Population Dynamics

Introduction

The number of animals in a certain region, such as a meadow, is known as a *population*. The manners in which the populations change with time are known as *population dynamics*. A population of bunnies, for instance, may increase due to reproduction or migration of other bunnies from nearby meadows. The population may decrease if they run out of food. If a predator, such as a wolf, enters the meadow and eats bunnies, the bunny population will also decrease. The predators' populations also change with time, and they depend on the amount of bunnies in the meadow. This lab explores the population dynamics of wolves and bunnies that live in a meadow together.

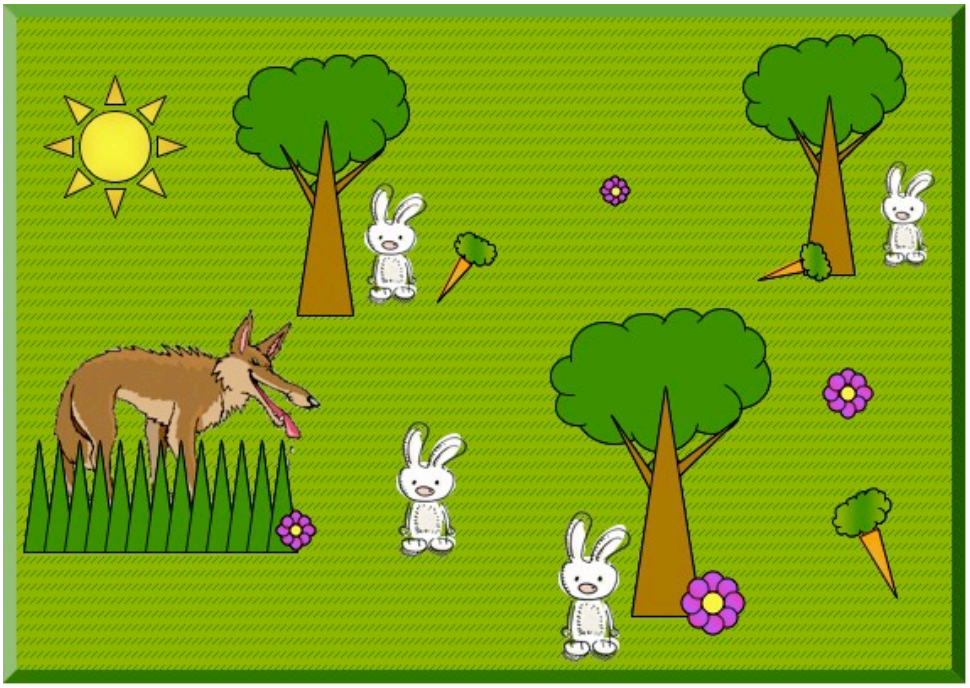


Figure 1. The Meadow.

Population Dynamics Simulation

Materials

One 11" x 17" sheet of paper: "the meadow"
30 2.5" x 2.5" gray paper squares: "the wolves"
75 1" x 1" pink paper squares: "the bunnies"

Instructions

Overview:

This simulation requires three or more participants. The three necessary roles are ***wolf manager***, ***bunny manager*** and ***data manager***. The wolves (gray squares) will be randomly dropped onto the meadow (large sheet) covered in bunnies (pink squares) to represent wolves catching and eating bunnies, which is necessary for the wolves to survive and reproduce. This process will be repeated for 20 rounds, and in each round, a varying number of wolves will be dropped onto a varying population of bunnies. The populations of wolves and bunnies in each round will depend on the previous round's results.

Student Instructions

It is necessary to assume certain requirements for both species' survival and reproduction. In this simulation, we will use the following assumptions:

A bunny does not survive if it is "eaten" by wolves, which is represented by a wolf partially covering that bunny after being thrown onto the meadow.
A bunny reproduces (generates a single additional bunny in the next round) if, after the entire population of wolves is thrown onto the meadow, it is not eaten. However, once the bunny population reaches a total of 75, no more bunnies can reproduce.
If no bunnies are left surviving after a round, three new bunnies repopulate the meadow by migration for the next round.

