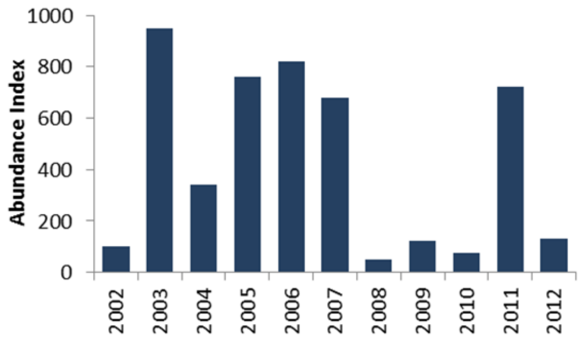
FW364
Midterm II - PRACTICE EXAM - KEY
March 2012

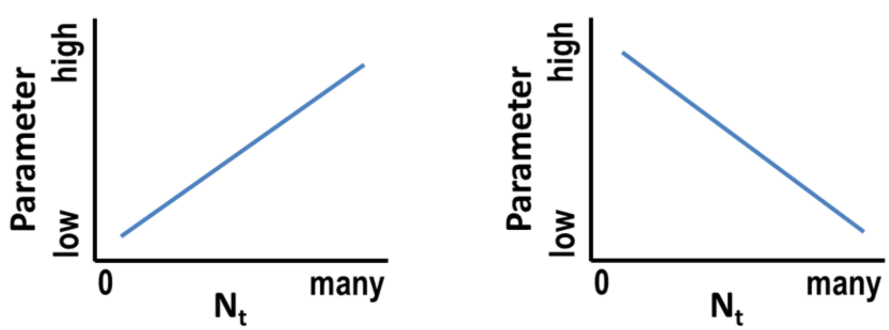
Density Dependence Practice Questions

1. The following figure shows the abundance through time of a marine fish species that releases its eggs directly into the water column, which causes the larvae that hatch to be greatly affected by currents and other abiotic processes. Circle the option below that best describes the population dynamics for this fish species.



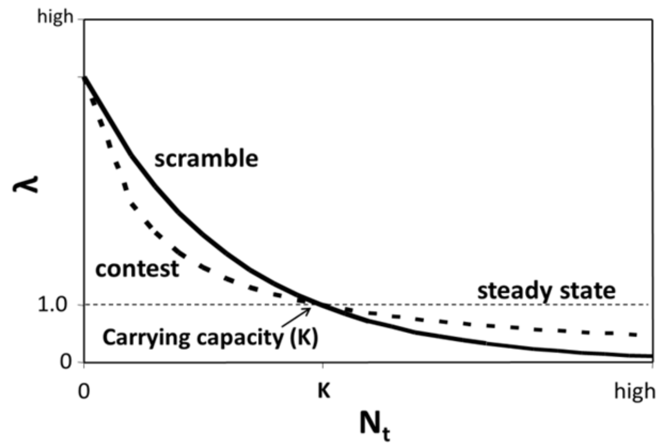
a. Allee effects (inverse density dependence)
b. Density independence
c. Scramble density dependence
d. Contest density dependence

2. To which figure below do the per capita population birth (b') and death (d') rates belong given density dependence? In other words, which of these parameters increases and which decreases with density in a population experiencing density dependence? Note: Although we may not expect the relationship between these parameters and density to be linear in all instances, a linear relationship is a close enough approximation for our purposes.



Parameter: ___**d'**___ Parameter: ___**b'**___

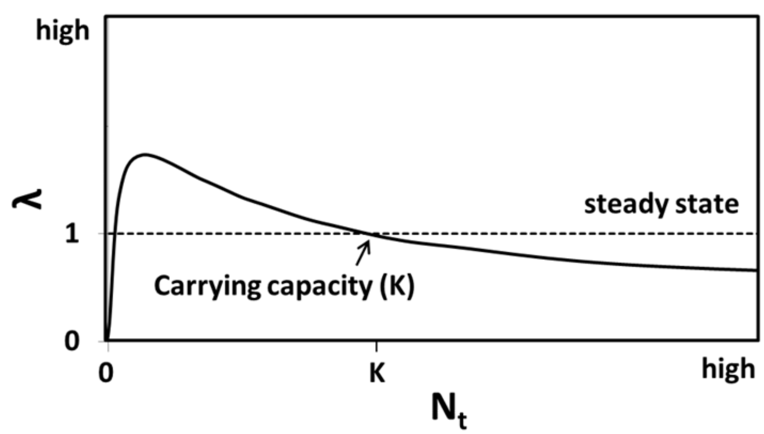
3. Draw a figure that represents the relationship between the population growth rate (λ) and population size (N_t) for scramble **and** contest density dependence (be sure to label which relationship is for scramble and which is for contest density dependence). On the same figure, draw a line that represents steady state. What is the significance of the point where the relationships for scramble and contest density dependence cross the steady state line?



