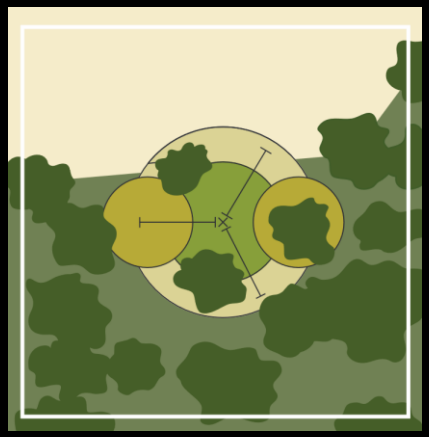
Studying growth in the Swiss NFI

Developments, achievements and challenges



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In collaboration with Marco Mina, Stefan Klesse, Marco Ferretti, Esther Thürig

Motivation

WSL Home > Forest > Forest development and monitoring > Swiss National Forest Inventory NFI

Swiss National Forest Inventory NFI

What does the Swiss forest look like and how does it change over time? The Swiss National Forest Inventory (NFI) answers these questions.

NFI field teams collect data on trees and forest stands on approximately 6500 sample plots and interview the local forestry services. Among other items, NFI publishes results on forest area, stemp count, volume, increment, yield, biodiversity, the quality of the protection function and socio-cultural services of the forest. The data are collected continuously and provide valuable information on how the Swiss forest is developing in the long term.

NFI designed to quantify states and changes statistically representative for Switzerland's tree population

'How?'
rather than 'Why?'

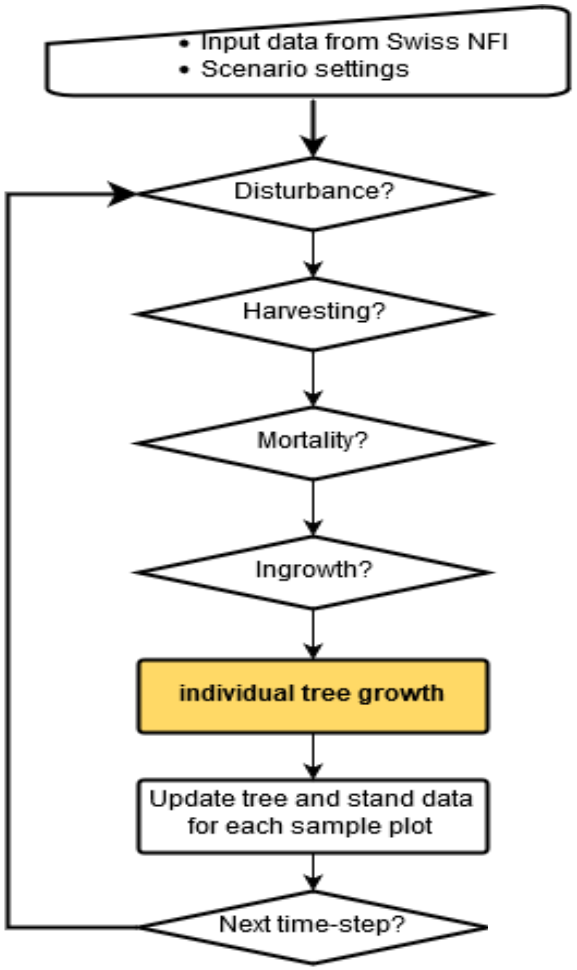
Motivation

Management Scenario Simulation Model (MASSIMO) predicts the future development of NFI trees

Statistical models for basal area increment (BAI) form the core of MASSIMO

$$BAI = e^{b_0} \times e^{b_1 \times (1 - e^{b_2 \times DBH})} \times \prod_{i=1}^{6} e^{b_i \times V_i} + \epsilon$$

Constant environmental conditions → Involving environmental change → Involving advanced stand dynamics



