Lab Section: _____ **Name:** _____

Pre-lab Homework Lab 7: Populations

After reading over the lab, answer these questions to be turned in at the beginning of the lab!

1. Define or explain the following.

   - Demography:

   - How does Age Specific Fertility Rate differ from Total Fertility Rate (TFR)?

   - How does Mean Life Expectancy differ from Age Specific Mortality Rate?

   - Population carrying capacity:

2. Read about populations in this lab manual and in the population/population ecology chapter of your textbook. What 4 factors (hint: used to calculate actual rate of population increase) can lead to changes in the size of a population?

3. In lab today we will be using a model to predict future population numbers. Read the introduction to today's lab; what are at least 2 limitations of using models?

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Name: _____ **Date/Lab time:** _____

Lab 7: Populations

LAB SYNOPSIS:

We will cover the topic of populations, mostly of humans.

- You will use a computer simulation to model human population change over time.
- We will watch a movie that explores changing demographics and associated social factors in several human populations throughout the world.

"Today – this Day of 7 Billion – is not about one newborn, or even one generation. This is a day about our entire human family…What kind of world has baby 7 billion been born into? What kind of world do we want for our children in the future? I am one of 7 billion. You are also one of 7 billion. Together, we can be 7 billion strong – by working in solidarity for a better world for all."
-2012, Ban Ki-moon, Secretary General, United Nations

OBJECTIVES: After successfully completing this lab, a student will be able to:

- Explain the major variables that affect population size.
- Explain problems associated with rapid growth and decrease in population.
- Make social decisions based on scientific background information on populations.

Introduction:

How can we know the future? We cannot, but we can use models to help us make predictions of what the future might be like. Good models are made using good data. This data can help us make models of tomorrow's weather, election results, global warming, etc. Models help us prepare for the future like whether to wear a raincoat but they are also essential in making good policy decisions (preparation for hurricane, building schools or calculating retirement benefits). However, models are limited by the accuracy of the data and do not/cannot take into consideration unexpected events such as new technology, earthquakes or tsunamis. See table 1 next page for some of the data used in modeling human demographics.

Demography is the study of population and population statistics (usually of humans).
A **Population** is a group of organism of the same species within a defined area.

Four major factors cause change in population sizes: births, deaths, immigration (migration into an area), and emigration (migration out of an area).

The simplest models of population change are shown in Figure 1:

Exponential growth occurs when a fixed birth rate exceeds a fixed death rate. Growth becomes ever more rapid as the population gets bigger. Forms a **J-curve.**

Logistic growth occurs when growth rate slows as the population reaches **Carrying Capacity** (*K*), the maximum number of individuals the environment can sustain over time.
Forms an **S-curve.**

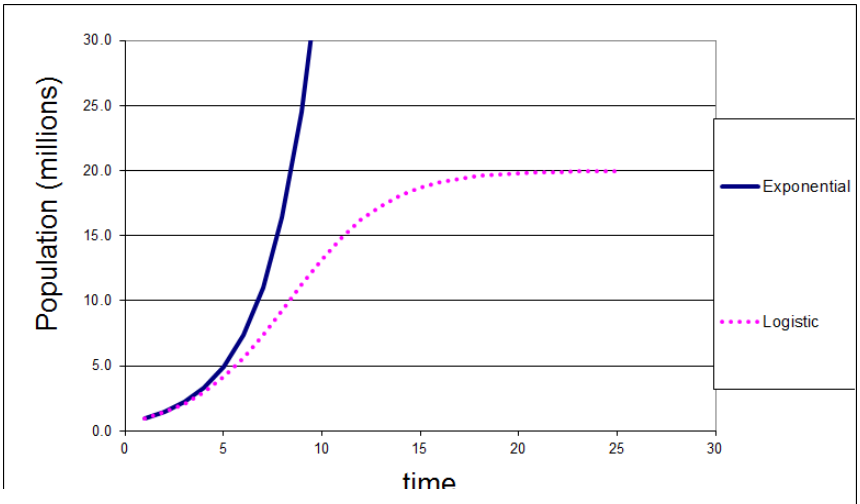


Figure 1. Exponential Growth **vs.** Logistic Growth

Both of these models are very simple. For example, they assume that birth rates and death rates are either constant or follow predictable rules. But in reality, these are influenced by many other factors. For example, think about everything that has shaped your decision on how many children to have, and when in your life to have them. Factors that influence the population models include:

Density-Dependent Factors affect the birth and death rates more when the population is larger; e.g. competition, predators, parasites, diseases, etc.

Density-Independent Factors are randomly occurring events that are not affected by population size; e.g. extreme weather events, fire, earthquakes, volcanic eruptions, asteroid impacts, etc.

