**StatisticsLab Colloquium**

*Tree mortality beyond field detection: challenges for inference, modeling and predictions*

October 24th 2024,
14.00 - 15.30
Englersaal, WSL Birmensdorf

Zoom Link:
https://wsl.zoom.us/j/64321999394?pwd=UGh
jemNRWHUwQVZvN0RWK0VKL1hLUT09

**Program:**

- *Introduction* by Marco Ferretti

- *Modelling tree mortality from forest inventory data: which approach for which purpose?* – Presentation by Jeanne Portier

- *Tree mortality observations on an annual time scale and the relationship with crown defoliation* – Presentation by Stefan Hunziker

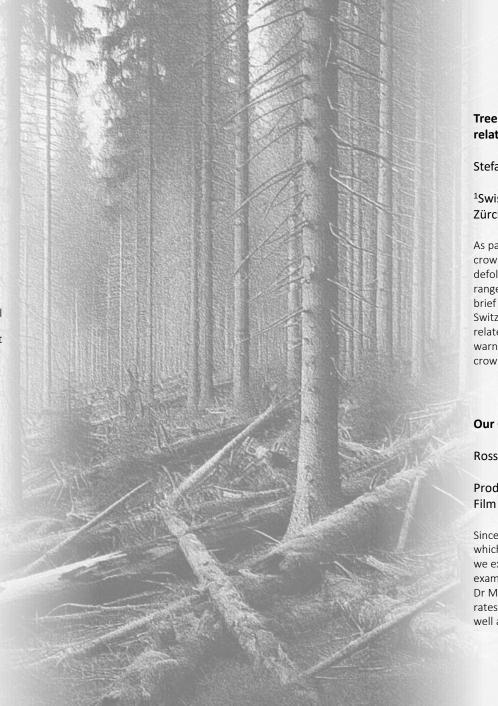- *Our Changing Forests* – Documentary Movie Preview by Ross Shackleton

# Abstracts

**Modelling tree mortality from forest inventory data: which approach for which purpose?**

Jeanne Portier[1,+], Nataliia Rehush[1], Jürgen Zell[1], Golo Stadelmann[1], Esther Thürig[1], Brigitte Rohner[1]

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In recent years, increasing background tree mortality has been observed across many European forests. Numerous studies investigate how forests are responding to global changes to foresee how these forests will develop in the future, and to generate management recommendations accordingly. Forest inventory data are often used in such studies as they can provide representative data at regional to national scales. Modelling approaches based on such empirical data can help identifying and understanding the drivers of tree mortality, as well as predicting current and future forest development trajectories. However, forest inventory data are complex and their statistical handling presents some methodological challenges. In addition, tree mortality data are highly unbalanced (higher proportion of living trees compared to dead trees), which further complicates the modelling process and performance assessment. For these reasons, while the drivers of tree mortality are increasingly well understood, we are still lacking concrete and practical guidelines on how to develop well-performing empirical tree mortality models that account for the complexity of forest inventory data.

We used Swiss National Forest Inventory data (~4300 plots, up to 5 times remeasured over the last 40 years) to identify the characteristics of forest inventory data that should be accounted for when modelling tree mortality. We determined if and how these characteristics could be implemented in various modelling approaches such as generalised mixed models, a survey approach, random forest and convolutional neural networks. We compared the performance of these approaches when inferring the effect of environmental factors on tree mortality as well as when predicting tree mortality. We conclude that the best-suited modelling approach depends on the goal of the model, i.e., inferring or predicting. We stress that metrics used to evaluate the performance of a modelling approach must be adapted to unbalanced data, and provide recommendations on best practices for modelling tree mortality from forest inventory data. Our results can help future tree mortality studies to choose, based on their goal, which modelling approach would be most suitable as well as the appropriate metrics to evaluate the model's performance.

**Tree mortality observations on an annual time scale and the relationship with crown defoliation**

Stefan Hunziker[1]

[1]Swiss Federal Institute for Forest, Snow and Landscape Research, WSL, Zürcherstrasse 111, CH-8903 Birmensdorf, Switzerland.

As part of the Long-term Forest Ecosystem Research (LWF), the condition of tree crowns is monitored on an annual time scale. This makes it possible to follow the defoliation trajectories of individual trees until they die and to consider a wide range of stress factors that may have played a role in this process. I will give a brief insight into research questions such as: How has tree mortality in Switzerland evolved over time? How are mortality and tree crown defoliation related? Are there tipping points and can crown defoliation serve as an early warning signal for increased mortality? What are the main drivers of increasing crown defoliation and ultimately tree mortality?

**Our Changing Forests**

Ross Shackleton, Chaitanya Arya, Kingshuk Kapuri, Barbara Gollwitzer

**Produced through the Filmmaking Marathon run by the Swiss Science Film Academy**

Since 2015, Europe's forests have faced increasing defoliation (leaf loss) rates — which is a key sign of the declining health and vitality of trees. In this short film, we explore this with researcher Ross Shackleton in Zurich's forests, who shows us examples of different levels of tree defoliation and discusses what is causing this. Dr Marco Ferretti further explains the alarming trends of increasing defoliation rates across Europe the implications of this for our environment and society as well as options to make forests more resilient in the future.