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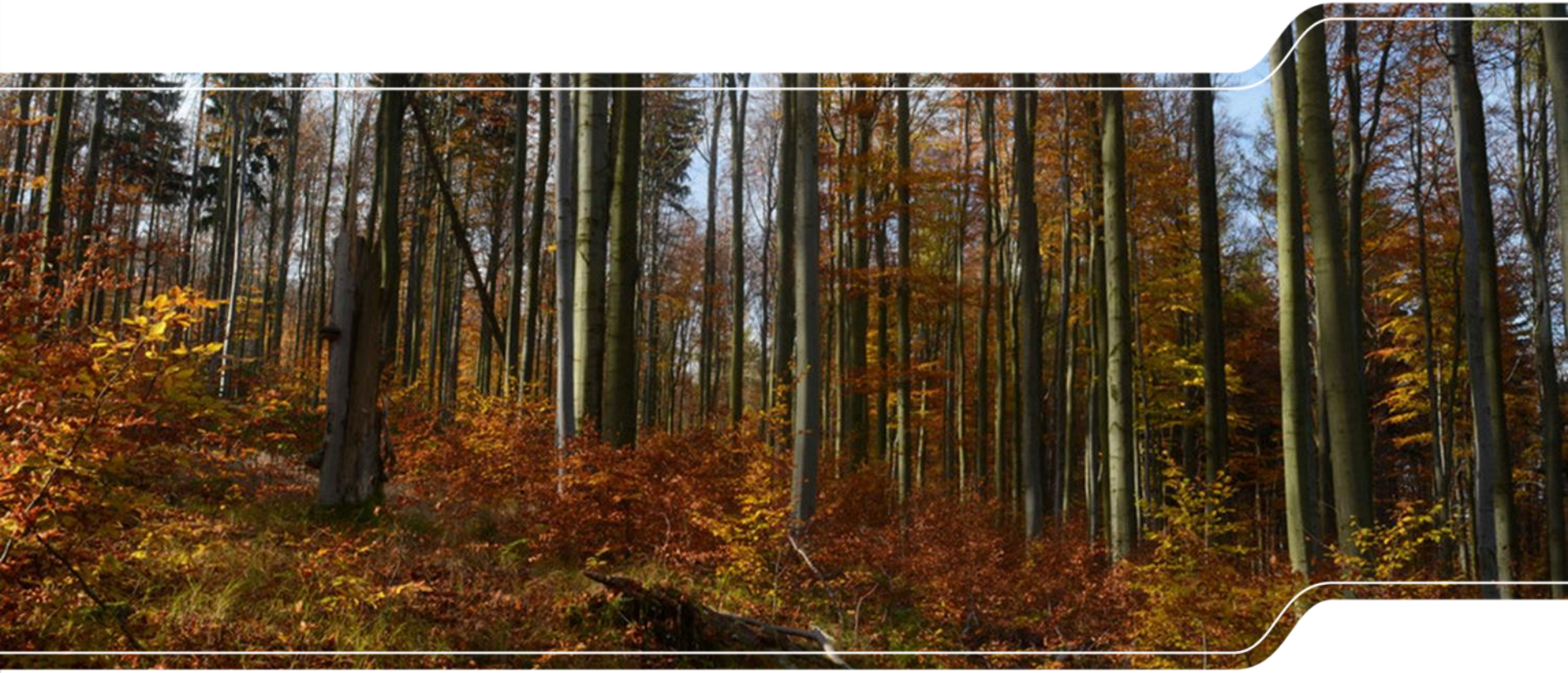
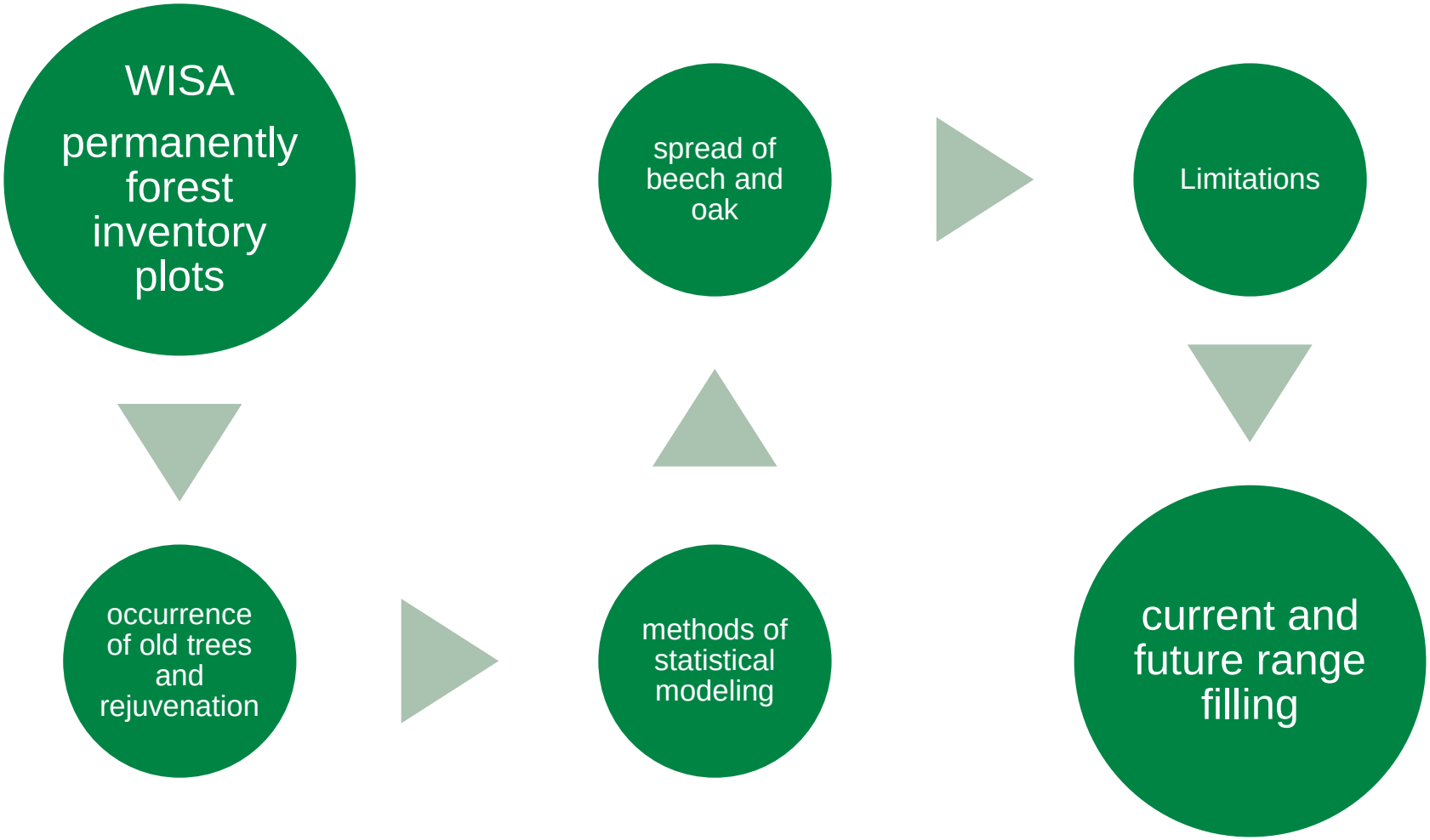
Modelling natural regeneration of beech and oaks

