

The Influence of Soilborne Pathogens on Seedling Mortality

Eric Sodja
Dr. Noelle Beckman

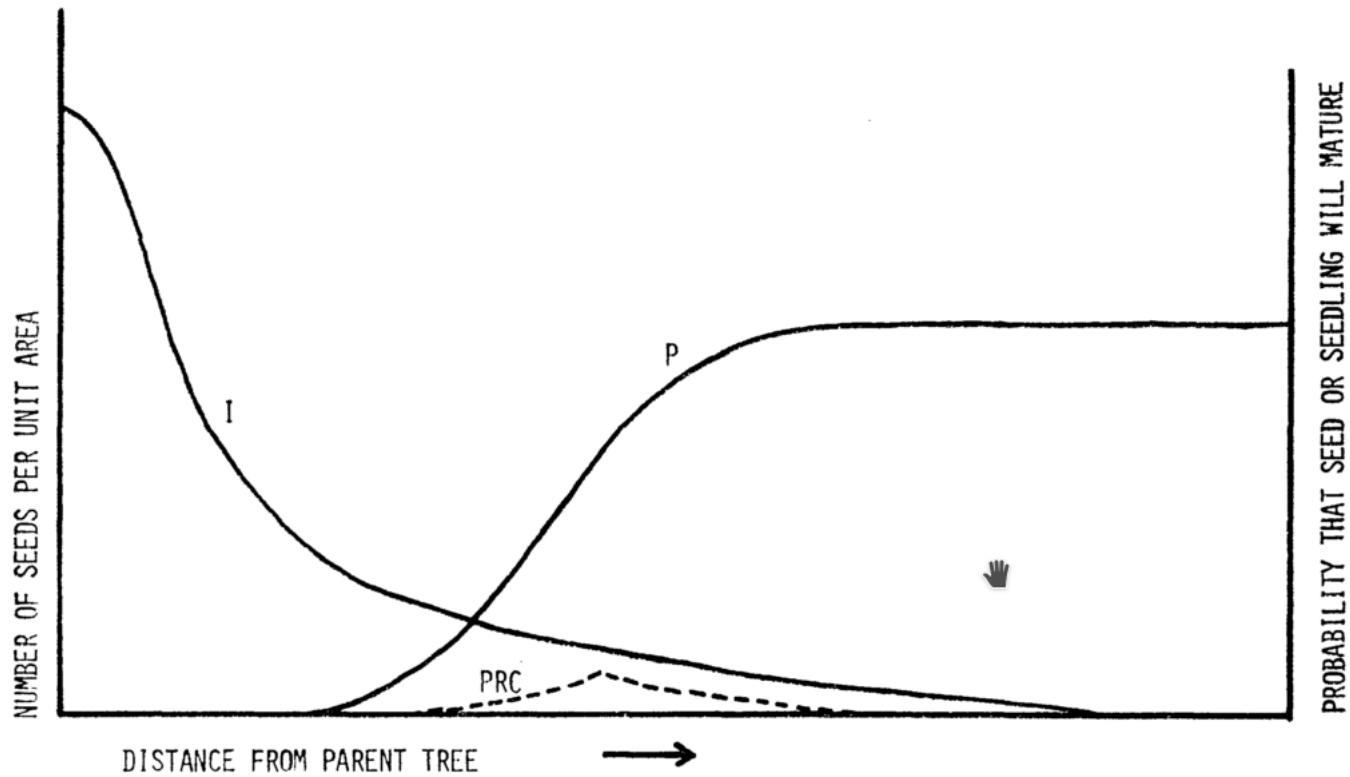


Diversity

- **One of the fundamental questions of ecology**
- **Proposed contributors:**
 - Habitat complexity
 - Niche differentiation
 - Specialized predators and pathogens