4. Considering the figure you drew in question 3, what is the significance, in terms of population fluctuations around carrying capacity, of scramble having a higher growth rate below carrying capacity and a lower growth rate above carrying capacity?

   The higher growth rate below carrying capacity makes scramble populations increase faster than contest populations for all population sizes below carrying capacity. The lower growth rate above carrying capacity makes scramble populations decrease faster than contest populations for all population sizes above carrying capacity. This combination of faster population increase below carrying capacity and faster population decrease above carrying capacity makes scramble populations more prone to deterministic fluctuations than contest populations.

5. Considering just the relationship you drew for **scramble** competition in question 3, how would this relationship change if there was an Allee effect operating in this population? I.e., Draw the relationship between the population growth rate (λ) and population size (N_t) for a scramble population with an Allee effect.



6. One of the situations below represents positive feedback, the other represents negative feedback. Label the correct type of feedback for each situation.

Situation 1: As population size declines, the inability to find mates reduces the birth rate, which causes further population decline.

Feedback type: ________**positive**_________

Situation 2: As population size increases, competition for resources causes a decreased population growth rate.

Feedback type: ________**negative**______

7. Complete the sentence below by choosing the best answer for each pair:

In scramble density dependence, resources are shared:

equally OR unequally

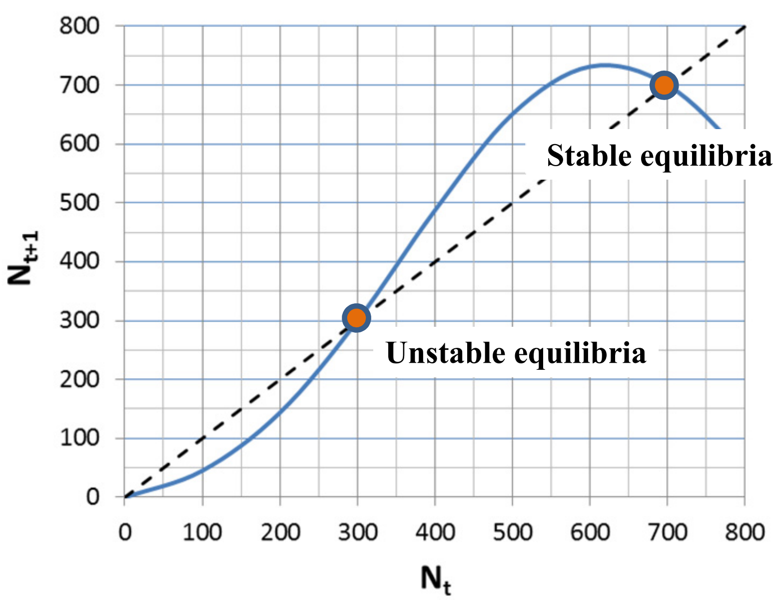
which therefore causes individuals to be affected:

symmetrically OR asymmetrically

which causes scramble (as opposed to contest) population dynamics to be:

more stable OR **less stable**

8. The figure below is a replacement curve. Using the choices next to the figure, circle whether the figure illustrates scramble or contest competition, and whether Allee effects are present. Label the equilibria in the figure and state whether the equilibria are stable or unstable.



Scramble OR Contest

Allee effects present OR No Allee effects

9. Using the replacement curve in question 8, determine how many individuals are present for each of the time steps below with a starting population size of 200 individuals.

