

Human Population Demography

Objectives:

1. Understand age structure diagrams.
2. Learn terms used in discussion of demography.

Concepts: Age distribution or age structure has affects on future population growth in many ways. The age structure of a population affects fertility rate and mortality rate and, thus, growth rates.

Models in Biology: Models have a long history in biology. Models are simplifications of complex systems or problems that allow us to focus on the most important variables. This focus on important variables helps us understand how changes in these variables will affect the system. Some models are verbal or graphical models while others models are mathematical in nature. Both types of models require making assumptions to simplify the complex system into something that can be described verbally, graphically, or mathematically (i.e., written down as an equation or set of equations). Such simplifications help us understand complex situations and allow us to make predictions about what may happen in the future.

Population growth is one areas of biology that has a rich history of mathematical models. You will be introduced to some of these in lecture. The simplest model of this type describes population growth in terms of births and deaths, but ignores other factors such as age structure (differences in fertility and mortality due to age) or the movement of individuals into or out of the population (immigration or emigration). The somewhat more complex model on which DemographyLab, the simulation program you will use today, is based is called the Leslie Matrix Model or the Euler Model. This particular model assumes, among other things, that the population is divided into age classes that vary from one another in important “vital rates,” such as mortality or births. One of the strengths of this model is that it allows us to predict population size and to predict if and when population size will continue to increase, level off, or even decline.

Introduction: In lab this week, you will learn how to navigate and use a program called DemographyLab to make projections about population growth of different countries. Then you will use this program to compare population growth of two countries and make predictions about their future. You will also be asked to consider some of the possible social and environmental consequences of these predictions or projections.

To start the lab:

1. Log on to: www.biologylabsonline.com Choose “DemographyLab.” Choose “Start Lab.”
2. Once the Java applet has loaded: on the left portion of the screen you will see a 'drop-down' menu where you can choose any of seven different countries. Below that, you will see choices of four different types of demographic data - **population size, population structure, fertility rate, mortality rate.**

Certain operations will remove you from this window. You can always click on “return to lab” button in the upper left corner of those other windows to get back to this original window.

3. Answer the questions below to help familiarize yourself with these four kinds of data and the program itself. Each term is defined in the program, so will not be defined here.

Population size: You can look at current and predicted population sizes for all 7 countries by clicking on "population size" and choosing the country from the drop-down or pull-down menu. You can choose 100, 200, or 300 year predictions.

- a. What is the population size of the U.S.A in 1998?
- b. What is the predicted population size of the U.S.A. in 2098? (pick 100 years and click on 'run')
- c. What is the total fertility rate used to calculate the population in 100 years?
- d. What is the predicted population after 200 years?
- e. What is the total fertility rate used to predict the population in 200 years?
- f. What, then, is one assumption of this model?

Population structure (what your text may call an 'age structure diagram')

Click on "population structure" to see such as diagram, and read the associated description. The population structure is represented as a series of two bar graphs that are on their sides, one for males and one for females. Male and female mortality rates differ, so there are differing percentages of 5 year cohorts of males and females alive at any one time. *Note: if you put the cursor over the end of the bar, you will see the actual number.* Because the graphs are small, they are sometimes difficult to read. This feature makes it a bit easier. Most of the graphs in this program will work this way.

Answer these questions for the U.S. population.

- a. What percentage of the male population is over 85 years old?
- b. What percentage of the female population is over 85 years old?
- c. Can you see the "baby boom?" In what ages is it most visible?

Fertility rate: You can compare fertility rates for each country.

- a. For the U.S., what age cohort has the highest fertility rate, and what is the fertility rate? Be sure to record the correct units here and below; these are described beside the graph.
- b. For Sweden, what age cohort has the highest fertility rate, and what is it?
- c. For Nigeria, what age cohort has the highest fertility rate and what is it?
- d. For China, what age cohort has the highest fertility rate and what is it?
- e. For Japan, what age cohort has the highest fertility rate and what is it?
- f. Based on the graphs, what age groups or classes are considered "reproductive age?"

Mortality rate: Mortality rates in this program are reported on separate graphs for males and females. To switch from male to female data just click the button at the bottom for the sex you want to view.

- a. For the U.S., what are the mortality rates of males and females under 5 years old? Make sure you use the correct units in this section also.
- b. For Sweden, what are the mortality rates of males and females under 5 years old?
- c. For Nigeria, what are the mortality rates of males and females under 5 years old?
- d. For China, what are the mortality rates of males and females under 5 years old?
- e. For Japan, what are the mortality rates of males and females under 5 years old?
- f. Are there any trends among countries for this statistic?

