1. Researchers studying a gypsy moth population make the following estimates: The average reproductive female lays 400 eggs; 10% of eggs hatch into larvae; 20% of larvae mature into pupae; 25% of pupae mature into adult females; 60% of adult females survive to reproduce. What is the correct value of fecundity f for this population?

A. 0.6
B. **1.2**
C. 0.6 moths/year
D. 1.2 moths/year
E. There is not enough information to answer this question

2. Polio has a generation time of about 10 days, and an associated finite-time growth rate λ of about 11. If we start with one case, about how many cases do we expect to see (provided there is no density-dependence) 20 days later?

A. 2.2
B. exp(2.2)
C. 22
D. **121**
E. 220

3. If m represents the unit meters, then what is $10^{3\text{m}}$?

A. 1000 m
B. 1000 m^3
C. **Complete nonsense**
D. The answer depends on context

4. A scientist wants to model a population of small perennial plants (ie., plants that reproduce more than once) with a simple population model (ie., without population structure). They should:

A. **Use a conceptual model with a census before reproduction**
B. Use a conceptual model with a census after reproduction
C. Use a conceptual model with one census before reproduction and one census after reproduction
D. Not even try to do this

5. Which of these is *not* an effect that tends to *balance* the tendency of populations to grow or decline exponentially without limit?

A. **Allee effects**
B. Competition for access to mates
C. Competition for access to resources
D. Resource depletion
E. Dynamics of natural enemies

6. Which of the following processes would *not* increase a population's tendency to cycle?

   A. Discrete-time, regulated dynamics with high growth rates
   B. Predator-prey dynamics
   C. Exploitation of depletable resources
   D. **Unregulated population growth**
   E. Time delays in organism development

This information is used for 2 questions. In a population of squirrels, newborn females have a 20% probability of surviving to reproduce in the next breeding season. One-year-old females have a 50% chance of surviving the next year, and older females have a 80% chance of surviving each year. We census *after* reproduction (we call the first group we count, the newborns, $x = 1$; thus the one-year-olds correspond to $x = 2$).

7. What is the value of p_2 in this population?

   A. 0.08
   B. 0.16
   C. 0.4
   D. **0.5**
   E. 0.8

   This is the probability that the group we label as "2" survives.

8. What is the value of ℓ_3 in this population?

   A. 0.08
   B. **0.1**
   C. 0.4
   D. 0.5
   E. 0.8

   This is the probability of survival from first being counted, through the first two years after that: $p_1 * p_2$.

This information is used for 2 questions. We construct a life table for a population of foxes, and find that the reproductive number $\mathcal{R} = 0.8$. Assume that foxes start reproducing *after* their first year ($f_1 = 0$).

9. What can you say about λ based on this information?

   A. $\lambda < 0.8$
   B. $\lambda = 0.8$
   C. $0.8 < \lambda < 1$
   D. $\lambda = 1$
   ANS: C

10. We infer from our measurements that this population is currently:

A. increasing
B. **decreasing**
C. stable
D. oscillating

11. The f and p values that form the basis of a life table always describe, for each individual counted ________, the number of individuals they are expected on average to produce that will be counted ________.

A. before reproduction; after reproduction
B. after reproduction; before reproduction one time step later
C. before reproduction; before reproduction one time step later
D. after reproduction; after reproduction one time step later
E. **at any point in the cycle; at the same point one time step later**

12. The values of f_1 in a life table (the fecundity of 1-year-olds)

A. Do not incorporate the survival probability between birth and the first census
B. Must be less than 1
C. **Are often small or zero because organisms take time to reach maturity**
D. Are not affected by life-history tradeoffs
E. Must be greater than 1 in order for the population to increase

13. Which of the following is *not* an example of a tradeoff?

A. **Birds with heavier beaks are more efficient at cracking seeds and better at defending territory**
B. Bushes which survive better in dry conditions grow more slowly in wet conditions
C. Trees which grow fastest in full sunlight have higher mortality in the shade
D. Rabbits which need less food to survive produce fewer offspring when food is plentiful

14. If every individual of an annual species has 100 offspring, which have 5% survival in good years, and 1% survival in bad years, and each kind of year occurs about half of the time, which of the following is closest to its long-term average growth rate?

