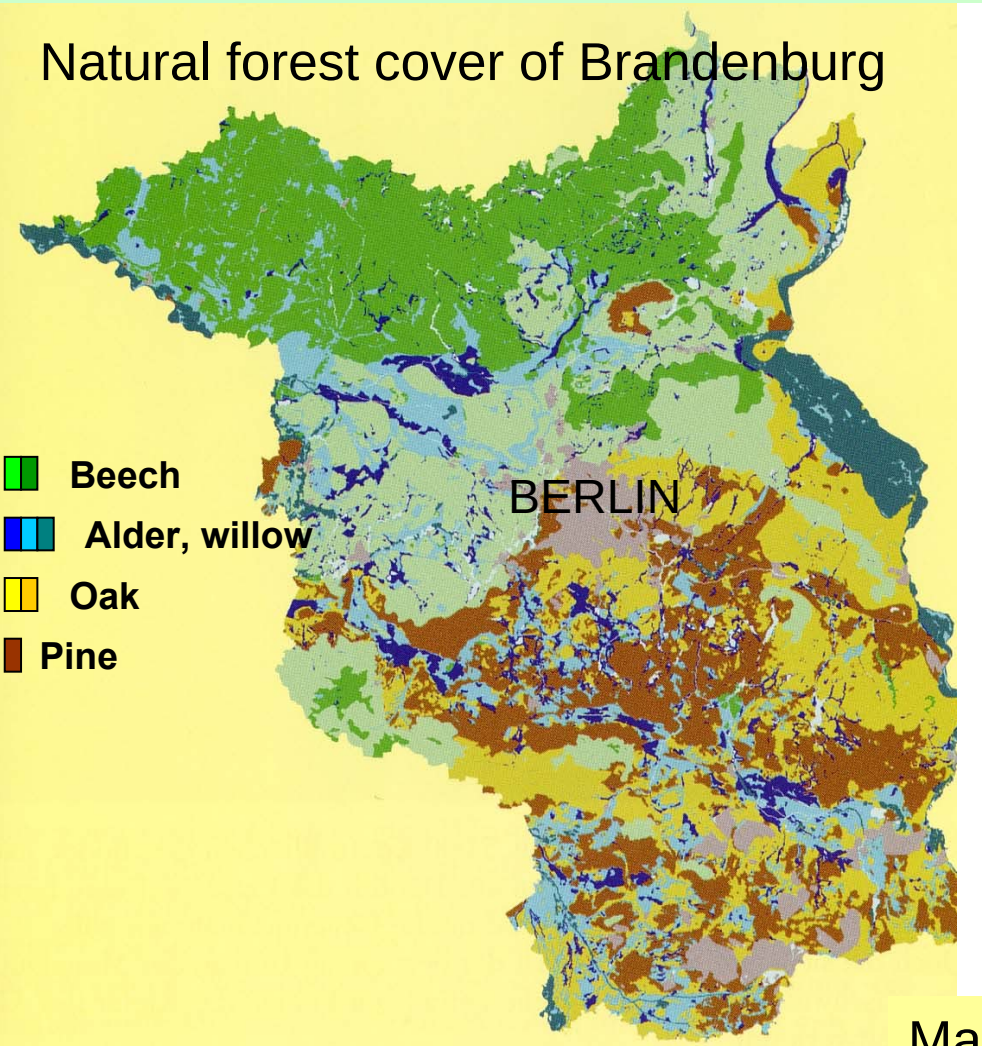
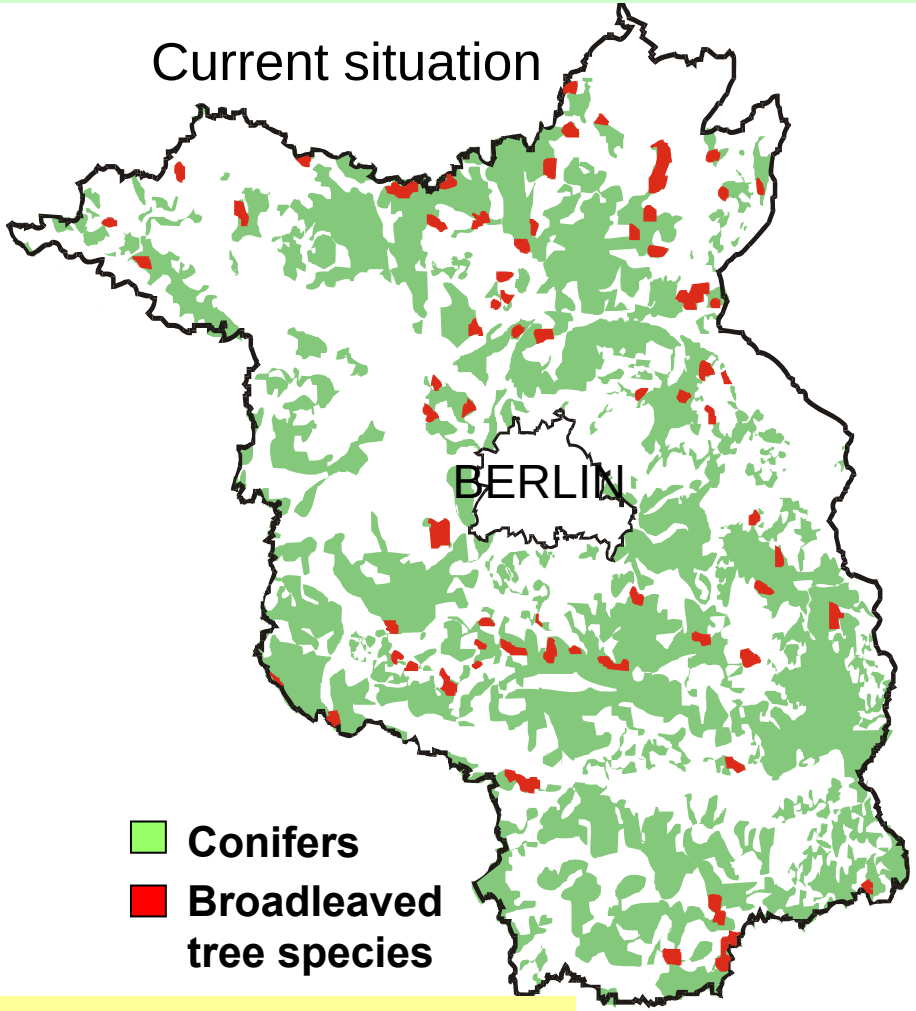
CNS