Now let's look at Population Structures again. To answer the questions below, make sure you have chosen the United States for the country and then click on "Population structure," so that one shows up. Click on "run." (You may want to change the scale to get a more precise view of the structure.) Click on "time series" for a graph of the predicted growth in 10-year increments. Click on "population structure" on the top tab. Here it allows you to see predictions in 5-year increments. The total population size is listed at the top and the population structure changes for every 5 years as well. For every five years you advance the time, it will give the population size and the population structure.

- a. Does population structure change over time or remain stable?
- b. When does the predicted growth of the U.S. start to decline?
- c. The predicted U.S. population will peak at _____ in the year _____.
- d. What will the population be in the U.S. when you retire? Follow your age cohort over the years.
- e. What does the population structure have to do with the probability of you receiving a Social Security check when you retire in about fifty years?
- f. Now use the CIA World Factbook (<https://www.cia.gov/library/publications/the-world-factbook/>) to look up the following information for the United States: Current Population Size (2004), Median Age, HIV/AIDS Adult Prevalence, GDP per capita, Oil Consumption, Area (land only). What do these statistics have to do with population growth?

To obtain the requested information use the url above to access the website. Once the site loads you will see a pull-down menu in which you can choose a country. Choose Japan or Nigeria and then click on the choice "People," and record the appropriate information. Then click on "Top of Page" to return to the top and then click on "Economy" to obtain the rest of the information. You will find the area under the choice "Geography."

A Study in Contrasts: Japan and Nigeria

Now that you know how to navigate the program, you will use the program to make a more in depth comparison of two countries, Japan and Nigeria. These countries were selected because they currently are very similar in population size but have many differences that may affect population growth. In addition, these countries face different expectations for population growth and potential problems due to their differing population structures.

Before continuing, use the World Atlas website (http://go.hrw.com/atlas/norm_hm/world.htm) to find the location of each country. Describe their locations below.

Japan:

Nigeria:

Using DemographyLab answer the following questions.

- a. What was the population size of Japan in 1998?
- b. What was the population size of Nigeria in 1998?
- c. Now look at population age structure of each of these countries. How are they different? (Draw a simple figure to represent the age structure of each country as part of your answer.)
- d. Based on these population structures, do you expect the population of Japan to increase, stay the same, or decline over the next 100 years?
- e. Based on these population structures, do you expect the population of Nigeria to increase, stay the same, or decline over the next 100 years?
- f. Now use the program to project population size of both countries for 100 years. What are the projected population sizes for Japan and Nigeria in 2098? Were your expectations met? Explain. NOTE: while doing your projections, record the population size projected for 2003. You will need this later.

g. Looking at both the population structures and the projected population sizes, what social problems might each country experience in the next 100 years? Explain your reasoning.

h. Now use the CIA World Factbook (<https://www.cia.gov/library/publications/the-world-factbook/>) to look up the following information:

| Information | Japan | Nigeria |
|---------------------------|--------------|----------------|
| Current Population Size | | |
| Median Age | | |
| HIV/AIDS Adult Prevalence | | |
| GDP per capita | | |
| Oil Consumption | | |
| Area (land only) | | |

To obtain the requested information use the url above to access the website. Once the site loads you will see a pull-down menu in which you can choose a country. Choose Japan or Nigeria and then click on the choice “People,” and record the appropriate information. Then click on “Top of Page” to return to the top and then click on “Economy” to obtain the rest of the information. You will find the area under the choice “Geography.” Return to the first page and repeat the process for the other country.

i. Compare the 2003 projected population size of each country to the current estimates. Are they close? If not, what might account for any differences?

j. How does the median age of Japan compare with that of Nigeria? How is any difference evident in the population structure you looked at earlier? What affect might any differences have on future population growth?

k. How does the prevalence of HIV/AIDS in these two countries differ? What effects might these differences have on the population growth projections of the DemographyLab Model?

l. How do GDP and oil consumption differ between these two countries? Based on these two statistics, does a person in Japan or a person in Nigeria have a greater impact on the environment? How might this change as populations and economies change in these two countries?

m. How does the expected population in Nigeria in 2098 compare to the current population of China? (Use DemographyLab to get these data.) How do their land masses compare? (You may need to use the World Atlas to get this information.) If the population of Nigeria grows as much as expected, what effects might you expect to see on the environment of Nigeria?

n. You may have noted earlier that one of the assumptions of model used in DemographyLab is that fertility rates and mortality rates remain constant. How realistic are these assumptions? What factors might cause fertility or mortality rates to change?

o. Look again at the population structure of the United States. In terms of population structure and projections concerning future population growth, is the U.S. population more like Japan or Nigeria? What does this imply about future population growth in the United States?

p. Do the 100 year projection again for the U.S. Were your predictions met? Explain.