A wolf does not survive if, after being thrown onto the meadow, it has eaten (is partially covering) two or less bunnies
A wolf reproduces if it eats 3 or more bunnies after a single throw into the meadow. It generates an additional wolf in the next round for every multiple of 3 bunnies that it is partially covering. (*Example:* 3 bunnies = 1 additional wolf, 5 bunnies = 1 additional wolf, 6 bunnies = 2 additional wolves).
If no wolves survive a round, a single new wolf migrates to the meadow, and attempts to catch bunnies in the next round.

All of these assumptions are included in the calculations within the Excel workbook, "LPCH Predator Prey 2009.xls", so you don't need to keep track of all the rules as you play. Simply follow the "Specific Tasks" outlined below.

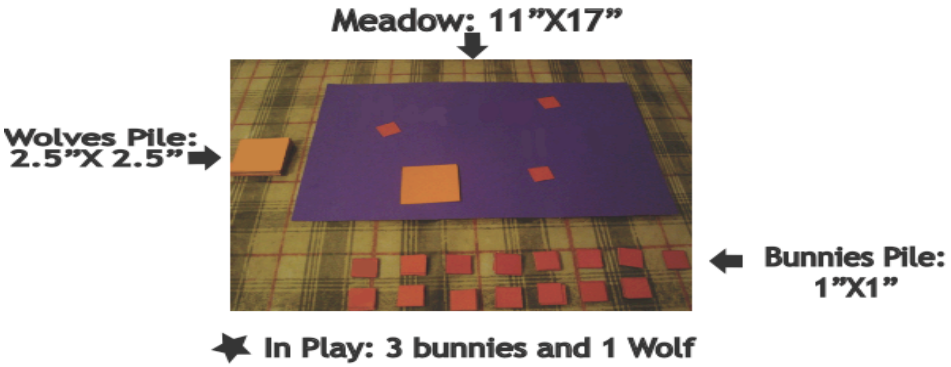
Setup:

Data Manager: Open the Microsoft Excel workbook "LPCH Predator Prey 2009.xls". The "Data Entry" sheet should be displayed, with headings for each of the 20 round numbers displayed along the top row, above periodic yellow columns under the heading "Bunnies Caught". These yellow columns will be the only cells you will be altering. ***Do not change any other cells***, as they may affect the accuracy of the calculations this data sheet will be conducting.

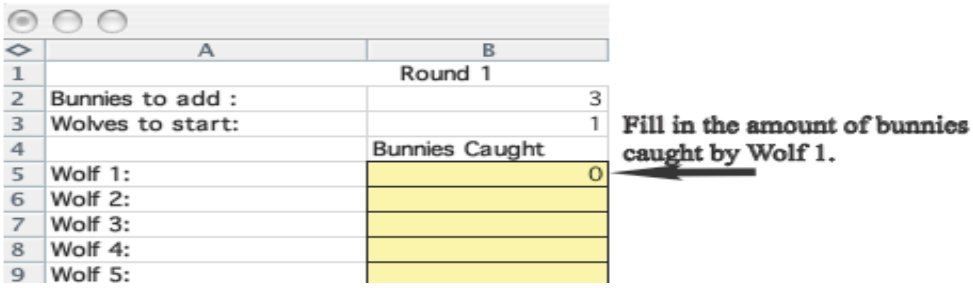
Specific Tasks:

1. **Bunny Manager**: Place 3 bunnies evenly into the meadow. Arrange all other bunnies in piles of 5 in front of you (off the meadow), to ease the counting of additional bunnies in future rounds.
2. **Wolf Manager:** Randomly throw 1 wolf into the meadow.

Example:"