tree species of assumed pnV

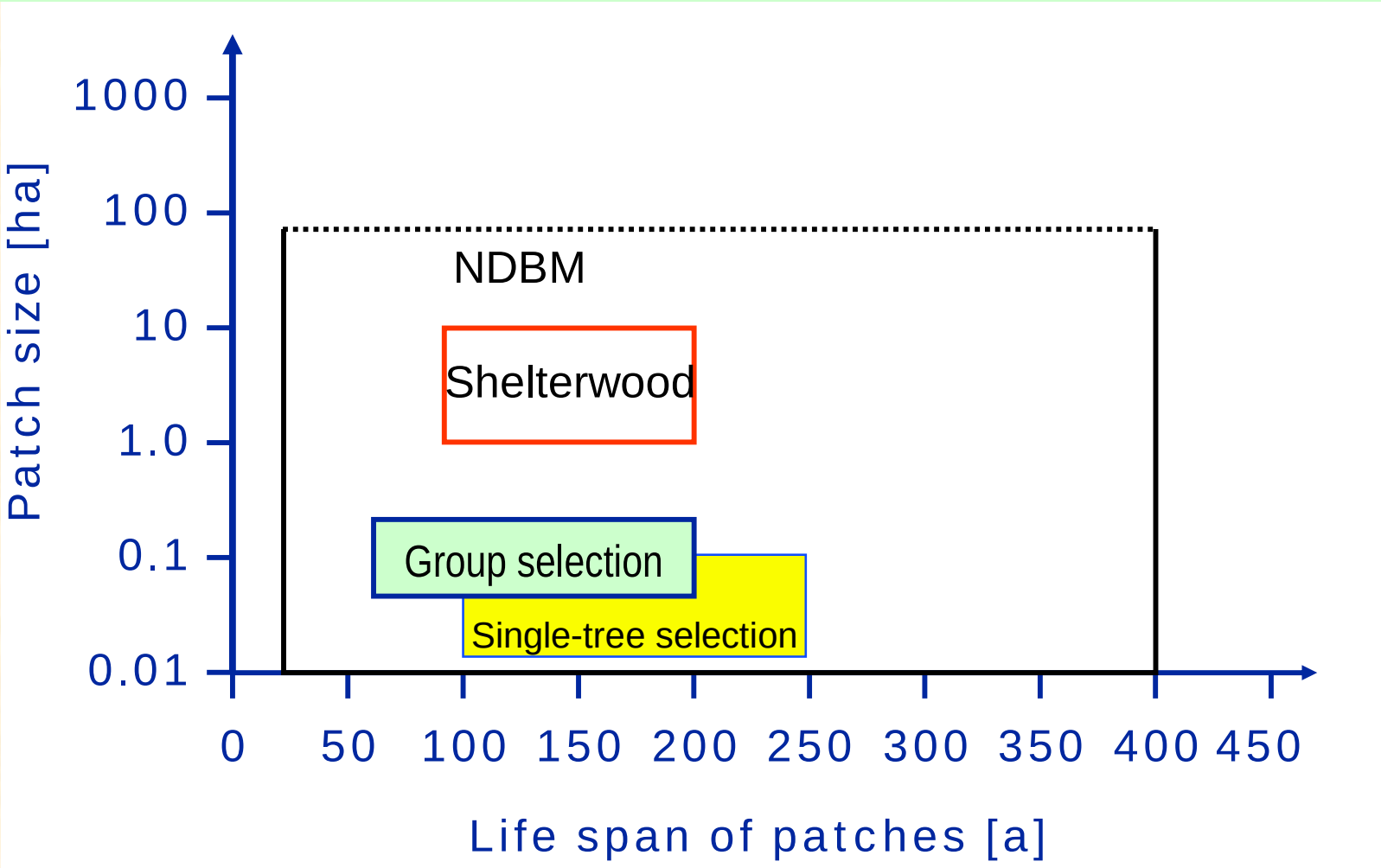




Maps: Hofmann (2004)

