

Integrating effects of species mixture into individual-tree growth models based on national forest inventory data



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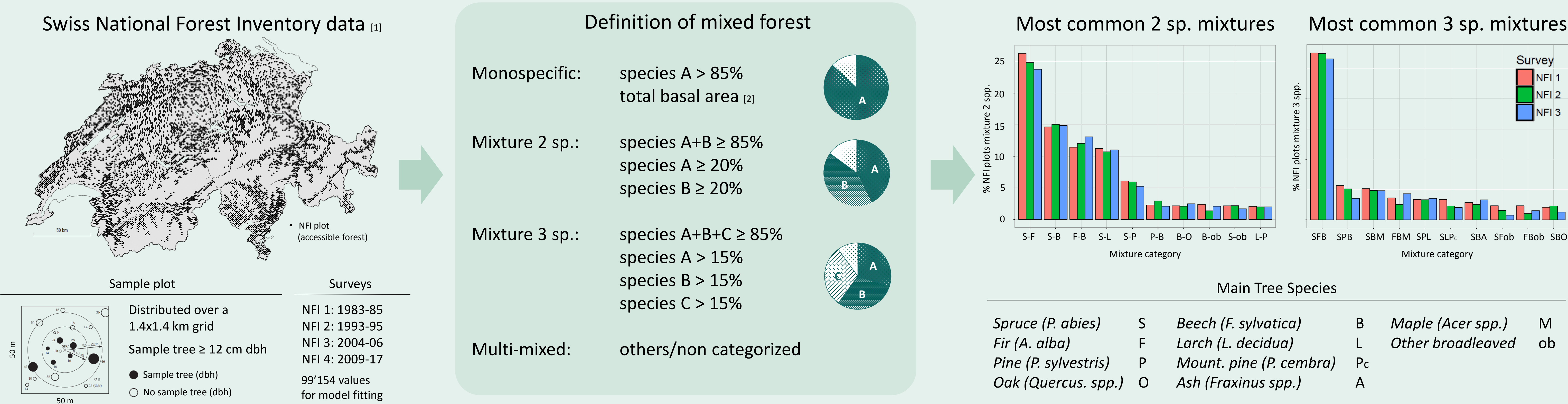
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The Project “Swiss SpeMixMod”

- Investigate and quantify the effects of species mixtures on tree growth along Switzerland’s environmental gradients
- Implementation of growth functions in scenario models for better predicting forest development in response to changes in climate and species composition

Descriptive analysis of species mixtures in Swiss forests using NFI data



Statistical modelling including the effect of species mixture

- Species-specific nonlinear mixed-effects models for individual basal area increment (BAI) derived from NFI data [3]
- Including effect of stand structure, site conditions, management interventions, climate variability and nitrogen deposition [4]

$$BAI = e^{b_1 \times (1 - e^{b_2 \times DBH})} \times e^{b_3} + \epsilon$$

b_1, b_2, b_3 : coefficients to be estimated
 ϵ : standard error

$$b_3 = \beta_0 + \beta_1 V_1 + \dots + \beta_i V_i + b_{plot}$$

β_0 : fixed intercept
 V_{1-i} : predictor variables
 β_{1-i} : model coefficients estimated for the explanatory variables
 b_{plot} : random intercept with NFI plots as grouping factor

