EFFECTS OF BARK BEETLE ATTACKS ON FOREST SNOWPACK AND AVALANCHE FORMATION – IMPLICATIONS FOR PROTECTION FOREST MANAGEMENT

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FOR DETAILS SEE

Teich et al., 2019:
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INTRO

FORESTS PROTECT AGAINST SNOW AVALANCHES

Healthy, dense **forests reduce** weak **layer formation** that contribute to slab avalanches.

BARK BEETLES KILL TREES

Driven by **climate change**, trends towards **more frequent** and **severe bark beetle disturbances** may reduce the protective capacity of mountain forests against avalanches.

PROBLEM

CONSEQUENCES FOR AVALANCHE HAZARD?

Needle loss following bark beetle attack decreases canopy interception, and increases light transmission and wind speeds, which **alters** snow accumulation, melt, redistribution and metamorphism.

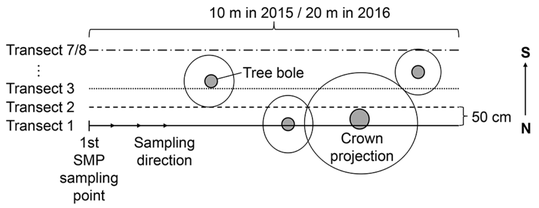
These changes may lead to more **homogeneous** snow layering (**snow stratigraphy**), a condition which is generally more **prone to avalanche release**.

DATA COLLECTION

THE SNOW MICRO PEN (SMP)

…is a digital snow penetrometer that automatically measures **snow hardness** with a constant speed along vertical profiles.

- **SMP measurements** were recorded along **transects** over two winter seasons.

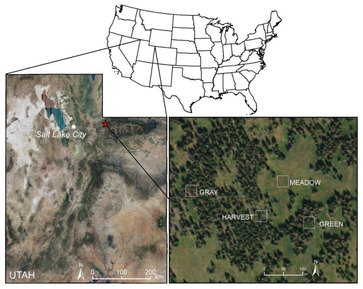


- **Snow height**, **canopy cover** and down **woody debris height** were measured for each transect.
- Variables on **meteorological conditions** present prior transect measurements were calculated.

STUDY SITES

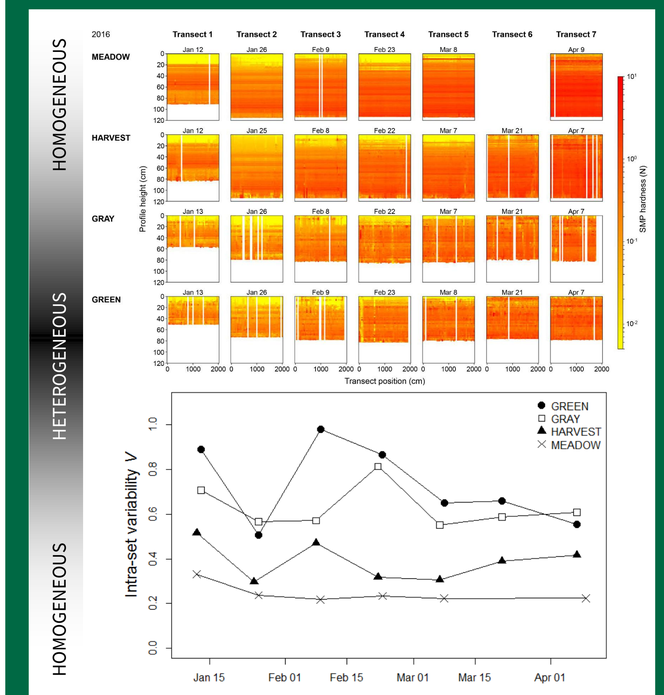
SPRUCE FOREST – FOUR PLOTS

…characterizing different stages within a spruce beetle outbreak cycle: **GREEN** - recently infested, **GRAY** - infested 3+-years ago, **HARVEST** – salvage-logged, **MEADOW** - open.



Uinta Mountains, Utah, USA

DATA ANALYSIS AND RESULTS



FROM 1D SMP HARDNESS PROFILES TO 2D SNOW STRATIGRAPHY

When plotted side-by-side, SMP hardness profiles reveal that **snow stratigraphy** is **more homogeneous** in HARVEST and MEADOW plots compared to GREEN and GRAY plots.

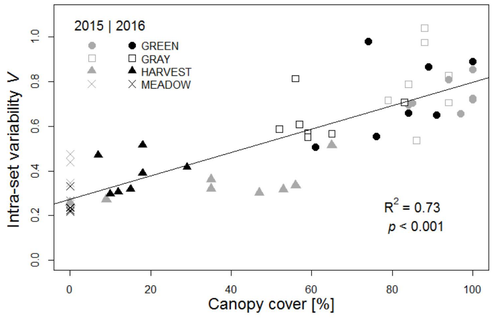
BUT HOW VARIABLE IS THE SNOW STRATIGRAPHY?

We quantified the difference between all SMP hardness profiles of each transect by calculating the similarity metric **Intra-set variability *V***.

WHAT INFLUENCES VARIABILITY IN SNOW STRATIGRAPHY?

We used linear mixed effects models to test which forest, snow and/or meteorological conditions influenced differences between our study plots.

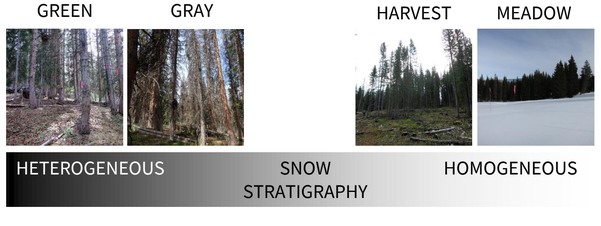
The **main predictor** was **canopy cover**, and only 14% of the variance was explained by the stage within the outbreak cycle. That is, **differences between green and gray stage stands did not depend on the reduction in needle mass per se**.



CONCLUSIONS

Newly dead trees can maintain avalanche protection…

…, but logged forest stands don't.



Leaving dead trees in place can have advantages, especially in protection forests where bark beetle populations have reached **epidemic levels**.

BFW. Austrian Research Centre for Forests

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