CNS

size of cutting areas and life span



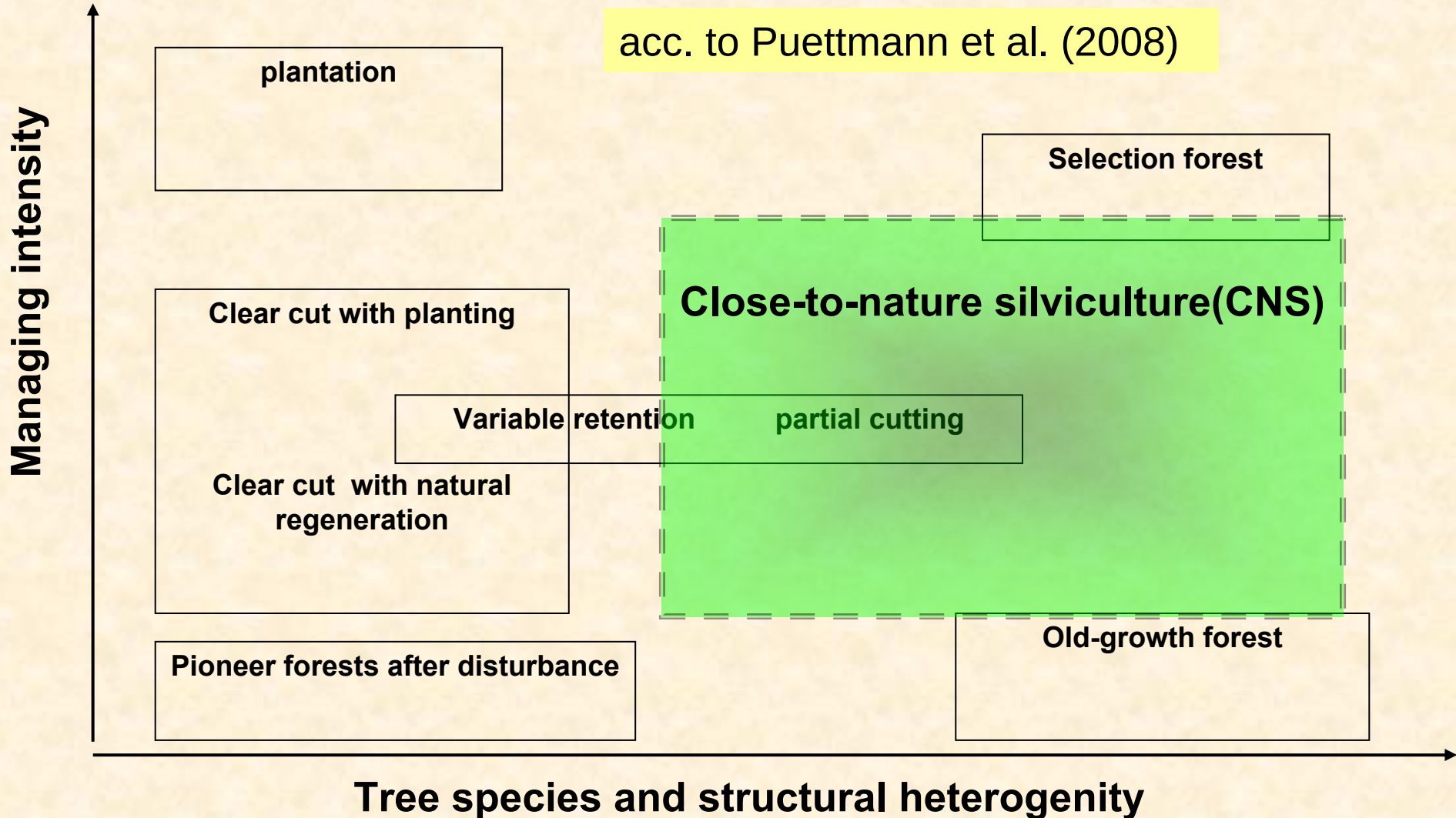
from Brang, Larsen, Spathelf et al. (2011, *in prep.*)

CNS

integrative approach

CNS

status


acc. to Puettmann et al. (2008)
plantation
Selection forest
Close-to-nature silviculture(CNS)
Clear cut with planting
Variable retention
partial cutting
Clear cut with natural regeneration
Pioneer forests after disturbance
Old-growth forest
Managing intensity
Tree species and structural heterogenity

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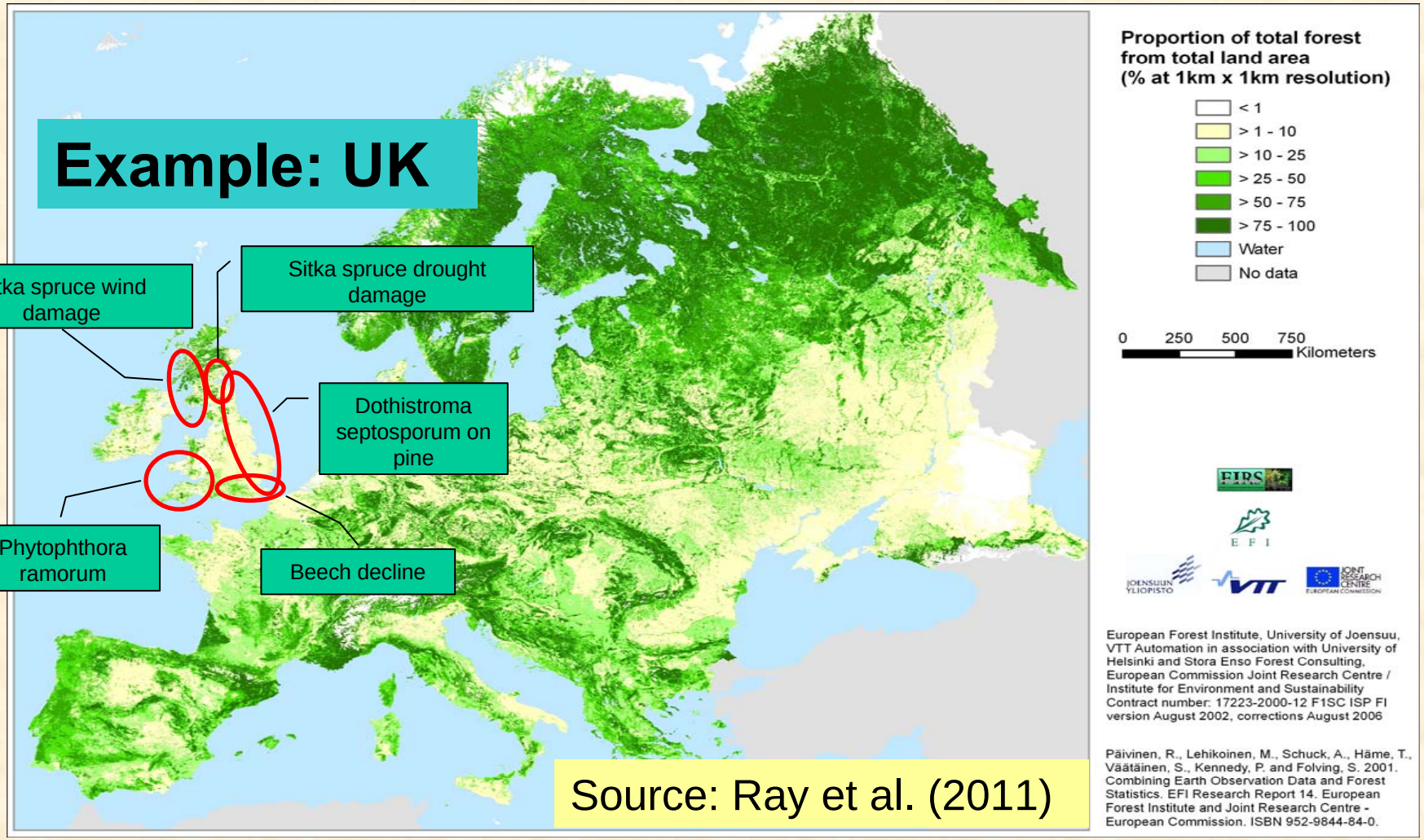
Adaptation strategies

