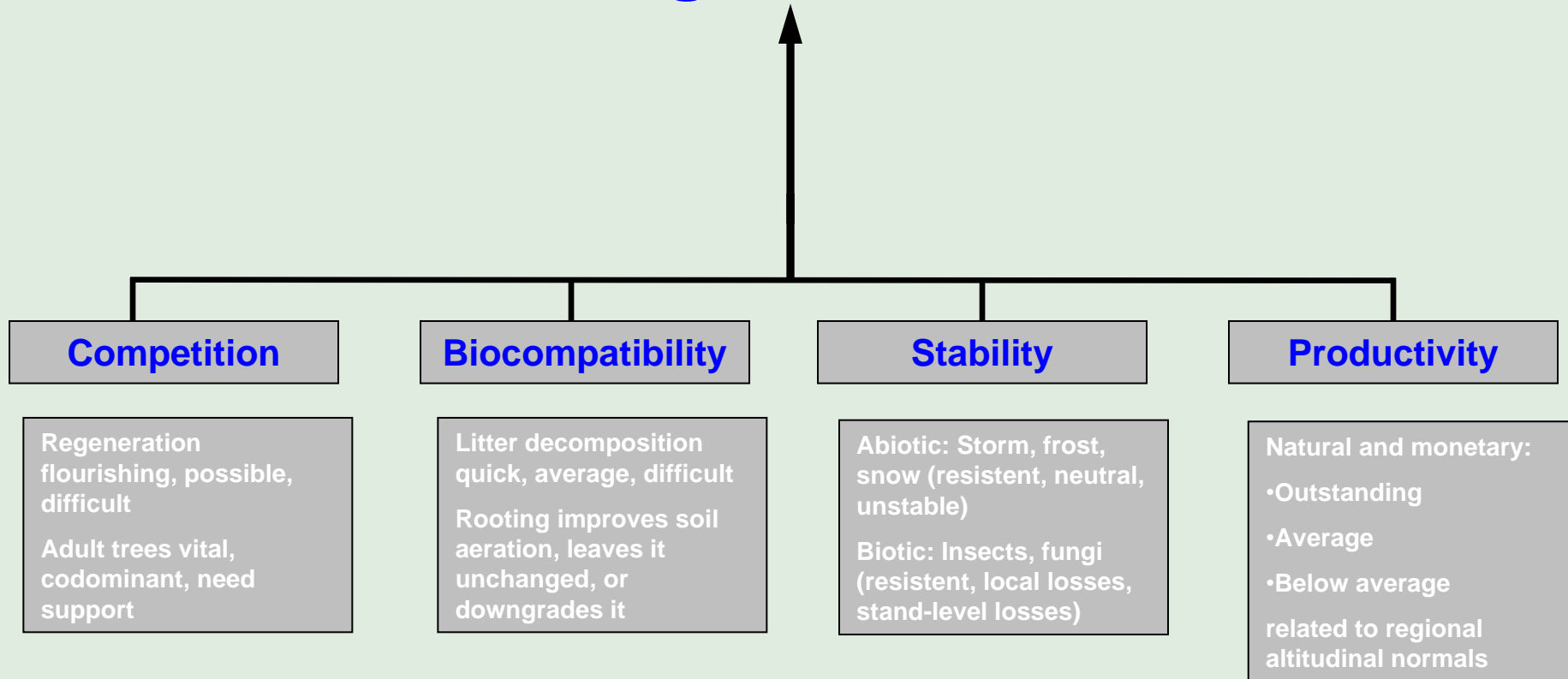# Transferring climate change research into forest management
– examples from Southwest Germany –

1. scientific concepts
2. specific forestry adaptation measures
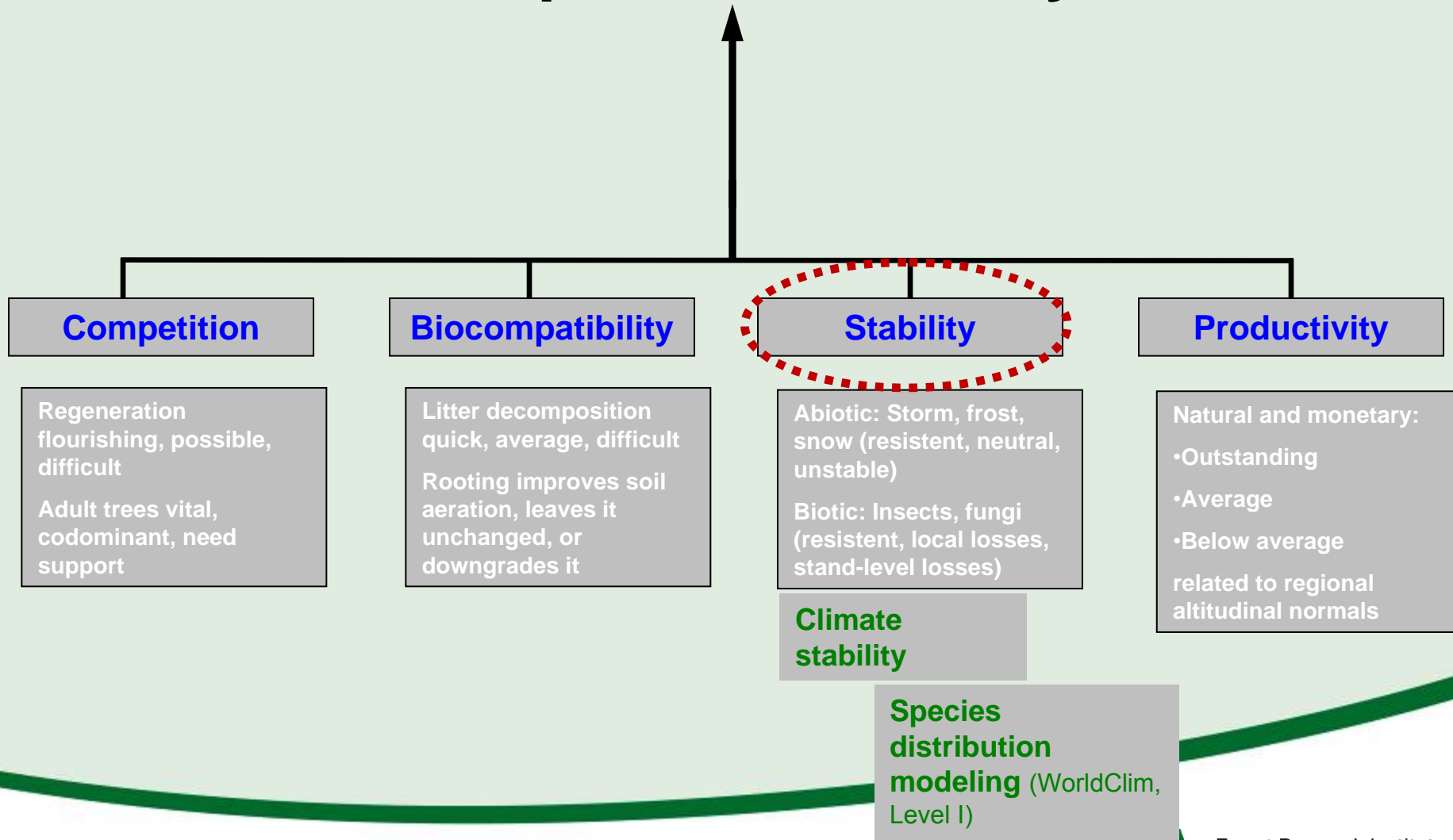
Axel Albrecht
Coordinator climate change research

9 Mars 2017
Colloque international
ENSA…Nancy

FVA Forest Research Institute
Baden-Württemberg

Traditional static tree species suitability ranking *(expert system)*

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                              ↑
        ┌──────────┬──────────┴──────────┬──────────┐
```

Competition	**Biocompatibility**	**Stability**	**Productivity**
Regeneration flourishing, possible, difficult **Adult trees vital, codominant, need support**	**Litter decomposition quick, average, difficult** **Rooting improves soil aeration, leaves it unchanged, or downgrades it**	**Abiotic: Storm, frost, snow (resistent, neutral, unstable)** **Biotic: Insects, fungi (resistent, local losses, stand-level losses)**	**Natural and monetary:** •**Outstanding** •**Average** •**Below average** **related to regional altitudinal normals**