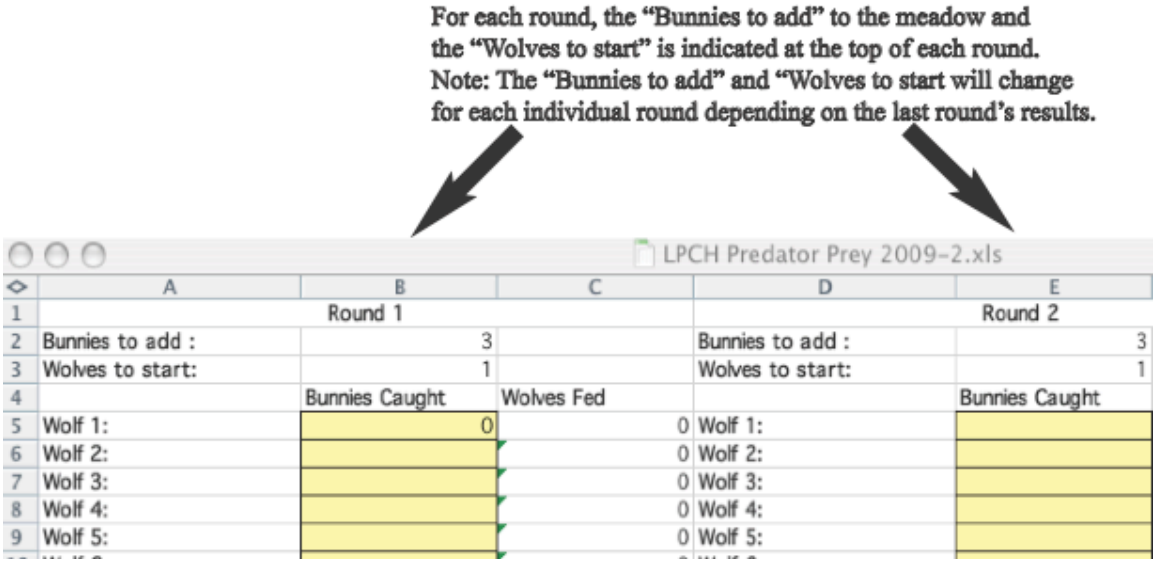
3. **Data Manager:** Record the amount of bunnies caught (covered or partially covered) by wolf 1 into the "LPCH Predator Prey 2009.xls" like shown below (This Example shows that 0 bunnies were caught.):



	A	B
1		Round 1
2	Bunnies to add :	3
3	Wolves to start:	1
4		Bunnies Caught
5	Wolf 1:	0
6	Wolf 2:	
7	Wolf 3:	
8	Wolf 4:	
9	Wolf 5:	

4. Data Manager: Read the amount of "Bunnies to add" underneath the heading for the **Next** round and tell the **Bunny Manager** to add that number of bunnies to the meadow.
5. Data Manager: Read the amount of "Wolves to Start" and tell the **Wolf Manager** to add that number of bunnies to the meadow.

Example of 1st Round:



LPCH Predator Prey 2009-2.xls

	A	B	C	D	E
1		Round 1			Round 2
2	Bunnies to add :	3		Bunnies to add :	3
3	Wolves to start:	1		Wolves to start:	1
4		Bunnies Caught	Wolves Fed		Bunnies Caught
5	Wolf 1:	0	0	Wolf 1:	
6	Wolf 2:		0	Wolf 2:	
7	Wolf 3:		0	Wolf 3:	
8	Wolf 4:		0	Wolf 4:	
9	Wolf 5:		0	Wolf 5:	

*** See bottom for an example of a later round**

6. **Bunny Manager**: Listen for "Bunnies to add" from the **Data Manager** and add them to meadow uniformly distributed.
7. **Wolf Manager**: Listen for "Wolves to add" from the **Data Manager** and randomly throw that number of wolves into the meadow. Note: Each wolf toss must be made **one** at a time.
8. **Bunny Manager:** After every toss of a wolf, remove the bunnies that have been caught by that single wolf and give them to the **Data Manager.** If the **Data Manager** is busy entering data from previous wolves, you may place the bunnies in a pile next to him or her, *but do not mix bunnies together that have been caught by different wolves. Instead, arrange each collection of bunnies that have been caught by each wolf in separate piles.*
9. **Bunny Manager:** Wait for the Data Manager to record the results and return the bunnies to you. Arrange the bunnies in piles of 5 as the **Data Manager** hands them to you.
10. **Wolf Manager:** Wait for the Data Manager to record the results and return the wolves to you.
11. **Repeat Steps 4-10 for the next rounds until round 20 is reached.**

Student Instructions

Round 12:

	AH	AI
1		Round 12
2	Bunnies to add :	11
3	Wolves to start:	6
4		Bunnies Caught
5	Wolf 1:	2
6	Wolf 2:	3
7	Wolf 3:	4
8	Wolf 4:	1
9	Wolf 5:	0
10	Wolf 6:	0

Add 11 bunnies to the meadow.

Since there are 6 wolves to start, the bunnies caught by each wolf must be entered.