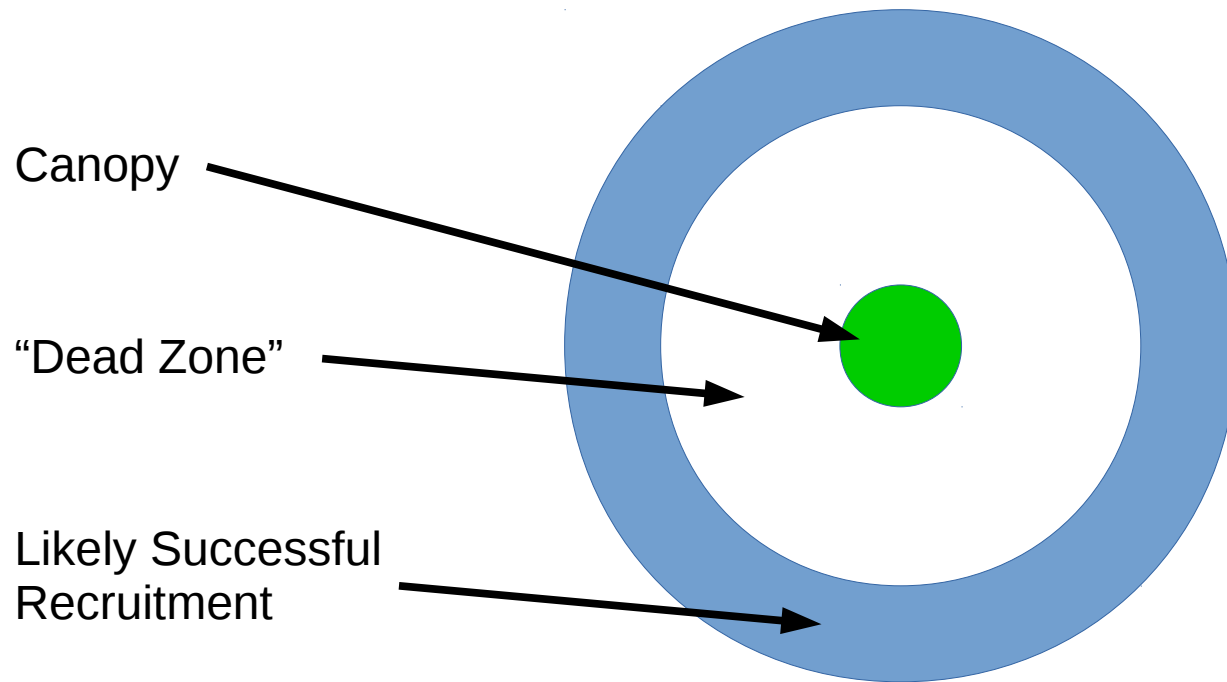
Janzen-Connell Effect



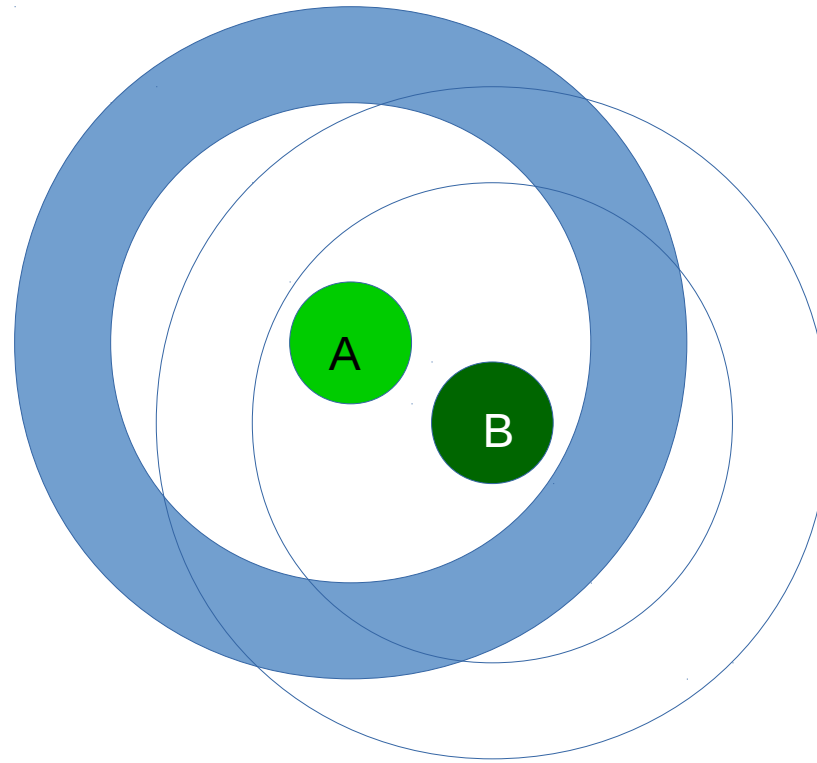
(Janzen, 1970)



