

Ecography

**ECOG-00448**

Matias, M. G., Gravel, D., Guilhaumon, F., Desjardins-Proulx, P., Loreau, M., Münkemüller, T. and Mouquet, N. 2014. Estimates of species extinctions from species–area relationships strongly depend on ecological context. – *Ecography* 37: xxx–xxx.

**Supplementary material**

805 **Appendix 1** Extended model description

806 *Individual-based simulation model*

807 Simulations were run with an individual-based model on a landscape grid where  
808 individuals competed for space (building on Gravel et al. 2006, Münkemüller et al.  
809 2012). The spatially explicit landscape was represented in a torus-shaped lattice of  
810 200 x 200 cells. Each cell  $x$  was characterized by its environmental condition  $E_x$ ,  
811 ranging between 0 and 100, and could host a single sessile individual. We considered  
812 equal dispersal kernels for all species in the species pool. However, each species,  $i$ ,  
813 was characterized by a specific offspring production rate,  $f_i$ , and a specific response  
814 curve of relative competitive performance along a gradient of environmental  
815 conditions.

816

817 Simulations were initialized by randomly distributing individuals from a pool of 200  
818 species (different species pools for different scenarios) across a landscape grid. Each  
819 time-step comprised 40000 successive updates of randomly selected cells to  
820 approximate continuous time dynamics (asynchronous updating). Each update of a  
821 cell started with mortality that randomly removed the resident individual (when the  
822 cell was occupied) with a rate of 0.1 and was followed by competition–colonization  
823 dynamics of recruitment. Recruitment either into empty space or by competitive  
824 replacement could occur following a lottery among candidate offspring (Chesson and  
825 Warner 1981). Offspring of a focal species could be part of the lottery for a vacant  
826 cell if (1) 'offspring rain' of the focal species was greater than zero, (2) there was no  
827 superior competitor already established (competitive performance depended on the  
828 match between environment and the species' niches), (3) the local environment was  
829 suitable enough for establishment and (4) the overall amount of 'offspring rain' from  
830 all species was sufficient. The size of offspring rain of species  $i$  for cell  $x$  was given  
831 by:

832

$$833 O_{ix} = \sum f_i w(d_{xy}) n_{iy} + I$$

834

$$835 \text{ with } w(d_{xy}) = \exp(-0.5 d_{xy})$$

836

837 Where the dispersal kernel  $w(d_{xy})$  is a function of the Euclidean distance,  $d_{xy}$ ,  
838 between cells  $x$  and  $y$ , and  $n_{iy}$  is abundance of species  $i$  in cell  $y$  (0 for absence, 1 for  
839 presence). We allow immigration from outside the lattice at rate  $I=0.001$  (Loreau and  
840 Mouquet 1999). We simulated dispersal dynamics with a radius of 5 cells and used a  
841 negative exponential dispersal kernel,  $w(d_{xy})$ . When a species successfully reached a  
842 cell, competitive interactions occurred between the resident individual (when the cell  
843 was occupied) and the offspring reaching the cell. An offspring could establish and  
844 replace the resident if its local competitive performance was larger than the one of the  
845 resident, mimicking resource competition as in earlier models of competition–  
846 colonization dynamics (Tilman 1994). An individual's competitive performance was  
847 determined by the local environmental condition,  $E_x$ . We used a gaussian survival  
848 function to describe the local competitive performance:

