

Efficiency of bark beetle management under climate change

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Background

- Spruce bark beetle (*I. typographus*) outbreaks greatly intensified across Europe
- Windthrows and drought are typical triggers
- Strong amplifying effect of climate change

Outbreak management tactics

DIRECT CONTROL of bark beetle populations

beetle trapping, **removal of infested and windfelled trees**,
insecticide application

INDIRECT CONTROL of bark beetle populations

manipulation of tree, stand and
landscape conditions:
thinnings, **reducing forest age**,
changing species composition, etc



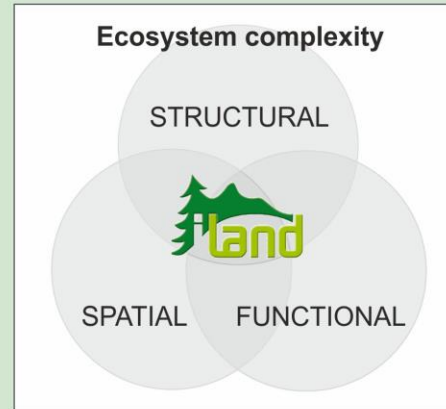
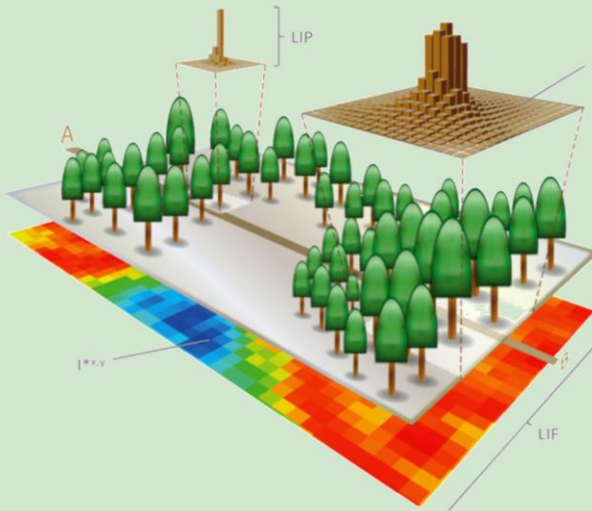
Our aims

- **Assess** the efficiency of main outbreak management tactics in terms of **disturbance reduction effect**
- Estimate effects of **climate change**
- Provide guidelines for creating **proper mix of measures** for different management objectives
- Demonstrate the role of **ecosystem models in practical disturbance management**



