Population Dynamics Graphs

OBJECTIVES:

- to learn about three types of population dynamics graphs
- to determine which type of graph you constructed from the Pike and Perch Game
- to interpret (describe, analyze) graphs of population dynamics

TASKS:

- read the notes and complete the questions on pages 3 and 4.

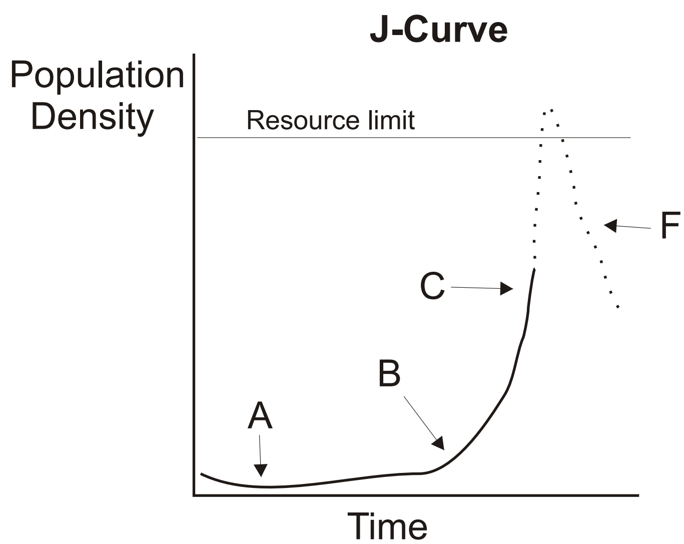
KEY TERMS:

- dynamics: continuous changes
- density: the number of individuals per unit area
- fluctuation: to rise and fall as if in waves
- limiting: placing a boundary on something; confining; restricting

NOTES:

Populations of organisms will usually increase as much as they can in their environment. For instance, as long as pike have enough food (i.e. yellow perch) to eat in Lake Winnipeg they will continue to grow, reproduce and add to their population. However, populations will not grow forever. Some form of resistance from the environment will stop the population's growth. The form of environmental resistance can be called a limiting factor since it limits population growth. For example, the lack of food for pike is a form of resistance or a limiting factor. If pike do not have enough food to eat their population will begin to decrease. These changes in population can be graphed.

The first two graphs begin in the same manner. Point A represents the lag phase. There are very few organisms in the beginning so the reproduction rate is low. The population grows very slowly. Then, as the young grow up and begin to reproduce, the population enters the acceleration phase at point B. Soon the population begins to grow very quickly in the exponential phase at point C. Exponential growth cannot occur for long due to environmental resistance.

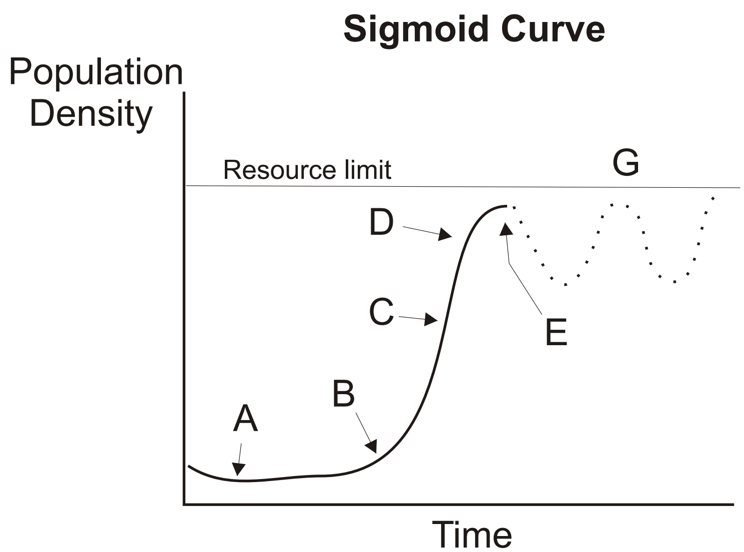


THE J-CURVE GRAPH

Limiting factors that produce the J-curve are density independent which means that they can affect a population at any density. For instance, natural disasters (fire, flood, drought), temperature, weather, sunlight, etc. are all density independent limiting factors that will affect any and every population. The effects of density independent limiting factors do not depend on the population reaching a certain density. Usually, density independent limiting factors cause a sudden crash or decline in population. This can be seen in the J-curve graph at point F.

