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Secondary seed dispersal by vehicles: simulating colonization on a heterogeneous landscape.

The importance of secondary dispersal of seed by vehicles is often assumed but little quantified. We completed a controlled experiment on seed loss from a vehicle and used these data in a simulation model to evaluate dispersal over space and time on a number of different landscapes. In the controlled seed loss experiment we placed a known amount of seed and soil slurry onto 0.1 m^2 plates that were then dried and attached to the chassis of a vehicle. The vehicle was driven set distances on paved and unpaved road surfaces under wet and dry conditions after which the plates were removed and number of remaining seeds quantified. Three different locations on the vehicle were assessed: bumpers, wheel wells and underside. Seven different long distance dispersal functions were fit to the data and the best model evaluated for road surface and condition, and location on the vehicle as well as for the total vehicle. Overall more seed were dispersed under wet conditions than dry, and on unpaved than paved roads. The dispersal functions for the four different road conditions were included in a cellular automata model with spatially heterogeneous population dynamics. In addition to basic population dynamics parameters (including reproduction and transition rates between seedbank and flowering plants), the model had a spatial component where dispersed seed survival was a function of environmental suitability. Two different dispersal curves were used as a result of fitting the empirical data. The proportion of seed which could be secondarily dispersed was set, between 10 % and 2%, to represent wet and dry vehicle accumulation and dispersal respectively. There were three simple underlying landscapes, all with a linear feature (road) horizontally dissecting the 7 cell x 3020 cell landscape, with the most suitable habitat located along the road feature. Cell size represented 1 km^2. The model was run for 20 generations and replicated 50 times for each scenario. While the details of the model results cannot be fully explained here, the model does demonstrate the importance of understanding secondary dispersal by vehicles in addition to environmental suitability for successfully predicting invasions. The improved understanding of the rate of seed loss, and distance and shape of vehicular secondary seed dispersal curves we have gained through this empirical and simulation exercise could help guide survey methods for newly invading species and development of prevention protocols.