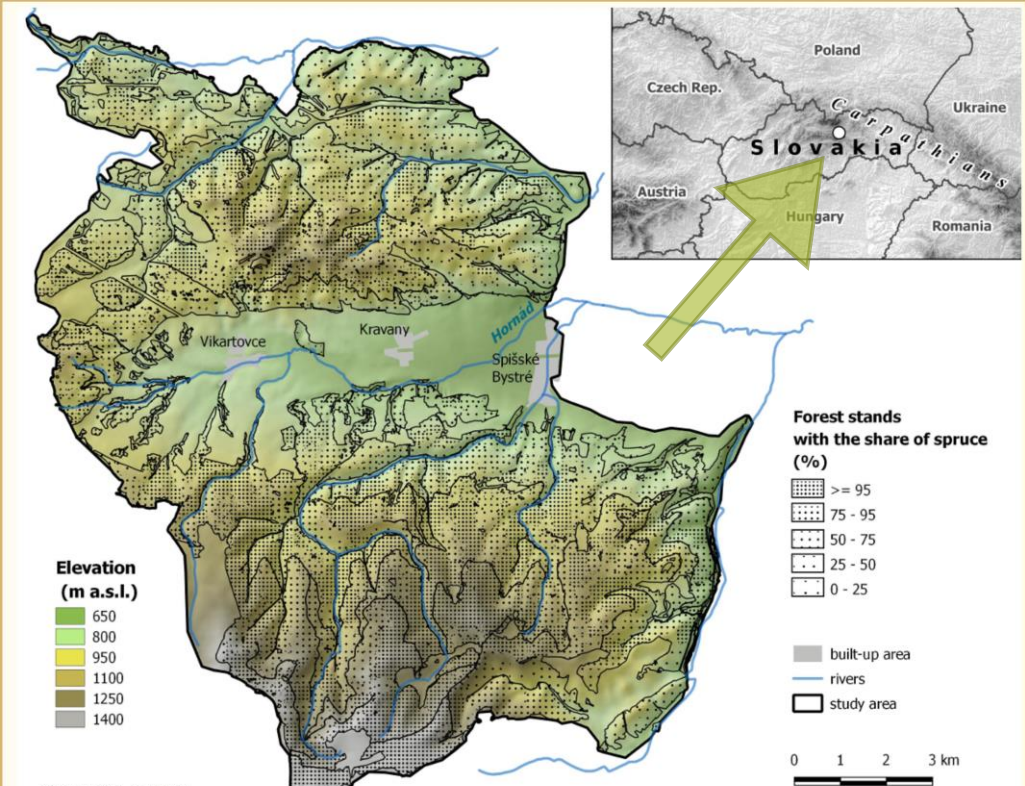
MODEL iLand

- process-based ecosystem model
- simulates forest landscape dynamics at the level of individual trees
- large-scale mortality events are simulated by spatially explicit models of disturbance agent (wind, bark beetles, wildfire)
- combines approaches from physiological, gap and landscape models



- individual tree resolution allows the simulation of complex silvicultural activities
- process-based architecture ensures robust responses of ecosystem processes to changing environmental conditions
- computational efficiency and open architecture allow for an efficient integration of complex models of the human system

Seidl, R., Rammer, W., Scheller, R.M., Spies, T.A., 2012. An individual-based process model to simulate landscape-scale forest ecosystem dynamics. *Ecological modeling* 231:87-100.



STUDY AREA

Location: Central Western Carpathians, Slovakia (Central Europe)

Area: 16,000 ha, 70 % forest cover

Species composition: Spruce 75 % — European larch 10 % — Scots pine 9 % — Silver fir 3 % — European beech 2 %