Involving environmental change

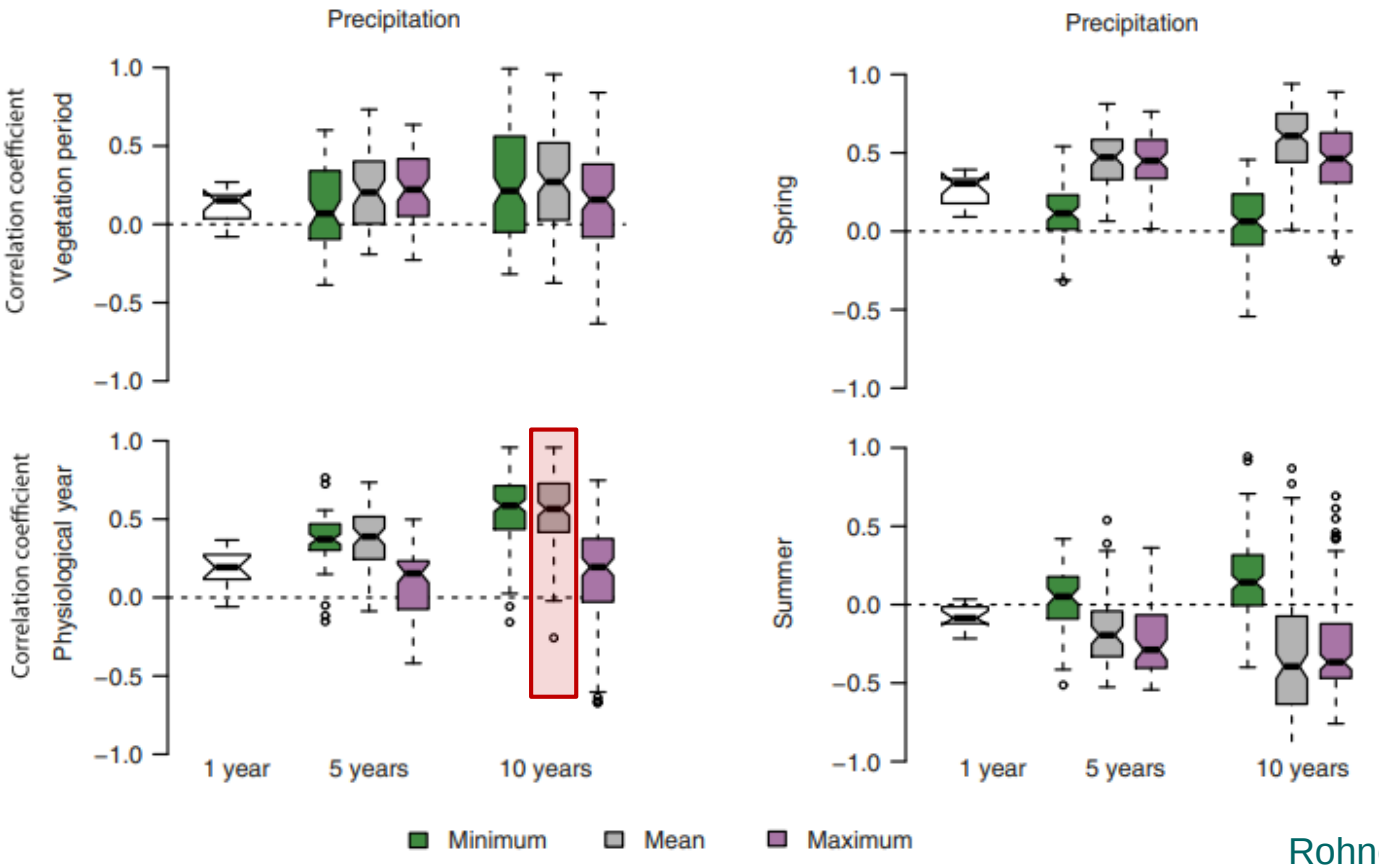
First attempts included straightforward temperature, drought and N-deposition effects based on space-for-time substitution