A. 0.5
B. 1
C. **2.2**
D. 3
E. 6

15. Which of these traits would be *most* typical of a K-strategist?

A. Has a low individual density at equilibrium
B. Has a high individual density at equilibrium
C. Competes poorly in crowded conditions
D. **Competes well in crowded conditions**

16. Which of these traits would be *most* typical of an r-strategist?

A. Large final size
B. **Good dispersal**
C. Production of a small number of high-quality offspring
D. Good competitive ability
E. Iteroparity

17. Which of the following is a disadvantage of dispersal?

A. Inbreeding
B. Long-term growth rate will follow the geometric mean
C. Stronger competition between offspring
D. **Cost of dispersal structures**
E. Parent's location is usually a poor environment

18. If newborns from a population are 60% females and 40% males, the balance hypothesis would predict that parents should invest ________ in each individual male offspring at evolutionary optimum.

A. the same amount
B. **1.5 times more**
C. 1.5 times less
D. 1.67 times less
E. 2.5 times more

19. It is hypothesized the kakapos, zebras and some other organisms that produce one offspring at a time may tend to produce males when they are in good condition. This is likely because females are selected to allocate more resources ________ to male than to female offspring, because males in these populations have ________ variation in reproductive success than females do

A. **per individual; more**
B. per individual; less
C. in total; more
D. in total; less

20. Japanese maples are trying to invade a stable Ontario forest dominated by sugar maples (we don't know whether they will be successful). Based on these assumptions, we would expect the reproductive number of the ________ population to satisfy ________.

A. sugar maple; $\mathcal{R} > 1$
B. Japanese maple; $\mathcal{R} > 1$
C. **sugar maple;** $\mathcal{R} = 1$
D. Japanese maple; $\mathcal{R} = 1$

Note that we said the new species is *trying* to invade.

21. A species of introduced rat reproduces very well on islands near South America with no other rats, but does not survive under very similar conditions on the mainland, where other species of rat are present. It is likely that the mainland environment ________ part of the fundamental niche and ________ part of the realized niche for this species.

A. is; is
B. **is; is not**
C. is not; is
D. is not; is not

22. We expect coexistence to occur when

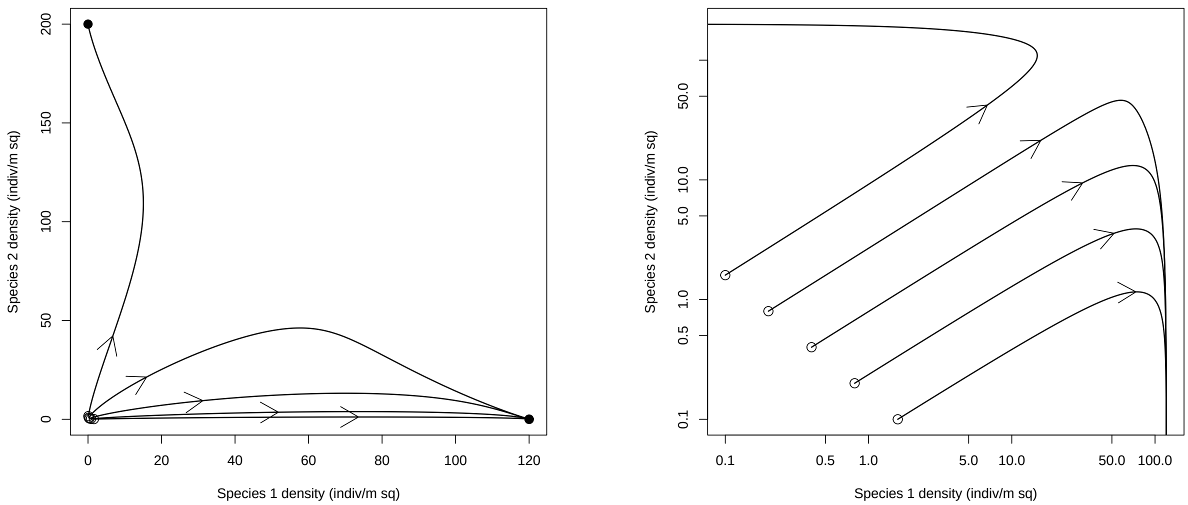
A. **Each species does better in an environment dominated by competitors than in an environment dominated by its own species**
B. Each species does better in an environment dominated by its own species than in an environment dominated by competitors
C. One species does better in an environment dominated by its own species, while the other does better in an environment dominated competitors
D. One species does better than the other in environments dominated by either species

23. Two species are coexisting stably. Based on this information, what is the strongest correct statement you can make about the individual-level competitive effects α?

