FW364 Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Midterm II Exam KEY

March 28, 2012 Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Be sure to read all questions carefully. Always give the best answer.**

**Show your work so I can give partial credit.**

1. (3 pts.) A negative effect on per capita birth rate of an increase in population density is an example of:

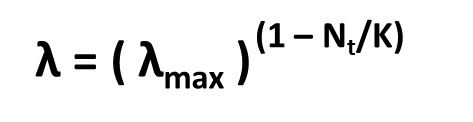
a. positive feedback

**b. negative feedback**

c. stochastic variation

d. extinction via demographic stochasticity

1. (3 pts.) Below is the equation describing how the population growth rate (λ) changes with density (Nt) for scramble competition. What happens to λ when Nt is very small?



a. λ approaches 0

**b. λ approaches λmax**

c. λ approaches 1

d. λ is less than 0

1. (3 pts.) The following data were obtained from a breeding colony of penguins over a period of years, as the population recovered from near extinction.

|  |  |
| --- | --- |
| size of colony (# of breeding pairs) | # of chicks produced |
| 15 | 10 |
| 20 | 15 |
| 30 | 25 |
| 50 | 50 |
| 100 | 120 |

This population shows evidence of:

a. density dependence

b. exponential growth

c. stochastic breeding success

**d. an Allee effect**

4. (3 pts.) The fundamental idea of a metapopulation is:

**a. local extinction, global persistence**

b. local extinction, global extinction

c. local persistence, global persistence

d. local persistence, global extinction

5. (3 pts.) In order for a metapopulation to persist:

a. at least one of the local populations must be a sink population

**b. at least one of the local populations must be a source population**

c. all of the local populations must have a λ greater than 1

d. immigration must be greater than emigration

6. (3 pts.) Distance among local populations has what affect(s) on metapopulation persistence?

a. increased distance increases metapopulation persistence due to decreased spatial correlation

b. decreased distance increases metapopulation persistence due to increased dispersal

c. distance has no effect on metapopulation persistence

**d. a) and b) above both apply**

1. (3 pts.) In Ramas, the standard deviation matrix in a stage-structured model represents:

a. deterministic variation in survival and fecundity rates

**b. environmental stochasticity in survival and fecundity rates**

c. survival and fecundity rates at the stable age distribution

d. all of the above

1. (4 pts.) The highlighted elementsin the following Leslie matrix for an **age**-**structured** population represent:

|  |  |  |  |
| --- | --- | --- | --- |
| **X** | **X** | **X** | **X** |
| **X** | **X** | **X** | **X** |
| **X** | **X** | **X** | **X** |
| **X** | **X** | **X** | **X** |

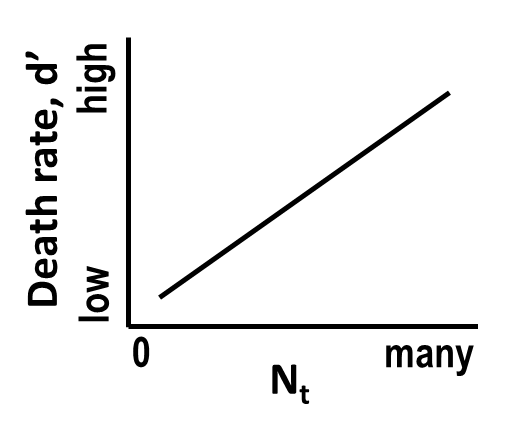
**a. impossible transitions (so equal 0)**

b. fecundity rates of each age class

c. survival rates of each age class

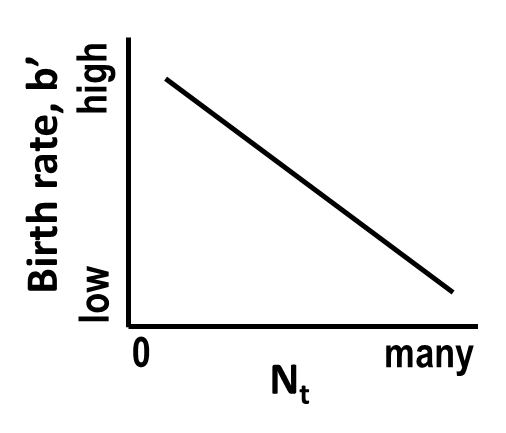
d. none of the above

1. (4 pts.) Draw a graph that illustrates the relationship between per capita **death** rate (y-axis) and population size (x-axis) for a population in which density dependence is operating.