849

$$850 \lambda_{ix} = h_i \exp(- (E_x - \mu_i)^2 / (2\sigma_i^2))$$

851

852 Where  $h_i$  is the species maximal performance at optimal environmental conditions  
853 corresponding to the niche optimum  $\mu_i$ . The parameter  $\sigma_i$  is niche breadth and  
854 described species as generalists or specialists. For empty patches, we set a boundary  
855 minimal performance for an offspring to establish to avoid occupation of unsuitable  
856 empty cells ( $\lambda_{ix}$  must be larger than the threshold value 0.1). Additionally, cells could  
857 stay empty if the overall amount of 'offspring rain' from all species was too small. We  
858 simulated this by using a probability equal to the total number of offspring from all  
859 neighbours divided by the expected number of offspring from all neighbours  
860 (calculated by assuming a fully occupied grid and an average offspring production  
861 rate). This ratio was set to one if it was greater than one. Finally, there was lottery  
862 competition among the offspring that successfully entered the cell. Chances of each  
863 species to establish were proportional to the relative amount of offspring rain. Thus,  
864 after each update, cells could stay empty, switch to an empty state due to mortality,  
865 and keep their original individual in case no colonizer could establish, or change to  
866 another species when there was a successful colonizer. We ran the simulations with  
867 5000 time-steps that were sufficient to create equilibrium dynamics.

868

869 Following these initial simulations, we did additional simulations following habitat  
870 loss. In particular, we use the equilibrium species distributions generated by the  
871 model described above, and run new independent simulations based on the endpoints  
872 of the previous simulations. Thus, based on each simulation run we generated 21  
873 replicates of each distribution of environmental conditions and species distributions  
874 patterns and implemented a gradient of habitat loss that ranged from 0 (no habitat  
875 loss) to 1 (complete habitat loss). Habitat loss consisted in removing the occupying  
876 species and, in order to make it a permanent feature of the landscape, setting  
877 environmental values outside the environmental range of any of the species niche  
878 range, thus making it impossible for any species to recolonize those cells.

### 879 *Simulating environmental patterns*

880 We used two different algorithms to generate environmental patterns by manipulating  
881 the distribution of environmental conditions (ranging from 0 to 100). The “random  
882 environmental pattern” was generated by randomly drawing environmental conditions  
883 for each cell from a uniform distribution of environmental conditions. The  
884 “autocorrelated environmental pattern” was generated using spatio-temporal gaussian  
885 random fields (package RandomFields, software R with mean of 50, variance of 200,  
886 scale of 10, i.e. spatial extend of autocorrelation, and alpha of 2, i.e. covariance of  
887 autocorrelation; Schlather 2012). This algorithm is based on a semi-variogram and  
888 allows setting the parameter "range" which determines how far the variance is  
889 invariant to the distance between the points. This “range” parameter is analogous to  
890 the “grain” of the environmental pattern.

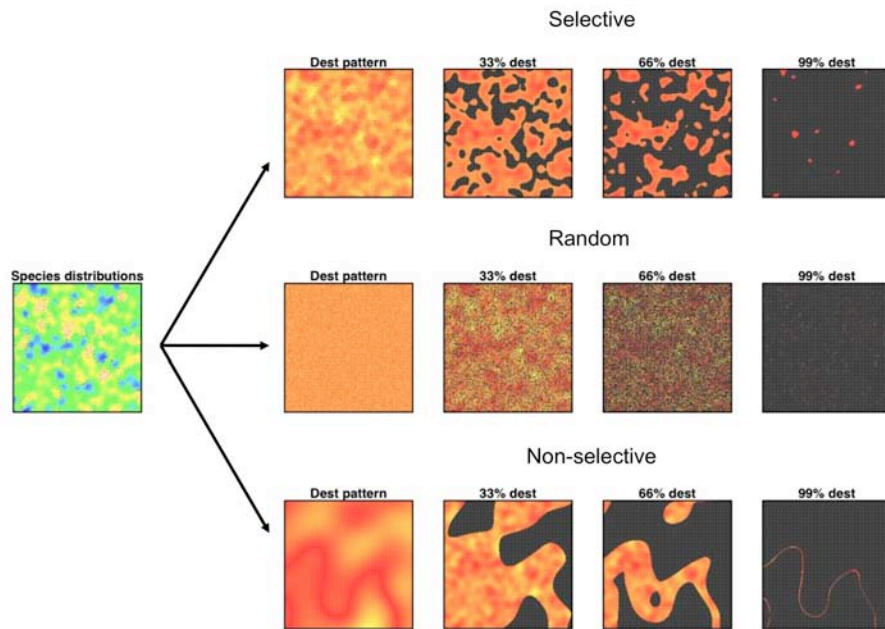
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### 892 References