factors influencing the occurrence and density of regeneration

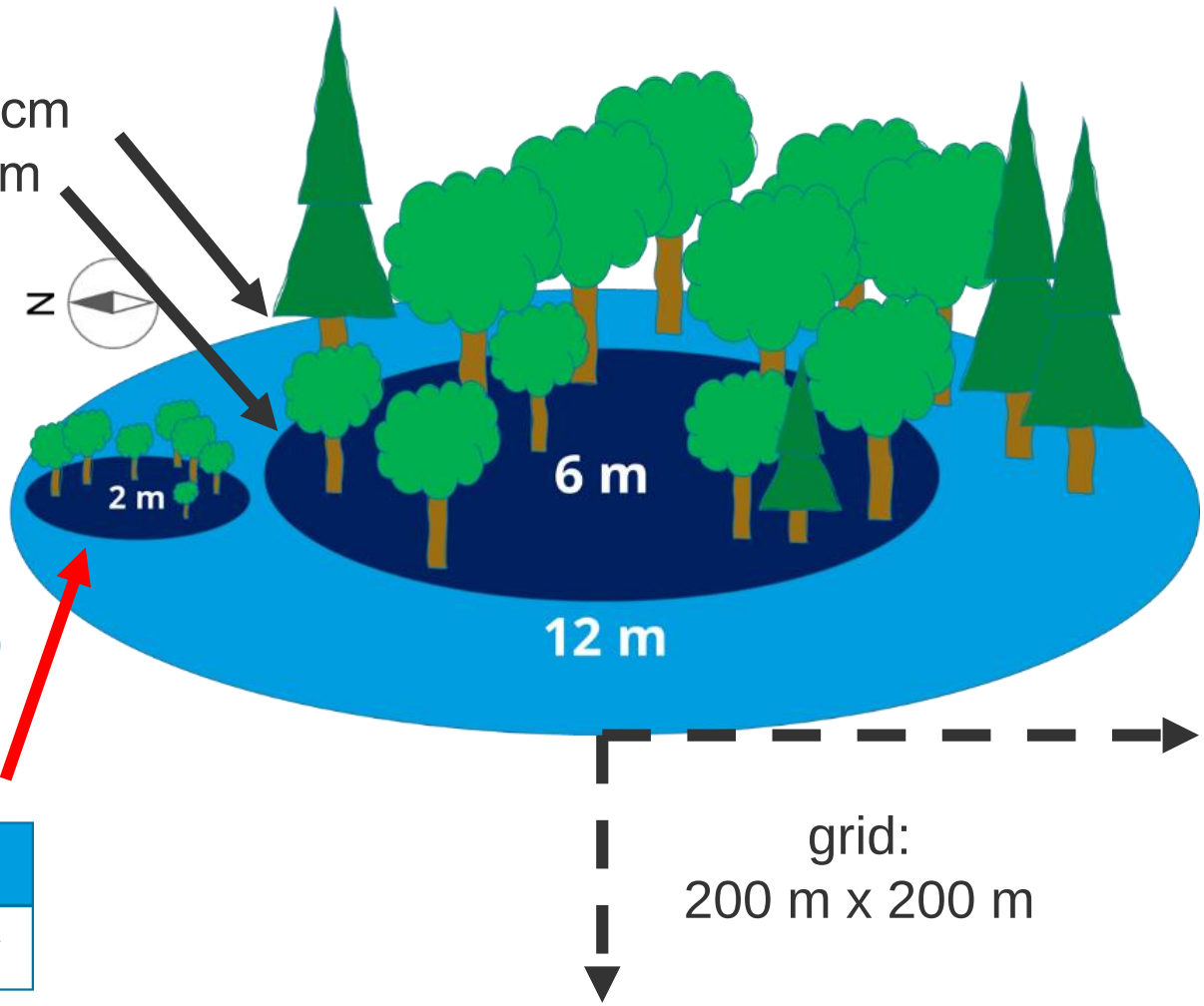


Sachsenforst
Wald braucht Zukunft

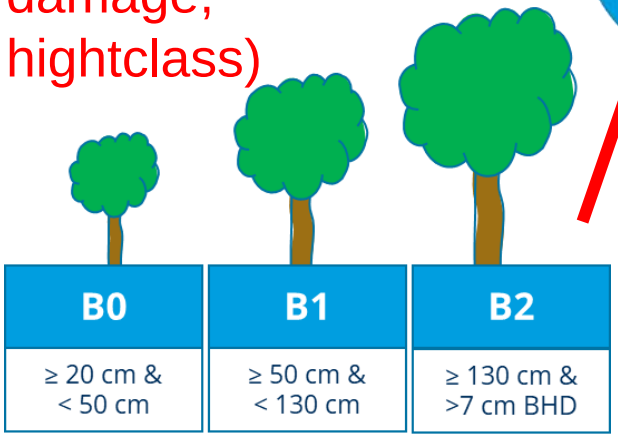
Instead of an outline



WISA – permanently forest inventory



rejuvenation
(count by species,
kind of regenration,
damage,
hightclass)



WISA – permanently forest inventory

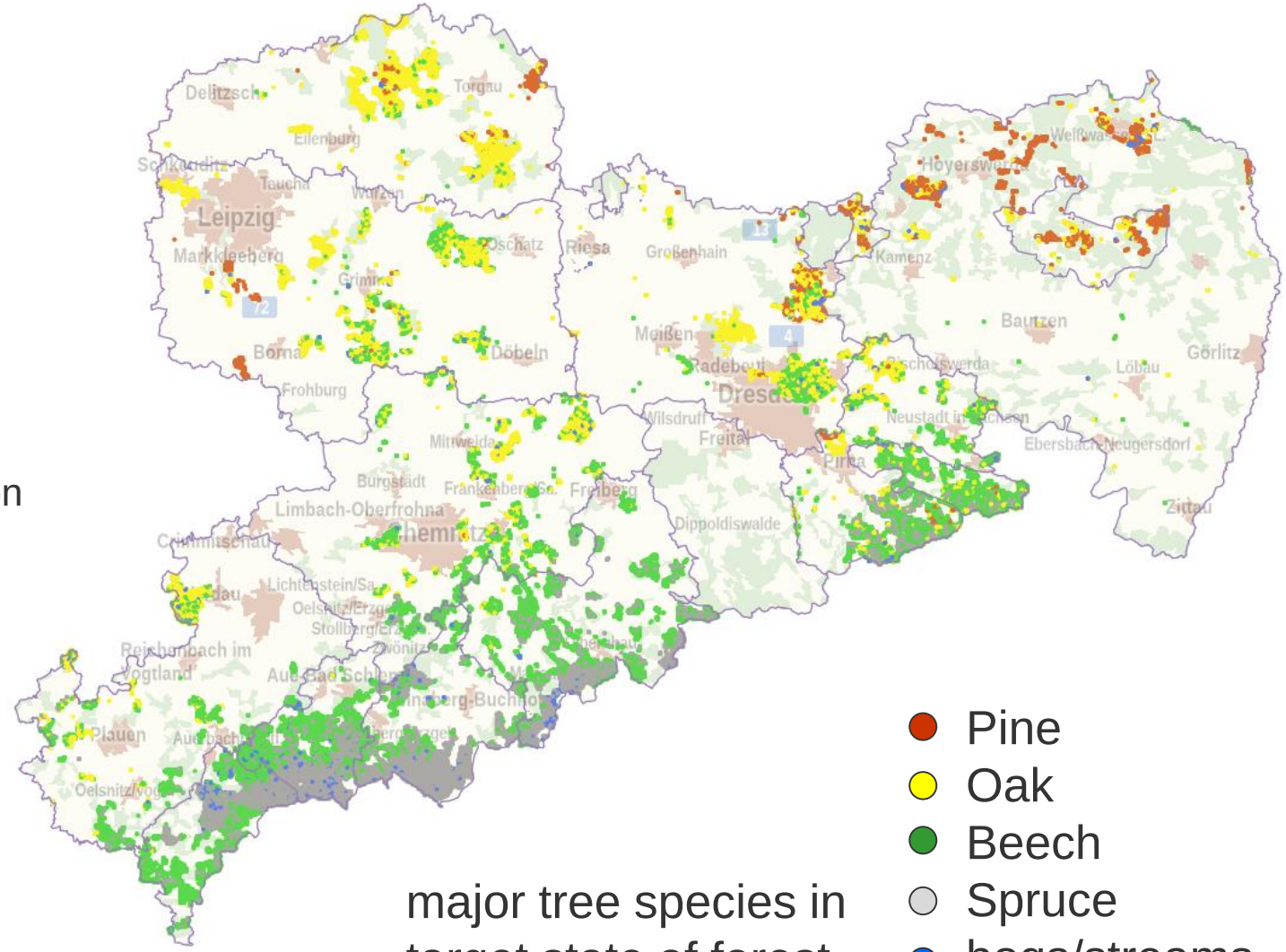
41.711 plots

36.211 plots
with regenration

425.388 small
trees counted

94% from
natural regeneration

6.010 plots
with planted trees
(24.040 ha)



