Populations

A **population** is a group of one species that live in the same area and can successfully interbreed. Several terms can be used when describing individuals within a population.

Generalists are organisms that have very broad niches. This gives them the freedom to have wide ranges and to fit into a variety of habitats. **Specialists** have a narrow niche and are very successful when conditions are favorable. However, if conditions are not favorable, specialists are more susceptible to extinction.

R-strategists are typically small organisms that have a high **biotic potential (r)** or population growth rate. They have large unprotected broods. These organisms generally have a short gestation time and individuals mature quickly. Insects and many plants are good examples of r-strategists.

K-strategists are generally larger and have fewer young. They invest large quantities of energy in rearing their young. Their population size does not vary

nearly as much as r-strategists. Their population size is usually the maximum size (**carrying capacity [K]**) the environment will allow.

The size and density of a population is determined by the interplay of a specie's biotic potential and the environmental resistance. **Environmental resistance** includes the limited availability of shelter, food and water. Without environmental resistance a population would grow **exponentially**.

Logistic growth describes the growth of a population in response to environmental resistance.
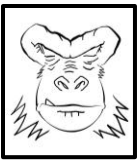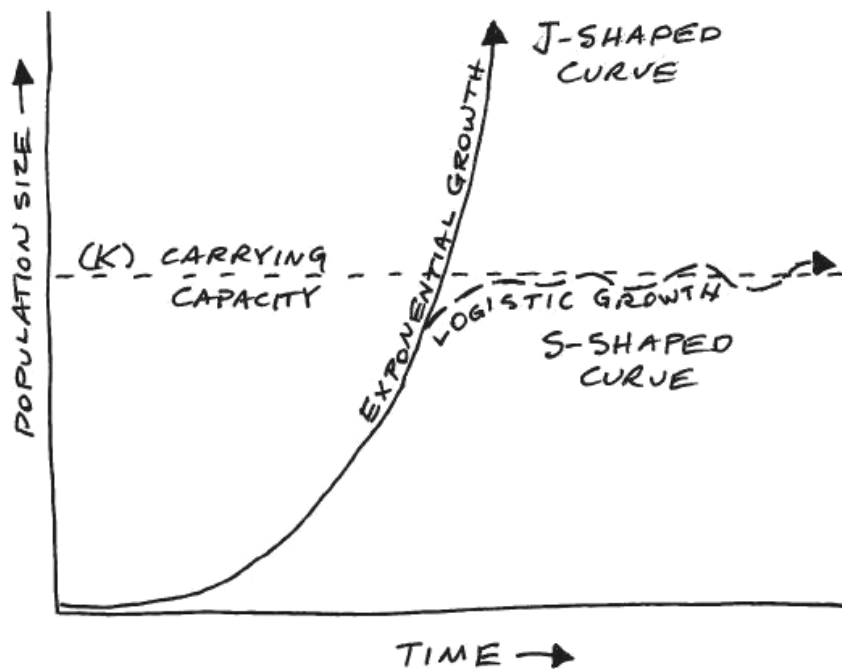
Population density describes the amount of a particular species in a given area. Many factors limit a population size; however, they all can be placed in two groups.

Density-dependent factors are environmental factors that have a greater effect on the more dense populations. An example of a density-dependent factor is the transmission of infectious disease.

Density-independent factors affect all populations regardless of size. Natural disaster, like fire and storms, are density-independent factors.

Individuals of a population are dispersed throughout the habitat in several ways.