		Picea abies	*Abies alba*	*Pinus* sp.	*Larix* sp.	Other conifers	*Fagus sylvatica*	*Quercus* sp.	*Acer* sp. and *Fraxinus* sp.	Other Broadleaves
Tree	DBH	+	+	+	+	+	+	+	+	+
	Basal area of larger trees	-	-	-	-	-	-		-	-
Stand	Stand density index	-	-	-	-			-	+	-
	DDOM	-	-				-	-	-	-
	Harvesting effect	+	+				+	+	+	+
	Forest type			+	-				-	
Site/Nutrients	Slope	-	-	-	-	-	-	-	-	-
	Eastness			+			+			
	Northness	+				-	+			
	Curvature	+					+		-	
	Available water capacity	+					+	+		+
	pH	-	-	-	+	-	-	-	-	
	N-Deposition	-	-	+		+	+	+	+	+
Climate	Temperature	+	+		+	+	+	+	+	
	ETa/ETp	+	+		+		+		+	+
	Global radiation	+	+		+					

Rohner et al. (2018) EJFR

Involving environmental change

How to define climatic variables for 10-year increments?

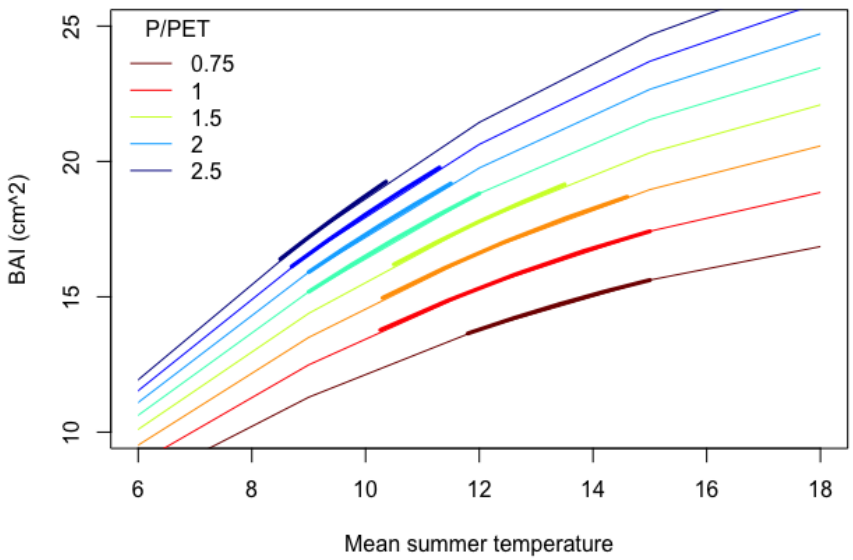


Rohner et al. (2016)
Forest Ecology and Management

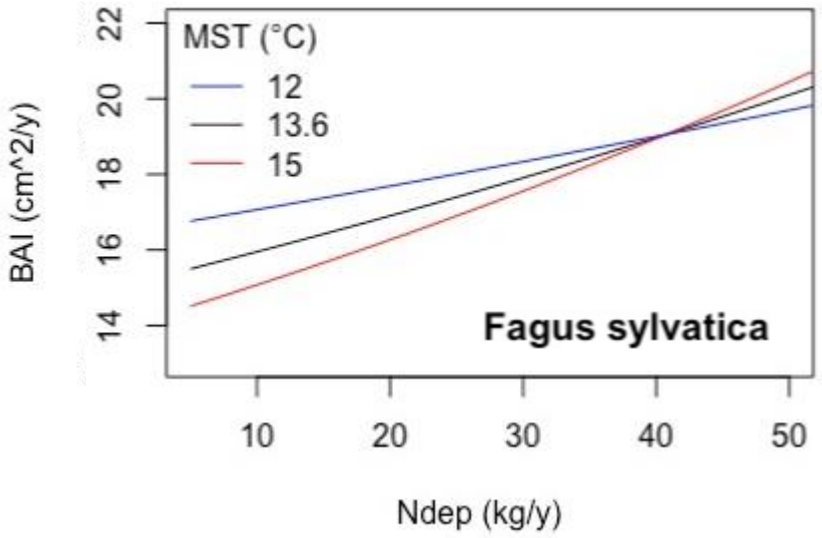
Involving environmental change

BAI models were further developed by integrating interactions, for example…

… drought and temperature



… temperature and N deposition



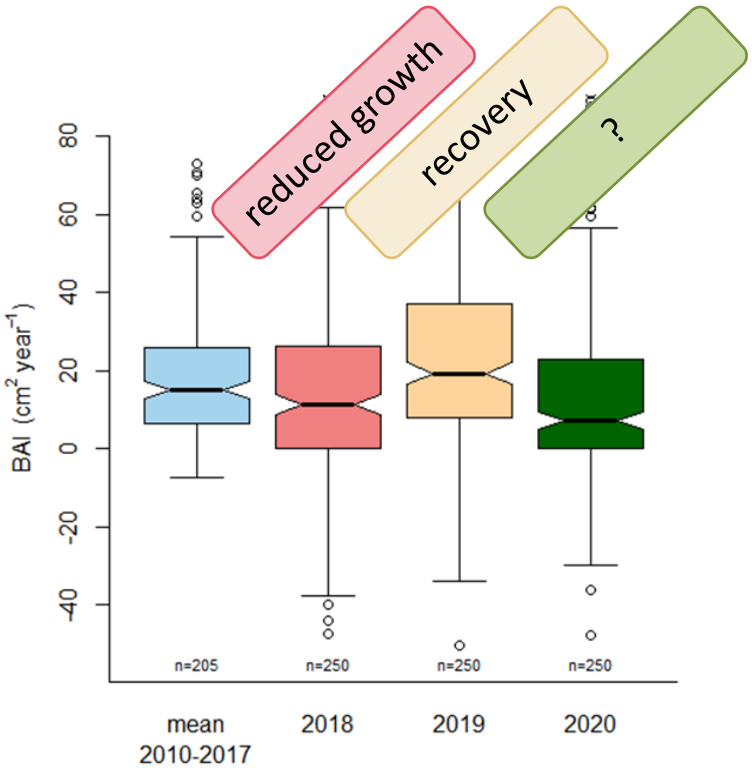
→ Temporal mismatch between seasonal drought and 10-year re-measurement

→ High spatial but low temporal variability

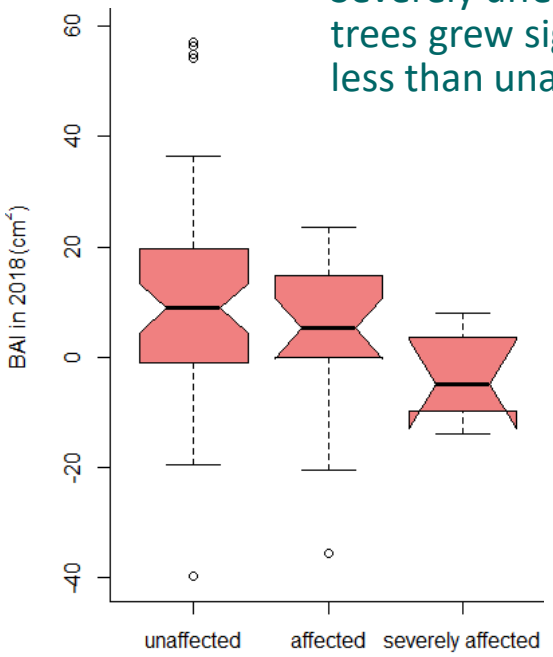
Klesse et al. (in prep.)