occurrence of old trees and rejuvenation

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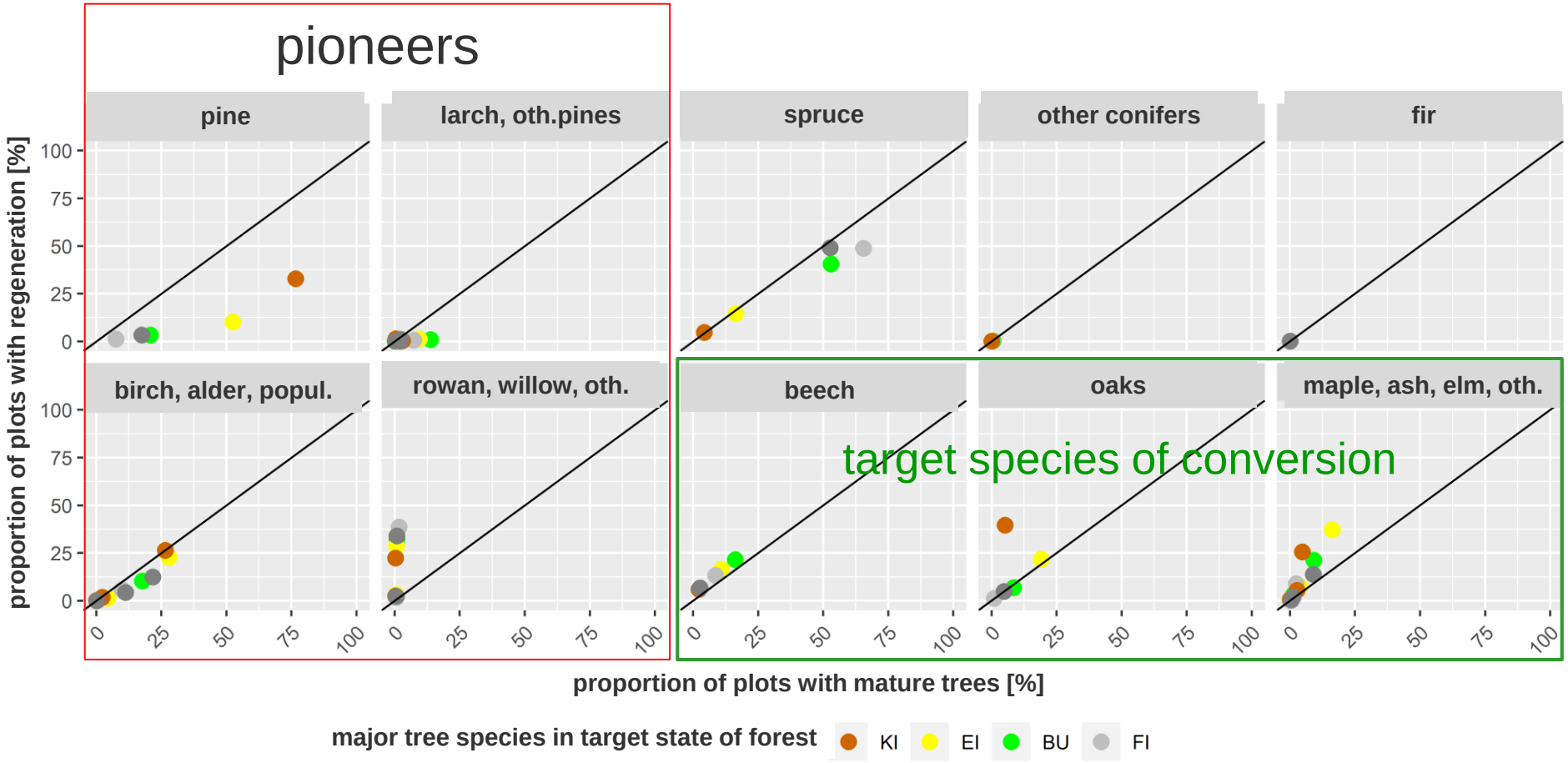

methods of statistical monitoring

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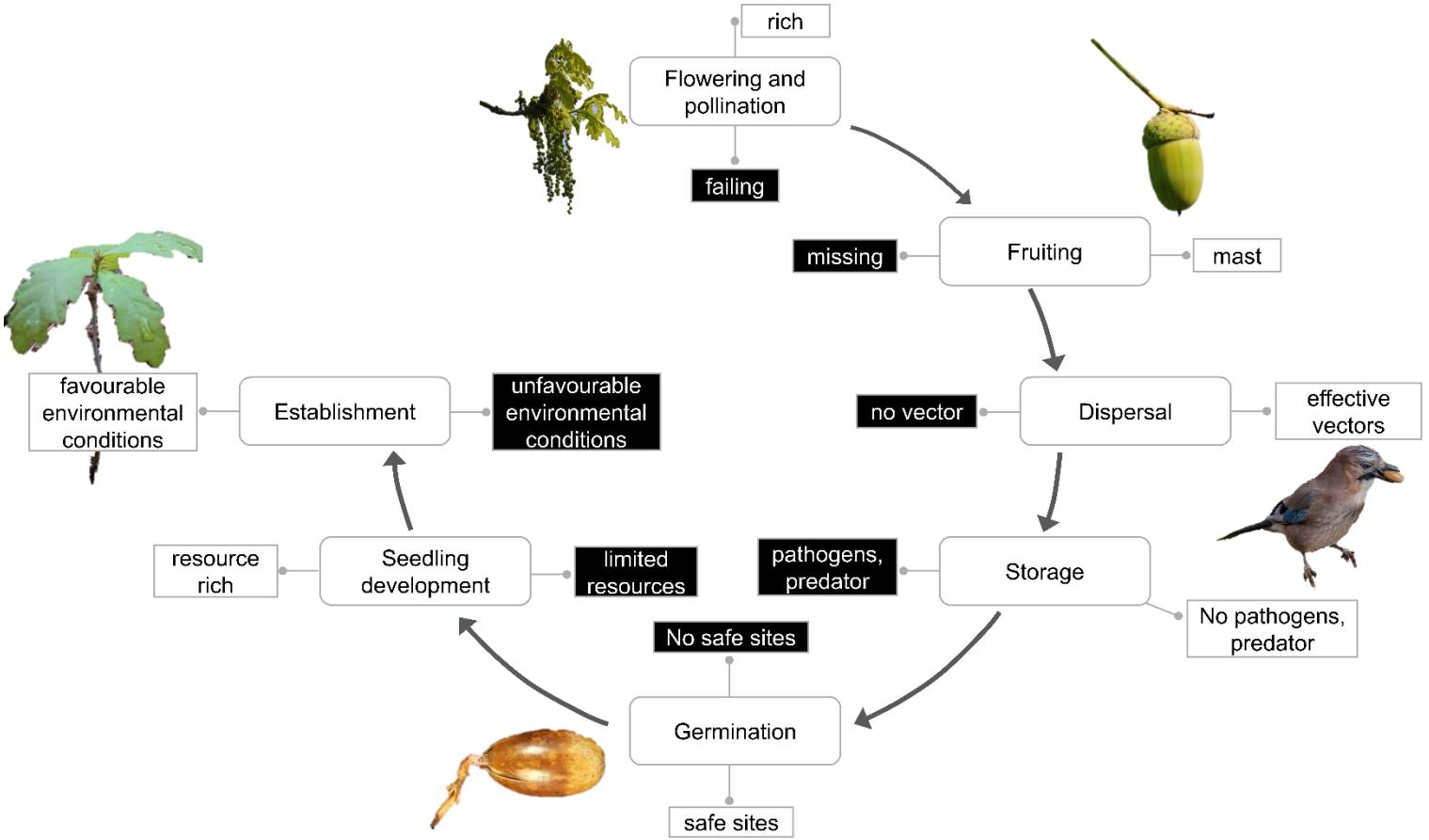
research project with the cair of silviculture at the Technical University Dresden:

Ecological concept following Clark et al. (2007) with 3 grades of limitations



methods of statistical monitoring

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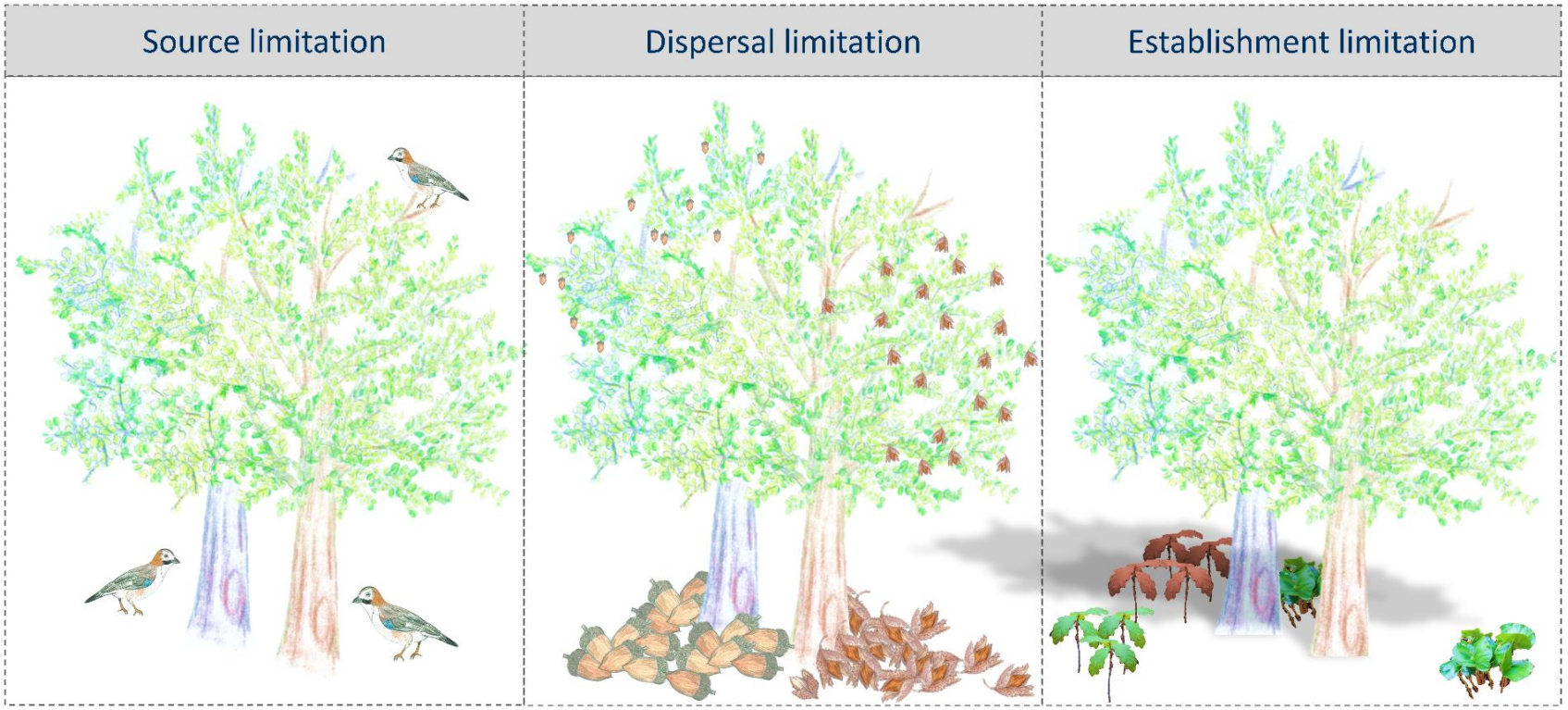

methods of statistical monitoring

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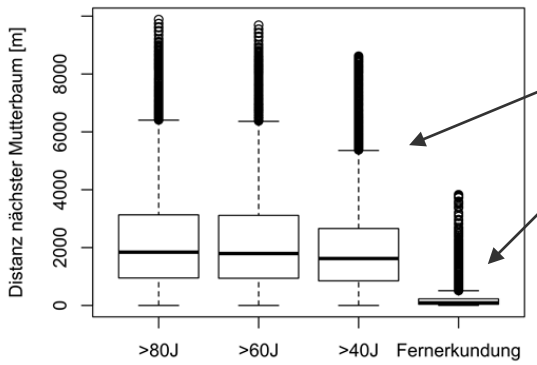
Source limitation	Dispersal limitation	Establishment limitation
distance to mature beech stands/trees	fruting intensity fructivore	site and stand condition



standwise inventory
and
remote sensing

soil maps,
regionalization of soil inventory,
WISA – stand informations
(dimension of trees, density)

methods of statistical monitoring

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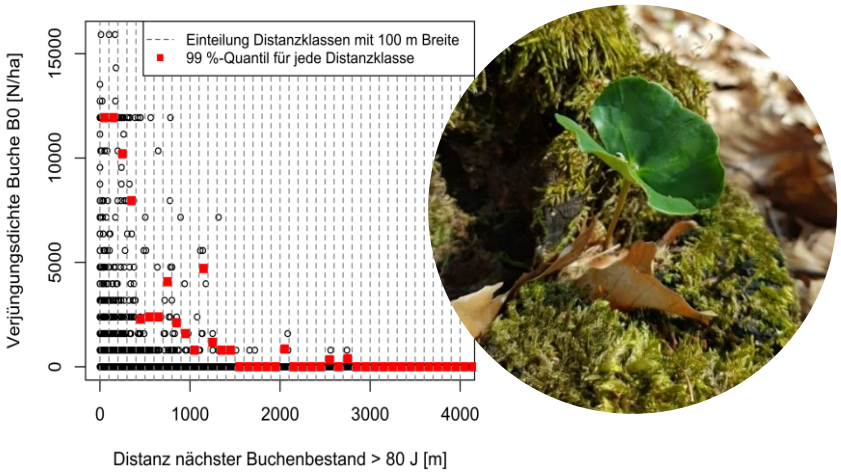
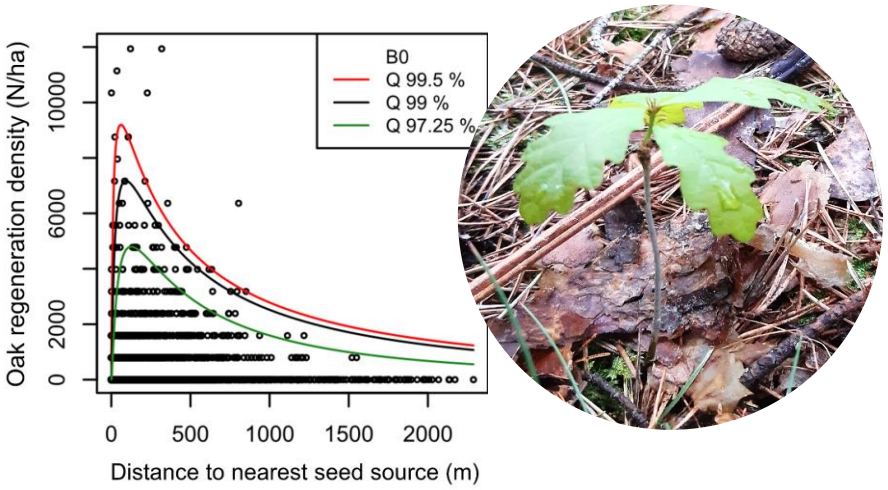
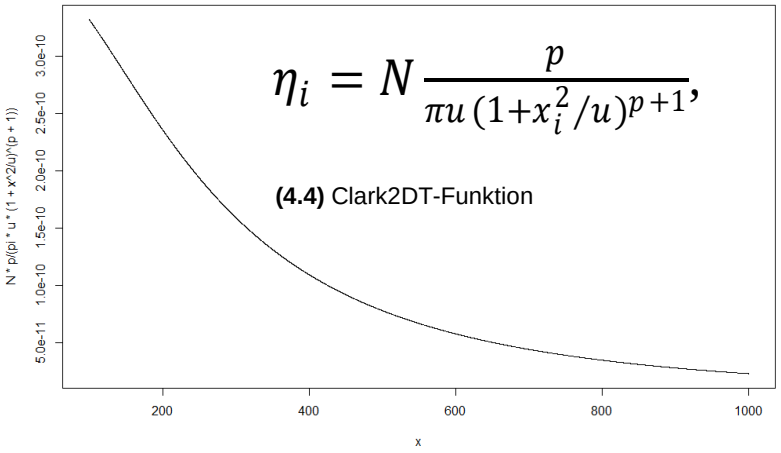
Quantile regression for distance ~ density relationship with various models tested