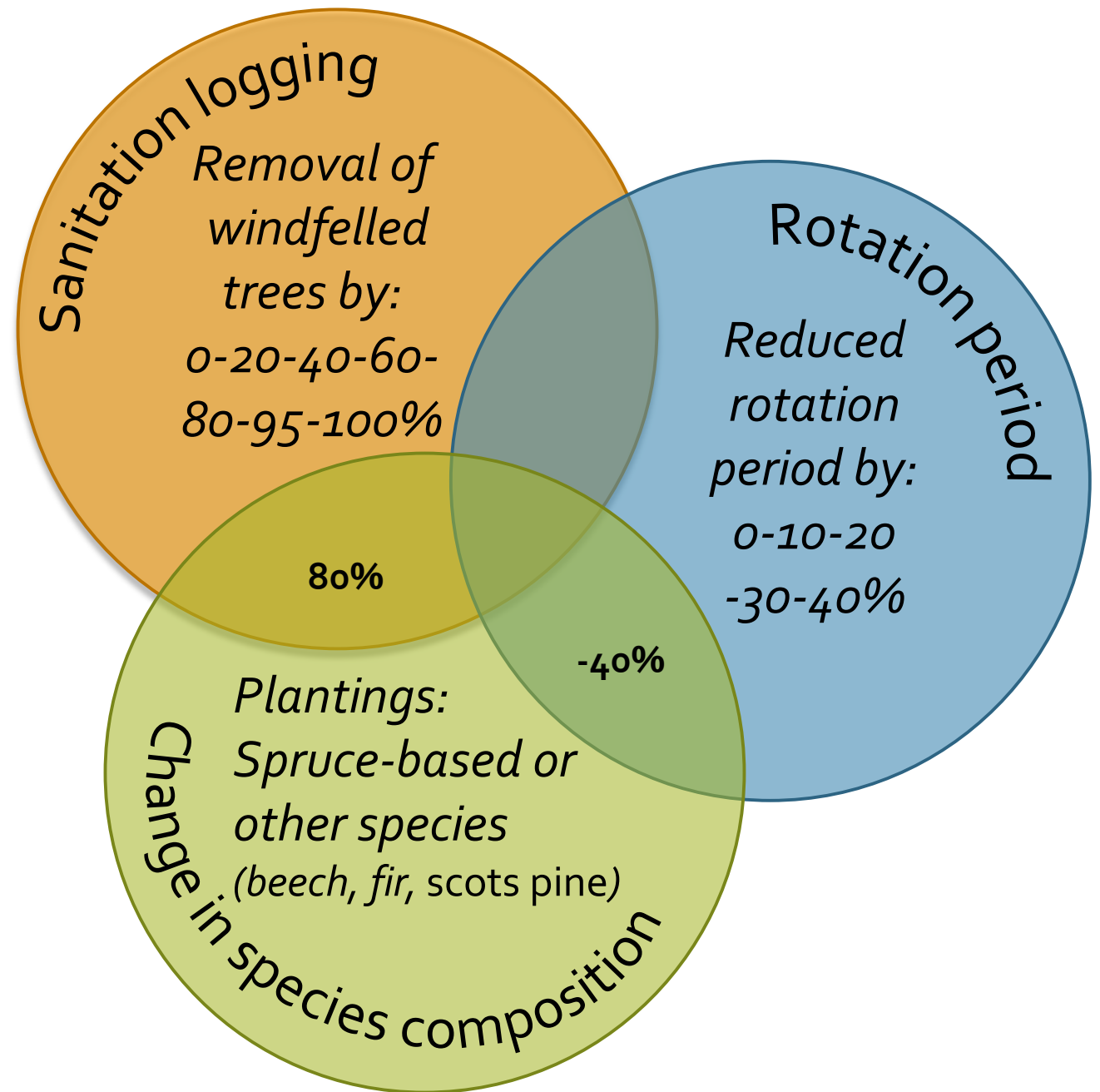
Environment: 620–1,550m a.s.l.; Cambisols, Podisols and Rendzinas; Growing season air temperature: 12–15°C; Growing season precipitation: 380–510 mm

Management: Timber production oriented management; rotation period ca 100 years; regeneration system in mixed stands is uniform shelterwood; a small-scale clearcutting system with 3 harvest cycles is applied in spruce monocultures with a maximum clear-cut area of 3.0 ha

Disturbances: regime of regular wind damage followed by bark beetle outbreaks; intensifying disturbance rate and a high proportion of salvage and sanitary felling in the recent two decades (figures below)

Experiments

- Forest exposed to multiple windthrows and bark beetle outbreaks
- Past climate conditions and climate change projections (RCP4.5 and RCP8.5)
- Business as usual management: small scale clearcut and shelterwood
- 100-200 years long experiments
- Response variable: Growing stock affected by wind and bark beetles



