INTRODUCTION TO POPULATIONS AND HUMAN POPULATION

- **Population** - A population is a group of individuals of the same species living in the same area or interbreeding and sharing genetic information.
- **Species** - all individuals that are capable of interbreeding, and so a species is composed of one or more populations.

- **Demography**: The statistical study of populations, allows predictions to be made about how a population will change
- **Population dynamics**: the general study of population changes.

Five key properties of any population are;

- **abundance-size**
- **birth rates**
- **death rates**
- **growth rates**
- **age structure**

- how rapidly a population's abundance changes over time depends on its **growth rate**, which is the difference between the **birth rate** and the **death rate**.

- The three rates—birth, death, and growth—are usually expressed as a percentage of a population per unit of time. For people, the unit of time is typically a year or greater. Sometimes these rates are expressed as actual numbers within a population during a specified time.

Density and Distribution of Populations

- **Population Density** - Number of individuals per unit area or volume.
- **Population Distribution** - Pattern of dispersal of individuals within the area of interest.

Characteristics of Populations

- Size: **number of individuals in an area**
    - Growth Rate:
        - Birth Rate (natality) - Death Rate (mortality)
        - How many individuals are born vs. how many die
        - Birth rate (b) − death rate (d) = rate of natural increase (r)

- Density: **measurement of population per unit area or unit volume**
    - Population Density = # of individuals ÷ unit of space

- Dispersion: **describes the spacing of organisms relative to each other**
    - Clumped
    - Uniform
    - Random

How Do Populations Grow?

Idealized models describe two kinds of population growth:

1. **Exponential Growth**

2. **Logistic Growth**

- Exponential growth occurs when a population increases by a fixed percentage each year.

- Exponential growth occurs in nature only when the starting population is small & the environmental conditions are ideal.
- This type of growth usually does not last long. Most populations are constrained by limiting factors.

- A J-shaped growth curve, described by the equation $G = rN$, is typical of exponential growth
  - G = the population growth rate
  - r = the intrinsic rate of increase, or an organism's maximum capacity to reproduce
  - N = the population size

