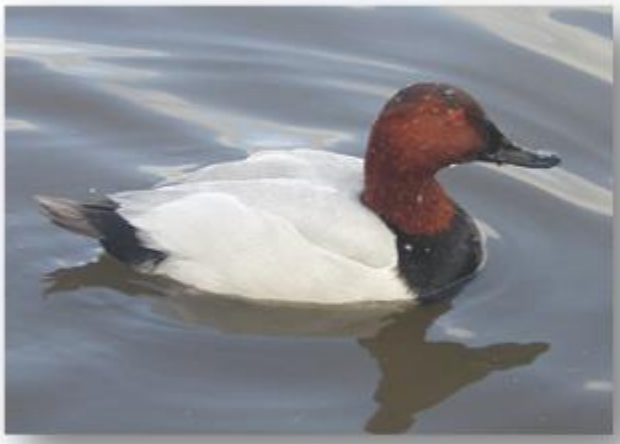
Heterogeneity and Exploitation: Exercise 11



Uses spreadsheet file, "Ex11_het_surv_harv.xlsx"

For the purpose of this exercise, we will define "demographic heterogeneity" as variation among individuals of a population in vital rates (survival or reproduction) that is not associated with any visible trait of the organism. For example, individuals within our population may vary in underlying survival probabilities (perhaps we have a high-survival group and a low-survival group), but there is no morphological or behavioral characteristic that we can observe that will allow us to categorize individuals. So the variation is invisible to us. This exercise deals with heterogeneity in underlying survival probabilities, although heterogeneity in reproductive rates is possible (and likely) as well.

We will begin with a harvested population that includes 2 groups of individuals, differing in survival only. We will consider an annual anniversary date at the beginning of the hunting season and apply a harvest rate (h) during the hunting season (keep things simple and assume no non-harvest mortality during the hunting season). The survivors of the hunting season then experience a probability of surviving nonhunting mortality sources (S). Because only hunting occurs during the hunting season portion of the year and only nonhunting mortality occurs during the remainder of the year we can obtain total annual survival (S_{Tot}) as the product of these *net* survival rates [$S_{Tot} = S(1-h)$]. Recall that *net* rates associated with a specific mortality source are finite rates that would occur in the absence of any other mortality source,

Take the following numerical example, beginning with 1000 individuals in each group:

Group 1 (low survival): $S = 0.4$, $h = 0.2$

Group 2 (high survival): $S = 0.6$, $h = 0.1$

Before using the spreadsheet, answer the following questions:

1. What is the annual survival rate for each individual within each group? Does the example make sense? In other words, if such heterogeneity exists, is it sensible that the individuals with the lower probabilities of surviving nonhunting mortality also have lower probabilities of surviving hunting mortality. What kinds of biological stories might underlie such variation?
2. We specified no time variation, so annual survival rates should be constant within each group. But what about overall survival of this 2-group mixture (i.e., what about annual survival rate of the combined groups). Should this also be constant over time? Why or why not? Assume that this example represented a cohort of young animals in year 1, aging and eventually reaching age 10. If we had no knowledge of the 2-group mixture, what might we conclude about age-specificity of survival?
3. Similar question to above. Harvest rates within each group are specified as constant over time (e.g., we apply the same set of harvest regulations each year). Should the overall harvest rate of the 2-group mixture be constant as well? Why or why not?
4. Use the spreadsheet, plug in the above survival and harvest rates and observe the trajectories of 2-group survival and harvest over time. If the trajectories did not correspond to your answers above, can you now explain exactly what happened?
5. So how might such heterogeneity be relevant to harvest theory? How might it be relevant to PVAs?
6. What would you expect to happen if you increase (make the rate differences larger) or decrease the variation between the 2 groups? Test your expectation with a couple of examples using the spreadsheet.
7. What happens when you reverse the relationship between nonhunting survival and harvest rates (i.e., low nonhunting survival corresponds to low harvest rate and high nonhunting survival corresponds to high harvest rate)?