Simulated wind and bark beetle disturbance

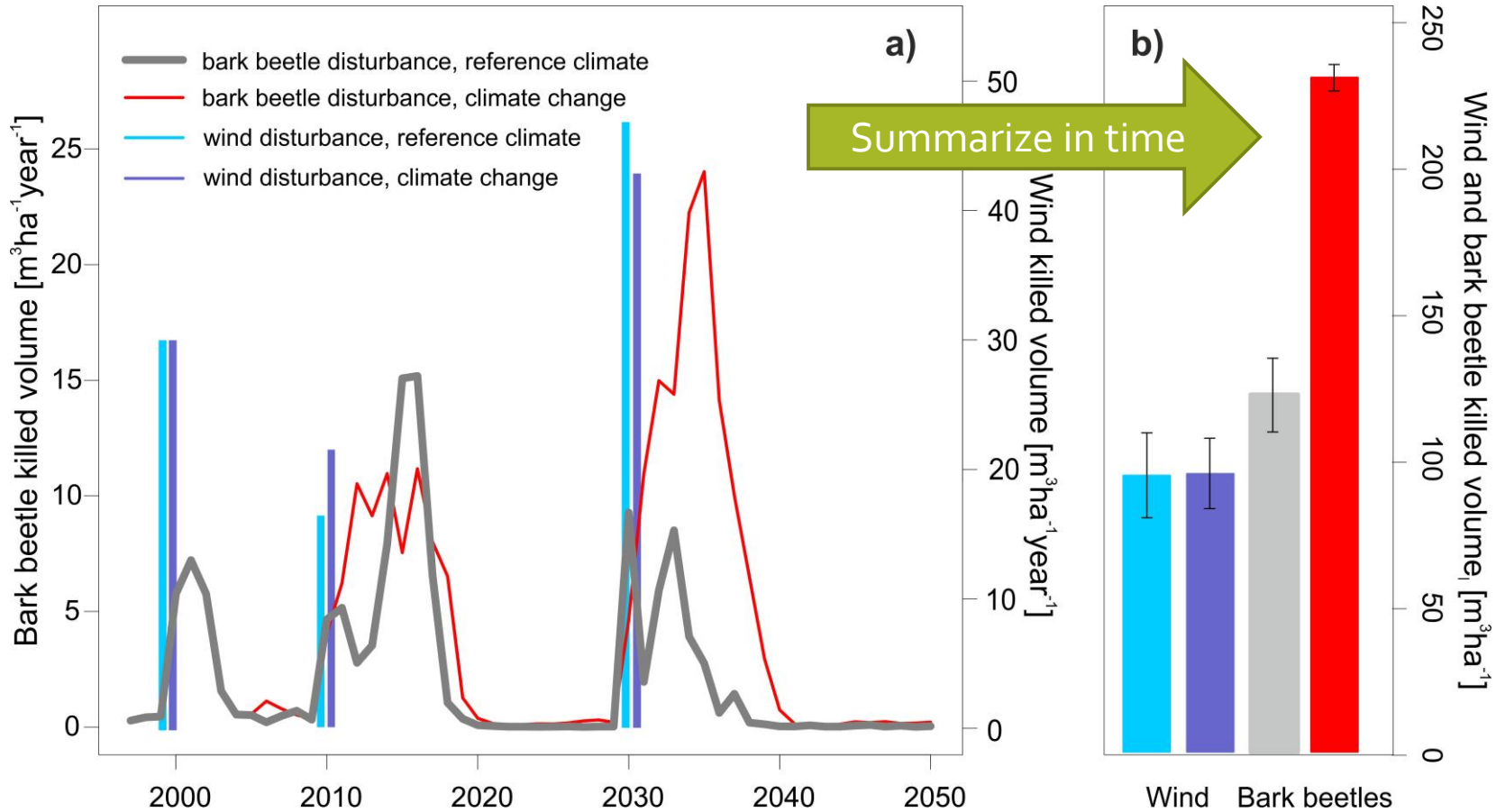
Predifined
windstorms



Windthrows



Bark beetle
outbreaks

