AP* ENVIRONMENTAL SCIENCE

POPULATION DYNAMICS

Population Dynamics

What I Absolutely Have to Know to Survive the AP Exam

A **population** is defined as all the members of the same species that inhabit a specific geographic area during a specific time. The ability for these individuals to interbreed establishes the gene pool for the population. The population's size is dictated by the following four factors:

- emigration – individuals leaving the population
- immigration – individuals moving into the population
- birth
- death

The change in population can be defined by the following:

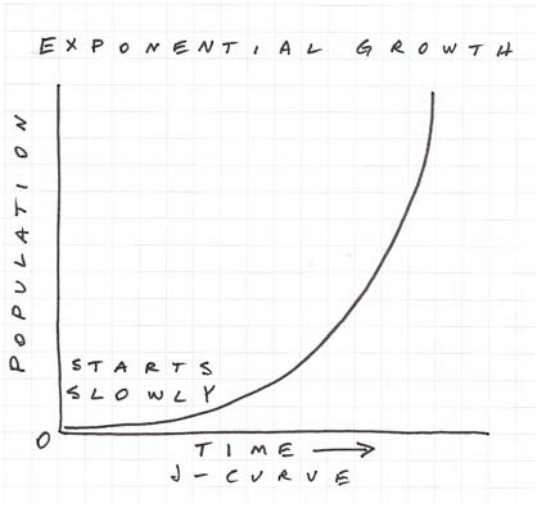
[immigration + birth] – [emigration + death] = population change

Population density is the number of individuals in a given area. An example of this would be the estimation of ten black-tailed prairie dogs per acre of occupied habitat. The individuals that make up the population do not always evenly distribute themselves in their habitat. Dispersion of the population follows three patterns:

- **random** – individuals of a population can be found throughout their range with little influence from other members determining their location
- **clumping** – individuals are found together within their range; this is due to the exploitation of limited resources or in some cases - "safety in numbers"
- **uniform** – individuals of a population are spaced evenly due to intraspecific competition of resources

The **biotic potential (r)** of a population is the amount a population would grow in the absence of limiting factors. If a population is allowed to grow in these conditions it will increase at an exponential rate.

Exponential growth starts slowly at first; however, without competition, predation and with unlimited resources it increases rapidly.



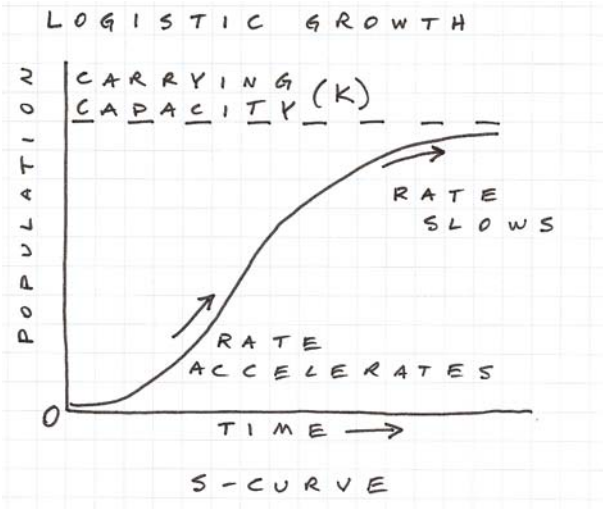
Rule of 70 is used to determine how long it would take for a population to double at its present growth rate. One simply has to divide 70 by the population's annual growth rate to determine the years needed to double the size of the population.

Ex. A population of prairie dogs has a growth rate of 7 percent.

70/7 = 10 years to double

Exponential growth is generally a short-lived situation in nature.

Environmental resistance (all of the factors that limit the size of a population) slows the growth rate. This leads to a decline in the growth rate and a "leveling-off" of the population. This pattern of growth is known as **logistic growth**.



Logistic growth begins with a period of exponential growth, but as environmental resistance increases the growth rate decrease until the population reaches the maximum number the area can sustain at which time the area's **carrying capacity (K)** has been reached.

Organisms can be classified as two different types based on their reproductive strategies.

r-strategists – These organisms reproduce early in life and have a high biotic potential. Their strategy for insuring the survival of the population is to reproduce early and often. They have large numbers of offspring with high infant mortality rate. Very little energy is used in caring for offspring.

