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Wildfire, landscape diversity and the Drossel-Schwabl model

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A debate was sparked by a seminal publication in 1998 whether the interaction of wildfire and vegetation recovery can be captured by an abstract model from statistical physics, the Drossel-Schwabl forest fire model. This debate has since then mainly focused on the frequency-area statistics of wildfires. We test whether this model, henceforth referred to as DSM, produces ecological patterns which were not considered in its design by modifying it to include succession. Rather than looking at the frequency-area statistics of fires, we focus on the mosaic of succession stages on the landscape created by fire. Landscape pattern emerges from the dynamics and is not enforced.

A study of fire disturbed boreal forests in Ontario, Canada, concluded that the diversity pattern of succession stages as a function of average annual area burned peaks at an intermediate level. This observation, known as intermediate disturbance hypothesis, has been made in several other ecological systems which are prone to disturbance, such as coral reefs and tropical rain forests. If the DSM captures important interactions between wildfire and vegetation recovery, it should produce this pattern effortlessly. To test for the pattern, we used four succession models developed for actual forests in Wyoming, Montana and Michigan, USA, and Douglas-Hemlock forests in Canada.

We concisely state how the quantities in the DSM relate to quantities of actual wildfire systems and the logic underlying the predictions. We show, both analytically and by simulation, that the DSM does indeed produce hump shaped disturbance-diversity curves for all four succession scenarios. We discuss the DSM, and its limits, in this context.