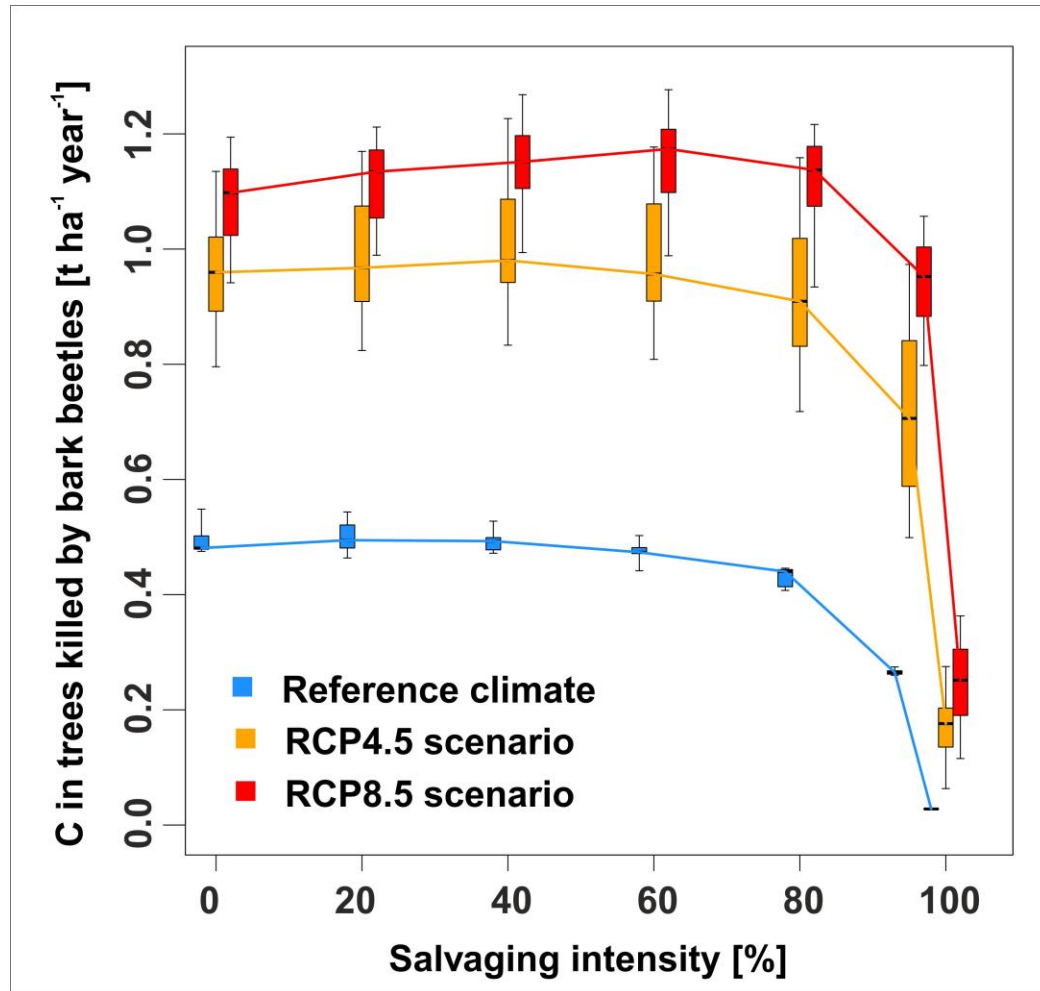


Summarize in time

Calculate
annual
average
damages

Sanitation logging experiment

Bark beetle killed trees [tC /ha/year]



What we learned?



