

A new population of invasive Spotted Knapweed has been identified outside of Moscow. In an effort to control this population, the bio-control agent *Larinus minutus* (lesser knapweed flower weevil) was released into this population five years ago and has shown good initial results, causing a significant reduction in the growth rate and density of the Knapweed population. Although the weevil seems to be doing an effective job, two observations have caused some concern. First, individual spotted knapweed plants differ widely in their levels of infestation by the weevil, with some individuals appearing almost entirely resistant. Second, since the weevil was introduced to this population five years ago, the proportion of individuals that appear resistant to the weevil has increased with a concomitant increase in the growth rate of the Knapweed population. Both observations are consistent with the hypothesis that the Knapweed population is evolving increased levels of resistance to the weevil. In order to evaluate this hypothesis, you have collected the following data:

Data Set #1: Results from a greenhouse study where the resistance of individual plants was evaluated by releasing 200 weevils into a mesh enclosure with a single plant and the average daily abundance of feeding weevils recorded over a five day period. In addition to evaluating the average weevil load (trait, z) of these parental plants, the weevil load of offspring generated by controlled crosses between these parental plants was evaluated in the same fashion. Thus, this experiment allowed the phenotypes of maternal, paternal, and offspring plants to be measured for 200 controlled crosses. This data is available online: Parent_Offspring_Data.csv.

Data Set #2: Results from a field study where the resistance of individual marked plants was evaluated by estimating the average daily abundance of feeding weevils on each plant during the flowering season. In addition, the fitness of each plant was estimated by evaluating whether plants marked as seedlings survived to flower and if so, how many seeds each marked plant produced. In summary, this data set resulted in estimates for weevil infestation (trait, z), survival (fitness component), and fertility (fitness component) for 1000 marked plants. This data is available online: Trait_Fitness_Data.csv.

Use the information in these data sets to evaluate the hypothesis that the Knapweed population is adapting to the introduced weevil by evolving increasing levels of resistance and a concomitant increase in population growth rate. The following numbered questions will help to walk you through this problem.

1. What proportion of the variation observed in levels of weevil infestation can be attributed to genetic variability among Knapweed individuals?

2. How strong is selection acting on the level of weevil infestation in this population of Knapweed? Does selection favor increased or decreased resistance?

3. Assuming all knapweed individuals have an identical generation time of two years and the life stage of all individuals is synchronized, what will the population mean weevil infestation level be after five generations?

4. What does your prediction for the evolution of weevil infestation levels suggest about the future growth rate of the Knapweed population? What does this suggest about the long-term efficacy of the biocontrol agent?

5. What assumptions are we making that may alter our conclusions and predictions for the long-term efficacy of the Bio-control agent? How could this study be better designed?