Abstract template for the conference "A century of national forest inventories – informing past, present and future decisions"

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Abstract title:		Modelling ingrowth for empirical forest prediction systems
Take-home message:		*Predicting ingrowth is important to estimate the future states of forests. Swiss NFI data are used to build empirical models for ingrowth (>12 cm dbh), including number of ingrowth, diameter and tree species.*
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General topic, see website: (please double click on the check box and activate the relevant one)	☐	Improving future NFIs by learning from the past
	☒	NFIs today and in the future
	☐	Cutting edge and futuristic inventory techniques and technologies
Preferred presentation form:	☒	Oral presentation
	☐	Poster
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Modelling ingrowth for empirical forest prediction systems

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Introduction Accurate and representative prediction of ingrowth (trees overgrowing the measurement threshold of 12 cm) is essential for modelling forest development. Beside the number of ingrowth, the basic tree attributes diameter and species are also important. These three characteristics were modelled based on data of the national forest inventory (NFI) in Switzerland. The study is covering large gradients of stand situations and climate variables, making the models suitable to predict ingrowth under climate change.

Materials and methods: As the number of ingrowth shows more zeros than a Poisson distribution would allow for, we tried three different probability distributions: zero inflated Poisson distribution (ZIP), negative binomial distribution (NB) and zero inflated negative binomial distribution (ZINB). All three variants were fitted with and without random effects, resulting in six different model types. Model selection was done backward, using BIC criterion. Among the final models, ZIP showed best predictions of independently observed number of ingrowth. Diameter of ingrowth was estimated with a Likelihood approach, applied to the probability density function of diameters. Further twelve trees species groups of ingrowth were fitted with a multinomial regression approach

Results: Our results indicate that number of ingrowth strongly depended on development stage of forests and basal area, while climate, nitrogen deposition and water holding capacity had a lower but still significant and interpretable effect. Diameter of ingrowth was higher on better site indexes and decreased with increasing stand density.

The multinomial tree species models shows clear dependence on climate: spruce and larch probability clearly decreased with increasing temperature, whilst all other tree species profited from increasing temperatures. The probability of fir, beech and ash ingrowth increased with basal area as an indicator of shade tolerance. The most important variable to predict species of ingrowth was the leading tree species group.

Conclusion: Ingrowth is an important process for the future of the forests. This study indicates that representative and repeated measurements of ingrown trees serve as a profound database to fit models for the amount, diameter and tree species of ingrowth. Such models are valid for a wide range of climatic and ecological conditions. Including climate variables revealed important insights in possible reactions of forest developments to changed climatic conditions. The models show, for example, that under warmer climates we can expect less ingrowth and the occurrence of spruce will decline. As the stochasticity of these observations is high the explained variances are low. Altogether, tree species of ingrowth can be best predicted by the leading tree species group of the previous stand.

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