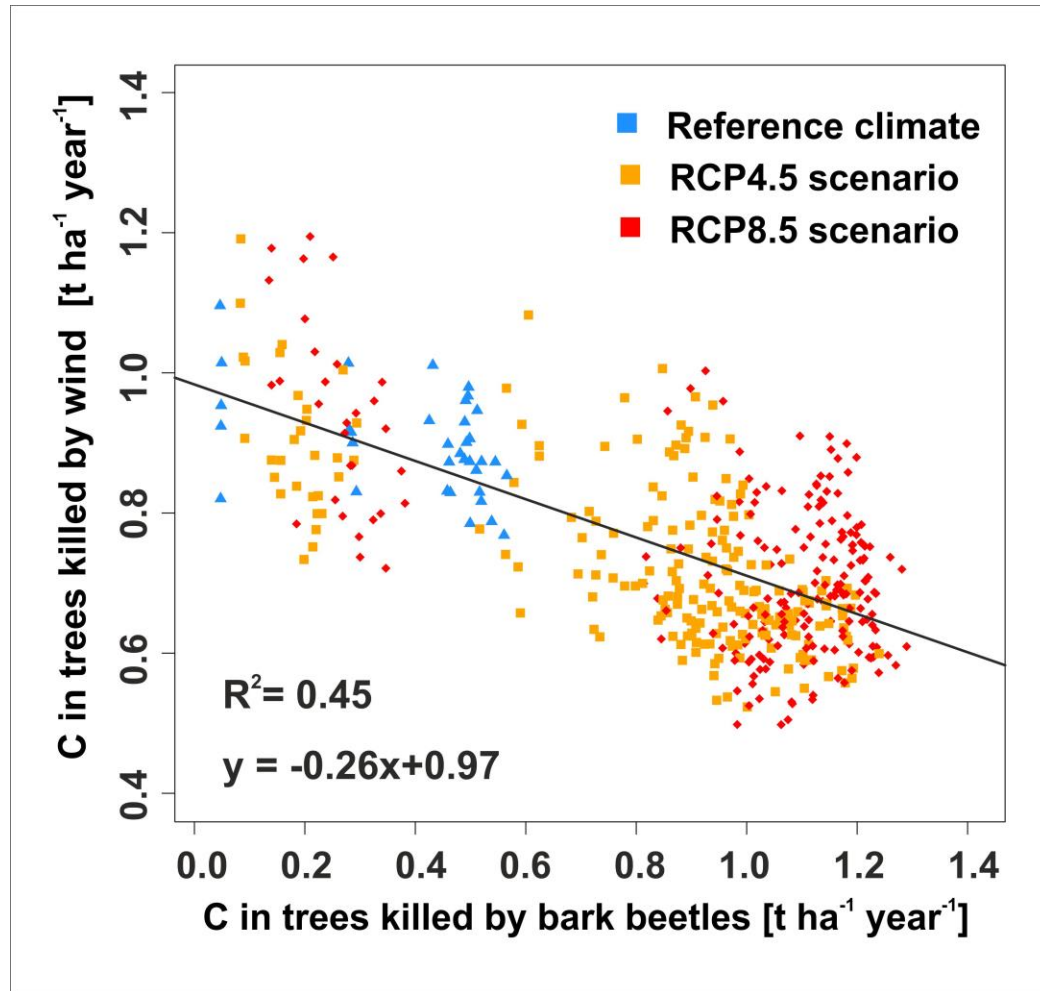
1. Climate change increased bark beetle disturbance 2-3 fold
2. Sanitation logging with intensity > 80% can dampen the outbreaks

... HOWEVER

3. Smaller intensities of SL inefficient
4. Relative efficiency of SL decreases under climate change

Sanitation logging experiment

Bark beetle vs wind killed trees [tC /ha/year]



What we learned?