Random dispersion occurs when a population is spread through a habitat by chance alone. An example of this would be the dispersion of dandelions on a hillside.
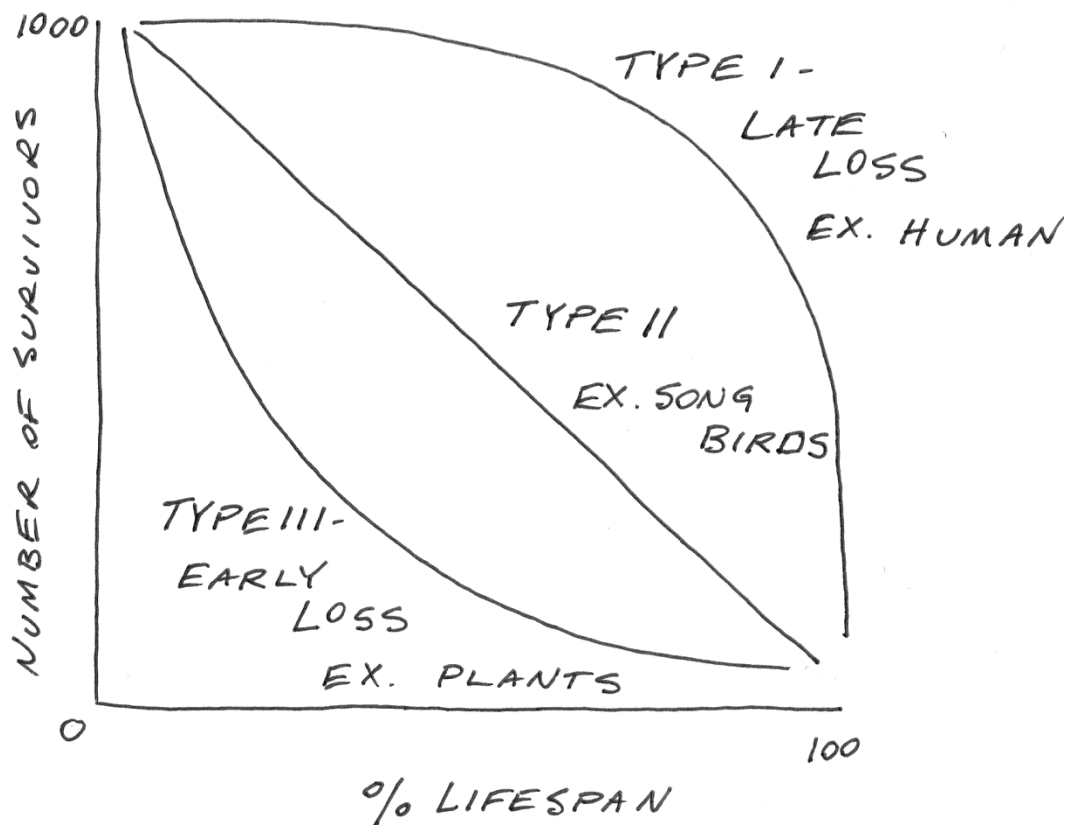
Uniform dispersion is the result of intraspecific competition and leaves the individuals of a population dispersed in an orderly fashion. Many seabirds exhibit uniform dispersion during the breeding season.

Clumped dispersion occurs when it is beneficial for the population to congregate together. This could be the result of isolated resources or for the safety of the species from predation.