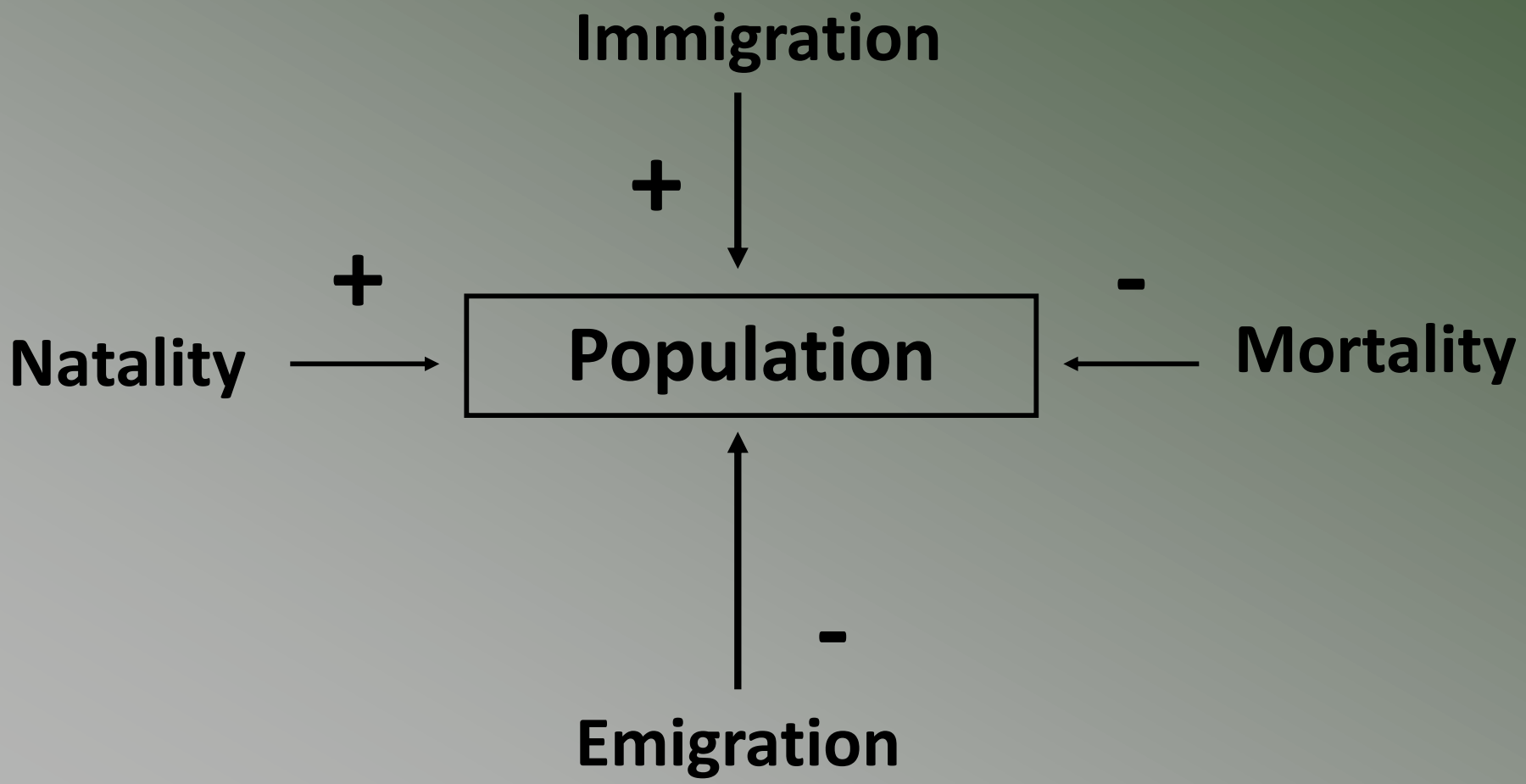
Logistic Growth

- **Logistic growth—indicated by an S-shaped curve**
- **Difference between logistic and exponential due to environmental resistance**

How Do You Affect Density?

1. **Immigration**: movement of individuals into a population
2. **Emigration**: movement of individuals out of a population
3. **Density-dependent factors**: Biotic factors in the environment that have an increasing effect as population size increases (disease, competition, parasites)
4. **Density-independent factors**: Abiotic factors in the environment that affect populations regardless of their density (temperature, weather)

Factors That Affect Future Population Growth



Density Dependent Factors

1. Competition
   - ↗ Intraspecific
   - ↗ Interspecific
2. Predation
3. Parasitism
4. Disease

Density Independent Factors

1. Abiotic factors

2. Unpredictable, catastrophic events

Carrying Capacity

- **Carrying Capacity is the maximum number of individuals of a given species the environment can support.**
  - **The closer the population to the carrying capacity, the greater the environmental resistance.**
    - **Biotic potential is having full effect and birthrate is a maximum during exponential growth.**

Factors Limiting Growth Rate

Declining birth rate or increasing death rate are caused by several factors including:

- Limited food supply
- The buildup of toxic wastes
- Increased disease
- Predation

Life **History** Patterns

- *r* - Strategists (Opportunistic)

Remember r=reproduction

- *k* - Strategists (Equilibrium)

Remember k=Karrying kapacity

- R Strategists
  - Short life span
  - Small body size
  - Reproduce quickly
  - Have many young
  - Little parental care
  - Ex: cockroaches, weeds, bacteria

- **K Strategists**
  - **Long life span**
  - **Large body size**
  - **Reproduce slowly**
  - **Have few young**
  - **Provides parental care**
  - **Ex: humans, elephants**

Age Structure

For long-lived organisms like ourselves, environmental factors like supply of food, water, and shelter; the prevalence of diseases have different effects on different age groups, and so the next step is to find a way to express how a population is divided among ages.