- *Passive or autonomous adaptation* (‚succession')

- *Active adaptation* (‚adaptation interventions')
  - ➢hotspots approach

from Millar et al. (2007, *adapted)*

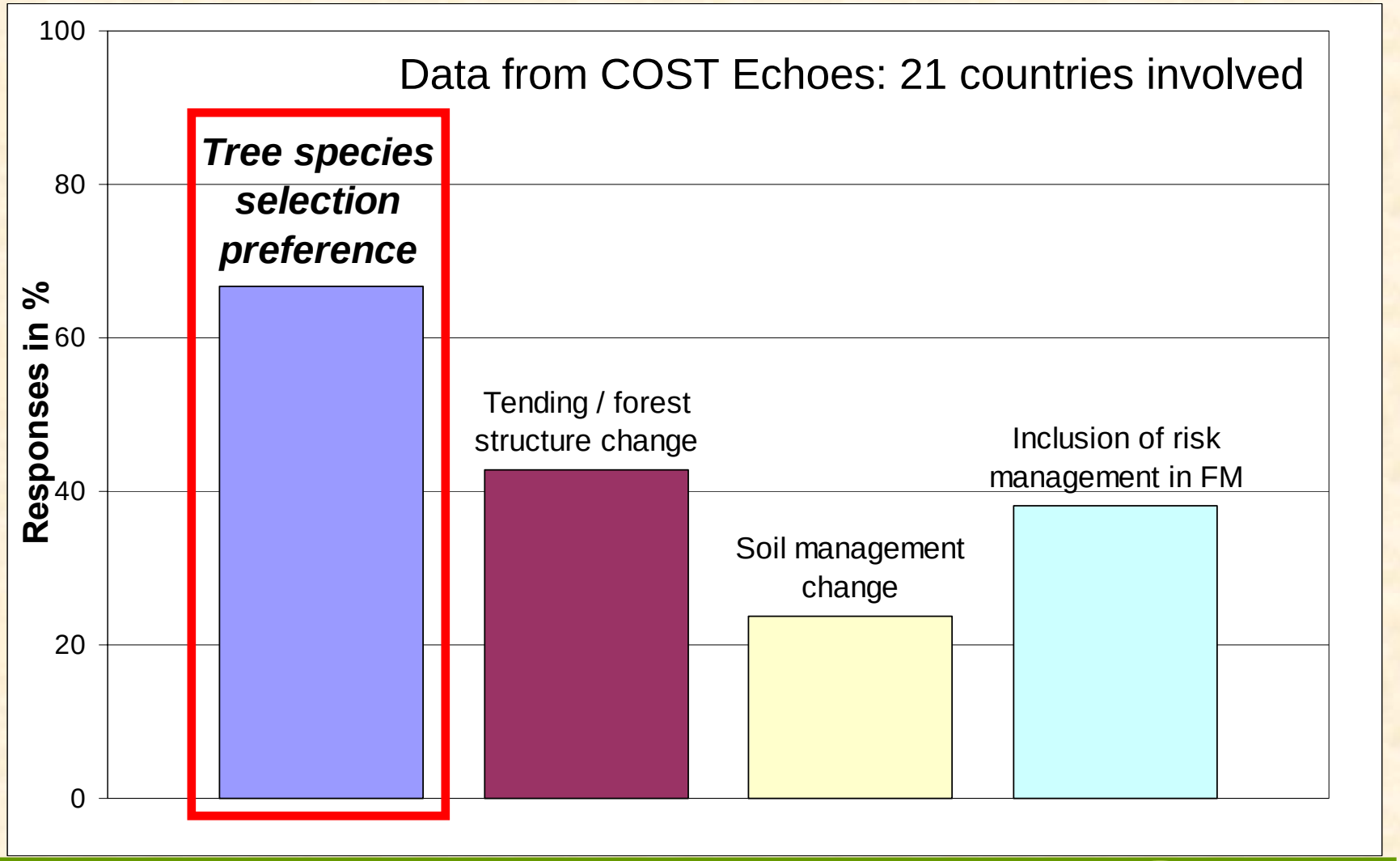
Active adaptation: hotspots



Adaptation principles

- Maintain forest climate
- Reduce average growing stock
- Replace high-risk stands
- ***Increase species richness and structural diversity, and***
- ***Maintain & increase genetic variation within tree species***