Aldinger and Michiels (1997)
Schlenker (1964, 1975), Krauss (1949)

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The first climate sensitive elements of tree species suitability

```
                              ↑
        ┌──────────────┬──────┴──────┬──────────────┐
```

Competition   **Biocompatibility**   **Stability**   **Productivity**

Regeneration flourishing, possible, difficult Adult trees vital, codominant, need support	Litter decomposition quick, average, difficult Rooting improves soil aeration, leaves it unchanged, or downgrades it	Abiotic: Storm, frost, snow (resistent, neutral, unstable) Biotic: Insects, fungi (resistent, local losses, stand-level losses)	Natural and monetary: •Outstanding •Average •Below average related to regional altitudinal normals

Climate stability

Species distribution modeling (WorldClim, Level I)

Hanewinkel et al. 2014: Converting probabilistic tree species range shift projections into... J Environ Manage 134(0), S. 153-165
Hanewinkel et al. 2010: Künftige Baumarteneignung für Fichte und Buche in Südwestdeutschland. AFZ - Der Wald (19), S. 30-33

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Result: Suitability maps *(example Silver fir)*

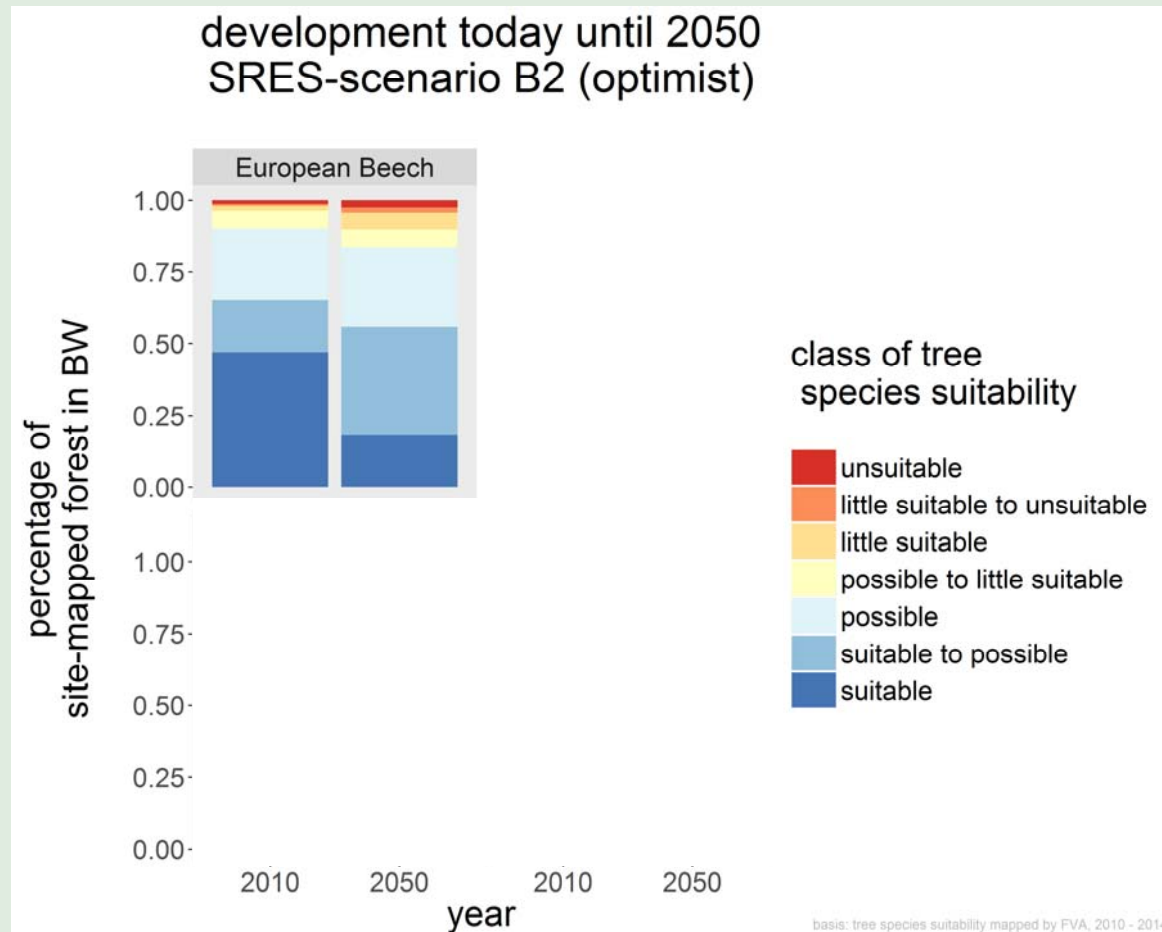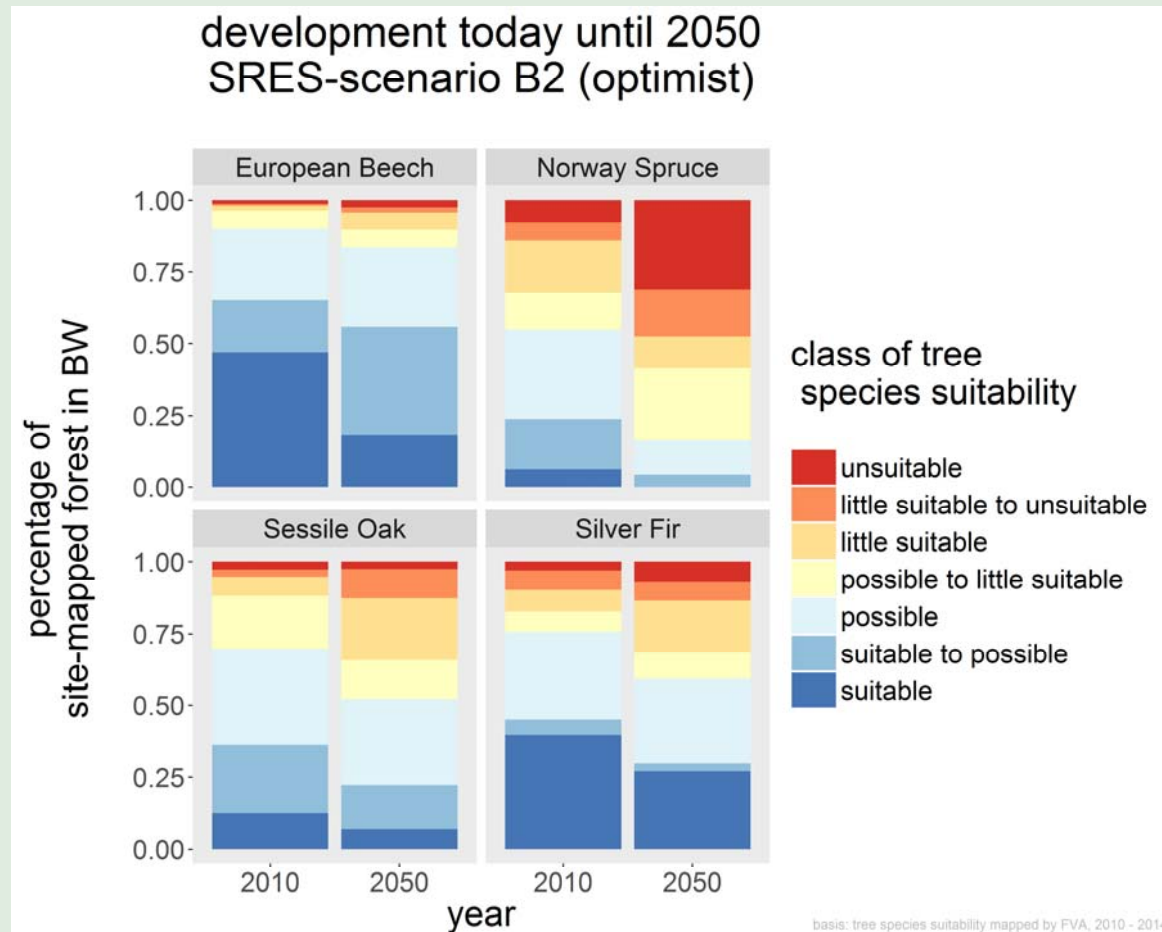## *recent*   *2050*
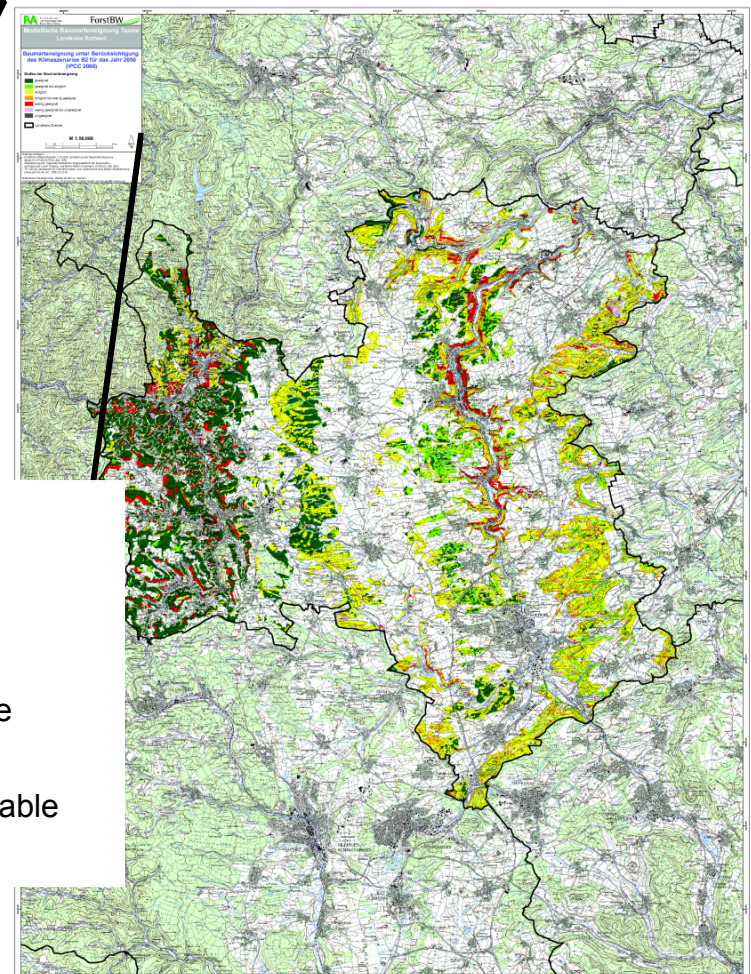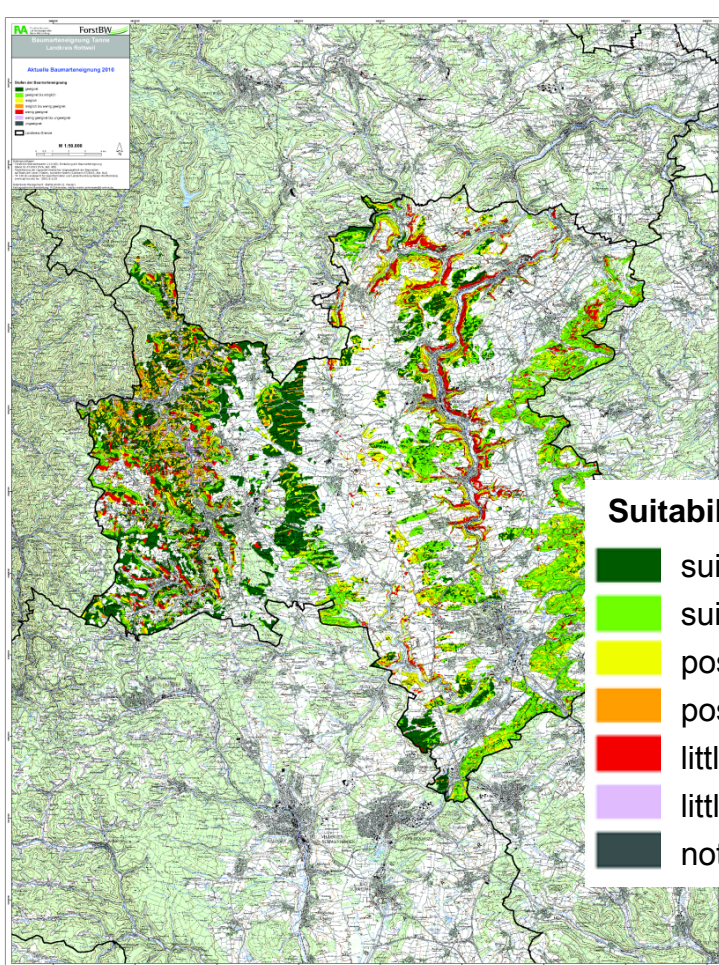
Suitability classes

- ■ suitable
- ■ suitable to possible
- ■ possible
- ■ possible to little suitable
- ■ little suitable
- ■ little suitable to not suitable
- ■ not suitable

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State-wide suitability changes

development today until 2050
SRES-scenario B2 (optimist)

European Beech

class of tree
species suitability

unsuitable
little suitable to unsuitable
little suitable
possible to little suitable
possible
suitable to possible
suitable

percentage of site-mapped forest in BW

year

basis: tree species suitability mapped by FVA, 2010 - 2014