Time	N_t
0	200
1	**144**
2	**81**
3	**33**
4	**10**
5	**3**

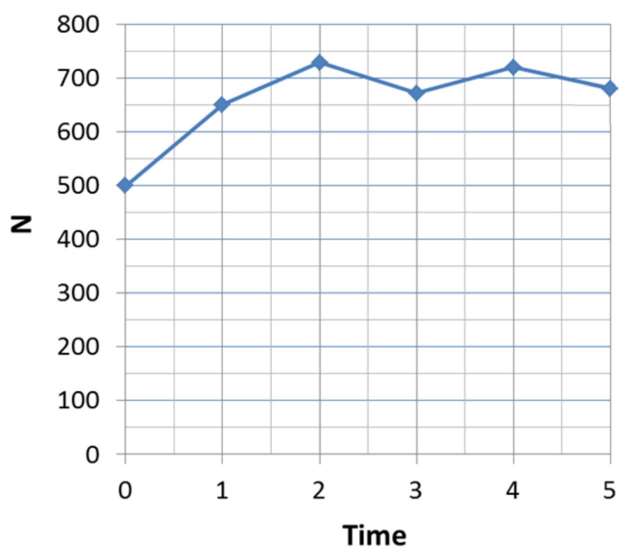
Note: These are exact numbers calculated from an equation. Your numbers obtained from the replacement curve will not be as precise. Just make sure your numbers are relatively close (e.g., within about 20 individuals)

10. Using the replacement curve in question 8, determine how many individuals are present for each of the time steps below with a starting population size of 500 individuals.

Time	N_t
0	500
1	**651**
2	**729**
3	**672**
4	**720**
5	**681**

Note: These are exact numbers calculated from an equation. Your numbers obtained from the replacement curve will not be as precise. Just make sure your numbers are relatively close (e.g., within about 20 individuals)

11. Using the population trajectory from question 10 and the grid below, draw a graph of density versus time. Be sure to label axes and tick marks. What is the carrying capacity?



Carrying capacity: __**700**__

12. Which of the choices below would be evidence for an Allee effect operating in a population? (more than one option may be correct)

    a. As population size increases at high density, competition causes the number of young produced to decrease
    b. As population size decreases to very low densities, the birth rate increases due to greater opportunity to mate
    c. <u>As population size increases from low density, the mortality rate decreases due to the greater protection from predators offered by the larger group</u>
    d. <u>As population size increases from low density, seed production increases due to greater attraction of pollinators</u>

DOODLE SPACE FOR QUESTIONS BELOW

Age and Stage Structure Practice Questions

13. In a closed population, the number of individuals in a **cohort**:

a. increases over time
b. decreases over time
c. may increase or decrease over time
d. remains the same over time

14. The first row of a Leslie matrix for an age-structured model consists of elements that describe:

a. the survival rates of the first age class
b. the fecundity rates of the first age class
c. the fecundity rates of all age classes
d. a combination of survival and fecundity rates for all age classes

15. What are the numbers on the matrix diagonal for an **age-structured** Leslie matrix? You can assume the fecundity of the age-0 class is zero and there are no composite age classes.

a. Numbers on the diagonal are the non-zero survival rates within an age-class
b. Numbers on the diagonal are the non-zero survival rates between age-classes
c. There are no numbers on the diagonal; all diagonal elements should be left blank
d. All numbers on the diagonal are zero because these transitions are impossible

16. Below are annual census data for a mountain lion population. Calculate the average survival and fecundity rates for the age classes below. You can assume mountain lions mature at age one and that the fecundity for all mature age classes is the same.

Age	2008	2009	2010	2011
0	48	48	45	50
1	10	12	12	15
2	10	9	10	9
3	4	2	3	4

Age 0 Survival: 2008: 12/48 = 0.25 2009: 12/48 = 0.25 2010: 15/45 = 0.33 Average: 0.28
Age 1 Survival: 2008: 9/10 = 0.90 2009: 10/12 = 0.83 2010: 9/12 = 0.75 Average: 0.83
Age 2 Survival: 2008: 2/10 = 0.20 2009: 3/9 = 0.33 2010: 4/10 = 0.40 Average: 0.31

Age 0 Fecundity: 0 (since mountain lions are not mature at age 0)
Since the fecundity for all mature (adult) age classes is the same, Age 1 = Age 2 = Age 3 = Adult fecundity
Adult fecundity: 2008: 48 / (10+10+4) = 2
2009: 45 / (12 + 9 + 2) = 1.96
2010: 50 / (12 + 10 + 3) = 2
Average adult fecundity = 1.99

17. Calculate next year's age-structured population size using the two sets of starting densities below and the honeyeater Leslie matrix:

Age class	Set 1	Set 2
0	60	10
1	5	10
2	5	10
3	4	10
4	4	10
5	3	10
6	3	10
7	2	10
8	2	10
9	2	0