Survivorship curves are used to illustrate reproductive strategies of species. Organisms have several different strategies to insure that their genetic information is passed on to the next generation. The following diagram illustrates these strategies.
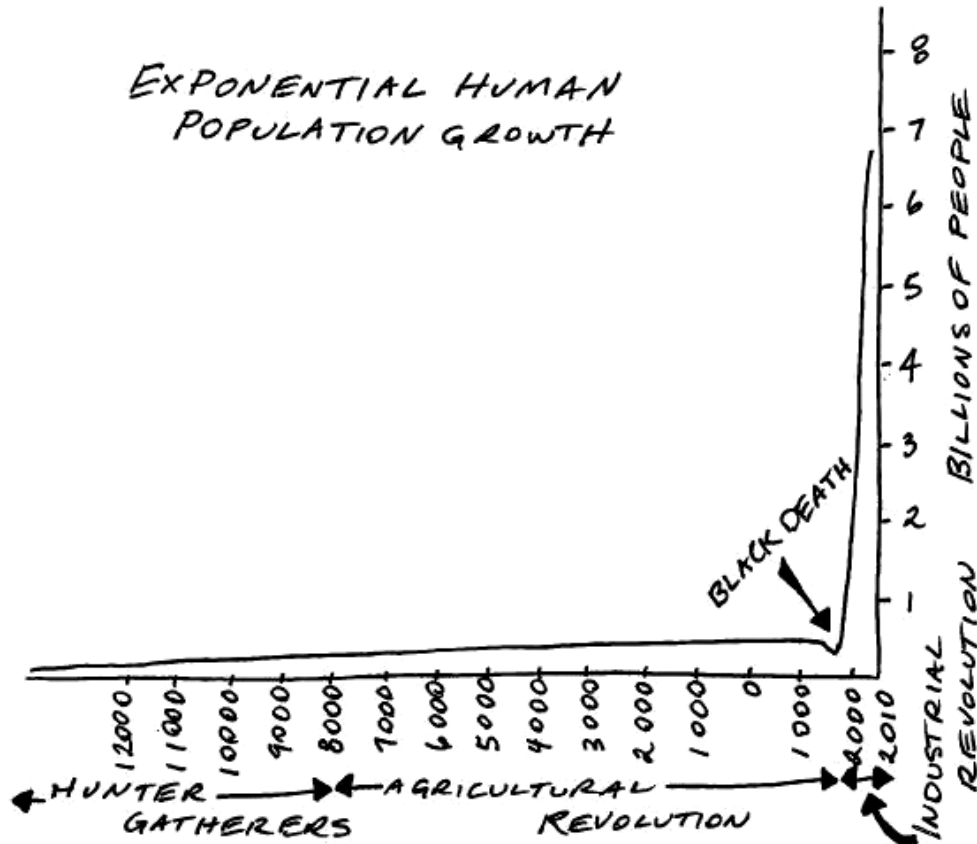
The Human Population

The current population is approximately 6.7 billion people! Throughout history, the human population has experienced exponential growth.

EXPONENTIAL HUMAN
POPULATION GROWTH

BLACK DEATH

BILLIONS OF PEOPLE

8
7
6
5
4
3
2
1

12,000 · 11,000 · 10,000 · 9,000 · 8,000 · 7,000 · 6,000 · 5,000 · 4,000 · 3,000 · 2,000 · 1,000 · 0 · 1,000 · 2,000 · 2010

←HUNTER GATHERERS→ ←AGRICULTURAL REVOLUTION→

INDUSTRIAL REVOLUTION

Several of the factors that have contributed to the exponential growth of the population include:

1. The Agricultural Revolution. The Agricultural Revolution led to food surpluses, and civilization, for the first time in human history. This stability led to an increase in population.

2. The Industrial Revolution and modern medicine. Improved living conditions and modern medicine have lead to longer life spans and decreased infant mortality.

These factors allowed death rates to decrease while birth rates remained high. This has led to rapid population growth.

There are several important terms to consider when discussing the human population. These terms include:

Total fertility rate: The average number of children per woman.

Replacement level fertility: The average number of children per woman necessary to sustain a population size. Ideally this would be two children per woman, one to replace the mother and one to replace the father. In reality, not all offspring survive to reproduce, so the average number or children per woman must remain slightly higher than two in order for a population to remain stable. Replacement level fertility can be only slightly higher than two in developed countries because of low infant mortality rates and good medical care.   In developing countries where infant mortality rates are high and medical options are not as good replacement level fertility may be substantially higher than two children per woman.

Crude Birth Rates: The number of births per 1,000 people per year. Crude birth rate and total fertility rates are affected by education level and employment opportunities of women in a population. Cultural expectations, cost of child rearing, and availability of birth control also affect CBR and TFR.

Crude Death Rates: The number of deaths per 1,000 people per year. CBR is affected by working conditions, availability of good medical care, availability of good nutrition, access to clean water, and general living conditions.

Infant Mortality Rate: The number of infants per 1,000 births that die prior to their first birthday.