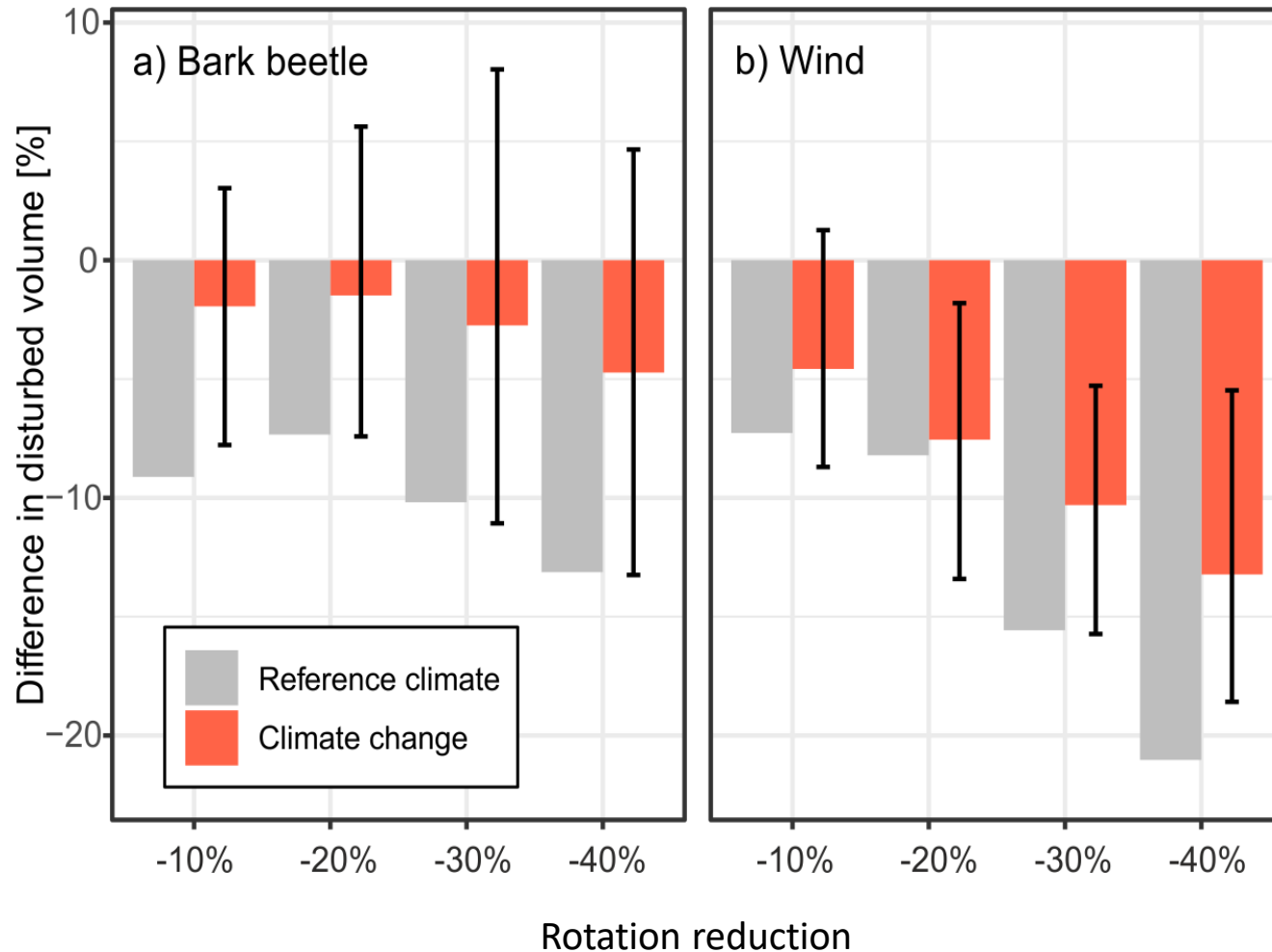


1. Climate change increased bark beetle disturbance 2-3 fold
2. Sanitation logging with intensity > 80% can dampen the outbreaks

... HOWEVER

3. Smaller intensities of SL inefficient
4. Relative efficiency of SL decreases under climate change
5. Too intensive outbreak suppression increases wind disturbance in the long-run

Rotation period experiment



What we learned?