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State-wide suitability changes

State-wide suitability changes

development today until 2050
SRES-scenario B2 (optimist)

- All four main tree species may suffer substantial losses

- Sessile Oak and Silver fir the least

- Results substantiate research need for alternatives
  - New species
  - New provenances

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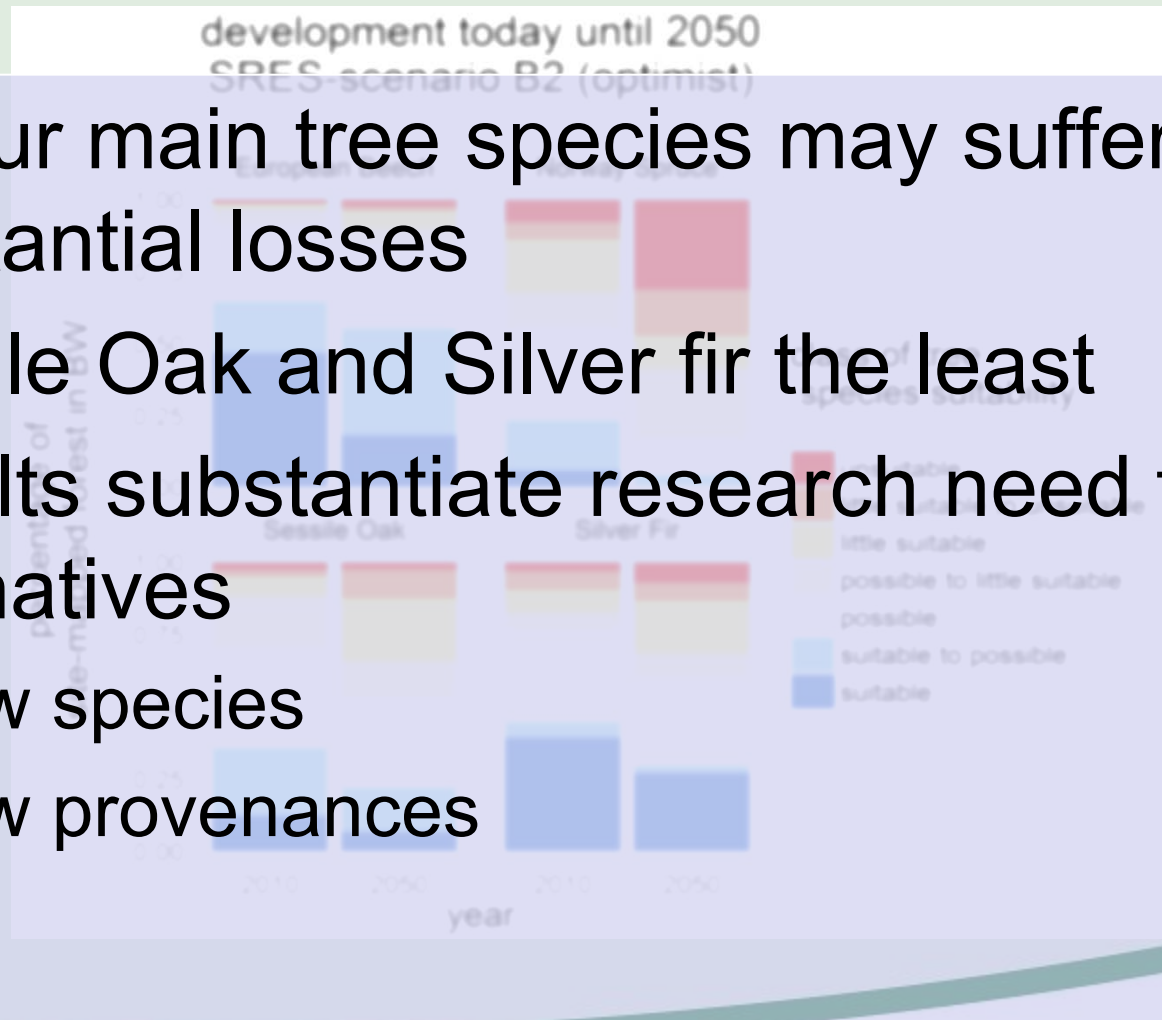
Vulnerability

- „Vulnerability" as politically determined expression

- Vulnerability maps illustrate climate change probabilities × value at risk

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Vulnerability maps

- Prototype for one case study:
  Bayesian belief network
  [BBN Rastatt / Baden-Baden, unpublished]

- Conditional probability tables
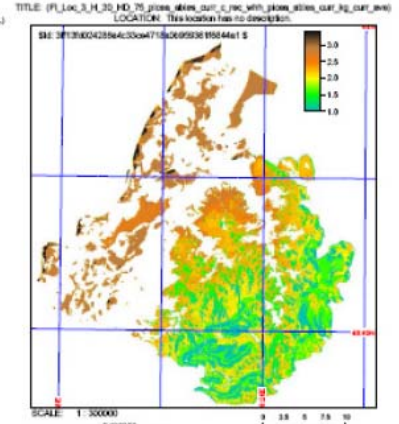
- Individual risks remain visible

- But may be aggregated
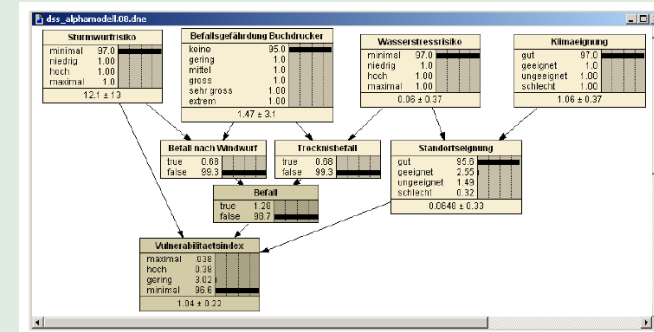
Abbildung 5: Alphamodell des Bayesian Belief Network.
