

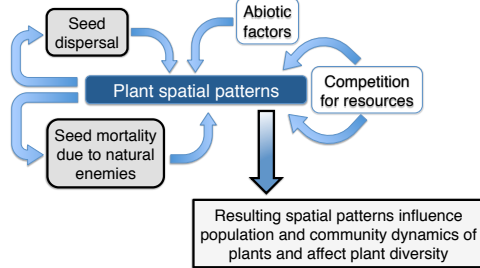
The interacting effects of clumped seed dispersal and distance- and density-dependent mortality on seedling recruitment patterns

Noelle C. Beckman¹, Claudia Neuhäuser², & Helene Müller-Landau³

¹Mathematical Biosciences Institute, ²University of Minnesota-Rochester, ³Smithsonian Tropical Research Institute

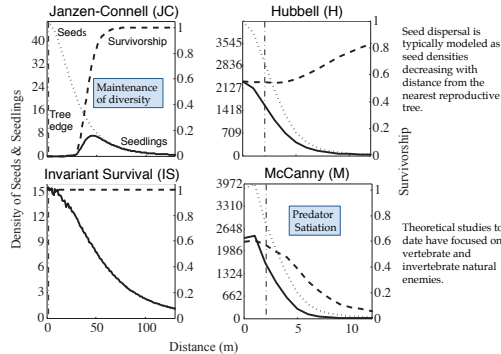
INTRODUCTION

Processes that contribute to spatial patterns of tree species

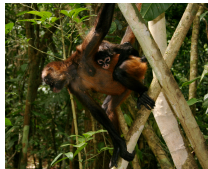


Question: How do patterns of seed dispersal and patterns of seed mortality by natural enemies influence spatial patterns of plants?

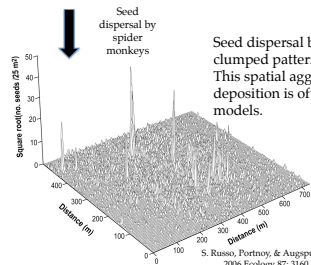
Recruitment patterns resulting from natural enemy attack



Seed dispersal by vertebrates.



80-90% of tropical plants vertebrate-dispersed
60% of all angiosperms are dispersed by biotic means

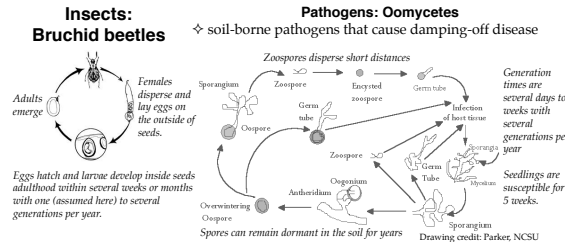


S. Russo, Portnoy, & Augspurger 2006 Ecology 87: 3160

Differences in the life histories and movement of natural enemies determine their ability to track seeds and seedlings through space and time. Specialized natural enemies are hypothesized to be critically important for shaping plant spatial patterns and maintaining plant diversity. Although soil-borne pathogens have been found to play a critical role in seedling survival, previous studies have not determined their influence on seedling recruitment patterns.

MODEL ORGANISMS

Both bruchid beetles and oomycetes are a major cause of plant mortality in agricultural and natural systems and tend to have a narrow range of hosts.



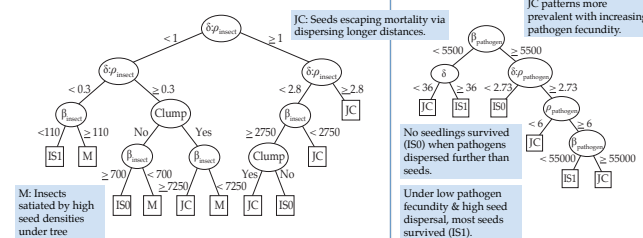
RESULTS

Insects

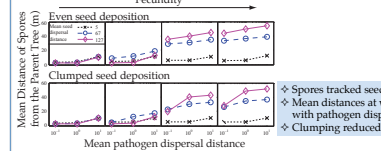
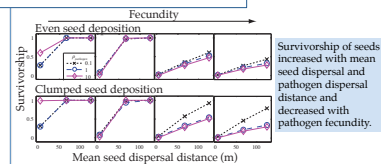
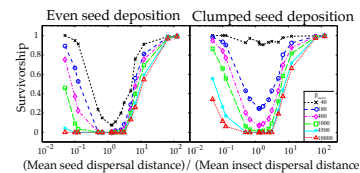
Pathogens

Factors important for recruitment patterns

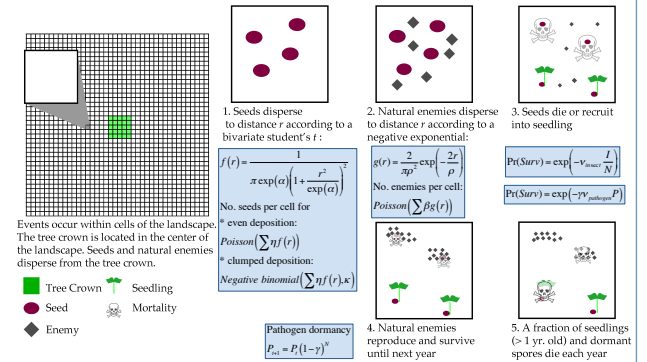
Identified using decision trees. IS0 indicates no seedlings survived. IS1 indicates 99% of seeds survived. δ is the mean dispersal distance of seeds.



Survivorship of seeds



MODEL PROCESSES: A spatially explicit simulation model



PARAMETER DESCRIPTIONS

Model Organism	Parameters	Values
Plant	Crown area	25 m ²
	α , Seed dispersal distance parameter*	2.3 (5, 4.7), 7.5 (67, 49), 8.75 (125, 72) m
	σ , Dispersion parameter for seed deposition	0.1
	η , Tree fecundity	10,000 m ⁻²
	α_0 , Annual seedling mortality	0.5
Insect	β_{insect} , Mean dispersal distance*	1 (1, 1), 10 (9.7, 40) (39), 50 (48), (76) m
	β_{insect} , Fecundity	40, 180, 400, 1000, 4500, 10000 eggs
	V_{insect} , Infectivity	0.2
Pathogen	Dispersal events within a fruiting season	4
	$\beta_{pathogen}$, Mean dispersal distance*	0.1 (0.14), 1 (1, 1), 10 (9.7) m
	$\beta_{pathogen}$, Fecundity	1000, 10000, 100000, 200000 spores
	$V_{pathogen}$, Infectivity	0.01
	γ , Probability of encountering one seed	0.0001
	μ , Annual mortality of dormant spores	0.9

CONCLUSIONS

Our modeling study suggests that the relative dispersal distances of seeds and natural enemies are crucial to determining establishment rates and spatial patterns of seedlings.
Better characterization of the movement and natural histories of natural enemies is critical to improving our understanding of seedling distributions and plant-enemy interactions.

ACKNOWLEDGEMENTS

National Science Foundation
University of Minnesota
Packard Fellowship in Science and Engineering
HSBC Climate Partnership

Published in *Journal of Ecology* 100 (4): 862-873
Contact: beckman.57@osu.edu
Website: www.noellebeckman.com