Janzen-Connell Effect



Janzen-Connell Effect



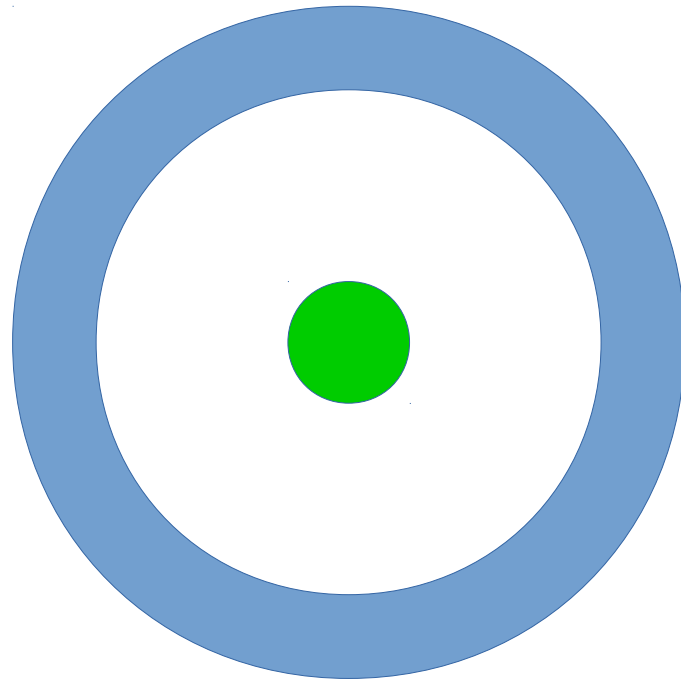
The “Dead Zone” of species A opens a gap for species B



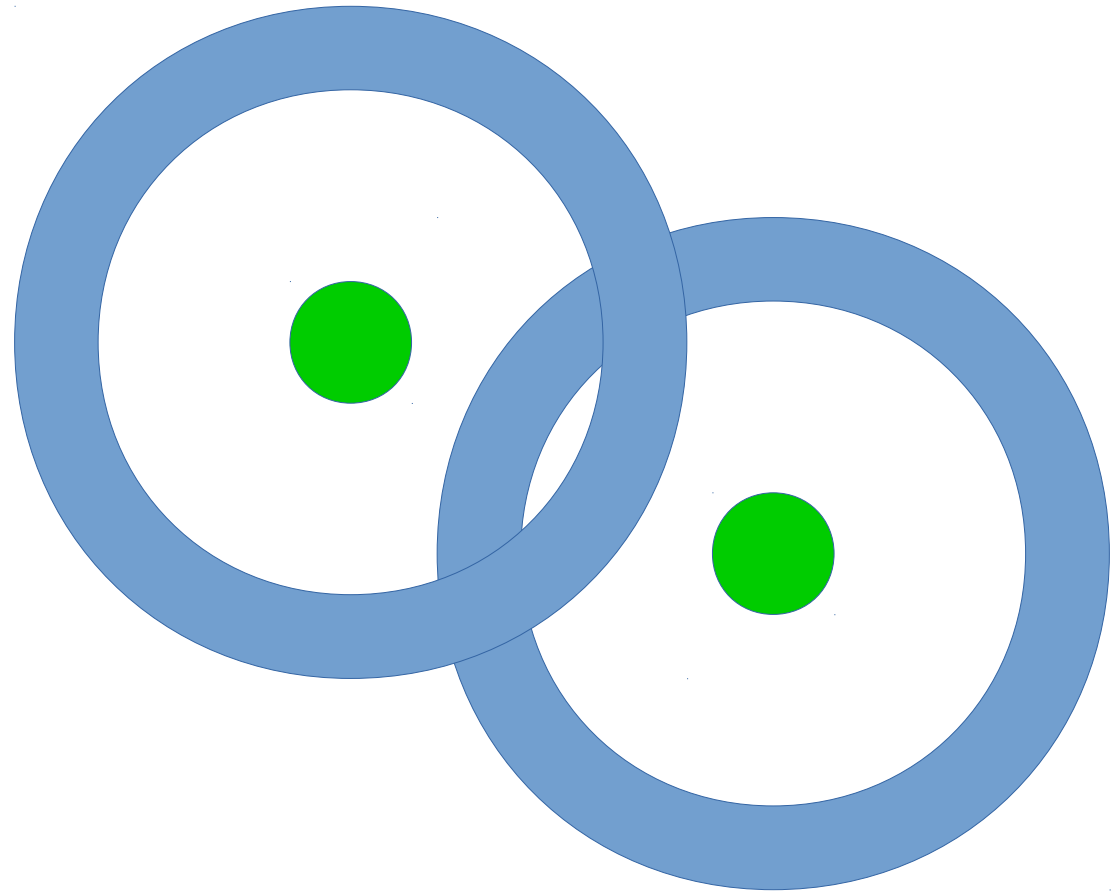
How do emergent patterns at the population level affect patterns of seedling recruitment?



