# Population Growth

How is population growth naturally regulated?

Why?

The current world population is estimated to be over 7 billion. At present the number of births annually exceeds the number of deaths, which means that the population is increasing, and is estimated to reach 9 billion by 2040. In 1750 the world population was estimated at less than 800 million. How are growing populations such as ours controlled and supported, and can they continue to grow indefinitely?

Model 1 – Population Growth
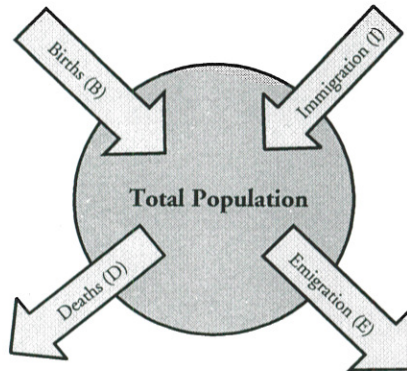
1. Refer to Model 1.

   a. What is the term used for populations moving into an area?

   immigration

   b. What is the term used for populations leaving an area?

   Emigration

   c. Name two factors that cause an increase in the population size.

   Births and immigration

   d. Name two factors that cause a decrease in population size.

   Deaths and Emigration

2. Using Model 1 and the letters B, D, E, and I, write mathematical expressions to show the types of population described below. *Note:* The use of > and < may be needed.

   a. A stable population (total number of organisms is not changing).

   $B + I = D + E$

   b. A declining population (total number of organisms is decreasing).
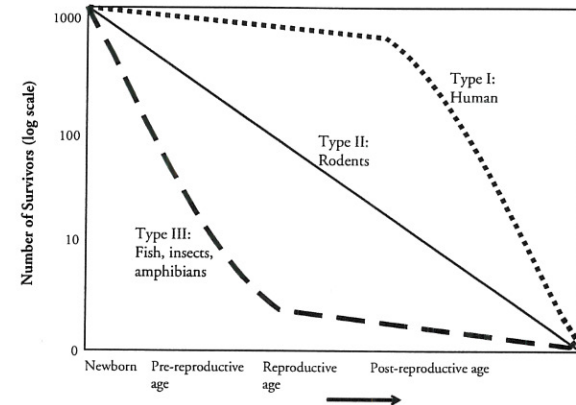
   $B + I < D + E$

   c. A growing population (total number of organisms is increasing).

   $B + I > D + E$

Model 2 – Survivorship Curves

3. Refer to Model 2.

   a. What does the x-axis on the graph in Model 2 represent?

   number of survivors (log scale)

   b. Which type of organism shows a steady decline in its population at all life stages?

   Type II

   c. Which type of organism loses most of the individuals in its population at an early life stage?

   Type III

   d. What survivor type are humans?

   Type I

4. At what life stage is each survivor type when the number of survivors is 100?

a. Type I – *Post-Reproductive*

b. Type II – *Reproductive*

c. Type III – *Pre Reproductive*

5. Which of the three types have the highest number of individuals that reach reproductive age?

Type I

Read This!

Through the process of evolution, all species have developed strategies to compensate for their survivorship type. Insects lay eggs by the hundreds. Mammals keep their young close by and protected until they reach adulthood. Factors such as these allow populations of species to survive and thrive despite their survivorship curve.

6. How do you think populations with Type II or III survivorship compensate for high pre-reproductive mortality?

They have large numbers of offspring

7. Consider the evolutionary strategies that each survivorship type has developed for producing and rearing their young. Propose an explanation for why type I survivors have the highest relative number of individuals/1000 births that survive until they reach post-reproductive age?

They provide parental care which ensures that their young are protected until they reach Reproductive age.

8. Under what circumstances might human populations not show Type I survivorship?

Under unstable society conditions like wars would cause high infant mortality.

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Model 3 – Growth Curves
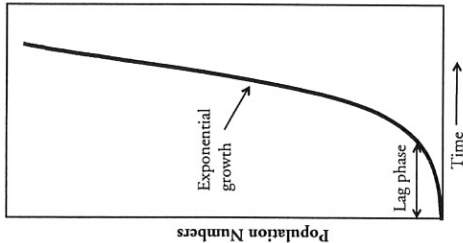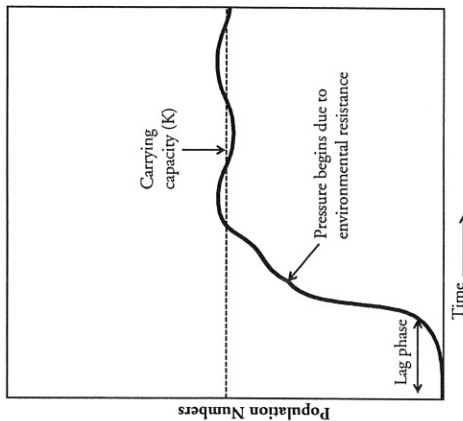
Diagram A—Exponential Growth Curve Diagram B—Logistic Growth Curve

9. Refer to Model 3.

a. During what phase of the growth curves in each diagram is the population just beginning to colonize an area?

Lag phase

b. Which type of population growth appears to continue unchecked?

Exponential growth

10. The growth curves in Model 3 are often referred to using the letters of the alphabet they resemble. The logistic growth curve is sometimes referred to as an S-curve. What letter would you use to describe the exponential growth curve?

J shaped curve

11. What causes the population to slow down during logistic growth?

pressure from environmental resistance

12. The maximum population an environment can sustain is affected by environmental factors that cause the population to level out or become stable. What term is used to describe this level of logistic growth?

carrying capacity (K)

13. Propose some reasons why population growth is so rapid immediately after the lag phase in both diagrams of Model 3?

Individuals are able to obtain enough resources to reproduce at the maximum rate

14. Exponential growth (diagram A) refers to the phenomena of populations that double in size every generation. If you start with a single bacterium capable of dividing every 20 minutes, how many bacteria would you have after just four hours?

STOP

15. In most natural populations rapid exponential growth is unsustainable. As populations increase, **environmental resistance** causes the growth rate to slow down, until carrying capacity is reached. With your group, brainstorm several factors that could be considered as environmental resistance.

limited food, waste buildup, predation.

16. Diagram B shows that the population size fluctuates around the carrying capacity. Considering what you know about interactions in the environment, discuss with your group some of the factors that could cause these fluctuations. In your answer you should relate these factors to the information from Model 1.

predation, births during Reproductive season, death Rate increased during harsh winter or disease.

STOP

Extension Questions

Read This!

Invasive species are species that are introduced into an environment but are not naturally found in that environment. One example of an invasive species is the American gray squirrel, introduced into Britain at the end of the 18th century. Until 1876 the only native squirrel in Britain was the European red squirrel, which was found in deciduous and coniferous forests. By 1940 the gray squirrel had displaced the red squirrel across most of the British Isles, and by 1984 the red squirrel was only found in isolated coniferous woodland areas. After its initial introduction, the gray squirrel population increased rapidly; however, in recent years population sizes within specific environments have become stable.

17. Explain why the newly-introduced gray squirrel initially showed rapid population growth and why the native red squirrel showed a population decline. Use ecological terms from the previous models in your answer.

The new gray squirrel population had virtually unlimited resources in a new environment. As it grew, predation started to affect it. Competition with other squirrel species also limited the amount of resources available for its population to grow.

18. Why has the population size of the gray squirrel become stable in recent years?

The population size stabilized because of interactions with the environment (predation, parasitism, disease, competition with other species and intraspecific competition).