Honeyeater Leslie matrix

0	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.703	0	0	0	0	0	0	0	0	0
0	0.717	0	0	0	0	0	0	0	0
0	0	0.751	0	0	0	0	0	0	0
0	0	0	0.769	0	0	0	0	0	0
0	0	0	0	0.746	0	0	0	0	0
0	0	0	0	0	0.717	0	0	0	0
0	0	0	0	0	0	0.806	0	0	0
0	0	0	0	0	0	0	0.778	0	0
0	0	0	0	0	0	0	0	0.667	0

For Set 1:

0	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48		60		14
0.703	0	0	0	0	0	0	0	0	0		5		42
0	0.717	0	0	0	0	0	0	0	0		5		4
0	0	0.751	0	0	0	0	0	0	0		4		4
0	0	0	0.769	0	0	0	0	0	0	*	4	=	3
0	0	0	0	0.746	0	0	0	0	0		3		3
0	0	0	0	0	0.717	0	0	0	0		3		2
0	0	0	0	0	0	0.806	0	0	0		2		2
0	0	0	0	0	0	0	0.778	0	0		2		2
0	0	0	0	0	0	0	0	0.667	0		2		1

For Set 2:

0	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48		10		38
0.703	0	0	0	0	0	0	0	0	0		10		7
0	0.717	0	0	0	0	0	0	0	0		10		7
0	0	0.751	0	0	0	0	0	0	0		10		8
0	0	0	0.769	0	0	0	0	0	0	*	10	=	8
0	0	0	0	0.746	0	0	0	0	0		10		7
0	0	0	0	0	0.717	0	0	0	0		10		7
0	0	0	0	0	0	0.806	0	0	0		10		8
0	0	0	0	0	0	0	0.778	0	0		10		8
0	0	0	0	0	0	0	0	0.667	0		0		7

18. If we decided to use a composite age class for all honeyeaters age 4 and older (but kept separate age classes for ages 0 through 3), what would the Leslie matrix with the composite age class be? Present the honeyeater Leslie matrix in two ways: one matrix using just symbols and the other matrix using numbers. To construct the second Leslie matrix, use the numbers from the Leslie matrix in question 17 and assume that survival within the age 4+ class is 0.743.

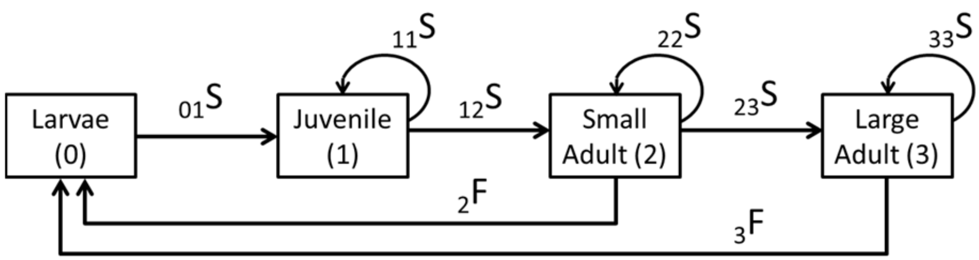
Leslie matrix with Symbols:

0	$_{Adult}F$	$_{Adult}F$	$_{Adult}F$	$_{Adult}F$
$_{01}S$	**0**	**0**	**0**	**0**
0	$_{12}S$	**0**	**0**	**0**
0	**0**	$_{23}S$	**0**	**0**
0	**0**	**0**	$_{34}S$	$_{44}S$

Leslie matrix with Numbers:

0	**0.48**	**0.48**	**0.48**	**0.48**
0.703	**0**	**0**	**0**	**0**
0	**0.717**	**0**	**0**	**0**
0	**0**	**0.751**	**0**	**0**
0	**0**	**0**	**0.769**	**0.743**

19. Construct the Leslie matrix that corresponds to the diagram of stage transitions below:



0	**0**	$_{2}F$	$_{3}F$
$_{01}S$	$_{11}S$	**0**	**0**
0	$_{12}S$	$_{22}S$	**0**
0	**0**	$_{23}S$	$_{33}S$

20. Assume that a bluegill population can be modeled with the box and arrow diagram in question 19. If the per capita fecundity of small and large adults is 2 and 10, respectively, the probability (for all stages) of advancing to the next stage is 50%, the probability of remaining in a stage (for juveniles, small adults, and large adults) is 25%, and starting densities of the four stages are: 10, 50, 20, and 5, how many bluegill will there be next year?