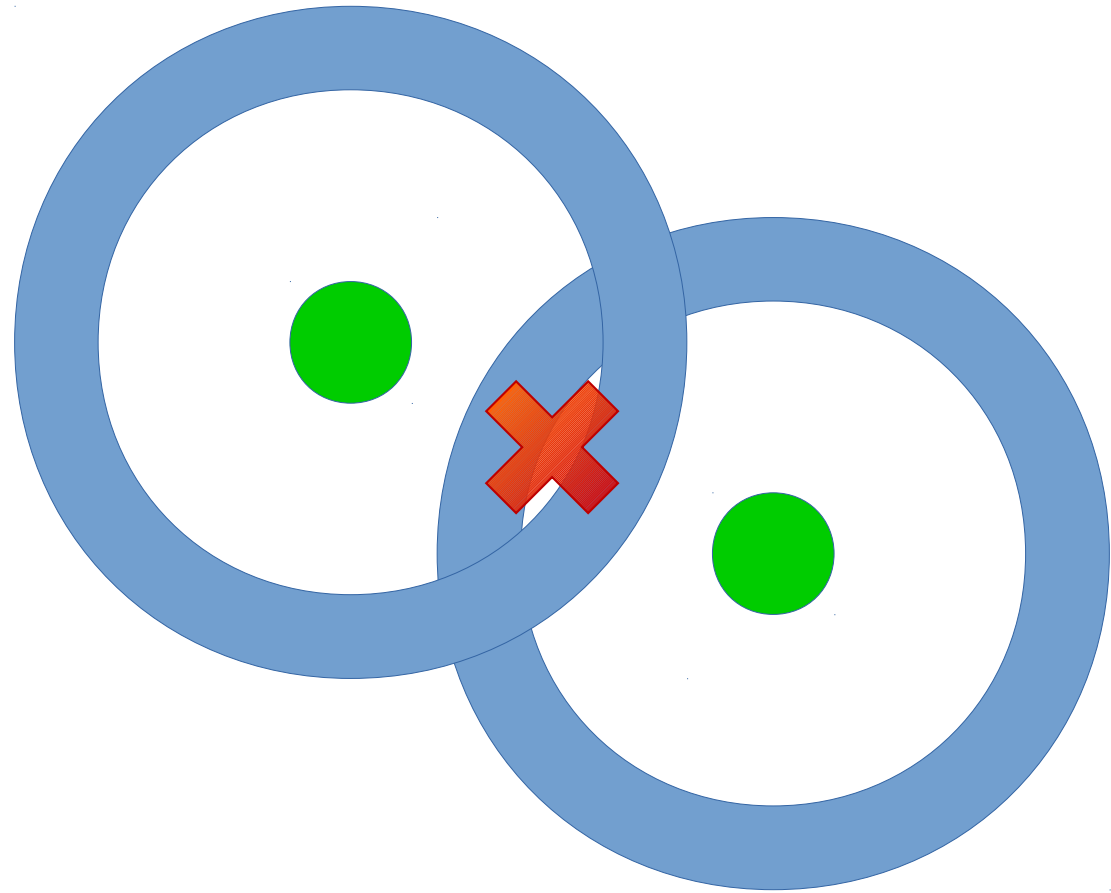
Emergent Patterns



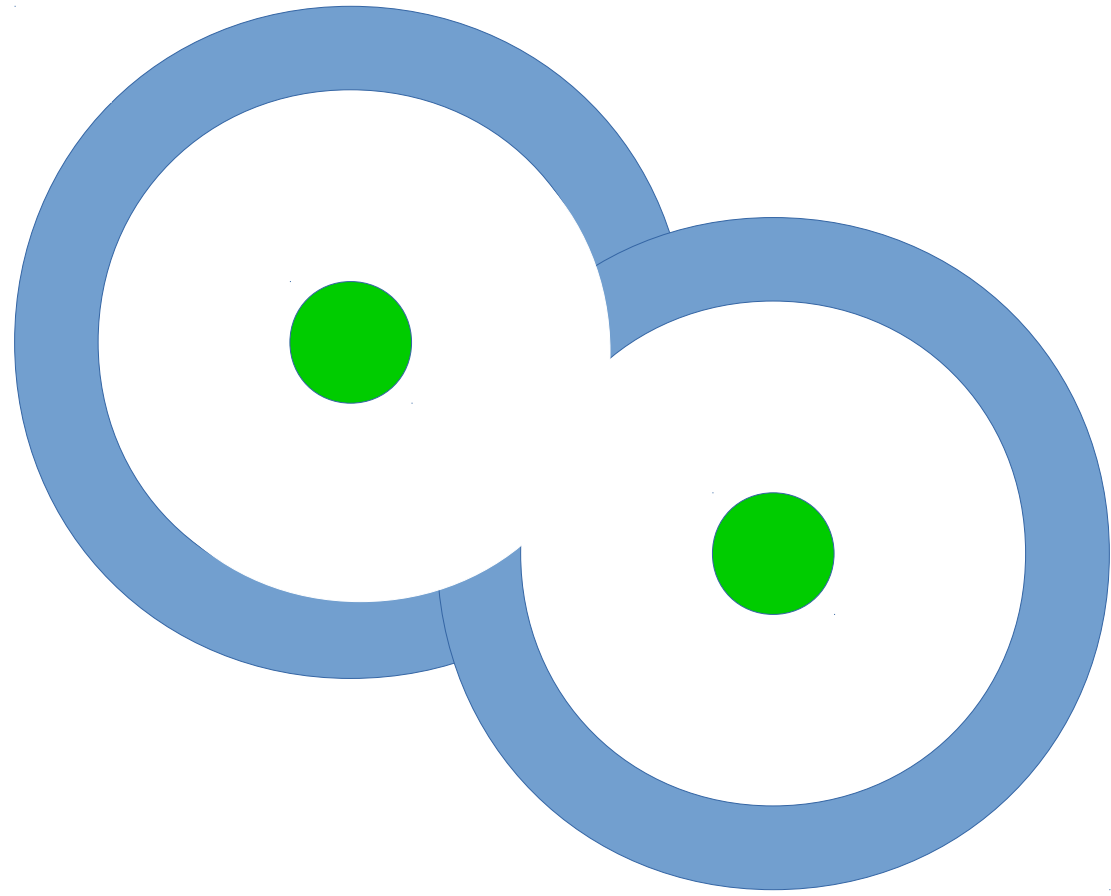
Emergent Patterns



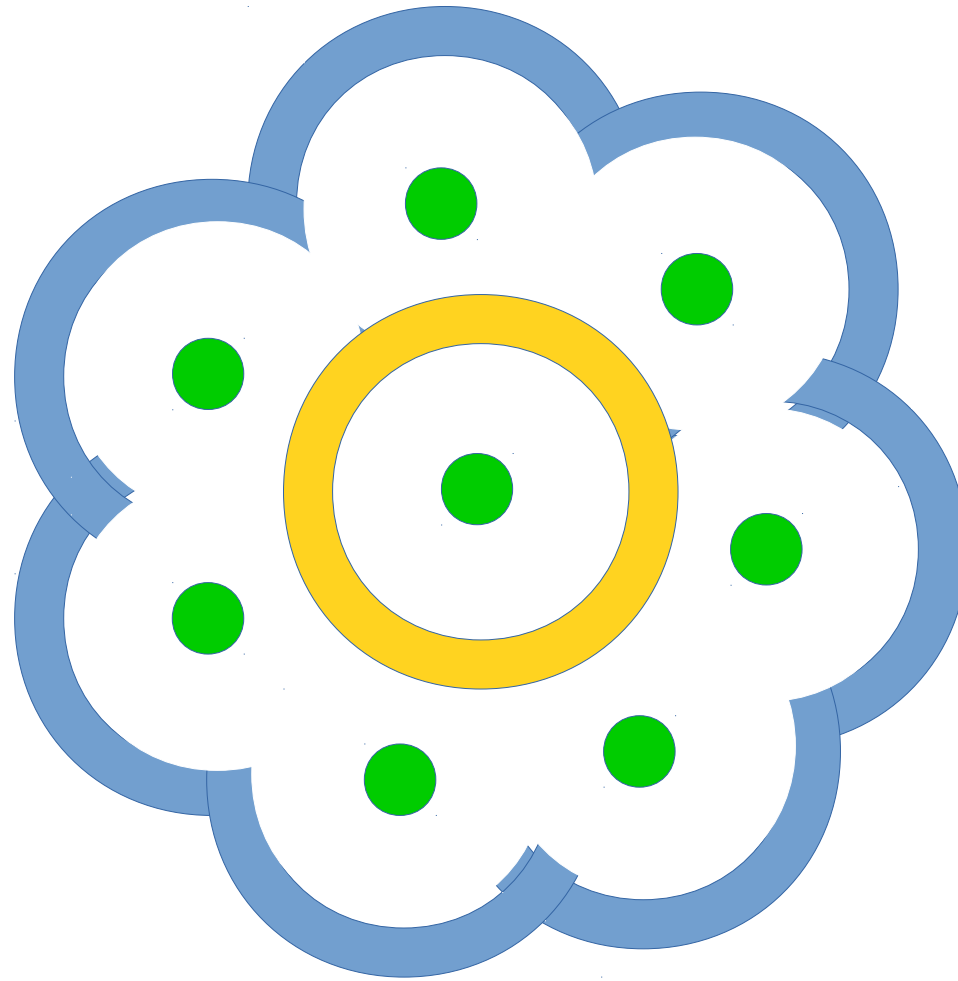
