Parent Background Information

Human Population Growth & Global Ecosystems

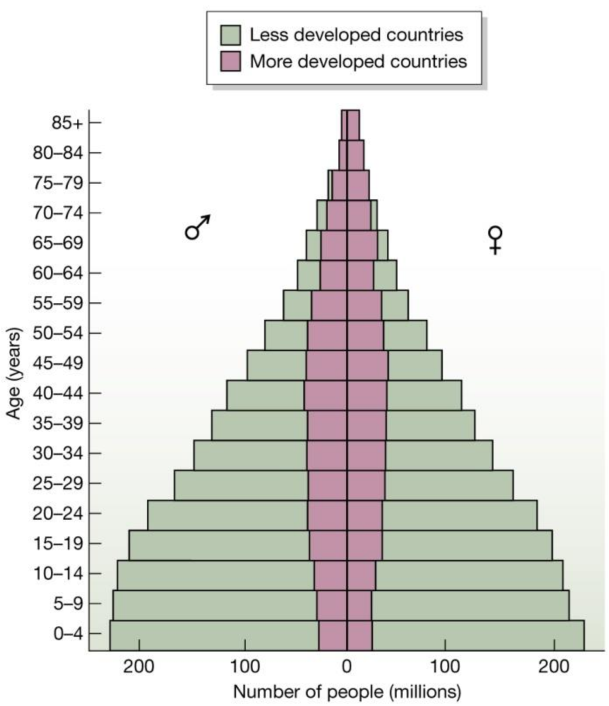
Understanding how human population growth effects ecosystems requires a basic understanding of population ecology. Population ecologists seek to understand how populations change in their *size, density, distribution* and *age structure* over time.

A *population* is a group of individuals that belong to the same species. The *size* of a population refers to the number of individuals in the population. Even when counting individuals is relatively straight forward, as in the case of a large mammal, the task of rounding up all the individuals in a population in order to count them can be difficult. It is, therefore, common for population ecologists to estimate the size of a population using an abundance (i.e. size) index. One such method for estimating the size of wild populations is called the *Mark-recapture Method* or *Lincoln-Peterson Index*. A demographer studying the size of a human population would typically use a census.

A population's *distribution* can be described as *random, regular, or aggregated.* Most organisms live in clumps. This is true for a variety of reasons, including protection from predators, increased chance of catching prey, living close to resources and availability of potential mates. Evenly and randomly distributed populations are relatively rare.

A population's *age structure* refers to the distribution of males and females at a given age in the group. This information can be used to ascertain a population's health (i.e. is it growing or declining) and make predictions about a population's future growth. For example, a population with a large number of individuals in the pre-reproductive age range can be expected to increase in size.

Age Structure Diagram



Populations cannot grow indefinitely. At some point a population will face environmental resistance to its growth. Some of these *limiting factors* are *density dependent*, e.g. food shortage, competition, and disease. Other limiting factors are *density independent*, e.g. hurricane, drought, forest fire. All ecosystems have a *carrying capacity* (K) that limits the size of populations (N). Carrying capacity is defined as the maximum number of individuals an ecosystem can support. A population reaches an ecosystems carrying capacity when the number of births is equal to the number of deaths.

The human population is undergoing *exponential growth*. As the population grows it extracts increasing amounts of resources from global ecosystems. Often, extracting resources from an ecosystem degrades the ecosystem. In addition to threatening the integrity of the ecosystem itself, ecosystem degradation threatens our ability to continue extracting the resources we need to survive. Some of the resources we need, e.g. oil and ore are non-renewable, and others e.g. lumber and light are renewable. Renewable resources can be used indefinitely as long as they are managed well and used in a sustainable manner. Non-renewable resources have a limited life-span and will have to be recycled or their use phased out.

The Quality of Human Life & Environmental Impact

Economic growth increases the availability of goods and services. *GDP (gross domestic product)* is used to measure *economic growth*. Increases in GDP (i.e. economic growth) can be brought about through *population growth*, increasing *production,* and increasing *consumption*.