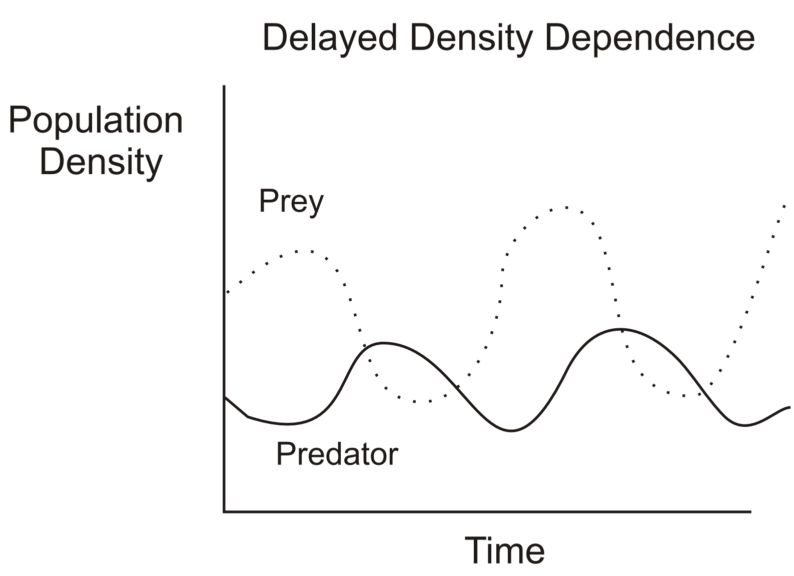
THE SIGMOID CURVE (S-CURVE)

Limiting factors that produce an S-curve are density dependent, which means that they only affect a population when it reaches a certain density. For instance, competition, predation, and disease usually only affect a population at specific densities. Note that a sigmoid curve results when a population's density is somehow controlled so that it can become somewhat stable. Also, the population needs to live in an environment that is able to renew or recycle resources continuously. Instead of crashing suddenly, the population enters a deceleration phase (point D). Then the population enters equilibrium (point E). Equilibrium is the point where the number of births equals the number of deaths in a population. The population does not increase or decrease when in equilibrium. Equilibrium may not last long due to changes in birth and death rates. Usually, the population fluctuates around the carrying capacity (point G). The carrying capacity is the population density that the ecosystem can support. Most populations are in this fluctuation phase (at point G).



DELAYED DENSITY DEPENDENCE

Another type of graph displays the relationship between predators and prey. Predators and prey will often have a relationship described as delayed density dependence. The density of each population is dependent on the density of the other. The predator's population curve occurs a little behind the population curve of the prey. This happens because the number of predators that survive and reproduces depends on the number of prey available for consumption. As the population of prey increase, the population of predators also increases. But, this causes a decrease in the population of prey and then a decrease in the population of predators. This is a never-ending cycle. According to many biologists, the carrying capacity of this graph occurs at the troughs, or low points, since this is the only level that can be sustained. Also, the population at the troughs is usually more consistent than at the peaks.



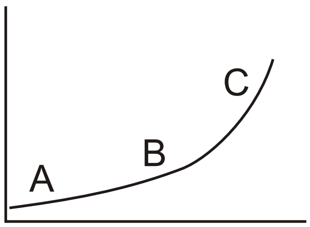
QUESTIONS: **(35)**

1) Out of the three graphs mentioned above, which graph best suits the Pike and Perch Game? (1)

2) What type of graph did you construct from the Pike and Perch Game?(1)

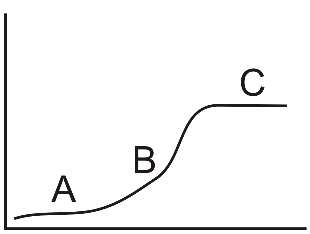
3) Interpret the following three graphs. Describe what is happening at each lettered point and predict what will happen next. Provide a reason for each statement and prediction.
The first one has been done for you. (22)

Graph 1



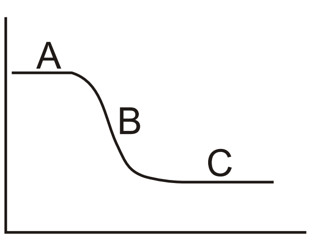
Point	Describe	Reason
A	increasing slowly	few animals are available to reproduce
B		
C		
?		

Graph 2



Point	Describe	Reason
A		
B		
C		
?		