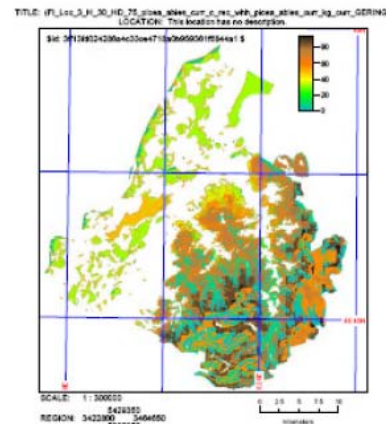
(b) Gering
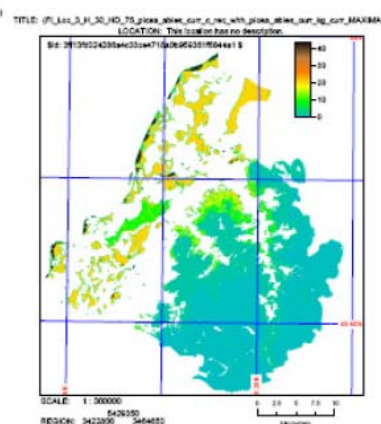
(d) Maximal

(f) Mittel

Adaptation strategy of the state: overview
9 priority actions

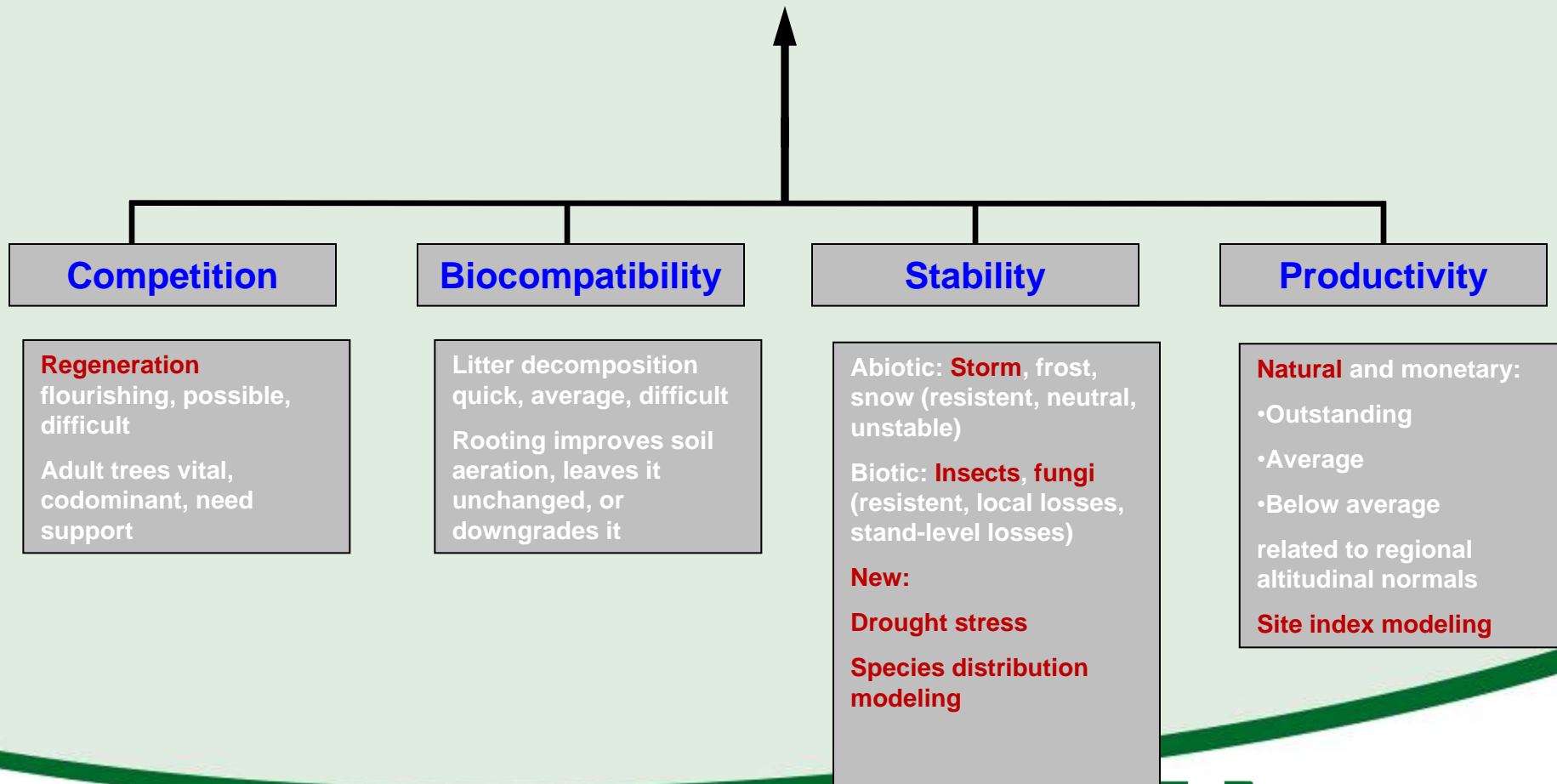| Group of actions |
| --- |
| Maintaining vital, resistant and adaptive forests |
| Maintaining economical forest utilization |
| Conserving habitat functions of forests |

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Adaptation strategy of the state: overview
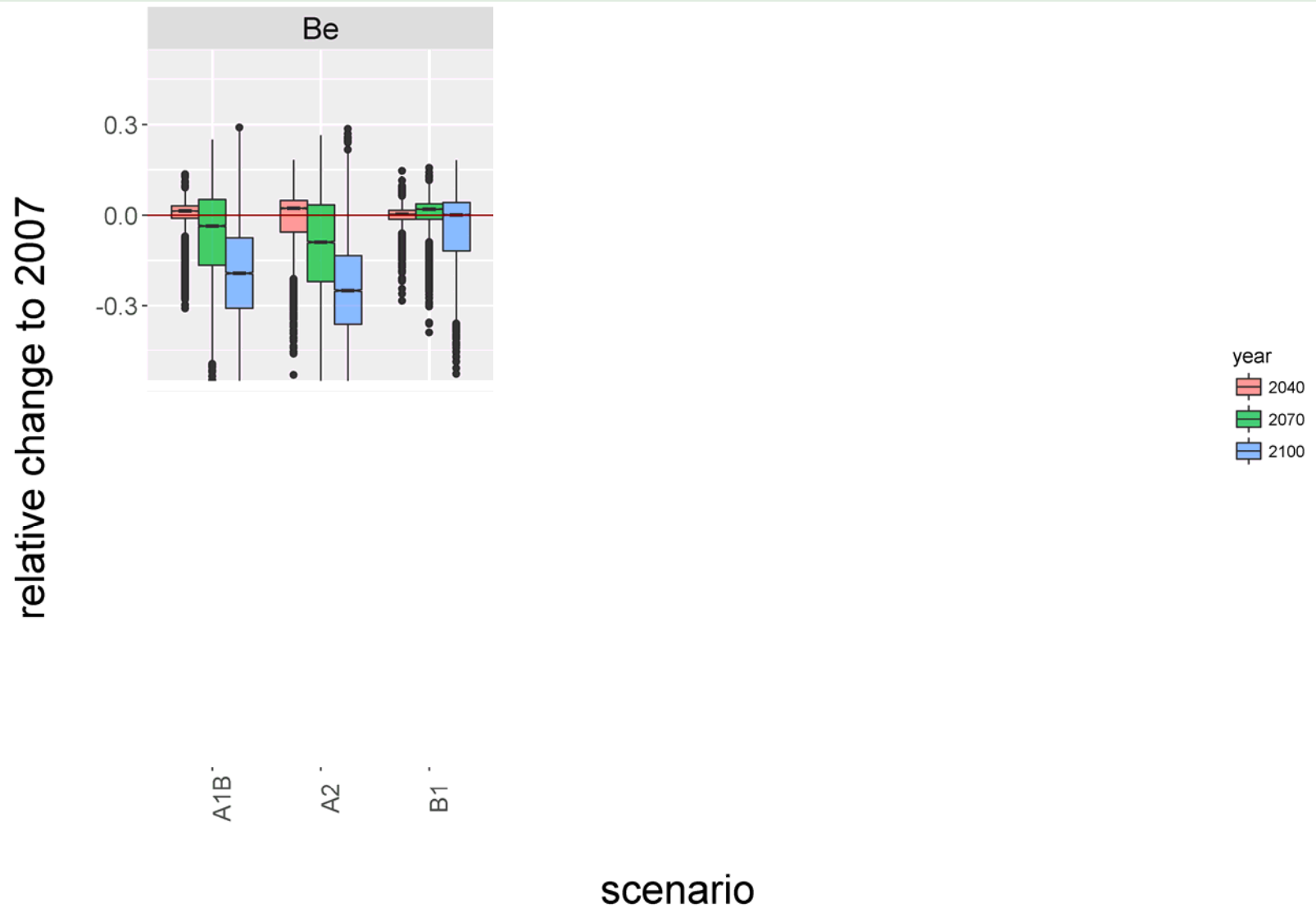## *9 priority actions*

Group of actions	Individual action
Maintaining vital, resistant and adaptive forests	R&D for climate sensitive **tree species suitability modeling**
	Development of a counseling service for forest owners
	Monitoring of forest pathogens
	Maintenance of soil fertility and facilitation of rooting
Maintaining economical forest utilization	Development of a comprehensive decision support system
	Silvicultural measures to reduce climate change caused mortality risiks
	Enhanced utizilation of timber from broadleaved trees
Conserving habitat functions of forests	Conservation and re-establishment of migration and range shifts (corridors, habitat networks)
	Supporting measures to **stabilize habitats especially endangered** by climate change

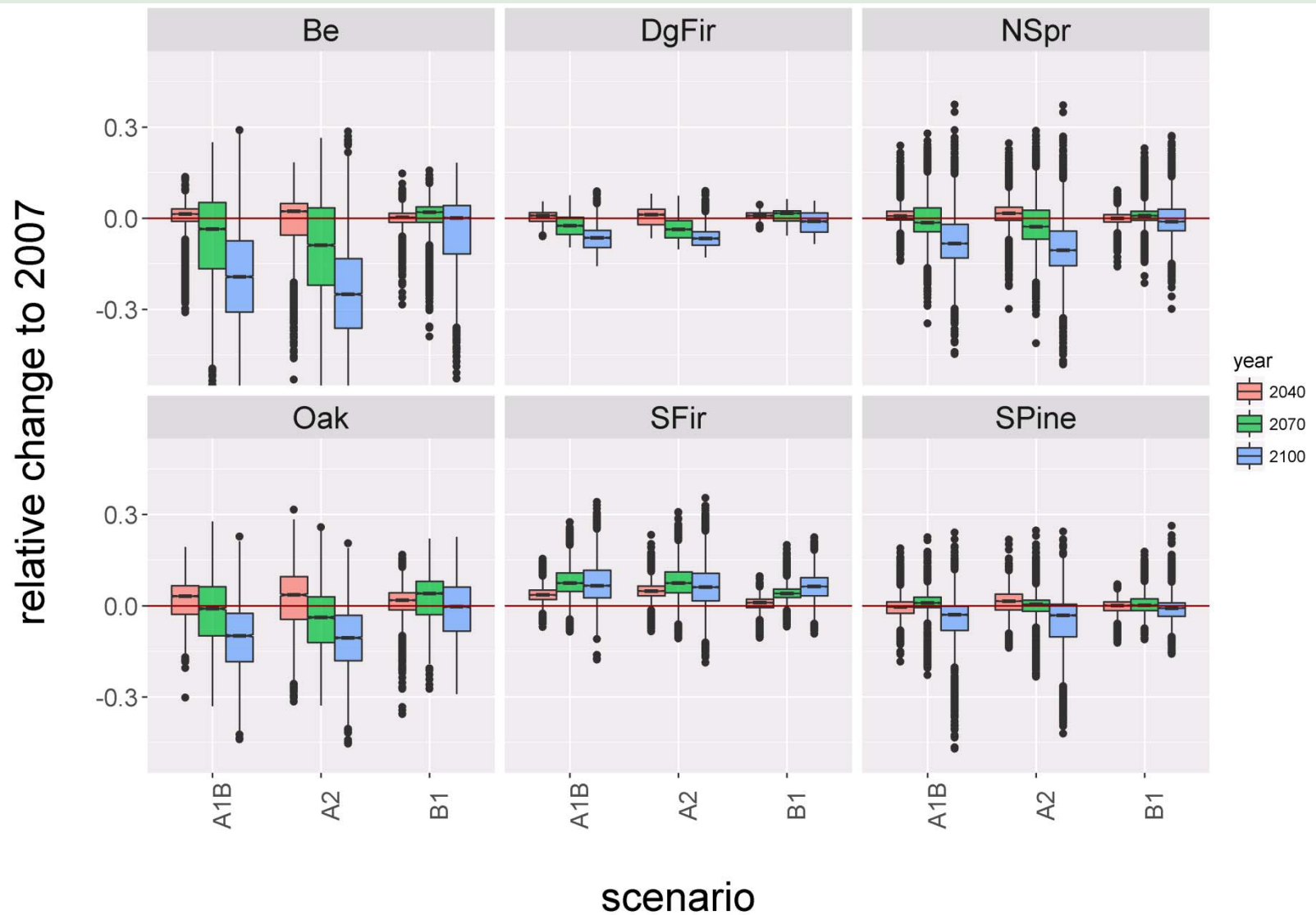# R&D for climate sensitive **tree species suitability** modeling
additional climate sensitive elements

Competition	Biocompatibility	Stability	Productivity
Regeneration flourishing, possible, difficult	**Litter decomposition** quick, average, difficult	**Abiotic: Storm**, frost, snow (resistent, neutral, unstable)	**Natural** and monetary:
Adult trees vital, codominant, need support	**Rooting improves soil aeration, leaves it unchanged, or downgrades it**	**Biotic: Insects, fungi** (resistent, local losses, stand-level losses)	•Outstanding
		New:	•Average
		Drought stress	•Below average
		Species distribution modeling	related to regional altitudinal normals
			Site index modeling

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Potential productivity changes

Nothdurft et al. (2013) spatio-temporal prediction of site-index …ForEcoMan

Potential productivity changes

Nothdurft et al. (2013) spatio-temporal prediction of site-index …ForEcoMan

base: Nothdurft 2013 Spatio-temporal prediction of site index...ForEcolMan
applied to real NFI2 trees with their respective real age

Potential productivity changes

– Friendly scenarios do exist, but they are unrealistic
– European beech may suffer dramatic losses
– Silver Fir appears quite robust
– Regional and altitudinal differences…

Silvicultural measures to reduce climate change-caused mortality risks

Among others: earlier harvesting.

