

Supplementary material

Annex I. Study region: the Spanish Northern Plateau.

The Spanish Northern Plateau is a flat area in the North of Spain, mainly covering the basin of the river Duero. In this territory *Pinus pinea* occupies 50,000 ha, mainly in pure even-aged, public owned forests. Stands are found between 600 and 900 m a.s.l. Climate is Mediterranean continental, with an annual irregular distributed rainfall of 350 to 600 mm and mean annual temperature of 10.5 to 13.5 °C. Winters are cold and long (minimum mean temperature in January is −0.5 °C) and short but hot and dry summers (maximum mean temperature in July is 30.7 °C, 20 mm of rainfall). In the analysed period (2013-2022) mean annual temperature has experienced an increase in 1.5 °C and mean annual rainfall a reduction in 20 mm with respect to 1960-1990 period (Bravo, 2022). Soils are sandy (sandy lands in the flat sedimentary basin of the river Duero, formed by alluvial and eolic sediments, 85-90% sand content) or lime (alkaline shallow soils in the limestone plateaus, which are remains of non-eroded calcareous hills). Sandy lands show low soil fertility, with acidic-neutral pH and low water holding capacity. Limestone plateaus show medium fertility and medium to high water holding capacity due to a considerable clay content.

Pinus pinea stands in the Northern Plateau have been multifunctionally managed since the end of the nineteenth century, in order to jointly enhance cone and timber production. Traditional even-aged stand management in *Pinus pinea* is based on shelterwood systems, and early and heavy thinnings to promote anticipated cone production (Gordo et al., 2012). The Northern Plateau is considered as one of the regions with a larger tradition for cone and pine nut collection and industrial processing, conforming one of the hotspots for the commercial activity linked to this product (Calama et al., 2020a).

Table S1. Correlation coefficients (and associated p-value in *italics*) between the rates of damages due to pine cone moth (PCM) and western conifer seed bug (WCSB) and different correlations.

Predictor	Dam_PCM	Dam_WCSB	Predictor	Dam_PCM	Dam_WCSB
pp_annual	0.0034	-0.2956	t_min_annual	0.0165	0.1059
	<i>0.9551</i>	<i><0.0001</i>		<i>0.7838</i>	<i>0.0451</i>
pp_fall	-0.0621	-0.0333	t_min_fall	0.0390	-0.1299
	<i>0.3154</i>	<i>0.5268</i>		<i>0.5158</i>	<i>0.0132</i>
pp_winter	0.0612	-0.21821	t_min_winter	-0.0168	-0.1968
	<i>0.3074</i>	<i><0.0001</i>		<i>0.7800</i>	<i>0.0002</i>
pp_spring	-0.0006	-0.2762	t_min_spring	-0.0112	0.2122
	<i>0.9919</i>	<i><0.0001</i>		<i>0.8520</i>	<i><0.0001</i>
pp_summer	-0.0509	0.0500	t_min_summer	0.0523	0.0820
	<i>0.3954</i>	<i>0.3415</i>		<i>0.3831</i>	<i>0.1182</i>
Martonne	0.0056	-0.3061	t_max_annual	-0.0246	0.3815
	<i>0.9253</i>	<i><0.0001</i>		<i>0.6824</i>	<i><0.0001</i>
tm_annual	-0.0145	0.30600	t_max_fall	-0.0164	0.3583
	<i>0.8618</i>	<i><0.0001</i>		<i>0.7850</i>	<i><0.0001</i>
tm_fall	0.0151	0.3234	t_max_winter	-0.0773	0.2842
	<i>0.8007</i>	<i><0.0001</i>		<i>0.1974</i>	<i><0.0001</i>
tm_winter	-0.0636	0.1211	t_max_spring	-0.0207	0.3495
	<i>0.7642</i>	<i>0.0208</i>		<i>0.7295</i>	<i><0.0001</i>
tm_spring	-0.0180	0.3100	t_max_summer	0.0915	0.0349
	<i>0.7642</i>	<i><0.0001</i>		<i>0.1265</i>	<i>0.5060</i>
tm_summer	0.0056	0.0587			
	<i>0.9253</i>	<i>0.2642</i>			

Note: Dam_PCM (rate of severity due to pine cone moth), Dam_WCSB (rate of severity due to western conifer seed bug), pp (precipitation), tm (mean temperature), t_min (mean value of minimum temperatures), t_max (mean value of maximum temperatures).

