

Relationship between forest stand, landscape variables and *Ips typographus* damage in Finland's nationwide forest

Introduction

Damage by the European spruce bark beetle (*Ips typographus* =SBB) have been happening in Finland since the early 2010s, but limited research leaves knowledge gaps to propose effective forest management practices. We studied the relationships between observed SBB damage during 2012–2020 and *P. abies* stands free of SBB damage reports, and landscape attributes.

Methods

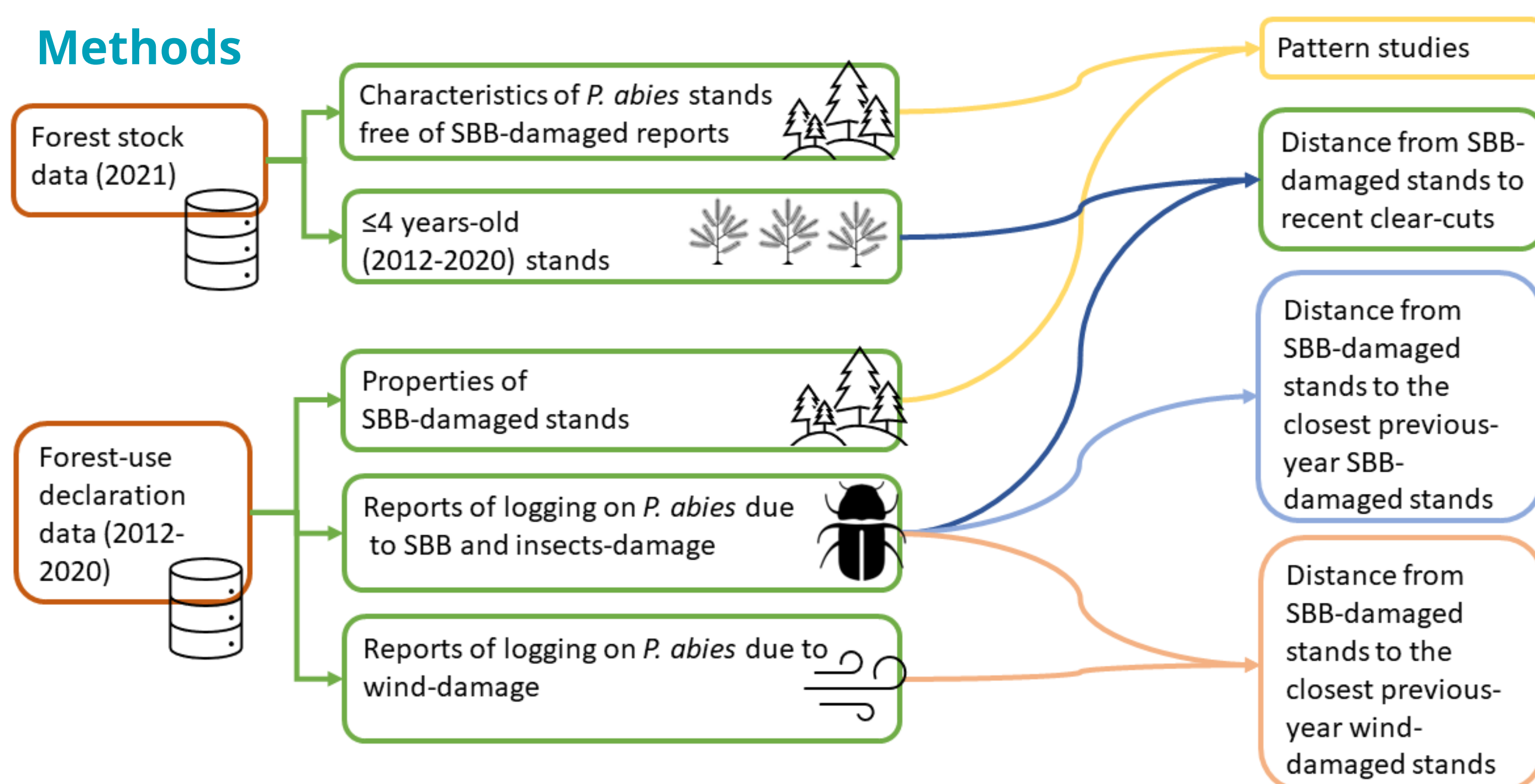


Fig. 1 Methodological workflow. We used Forest stock and Forest-use declarations datasets, covering all Finland (available from Metsäkeskus), and used stands ≤4 years-old as a proxy for recent clear-cuts.

Results

- The total number of harvesting operations due to SBB damage was 4,691, with an epidemic phase during 2013-2016.
- SBB showed preference for *semi-coarse or coarse heath forest soil* (Soil type), *mesic heath forests* (Fertility class) and *mature stands* (Development class) (Table 1).
- The annual number of SBB damage increased when approaching the closest clear-cut in a range of 0–5 km, modelled with GLMM ($p < 0.001$) (Fig. 2, Fig. 3).