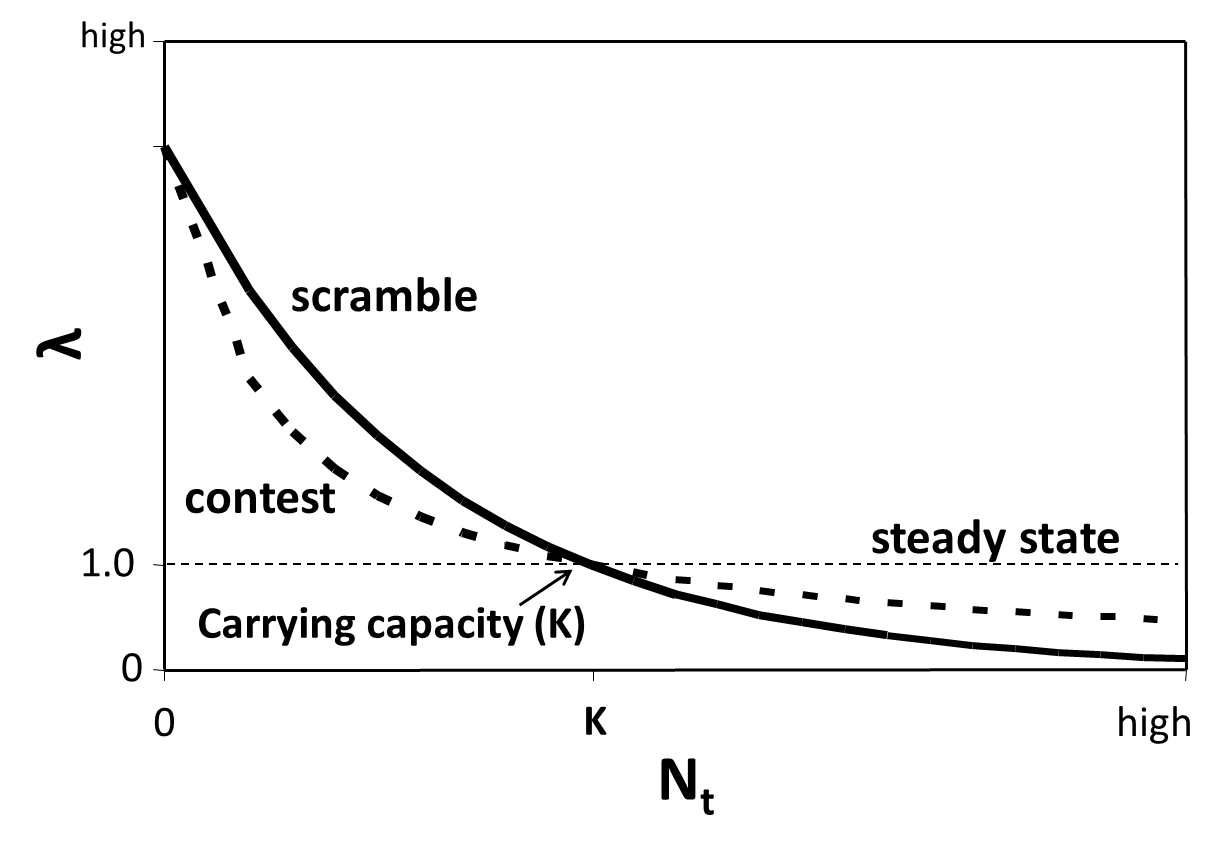
**Note: Figure just has to show increase; exact shape does not matter**

1. (4 pts.) Draw a graph that illustrates the relationship between per capita **birth** rate (y-axis) and population size (x-axis) for a population in which density dependence is operating.

