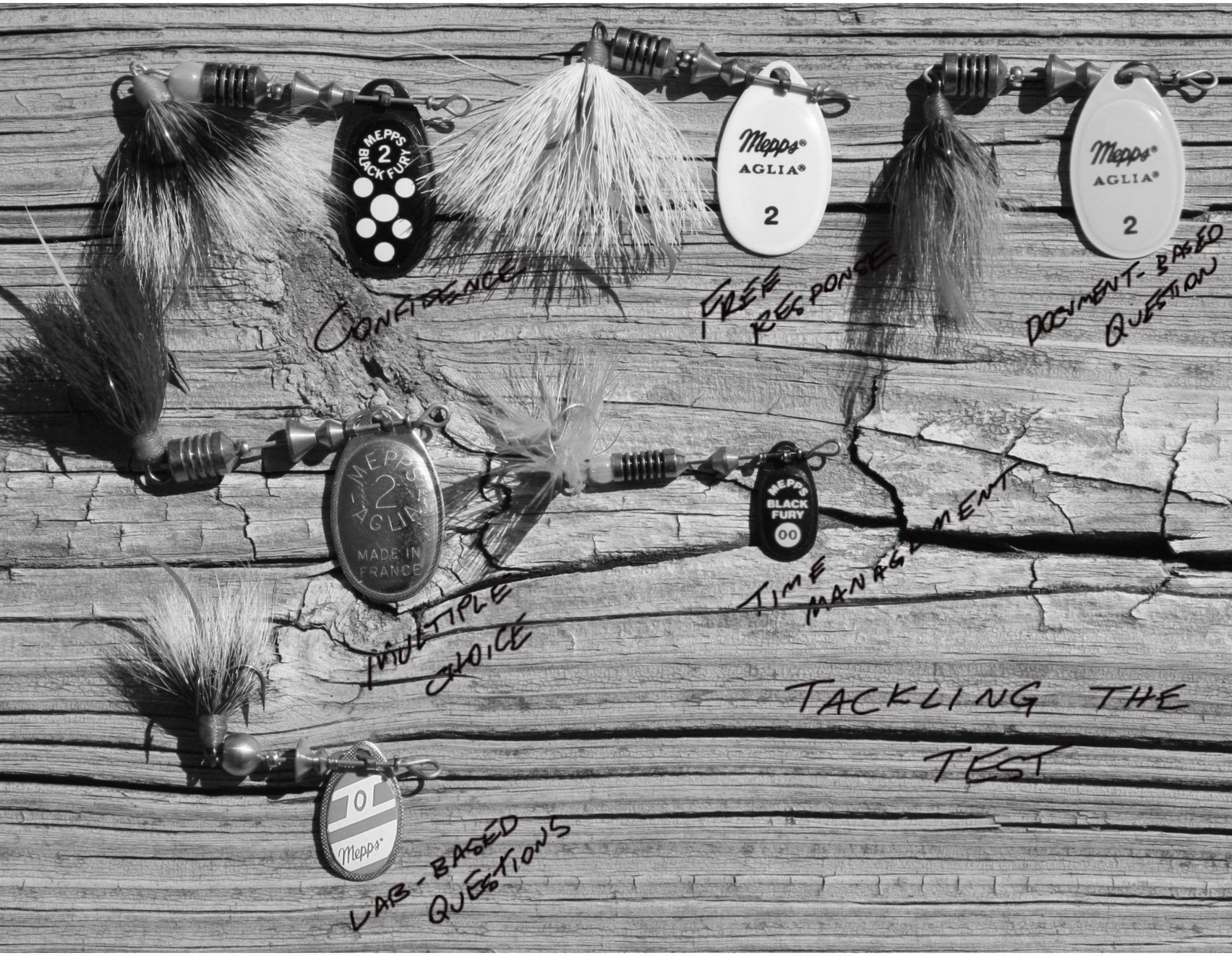
Advanced Placement

ENVIRONMENTAL SCIENCE

Population



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Population Dynamics

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

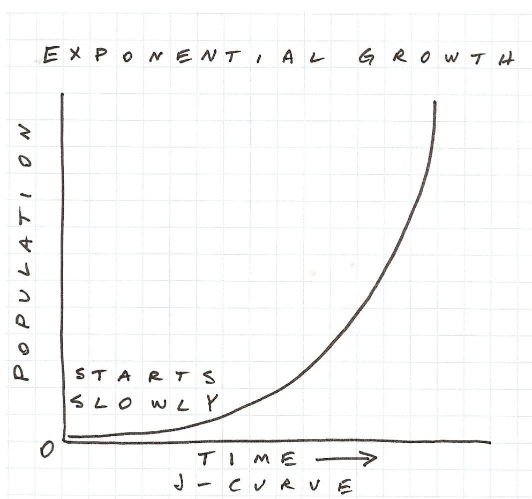
The **biotic potential (r)** of a population is the amount a population would grow in the absence of limiting factors. If a population is allowed to grow in these conditions it will increase at an exponential rate.

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.

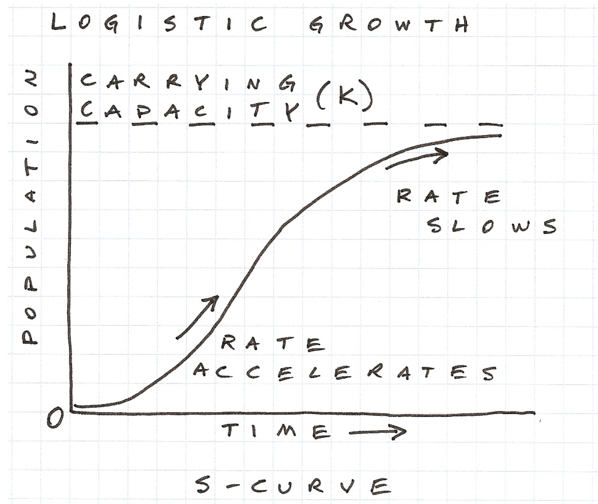