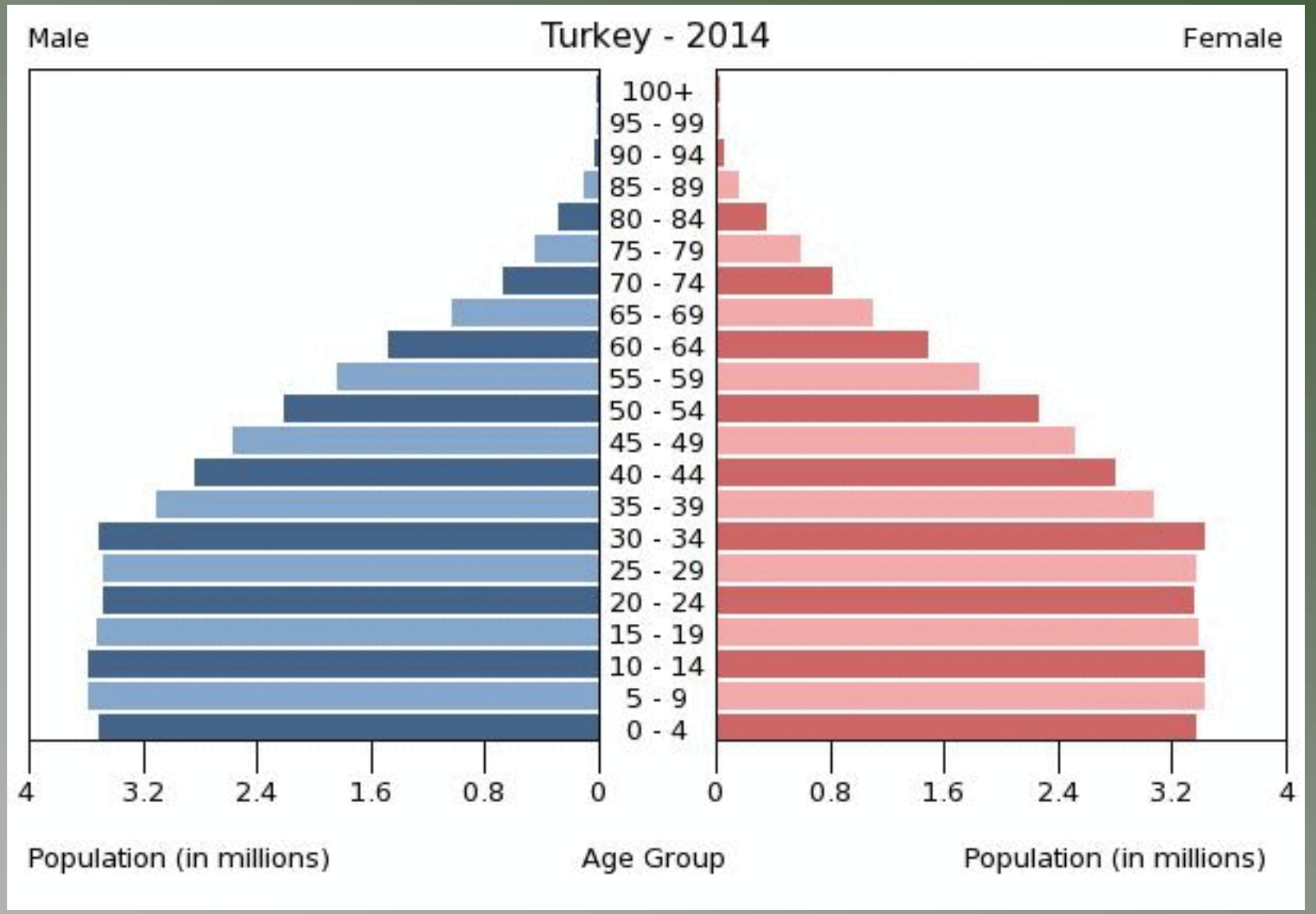
- The age structure of a population affects current and future
  - birth rates,
  - death rates, and
  - growth rates;
- has an impact on the environment; and has implications

for current and future social and economic conditions.

Age Distribution

- Distribution of males and females in each age group of a population
- Used to predict future population growth
- What proportion of population is in each cohort?
- Age Structure Diagrams

- **Age Structure Diagrams divide populations into three age groups.**
  - **Pre-Reproductive**
  - **Reproductive**
  - **Post-Reproductive**



Source: [CIA World Factbook](#) - This page was last updated on June 30, 2015

Although age structures can take many shapes, four general types are most important to: a pyramid, a column, an inverted pyramid (top-heavy), and a column with a bulge.

