

POP ECOLOGY FILES



People
and the
Planet

Lessons for a Sustainable Future

INTRODUCTION

Line graphs are well suited for showing change over time. Since populations are constantly in flux, line graphs are often used to illustrate changing population sizes over time. Analyzing a species' population growth curve can reveal a lot about the species. Does it make seasonal migrations? Does resource availability impact population numbers? And if so, how? How is population size impacted by predatory species? Human population growth is also easily visualized with a line graph. The graph of our human population is often referred to as a "J-curve," which signifies **exponential growth**. Comparing the graph of human population growth to that of other species reveals the importance of maintaining a balance between people and our resource base.

MATERIALS

- Student Worksheet
- Species 1 – 6 Worksheets
- Graph paper
- Calculator (optional)

PROCEDURE

1. Read the following paragraph aloud:

"A population graph shows what happens to the population of a species over time. The x-axis shows passage of time; the farther you go to the right, the more time elapses. The y-axis shows population size; as you go up the axis, the population increases. The scales for both population and time are determined by the data."

2. Distribute copies of the Student Worksheet to each student and give them time to complete it individually. You will refer back to this graph at the end of the lesson.

CONCEPT

Comparing the size and fluctuation of various species' populations provides insight into the nature of population growth and ecology.

OBJECTIVES

Students will be able to:

- Create and analyze graphs that depict population change over time.
- Support a claim to identify a species using its population growth curve as evidence.
- Compare characteristics of human population growth to that of other species.

SUBJECTS

Science (life, Earth and environmental), math

SKILLS

Graphing and analyzing data, interpreting line graphs, identifying trends and patterns, problem solving

METHOD

Students graph and interpret growth curves for six mystery species and humans.

3. Divide the class into six groups and distribute graph paper to each student. Provide each group with copies of one of the Species Worksheets. Each group will complete a different Species Worksheet; each group member should have their own copy of that Species Worksheet.
4. Read the following paragraph aloud and display the Species Background chart. (The chart is also included on the Species Worksheets.)

"Your aunt is a well-respected naturalist, studying how populations change over time. She has just returned from a research trip where she studied six different species in multiple locations. In order to make note-taking a little faster, she and her team used a numbering system to easily identify which population data set went with which species. Unfortunately, after unpacking her belongings, your aunt realized that her "key," which matched the data sets to the species descriptions, was lost!

Your aunt needs your help in graphing the data and matching each data set to the right species. Below are the species she studied on her trip."

Species	Background	Length of time and location studied
Bacteria X (1st population)	A common bacteria found in soil	Studied in a laboratory test tube over the course of several weeks
Cerulean Warbler	A tiny migratory forest bird that may be added to the endangered species list	Central Maryland, over several years
Bristlecone Pine	A slow-growing tree species that can live several thousand years	Eastern California, over several years
Eastern Cottontail	A common fast-breeding rabbit from the eastern United States	Central Ohio, over several years
Red Fox	One of several predators of the cottontail rabbit	Central Ohio, over several years
Bacteria X (2nd population)	A common bacteria found in soil	Studied in a laboratory test tube over several weeks. New nutrients provided regularly.

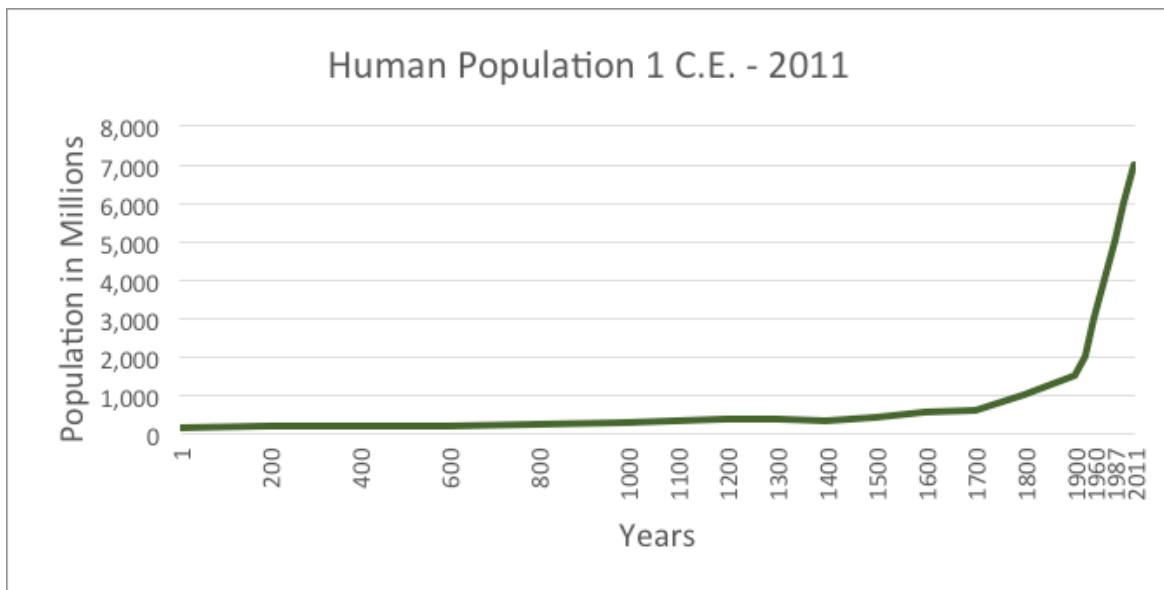
5. Instruct students to complete their Species Worksheet, through #5, with their group (they will complete the chart later). All students should complete a graph of the group's population data.
6. Ask students to form new groups, where each student in the group completed a different Species Worksheet. (There should be six students in each group.) Students should compare their graphs and species predictions and then complete the chart on the bottom of their Worksheets to indicate which species goes with which data set/graph. Students should also re-title their graph with the appropriate species name, rather than just the Data Set number.