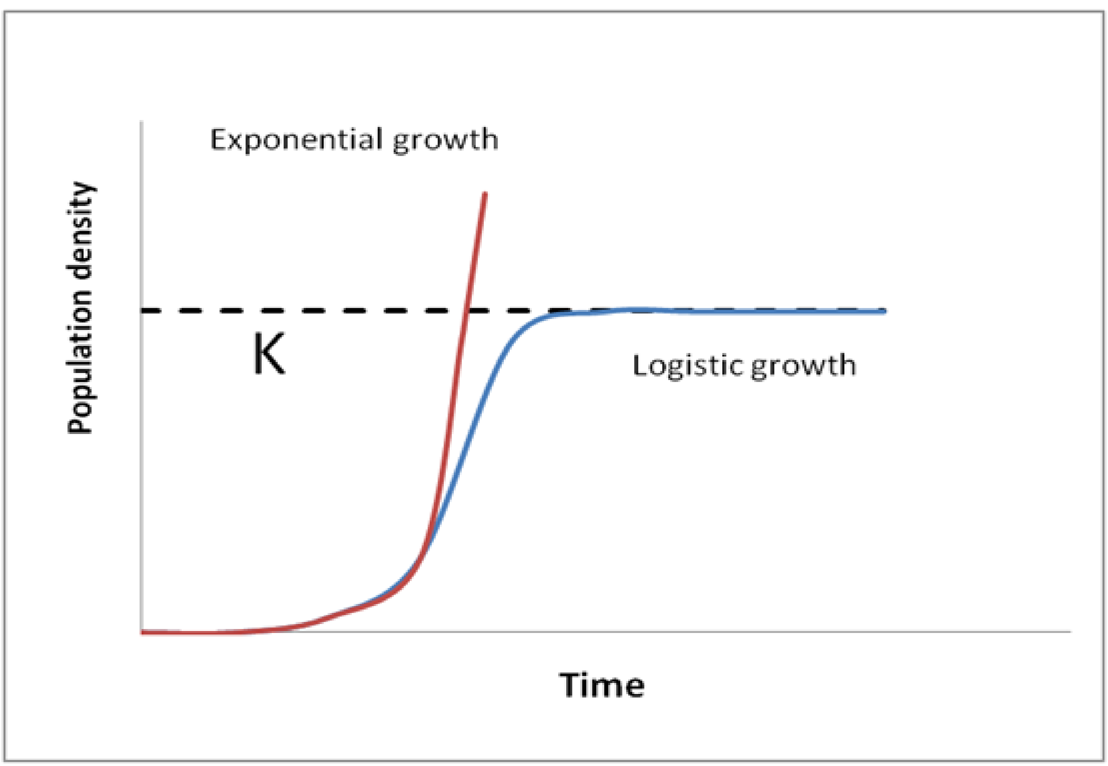
Economic development is the improvement of ***lifestyle*** (i.e. quality of life) brought about by economic growth. *GDP per capita* can be used to measure *economic development*. To calculate GDP per capita simply divide GDP by the size of the population. For example, in 2016 U.S. GDP was ~18.5 trillion dollars. If we divide GDP (18.5 trillion dollars) by the size of the U.S. population in 2016 (~319 million) the GDP per capita was about $58,000 dollars.

Improvements in quality of life are associated with increases in per capita GDP, and an increase in per capita GDP is associated with increased consumption. The lifestyle of U.S. citizens is characterized high levels of consumption. This, in turn, is associated with high levels of resource and energy use. It is interesting to note that the U.S. constitutes about 5% of the world's population and is responsible for about 25% of the world's resource and energy use.

Economic growth and development always happen in an environmental context. Improvements in our quality of life cannot be considered in a vacuum. Environmental integrity has to be considered along with issues pertaining to our quality of life. For example, we cannot consider something an improvement in our quality of life if it threatens the integrity of the environment on which we depend. This necessarily involves trade-offs and compromise. We have to address quality of life issues (infrastructure, healthcare, food, etc.) and environmental issues (habitat destruction, climate change, sustainable agriculture, etc.) simultaneously.

Patterns of Population Growth & the Demographic Transition in Developing & Developed Countries