reduce target dimensions by 10 - 20%, especially in high-risk conifers.

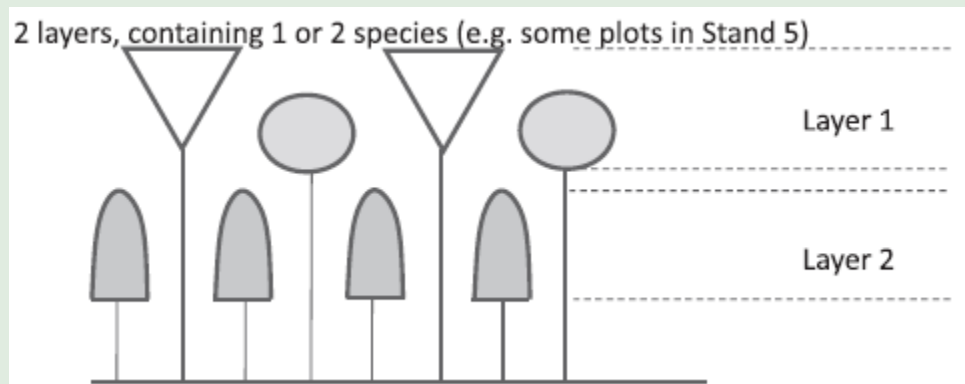*reason: most of climate change-caused mortality increases with age (syn. diameter, height)*
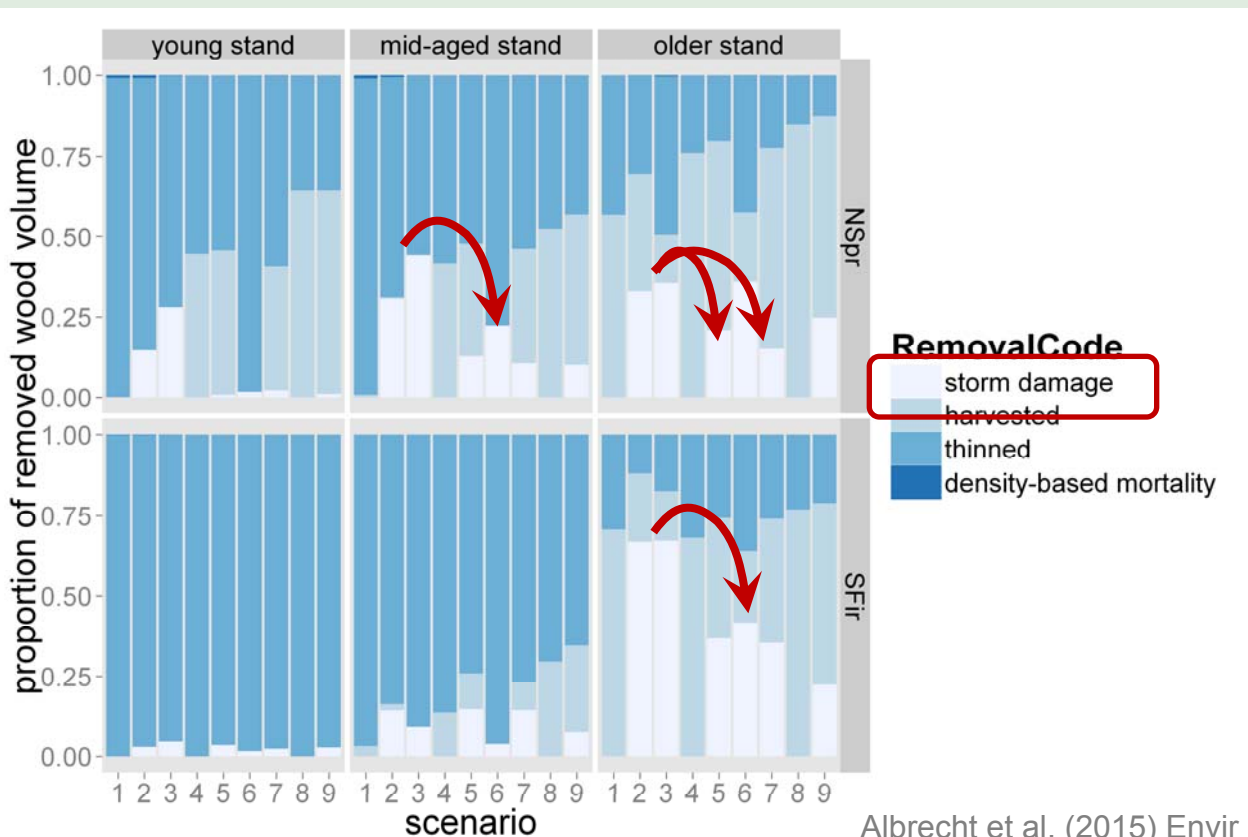
Example storm damage: adapting silviculture may help reducing storm damage up to 50 %

Albrecht et al. (2015) Envir Softw Mod

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Increase species diversity

Species diversity effects
- Risk diversification (portfolio)
- Reinsurance against (unknown?) mortality
- Many cases: increased increment

2 layers, containing 1 or 2 species (e.g. some plots in Stand 5)

Layer 1

Layer 2

Forrester and Albrecht (2014) Light absorption… ForEcolMan
Forrester et al. (2013) Complementarity… ForEcolMan
Forrester et al. (2014) Using a stand-level model…ForestEcosystems

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Conserving habitats especially endangered by climate change

Wet sites (i.e. peat bogs, marshes)
- No drainage
- Restoration

Montane and subalpine sites
- Elevational limit
- Altitudinal migration impossible
- Indicator species: montane bird species
(capercallie *Tetrao urogallus*, hazel grouse *Tetrastes bonasia*, pygmy owl *Glaucidium passerinum,,* three-towed woodpecker *Picoides tridactylus*

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Species conservation: climate change endangers!