Emergent Patterns



Emergent Patterns



Emergent Patterns

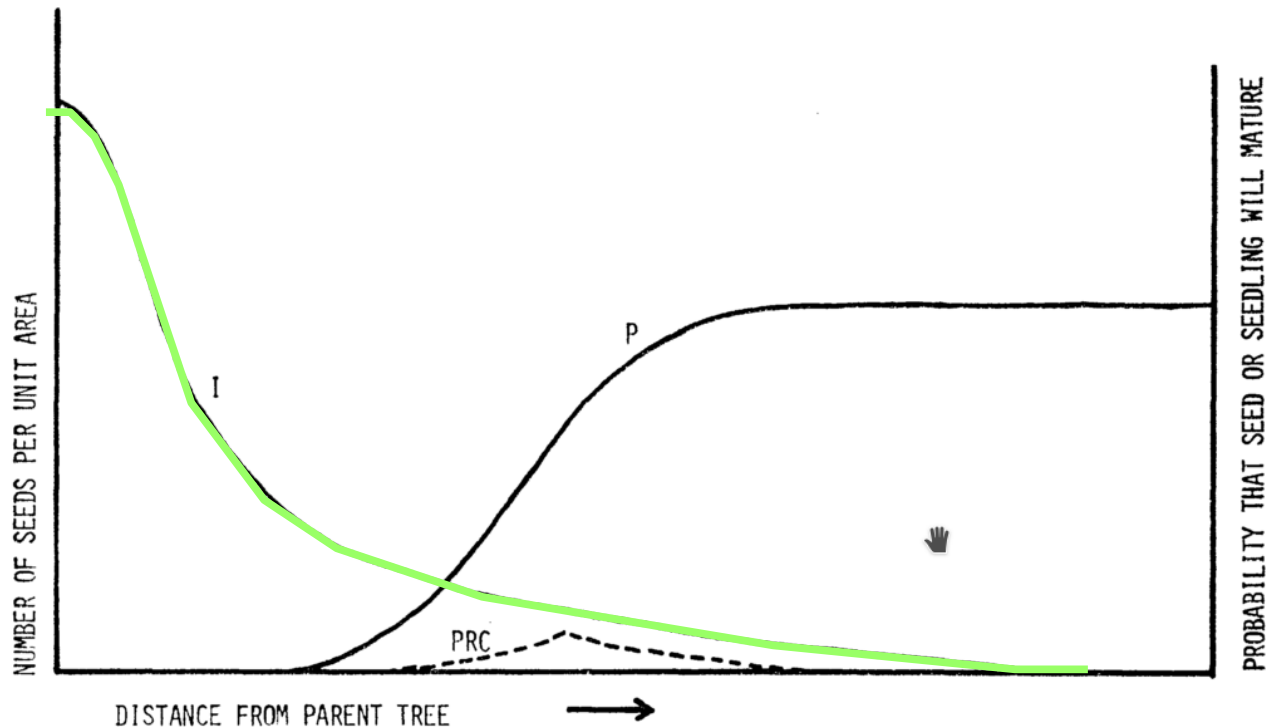


How does an extreme spatio-temporal life cycle mismatch between consumer and producer affect Janzen-Connell patterns?



Model Tree Life Cycles

- **Mature trees disperse seeds once a year according to a dispersal kernel**



(Janzen, 1970)