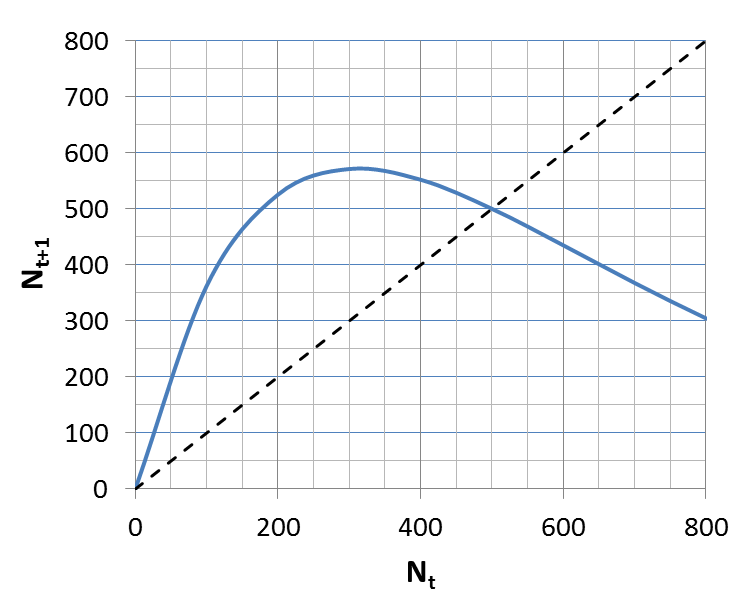


**Note: Figure just has to show decrease; exact shape does not matter**

1. (6 pts.) Draw a graph that illustrates the relationships between per capita **population growth** **rate** (y-axis) and population size (x-axis) for **scramble and contest** density dependence. Draw these relationships on the same figure. Be sure to clearly label which relationship is for scramble and which relationship is for contest density dependence.



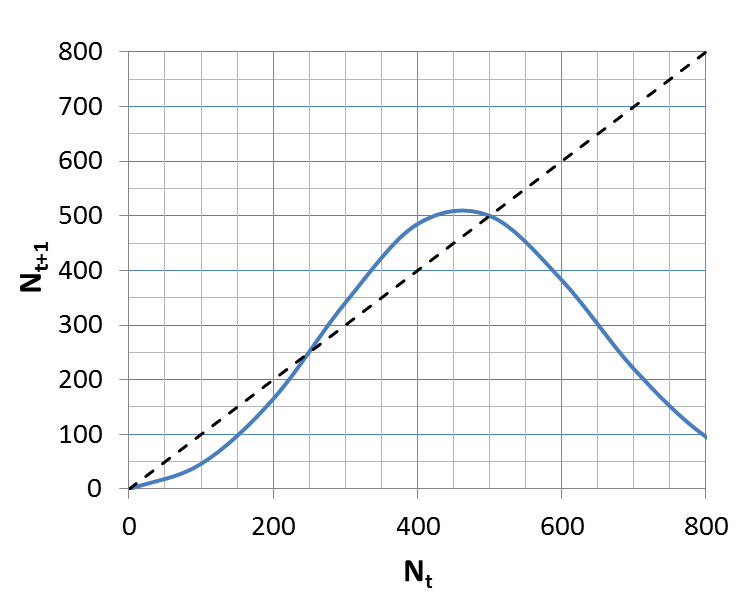
1. (7 pts.) The three figures below are replacement curves. Using the choices next to each curve, circle whether the curves illustrate either scramble or contest competition, and whether Allee effects are present. Mark all equilibria on the curves (by drawing a dot) and label whether those equilibria are stable or unstable. Hint: To determine whether equilibria are stable, pick a few starting population sizes and see how the population progresses.



**Stable equilibria**

**Scramble** OR Contest

Allee effects present OR **No Allee effects**

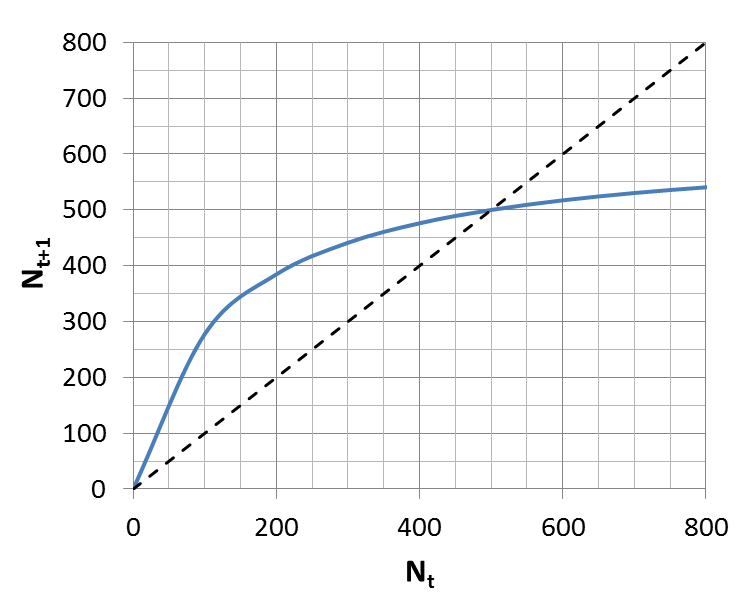


**Stable equilibria**

**Unstable equilibria**

**Scramble** OR Contest

**Allee effects present** OR No Allee effects



**Stable equilibria**

Scramble OR **Contest**

Allee effects present OR **No Allee effects**

1. (8 pts.) From the following data on the abundance through time of a fish species, **rank** the age classes from highest to lowest **average** **survival rates**. Assume that the survival of age class 3 is unknown. Show your work!

