Individual Variation in Animal Movement

This should be the abstract

# Introduction

## Animal movement models overview

## Individual variation in animal movement

## Consequences of individual variation in movement

## Statistical approaches to model movement

## Incorporating individual variation

## Markov Models overview

## Statistics of extremes overview

Although there is variation in animal movement at the individual scale, the general focus has been on understanding the typical movement patterns, built around average measures at population levels. This focus on generality has driven to a lack of frameworks for understanding variation, how it is maintained, and the consequences of this variation across populations, communities, and ecosystems. Although there have been recent calls for incorporating individual variation in movement (Snell et al. 2019, @shaw2020causes) we still need to develop theory that explores different types of variation in movement patterns to understand its consequences across these levels. In particular, when considering species interactions, incorporating individual variation becomes essential to understand how positive or negative feedback loops play into the maintenance of variation in movement as individuals respond to external factors in their environment (Shaw 2020).

The specific case of seed dispersal is interesting because of the different levels and interactions happening. At the individual level, we focus on an individual bird consuming fruit and dispersing the seeds of the tree. How this particular individual moves across the landscape directly affects the dispersal for that specific tree and other trees from which it consumes fruit. At the same time, that individual has intra-individual variation in movement patterns associated to specific events in that individual’s lifetime, such as breeding and nesting. Interspecific interactions come at play as multiple species find themselves together feeding from the same tress, and thus competing for these resources, while at the same time intraspecific interactions due to social behavior broadly determine general movement patterns. From the plant’s perspective, the variation in movement patterns across all dispersers will determine eventual plant population spatial spread and success. Individuals will vary in their distances traveled while foraging or searching, directly influencing seed dispersal for the plant. Individuals with a tendency to travel larger distances or with higher probabilities of long-distance movements, will have a larger impact on plant population dynamics by increasing the plant’s long-distance dispersal. These long-distance movements for seed-dispersing animals, or long-distance dispersal events for plants, can lead to spatial sorting of populations and range expansions [These are sources I haven’t finished reading yet: Shine2011PNAS, Philips2008AmNat, Riotte-Lambert2019Trends.]

Long-distance dispersal in plants is fundamental…..

And thus providing theoretical frameworks that incorporate individual variation in animal movement can help us link that variation to seed dispersal patterns, and in particular to range expansion dynamics, having consequences at the landscape and regional scales.

Shaw makes references to how interspecific interactions can contribute to individual movement variation in parasite/pathogen systems. In my case, I would consider how presence of other competitive frugivores could influence this variation (Competition between toucans for the virola fruits and space. Larger aracari kick out the little ones (Holbrook 2011)). Shaw brings up how worse conditions can cause increased movement for searching better habitats and escape from these areas.

Traits that vary throughout an individuals lifetime can contribute to intra-individual variation. We saw this with the data from holbrook 2011 where breeding state and such would have impacts over

Seems like I am mostly focused here on variation in foraging movements? Although the long-distance movements, or deviations from typical movement patterns (the rare events) might not be associated to foraging?

Holbrook, Kimberly M. 2011. “Home Range and Movement Patterns of Toucans: Implications for Seed Dispersal.” *Biotropica* 43 (3): 357–64.

Shaw, Allison K. 2020. “Causes and Consequences of Individual Variation in Animal Movement.” *Movement Ecology* 8 (1): 1–12.

Snell, Rebecca S, Noelle G Beckman, Evan Fricke, Bette A Loiselle, Carolina S Carvalho, Landon R Jones, Nathanael I Lichti, et al. 2019. “Consequences of Intraspecific Variation in Seed Dispersal for Plant Demography, Communities, Evolution and Global Change.” *AoB Plants* 11 (4): plz016.