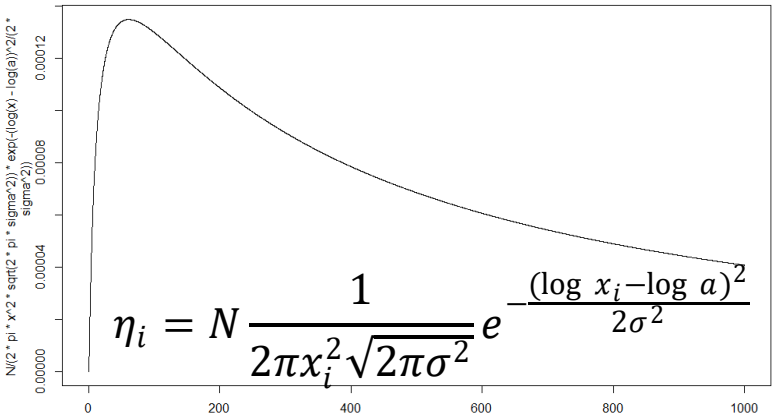






$$\eta_i = N \frac{p}{\pi u \,(1+x_i^2/u)^{p+1}},$$

(4.4) Clark2DT-Funktion



$$\eta_i = N \frac{1}{2\pi x_i^2 \sqrt{2\pi\sigma^2}} e^{-\frac{(\log x_i - \log a)^2}{2\sigma^2}}$$

(2.2) log-Normal Modell (Stoyan & Wagner 2001)

methods of statistical monitoring

Zero-altered negative binomial models (ZANB) for modelling influencing factors between occurrence/density ~ site and stand conditions

$$OakDensity_i \sim ZANB(\mu_i, \pi_i, k)$$

Occurrence (0,1) within an Bernoulli-model

$$logit(\pi_i) = \gamma_0 + z_{1i}\gamma_1 + \ldots + z_{ni}\gamma_n + v_i$$

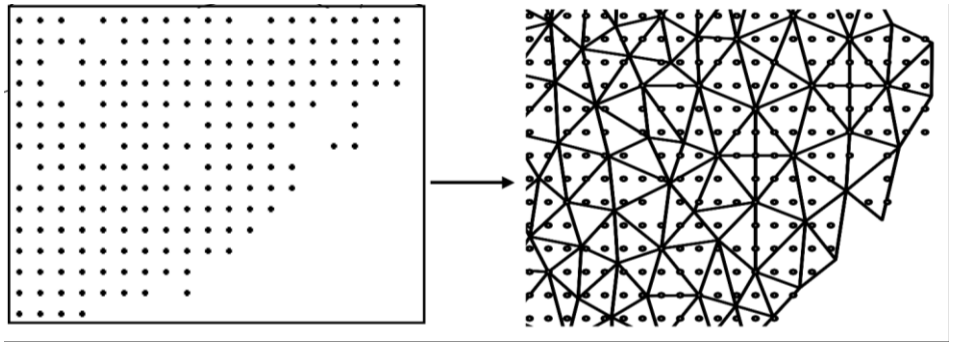
$$v = (v_i)_{i=1,\ldots,n} \sim N(0, \sum_v)$$

and density within an zero-truncated negativ binomial model

$$\log(\mu_i) = \beta_0 + x_{1i}\beta_1 + \ldots x_{mi}\beta_m + u_i$$

$$u = (u_i)_{i=1,\ldots,n} \sim N(0, \sum_u)$$

u and v for spatial random effects via triangular nets of plots



potential spread

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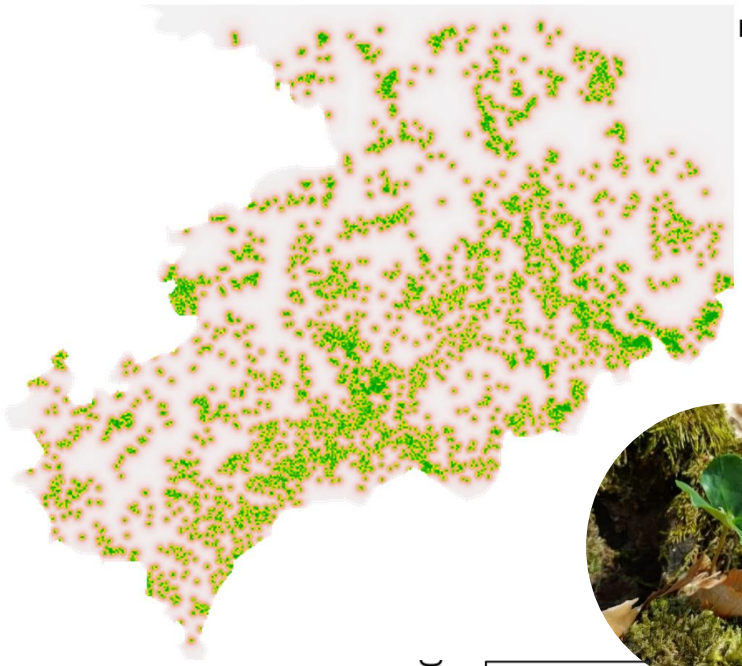
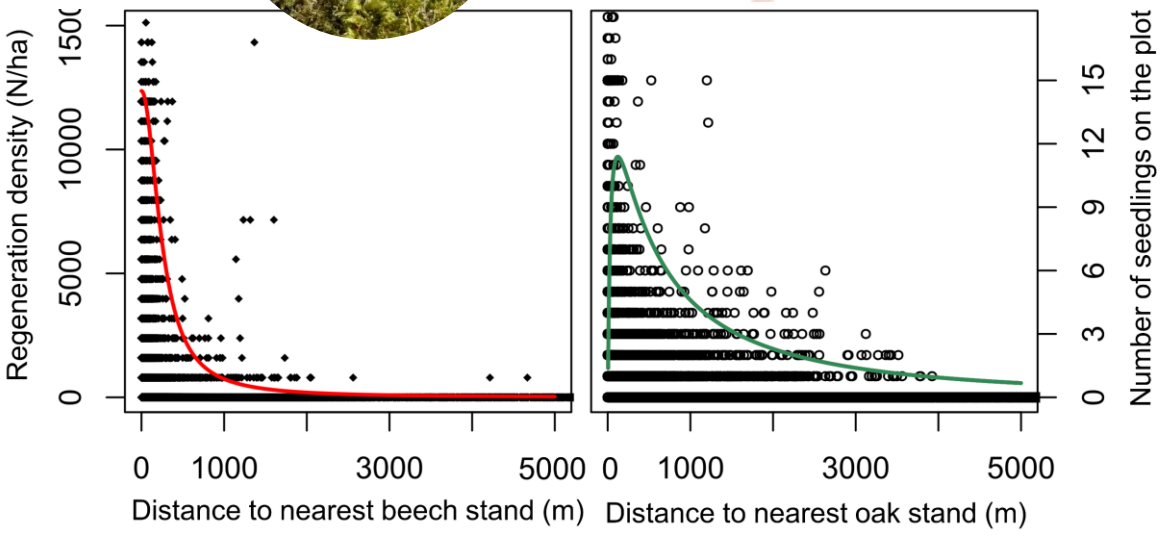


up to 500-700 m (2.000 to 5.000 ha^{-1})



up to 1.500 - 1.000 m (2.000 to 5.000 ha^{-1})