|  |  |  |  |
| --- | --- | --- | --- |
|  | Abundance | | |
| age class | Year 1 | Year 2 | Year 3 |
| 0 | 500 | 400 | 450 |
| 1 | 30 | 40 | 20 |
| 2 | 30 | 20 | 20 |
| 3 | 30 | 25 | 15 |

**Average survival rate of age class 0 is the average of: (40/500 = 0.08) and (20/400 = 0.05), which is: 0.065.**

**Average survival rate of age class 1 is the average of: (20/30 = 0.67) and (20/40 = 0.50), which is: 0.585.**

**Average survival rate of age class 2 is the average of: (25/30 = 0.83) and (15/20 = 0.75), which is: 0.790.**

**Survival rates of age classes, from highest to lowest:**

**age-2 (highest), age-1, age-0 (lowest)**

1. (4 pts.) How many **non-zero** elements (at most) does the Leslie matrix have for an **age-structured** population consisting of 2 immature age classes (i.e. not reproducing) and 3 reproductive age classes (so there are 5 age classes total)? Show your work!

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **0** | **0** | **F** | **F** | **F** |
| **S** | **0** | **0** | **0** | **0** |
| **0** | **S** | **0** | **0** | **0** |
| **0** | **0** | **S** | **0** | **0** |
| **0** | **0** | **0** | **S** | **0** |

**Seven non-zero elements**

1. (8 pts.) Construct the Leslie matrix that corresponds to a population having 3 stage classes: larvae, juveniles and adults. Larvae and juveniles have a 0.3 probability of surviving and staying in the same stage, and a 0.4 probability of surviving and moving to the next stage. Adults have a 0.8 probability of surviving, and adults have a per capita adult fecundity of 15 (larvae and juveniles do not have young).

|  |  |  |
| --- | --- | --- |
| **0.3** | **0** | **15** |
| **0.4** | **0.3** | **0** |
| **0** | **0.4** | **0.8** |

For **questions 16, 17, and 18**, refer to the following Leslie matrix, which describes an annually-reproducing population consisting of five stages: larvae, small juveniles, large juveniles, small adults, and large adults:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 0 | 0 | 0 | **4.0** | **10.0** |
| **0.05** | **0.15** | 0 | 0 | 0 |
| 0 | 0.20 | **0.25** | 0 | 0 |
| 0 | 0 | 0.35 | 0.55 | 0 |
| 0 | 0 | 0 | 0.15 | 0.85 |

1. (6 pts.) If there are 200 larvae and 100 small juveniles this year, how many **small juveniles** will there be next year?

**Using the highlighted survival rates:**

**(200 • 0.05) + (100 • 0.15) = 10 + 15 = 25 small juveniles**

1. (6 pts.) What is the probability of a large juvenile surviving and remaining as a large juvenile from one year to the next? (If you make a mistake on a question like this, explaining or showing your reasoning can give partial credit.)

