Introduction to Theoretical Ecology Assignment 5

Age-Structured Models

COM(P)ADRE is an online repository containing matrix population models on hundreds of plants, animals, algae, fungi, bacteria, and viruses around the world. In this assignment, you will be analyzing the population matrix of a species (of your choice) using the data provided on the website and making some interpretations of your results.

Please follow the instructions below to select a suitable species for the assignment questions:

1. Visit the database at https://compadre-db.org/ExploreDatabase.
2. Pick a species you like, either by clicking on the entries below or searching by the taxonomy of organisms on the upper right.
3. This species should meet the following criteria:
    a. It has data on two or more populations.
    b. These populations should be “distinct” enough for comparisons (e.g., populations at different latitudes, populations in different habitat types, populations inhabiting different soil types, etc.).
    c. These populations should have population matrix data over the same time period. If there are multiple time periods, please use the overall period data for comparisons across sites.
    d. If some of the criteria are not met, you may want to look for another species.
4. After you get an ideal species, you can now start working on your questions. A worked example is provided in the following for your reference.

1. Briefly introduce the life stages of the species you chose. (1 pt)

Example:

Brevicoryne brassicae, known as the cabbage aphid, is a worldwide agricultural pest of members in the genus *Brassica*, including cabbage, broccoli, Brussels sprouts, and cauliflower. Its life cycle can be classified into six main stages:

(1) 1st instar: either remains in the same stage or transitions to the next stage

(2) 2nd instar: either remains in the same stage or transitions to the next stage

(3) 3rd instar: either remains in the same stage or transitions to the next stage

(4) 4th instar: either remains in the same stage or transitions to the next stage

(5) Adult (reproductive female): either remains in the same stage or transitions to the next stage; reproduces and produces 1st instar

(6) Post adult (post-reproductive adult female): either remains in the same stage or dies; does not reproduce

2. Create Leslie matrices for the populations and derive their asymptotic growth rates λ's (please include your R code). (5 pts)

Example:

Population (feeding location)	Asymptotic growth rate λ
Flower	1.250
Leaf top	1.175
Leaf bottom	1.171

R Code

```
flower <- matrix(data = c(0.32, 0, 0, 0, 3.25, 0,
                          0.6, 0.3, 0, 0, 0, 0,
                          0, 0.57, 0.41, 0, 0, 0,
                          0, 0, 0.41, 0.49, 0, 0,
                          0, 0, 0, 0.37, 0.95, 0,
                          0, 0, 0, 0, 0.05, 0.74),
                 ncol = 6,
                 nrow = 6,
                 byrow = T)

leaf_top <- matrix(c(0.41, 0, 0, 0, 2.04, 0,
                     0.56, 0.57, 0, 0, 0, 0,
                     0, 0.33, 0.43, 0, 0, 0,
                     0, 0, 0.39, 0.53, 0, 0,
                     0, 0, 0, 0.34, 0.95, 0,
                     0, 0, 0, 0, 0.05, 0.88),
                   ncol = 6,
                   nrow = 6,
                   byrow = T)

leaf_bottom <- matrix(c(0.31, 0, 0, 0, 2.15, 0,
```

```
                0.63, 0.42, 0, 0, 0, 0,
                0, 0.46, 0.53, 0, 0, 0,
                0, 0, 0.29, 0.52, 0, 0,
                0, 0, 0, 0.33, 0.95, 0,
                0, 0, 0, 0, 0.05, 0.85),
        ncol = 6,
        nrow = 6,
        byrow = T)

as.numeric(eigen(flower)$values[1])
as.numeric(eigen(leaf_top)$values[1])
as.numeric(eigen(leaf_bottom)$values[1])
```

3. Compare the λ's of these populations and provide some interpretations/explanations of your findings. You can think about the biology of that species and the abiotic/biotic characteristics associated with each population. (4 pts)

Example:

Aphid population feeding on flowers had a higher asymptotic growth rate (λ = 1.250) than that feeding on leaf top (λ = 1.175) and leaf bottom (λ = 1.171), while the two leaf-feeding populations had similar asymptotic growth rates. The slight difference in λ between flower-feeding and leaf-feeding populations may be due to the difference in nutritional quality as well as the concentrations of chemical defenses in the two plant parts: flower tissues may contain higher sugar contents and lower amounts of glucosinolates compared with leaves. As a result, aphids feeding on flowers may be able to grow faster and had higher fecundity, leading to a greater population growth.