

Spatial structure of natural boxwood and the invasive box tree moth can
promote coexistence

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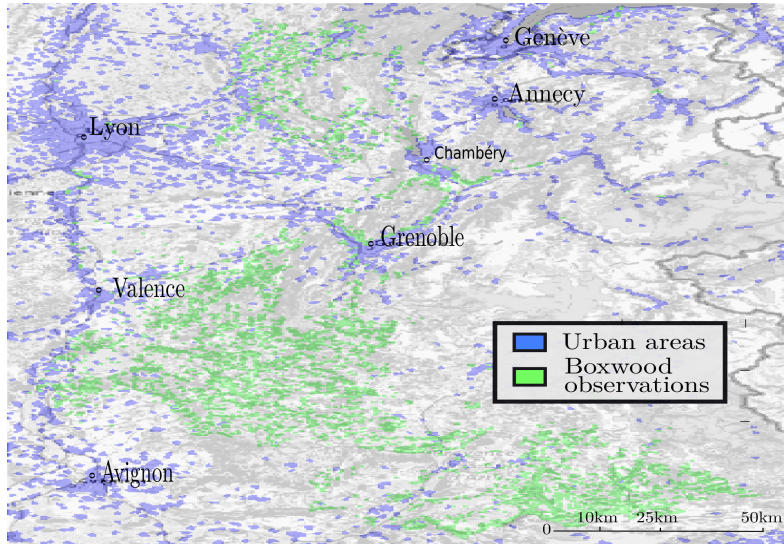


Figure 1: Simulation space of the cellular automaton representing the distribution of boxwood in the French alpine arc, based on data from the National Alpine Botanical Conservatory. 570 by 351 cells of 29 hectares each, about 58 000km².

					Rn : 0 Leaves : 1760 Larvae : 0	Rn : 0.07 Leaves : 1497 Larvae : 4	Rn : 0.13 Leaves : 2013 Larvae : 11	Rn : 0.25 Leaves : 1515 Larvae : 15		
Rn : 0.5 Leaves : 1886 Larvae : 38	Rn : 0.25 Leaves : 2129 Larvae : 21	Rn : 0.13 Leaves : 1553 Larvae : 8	Rn : 0.07 Leaves : 1683 Larvae : 5	Rn : 0 Leaves : 2021 Larvae : 0	Rn : 2 Leaves : 1987 Larvae : 160	Rn : 1 Leaves : 1660 Larvae : 67	Rn : 0.75 Leaves : 1370 Larvae : 41	Rn : 0.5 Leaves : 1841 Larvae : 37		
Rn : 0.75 Leaves : 1749 Larvae : 53	Rn : 1 Leaves : 1911 Larvae : 77	Rn : 2 Leaves : 2163 Larvae : 174	Rn : 0 Leaves : 2428 Larvae : 0	Rn : 0.07 Leaves : 2091 Larvae : 6	Rn : 0.13 Leaves : 2161 Larvae : 11	Rn : 0.25 Leaves : 2018 Larvae : 20	Rn : 0.5 Leaves : 2368 Larvae : 48	Rn : 0.75 Leaves : 1899 Larvae : 57		
Rn : 2 Leaves : 1711 Larvae : 137	Rn : 1 Leaves : 1694 Larvae : 68	Rn : 0.75 Leaves : 2121 Larvae : 64	Rn : 0.5 Leaves : 1644 Larvae : 33	Rn : 0.25 Leaves : 1960 Larvae : 20	Rn : 0.13 Leaves : 2021 Larvae : 11	Rn : 0.07 Leaves : 2536 Larvae : 7	Rn : 0 Leaves : 1609 Larvae : 0	Rn : 2 Leaves : 2220 Larvae : 178	Rn : 1 Leaves : 1645 Larvae : 66	

Figure 2: Schema of the mesocosm manipulation. R_n represents the competition for the resource. The spatial layout is due to the topography of the installation site

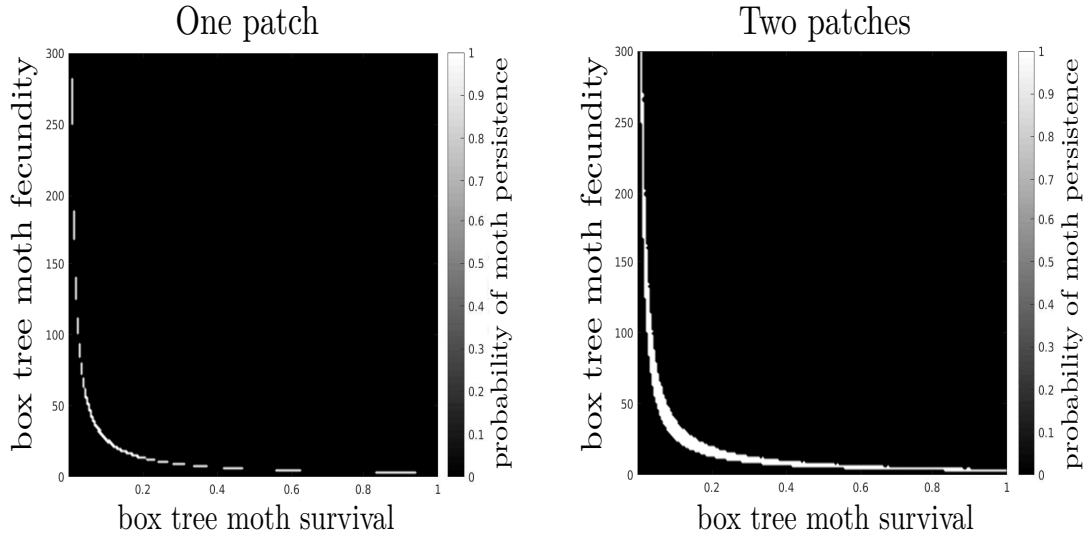


Figure 3: Final state map for the mean field model (left) and the double-patches model (right) as a function of fertility f and maximum survival $S_{m,max}$. The parameter values considered ecologically real are $f = 120$ and $S_{m,max} = 0.5$.

In the two-patch case, patches are initially saturated with boxwood, and the patch 1 contains just one moth. This spatialization of the model into two patches leads to new peculiar and rare end states at the frontier between coexistence and extinction which are not represented. We observe five states: i) overall disappearance of the moth and persistence of the boxwood (black) ii) global coexistence of the two species (white) iii) extinction of the moth and the boxwood in patch 1 and coexistence in patch 2, iv) extinction of only the moth in patch 1 and coexistence in patch 2, v) coexistence of the two species in patch 1 and the absence of moth in patch 2. It is important to note that cases iii) and iv) are not actually final states; the increase in simulation time shows that in fact the moth population in patch 2 decreases slowly until its extinction. For iii), after the extinction of the moth, the boxwood recovers in patch 2 until it reaches a state where it could disperse and recolonize patch 1. Moreover, before the moth extinction, during its decline the dispersal to patch 1 is still active, though low. Thus, in this situation patch 2 is a source of moths, and patch 1 is a well since migrating moths find no resource and die immediately. On the other hand, for iv), moth densities are too low in patch 2 and there is no dispersal towards patch 1. Cases iii) and iv) are not asymptotic states, but they are still taken into account because on an ecologically reasonable time scale they are actually present.

Nevertheless, except for the states i), global extinction of the moth, and ii), global coexistence of the two species, the other states are highly anecdotal because they correspond to only a few very precise parameter values and are almost invisible in the parameter space. What is remarkable in the space of parameters, however, is the slight expansion of the space corresponding to the coexistence of boxwood and moth