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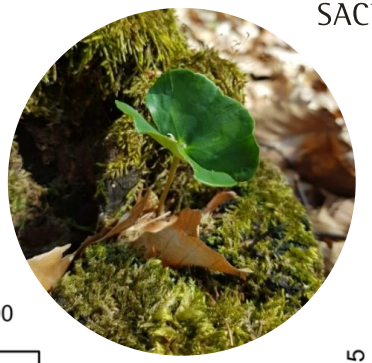
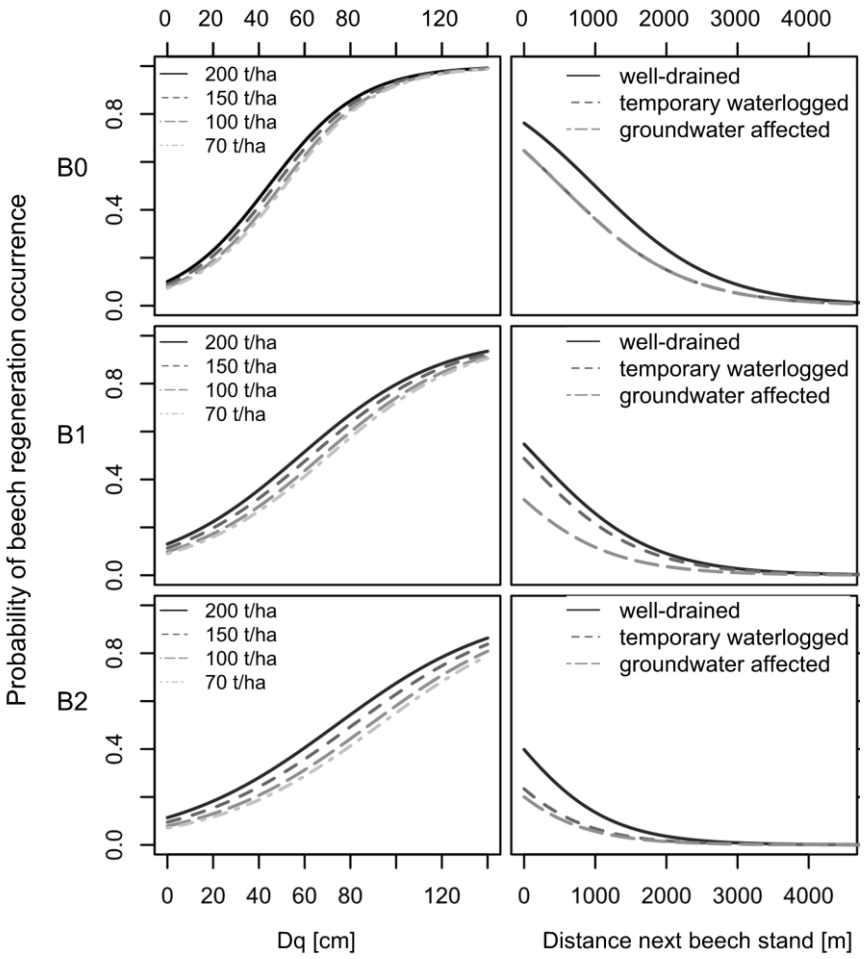
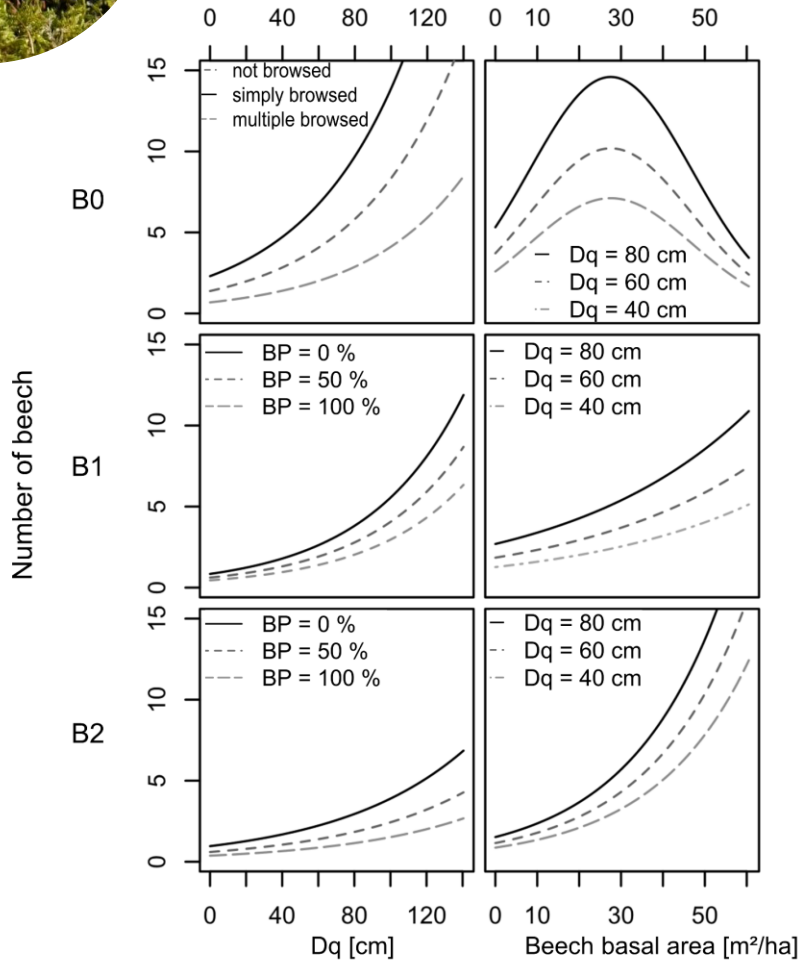
limitations



occurence ~
tree dimension, humus thickness, distance, soil water regime

density ~
browsing, tree dimension, basal area





limitations

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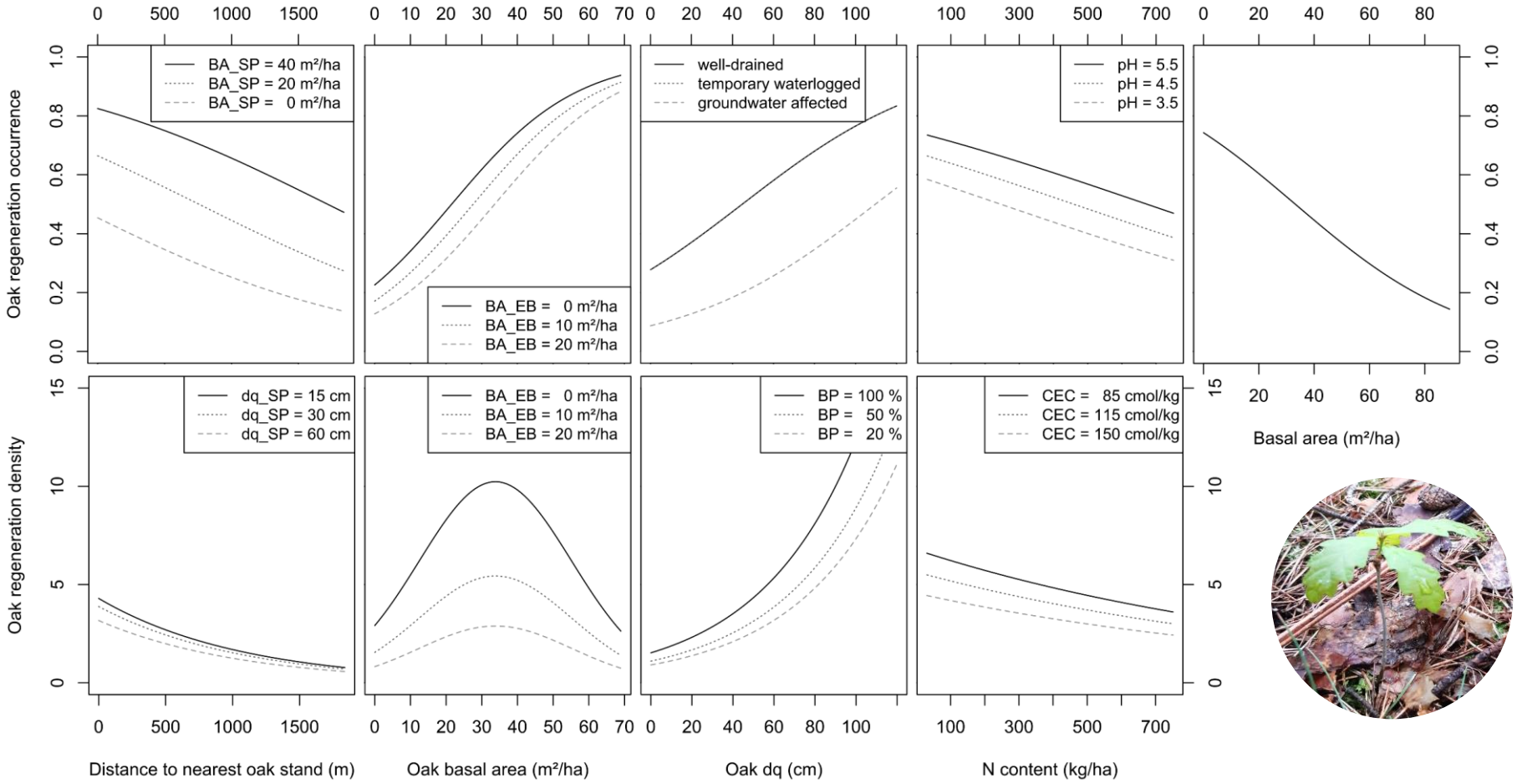
occurence ~ distance, basal area, tree dimension, soil water regime, soil N-content and pH