A. Both must be < 1
B. Both must be > 1
C. **At least one must be** < 1
D. At least one must be > 1
E. None of the above

24. If $K_1 = 75\,\mathrm{indiv}_1$, $K_2 = 50\,\mathrm{indiv}_2$, $\alpha_{12} = 1\,\mathrm{indiv}_2/\mathrm{indiv}_1$, and $\alpha_{21} = 1\,\mathrm{indiv}_1/\mathrm{indiv}_2$, which of the following is definitely true?

A. **Species 1 will win in competition regardless of starting densities**
B. Species 2 will win in competition regardless of starting densities
C. The system demonstrates founder control
D. The system demonstrates coexistence
E. Species 2 can invade species 1 when species 1 is at its (positive) equilibrium density



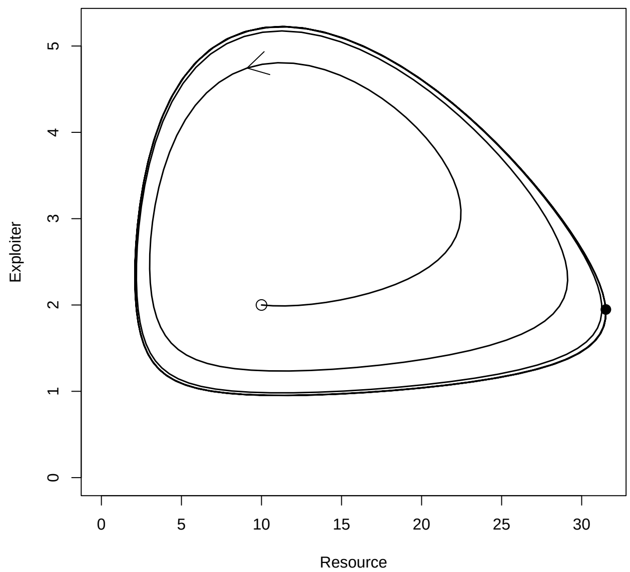
Use the phase plot above (shown on two different scales) for the next two questions.

25. The figures show

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

26. Species ________ has a larger value of K, and species ________ has a larger value of $r_{\max}$.

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



Use the figure above for the next two questions. It shows a simple model of an interaction between an exploiter and a resource species.

27. The figure shows:

A. Unstable oscillations
B. Neutral oscillations
C. **A limit cycle**
D. Damped oscillations

28. This figure is consistent with a simple model that has: ________ density dependence and ________ predator satiation

A. No; weak
B. No; strong
C. Prey; weak
D. **Prey; strong**

29. Predator satiation implies that, when the density of ________ goes up, the per capita rate at which ________ goes down.

A. predators; predators eat
B. prey; predators eat
C. predators; prey get eaten
D. **prey; prey get eaten**

30. Resource-exploiter systems have an intrinsic tendency to oscillate because each species has a ________ effect on its own growth rate.

A. direct, positive
B. indirect, positive
C. direct, negative
D. **indirect, negative**

Use this information for the next two questions. A population of grouse and a population of foxes are at equilibrium under reciprocal control – ie., the grouse population is primarily controlled by fox predation, and the fox population is primarily controlled by the food supply of grouse. Grouse hunting is then banned in the area, leading to a permanent decrease in the death rate of the grouse.

31. What is the strongest *immediate* effect of reducing the death rate of grouse?

A. A decreased number of grouse
B. **An increased number of grouse**
C. A decreased number of foxes
D. An increased number of foxes

32. What is the strongest *long-term* effect of reducing the death rate of grouse?

A. A decreased number of grouse
B. An increased number of grouse
C. A decreased number of foxes
D. **An increased number of foxes**

33. Population cycles that always return to the point where the population started are referred to as

A. Limit cycles
B. Damped oscillations
C. Chaotic oscillations
D. **Neutral cycles**
E. Diverging cycles

34. In general, imposing density-dependent growth on a predator tends to

A. Lead to neutral cycles
B. **Stabilize predator-prey dynamics**
C. Destabilize predator-prey dynamics
D. Stabilize or destabilize dynamics depending on whether the predator experiences satiation or not
E. Cause predator extinction

35. Which of the following is the most accurate explanation for the reciprocal control theory of why cod densities apparently went up in the early days of mass fishing?