Adaptation principles: results of a European survey



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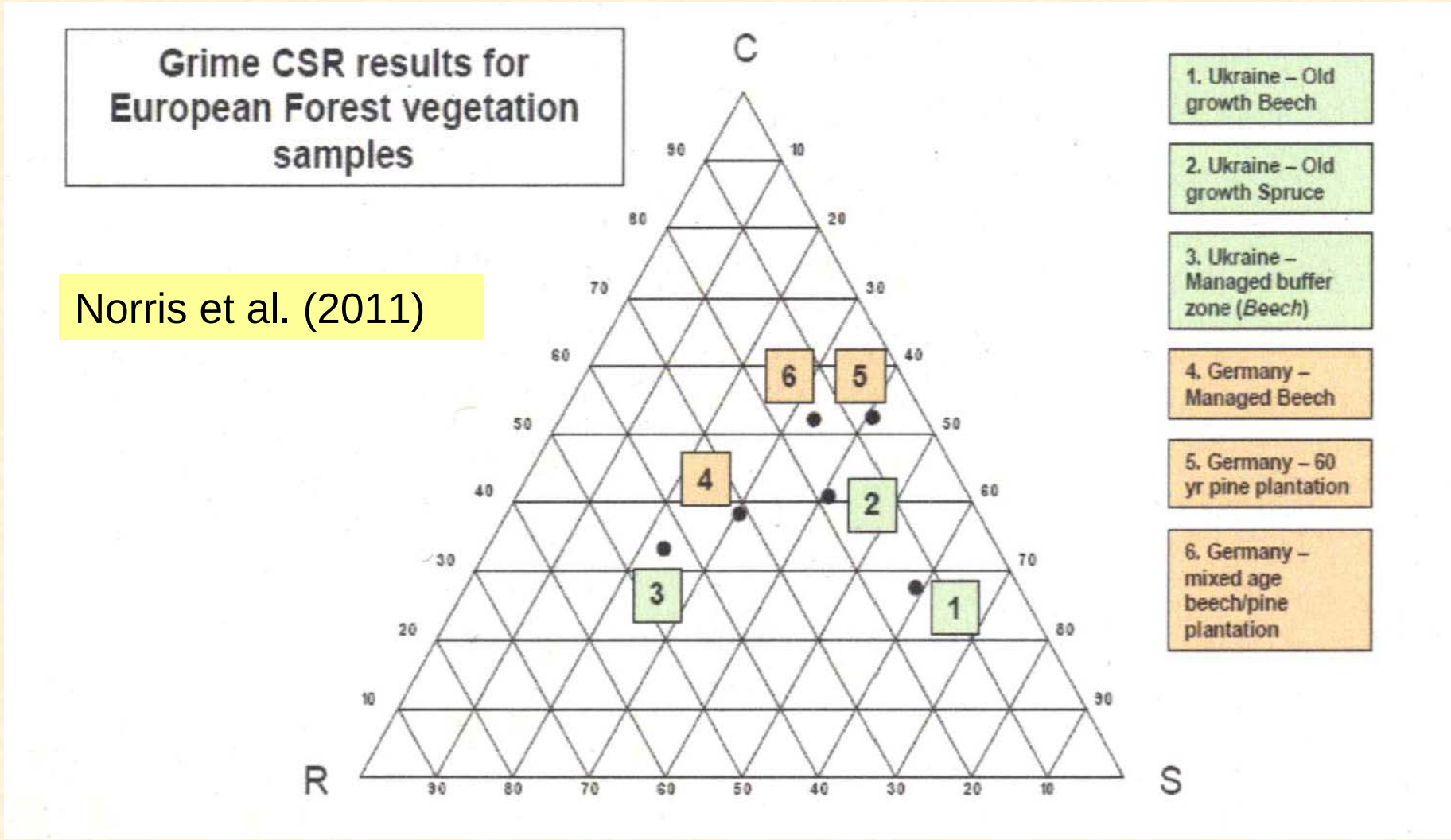
Species richness/mixture: *seepage*