Species-specific models for BAI including categorical variable for mixtures

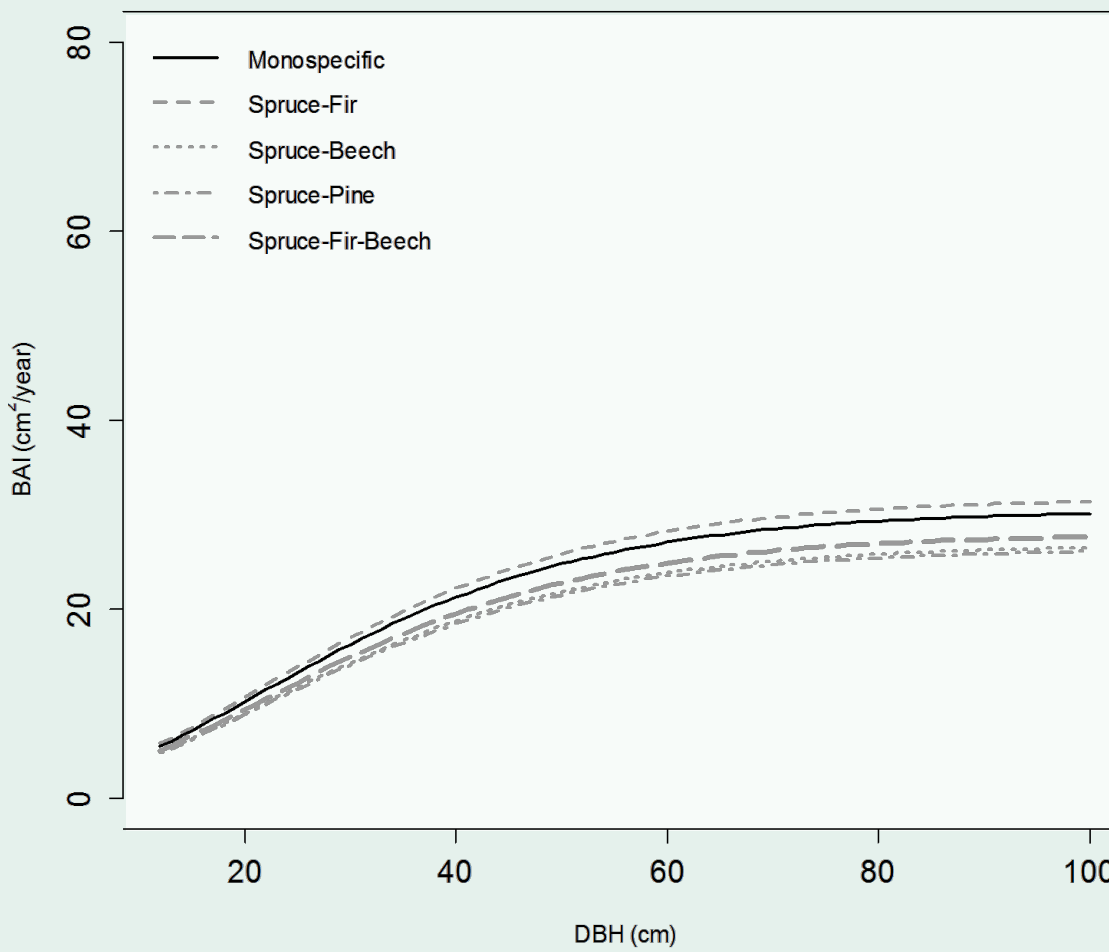
Tree species	Stand, site and climatic variables											Mixture variable			
	BAL	SDI	DDOM	E/U	GRB	SLOPE	NORTH	NDEP	TEMP	DRI	SR	AWC	PH	S-F	S-B
Spruce	***	***	**	n.s.	***	***	***	***	***	***	n.s.	***	***	***	***
Fir	***	***	n.s.	n.s.	n.s.	***	n.s.	***	***	***	n.s.	n.s.	***	***	***
Beech	***	n.s.	***	n.s.	***	***	*	***	***	***	n.s.	***	*	n.s.	n.s.
Larch	***	***	n.s.	**	n.s.	***	n.s.	n.s.	***	***	n.s.	n.s.	n.s.	***	n.s.
Pine	***	n.s.	n.s.	***	n.s.	n.s.	n.s.	***	n.s.	n.s.	n.s.	n.s.	***	n.s.	n.s.