Involving environmental change

WSL 2018 drought initiative: Annual re-measurements on some NFI plots showed the potential of increased temporal resolution to quantify drought effects.



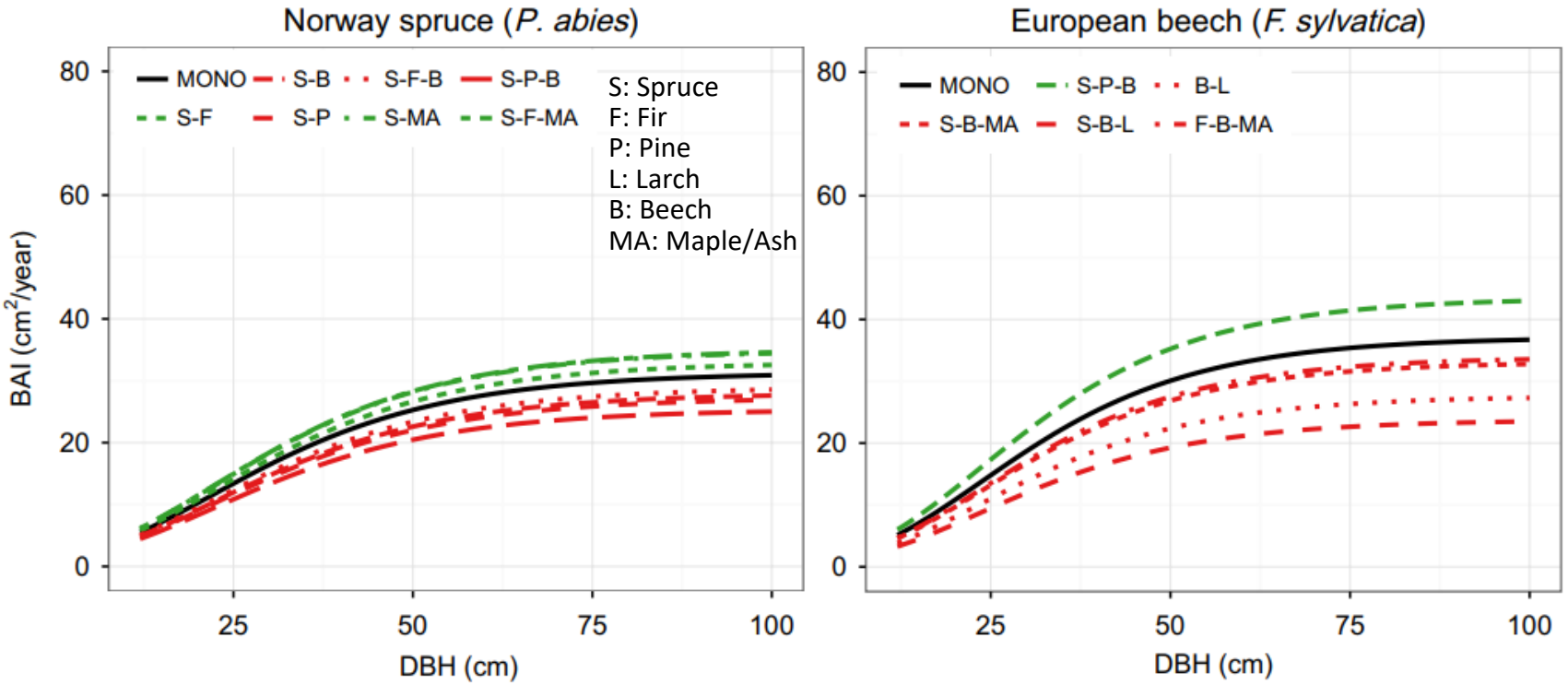
Severely affected beech trees grew significantly less than unaffected ones



