1. Quebec is a sprawling province, whose area exceeds that of the next-largest province (Ontario) by around 40 Mha. PEI is a small province with an area of < 1 Mha – only about one tenth the area of the next smallest province. Which of these provinces is more unusual (more different from the others)?

A. Quebec is more unusual, whether we think additively or multiplicatively
B. PEI is more unusual, whether we think additively or multiplicatively
C. **Quebec is more unusual if we think additively, and PEI is more unusual if we thinking multiplicatively**
D. Quebec is more unusual if we think multiplicatively, and PEI is more unusual if we think additively

2. What happens in the long run to a structured, unregulated population with *non-interacting* cohorts?

A. It reaches a stable age distribution
B. It reaches a stable population size
C. **The age distribution cycles while the total population size grows approximately exponentially**
D. The age distribution grows approximately exponentially while the total population size cycles

3. In a population of small mammals both sexes have a survival probability of 1/3, and females produce on average 3 offspring per year who survive to be counted. (both of these values are independent of population density). Which of the following is true?

A. $f = 3$
B. $p = 2/3$
C. the average lifespan is 3 years
D. **the finite rate of growth λ depends on the sex ratio**
E. the finite rate of growth λ is 3.33

4. Which of the following traits is *not* typically associated with r strategies?

A. Fast life cycle
B. **Efficient resource use**
C. Relatively small investment per offspring
D. Relatively large investment in dispersal

5. If we compare the stable age distribution from a relatively stable, developed country (eg., Sweden) and a rapidly growing, developing country (eg., Honduras), we expect to see that the growing country's age distribution is ________ than the stable country's.

A. more elliptical (with a wide middle)
B. less elliptical
C. **more triangular (with a wide base)**
D. less triangular

6. Choose the most precise correct answer. For a population to be regulated, its per-capita reproductive number *must* respond ________ to ________.

A. directly; population size
B. **either directly or indirectly; population size**
C. directly; population size or external factors like climate
D. either directly or indirectly; population size or external factors like climate

7. Choose the strongest correct answer. Dushoff believes that all ________ populations experience regulation ________.

A. successful; all the time
B. successful; in the long term
C. surviving; all the time
D. **surviving; in the long term**

8. Which of the following does *not* describe a life-history tradeoff?

A. **Organisms that use more resources for survival can reproduce more times, and produce more total offspring under good conditions**

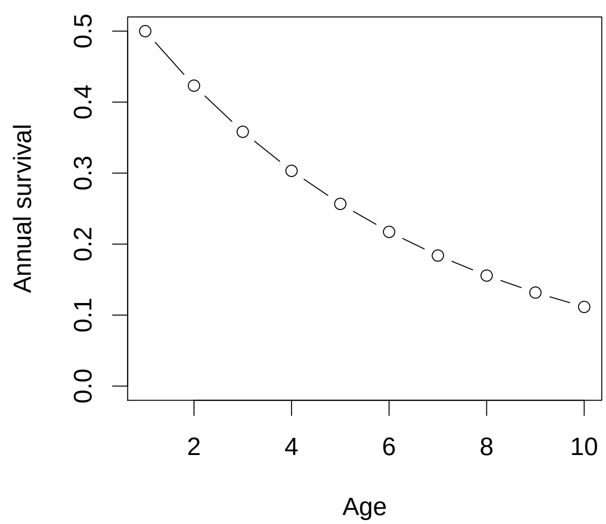
B. Organisms that reproduce only once can produce more offspring at that time than if they saved resources so that they could survive and reproduce again

C. Organisms that use more resources to help their offspring disperse cannot produce as many total offspring

D. Organisms that use more resources to help their offspring survive cannot produce as many total offspring

9. A group of tree species shows a tradeoff between $r_{\max}$ and K. We would expect to see:

A. **Species with high K doing well in less disturbed areas and species with high $r_{\max}$ doing well in more disturbed areas**
B. Species with high $r_{\max}$ doing well in less disturbed areas and species with high K doing well in more disturbed areas
C. Species with high K doing well in all areas
D. Species with high $r_{\max}$ doing well in all areas

