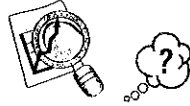


Name _____

Course/Section _____

Date _____

Professor/TA _____



Activity 53.2 What models can you use to calculate how quickly a population can grow?

1. In the simplest population growth model, $dN/dt = rN$.

a. What does each term stand for?

Term	Stands for
N	
dt	
r	
dN	

b. What type of population growth does this equation describe?

c. What assumptions are made to develop this equation?

2. Population growth may also be represented by the model $dN/dt = r_{max}N[(K - N)/K]$.

a. What is K ?

b. If $N = K$, then what is dN/dt ?

c. Describe in words how dN/dt changes from when N is very small to when N is large relative to K .

d. What assumptions are made to develop this equation?

3. You and your friends have monitored two populations of wild lupine for one entire reproductive cycle (June year 1 to June year 2). By carefully mapping, tagging, and censusing the plants throughout this period, you obtain the data listed in the chart.

Parameter	Population A	Population B
Initial number of plants	500	300
Number of new seedlings established	100	30
Number of the initial plants that died	20	100

- a. Calculate the parameters for each population.

Parameter	Population A	Population B
B (births during time interval)		
D (deaths during time interval)		
b (per capita birth rate)		
m (per capita death rate)		
r (per capita rate of increase)		

- b. Given the initial population size and assuming that the population is experiencing exponential growth at growth rate r , what will the number of plants be in each population in 5 years? (Use the initial population size as time 0 and compute to time 5.)

Population A:

Population B:

4. Using the exponential growth formula, you can determine the amount of time it will take for a population to double in size if you know r_{max} or r . The doubling time is equal to

$$\log_{10}2/\log_{10}(1 + r)$$

Alternatively, the doubling time per unit time can be estimated by using the formula:

70 divided by the percentage increase per unit time (as a whole number)

Using either of these formulas—the exponential growth formula or the approximate doubling rate formula—calculate the following.

- a. If the population of a country is growing at 2% per year, how many years will it take for the population to double?
- b. If your bank account is growing at the rate of 1% per year, how many years will it take for your money to double?

Name _____

Course/Section _____

5. You are studying the growth of a particular strain of bacteria. You begin with a tiny colony on a petri plate. One day later, you determine that the colony grew and exactly doubled in size. A calculation showed that if the colony continued to grow at the same (constant) rate, it would cover the entire plate in 30 days. (Assume that colony size is directly proportional to the number of individual bacteria.)

- a. What is the value of r ?
- b. On what day would the bacteria cover half the plate?

6. You collect data on birth and mortality in three populations of grasshoppers, and you calculate the following birth and death rates for these populations. Both populations are experiencing exponential growth:

	b	d
Population A	0.90	0.80
Population B	0.45	0.35
Population C	0.15	0.05

Are these statements true or false?

- T/F a. Population A is growing at the fastest rate.
T/F b. Population C has the lowest death rate.
T/F c. Population C is growing at the slowest rate.
T/F d. All populations are growing at the same rate.

7. In a herd of bison, the number of calves born in 1992, 1993, and 1994 was 55, 80, and 70, respectively. In which year was the birth rate greatest?

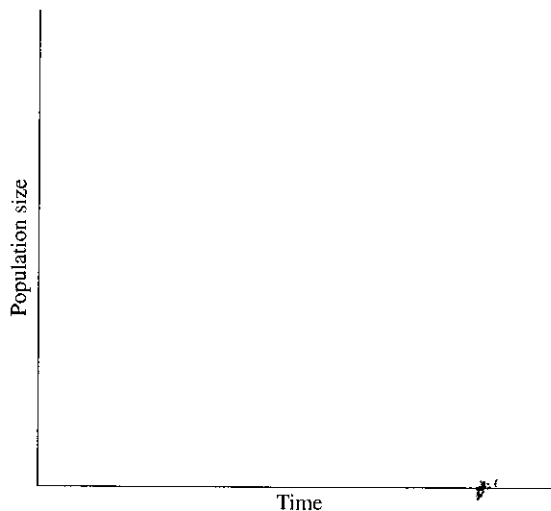
8. A population of pigeons on the west side of town has a per capita annual growth rate of 0.07. A separate population of pigeons on the east side of town has a per capita annual growth rate of 0.10. If both populations are growing exponentially and both are censused the following year, in which of the populations will dN/dt be greatest?

9. Suppose you have a “farm” on which you grow, harvest, and sell edible freshwater fish. The growth of the fish population is logistic. You want to manage your harvest to maintain maximum yields (that is, the maximum rate of production) from your farm over a number of years.

As a fisheries manager, you are responsible for deciding how many walleye can be harvested without destabilizing the population.

- a. Below is a data table showing the walleye population in a typical pond on your fish farm over 24 weeks. Draw a graph showing how population size in the pond changes through time.

Time (weeks)	1	2	3	4	5	6	7	8	9	10	11	12
Population size	100	101	102	103	104	106	110	115	125	140	155	172
Time (weeks)	13	14	15	16	17	18	19	20	21	22	23	24
Population size	188	201	209	217	221	225	229	233	235	237	238	239



- b. How large should you let the population get before you harvest? Identify the point on your graph *and explain why*.

Name _____

Course/Section _____

- c. Assume the carrying capacity for your pond is 250 individuals. Check your answer in part b by using the data in the chart and computing the change in the population size (dN/dt) when the population is at several different levels relative to its carrying capacity. Use $K = 250$ and $r_{max} = 0.20$.

Population size (N)	$(K - N)/K$	dN/dt
25 (low)		
50 (moderately low)		
125 (half K)		
200 (moderately high)		
250 (high)		

10. A rabbit population has the following life table.

Age class	Number of survivors	Number of deaths	Mortality rate	Number of offspring per reproducing pair
0-1	100	10	0.10	0
1-2	90		0.33	1.5
2-3	60	30		2.0
3-4	30	24	0.80	2.5
4-5		6	1.0	0

- a. Fill in the missing data in the table.
- b. Owing to a good food supply and a small predator population, the rabbit population is growing by leaps and bounds. The rabbits call a meeting to discuss population control measures. Two strategies are proposed:
- Delay all rabbit marriages until age class 2-3 (rabbits *never* breed until after marriage).
 - Sterilize all rabbits in age class 3-4.

Which of the proposed strategies will be more effective in slowing population growth? Explain your reasoning and show your calculations.