When birth rates exceed death rates, the size of a population will increase. Migration also plays a role in population size. **Emigration** refers to organisms leaving an area while **immigration** refers to individuals coming into an area.

Doubling time refers to the number of years that it takes for a population to double. The doubling time of a population can be estimated with the "rule of 70". Use the following equation.

Doubling time = 70/the percentage growth rate

For example, if a population is growing at 2% annually then:

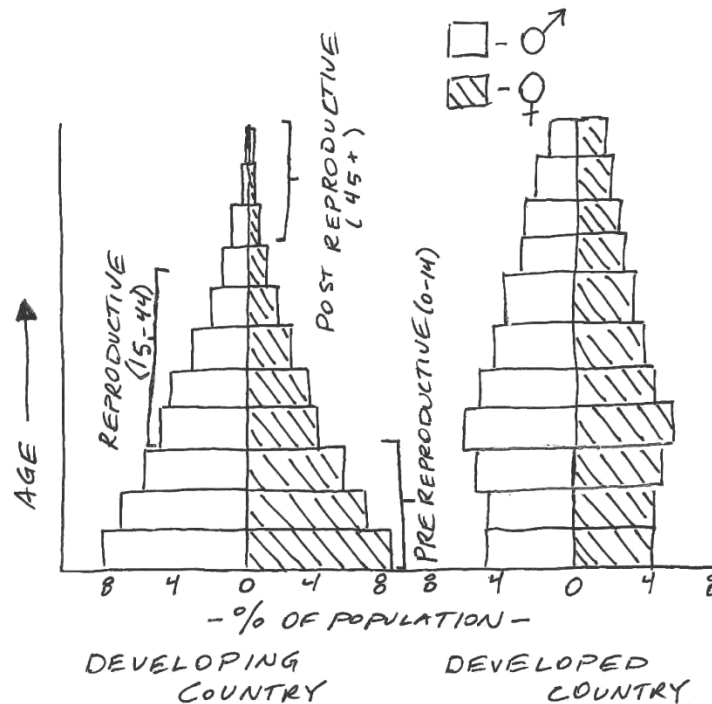Doubling time = 70/2% (keep as a whole number)

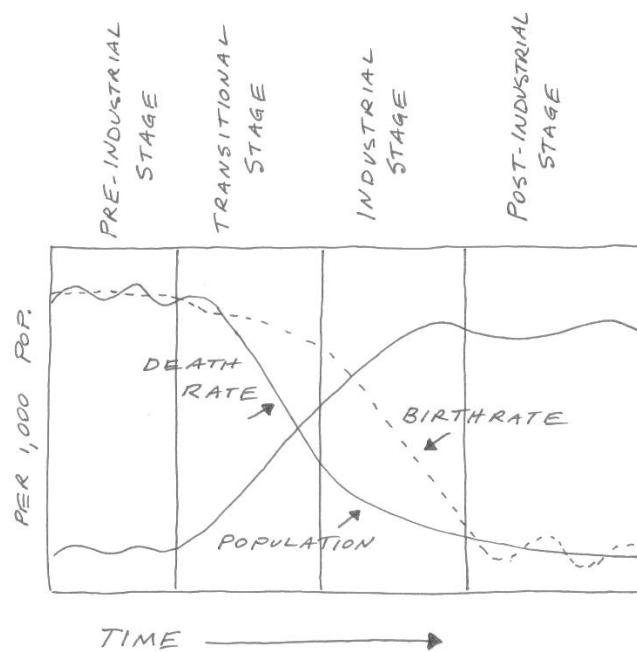In this example, the number of years that would be required for this population to double is 35.
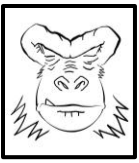
Age-Structure Diagrams (population pyramids) can be used to analyze the make-up of a population and project future growth trends.

The **Demographic Transition** describes the transition of a country's population as it moves from a developing country to a developed country.

The **pre-industrial stage** is characterized by high birth rates and high death rates. This results in a stable population size.