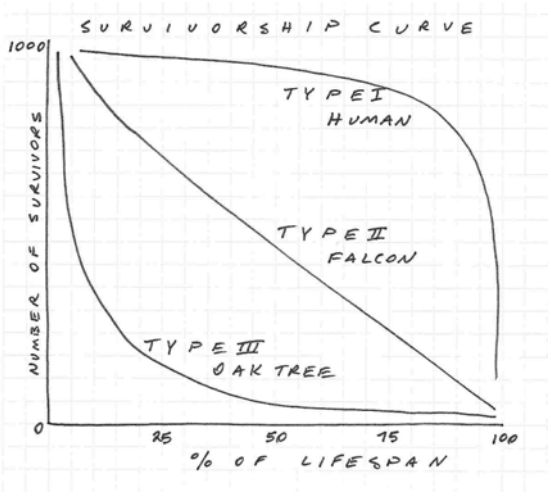
K-strategists – These organisms reproduce later in life and typically have very few young. These organisms generally expend a great amount of energy in care of offspring. The survival of population is insured with quality not quantity.

Survivorship curves reflect reproductive strategies. Most organisms can be classified into three different curves.

Type I curves are when most deaths occur in the later stages of a species' life
ex. human

Type II curve indicates that death occurs at a fairly constant rate in a species' life
ex. peregrine falcon

Type III curves occur typically when many offspring are produced but infant mortality rate is high
ex. oak tree



The human population is currently **6.72 billion.** It has a growth rate of **1.14%.** That means the world's population would reach 13 billion people in sixty years if the growth rate stayed the same. Most people do believe that it will slow down; however, with resources already being exploited at unsustainable rates, any growth will create problems that will have to be addressed.

Growth rate of a population is calculated by **subtracting the death rate from the birth rate and dividing by the size of the population multiplied by 100 to receive a %.**

The growth rate can also be calculated as follows:

crude birth rate-the number of live births per 1000 population in a year
crude death rate-the number of deaths per 1000 population in a year

CBR-CDR / 10 = % growth rate

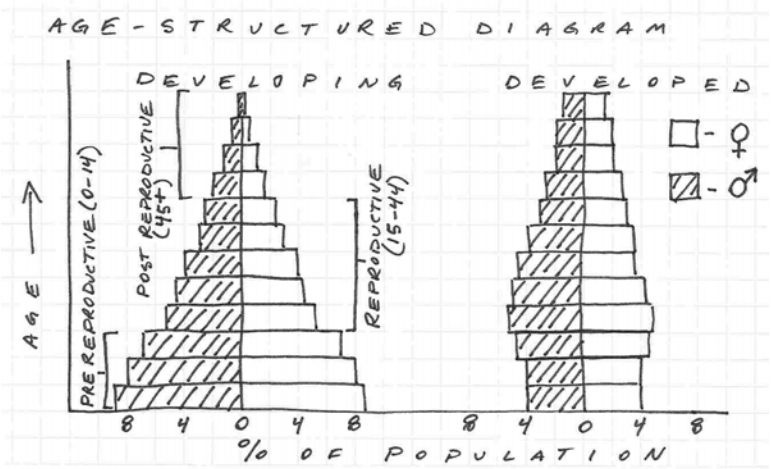
Zero population growth (ZPG) occurs when the birth rate of a population equals the death rate. ZPG occurs in populations during two phases. First, when birth rate and death rate are equally high and second, when birth rates and death rates are equally low.

The overall growth rate, CBR, and CDR are good indicators of a country's stability and economic progress. Other key characteristics of a developing nation and a developed nation follow:

total fertility rate – average number of children born to a woman over her lifetime
- **Developed Countries – 2.1**
- **Developing Countries – 3.0 +**

replacement fertility rate – the number of children a woman must have to maintain a population
- **Developed Countries – 2.1**
- **Developing Countries – 2.5 -3.3**

An **Age-structured diagram** is used as a graphical representation of a country's population.



It divides the population into three categories:
pre-reproductive (0-14)
reproductive (15-44)
post-reproductive (45-death)

It also divides the males and females of the population and represents all cohorts with its percentage of the total. These diagrams can be used to quickly determine if a population has a high potential for growth, if their growth rate is zero, or if the population is shrinking.

A population with a large percentage of its individuals in the pre-reproductive and reproductive cohorts has a high potential for growth.
Infant mortality and life expectancy are the two most important factors when considering the overall health of a nation.

A **demographic transition** occurs when a society changes from a high birth rate and high death rate to society with both a low birth rate and death rate. Four stages transpire during the demographic transition:

1. **pre-industrial** – population grows slowly due to high birth rate and high death rate – living conditions are considered poor
2. **transitional** – with improvements in medicine, sanitation, and food supply the death rate declines; however, the birth rate remains high = rapid population growth
3. **industrial** – population growth slows with low birth rate accompanied by a equally low death rate
4. **post-industria**l – zero population growth and often a lower birth rate creates a decline in the population.

