Formulas

discrete time growth:

- $N_T = N_0 \lambda^T$
- $\lambda = f + p$
- $\mathcal{R} = f/(1-p)$

continuous time growth:

- $N(t) = N(0)\exp(rt)$
- $r = b - d$
- $\mathcal{R} = b/d$

structured growth:

- $\ell_x = p_1 \times p_2 \times \ldots p_{x-1}$
- $\mathcal{R} = \sum \ell_x f_x$

1. Which of the following would be expected to lead to a population producing more females than males at birth, while using a similar amount of resource per individual for each sex?

A. Increased cost of producing females
B. Higher population density
C. Lower population density
D. Greater variation in male reproductive success
E. Restricted dispersal leading to within-family mating

Use this information for the next two questions. Two competing species of vulture use more or less exactly the same food resources. Species A is more efficient at finding food resources, and outcompetes Species B in favorable environments. Species B is more efficient at using water, and outcompetes Species A in drier environments. In intermediate environments, the two species co-exist.

2. In this case, we expect:

A. Species A and B both have larger fundamental than realized niches
B. Species A and B both have larger realized than fundamental niches
C. Species A has a larger fundamental than realized niche; while Species B has a larger realized than fundamental niche
D. Species B has a larger fundamental than realized niche; while Species A has a larger realized than fundamental niche

3. When these vultures are in intermediate environments, we _________ that both of the individual-level competition coefficients (α) < 1, and _________ that both of the population-level competition coefficients (E) < 1.

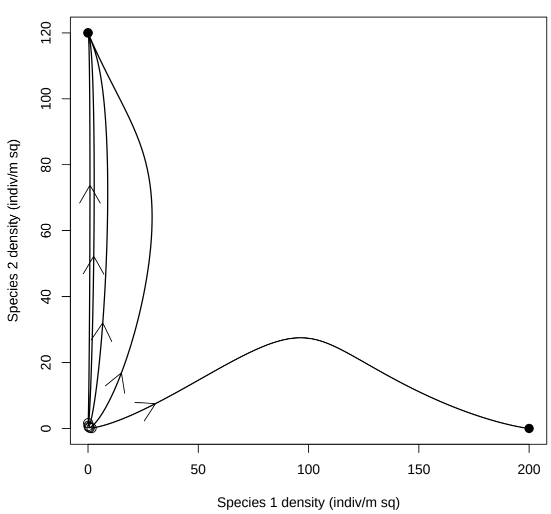
A. know; know
B. know; don't know
C. don't know; know
D. don't know; don't know

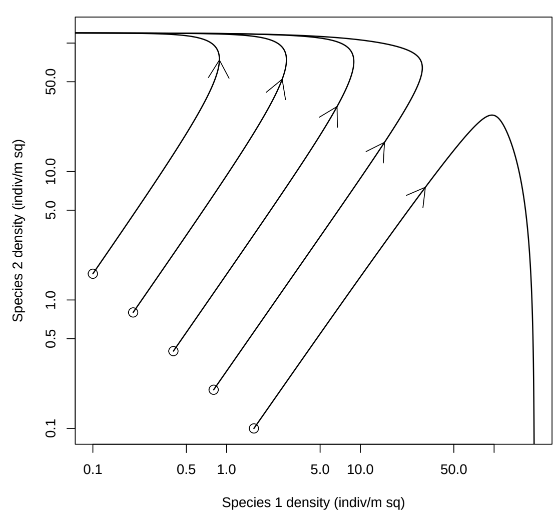
4. The bacteria you are studying enter a resting state, but only when under stress, typically due to crowded conditions. If the resting state has lower mortality than the bacteria normally experience when not stressed, we would also expect that, compared to unstressed conditions, the resting state has _________ birth rates and _________ reproductive number $\mathcal{R}$.

A. lower; lower
B. lower; higher
C. higher; lower
D. higher; higher

5. A landscape is changing over decades, so that sometimes conditions are good for dry-adapted plants, and sometimes they are bad. A short-lived aloe species and a long-lived cactus species are dry-adapted plants living on this landscape. At any given time their $\mathcal{R}$ values are roughly similar. *Compared to the shorter-lived aloe,* the longer-lived cactus would be expected to have higher λ:

A. Never
B. Always
C. Only when conditions are good
D. Only when conditions are bad





Use the phase plot above (shown on two different scales) for the next two questions.

6. The figures show

A. Balanced competition
B. Equal competition
C. Founder control
D. Dominance
E. Coexistence

7. Species __________ has a larger value of K (when compared using units shown), and species __________ has a larger value of $r_{\max}$.

A. 1; 1
B. 1; 2
C. 2; 1
D. 2; 2

Use this information for the next two questions. A population goes from 100 individuals to 1000 individuals in 10 generations.

8. What is the population's average finite rate of increase λ for this period (using generations as a time step)?

A. 0.23
B. 0.86
C. 0.94
D. 1.26
E. This question cannot be answered with the information provided

9. If each generation takes 10 years, what is the population's average instantaneous rate of increase r for this time period?

