

## Natural Selection: Predator-Prey Interaction

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The following exercise will simulate predator-prey interactions in a natural ecosystem. In this model there is a simplified prey population of five different species (beans) and three different predator species with different feeding adaptations (types). The prey species vary in their appearance and size, while the predator species vary in their style of feeding or mouthparts.

### Model:

1. The variation in mouthparts (feeding types) of the predator population will be represented by:

Tweezers	A thin clasping mouthpart (Song Birds)
Spoons	A scooping or engulfing mouthpart (Ducks)
Eye dropper	A sponge-like mouthpart (Flies)

2. The stomach of the predators will be represented by:

A small cup – One per organism

3. The variation in the species of the prey population will be represented by:

Small Black Beans  
Small Red Beans  
Small White Beans  
Brown/Tan Beans  
Large White beans

4. The ecosystem type will be represented by:

A cloth square representing a general type of ecosystem  
(I.e. Forests, Deserts, Tropical Forests, Arctic, desert, grassland)

5. The feeding cycle (time) will be represented by:

A time limit on a stopwatch

This is a group exercise. Divide into groups of four.

### Directions:

1. Each group will consist of three people playing the role of predators and one person as the timekeeper.
2. The three predators will obtain a mouthpart and stomach for use throughout the exercise. **DO NOT EXCHANGE MOUTHPARTS ONCE THE EXERCISE HAS BEGUN.**
3. The timekeeper will spread the cloth (ecosystem) on the table, simulating hills and valleys to give it a 3-D effect.

4. Fill in the data below:  
 Ecosystem name; \_\_\_\_\_  
 Ecosystem description; \_\_\_\_\_  
 Your predator description; \_\_\_\_\_  
 Which prey species would you (predator) most likely feed upon?  
 \_\_\_\_\_

Write a statement that discusses the different predators and predicts their probable prey species.

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5. The timer will count out ten beans from each bean type as the initial prey population and place in a beaker.  
 6. The predators must carry their “stomach” (small cup) with them (in their hand) at all times during the ‘capture’ period.

**Starting the exercise:**

1. With the predator’s back turned to the ecosystem. The timer will randomly scatter the initial prey populations over the entire ecosystem (cloth). The predators cannot look until the timekeeper is finished.
2. At the timer’s signal, the predators will have 20 seconds to hunt and capture your prey. You must capture and deposit the prey in your stomach. Any prey that might drop out of you stomach or the ecosystem will be lost. A predator may attempt to ‘steal’ prey from other predators (survival of the fittest), but not from their stomachs; you are not parasites.
3. At the end of 20 seconds the hunt is over. Any prey in the mouthpiece is to be dropped and not deposited in the stomach.
4. The predators will count the number of each prey type in their stomachs and record it in data table 1. Share your results with the rest of the table.
5. Calculate the number of surviving prey for each type. Also calculate the prey’s reproductive success by adding 1 offspring for each survivor. Add the offspring to the surviving populations of prey species for a new population in the next generation (feeding cycles).
6. The timekeeper will add the offspring to the surviving populations and mix in the beaker.
7. Repeat steps 7-12 for each new generation (feeding cycles), and fill in Data Table 2. And so on.
8. Once you have completed three feeding cycles, you can return all the equipment back to the container.

**Calculations:**

1. Each person must calculate their predator efficiency for each round, using the following equation:

2. 
$$\text{Predator efficiency} = \frac{\text{Total \# of prey killed by a specific predator}}{\text{Total \# of prey at the start of each generation}} \times 100$$

3. *Record your results in Table 4 and calculate the average and graph your data as a bar graph.*
4. Fill in Table #5: Prey survivorship rates for each type of prey. Calculate the total number of surviving individuals for each prey species and graph the data as a bar graph.
5. Based on your data and graphs, write a conclusion regarding the predator-prey interactions of this exercise.
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**Data Table #1**

	Black	Red	White	Brown	Large White	Total Prey Numbers
Initial Number of Prey	10	10	10	10	10	50

Number of Prey Killed: Predators:	Tweezers	_____	_____	_____	_____	_____	_____
	Spoon	_____	_____	_____	_____	_____	_____
	Eye dropper	_____	_____	_____	_____	_____	_____
Total Number of Prey Killed:	_____	_____	_____	_____	_____	_____	_____
Total Number of Survivors:	10 - #killed =	_____	_____	_____	_____	_____	_____
Number of Offspring:		_____	_____	_____	_____	_____	_____
Next Population Total Numbers: (Survivors + Offspring =)		_____	_____	_____	_____	_____	_____