Ex. A population of prairie dogs has a growth rate of 7 percent.

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 ensuring 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 ensured with quality not quantity.

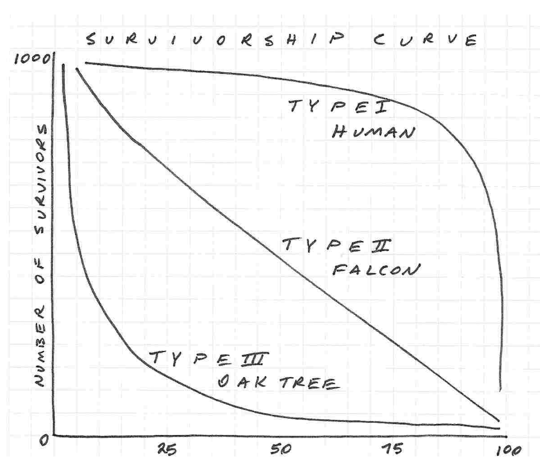
Survivorship curves reflect reproductive strategies. Most organisms can be classified into three different curves.

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 **over 7 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

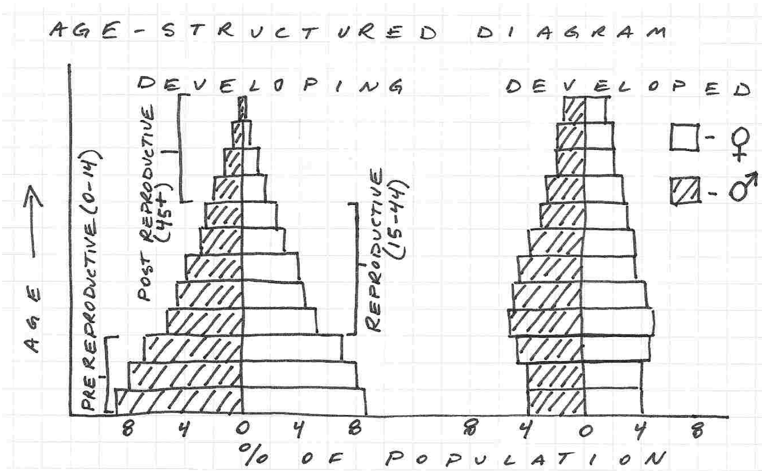
Developed Countries – 2.1
Developing Countries – 3.0 +

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.