- **The pyramid age structure** occurs in a population that has many young people and a high death rate at each age—and therefore a high birth rate, characteristic of a rapidly growing population and also of a population with a relatively short average lifetime.
- **A column shape** occurs where the birth rate and death rate are low and a high percentage of the population is elderly.
- **A bulge** occurs if some event in the past caused a high birth rate or death rate for some age group but not others.
- **An inverted pyramid** occurs when a population has more older than younger people.

Longevity and Its Effect on Population Growth

- The **maximum lifetime** is the genetically determined maximum possible age to which an individual of a species can live.
- **Life expectancy** is the average number of years an individual can expect to live given the individual's present age. Technically, life expectancy is an age-specific number: Each age class within a population has its own life expectancy. For general comparison, however, we use the life expectancy at birth.

- Life expectancy is much higher in developed, more prosperous nations. Nationally, the highest life expectancy is 84 years, in the tiny nation of Macau. Life expectancy of
- Japan 82.1 years.
- Singapore, Hong Kong, Australia, Canada, France, Guernsey, Sweden, Switzerland, Israel, Anguilla, Iceland, Bermuda, Cayman Islands, New Zealand, Gibraltar, and Italy 80 years or more
- The United States 78 years.
- Turkey 78 years
- China over 73 years;
- India just over 69 years.
- Swaziland **has the lowest of all nations** at 32 years.
- The ten nations with the shortest life expectancies are all in Africa. Not surprisingly, there is a relationship between per capita income and life expectancy.

- **An ACUTE DISEASE or EPIDEMIC DISEASE appears rapidly in the population, affects a comparatively large percentage of it, and then declines or almost disappears for a while, only to reappear later. Epidemic diseases typically are rare but have occasional outbreaks during which a large proportion of the population is infected.**

- **A CHRONIC DISEASE, in contrast, is always present in a population, typically occurring in a relatively small but relatively constant percentage of the population. Heart disease, cancer, and stroke are examples.**

The Human Population's Effects on the Earth

- **The danger that the human population poses to the environment is the result of two factors: the number of people and the environmental impact of each person.**

- When there were few people on Earth and limited technology, the human impact was primarily local.
- Human impact on Earth started with the use of fire to clear land, and it continued, new research shows, with large effects on the environment by early civilizations.

- The problem now is that there are so many people and our technologies are so powerful that our effects on the environment are even **more global and significant**.
- This could cause a negative feedback—the more people, the worse the environment; the worse the environment, the fewer people.

- Before the invention of chlorofluorocarbons (CFCs), which are used as propellants in spray cans and as coolants in refrigerators and air conditioners, we were not causing depletion of the ozone layer in the upper atmosphere.
- Before we started driving automobiles, there was much less demand for steel, little demand for oil, and much less air pollution.

The Human Carrying Capacity of Earth

- What is the HUMAN CARRYING CAPACITY of Earth—that is, how many people can live on Earth at the same time?
- The answer depends on what quality of life people desire and are willing to accept.

- Limiting factors can be group as
- **short-term factors** that affect a population during the year in which they become limiting
- **intermediate-term factors** those whose effects are apparent after one year but before ten years
- and **long-term factors** those whose effects are not apparent for ten years.

- Some factors fit into more than one category, having, say, both short-term and intermediate-term effects.

- An important short-term factor is the disruption of food distribution in a country, commonly caused by drought or by a shortage of energy for transporting food.
- Intermediate-term factors include desertification; dispersal of certain pollutants, such as toxic metals, into waters and fisheries; disruption in the supply of nonrenewable resources, such as rare metals used in making steel alloys for transportation machinery; and a decrease in the supply of firewood or other fuels for heating and cooking.

- Long-term factors include soil erosion, a decline in groundwater supplies, and climate change. A decline in resources available per person suggests that we may already have exceeded Earth’s long-term human carrying capacity.

- Estimating the human carrying capacity of Earth has typically involved three methods.

- **One method**, which we have already discussed, is to simply extrapolate from past growth, assuming that the population will follow an S-shaped logistic growth curve and gradually level off.

- The second method can be referred to as the packing problem approach.
  - how many people might be packed onto Earth, not taking into sufficient account the need for land and oceans to provide food, water, energy, construction materials, the need to maintain biological diversity, and the human need for scenic beauty. This approach, which could also be called the standing-room-only approach, has led to very high estimates of the total number of people that might occupy Earth—as many as 50 billion.