BAL: basal area trees larger than target tree; SDI: stand density index; DDOM: mean 100 largest diameters per ha; E/U: uneven stand structure compared to even structure; GRB: growth boost due to release effect; NORTH: northness; NDEP: nitrogen deposition; TEMP: temperature; DRI: drought index (high-wet conditions); SR: solar radiation; AWC: available soil water holding capacity; PH: soil pH; S-F, S-B, ..., S-F-B: target tree in a plot belonging to one of the different categories of species mixture

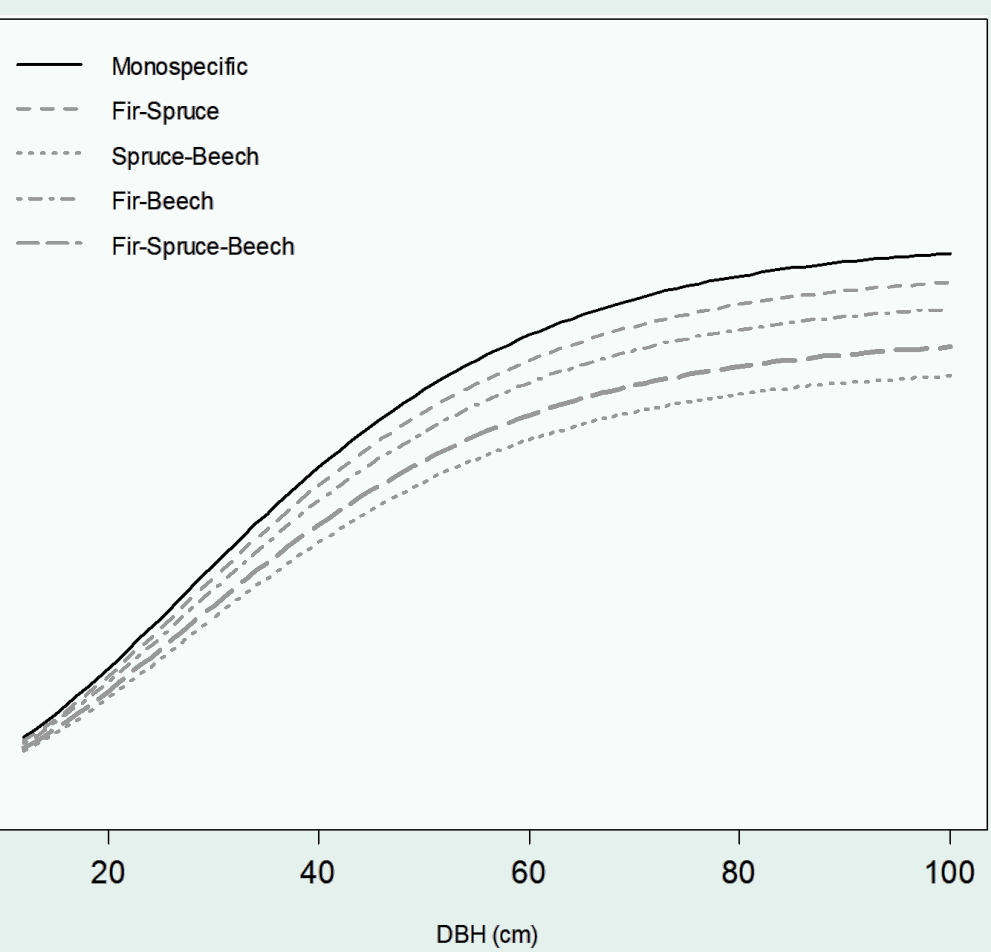
***: p-value < 0.001; **: p-value < 0.01; *: p-value < 0.05; n.s.: non-significant