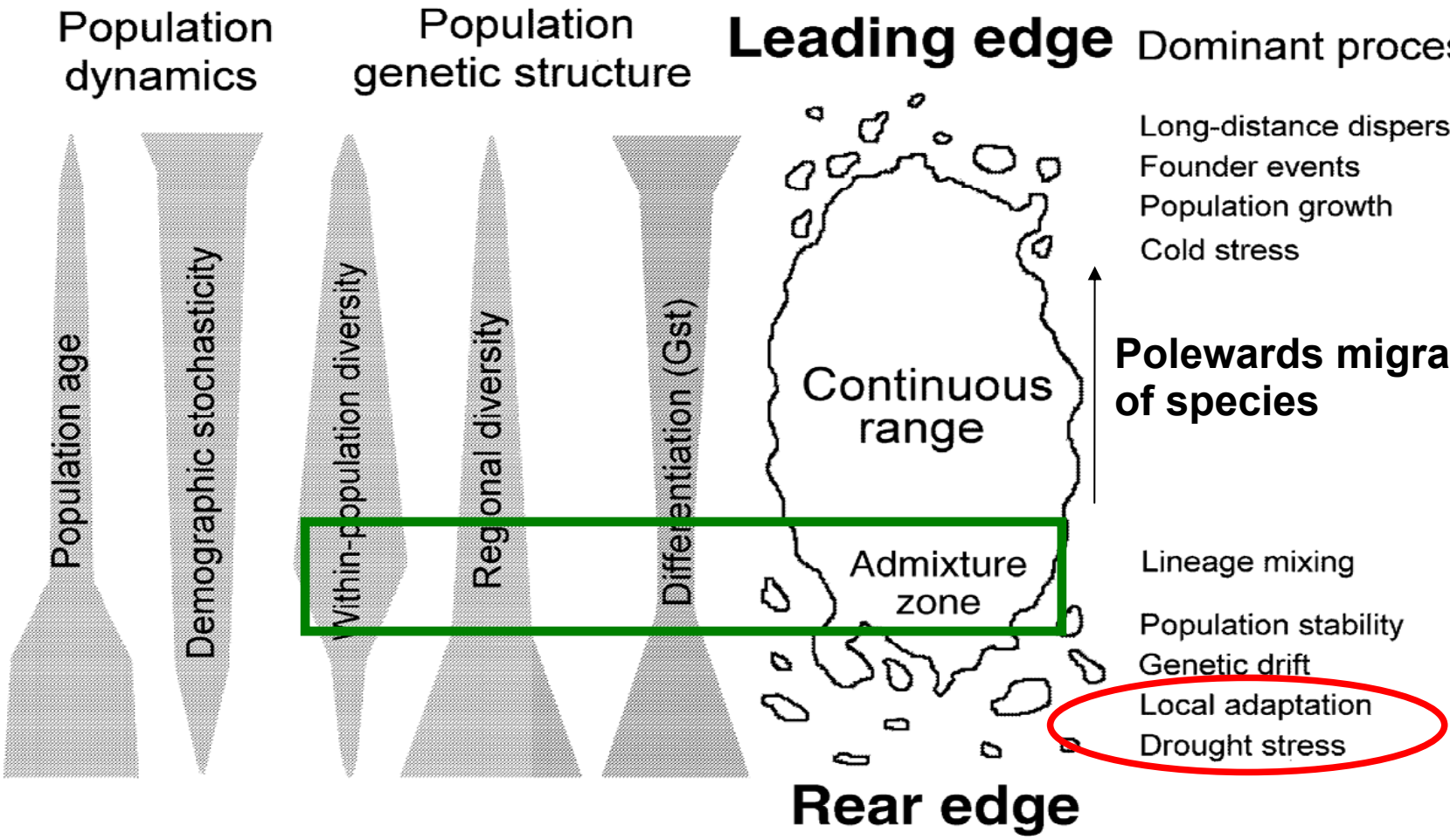

	Infiltration		
	m^3/a	mm/a	% of open land prec.
Pine forests	300	47	7
Beech forests	900	141	23
Pine and beech forests	400	63	10

acc. to Müller (2007)


Species richness/mixture: *resilience*

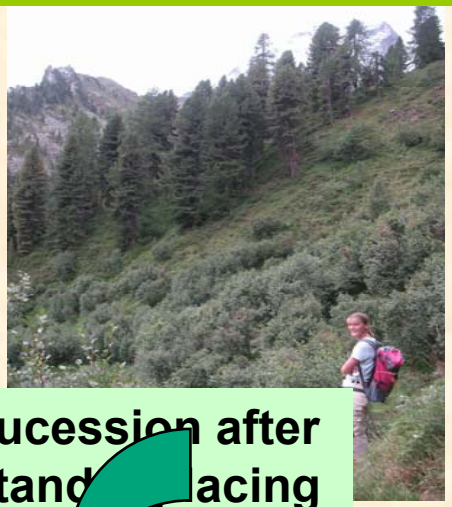


Species richness/mixture: *genetic variation*

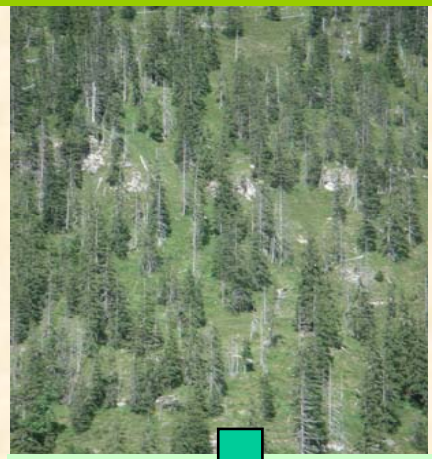


Hampe & Petit (2005)

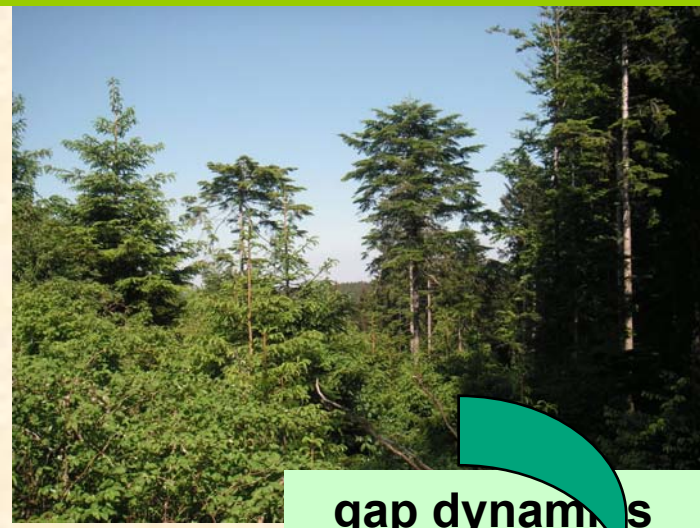
Implementation: *variable cutting schemes*



