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Appendix 1

Calculation of system saturation and definition of scenarios

In this appendix we explain how the termination criterion CFA, consecutively failing animals before simulation stops, is related to system saturation.

The effect of CFA was always analyzed in steps of 2 units from 0 to 5000 for rapidly saturating scenarios with power-law body mass input distribution, and in steps of 20 units from 0 to 50 000 for slowly saturating scenarios with uniform input distribution; separately for each of the five replicates. The maximum values of CFA were chosen to avoid extremely long computing times without anymore significant changes (Fig. A1). A simple and direct community measure, the number of individuals, shows a clear saturation effect with increasing CFA.

The saturation level of the total number of animals NoAn was estimated by fitting a Michaelis–Menten kinetics saturation curve (Monod function) using non-linear least-squares regression (Gauss–Newton algorithm)

$$\text{NoAn} = \frac{a \times \text{CFA}}{b + \text{CFA}} \qquad \text{(A1)}$$

For scenarios with uniform input distribution the model fitted the data perfectly. For scenarios with other power-law input distributions the curve showed very fast saturation. By only considering NoAn values > 0.8 × NoAn (CFA = 5000) for the fit we also achieved very good agreement between model and data for these scenarios (Fig. A1); lower saturations were not considered for these scenarios anyway for reasons of stochasticity.

We then can calculate a saturation level in terms of animal numbers or community-level carrying capacity

$$\text{SATan} = \frac{\text{NoAn}}{a} \qquad \text{(A2)}$$

where a is the asymptote of the saturation curve and so the number of successful animals the model predicts at complete saturation.

For a defined series of SATan values (between 0.3 and 0.99) the corresponding CFA was then derived for each scenario in order to be used as equivalent termination criterion for simulations. A specific combination of parameters (resource availability to community and individuals and the input distribution) and one specific level of saturation (SATan) are regarded as a scenario. We only analyzed scenarios with a corresponding CFA within the range used for the saturation fit (i.e. up to 5000 or 500 000, dependent on the choice of input distribution). When steep input distributions were used saturation was reached at extremely low CFA and the stochastic effect of the input distribution then dominated simulation results at low saturation. We therefore discarded scenarios with CFA < 3 to eliminate most of this stochastic effect and guarantee comparability between different scenarios.

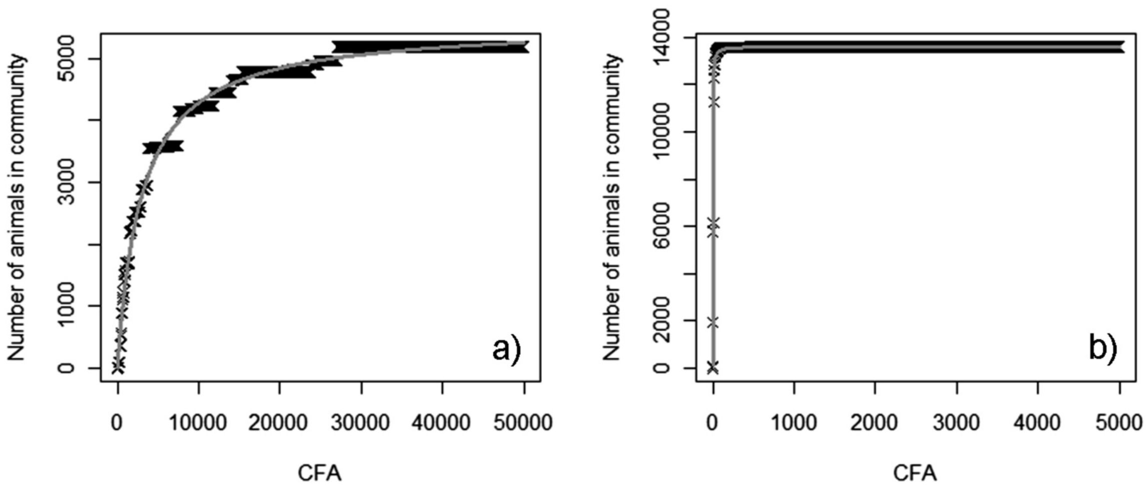

Figure A1. Illustration of the relationship between number of animals in the community and *CFA*, the number of consecutively failing animals used as a termination condition for the simulations. (a) shows one replicate of a simulation with uniform input distribution, (b) with power-law input distribution (exponent –1.2), both with γ_{PI} of 10×10^{-2}. The light grey line shows the fitted Monod model.

