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ESCI 197C INTRODUCTION TO FIELD RESEARCH
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Maple Seed Dispersal Project

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Introduction

Seed dispersal is the first in a series of events leading to individual tree establishment, forest restoration, and forest succession. Accurate description of these processes is important to understanding tree population persistence, forest succession, responses to disturbances, and adaptation to climate change (Clark et al. 1999). Seed dispersal links tree generations by connecting reproduction of mature trees with establishment of their offspring. Forecasts of forest restoration following disturbance or range shifts tracking climate change generally assume seeds will be available. Reality often differs: forest responses frequently are limited by seed dispersal (Gómez-Aparicio et al. 2007, Morgan et al. 2018, Flores and Holmgren. 2021, Busby and Holz 2022). The discrepancy between forecasted and observed responses is due in part to limited knowledge about seed dispersal patterns (McEuen and Curran 2004, Gómez-Aparicio et al. 2007). The most important knowledge gap concerns long-distance dispersal, which is both rare and difficult to study (Nathan and Muller-Landau 2000).

In wind-dispersed species, most seeds land close to the parent tree (Gómez-Aparicio et al. 2007). For wind-dispersed seeds (anemochory), long-distance dispersal involves a small fraction of seeds that are caught in rare updrafts (Nathan and Muller-Landau 2000). These rare dispersal events often are essential to successful recruitment following large fires or other disturbances and tracking climate change (Morgan et al. 2018). Some tree species such as maples (*Acer* spp.) may increase the probability of long-distance dispersal with secure seed attachments, that require strong winds to dislodge seeds from twig nodes.

In this project, we will study spatial patterns in dispersal of Bigleaf Maple (*Acer macrophyllum*) seeds. Many factors potentially affect seed dispersal distributions, including patterns in wind speed and direction, site topography, height above ground of the release site, and surrounding trees or other obstacles. We will control for most factors by hand-releasing maple samaras from the two peaks on Western's "Stairs to Nowhere" sculpture. This approach will allow us to delineate the distribution of seed dispersal distances from two heights. If we are lucky, occasional wind gusts will allow us to record the right tail of the dispersal distribution.

Seed Dispersal Questions

(1) What is the average dispersal distance for each release height?

(2) How variable are dispersal distances?
(What is the standard deviation for each release height?)

(3) How does seed release height affect distribution of seed dispersal distances?

(4) How strong is the correlation between dispersal distance and time aloft?

(5) Which statistical distribution best describes dispersal distances?

(6) What fraction of seeds achieve "long" dispersal distances, i.e., what is the frequency of seeds above the right tail in the statistical dispersal distributions considered in step (5)?

Dispersal Distribution Hypotheses

(1) If wind affects seed dispersal distance, then seeds released from taller heights will have longer dispersal distances than seeds released from shorter heights, because seeds falling longer distances have a greater probability of encountering wind.

(1b) If wind has a minimal influence on dispersal distances, then seeds released from taller heights will have dispersal distances similar to seeds released from shorter heights, because seeds

(2) If wind affects seed dispersal distance, then seeds released from taller heights will have more variable dispersal distances (larger standard deviation) than seeds released from shorter heights, because seeds falling longer distances have a greater probability of encountering wind.

(3) If wind gusts are the primary cause of large dispersal distances, then dispersal distance and time aloft will be positively correlated, because seeds longer time aloft increases probability of a wind gust catching a falling seed.

(4) If wind gusts are the primary cause of large dispersal distances, then the distribution of seeds dropped from taller heights will have a thicker "right tail" than seeds released from shorter heights, because seeds falling longer distances have a greater probability of encountering wind gusts and being transported long distances.

Field Methods

1 Equipment: 3 measuring tapes, 2 stopwatches, data sheets, buckets of maple seeds.

2 Site preparation: extend measuring tapes at three angles from the base of the stair sculpture.
Place a bucket of maple seeds on the top step of each peak in the sculpture.
Station two dispersal timers with stopwatches in the dispersal "arena."
Station at least two distance measurers in the dispersal arena.
One person stands ready with a data sheet for recording distance and time aloft for each seed.

3 Each person releases a maple seed from one of the sculpture peaks. The seed should be held level with the top of the sculpture, with arm extended perpendicularly out from the edge of the sculpture. Release the seed by opening clasping fingers, without tossing it or otherwise adding height or velocity. Timers should start their stopwatches

4 Everyone should allow the seed to reach ground (grass) level without interference.
Timers stop stopwatches when the seed reaches the ground.

5 Timers report dispersal time (seconds) to the recorder.
One of the distance measurer locates the seed on the ground and reports dispersal distance to the recorder using the nearest measuring tape.

6 Rotate among people releasing maple seeds. Each person should release many seeds from both sculpture peaks. Total number of seeds released should be at least 200.

Data Analysis

1 Import seed dispersal data (time and distance) into R. Raw data can be entered into a spreadsheet and then imported into R, or data can be entered directly into R.

2 Calculate means and standard deviations (SD), for both dispersal time and distance, for seeds released from each sculpture peak.

3 Compare distributions (mean, SD) for low and high sculpture peak release sites.

4 Calculate correlation between dispersal times and distances, for each release site.

5 Fit statistical distributions to dispersal distance data:
Linear, Gaussian (Nathan and Muller-Landau 2000), negative exponential (Clark et al. 1999), and Gamma (Masaki et al. 2019). Details and instructions are forthcoming …

6 Determine which distribution best fits dispersal distance data. Details and instructions are forthcoming …

7 Compare dispersal distance data with the best-fitting distribution (step 6). Determine the number of seeds above the right tail of the distribution (long-distance dispersal events). Divide this number by the total number of seeds to calculate the fraction of seeds that achieved long distance dispersal.

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<u>Maple seed data</u> Release site: ____low ____high

Seed Number	Distance (cm)	Time aloft (sec)	Notes