TIGERS, BIRDS, AND BEADS: A POPULATION SIMULATION

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Files can be found online at http://tinyurl.com/p673fr7

Scientists continually aim to preserve animal populations that are nearing extinction. In this activity, we simulate the work of a biologist in determining whether a species is becoming endangered. Multiple factors cause a species' population to decline, including destruction of its natural habitat, introduction of exotic species, illegal hunting, legal exploitation, and natural causes. Scientists have identified five categories by which they classify the changes in an endangered species' population over time, from lowest threatened level to highest threatened levels: critically endangered, endangered, vulnerable, near threatened and least concern. The following chart explains the percentages considered when determining how to classify a species in the described level of endangerment.

	Population Reduction (A2)	**Population Reduction with Limited Mature Individuals (C1)**	**Very few Mature Individuals (D)**
Critically Endangered (CR)	≥ 80% population reduction over a 10 year period	Population size estimated to be fewer than 250 mature individuals and a continuing decline of at least 25% within 3 years.	Population size estimated to number fewer than 50 mature individuals.
Endangered (EN)	≥ 50% population reduction over a 10 year period	Population size estimated to be fewer than 2500 mature individuals and a continuing decline of at least 20% within 5 years.	Population size estimated to number fewer than 250 mature individuals.
Vulnerable (VU)	≥ 30% population reduction over a 10 year period	Population size estimated to be fewer than 10,000 mature individuals and a continuing decline of at least 10% within 10 years.	Population size estimated to number fewer than 1000 mature individuals.
Near Threatened (NT)	Will fall under one of the threatened categories within 10 years based on observations. For our purposes ≥ 25% population reduction over a 10 year period.		
Least Concern (LC)	Does not qualify for any of the threatened categories or near threatened category.		

Materials:

Red bead - one male animal; white bead - one female animal; black bead - an animal incapable of reproducing.

- Plastic container labeled "Living Population" filled with red, white, and black beads.
- Ziploc bag: "Babies" - red, white, and black beads.
- Empty plastic container : "Deceased Population"
- TI 84 graphing calculator (optional Microsoft Excel)

Procedure:

1. Count your beads in the Living Population pile. Fill in C4.
    a. Count your black beads. Fill in D4 and E4.
    b. Fill in G4, I4, J4, and K4 per the instructions on the table.
    c. Use the chart on page 1 to classify and determine the threatened level. Fill in N4.
2. Use your entry from I4 to fill in C5.
    a. Use your entry from J4 to fill in D5.
    b. Use your entry from K4 to fill in E5.
3. From the Living Population pile of beans, pull out two handfuls of beans **and count the number of beans that you took**. Record your results in F5. Place these beans in the "Deceased Population" pile.
    a. Use your results from columns F5 and C5 to fill in G5.
4. Count your male and female pairs in the Living Population pile. From the Babies pile, add one bead (selected randomly) back into your population for every male and female pair you have in your species.
   Use this information to fill in H5 and I5.
5. Count your black beads and determine how many mature species you should have. Use this to fill in J5 and K5.
6. Calculate the percent remaining of the living population and the percent deceased of the living population. Fill in L5 & M5.
7. Using the chart on page 1, identify the species' threatened level classification in N5.
8. Repeat steps 2-7 five more times, working your way down the table.
9. Respond to the questions listed following the table.

Data Collection Table

A/1	B	C	D	E	F	G	H	I	J	K	L	M	N
2	**Year**	**Living Population**	**Immature Population**	**Mature Population**	**Deceased Population**	**Remaining Population**	**M/F pairs**	**New Remaining Population**	**New Immature Population**	**New Mature Population**	**% Remaining of Living Population**	**% Deceased of Living Population**	**Threatened Level/ Reason**
3		All Beads	Black Beads	All Beads- Black Beads	Beads You Pulled	C - F	Red & White Bead Pairs	G + H	New # Black Beads	I - J	I / C	100% - L	Use Chart on Pg 1
4	0				**0**	C4:	**0**	G4:	D4:	E4:	100.0%	0.0%	
5	10												
6	20												
7	30												
8	40												
9	50												
10	60												
11	70												
12	80												
13	90												
14	100												
15	110												
16	120												
17	130												
18	140												
19	150												

Exploration

1. Determine which function best represents or models this situation (i.e. linear, quadratic, or exponential). Explain why you chose this model. Graph the year and the remaining population.

2. Based on your function, make a prediction of when your species will become extinct.

3. Continue the experiment until the species becomes extinct. Record the data in the table. Does this match your prediction from your equation? Explain.

4. If the initial population size were doubled, would that double the amount of time that it takes for the population to become extinct? Why or why not?

5. Are there any situations in which you could classify your species under two different threatened levels? What do you do in this situation?

6. What if you pulled 1 handful of beans instead of 2 handfuls as directed in step 3- what do you think would happen to the population? What about 3 handfuls of beans? Determine how the number of deceased species is related to the rate of change.

7. Determine what would happen if you add 2 beans for each male and female pair instead of the 1 bean as directed in step 4?

Extension

1. You have determined the cause of the decrease in your species population and now want to increase its population. Design an experiment which satisfies these conditions. (Hint: Determine which quantities are relevant.)

2. Design a table to collect your data and repeat the experiment for 50 years to support your claim.

3. Use your data to graph and find the equation for the curve of best fit.

4. Compare this function to the previous function in the initial experiment. How are they similar? How are they different?

5. Determine how long will it take your population to double? Triple? Justify your answer.

6. Determine what the population will be in 70 years assuming that the population continues to increase at the same rate? 70 years? 80 years? 90 years? 100 years? Justify your solutions.