$$\begin{vmatrix} 0 & 0 & 2 & 10 \\ 0.50 & 0.25 & 0 & 0 \\ 0 & 0.50 & 0.25 & 0 \\ 0 & 0 & 0.50 & 0.25 \end{vmatrix} * \begin{vmatrix} 10 \\ 50 \\ 20 \\ 5 \end{vmatrix} = \begin{vmatrix} 90 \\ 18 \\ 30 \\ 11 \end{vmatrix}$$ **= 149 bluegill total**

For questions 21-24 refer to the following Leslie matrix, which describes an annually-reproducing population consisting of four stages: larvae, juveniles, small adults, and large adults.

0	0	2.0	14.0
0.05	0.15	0	0
0	0.35	0.25	0
0	0	0.35	0.75

21. What is the survival rate of larvae?

a. <u>0.05</u>
b. 0.15
c. 0.35
d. 0.50

22. What is the probability of a small adult becoming a large adult?

a. 0.05
b. 0.15
c. 0.25
d. <u>0.35</u>

23. If the population consists of 100 larvae, 50 juveniles, 25 small adults and 25 large adults, how many **larvae** will there be next year? Assume that no individuals die before they reproduce.

a. 100
b. 200
c. 300
d. <u>400</u>

24. If the survival from small adults to large adults was 0.8, would there be a problem?

a. <u>Yes</u>
b. No

If you picked Yes above, why would this survival rate be a problem?

The new survival rate (0.8) would be problematic because the total survival rate for small adults (i.e., survival rate from small adults to large adults plus survival rate within small adults) would be greater than one: 0.25 + 0.8 = 1.05

Metapopulation Practice Questions

25. What is the fundamental metapopulation concept (i.e., the metapopulation mantra)? Describe what this concept means (using more than the four words included in the mantra ☺).

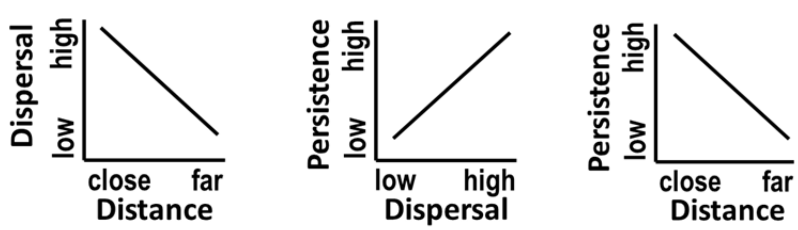
    Local extinction, global persistence, which means that while local populations may go extinct at a relatively high frequency, a set of local populations connected by limited dispersal (i.e., the metapopulation) may persist with a relatively high probability.

26. Which of the statements below describe a viable metapopulation structure? (more than one option may be correct)

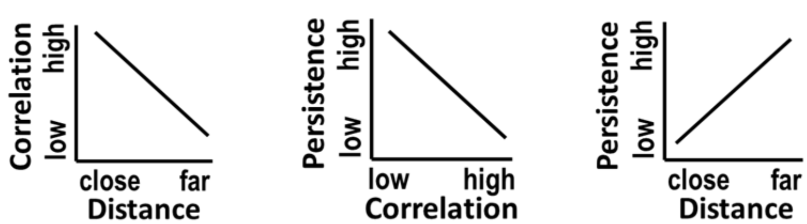
    a. Metapopulation entirely comprised of source populations
    b. Metapopulation entirely comprised of sink populations
    c. Metapopulation with one source population and all other local populations are sinks
    d. Metapopulation with all local population growth rates less than one

27. Illustrate the contradictory effect of distance among metapopulations on metapopulation persistence due to effects of distance on dispersal and spatial correlation by providing relationships in the figures below.

    Effect of distance on persistence due to dispersal effects:



    Effect of distance on persistence due to spatial correlation effects:



28. Assuming that extinctions of local populations within a metapopulation are completely independent events, what is the probability of **persistence** for a metapopulation comprised of 15 local populations, each having a probability of extinction of 0.9?

    Probability of local population extinction (p_e) = 0.9
    x = 15 local populations
    $P_p = 1 – p_e^x$
    $P_p = 1 – (0.9)^{15}$
    $P_p = 0.79$