Worksheet 7: Life History

1. What is the principle of allocation? How does it lead to trade-offs among reproduction, growth, and survival? (pg. 182) The principle of allocation predicts that organisms should balance out their allocation of energy to reproduction, growth, and survival. This leads to trade-offs for because energy allocated to survival is not available for growth or reproduction and energy allocated to reproduction is not available to survival and growth, etc. The degree to which a species allocates energy to one of these life history properties over another (i.e., its pattern of energy allocation) has evolved in response to its environment. See r-K selection as an example.

2. Two plant species co-occur in an oak savanna. One is fairly long-lived and produces few large seeds. The other is short-lived and produces many small seeds. (pg. 188-189, Fig. 8-12, pgs 198-199)
   a. Compare and contrast the advantages and disadvantages of these two life histories. The advantage of producing few large seeds is that each seed has a store of energy reserves that increases its chances of survival after germination (for example, in the face of low light, low nutrients, or competition with other species). The trade-off is that large seeds are not easily dispersed to new locations because of their weight and so the plant sacrifices dispersal (i.e., colonization of new habitats) for increased seedling survival. On the other hand, small-seeded species benefit from high seed dispersal because of their small size but these seeds suffer high mortality once they germinate because they do not have enough energy reserves to survive very long in locations where nutrients or water might be limiting or successfully compete with other species.
   b. Which species is most likely an r-selected and which species is most likely a K-selected species? Explain your answer in terms of the principle of allocation and the kind of environmental conditions to which these two life histories tend to correspond. The short-lived, small-seeded species is r-selected because it allocates less energy to longevity (survival) and more energy to reproductive output and dispersal. The long-lived large-seeded species is K-selected because it allocates more energy to longevity and competitive ability but less energy to reproduction. r-selected species tend to occur in habitats that are short-lived and relatively unoccupied, so there is a premium on dispersal to newly established locations (like following a disturbance) where resources are generally not limiting and there are few other species (i.e., noncompetitive situations). K-selected species tend to occur in habitats that are more stable (that is more long-lived and constant), so there is a premium on being competitive in locations where resources are limiting due to the presence of many other species.

3. List three traits of an r-strategist and three traits of a K-strategist. Give an example of each. (pgs. 198-199) r-strategists: high reproductive rate, short-lived, rapid development, small body size, high number of offspring, minimal parental care, etc. Examples: dandelion, telegraph weed, salmon, spotted salamander (see textbook pg. 180), cottonwood.
   K-strategists: allocate more energy to survival (e.g., competitiveness) than reproduction, long-lived, slower development and growth rates, delayed reproduction, large body size, more parental care, etc. Examples: elephant, bear, oaks, humans, tortoise, chestnut
4. Different types of selective forces in the environment have shaped the patterns of life history evolution exhibited in \( r \)-selected and \( K \)-selected species. Compare and contrast the different types of environments to which \( r \)-selected and \( K \)-selected species are adapted. (pgs. 198-199) Because of their allocation to reproduction and dispersal, \( r \)-selected species are adapted to temporary or new habitats. In contrast, because of their allocation to growth and maintenance, \( K \)-selected species are adapted to more long-lived and constant habitats that put a premium on competitive ability.

5. Based on their life history traits and types of environments to which they are adapted, a typical \( r \)-and \( K \)-selected species will differ in their population dynamics. In other words, each will show a different pattern of population growth over time. (pgs. 198-199)

a. In the graphs below, draw a curve showing how population size will behave over time for a typical \( r \)-selected and a typical \( K \)-selected species.

\[
\begin{align*}
\text{r-strategist} & \quad \text{K-strategist} \\
\text{Population size (N)} & \quad \text{Population size (N)} \\
\text{Time} & \quad \text{Time}
\end{align*}
\]

b. Explain why these life histories produce the types of growth curves they do.
The population growth curve for the \( r \)-strategist shows pattern of periodic high and low abundance, which reflects the temporary nature of the availability of suitable resources/habitat. The \( K \)-strategist growth curve shows a more stable population over time, which reflects a resource base/habitat that is relatively more constant. NOTE: the population crash and then recovery of the \( K \)-strategist illustrates the concept of carrying capacity; that is, after some kind of disturbance (say a fire or hurricane), the population will tend to return to a stable size that can be supported (“carried”) by an otherwise more or less stable environment.