The Demography of Plants

I. Introduction

A. Population
1. A group of actually or potentially interbreeding individuals of the same species (a “genetic” definition)
2. The individuals of a species occurring within a defined homogeneous area (an ecological definition)
3. The individuals included will depend on the study objectives
4. For plants we need to decide what is an individual.
   a. ramet – the physiological individual
   b. genet – the genetic individual
   c. for plants the large variation in size of adults poses a problem
      1. age versus stage
   d. the demography of modules

B. Demography – study of population changes

C. Why are we interested in populations and population ecology
1. Its role in helping to explain ecology
2. Conservation biology
3. Invasive species

II. The growth of a population

A. The fundamental equation of population growth

\[ N_{t+1} = N_t + B - D + I - E \]

- \( N_t \) = number at time \( t \)
- \( N_{t+1} \) = number at time \( t+1 \)
- \( B \) = births
- \( D \) = deaths
- \( I \) = immigration
- \( E \) = emigration

B. Population growth in terms of the intrinsic rate of increase

\[ N_t = N_0 e^{rt} \]

- \( t \) = time
- \( r = (B-D) \) = birth rate – death rate.

Intrinsic rate of increase per individual

- \( N_0 \) = number at time \( 0 \)

1. If the per-capita rates of birth and death remain constant over time then growth of the population will be exponential
2. The population equation holds only for the early stages of population growth
3. Note the similarity to the relative growth rate of an individual that we discussed earlier

D. Limitations to population growth: the logistic equation

\[ \frac{dN}{dt} = rN\left( \frac{K - N}{K} \right) \]

- \( K \) = carrying capacity
- \( N \) = number of individuals

1. The term \( (K-N)/K \) modifies the exponential term so that it becomes smaller as \( N \) approaches \( K \)
2. When $N = K$ the growth rate becomes zero

III. Examples of population growth.
   A. The population of a buttercup is a function of recruitment and deaths
   B. Populations can grow (or go extinct)

IV. Predicting population growth
   A. How do we get the data?
      1. Determine the age (or size) structure of the population at a single point in time
      2. Follow a cohort (individuals all born within a very short period)
      3. Follow the fates of plants of a given size or stage
   B. The transition matrix for understanding the regulation of population growth
      1. The method
         a. classify individuals into useful categories (size, age, etc.) and count their numbers to yield a column matrix
         b. identify how individuals in each category contribute to the population at the next time ($t+1$)
         c. measure the probability of survival and the fecundity of individuals of each category of plants and use these values to create a transition matrix.
         d. Multiply (using matrix algebra) the column matrix by the transition matrix to get the population at the next time ($t+1$)
         e. Continue this process until a stable age distribution results.
      2. Examples of transition matrices.
         a. Law’s study of *Poa annua* (annual bluegrass)
   C. The life table
      1. Dynamic versus static life tables.
      2. Construction of a life table – *Phlox drummondii* as an example
      3. The net reproductive rate $R_0$

VI. The causes of mortality
   A. environmental catastrophe
   B. day to day stresses
   C. effects of plant size

VII. Survivorship curves
   A. Type I. Mortality rate greatest for older ages (most individuals approach the maximum life span)
   B. Type II. Constant mortality rate (probability of death is independent of age)
   C. Type III. Mortality rate is greatest for younger ages.
Readings

TEXT: Chapter 7 (pp 117-141) covers population growth and decline but goes into more detail in some aspects than I will certainly do in lecture. I will cover a few aspects related to life history effects on plant growth in the next lecture, so reading these now won’t hurt!

Silvertown and Lovett Doust. 1993  Pages 73-114  This material goes into more detail than I have in lecture so you will need to do a little picking and choosing to find the most relevant stuff. Pages 82-90 and 103-106 relate more closely to material I will cover later on when we discuss the ecology of seeds and seedlings

Study questions:

1. Compare the growth of a population to the growth of an individual. What common factors cause both to exhibit exponential growth in the early stages? How does self-limitation of growth in an individual plant compare to the carrying capacity in the logistic equation? (hint: think about modules and individuals).
2. Distinguish between a static and a dynamic life table. What are the advantages and limitations for each?
3. For plants, we often use size rather than the more difficult to determine age in demographic studies. What are the advantages of using size (think about the ecological importance of size)? What are the disadvantages?
4. Contrast the use of age versus stage in demographic studies.
5. Do you think it would be possible to apply a life-table approach to the study of modules on a single plant?