sucession after stand-replacing disturbance



cohort dynamics

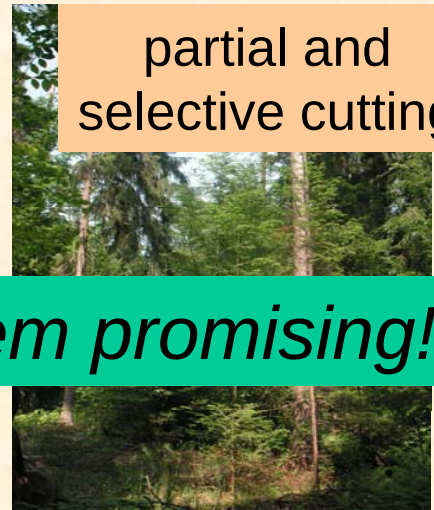


gap dynamics

acc. to Kuuluvainen (2002, *adapted*)

Clear / strip cutting

partial cutting

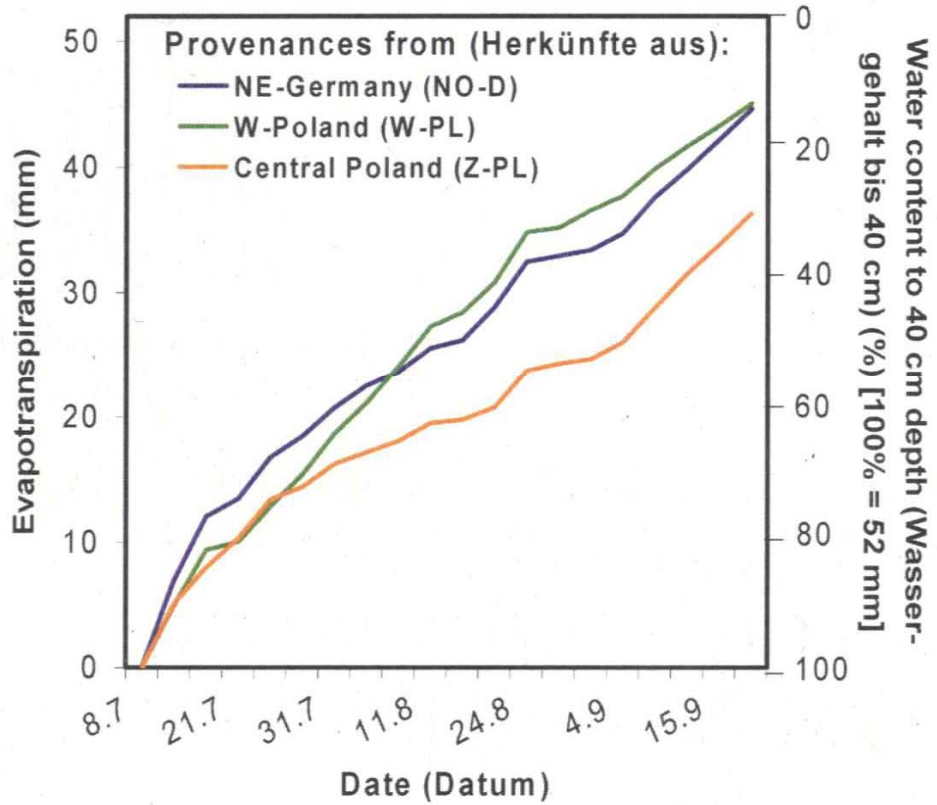


partial and selective cutting

Group selection system promising!

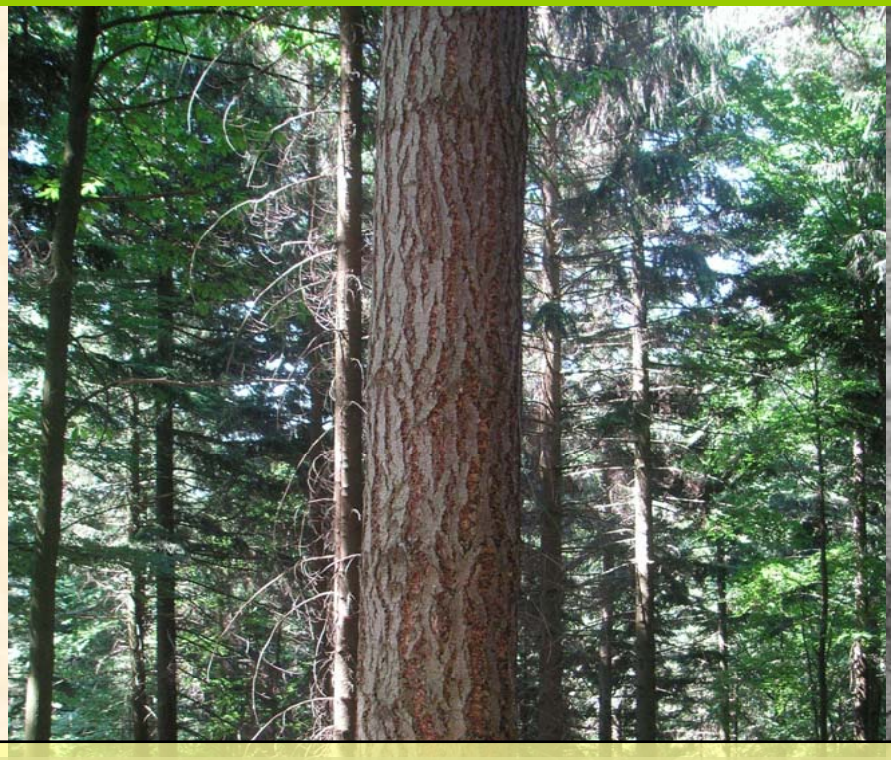
Implementation: *planting 'new' provenances of established species*

Suitability of provenances with higher drought stress tolerance from Southeast Europe?