Rohner et al. (2021) Ecological Indicators

Involving advanced stand dynamics

Mixing tree species affects BAI, but depending on species and site conditions



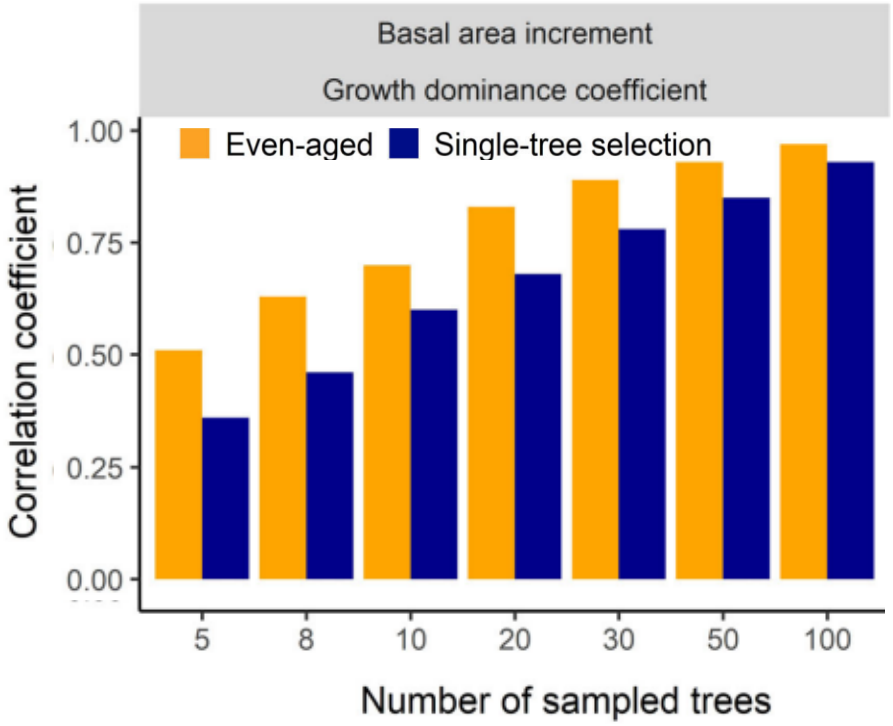
Mina et al. (2018)
Journal of Ecology

Involving advanced stand dynamics

Growth partitioning: relative contribution of differently sized trees to stand growth

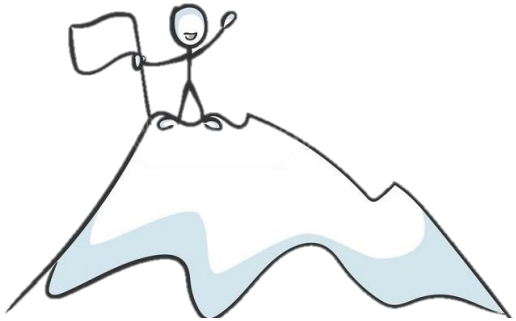
→ Are NFI plots large enough to study growth partitioning?

→ Using EFM data to simulate decreasing sample sizes



Bose et al. (2021)
Plant Biology

Achievements and challenges

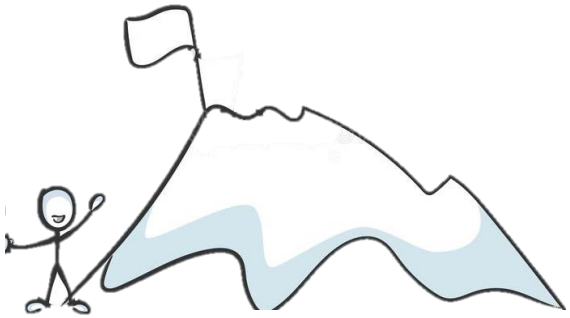


Representative empirical relationships

Statistical representative BAI models include plausible

- Climatic effects
- N deposition effects
- Species mixing effects

→ MASSIMO includes environmental change in scenario analyses for the next few decades