During the **transitional stage** the death rate begins to drop with the advent of better food, medicine, and working conditions. Cultural traditions maintain a high birth rate and the population begins to grow rapidly.

During the **industrial stage** the birth rate begins to drop. The population continues to rise as the birth rate and death rate are still separated.

The **post-industrial** stage is characterized by the stabilization of population growth as the birth rates and death rates begin to come together again.

The question of whether or not the human population can, or should, be slowed down is often controversial. Because of our ability to innovate and problem solve it is very difficult to estimate what the carrying capacity of the human population is. The following steps could curb population growth:

1. Provide more educational and employment opportunities for women. Women in the workforce are much less likely to have large families.

2. Provide education about family planning options.

3. Some countries have initiated campaigns to educate its citizens about the benefits of smaller families. Others have initiated financial penalties on large families and financial incentives for small families.

Population Review Questions

1. The population change in a particular year can be calculated by

A) (deaths + emigration) * 1000

B) (births + immigration) - (deaths + emigration)

C) (deaths + immigration) + 1000

D) births - (deaths + immigration)

E) (emigration + immigration)/ (deaths – births)

2. Which of the following would contribute the greatest number of individuals to the population in one year?

A) a country of 1.5 million people with a growth rate of 3%

B) a country of 5 million people with a growth rate of 2.5%

C) a country of 100 million people with a growth rate of 2%

D) a country of 500 million people with a growth rate of 1.5%

E) a country of 50,000 with an annual growth rate of 1.5%

3.   Rapidly growing countries have an age- structure diagram that

A) forms an inverted pyramid.

B) has a broad-based pyramid.

C) shows little variation in population by age.

D) has a large population of senior citizens

E) Has an even number of individuals in each age group

4. During demographic transitions, birth rates of a population are high during the

A) Pre-industrial and industrial stages.

B) Post-industrial and transitional stages.

C) Industrial and postindustrial stages.

D) Pre-industrial and transitional stages.

E) Post-industrial stage only.
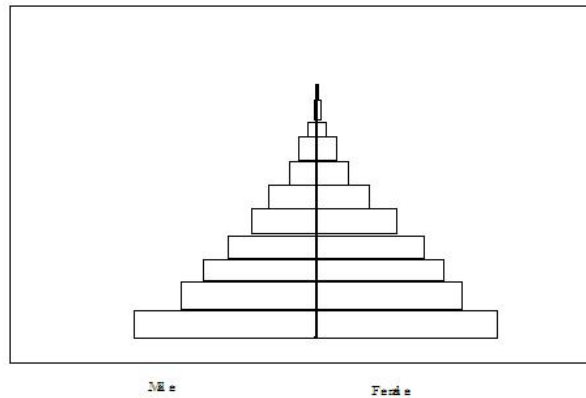
Human Population Growth

Population size

Time
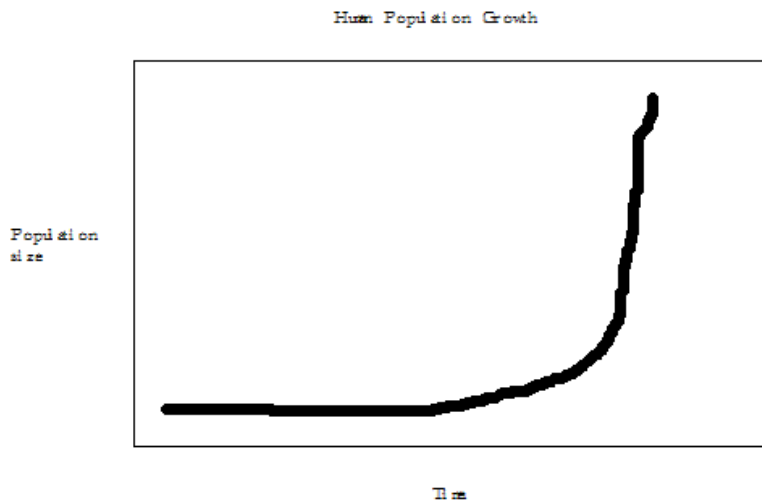
5. The type of growth shown above is said to be