(capercaillie, 2010 → 2050, SRES A1B)

Capercaillie

2010

2050

Without forest adaptation: losses expected
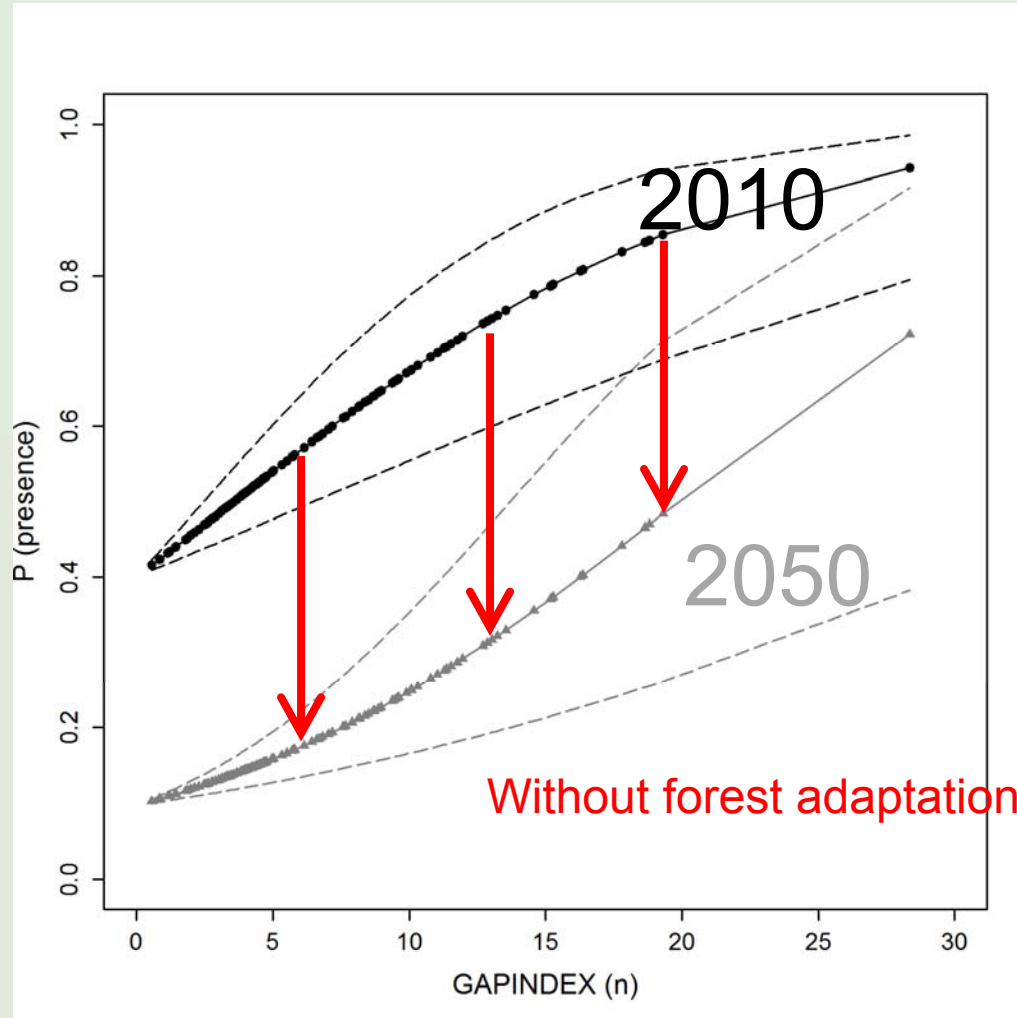
Substantial conservation measures

(capercallie, 2010 → 2050, SRES A1B)

- Increasing blueberry cover and
- Increasing number of gaps…
…may compensate negative impacts of climate change partly (and for a limited time)

2010

2050
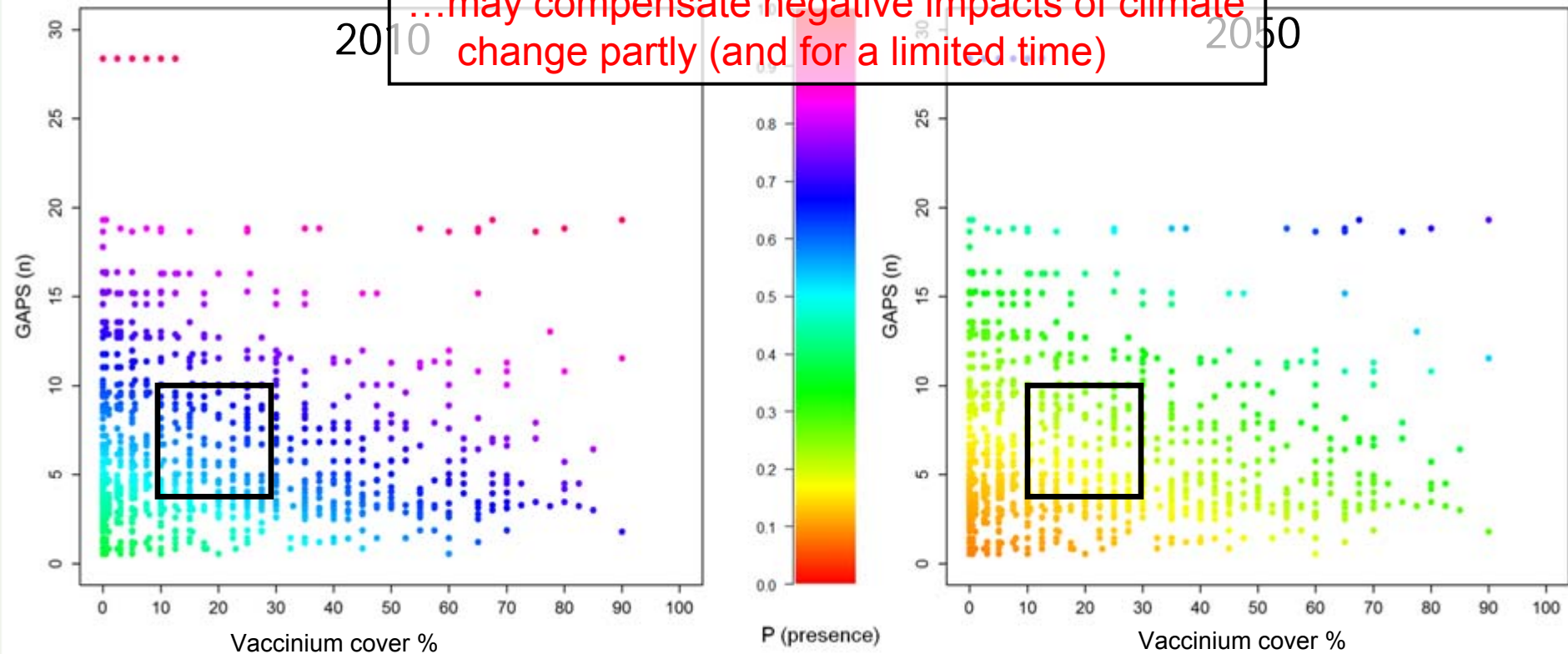
In short

Science to forest management transition goes best by maps

- Multi-criterial tree species suitability maps *(long-term potential; choice of tree species)*
- Vulnerability maps *(short / mid-term; priorities of conversion for existing stands)*

What we can do

… Increase species diversity *(no regret)*
… Increase structural stand diversity *(no regret; certain condidtions only!)*
… Convert vulnerable (conifer) stands to climate adapted species first
… Improve the awareness for the (non-catastrophic) urgence
… Do not use uncertainty as an excuse to refrain from adaptation

Future science and research hotspots

…Extrapolation
…New tree species / provenances
…Competition
…Adaptive capacity (ontogenetically, genetically…)

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Thank you for your attention

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