Fig. 2 *Picea abies* wind-damaged stand which results later in a clear-cut.

Table 1 Comparison of SBB-damaged stands and *P. abies* stands free of its damage reports in terms of forest stand variables.

Stand variables	Statistic value	df	p-value
Soil type	$\chi^2 = 562.7$	13	<0.001
Fertility class	$\chi^2 = 109.6$	4	<0.001
Development class	$\chi^2 = 5661.9$	4	<0.001
Mean DBH >15 cm	U = 5137488938		<0.001
Mean age >25 years	U = 5128003		<0.001

Conclusions

- Soil type, fertility class, development class, mean DBH and mean age are critical for SBB damage.
- There is a clear linear relationship between the distance from clear-cuts to the closest SBB-damaged stands and the number of SBB damage.
- If the number of clear-cuts increases, it is expected that new SBB damage will appear in the nearby area.

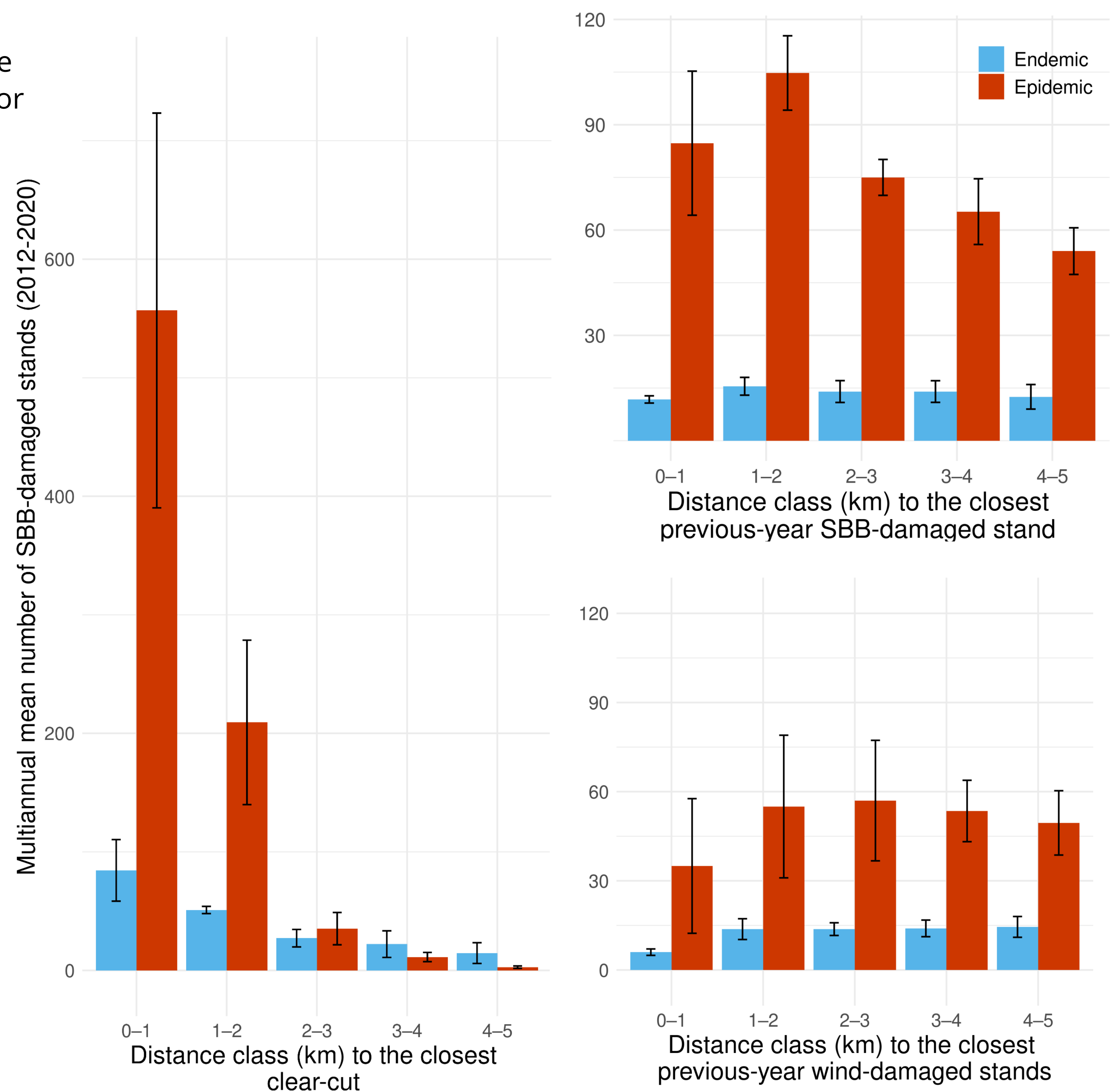


Fig. 3 Landscape attributes and annual mean number of SBB-damaged stands classified into five distance classes. Note the different y axis.