**Data Table #2**

	Black	Red	White	Brown	Large White	Total Prey Numbers
Initial Number of Prey	_____	_____	_____	_____	_____	_____

Number of Prey Killed: Predators:	Tweezers	_____	_____	_____	_____	_____	_____
	Spoon	_____	_____	_____	_____	_____	_____
	Eye dropper	_____	_____	_____	_____	_____	_____
Total Number of Prey Killed:	_____	_____	_____	_____	_____	_____	_____
Total Number of Survivors:	10 - #killed =	_____	_____	_____	_____	_____	_____
Number of Offspring:		_____	_____	_____	_____	_____	_____
Next Population Total Numbers: (Survivors + Offspring =)		_____	_____	_____	_____	_____	_____

**Data Table #3**

		Black	Red	White	Brown	Large White	Total Prey Numbers
Initial Number of Prey		_____	_____	_____	_____	_____	_____
Number of Prey Killed: Predators:	Tweezers	_____	_____	_____	_____	_____	_____
	Spoon	_____	_____	_____	_____	_____	_____
	Eye dropper	_____	_____	_____	_____	_____	_____
Total Number of Prey Killed:		_____	_____	_____	_____	_____	_____
Total Number of Survivors:	10 - #killed =	_____	_____	_____	_____	_____	_____
Number of Offspring:		_____	_____	_____	_____	_____	_____
Next Population Total Numbers: (Survivors + Offspring =)		_____	_____	_____	_____	_____	_____

**Data Table #4**

Predator Efficiency:	Forceps	Spoons	Eye dropper
Predation # of Round 1	_____	_____	_____
Predation # of Round 2	_____	_____	_____
Predation # of Round 3	_____	_____	_____
Average Efficiency:	_____	_____	_____

