BIOL 151 -- Introductory Zoology
Spring 2013, Minot State University
Laboratory #2: Population growth

The basis for selective pressure (the forces producing diversification over time, i.e., resulting in evolution) is population growth. A population is a group of individuals occupying the same place at the same time. Population growth is the rate of change in the number of individuals in a population. For example, a population (or species) facing extinction has a negative population growth. A population with positive population growth can face significant crowding issues, and significant problems from limited resources. For example, Canada geese are causing habitat deterioration at their breeding grounds in the North because there are too many individual geese consuming the resources (i.e., food and space) that are there.

In this lab exercise, you will be exposed to the factors that affect population growth. There are essentially three factors: how many offspring are born at any time (i.e., the reproductive rate, r), how many individuals are in the population at any time (the population size, N) and the number of individuals that can be sustained (i.e., the carrying capacity, K).

MATERIALS AND METHODS

Bean model – For this section, record your data in Table 1 (in RESULTS)

Low reproductive rate model

1. Count out five beans and 20 beans and place them in separate piles. Place the 20 bean pile to the side. You will begin with the five-bean pile.

2. Pick up a bean. Flip a coin. If heads, place the bean with a new bean in a **separate pile** (i.e., this individual was able to find and consume enough resources to reproduce). If tails, place the original bean by itself in the **separate pile** (i.e., it is still alive, but has failed to reproduce).

3. Repeat step 2 for the remaining four beans. This new pile of beans (that will have five or more beans depending on the coin tosses) is the population size after one generation. Record this new population size on Table 1.

4. Repeat steps 2 and 3 with this “Generation 1” pile. After repeating steps 2 and 3, this newest pile of bean (that will have as few as five bean or possibly many more) is the “Generation 2” pile. Record this new population size on Table 1.

5. Repeat steps 2-4 for the 20 bean population. Enter the two new data points (i.e,. Generation 1 and Generation 2) in Table 1.

High reproductive rate model

Perform the simulation as above, except when the individual reproduces, add two beans rather than just one. Be sure to do this beginning with five beans and then repeat the exercise with 20 beans. Then enter these four new data points on Table 1.

Finally, be sure to fill in the “Population Change” blanks on Table 1.

Computer model (or simulation)
Populations can grow according to this equation,

$$\frac{dN}{dt} = rN\,\frac{(K - N)}{K}$$

where N is population size, t is time, r is reproductive rate (how many offspring produced in a given time interval, e.g., babies per day) and K is the carrying capacity (the maximal number of individuals that the habitat can support indefinitely).

The simulations that you performed with the beans were a reasonable approximation of this model, except that there is no concept of carrying capacity included. This can be done, but the intent of making you count beans is to appreciate what is done by the computer model. However, the computer can count much quicker and this allows you to do thousands of generations instantaneously. It also allows you to investigate many variations of reproductive rate, carrying capacity, and initial population size.

1. Open the spreadsheet file titled "Population Growth." It can be downloaded at my website. ("Pearl-Verhulst" is the name of the growth model that describes single-species population growth.)

2. Set "K = 100" by typing 100 in the appropriate cell on the spreadsheet. Set the population size in "generation zero" to 2. Set the reproductive rate (r) to 1. Pay attention to the shape of the resulting curve on the graph: (a) how steep it gets at its steepest, (b) where (and if) it flattens out, and (c) how fast (how many generations?) it took to flatten out. **(Do not write answers to these questions. Just talk about them with your lab partner.)**

3. Vary the generation zero population size. Experiment with as many values as you wish. Because the results are instant, you are not limited in how many simulations you run. Try many values. Again, pay attention to the shape of the resulting curve on the graph: (a) how steep it gets at its steepest, (b) where (and if) it flattens out, and (c) how fast (how many generations?) it took to flatten out. **(Do not write answers to these questions. Just talk about them with your lab partner.)**

4. Reset the values to the original ones in step 2. Now vary the carrying capacity value. Again, pay attention to the shape of the resulting curve on the graph: (a) how steep it gets at its steepest, (b) where (and if) it flattens out, and (c) how fast (how many generations?) it took to flatten out. **(Do not write answers to these questions. Just talk about them with your lab partner.)**

5. Reset the values to the original ones in step 2. Now vary the reproductive rate. **(Do not write answers to these questions. Just talk about them with your lab partner.)**

Now, set up the simulation so that (a) the population starts at a small size and then (b) become stable at K. Draw this population growth curve in the graph in the RESULTS. In addition to drawing this graph, list the parameters that you used in your simulation. Now, manipulate one parameter so that the new growth curve is one that leads to extinction. Draw this curve on the same graph while drawing attention to the one parameter you changed.

Turn in this sheet and the next one **Name______________**

RESULTS (Three points)

Table 1.-- Results of bean model of simulation. (one point)

r	initial N	gen 1 N	change[a]	gen 2 N	change[b]
low	5				
low	20				
high	5				
high	20				

[a] (gen 1 N) – (initial N)
[b] (gen 2 N) – (gen 1 N)

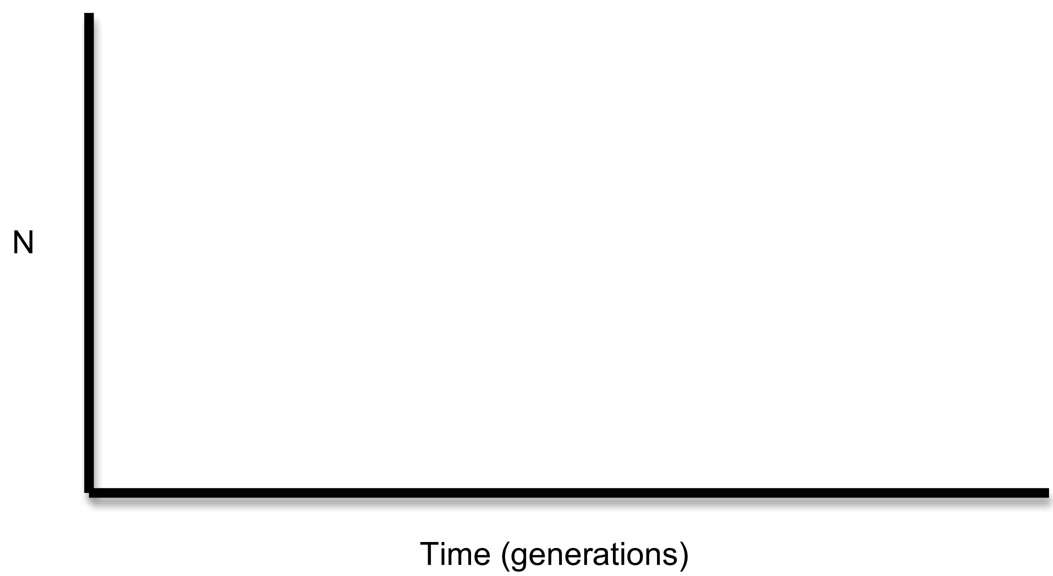

Fig. 1. -- Results of two computer simulations wherein one parameter was varied causing extinction of the population. (two points)

(In this space below, thoroughly describe what this figure presents and WHAT THE MEANING IS.)

DISCUSSION

For a population that begins small and results in an S-shaped curve, when is the curve steepest: early on, during middle, or late (remember that the x-axis refers to biological time [in generations])? Why do you think this happens? (one point)

How does one vary the model to make the curve jump up and down (i.e., oscillate)? (one point)