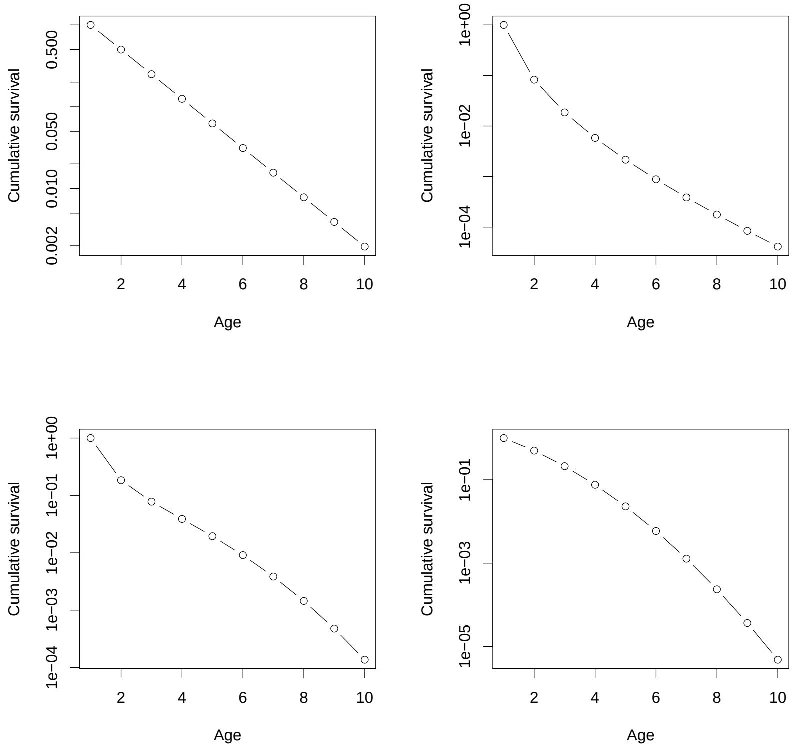


Use the picture above for the following 2 questions.

10. What does this picture of survivorship in an idealized age-structured population indicate about *mortality* in this population?

A. Mortality is constant
B. **Mortality is elevated in older individuals**
C. Mortality is elevated in younger individuals
D. Mortality is elevated in both older and younger individuals

11. The pictures below show *cumulative* survival. Which one corresponds to the picture shown above?



ANS: D

12. A certain species of moth reproduces only once in its lifetime. A researcher estimates that female moths that survive to become reproductively mature produce 150 eggs on average; that 40% of eggs will hatch; and that 3% of the female eggs that hatch will survive to become reproductively mature moths. If the moths lay equal numbers of male and female eggs, what is the finite rate of growth λ for this population? Assume that the time step of the model is equal to the amount of time it takes the moths to complete one generation (the generation time)

A. 0.45
B. **0.9**
C. 1.8
D. 2.25
E. 4.5

13. Given the information in the previous question, what is the strongest statement you can make about the reproductive number $\mathcal{R}$ for this population?

A. λ and $\mathcal{R}$ are both on the same side of 1
B. λ and $\mathcal{R}$ are both on the same side of 0
C. $\mathcal{R}$ is between 1 and λ
D. λ is between 1 and $\mathcal{R}$
E. λ and $\mathcal{R}$ are equal
ANS: E

14. In some populations (like cod fish), it is hard to estimate the contribution of old individuals to population growth because old individuals have:

A. high values of both p and f
B. low values of p and high values of f
C. high values of both ℓ and f
D. **low values of ℓ and high values of f**

15. The size of a population of introduced beetles is estimated at 100 in 2014, and 200 in 2016. If we assume this population is growing exponentially, what population size would you predict for 2020?

A. 300
B. 400
C. 600
D. **800**
E. 1600

16. Many species maximize their long-term average value of λ by:

A. speeding up their life cycle in general
B. slowing down their life cycle in general
C. **speeding up their life cycle when conditions are good**
D. slowing down their life cycle when conditions are good

17. A species of plant produces 15 seeds on average in the first year after it is born, and 50 seeds on average in the second year after it is born, assuming it survives. Seeds survive the first year (and become adults) with probability 0.05, and first-year adults survive to become second-year adults with probability 0.7. Second-year adults always die.

a) (2 points). If we model this population by counting *after* reproduction, how many age classes do we have? How would you describe the individuals censused in each age class, and how would you number the age classes?

The age classes we consider are: the new seeds, the one-year-old post-reproductive adults, and the two-year-old post-reproductive adults. Since the two-year-olds are done reproducing (or even surviving), we typically choose not to count them. So we have two age classes: new seeds (age-class 1) and not-yet-finished adults (class 2).

One point for the idea that we start with newborns, one point for the idea that the first age class is always number 1.

b) (1 points). How would this differ if we counted *before* reproduction?

Before reproduction, we have two classes of adults about to reproduce. We also number them 1 and 2.

Need to be clear that we're not *counting seeds, but starting with first-year adults*

c) (2 points). If a scientist constructs life tables for the two scenarios above, what factors would you expect to be the same, and which ones could differ?

ℓ_1 is always 1! f_1 represents the product of the same two quantities (seed survival and first-year production) and should be the same in both life tables. The other fs and ps generally differ (although in this case we would also expect the two ps referring to adult survival to be the same; these are p_2 in the after case and p_1 in the before case. The "contributions" ℓf and their total $\mathcal{R}$ will always be the same no matter where in the life cycle you start a life table.

One point for the idea that ps and fs can differ. One point for the idea that contributions and $\mathcal{R}$ should be the same.

d) (4 points). Construct a life table for the case where we count *after* reproduction (not the most common way). Show how you calculate the values of f_x, and then complete the life table below.

We start with seeds, f_1 is the probability of a seed surviving, multiplied by the expected number of seeds it will produce: 0.05*15=0.75, and f_2 is the probability of the one-year-old adult surviving multiplied by an expected number of seeds: 0.7*50=35.

The first survival probability is from seed to adult, so p_1 in this case is equal to 0.05. The second survival probability is from adult until *after the last time the plant reproduces*. Conventionally, we write $p_2 = 0$ in this case, but you could also say 0.7, as long as you then write a third row showing $f_3 = 0$.

Life table

x	f_x	p_x	ℓ_x	$\ell_x f_x$
1	0.75	0.05	1.000	0.75
2	35	0	0.05	1.75
R				2.5

Roughly one point per column (p, f, l, contribution)