ALTERNATE PROCEDURE

Instead of having students plot the data, remove the names from the graphs in the Pop Ecology Files: Answer Key and distribute print copies, or project these graphs. Then give students a chance to guess which graph represents which species and explain their thinking.

Answers to Student Worksheets

- Years
 - Population in millions
 - Answers may vary
- Line graphs are helpful when comparing information across the same period of time.



Answers to Species Worksheets

See Answer Key

DISCUSSION QUESTIONS

- After meeting with your second group, did your thinking change about which species you graphed? Why or why not?
- Which of the populations show seasonal fluctuations? What do you think is causing their populations to shrink and grow?

The rabbit, fox and warbler. Lack of resources like food, air, water and shelter cause seasonal fluctuations each winter.

- If your aunt found out that by July 2nd, 2016, the fox population dropped to 36 individuals, would that be a cause for concern? Why?

No, because each July the fox population has between 35 and 39 individuals, and then it rebounds.

4. How do you think the populations of the rabbits and the foxes are related?

The fox population grows when rabbits are abundant, and shrinks when they are scarce.

5. Why doesn't the pine tree population experience much change over time?

The pine tree species has a long life span and is very slow growing, which means that it takes a long time to add new trees to the population. This results in little population change over time.

6. What is the overall trend of the Cerulean Warbler population? What might this mean?

The trend line on the warbler graph is a downward slope. This indicates a population that is steadily decreasing.

7. How can you tell which bacteria is which?

One of the bacteria has new nutrients provided regularly, and the other does not, so we see a sharp decline in the bacteria that does not.

8. Ask students to guess what species they graphed on the original Student Worksheet. If students are unsure, reveal that the graph shows human population growth from 1 C.E. to 2011.

9. Because of its appearance, the human growth curve is called a J-Curve. Are any of the species graphs similar?

The closest fit is the first portion of either bacteria population.

10. Would we want the human curve to look like the 1st bacteria population? Why?

No, because the bacterial population plummets once their resources are exhausted.

11. Are humans susceptible to the kind of resource shortages that affect populations of the other species?

Yes, we also depend on food, water, air, and shelter to survive.

12. What might the ideal graph for humans look like over the next 200 years?

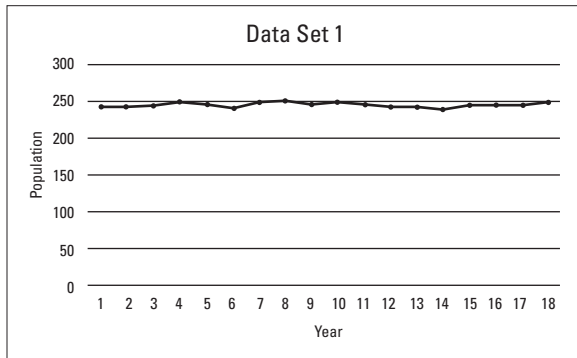
The curve would level off, like the 2nd population of bacteria

ASSESSMENT

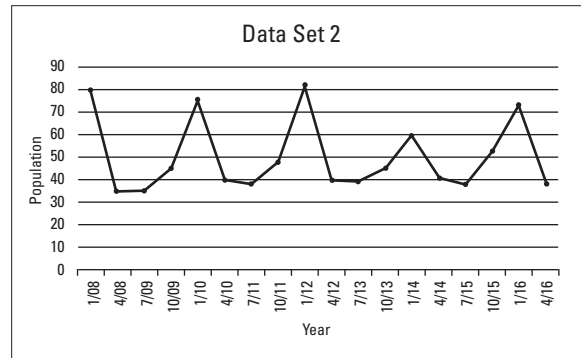
Review students' answers on the Student Worksheets and evaluate their participation in group and class discussion.

