1.018/7.30J Fall 2003
Fundamentals of Ecology

Problem Set 3: Population Ecology

due November 18, 2003

1. Two species, A and B, are placed in a limited environment in a laboratory at various initial population densities. 10 different densities were tested. After a month, the population densities of both species were measured.

	Initial densities (t=0)		Densities after one month	
Trial #	N_A	N_B	N_A	N_B
1	50	15	55	20
2	100	10	110	20
3	60	35	60	45
4	20	20	25	15
5	30	15	40	15
6	20	25	20	20
7	60	25	65	35
8	30	40	20	40
9	20	40	15	35
10	135	5	135	10

(a) Plot the isoclines for Species A and B (use the blank graph on the last page). Explain your method for determining the isoclines.
(b) What kind of interaction do these two species have?
(c) Will it be stable or unstable?
(d) If it is unstable, what factors would make it stable? If it is stable, what factors would make it unstable?
(e) Approximate the maximum population density possible for Species A, in the absence of Species B.
(f) Can you determine the maximum density for Species B in the absence of Species A? If so, estimate this maximum density. If not, why not?

2. Now, you repeat this experiment with two more species, C and D. You start with the same initial population densities as in your previous experiment, and again, observe how the populations change after one month. Using these data, answer the same questions as in Question 1 for Species C and D.

(a) Plot the isoclines for Species C and D (use the blank graph on the last page). Explain your method for determining the isoclines.
(b) What kind of interaction do these two species have?
(c) Will it be stable or unstable?
(d) If it is unstable, what factors would make it stable? If it is stable, what factors would make it unstable?
(e) Approximate the maximum population density possible for Species C, in the absence of Species D.
(f) Can you determine the maximum density for Species D in the absence of Species C? If so, estimate this maximum density. If not, why not?

	Initial densities (t=0)		Densities after one month	
Trial #	N_C	N_D	N_C	N_D
1	50	15	60	15
2	100	10	100	5
3	60	35	55	30
4	20	20	35	30
5	30	15	35	20
6	20	25	25	30
7	60	25	60	15
8	30	40	25	40
9	20	40	20	50
10	135	5	125	3

3. Below are mortality and fecundity data for two populations, each of a different species.

x = age (at beginning of age interval)
n_x = number alive at age x
q_x = per capita mortality during the age interval from x to x+1 (i.e. fraction that die before reaching next age interval)
l_x = proportion of organisms surviving from the start of the life table to age x ($l_x = n_x / n_o$)
b_x = per capita birth rate for individuals in age interval.

Species A:

x (yrs)	**q_x**	**l_x**	**n_x**	**b_x**
0	0.19	1.0	5000	0
1	0.25			0
2	0.21			0
3	0.17			0.4
4	0.2			0.9
5	0.24			0.5

Species B:

x (yrs)	**q_x**	**l_x**	**n_x**	**b_x**
0	0.99	1.0	2200	0
1	0.2			0
2	0.12			0
3	0.08			0
4	0.09			0
5	0.15			200

n.b. In class, we mentioned that life tables are often expressed in terms of daughters born per female. In this case, assume that b_x is expressed per individual (not per female).

(a) Fill in the numbers in the columns l_x and n_x. (We didn't specifically discuss l_x in lecture, but your book describes l_x). Remember that while q_x describes mortality from one interval to the next, l_x describes the fraction surviving compared to the initial number.

(b) For each species, draw the survivorship curve and state whether it exhibits a Type I, II or III survivorship curve (remember the y axis in a survivorship curve is logarithmic).

(c) Let's say that while you very carefully collected your data, you were less careful with labeling each of the data sets. You know that these data come from either sparrows, salmon or deer. For each Species, state which animal it is likely to be and why.

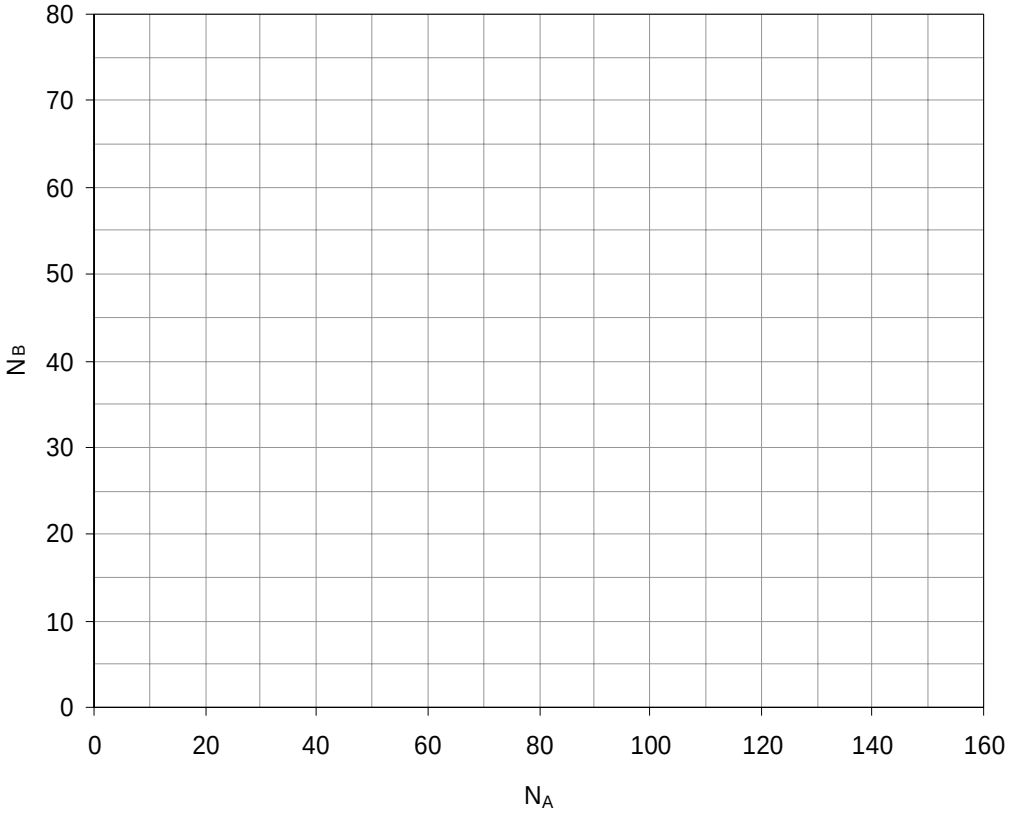
Another parameter that is frequently considered in population studies is the net productive rate R_o. R_o is defined as the number of individuals born per individual per generation. As described in your text, you can calculate R_o as:

$$R_o = \sum l_x b_x \qquad \text{over all age groups}$$

(d) In general, for what value of R_o will the total number of individuals in a population remain the same?

(e) For the above two populations, calculate R_o. Are these populations expanding, diminishing, or staying the same?

Problem 1



Problem 2