Czajkowski & Bolte (2006)

Implementation: *planting 'new' species*



Non-native tree species with good performance and low risk in Northeast Germany

- *Douglas fir (Pseudotsuga menziesii)*
- *Black locust (Robinia pseudoacacia)*
- *Grand fir (Abies grandis)*
- *Red oak (Quercus rubra)*
- *Western red cedar (Thuja plicata)*

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CNS compatible with adaptation principles?

Adpatation principle	Maintenance of forest climate	Reduction of average growing stock	Replacement of high-risk stands	Maintenance and increase of genetic variation within trees	INCREASE OF SPECIES RICHNESS AND STRUCTURAL DIVERSITY	Number of non-compatible principles (−)
CNS type						
Single-tree selection system	+	+	−	+	− +	1-2
Group selection system	+	+	+	+	+	
Shelterwood system	+	+	+	+	+ −	1
NDBM	+ −	+	+	+	+	1

from Brang, Larsen, Spathelf et al. (2011, *in prep.)*

→CNS compatible with adaptation principles, but needs some adjustments!

Conclusions I

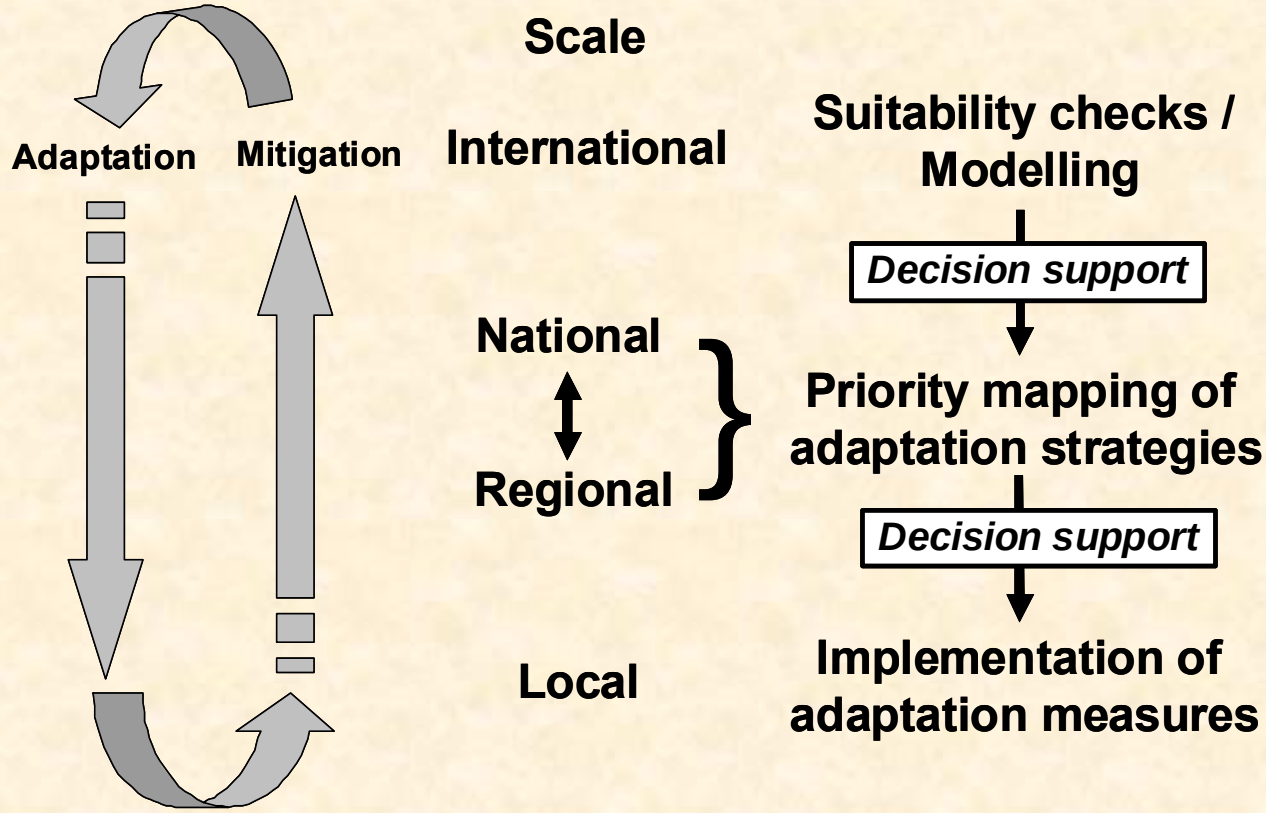
- **Increase of species richness, genetic variation and structural diversity most important adjustment screws for forest adaptation**

➢ *Temperate, subcontinental zone of Europe:* High need for adapted forests to provide a high variety of goods and services; measures: forest conversion, structural enrichment, incorporation of stand legacies (higher degree of ‚oldgrowthness'), forest conservation

➢ *Tropics and subtropics:* High importance of adapted tropical forests for global mitigation needs (REDD+), local livelihoods (safety nets for poor people) and for the containment of transboundary conflicts; measures: forest conservation ('no access'), SFM

Conclusions II

Suggestion for an integrative concept of adaptive forest management



from BOLTE, A., AMMER, C., LÖF, M., MADSEN, P., NABUURS, G.-J., SCHALL, P., ROCK, J. & SPATHELF, P. (2009): Adaptive forest management in central Europe: Climate change impacts, strategies and integrative concept. Scandinavian Journal of Forest Research 24. 473-482.

Forest conversion in pine stands near Eberswalde