density ~ distance, tree dimension, basal area, browsing, soil N-content and CEC

current and future range filling

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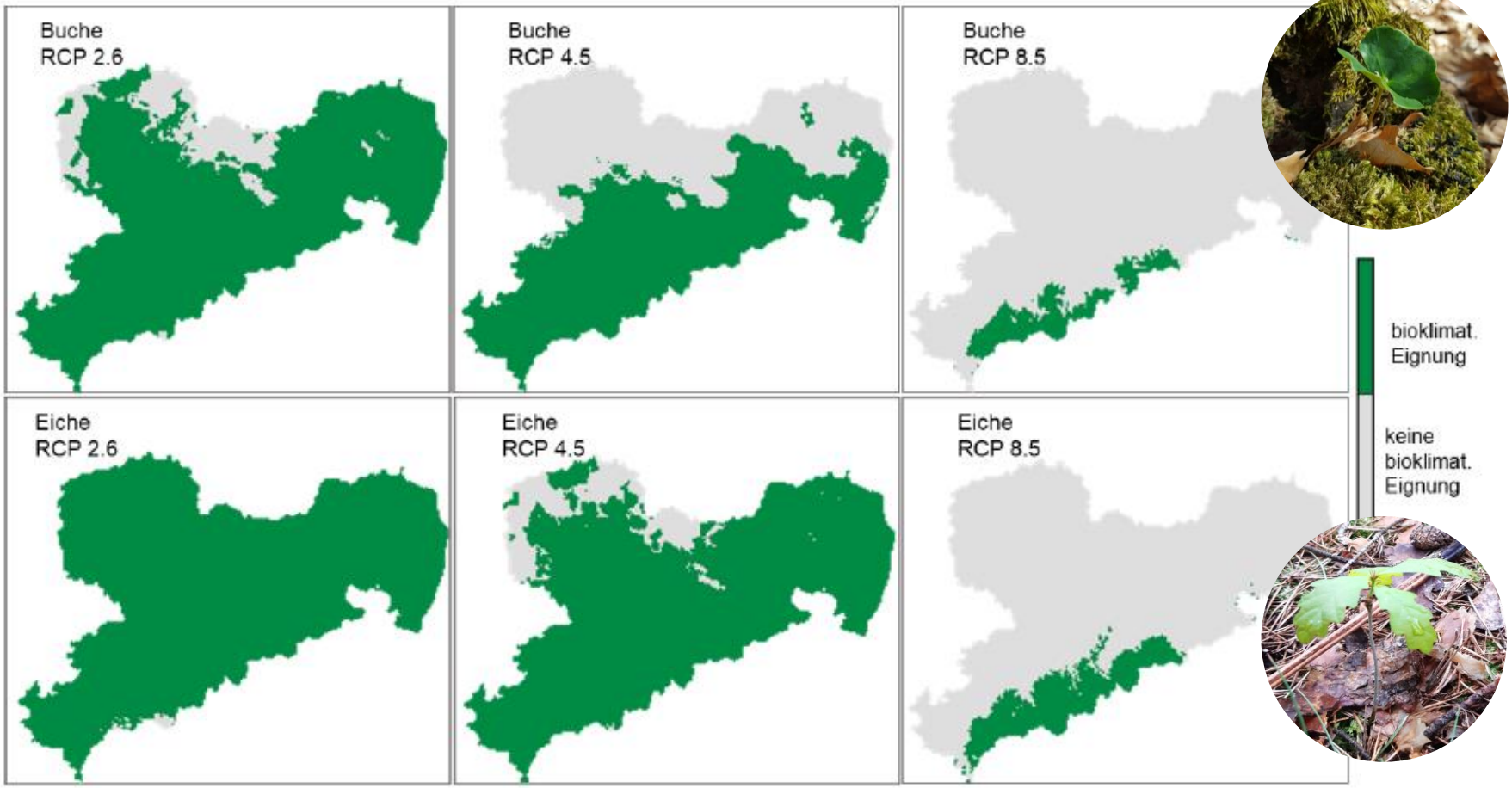

„climate envelop“ for beech and oak (Kölling 2007/Ammer et al. 2008)
(actually we refresh our own maps based on BERN-model)

current and future range filling

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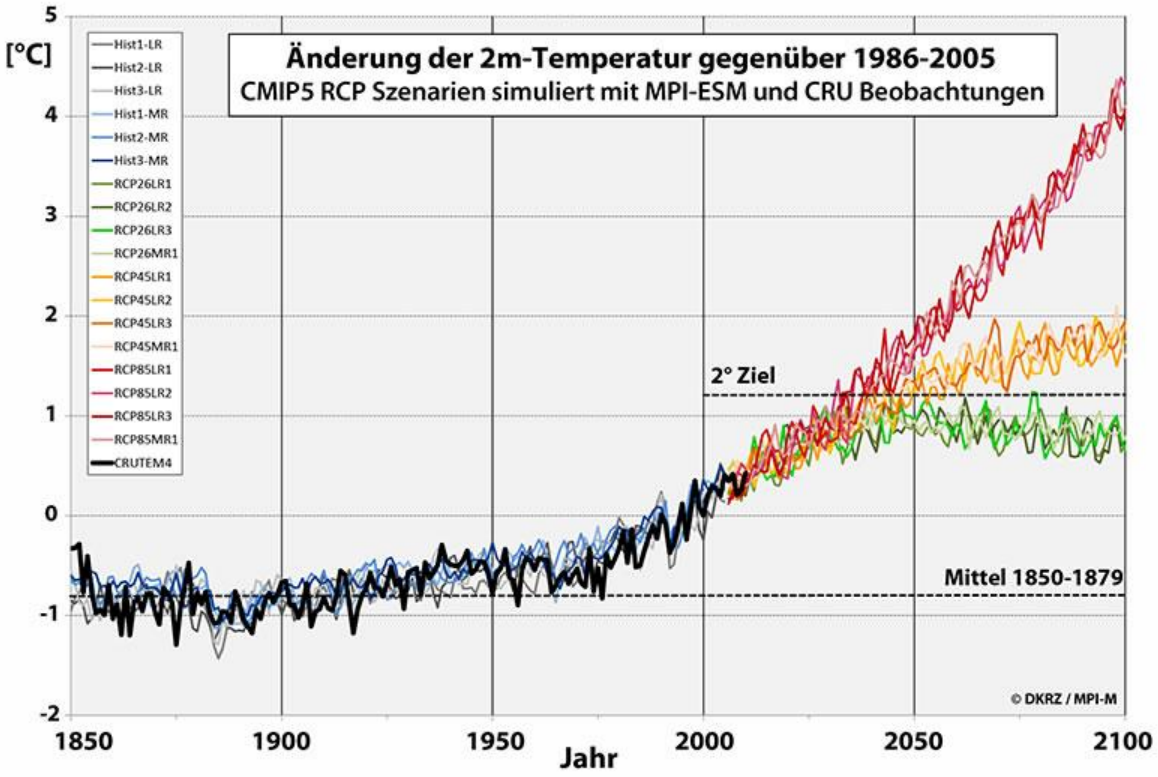
What is a probable scenario?