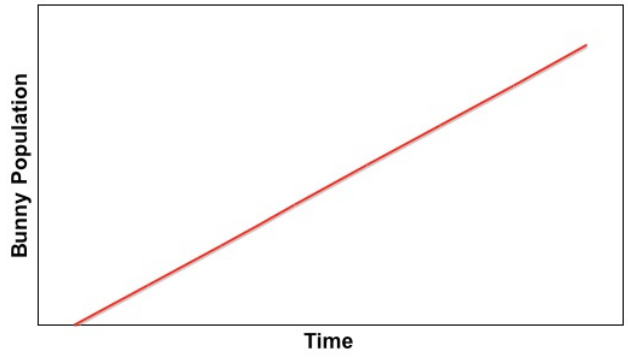
Concept Questions:

1. Open the sheet "Results Plot" in the Excel Workbook. This shows the populations of wolves and bunnies throughout the rounds. Either print out the plot that is shown, or describe and sketch it.
2. What happens to the bunny population when the wolf population increases?

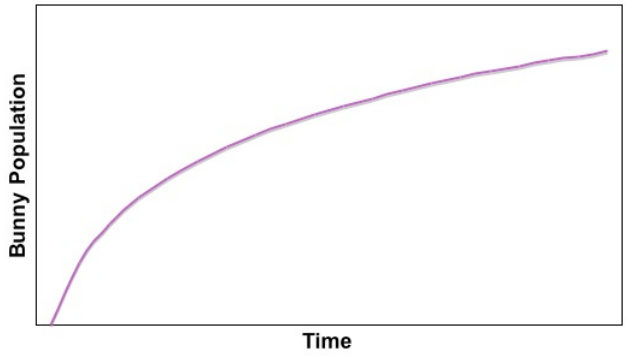
3. What happens to the wolf population when the bunny population decreases?

4. Does the wolf population ever outnumber the bunny population? For how long? If this period of time is very short compared to the entire simulation, why do you think that is the case?

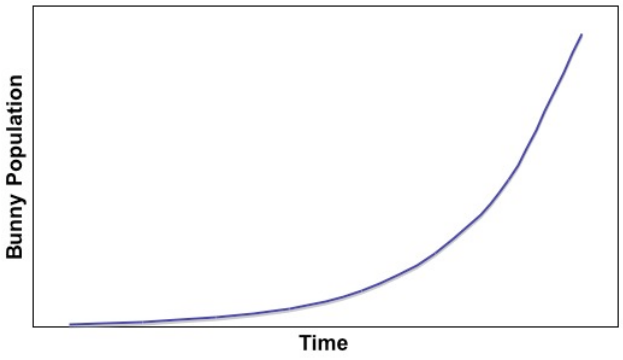
5. Which graph from below (a, b, c, or d) best illustrates the bunny population given no predators and unlimited resources? Which one most closely illustrates the results of the simulation you just performed?



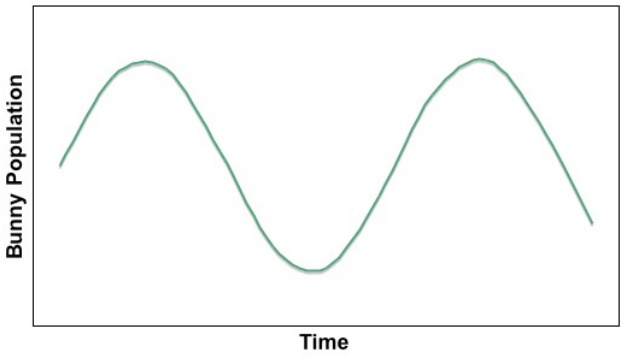
(a) Linear



(b) Logarithmic



(c) Exponential



(d) Oscillating

6. In our simulation we chose to limit the total number of bunnies to 75. What might limit the bunny population in real life?

7. Look at the population plots generated by other groups in the class. Do their plots look the same as yours? In what ways, if any, are they different?

8. What do you think would happen to the wolves and the bunnies if you introduced an additional predator, such as a coyote, which required fewer bunnies to reproduce?

References:

Gatton, M. *Predator-Prey Population Dynamics*, Professional Performing Arts School, New York, NY. Adapted from: http://educ.queensu.ca/%7Escience/main/concept/biol/b11/B11LACG2.htm,