Graph 3

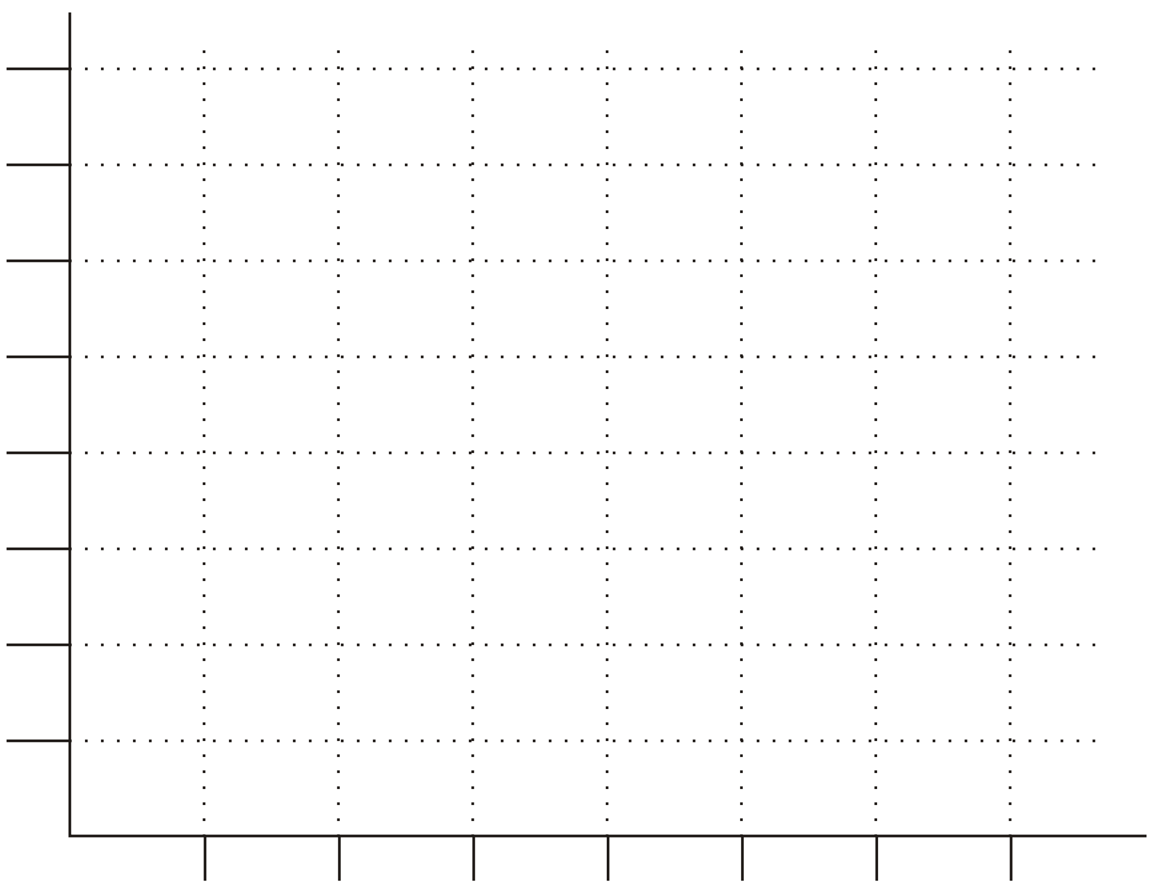


Point	Describe	Reason
A		
B		
C		
?		

4) Using the following data, construct a population dynamics graph. (11)

Yellow Perch in Lake Winnipeg

Year	Population
1997	10 000
1998	13 000
1999	15 000
2000	16 000
2001	12 000
2002	11 000
2003	11 000



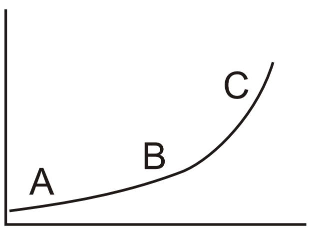
ANSWER KEY: **(Out of 35)**

1) Out of the three graphs mentioned above, which graph best suits the Pike and Perch Game? (1)
The best graph for this game is the delayed density dependence graph (predator/prey relationship).

2) What type of graph did you construct from the Pike and Perch Game? (1)
Answers may vary but ideally they would have constructed the delayed density dependence graph.

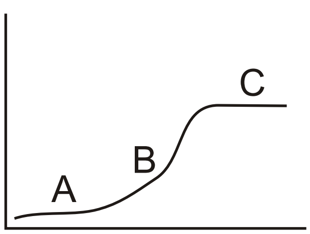
3) Interpret the following three graphs. Describe what is happening at each lettered point and predict what will happen next. Provide a reason for each statement and prediction.
The first one has been done for you. (22)

Graph 1



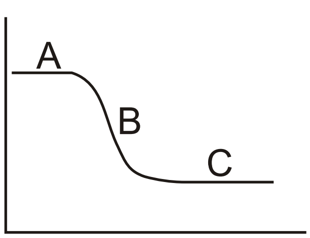
Point	Describe	Reason
A	increasing slowly	few animals are available to reproduce
B	increasing faster	more are able to reproduce
C	increasing exponentially	all animals are healthy and reproducing
?	population crash	cannot continue to grow forever, will experience some form of environmental resistance

Graph 2



Point	Describe	Reason
A	slowly increasing	few are reproducing
B	increasing quickly	more are able to reproduce
C	equillibrium	at the carrying capacity of the ecosystem
?	continue at equilibrium	remain at equilibrium until environmental resistance changes it

Graph 3



Point	Describe	Reason
A	equilibrium	at the carrying capacity of the ecosystem
B	decrease quickly	some form of environmental resistance has caused the population to decrease
C	equilibrium	at a new carrying capacity of this ecosystem
?	remain or increase	may remain at this carrying capacity or increase again to the higher carrying capacity

4) Using the following data, construct a population dynamics graph. (11)

Yellow Perch in Lake Winnipeg

Year	Population
1997	10 000
1998	13 000
1999	15 000
2000	16 000
2001	12 000
2002	11 000
2003	11 000

- 7 marks for each point plotted correctly
- 1 mark for title of graph
- 2 marks for labeling axes
- 1 mark for connecting the points