april 2021 – 420 ppm CO_2 in atmosphere – RCP2.6 exceeded

RCP4.5 with fulfillment of climate targets possible, but this is unlikely

RCP8.5 catastrophe path, unlikely because existing societies and economies have disintegrated



RCP-Szenarien für den 5. IPCC-Sachstandsbericht				
Bezeichnung	RCP8.5	RCP6.0	RCP4.5	RCP2.6
Treibhausgaskonzentration im Jahre 2100	1370 ppm CO_2-äq	850 ppm CO_2-äq	650 ppm CO_2-äq	400 ppm CO_2-äq
Strahlungsantrieb 1850-2100	8,5 W/m²	6,0 W/m²	4,5 W/m²	2,6 W/m²
Einstufung				

current and future range filling

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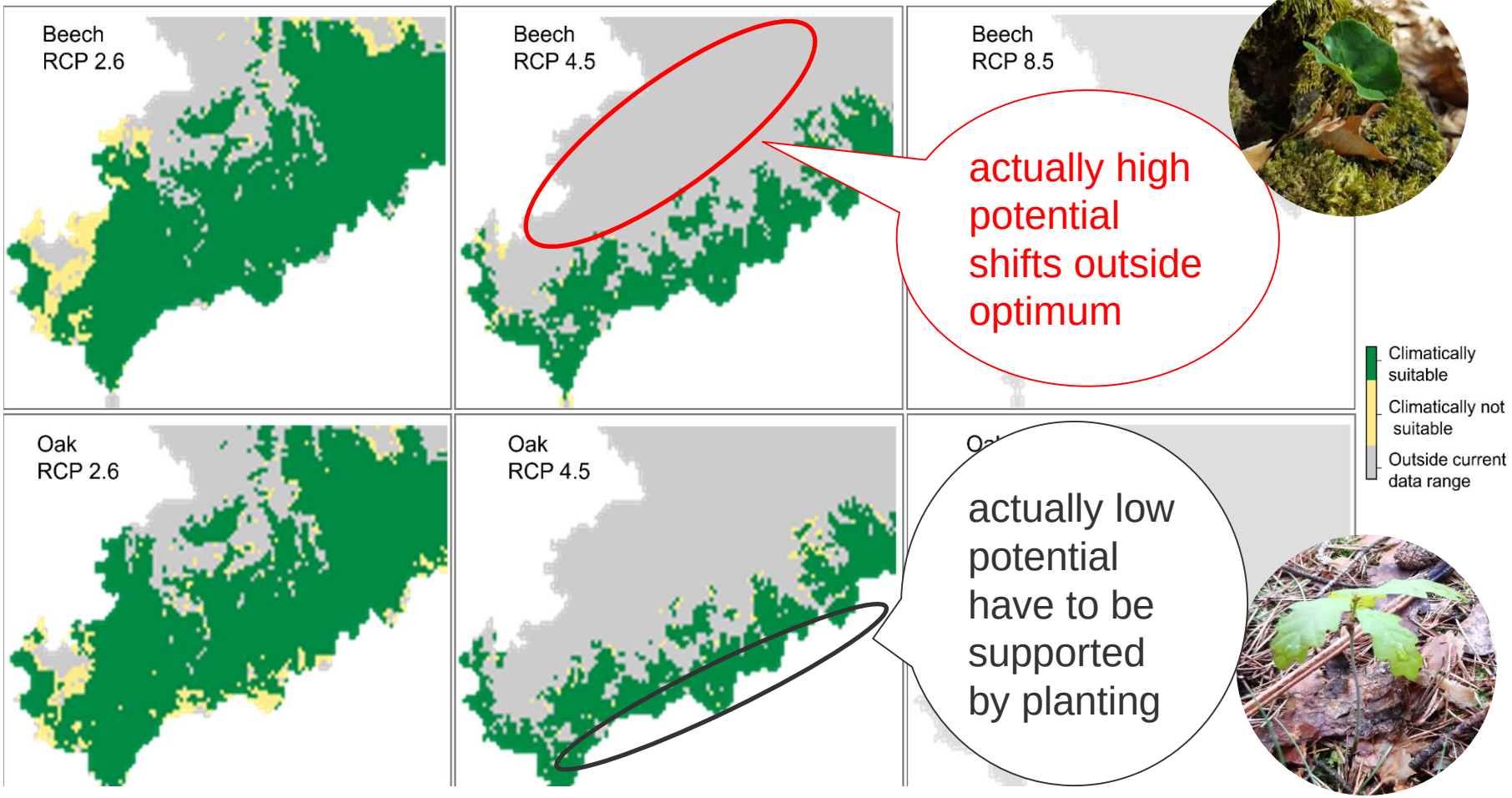
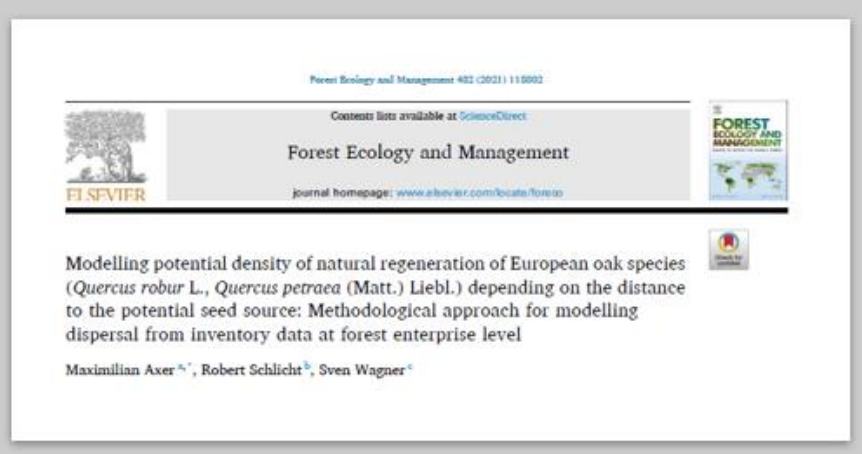


Figure S 4.2. Spatial prediction for the bioclimatic suitability of beech regeneration (above) and oak regeneration (down) of size class *B0* for a part of the study area. The prediction is based on mean annual temperature and mean annual precipitation for the reference period (2091–2100) for the RCP scenario 2.6, the RCP 4.5 scenario and the RCP 8.5 scenario.

Literature


D 20867 E
ALLGEMEINE
FORST UND JAGDZEITUNG
Methodische Ansätze zur forstbetriebsweisen Modellierung der Fernausbreitung der Buche aus Inventurdaten: Potenzielle Verjüngungsdichte von Buche in Abhängigkeit der Distanz zum Buchenaltbestand


Forest Ecology and Management
ELSEVIER
Modelling potential density of natural regeneration of European oak species (Quercus robur L., Quercus petraea (Matt.) Liebl.) depending on the distance to the potential seed source: Methodological approach for modelling dispersal from inventory data at forest enterprise level
Maximilian Axer, Robert Schlicht, Sven Wagner


sustainability
MDPI
Article
The Potential for Future Shifts in Tree Species Distribution Provided by Dispersal and Ecological Niches: A Comparison between Beech and Oak in Europe
Maximilian Axer, Robert Schlicht, Rico Kronenberg and Sven Wagner


European Journal of Forest Research
ORIGINAL PAPER
Modelling natural regeneration of European beech in Saxony, Germany: identifying factors influencing the occurrence and density of regeneration
Maximilian Axer · Sven Martens · Robert Schlicht · Sven Wagner