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:

- $\ell_x = p_1 \times p_2 \times \ldots p_{x-1}$
- $\mathcal{R} = \sum \ell_x f_x$
- $\sum \ell_x f_x \lambda^{-x} = 1$
- $\mathrm{SAD}(x) \propto \ell_x \lambda^{-x}$

competition:

- α_{ij} = effect **of** species i **on** species j
- $C = \alpha_{12}\alpha_{21}$
- $E_{ij} = \alpha_{ij}K_i/K_j$

1. Compared to the geometric mean, the arithmetic mean is much __________ when variation is __________, and more similar when variation is __________.

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

2. 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

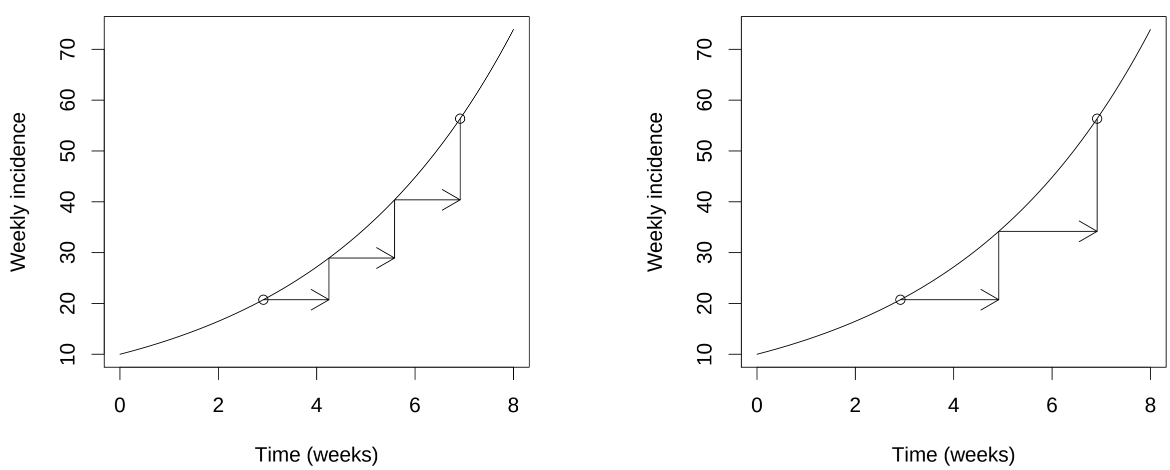
Use the following information for the next two questions. A large lake has big fish and small fish at equilibrium under reciprocal control – ie., the small fish are controlled by predation from large fish, and the large fish are controlled by the food supply of small fish. Fishing has been prohibited in this lake for many years, but now will be allowed at a relatively low level that is not expected to change the fact that the two kinds of fish are the main factors controlling each others' population growth. Both big and small fish will be caught and taken.

3. What effect would you expect to see in the *short term*?

A. Populations of both small and large fish increase
B. Populations of small fish decline, while populations of large fish increase
C. Populations of large fish decline, while populations of small fish increase
D. Populations of both small and large fish decline

4. What effect would you expect to see in the *long term*?

A. Populations of both small and large fish increase
B. Populations of small fish decline, while populations of large fish increase
C. Populations of large fish decline, while populations of small fish increase
D. Populations of both small and large fish decline



5. The picture above illustrates the idea that, for a fixed rate of spread, a disease with a faster generation time has:

A. larger instantaneous rate of growth
B. smaller instantaneous rate of growth
C. larger effective reproductive number
D. smaller effective reproductive number

6. If r_f and r_e represent the *per capita* growth rates of a resource and exploiter species with density N_e and N_f respectively, which of the following is (almost) always true?

A. r_e increases when N_e increases
B. r_f increases when N_e increases
C. r_e increases when N_f increases
D. r_f increases when N_f increases
E. None of the above

7. Cole's paradox asks why some plants are iteroparous (reproduce more than once). Which of the following points does *not* help to explain Cole's paradox?

A. Plants must deal with variation in reproductive success through time
B. Plants must deal with variation in reproductive success across space
C. Plant offspring may be less likely to survive than established plants
D. Plant populations are regulated

8. According to simple models, influenza vaccination in Ontario most likely __________ reduce the average number of infectious people and __________ increase the average number of susceptible people.

A. does; does
B. does; does not
C. does not; does
D. does not; does not

9. Spruce trees are not found in Hamilton forests because

A. $r = 0$
B. $0 < r < 1$
C. $\mathcal{R}_0 = 0$
D. $0 < \mathcal{R}_0 < 1$

10. Compared to a realized niche, a fundamental niche is usually __________ but sometimes __________.

A. bigger; the same size
B. the same size or bigger; smaller
C. smaller; the same size
D. the same size or smaller; bigger

11. Why do we usually add density dependence in the resource species in a model of exploitation, but less often add it for the exploiter species?

A. Because exploiters are not likely to experience density dependence
B. Because explicitly modeling the resource species already provides a form of density dependence for the exploiter
C. Because density dependence for the resource species is stabilizing, while density dependence for the exploiter species is destabilizing
D. Because density dependence for the resource species is destabilizing, while density dependence for the exploiter species is stabilizing

12. What sort of behaviour do you expect to see from a simple model of exploiter-resource species interactions with both exploiter and resource-species density-dependence added?

A. Neutral cycles
B. A limit cycle
C. Damped oscillations
D. A limit cycle if *exploiter* density dependence is strong, and damped oscillations otherwise
E. A limit cycle if *resource* density dependence is strong, and damped oscillations otherwise

13. Researchers survey a population of plant by counting new shoots every spring. They estimate that shoots have a 10% probability of maturing to reproduce; reproducing adults produce 1000 seeds and then die; and seeds have a 4% probability of germinating to become shoots. What is λ for this population?

A. 1
B. 2
C. 4
D. 5
E. 100