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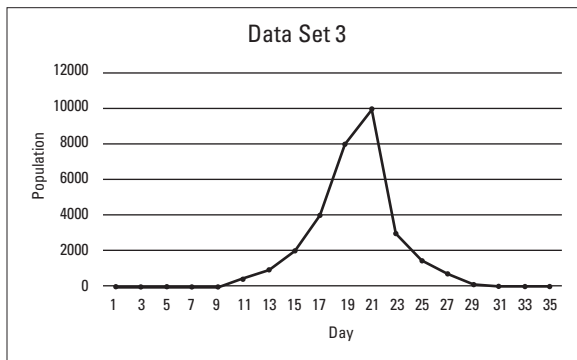
ANSWER KEY



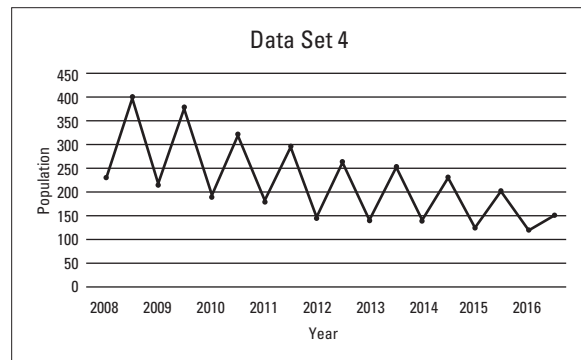
Data Set 1: Bristlecone Pine. The species is slow growing and has a long life span so there is little change over time.



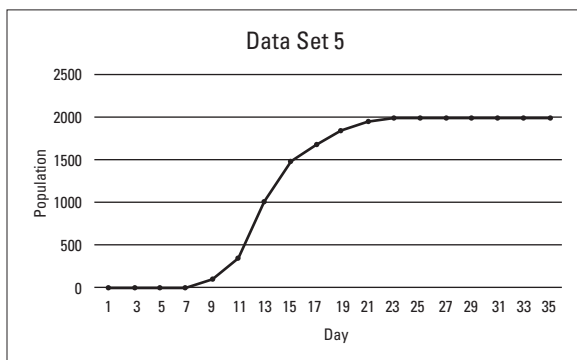
Data Set 2: Red Fox. The population fluctuates annually, following the boom and bust of rabbit numbers.



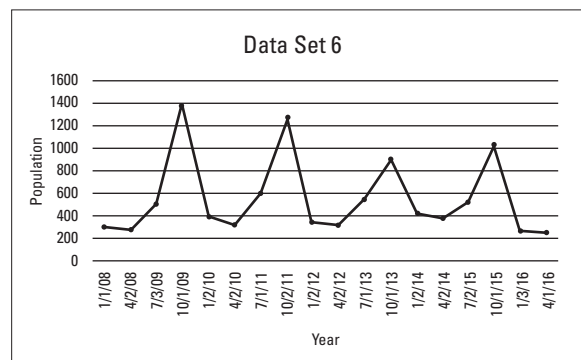
Data Set 3: Bacteria X (1st population). The bacterial colony grows fast but once resources run out, it dies fast as well.



Data Set 4: Cerulean Warbler. The population is declining over time.



Data Set 5: Bacteria X (2nd population). The population stabilizes because although bacteria are being supplied with new nutrients, they are growing in a finite area.



Data Set 6: Eastern Cottontail. The population shows large annual spike, and rabbits are capable of multiplying rapidly when conditions allow.

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STUDENT WORKSHEET

Name: _____

Date: _____

1. Graph the following data in the box below.

Year	1 C.E.	200	400	600	800	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	1927	1960	1974	1987	1999	2011
Population (in millions)	170	190	190	200	220	265	320	360	360	350	425	545	610	1000	1500	2000	3000	4000	5000	6000	7000

Before you start:

- a. What is your x-axis (independent) going to be? Label it.
- b. What is your y-axis (dependent) going to be? Label it.
- c. What is the title of your graph?