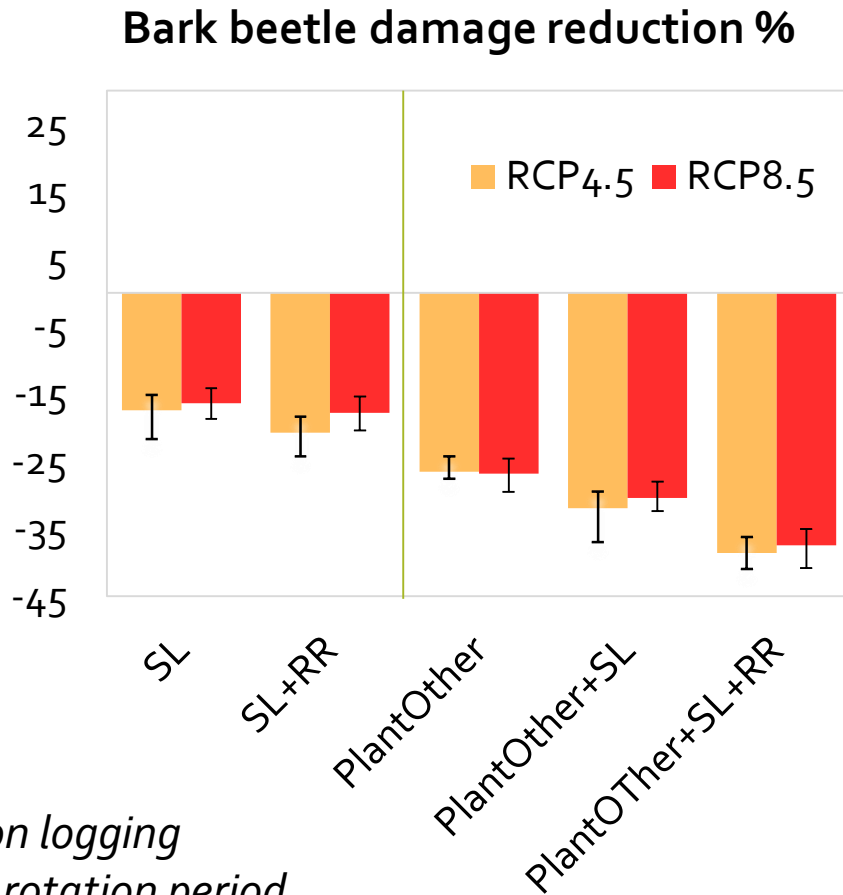


1. Reduced rotation length reduces both wind and bark beetle disturbance both under reference climate and climate change

HOWEVER...

2. Climate change **significantly** reduces this effect
3. Collateral effects (biodiversity, carbon) are severe

Combined experiment



SL: sanitation logging

RR: reduced rotation period

PlantOther: plant more fir/beech/scots pine instead of spruce

Results are compared to the case where NO disturbance reduction actions are taken

What we learned?



1. More actions generate stronger effect though far from being additive
2. Change in species composition reduces the disturbance but lead times are long
3. Warmer climate reduces the overall efficiency of the compound of measures

Conclusions

- Climate change amplifies outbreaks and reduces efficiency of all management tactics
- High intensities of sanitation logging are effective (>80%) -> reasonable for small and concentrated windthrows only
- Reduced rotation period decreases wind and bark beetle disturbance but effects are not large and diminish under climate change
- Combination of actions leads to higher decrease in damage but the effects are not being additive
- All measures have collateral effects on forest C and biodiversity, which need to be considered

RESEARCH ARTICLE

Journal of Applied Ecology 

Is salvage logging effectively dampening bark beetle outbreaks and preserving forest carbon stocks?

Laura Dobor¹ | Tomáš Hlásny¹  | Werner Rammer²  | Soňa Zimová¹ | Ivan Barka³ | Rupert Seidl²



Contents lists available at ScienceDirect

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journal homepage: <http://ees.elsevier.com>



Research article

Spatial configuration matters when removing windfelled trees to manage bark beetle disturbances in Central European forest landscapes

Laura Dobor^a, Tomáš Hlásny^{a,*}, Werner Rammer^b, Soňa Zimová^a, Ivan Barka^c, Rupert Seidl^b

„Reducing forest rotation age to address increasing disturbances in Central Europe: Potential and limitations“ (submitted)

„Disentangling the effect of multiple management measures on wind and bark beetle disturbance in a Central European forest landscape“ (in prep.)

THANK YOU FOR YOUR ATTENTION!

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