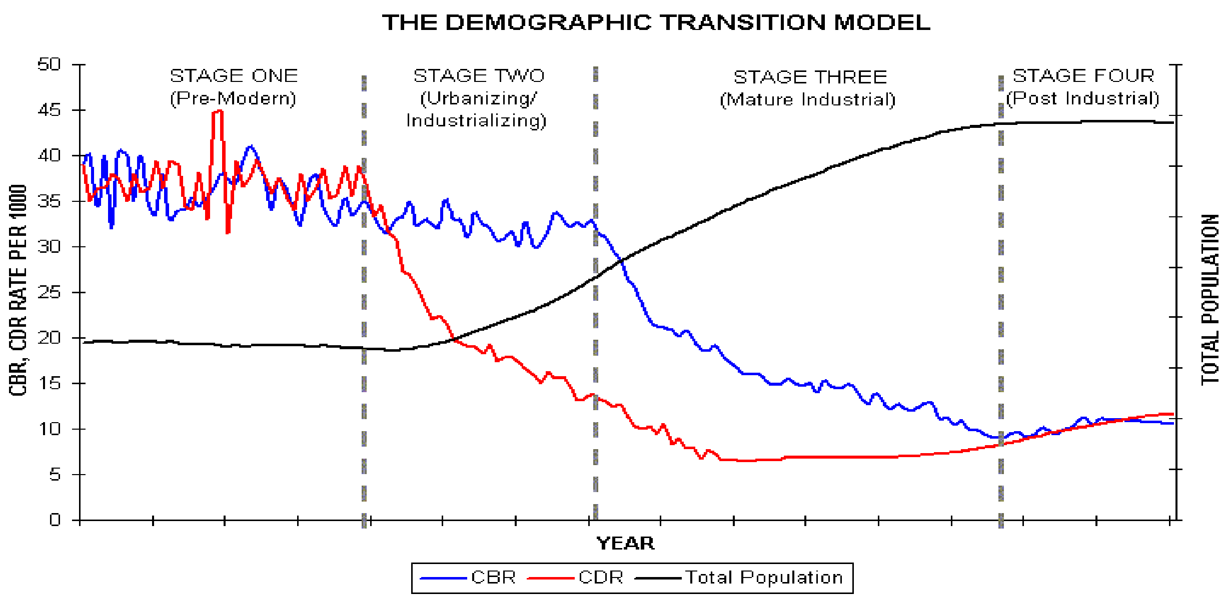
Population growth is typically described using 3 different models: *linear, exponential, and logistical*. The following are examples of each model.



Exponential growth occurs when a population's growth rate increases in proportion to the population's size (As the population grows, its growth rate – the number of organisms added each generation – increases.). *Logistical growth* occurs when a population's growth rate decreases as the population's size approaches the carrying capacity of its ecosystem.

Countries can be classified as developed or as developing. Developed countries typically have low - no population growth, diverse industrial economies and high per capita GDP. Developing countries are characterized by rapid population growth, agrarian economies and low per capita GDP.

The demographic transition is a model used to describe the development of a country. Traditionally the demographic transition is divided into 4 stages: pre-industrial, transitional, industrial, and post-industrial. A country in the pre-industrial stage of development is characterized by high birth and death rates and zero population growth (ZPG). In the transitional stage death rates fall, birth rates remain high and the population grows exponentially. During the industrial stage birth rates fall to the level of death rates the growth rate returns to ZPG. Finally, in the post-industrial stage birth rates fall below death rates, population growth becomes negative and the population begins to shrink in size.



Human Innovation & Environmental Impact

Human innovation has the potential to mitigate or to amplify our environmental impact. For example, techniques developed during the agricultural and green revolutions (e.g. fertilizers, pesticides, hydroponics) have allowed us to produce more food on fewer acres of land. This decreased the amount of habitat destruction required to grow food. However, some of the techniques that have allowed us to increase food production are considered unsustainable having also led to soil loss and degradation. Modern farming equipment is provides an instructive example. Although machines have made it possible to cultivate more acres of land in a shorter period of time than ever before, indiscriminate use of such technology led to the United States' Dust Bowl in the 1930's and to the current Dust Bowl like conditions in parts of China. Implementation of new technology must always be considered in an environmental context and efforts must continually be made to monitor the environmental consequences of our innovations.

Being Green & Sustainability

Merriam-Webster defines being 'green' in the following way:

> 10 ***a*** *often capitalized***:** relating to or being an environmentalist political movement ***b*:** concerned with or supporting environmentalism <*green consumers who practice recycling*> ***c*:** tending to preserve environmental quality (as by being recyclable, biodegradable, or nonpolluting) <*greener energy solutions*>

One can see from the above statements that there is a positive correlation between being green and sustainability. Living sustainably means that one does not take more of a potentially renewable resource from an ecosystem than the ecosystem can naturally replenish. Sustainable living also entails not overwhelming an ecosystems capacity to cleanse and renew itself through natural processes. An ecological footprint is a common measure used to determine if an individual's lifestyle is sustainable or 'green.' One's ecological footprint refers to the amount of biologically productive land and water required to provide the renewable resources one uses and dispose of one's waste. A 'green' individual lives a sustainable lifestyle and has a relatively small ecological footprint.

Internet Resources:

- Khan Academy
- Bozeman Science