A) Sigmoidal

B) Logistic

C) Exponential

D) Linear

E) Late-loss

Use the following graph to answer questions 6 and 7

6. 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

7. 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
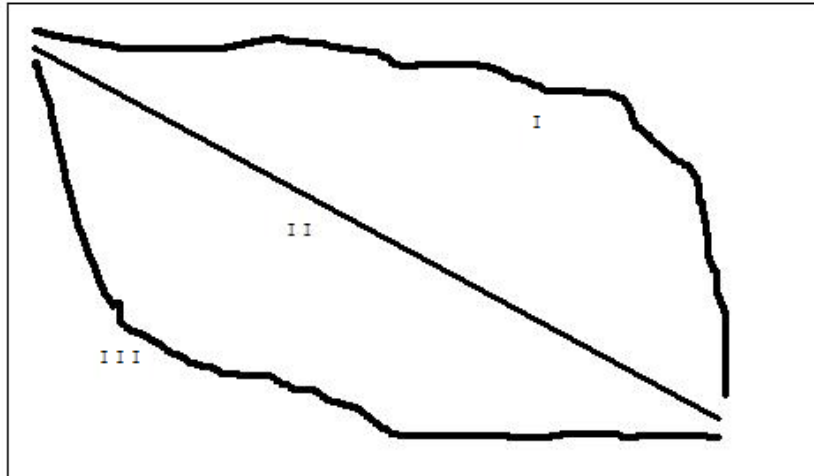
8. In the graph above, the human population would be best represented by which survivorship curve?

A) I

B) II

C) III

D) I and III

E) II and III

9. 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

10. Which of the following are characteristics of generalist species?

I. Utilizes multiple food sources

II. Thrives in a wide range of habitats

III. Very prone to extinction

A) I only

B) II only

C) III only

D) I and II only

E) I and III only

11. Which of the following is a density-dependent limiting factor?

I. Fire

II. Food

III. Disease

IV. Natural Disaster

A) I only

B) II only

C) III only

D) I and II only

E) II and III only

12. Which of the following describes the average number of children per woman in a given country?

A) Replacement level fertility

B) Infant mortality

C) Crude birth rate

D) Total fertility rate

E) Per capita rate

13. If a country has a population growth rate of 5% approximately how many years will that countries population take to double in size?

A) 2 years

B) 5 years

C) 15 years

D) 35 years

E) 50 years

Free Response

1. Living organisms employ different reproductive strategies to ensure that their species is successful.

A. Identify two characteristics of K-Strategists.

B. Identify two characteristics of R-Strategists.

C. Is the population size of R-Strategists, or K-Strategists more likely to fluctuate wildly above and below carrying capacity?
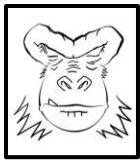
Multiple Choice Scoring Guidelines

1. B	6. A	11. E
2. D	7. B	12. D
3. B	8. A	13. C
4. D	9. D	
5. C	10. D	

Free Response Scoring Guidelines

1.A. (2pts total) 1 point for each correctly identified characteristic of a k-strategist. Possible answers include:

Specialist species	Large offspring
Good parental care	Long gestation periods
Small number of offspring	Population size hovers near carrying capacity

1.B. (2pts total) 1 point for each correctly identified characteristic of an r-strategist. Possible answers include:

Generalist species	Small offspring
Little or no parental care	Short gestation periods
Large number of offspring	Population size fluctuates wildly

1.C. (1pt total) Point is earned for correctly describing that the population size of R-strategists is more likely to have large fluctuations compared to k-strategist whose populations are more likely to stabilize near carrying capacity.

Multiple choice points earned + Free response points earned / 18 * 100= Quiz average

(_____ + _____) / 18 * 100 = _____ Quiz Grade