***: Positive effect (pos. slope coeff.)
***: Negative effect (neg. slope coeff.)

Spruce BAI differs weakly depending on species mixtures



Fir BAI differs significantly depending on species mixtures

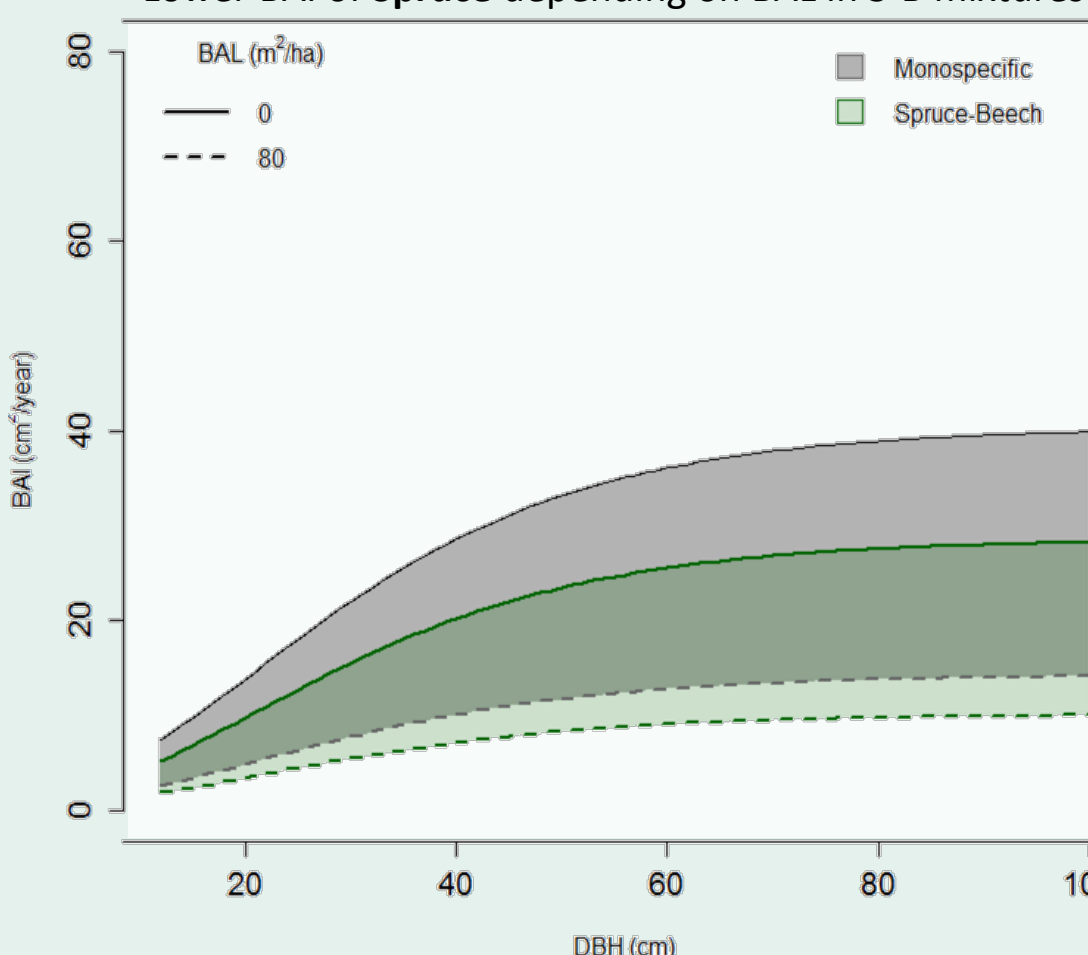


Interactions between categorical variable for mixtures and the other predictors

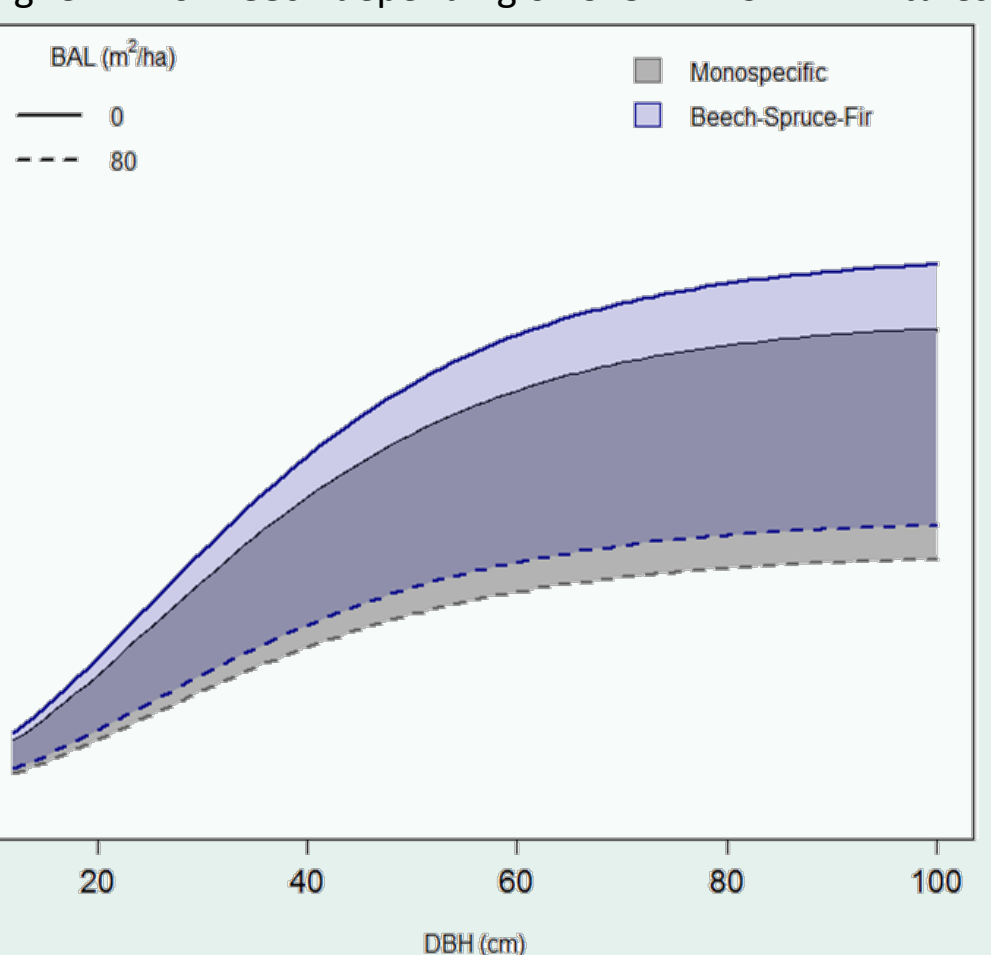
Tree species	Mixture	BAL	SDI	DDOM	GRB	SLOPE	NORTH	NDEP	DRI	TEMP	PH	AWC
Spruce	S-F	***	n.s.	***	n.s.	n.s.	n.s.	n.s.	***	***	***	***
	S-B	***	***	***	n.s.	n.s.	n.s.	n.s.	***	***	***	***
	S-L	***	***	***	n.s.	n.s.	n.s.	n.s.	***	***	***	***
	S-P	n.s.	***	***	***	***	***	***	***	***	***	***
	S-F-B	***	n.s.	***	***	***	***	***	***	***	***	***
Beech	S-F	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	***	***	***	***
	S-B	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	***	***	***	***
	S-L	***	n.s.	***	n.s.	n.s.	n.s.	n.s.	***	***	***	***
	S-P	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	***	***	***	***
	S-F-B	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	***	***	***	***

Interpretation of the coefficient of the interaction → change in the slope BAI ~ variable between the monospecific and the mixture

Lower BAI of Spruce depending on BAL in S-B mixtures



Higher BAI of Beech depending on SLOPE in S-F-B mixtures



Work in progress → use of other continuous variables; model validation with long-term forest data; implementation in scenario model

Conclusions

- Significant but not uniform effects of species mixture on BAI of the main tree species across Switzerland ‘s environmental gradients
- The effect of some mixtures are significant only depending on stand density, climatic and soil conditions, topography and/or management

REFERENCES

[1] Swiss National Forest Inventory. <http://www.lfi.ch/>. Swiss Federal Institute WSL, Birmensdorf, Switzerland. [2] Drössler 2010. Tree species mixtures – a common feature of southern Swedish forests. *Forestry* 83, 433-441. [3] Thürig et al. 2005. Evaluation of the growth function of an empirical forest scenario model. *Forest Ecology and Management* 204, 51-66. [4] Rohner et al. (in prep). Combining site, stand, management, climate and nutrient effects in the growth function of an empirical forest scenario model.