Water, water everywhere? Solutions to modelling the autocorrelated distribution of ubiquitous Amazonian vertebrates

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Abstract: Making and breaking species distribution models (SDMs) continues to inspire statistical ecologists, however the speed of statistical advances means that the application of SDM methods is often limited by uncertainty regarding model and parameter selection. To compare and evaluate SDM methods (MaxEnt, LASSO penalized point process and Ensemble models) we simulated empirically informed species distributions and ecological sampling patterns. Analysis of simulation results was used to identify the statistical and ecological adequacy of the SDM methods and derive a modelling framework that generates reliable SDMs based on the classification of (i) species distribution and (ii) sample properties. We then challenged this framework by modelling data that violate key SDM assumptions. The presence and absence of 30 species of mid- and large-bodied vertebrates was obtained during 7 years of field surveys in two Amazonian field sites – one terrestrial and one riparian. The "terrestrial" site is a 360 km^2 area located within the Brazilian arc of deforestation. A total of 7904 camera trap days, 4900 track-station nights and 2739 km diurnal line transect census were used to sample forest fragments, corridors, and matrix. The "riparian" site traverses a protected area, and we used 6836 km of boat census to survey 165 km of waterways with a steep gradient in anthropogenic disturbances. We cannot assume that the sampled species are at equilibrium nor that sample locations are spatially independent. The results of the SDM analyses using our framework were compared to Bayesian occupancy model predictions that specifically included spatial autocorrelation and differences in detection probabilities. We found that with certain modifications the SDM framework developed was robust to violations of these key SDM assumptions. It remains to be seen whether this framework can be generalized to different scales or different species groups.