Multiple Choice

1. Carrying Capacity of a population is determined by

I. Biotic Potential
II. Environmental Resistance
III. Reproductive Strategies

A. I only
B. I and II only
C. I and III only
D. I, II, and III
E. None of the above

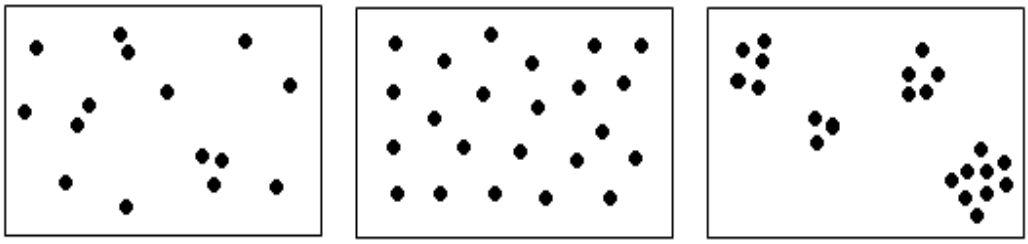
2. The Protist that causes malaria spends part of its life cycle in human beings. The protist benefits while the human is negatively impacted. This type of relationship is best described as

A. predation
B. amensalism
C. mutualism
D. commensalism
E. parasitism

3. Male deer often fight in order to establish dominance, and secure a mate. This type of relationship is best described as

A. interspecific competition
B. commensalism
C. predation
D. intraspecific competition
E. mutualism

Questions 4-6 refer to the following graphs.