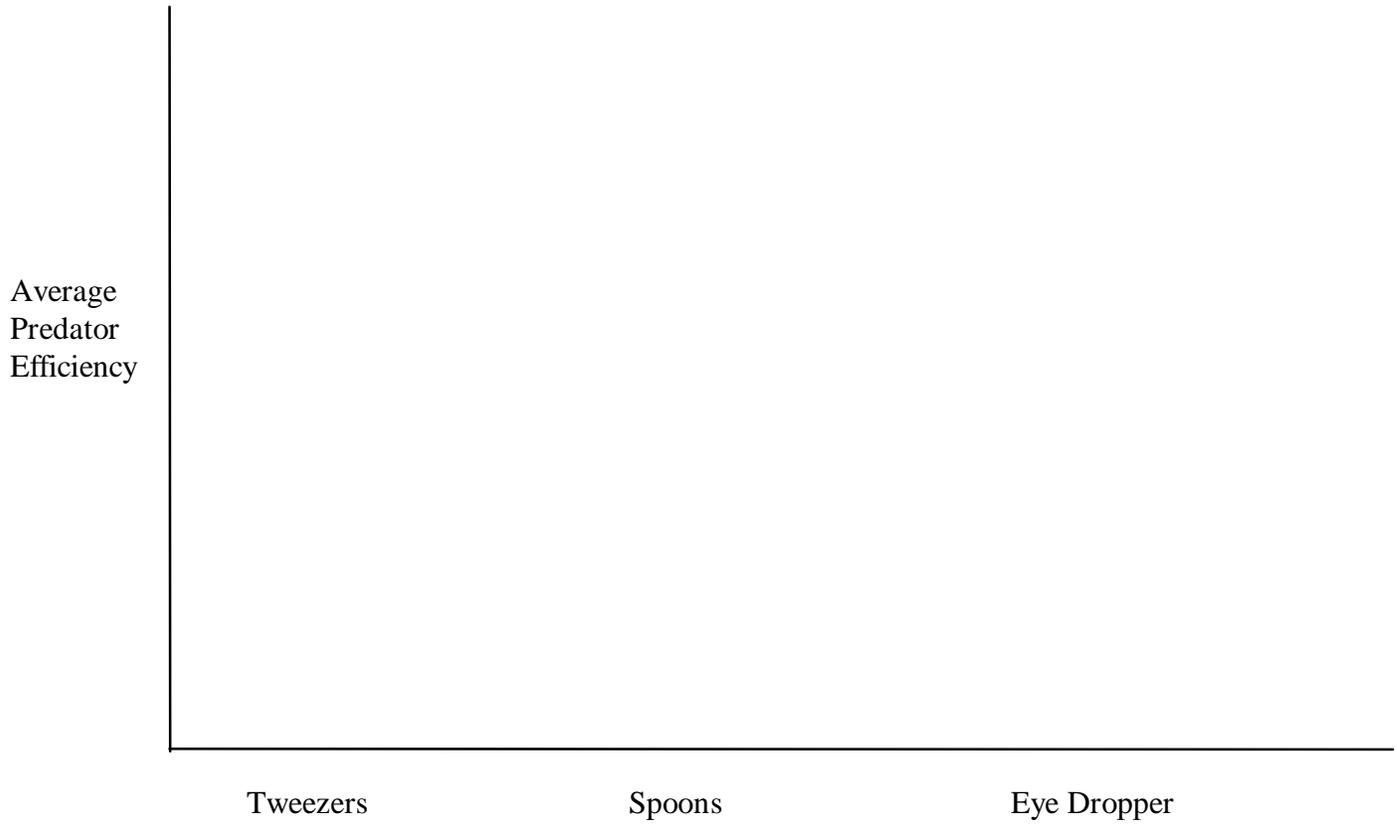
**Data Table #5**

Prey Survivorship Rates

	Black	Red	White	Brown	Large White	Total Prey
Initial Prey Numbers:	10	10	10	10	10	50
After Round # 1	_____	_____	_____	_____	_____	_____
After Round # 2	_____	_____	_____	_____	_____	_____
After Round # 3	_____	_____	_____	_____	_____	_____
Average Survivorship	_____	_____	_____	_____	_____	_____

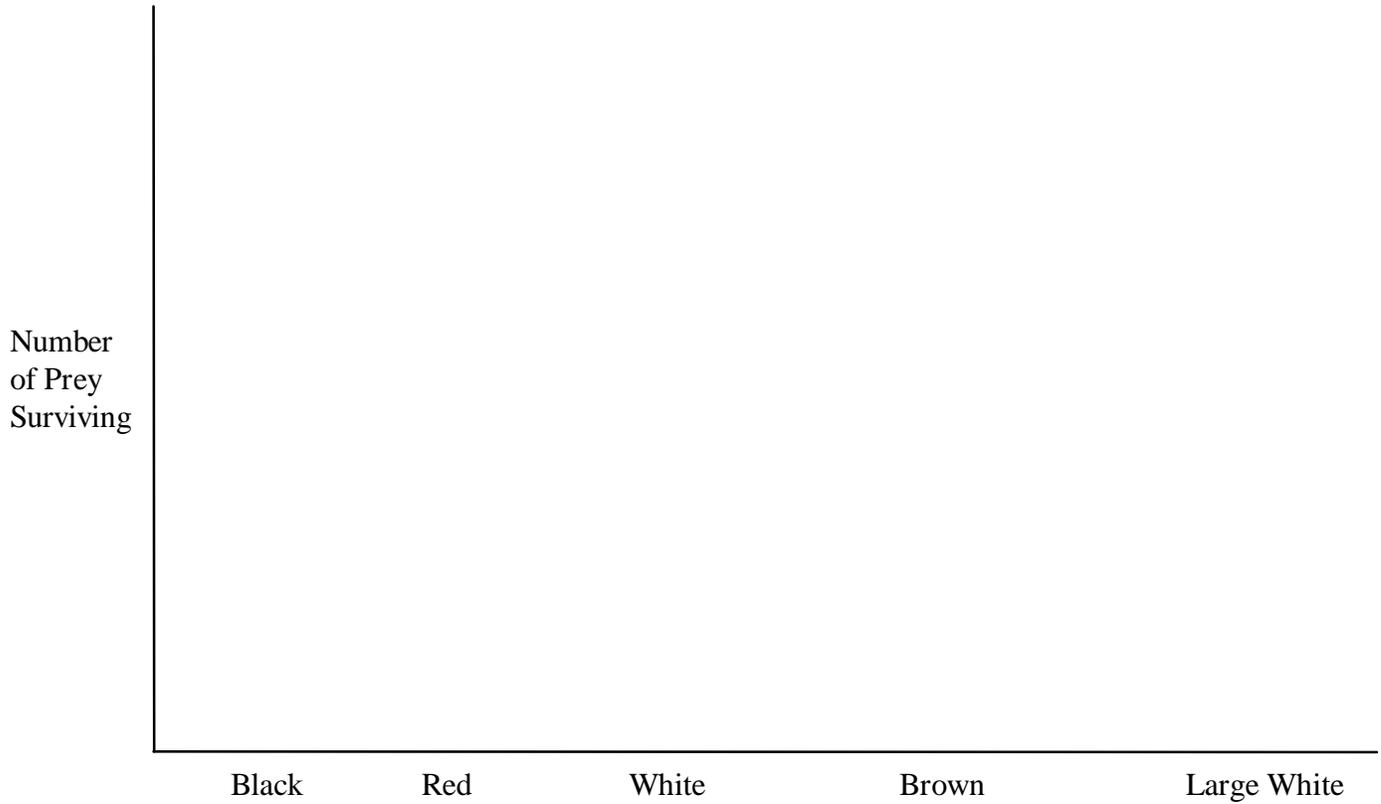
Graph #1:

**Predator Efficiency**



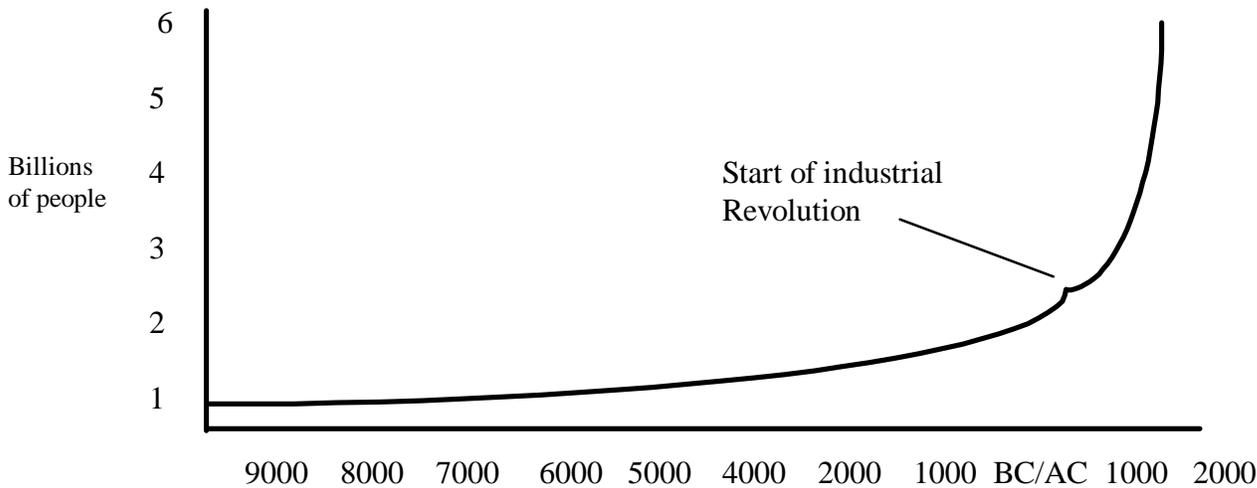
Graph #2:

**Prey Survivorship**



### Human Population:

The world human population has grown at an unprecedented rate over the past three centuries and is in a J shape growth. In 1987, the population passed 5 billion. If the current rate of 2% per year growth persists, the population will double in only 35 years. This means that the human population will be 10 billion in 2032. It took 1800 years for the human population to reach 1 billion people, but now it will only take 35 years to increase the population by 5 billion. (See graph below) Most of the growth will occur in underdeveloped countries. There is now serious concern among scientists that the number of humans in the world and our impact on the environment will overload the life support systems of Earth.



**Group Discussion.** Discuss the next four questions with the people at your table for 5-10 minutes; making sure everyone gives their opinion/ideas. There are no correct answers for this section.

1. Although the whole planet's carrying capacity has not been determined, what do you think the carrying capacity of Earth is? Are we already over the carrying capacity or not and why do you feel this way.