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907 **Appendix 2** Types and magnitude of habitat loss  
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910

911 Figure A2 – Types of habitat loss: selective, non-selective or random. Selective  
912 habitat loss represents the destruction of patches by habitat type, which mimics  
913 certain types of targeted deforestation or resource exploration. Non-selective habitat  
914 loss completely disregarded the distribution of environmental conditions and  
915 gradually spreads across the landscape (e.g. volcano eruptions, indiscriminate  
916 deforestation patterns). Random habitat loss has no particular spatial structure or  
917 relationship to the distributions of environmental conditions. Black cells indicate  
918 destroyed areas.

919

920 **Appendix 3**

921 Table A3 – Deviations (in %) of area-based estimates (SAR and EAR), and instantaneous measures for different coexistence mechanisms and  
 922 distributions of environmental conditions and for all three different patterns of habitat loss (selective, random or non-selective). Values indicate  
 923 overall averages across all replicates of the average deviation across the habitat loss range in each replicate; values inside brackets indicate the  
 924 range of estimation values (i.e. average maximum and average minimum deviation). Negative values indicate an underestimation of species  
 925 loss.

Estimates	Habitat loss	Coexistence mechanisms / Environment					
		Species sorting		Trade-off		Neutral	
		Autocor.	Random	Autocor.	Random.	Autocor.	Random.
SAR	Selective	-19,68 (-0,35:-37,82)	-21,88 (0,06:-62,13)	1,67 (23,67:-6,12)	1,53 (22,85:-7,11)	-0,36 (17,96:-8)	-0,39 (15,41:-7,29)
	Random	-4,66 (5,69:-20,38)	-8,04 (0,22:-34,06)	1,41 (22,63:-7,05)	1,39 (22,86:-6,61)	-0,57 (16,13:-8,22)	-0,5 (16,86:-7,4)
	Non-selective	-3,21 (2,08:-10,42)	-4,05 (0,33:-15,87)	-1,09 (2,41:-4,67)	-1,1 (4,12:-5,11)	-2,07 (0,61:-5,76)	-2,55 (0:-7,81)
EAR	Selective	-58,76 (1,47:-88,94)	-61,52 (0,45:-97,88)	-36,98 (0,45:-91,19)	-37,3 (0,45:-91,87)	-39,01 (0,5:-96,44)	-39,06 (0,5:-96,39)
	Random	-44,25 (0,62:-92,36)	-47,64 (0,5:-96,82)	-37,28 (0,39:-91,36)	-37,4 (0,5:-92,26)	-39,23 (0,5:-96,28)	-39,17 (0,5:-96,22)
	Non-selective	-42,81 (0,62:-89,31)	-43,69 (0,45:-96,54)	-39,57 (0,73:-91,06)	-39,79 (0,67:-92,08)	-40,72 (0,5:-96,28)	-41,22 (0,5:-95,94)
Instantaneous	Selective	-6,49 (-0,35:-10,78)	-4,3 (0,06:-7,98)	-8,36 (2,95:-38,13)	-8,59 (2,28:-36,64)	-14,04 (0:-59)	-14,32 (0:-59,56)
	Random	-22,8 (0,49:-69,72)	-18,24 (0:-67,52)	-9,03 (1,56:-37,72)	-8,79 (1,73:-37,77)	-14,6 (0:-61,33)	-14,49 (0:-60,67)
	Non-selective	-13,59 (0,49:-42,43)	-10,74 (0,33:-43,56)	-7,04 (0,22:-21,13)	-7,25 (0,28:-22,54)	-11,38 (0,06:-35,06)	-12,09 (0:-37,06)