Causal relationships for a more mechanistic MASSIMO

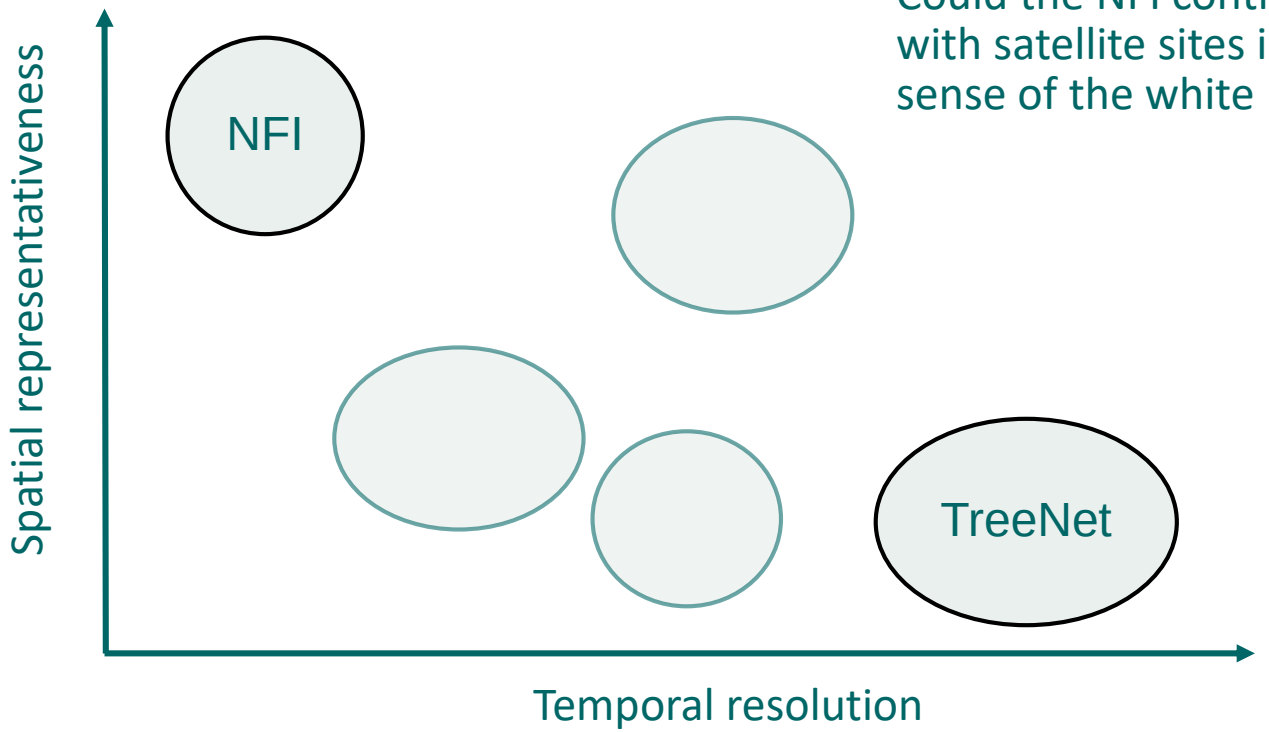
Low temporal resolution

→ Climatic effects blur within 10-year intervals
→ Rather spatial than temporal effects

Size of individual NFI plots smaller than stands

→ Stand dynamics are difficult to grasp

… and opportunities



Could the NFI contribute with satellite sites in the sense of the white paper?

Thank you!

To all collaborators in the various projects
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Literature

Bose A.K., Rohner B., Bottero A., Ferretti M., Forrester D.I. (2021) Did the 2018 megadrought change the partitioning of growth between tree sizes and species? A Swiss case-study. Plant Biology

Mina, M.; Huber, M.O.; Forrester, D.I.; Thürig, E.; Rohner, B. (2018) Multiple factors modulate tree growth complementarity in Central European mixed forests. Journal of Ecology, 106: 1106-1119.

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