A. Reduced cod density dependence due to people catching cod
B. Reduced cod density dependence due to people catching sharks
C. Increased cod needed to regain equilibrium and balance the effect of people catching cod
D. **Increased cod needed to regain equilibrium and balance the effect of people catching sharks**

36. If a common-cold-causing virus has an initial reproductive number $\mathcal{R}_0 = 2$, and conditions stay constant, we would expect disease incidence to start decreasing once

A. less than 2/3 of the population is susceptible
B. **less than 1/2 of the population is susceptible**
C. less than 1/3 of the population is susceptible
D. less than 1/4 of the population is susceptible

Use this information for the next three questions. The initial growth rate of HIV in Southern Africa was estimated at $r_0 = 0.5$/year and the death rate of infected people was estimated $d = 0.1$/year. Assume this growth can be well modeled by a simple birth-death model of HIV *cases*.

37. What is the initial doubling time of the disease?

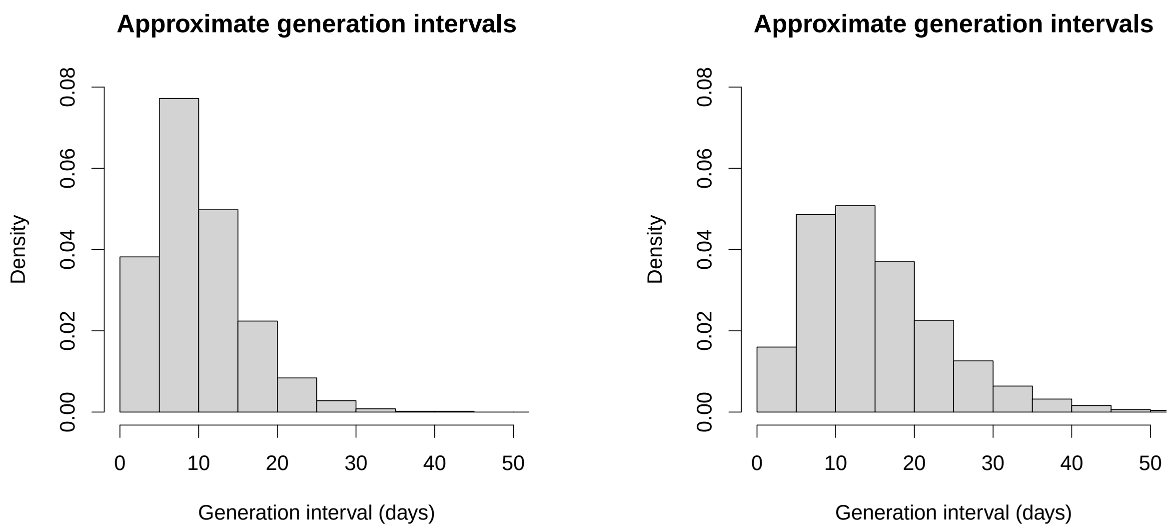
A. 0.35 yr
B. 0.50 yr
C. 0.72 yr
D. **1.4 yr**
E. 2.0 yr

38. What is the estimated transmission rate β (analogous to the birth rate of cases)?

A. 0.2/yr
B. 0.4/yr
C. 0.5/yr
D. **0.6/yr**

39. What is the estimated value of $\mathcal{R}_0$?

   A. 0.5
   B. 2
   C. 3
   D. 4
   E. **6**



See the figure above.

40. The estimated initial exponential growth rate during the West African Ebola Outbreak was $r_0 = 1/\text{month}$. The graphs show estimated generation-interval distributions for that outbreak. Compared to the one on the left, the one on the right shows ________ intervals which would correspond to ________ estimates of $\mathcal{R}_0$ corresponding to the estimate of r_0.

   A. **Longer; larger**
   B. Longer; smaller
   C. Shorter; larger
   D. Shorter; smaller