Appendix 2

Analysis of validation data

Table A2.1. Analysis of validation data for the scaling exponent of species richness and individual abundance by a maximum likelihood fit of a power-law probability density function.

	Species no.			Individual no.		
	Min. exponent	Max. exponent	Mean exponent	Min. exponent	Max. exponent	Mean exponent
Patch (n = 5)	–1.23	–1.03	–1.09	–1.79	–1.46	–1.59
Biome (n = 5)	–1.15	–1.06	–1.11	–1.71	–1.43	–1.54
Region (n = 6)	–1.08	–1.02	–1.05	–1.89	–1.51	–1.68
Overall (n = 16)	–1.23	–1.02	–1.08	–1.89	–1.43	–1.61

Fits from 5 g to 100 kg (the body mass range in the model); only species within this range were considered. Species data for five different North American biomes (riparian forest, coniferous forest, desert, shrub swamp, and talgrass prairie) and of five homogeneous patches within these biomes from Brown and Nicoletto (1991); species data for six different rather heterogeneous regions in Australia from Burbidge and McKenzie (1989); primarily insectivorous and carnivorous as well as aerial species were excluded before analysis. Relative number of individuals for the fit of individual abundance was calculated for each species by applying allometric equations for population density with exponents of –0.75 and –1 to all communities; Shown results are summaries from all these different fits.

Table A2.2. Analysis of validation data for the scaling exponent of species richness and individual abundance by a maximum likelihood fit of a power-law probability density function. Only species with body mass > 100 g are considered for this analysis.

	Species no.			Individual no.		
	Min. exponent	Max. exponent	Mean exponent	Min. exponent	Max. exponent	Mean exponent
Patch (n = 5)	–1.21	–0.92	–1.09	–3.14	–1.15	–1.99
Biome (n = 5)	–1.31	–1.12	–1.20	–2.45	–1.70	–2.08
Region (n = 6)	–1.21	–0.77	–1.01	–2.58	–1.02	–1.95
Overall (n = 16)	–1.31	–0.77	–1.10	–3.14	–1.02	–2.00

Fits from 100 g to 100 kg; only species within this range were considered. Species data for five different North American biomes (riparian forest, coniferous forest, desert, shrub swamp, and talgrass prairie) and of five homogeneous patches within these biomes from Brown and Nicoletto (1991); species data for six different rather heterogeneous regions in Australia from Burbidge and McKenzie (1989); primarily insectivorous and carnivorous as well as aerial species were excluded before analysis. Relative number of individuals for the fit of individual abundance was calculated for each species by applying allometric equations for population density with exponents of –0.75 and –1 to all communities; Shown results are summaries from all these different fits.

Table A2.3. Number of species and individuals in validation communities.

	Species no.			Individual no.		
	Min. no.	Max. no.	Mean no.	Min. no.	Max. no.	Mean no.
Patch (n = 5)	16	22	19.0	9455	21153	13742
Biome (n = 5)	40	86	65.6	21918	64258	44635
Region (n = 6)	9	24	16.7	7687	16653	11580
Overall (n = 16)	9	86	32.7	7687	64258	22585

Values given are for species with a body mass between 5 g and 100 kg. Species data for five different North American biomes (riparian forest, coniferous forest, desert, shrub swamp, and talgrass prairie) and of five homogeneous patches within these biomes from Brown and Nicoletto (1991); data for six different rather heterogeneous regions in Australia from Burbidge and McKenzie (1989); primarily insectivorous and carnivorous as well as aerial species were excluded before analysis. Number of individuals is per km^2 and was calculated for each species by applying a reported allometric equation for population density after Damuth (1981b) for mammals.