2. Why did we use a line graph above? (Please answer in 1-2 full sentences)

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SPECIES 1 WORKSHEET

Name: _____ Date: _____

Data Set 1		Please answer questions #1-4, based on your data. Then, plot your graph on the graph paper and use your completed graph to help you answer question 5. Don't forget to title your graph with your Data Set number.																												
Date	Pop.																													
Year 1	245	1. What information will go on your dependent axis? _____																												
Year 2	243																													
Year 3	246	2. What information will go on your independent axis? _____																												
Year 4	250																													
Year 5	247	3. What scale will you use on your dependent axis? _____																												
Year 6	245																													
Year 7	250	4. What scale will you use on your independent axis? _____																												
Year 8	252																													
Year 9	248	5. What species do you think you are working with? How do you know? Use information from the Species List below as evidence to support your answer. (1-2 full sentences) _____ _____ _____ _____ _____																												
Year 10	250																													
Year 11	247	<table border="1"> <thead> <tr> <th>Data Set #</th> <th>Species</th> <th>Background</th> <th>Length of time studied</th> </tr> </thead> <tbody> <tr> <td></td> <td>Bacteria X (1st population)</td> <td>A common bacteria found in soil</td> <td>Studied in a laboratory test tube over the course of several weeks.</td> </tr> <tr> <td></td> <td>Cerulean Warbler</td> <td>This tiny migratory forest bird may be added to the endangered species list.</td> <td>Central Maryland, over several years</td> </tr> <tr> <td></td> <td>Bristlecone Pine</td> <td>This slow-growing tree species can live several thousand years</td> <td>Eastern California, over several years</td> </tr> <tr> <td></td> <td>Eastern Cottontail</td> <td>The common fast-breeding rabbit from the eastern United States</td> <td>Central Ohio, over several years</td> </tr> <tr> <td></td> <td>Red Fox</td> <td>One of several predators of the cottontail rabbit</td> <td>Central Ohio, over several years</td> </tr> <tr> <td></td> <td>Bacteria X (2nd population)</td> <td>A common bacteria found in soil</td> <td>Studied in a laboratory test tube over several weeks. New nutrients provided regularly.</td> </tr> </tbody> </table>	Data Set #	Species	Background	Length of time studied		Bacteria X (1 st population)	A common bacteria found in soil	Studied in a laboratory test tube over the course of several weeks.		Cerulean Warbler	This tiny migratory forest bird may be added to the endangered species list.	Central Maryland, over several years		Bristlecone Pine	This slow-growing tree species can live several thousand years	Eastern California, over several years		Eastern Cottontail	The common fast-breeding rabbit from the eastern United States	Central Ohio, over several years		Red Fox	One of several predators of the cottontail rabbit	Central Ohio, over several years		Bacteria X (2 nd population)	A common bacteria found in soil	Studied in a laboratory test tube over several weeks. New nutrients provided regularly.
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Year 15	248																													
Year 16	248																													
Year 17	247																													
Year 18	250																													

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SPECIES 2 WORKSHEET

Name: _____ Date: _____

Data Set 2		Please answer questions #1-4, based on your data. Then, plot your graph on the graph paper and use your completed graph to help you answer question 5. Don't forget to title your graph with your Data Set number.																												
Date	Pop.																													
1/1/08	80	1. What information will go on your dependent axis? _____																												
4/2/08	35																													
7/3/09	35	2. What information will go on your independent axis? _____																												
10/1/09	45																													
1/2/10	75	3. What scale will you use on your dependent axis? _____																												
4/2/10	40																													
7/1/11	38	4. What scale will you use on your independent axis? _____																												
10/2/11	48																													
1/2/12	82	5. What species do you think you are working with? How do you know? Use information from the Species List below as evidence to support your answer. (1-2 full sentences) _____ _____ _____ _____ _____																												
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7/1/13	39	<table border="1"> <thead> <tr> <th>Data Set #</th> <th>Species</th> <th>Background</th> <th>Length of time studied</th> </tr> </thead> <tbody> <tr> <td></td> <td>Bacteria X (1st population)</td> <td>A common bacteria found in soil</td> <td>Studied in a laboratory test tube over the course of several weeks.</td> </tr> <tr> <td></td> <td>Cerulean Warbler</td> <td>This tiny migratory forest bird may be added to the endangered species list.</td> <td>Central Maryland, over several years</td> </tr> <tr> <td></td> <td>Bristlecone Pine</td> <td>This slow-growing tree species can live several thousand years</td> <td>Eastern California, over several years</td> </tr> <tr> <td></td> <td>Eastern Cottontail</td> <td>The common fast-breeding rabbit from the eastern United States</td> <td>Central Ohio, over several years</td> </tr> <tr> <td></td> <td>Red Fox</td> <td>One of several predators of the cottontail rabbit</td> <td>Central Ohio, over several years</td> </tr> <tr> <td></td> <td>Bacteria X (2nd population)</td> <td>A common bacteria found in soil</td> <td>Studied in a laboratory test tube over several weeks. New nutrients provided regularly.</td> </tr> </tbody> </table>	Data Set #	Species	Background	Length of time studied		Bacteria X (1 st population)	A common bacteria found in soil	Studied in a laboratory test tube over the course of several weeks.		Cerulean Warbler	This tiny migratory forest bird may be added to the endangered species list.	Central Maryland, over several years		Bristlecone Pine	This slow-growing tree species can live several thousand years	Eastern California, over several years		Eastern Cottontail	The common fast-breeding rabbit from the eastern United States	Central Ohio, over several years		Red Fox	One of several predators of the cottontail rabbit	Central Ohio, over several years		Bacteria X (2 nd population)	A common bacteria found in soil	Studied in a laboratory test tube over several weeks. New nutrients provided regularly.
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10/1/13	45																													
1/2/14	60																													
4/2/14	41																													
7/2/15	38																													
10/1/15	53																													
1/3/16	73																													
4/1/16	38																													