- Third method (a philosophical movement) makes sustaining the biosphere the primary moral imperative. Its proponents argue that the whole Earth is necessary to sustain life, and therefore **everything else must be sacrificed to the goal of sustaining the biosphere**. People are considered active agents of destruction of the biosphere, and therefore the total number of people should be greatly reduced. Estimates based on this rationale for the desirable number of people vary greatly, from a few million up.

- In summary, the acceptable carrying capacity is not simply a scientific issue; it is an issue combining science and values, within which science plays two roles.
- First, by leading to new knowledge, which in turn leads to new technology, it makes possible both a greater impact per individual on Earth's resources and a higher density of human beings.
- Second, scientific methods can be used to forecast a probable carrying capacity once a goal for the average quality of life, in terms of human values, is chosen. In this second use, science can tell us the implications of our value judgments, but it cannot provide those value judgments.

Can We Achieve Zero Population Growth?

- A condition in which the human population, on average, neither increases nor decreases? Much of environmental concern has focused on how to lower the human birth rate and decrease our population growth. As with any long-lived animal population, our species could take several possible approaches to achieving zero population growth.

Age of First Childbearing

- The simplest and one of the most effective means of slowing population growth is to delay the age of first childbearing. As more women enter the workforce and as education levels and standards of living rise, this delay occurs naturally. Social pressures that lead to deferred marriage and childbearing can also be effective.

- Typically, countries where early marriage is common have high population growth rates. In South Asia and in Sub-Saharan Africa, about 50% of women marry between the ages of 15 and 19, and in Bangladesh women marry on average at age 16. In Sri Lanka, however, the average age for marriage is 25. The World Bank estimates that if Bangladesh adopted Sri Lanka's marriage pattern, families could average 2.2 fewer children. For many countries, raising the marriage age could account for 40–50% of the drop in fertility required to achieve zero population growth.

Birth Control: Biological and Societal

- Another simple way to lower the birth rate is breast feeding, which can delay resumption of ovulation after childbirth.

- Family planning is still emphasized, however. Traditional methods range from abstinence to the use of natural agents to induced sterility.
- Modern methods include the birth-control pill, which prevents ovulation through control of hormone levels; surgical techniques for permanent sterility; and mechanical devices.
- Abortion is also widespread and is one of the most important birth-control methods in terms of its effects on birth rates—approximately 46 million abortions are performed each year. However, although now medically safe in most cases, abortion is one of the most controversial methods from a moral perspective.

National Programs to Reduce Birth Rates

- Reducing birth rates requires a change in attitude, knowledge of the means of birth control, and the ability to afford these means. As we have seen, a change in attitude can occur simply with a rise in the standard of living.

- In many countries, however, it has been necessary to provide formal family-planning programs to explain the problems arising from rapid population growth and to describe the ways that individuals will benefit from reduced population growth. These programs also provide information about birth-control methods and provide access to these methods.

- The first country to adopt an official population policy was India in 1952. Few developing countries had official family-planning programs before 1965. Since 1965, many such programs have been introduced, and the World Bank has lent $4.2 billion to more than 80 countries to support “reproductive” health projects. Although most countries now have some kind of family planning program, effectiveness varies greatly.

- A wide range of approaches have been used, from simply providing more information to promoting and providing means for birth control, offering rewards, and imposing penalties. Penalties usually take the form of taxes. Ghana, Malaysia, Pakistan, Singapore, and the Philippines have used a combination of methods, including limits on tax allowances for children and on maternity benefits. Singapore does not take family size into account in allocating government-built housing, so larger families are more crowded. Singapore also gives higher priority in school admission to children from smaller families. Some countries, including Bangladesh, India, and Sri Lanka, have paid people to be voluntarily sterilized. In Sri Lanka, this practice has applied only to families with two children, and only when a voluntary statement of consent is signed.

History of the Human Population

- **Doubled three times in the last three centuries**
- **About 6.1 billion and may reach 9.3 billion by the year 2050**
- **Improved health and technology have lowered death rates**

- Human population has had an exponential growth pattern.
  - Doubling time currently estimated at 53 years.
- Population Size
  - 1800 1 Billion
  - 1930 2 Billion
  - 1960 3 Billion
  - 2000 6 Billion