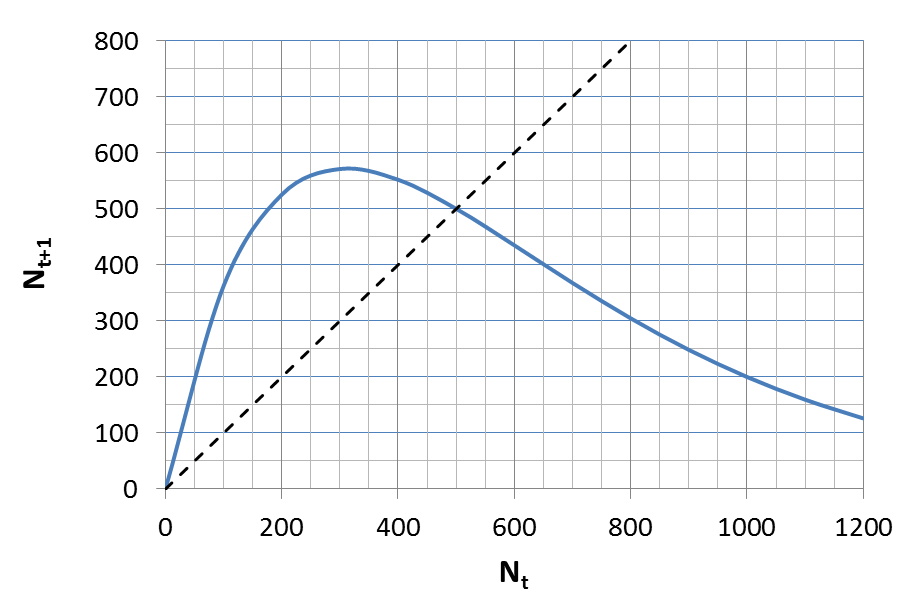
**0.25 = 25% (see highlighted survival rate above)**

1. (6 pts.) If the population currently consists of 100 small adults and 50 large adults, how many **larvae** will there be in the population next year? Assume that no adults die before reproducing.

**Using the highlighted fecundity rates:**

**(100 • 4.0) + (50 • 10.0) = 400 + 500 = 900 larvae**

1. (10 pts.) The following curve is a replacement curve.
2. For a starting density of N0 = 100, draw how the population progresses on the replacement curve (draw right on the figure).



**Trajectory:**

**Time N**

**0 100**

**1 362**

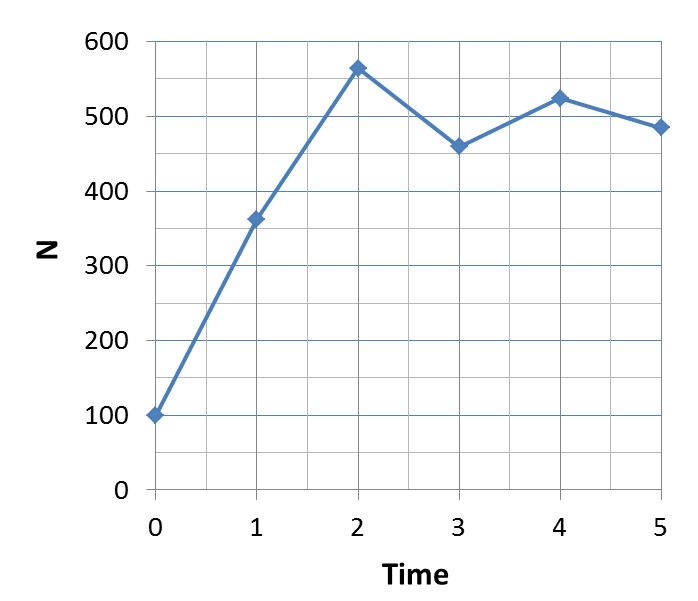
**2 564**

**3 459**

**4 524**

**5 485**

(b) Draw a graph below (on the grid provided) showing how the density changes over time for N0 = 100. In other words, make a plot of density versus time for the population trajectory you determined on the replacement curve above (**you only need to plot from time 0 to time 5**). Be sure to provide axis labels as well as numbers for the tick marks. What is the carrying capacity for this population?



Carrying capacity: **500**

1. (6 pts.) What is the probability of **persistence** of a metapopulation composed of 4 subpopulations (local populations) which each have an extinction probability of 60%? (Assume subpopulations operate completely independently)

**x = 4 local populations**

**pe = 0.60**

**Pp = 1 – pex**

**Pp = 1 – 0.604**

**Pp = 0.87**

**Bonus Questions**:

BQ1: (2 pts.) The following Leslie matrix for a **stage-structured** amphibian population is ecologically **impossible**. Can you find the offending elements? Explain what the problem is.

|  |  |  |  |
| --- | --- | --- | --- |
| 0 | 0 | 0 | 25.0 |
| 0.02 | 0.45 | 0 | 0 |
| 0 | 0.18 | **0.70** | 0 |
| 0 | 0 | **0.40** | 0.98 |

**The two survival rates of the third stage class add up to 1.10, which is greater than 1 and so impossible.**

BQ2: (2 pts.) What important (single) parameter can describe the survival and fecundity rates in a Leslie matrix when the population is at the stable age distribution?

**λ, the dominant eigenvalue (which is equivalent to the population growth rate, λ)**