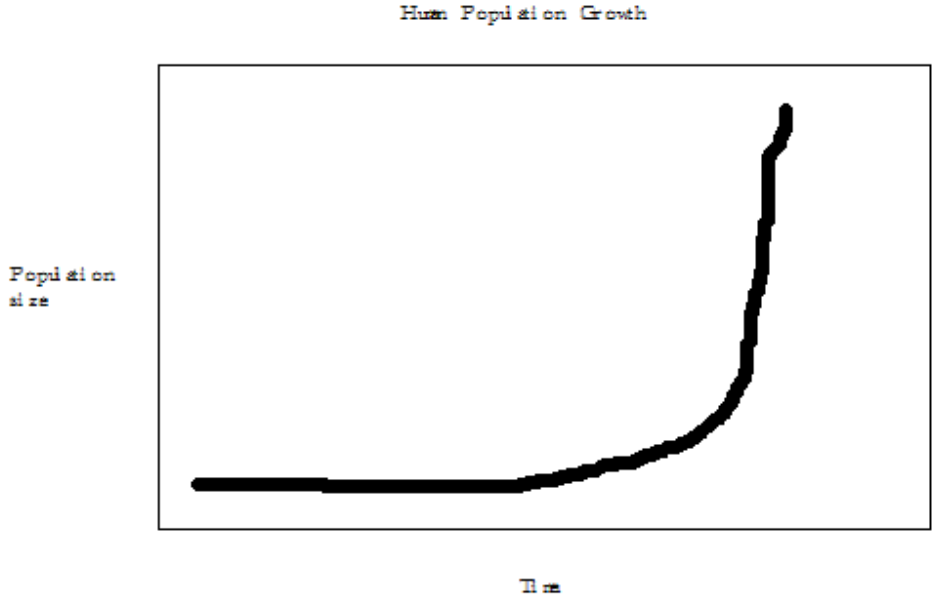
A B C

4. This type of population distribution is often shown by territorial animals.

5. This type of population distribution is exhibited by organisms that gather near needed resources.

6. The type of population distribution that is exhibited by organisms that reproduce by wind dispersed seeds.

Questions 7 and 8 refer to the following graph

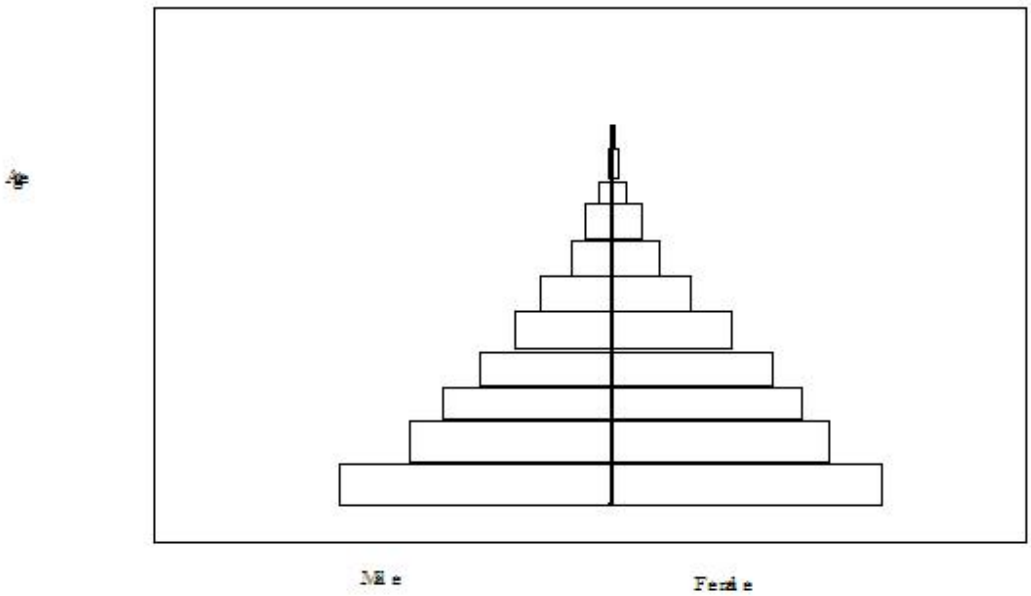


7. The type of population growth shown in the graph above occurs only when

   A. Death rates exceed birth rates.
   B. Total fertility rates reach 2.0
   C. Resources are unlimited
   D. Density- dependent limiting factors are regulating population size
   E. Emigration exceeds Immigration

8. The type of growth shown here is said to be
   A. Sigmoidal
   B. Logistic
   C. Exponential
   D. Linear
   E. Late-loss

Questions 9 and 10 refer to the following graph

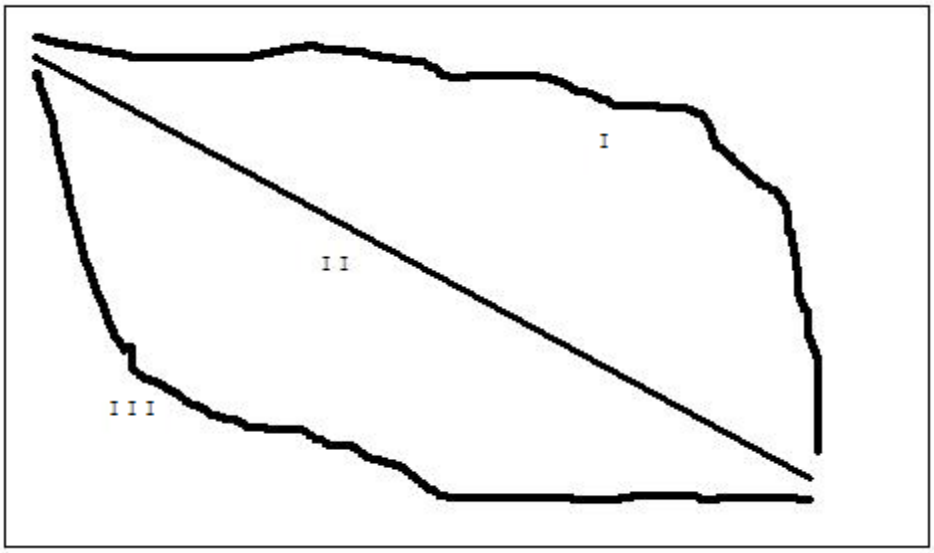


9. The type of diagram shown above is referred to as an

A. Age-Structure diagram
B. Energy Pyramid
C. Life Table
D. Survivorship Table
E. Trophic structure diagram

10. The diagram above shows a population that is experiencing

A. Zero population growth
B. Rapid population growth
C. Slow population growth
D. High unemployment
E. Decreasing population growth



11. In the graph above, humans would be best represented by the line labeled
    A. I
    B. II
    C. III
    D. I and III
    E. II and III

12. Emigration refers to
A. Organisms moving into an area
B. The difference between per capita birth and death rates
C. The total number of organisms living in a given area
D. Organisms moving out of an area
E. None of the above

Free Response

The human population has been increasing at alarming rates. While the human population increases there are some countries that have declining populations, and others that are increasing at near exponential rates.

A. Assuming an annual growth rate of 1.2%, approximately how many years would it take for the human population to double?

B. Identify one country, or region, that has a decreasing human population, and one country, or region, whose human population is increasing.

C. A country with a population of 1 million has a crude birth rate of 20 and a crude death rate of 10. It has no immigration or emigration. What is the percentage growth rate during this year, and approximately how long would it take for this population to double?

D. Identify and describe one step that can be taken to slow a country's growth rate.