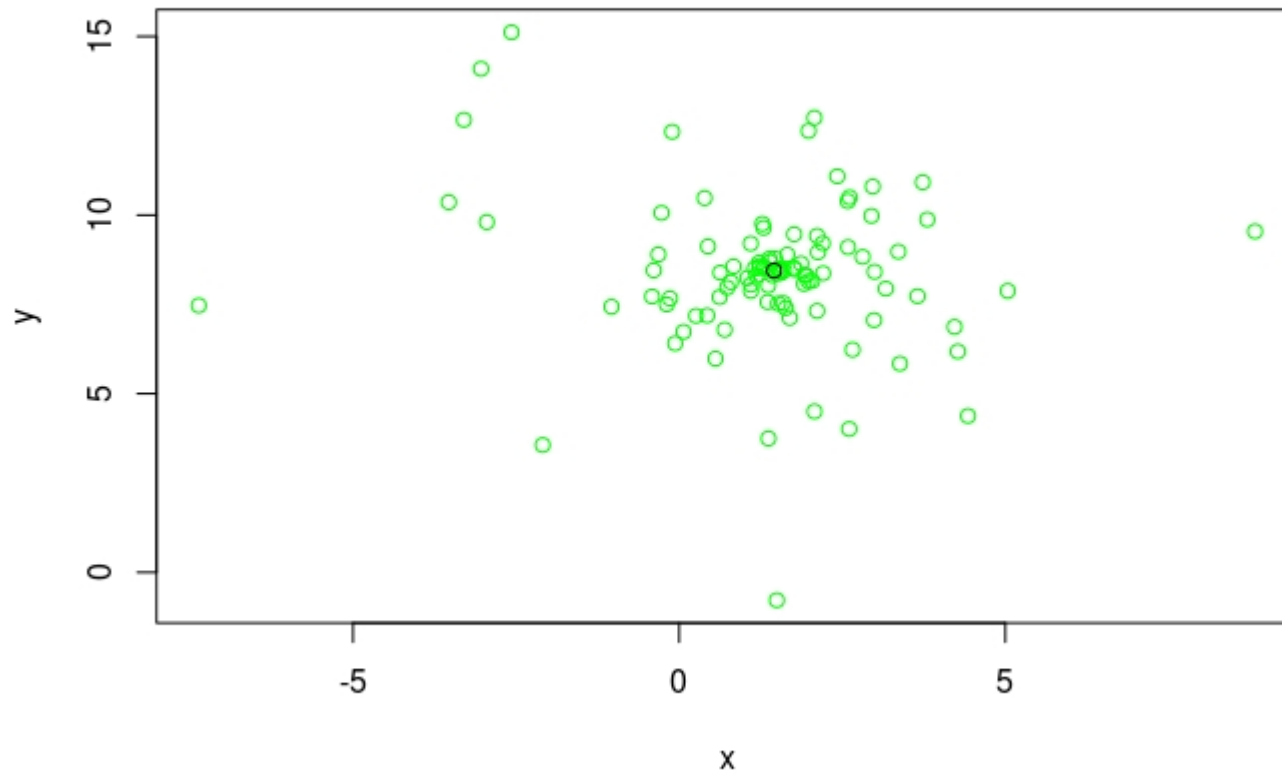


Model Pathogen Life Cycles

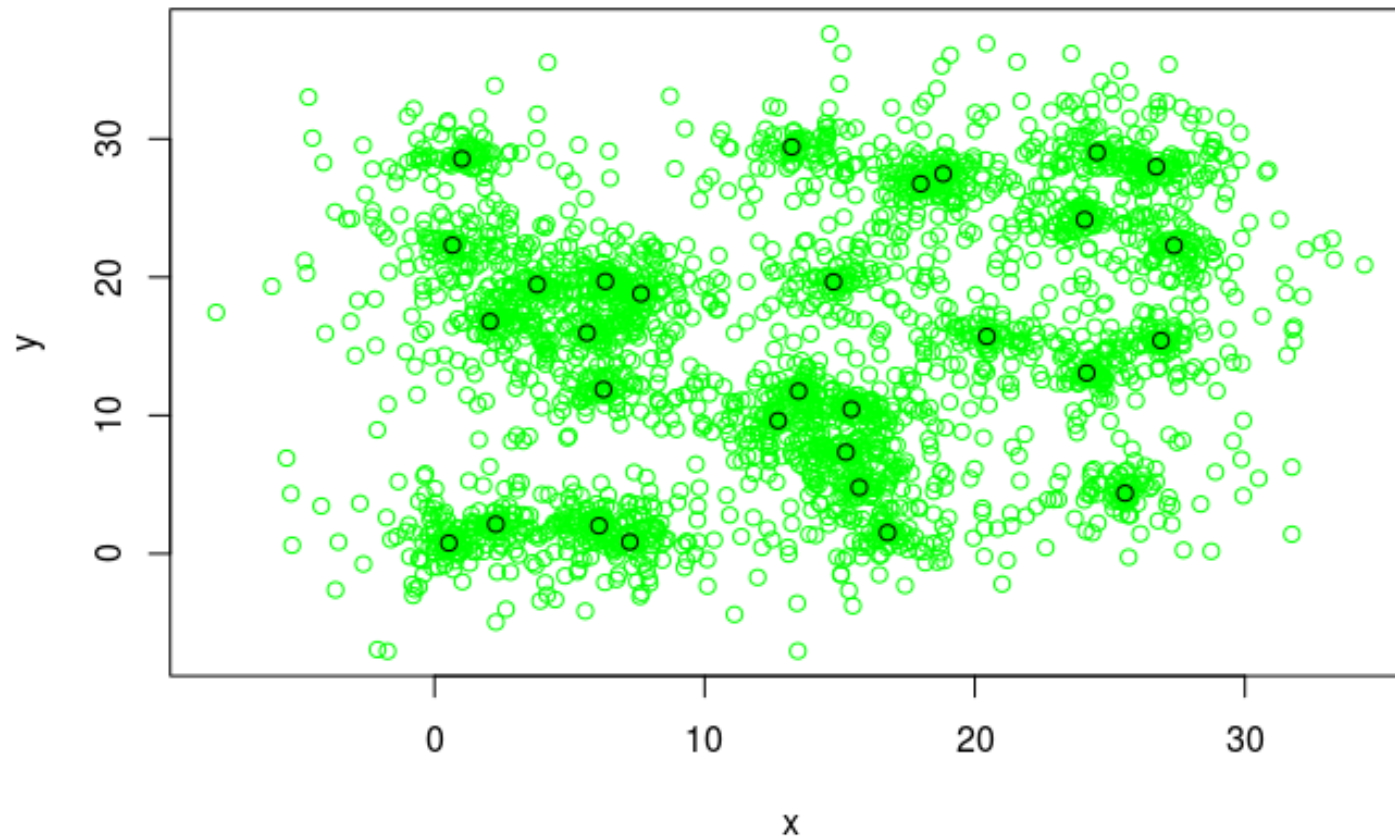
- **Oomycetes**
- **2 modes of reproduction**
 - Zoospores – flagellated for movement through soil water
 - Oospores – long term dormancy, local hyphal colonization
- **Reproduction several times a year, depending on conditions**
- **Zoospore dispersal on much smaller scale**
- **Long-term colony in roots of parent trees**



Individual-scale Models



Population Models



Black = trees
Green = seeds



Population Models

- **A seed survives pathogen infection according to:**

$$P(\textit{survival}) = e^{(-\gamma v d)}$$

γ = probability a seed will encounter a spore

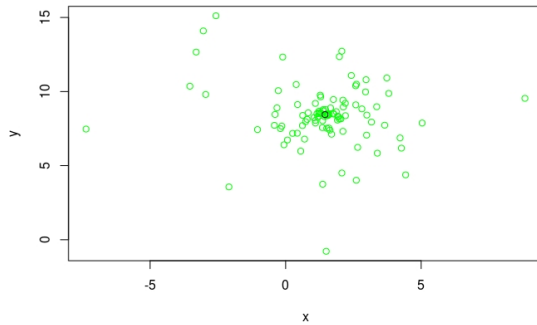
v = infectivity

d = density of spores

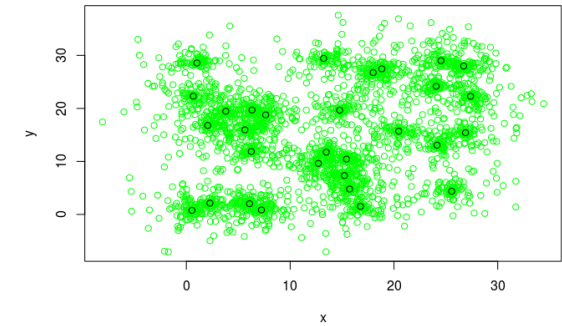


Hybrid Modeling

Individual Model



Tree Population Model



$$P(\text{survival}) = e^{(-\gamma v d)}$$

Seedling Survival



Outputs

- **Demographics of trees**
 - Lifespan, age distribution, infection rate
 - Cause of mortality (intraspecific competition vs. pathogen infection)
 - Seedling survival rate
- **Spatial distribution of trees**
 - Regularity of arrangement
 - Average distance between neighbors



Analysis

- **Sensitivity Analysis**

- Test various parameter combinations
- Which parameters have the biggest effect?



Expected Results

- **More active fungi will create larger gaps in tree population because of increased seed mortality**
- **Density-dependent mortality will increase with decreasing pathogen activity**
- **Increased lifespan of infected living trees contributes to pathogen mortality**



Questions?