A. 0.023/yr
B. 0.023 yr
C. 2.3/yr
D. 2.3 yr
E. This question cannot be answered with the information provided

10. In simple, discrete-time models of a single species competing for resources, we often see population cycles:

A. In models without resource depletion
B. In models with resource depletion
C. In models with or without resource depletion
D. We don't see population cycles in simple discrete-time models

11. Which of the following is a 'bet-hedging' adaptation that allows organisms to average over risk within a generation?

A. Investment in males
B. Iteroparity
C. Long lifespan
D. Short lifespan
E. High R

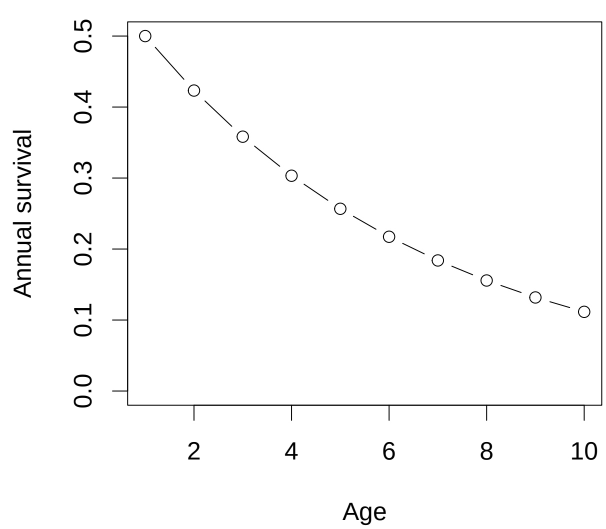
Use the following information for the next two questions. In a population of dandelions: adults produce 50 seeds each; 1% of seeds survive to become adults; 50% of first-year adults survive to reproduce again.

12. If we count before reproduction, f_1 is ________; and f_2 is ________.

A. 0.5; 0.25
B. 0.5; 0.5
C. 0.5; 25
D. 0.5; 50
E. 50; 50

13. If we calculate the long-term growth rate λ of a population under these parameters, we would expect:

A. $\lambda = 1$
B. $\lambda = \mathcal{R}$
C. λ is between 1 and $\mathcal{R}$
D. $\mathcal{R}$ is between λ and 1

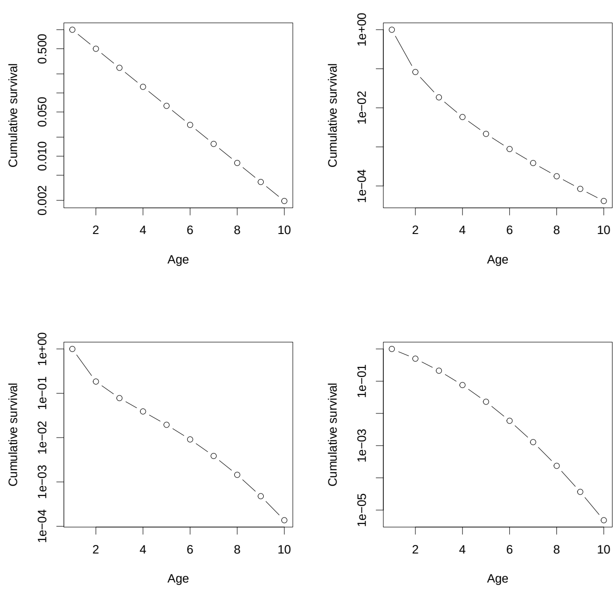


Use the picture above for the following 2 questions.

14. 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

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



A. Upper left
B. Upper right
C. Lower left
D. Lower right

16. It is likely that organisms living in highly variable environments will evolve to put __________ resources into __________, when compared to organisms in more stable environments.

A. more; male (rather than female) offspring
B. less; male (rather than female) offspring
C. more; dispersal
D. less; dispersal

17. In terms of distance on the log and linear scales, 20 is to 30 as 30 is to:

A. 40
B. 45
C. 40 on the linear scale, or 45 on the log scale
D. 40 on the log scale, or 45 on the linear scale

18. In some populations (like hemlock trees), it is hard to estimate the contribution of old individuals to population growth because old individuals have:

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

Use this information for the next two questions. In a population of beetles, all reproduction is sexual. Females in this population produce many fewer male than female offspring.

19. What can you say about the *average* relative fitness at birth of females and males in this population?

A. Females have higher fitness per individual
B. Males have higher fitness per individual
C. Both sexes have equal fitness per individual
D. There is not enough information to tell

20. Based on the balance argument, we would expect to find that in this population:

A. Males are less likely than females to survive to reproduce
B. Males are more likely than females to survive to reproduce
C. Females use more resources for each individual female offspring than for male offspring
D. Females use less resources for each individual female offspring than for male offspring

Name ______________ **Macid** ______________**Tutorial section** _______**Version 4**

Short-answer questions

Answer questions *in pen.* *Briefly* show necessary work and equations. Points may be *deducted* for wrong information, even when the correct information is also there.

21. (2 points) In a population of perennial plants, seeds have a 10% probability of surviving to become adults and reproduce the first year. Adult plants (one-year-old and up) have an 60% chance of surviving each year to reproduce again.

a) What is ℓ_2 in this population if we measure before reproduction? As discussed in class, assume we call the first age class we observe age 1 in both cases.

b) What is ℓ_2 in this population if we measure after reproduction?

22. An annual plant has variable fecundity: each female has an average of 3 successful female offspring in an good year (half of the time) and an average of 0.6 successful female offspring in a bad year (the other half of the time).

a) (1 point) What is the long-run average R for this species?

b) (1 point) Now consider a perennial species that survives for 2 years but that has only half the fecundity per year: 0.3 successful female offspring per female for 1-year-olds and 1.5 successful female offspring per female for 2-year-olds (there is 100% survival from year 1 to year 2, and no survival after that). Construct the life table.

x	f_x	p_x	ℓ_x	

c) (1 point) What is R for the perennial species?