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SPECIES 3 WORKSHEET

Name: _____ Date: _____

Data Set 3		Please answer questions #1-4, based on your data. Then, plot your graph on the graph paper and use your completed graph to help you answer question 5. Don't forget to title your graph with your Data Set number.
Date	Pop.	
Day 1	2	1. What information will go on your dependent axis? _____
Day 3	5	
Day 5	10	2. What information will go on your independent axis? _____
Day 7	25	
Day 9	100	3. What scale will you use on your dependent axis? _____
Day 11	350	
Day 13	1000	4. What scale will you use on your independent axis? _____
Day 15	2000	
Day 17	4000	5. What species do you think you are working with? How do you know? Use information from the Species List below as evidence to support your answer. (1-2 full sentences) _____ _____ _____ _____ _____
Day 19	8000	
Day 21	10000	
Day 23	3000	
Day 25	1500	
Day 27	750	
Day 29	100	
Day 31	50	
Day 33	25	
Day 35	10	

Data Set #	Species	Background	Length of time studied
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Date	Pop.																													
5/08	236	1. What information will go on your dependent axis? _____																												
7/08	402																													
5/09	221	2. What information will go on your independent axis? _____																												
7/09	380																													
5/10	198	3. What scale will you use on your dependent axis? _____																												
7/10	324																													
5/11	187	4. What scale will you use on your independent axis? _____																												
7/11	298																													
5/12	150	5. What species do you think you are working with? How do you know? Use information from the Species List below as evidence to support your answer. (1-2 full sentences) _____ _____ _____ _____ _____																												
7/12	267																													
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7/13	254																													
5/14	142																													
7/14	233																													
5/15	132																													
7/15	206																													
5/16	122																													
7/16	152																													

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SPECIES 5 WORKSHEET

Name: _____ Date: _____

Data Set 5		Please answer questions #1-4, based on your data. Then, plot your graph on the graph paper and use your completed graph to help you answer question 5. Don't forget to title your graph with Data Set number.	
Date	Pop.		
Day 1	2	1. What information will go on your dependent axis? _____	
Day 3	5	2. What information will go on your independent axis? _____	
Day 5	10	3. What scale will you use on your dependent axis? _____	
Day 7	25	4. What scale will you use on your independent axis? _____	
Day 9	100		
Day 11	350	5. What species do you think you are working with? How do you know? Use information from the Species List below as evidence to support your answer. (1-2 full sentences) _____	
Day 13	1000	_____	
Day 15	1500	_____	
Day 17	1700	_____	
Day 19	1850	_____	
Day 21	1950		
Day 23	2000		
Day 25	2000		
Day 27	2000		
Day 29	2000		
Day 31	2000		
Day 33	2000		
Day 35	2000		

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Date	Pop.																													
1/1/08	300	1. What information will go on your dependent axis? _____																												
4/2/08	280	2. What information will go on your independent axis? _____																												
7/3/09	500	3. What scale will you use on your dependent axis? _____																												
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10/1/13	900																													
1/2/14	420																													
4/2/14	390																													
7/2/15	520																													
10/1/15	1,020																													
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