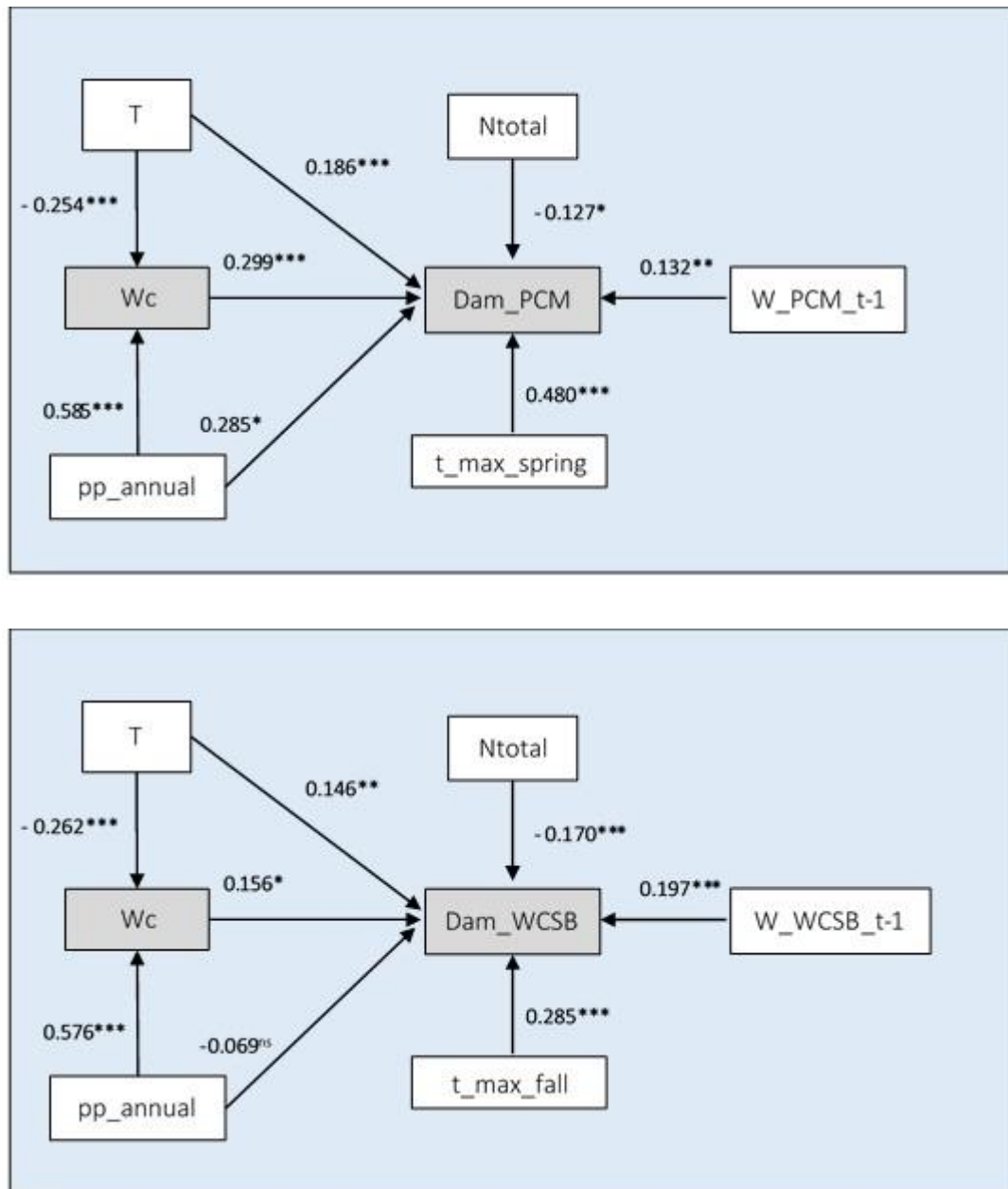


Figure S1. Final structure for the selected individual Structural Equation Models for: Dam_PCM (rate of severity due to pine cone moth, above), and Dam_WCSB (rate of severity due to western conifer seed bug, below). Arrows show the direction of the relation between variables, and the number the standardized parameter for the relation. Shaded cells represent endogenous variables and empty cell exogenous ones. *** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10, ns non-significant. Abbreviation : Ntotal (total number of cones per hectare), pp_annual (annual mean precipitation), T (stand age), tm_fall (mean temperature in fall season), t_max_spring (mean value of maximum temperatures in spring), Wc (average weight of a single

cone), W_PCM_t-1 (weight of cones per ha affected by PCM in the previous year), W_WCSB_t-1 (weight of pine nuts per ha affected by WCSB in the previous year).