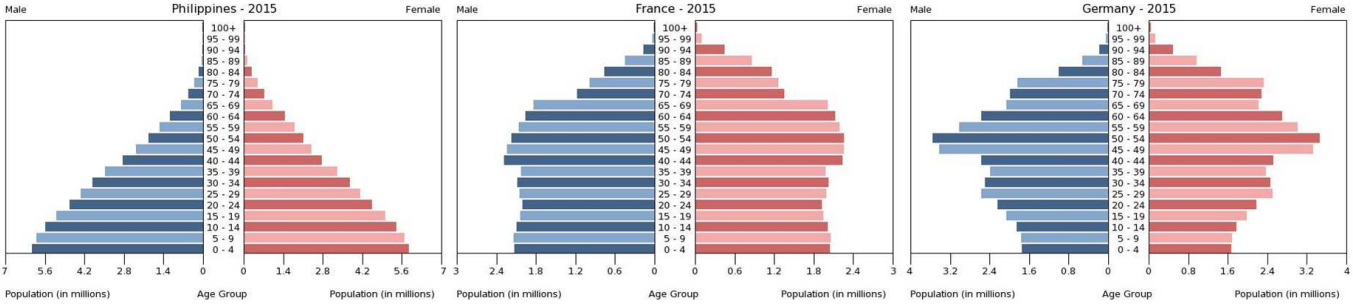
Demographers also use the following information to model human population changes more accurately:

Table 1: Data Used to Improve the Models for Human Demographics

• **Mean Life Expectancy:** How long, on average, someone is expected to live. In 1950 the USA mean life expectancy was only 68 years, now it is 78 years. (In 1950 social security benefits started at age 62. Now it still starts at 62, "early retirement")
• **Age-Specific Mortality Rate** The average chances of dying within a specific age range. For example in the USA for ages 25-34, you have a 1 in 1,865 chance of dying within the next year. But a 1 in 17 chance of dying if you are 75 to 84 years old.
• **Age-Specific Fertility Rate:** The average number of births per female during a specific age interval.
• **Total Fertility Rate (TFR):** The total number of offspring that a female would have in her whole lifetime, on average, if she lived through her reproductive years. In 1950 the US TFR was 3.6, now it is 1.8
• **Doubling Time:** The time it would take a population to double, given no changes in age-specific mortality or fertility rates. In our model, any change in the fertility or the mortality graphs will result in a change in Doubling Time. The doubling time in the US is now ~65 years. (Current US population is ~319,000,000)

A **Census** is an official count or survey of a population, is used to confirm and adjust demographic models.

Population Age Distributions (aka Population Pyramids) are a common way to visualize the age-sex structure of a population. A pyramidal shape with a broadening base indicates a rapidly growing population (fig. 2A), a house-shape indicates slowly growing to stable population (fig. 2B), and a diamond-shaped graph indicates a shrinking population (fig. 2C).



A (rapid growth) B (slow to stable) C (shrinking)

Figure 2. Population Pyramids for A. Philippines, B. France and C. Germany. Source: U.S. Census Bureau (https://www.census.gov/popclock/world)

Exercise 1: Modeling Population Growth

Now you are going to use a computer model to explore various factors affecting human population growth in detail. Working with a lab partner, open the online demography simulator at: http://bit.ly/1qdm0Ud

Part A: Population Trends in Nigeria.

Choose "Nigeria" From the "Country:" menu. Answer questions 1-6 before running the simulator:

1) What is the population of Nigeria in 2015 (in millions)? _____

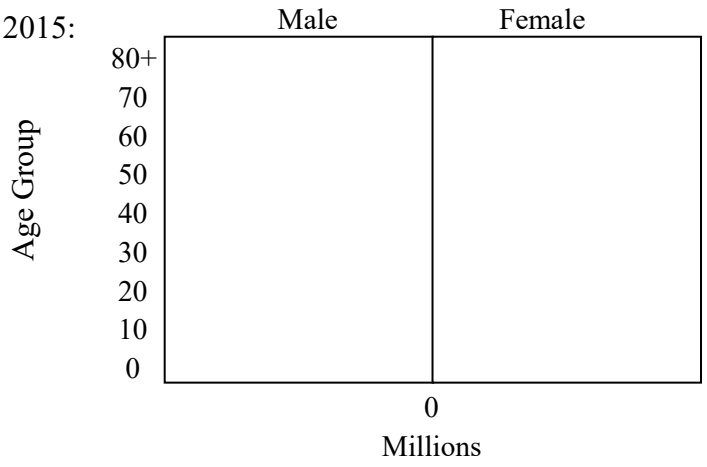
2) What is the Average Birth Rate (# of children/female) in Nigeria? _____

3) What is the Average Death Rate (% per year) in Nigeria? _____

4) Click on the box to see the age-specific death rates.
What is the death rate (%) for children ages 0-4 in Nigeria? _____

5) What is the population growth rate (% per year) in Nigeria? _____

6) Sketch the "Population by Age Group" graph in 2015:
(Label the x-axis appropriately)



Click "Run" twice to model about 100 years of rapid population growth. Then answer questions 7-11. (Note: 1000 million = 1 billion!)

7) Sketch the (simulated) growth of Nigeria's population from 2015-2100:
(Label the y-axis appropriately)

8) What is the simulated population of Nigeria in 2100, given the current birth & death rates?

9) Do you think the population in Nigeria could actually grow this large by then? Why or why not?

10) What are some problems associated with rapid population growth?

11) What are some benefits of rapid population growth?

12) What do you think the leaders in Nigeria should do to manage and/or adapt to the impending population growth?

Part B: Population Trends in Italy

Now choose "Italy" from the "Country:" menu. Answer questions 13-18 before running the simulator:

13) What is the population of Italy in 2015 (in millions)? _____

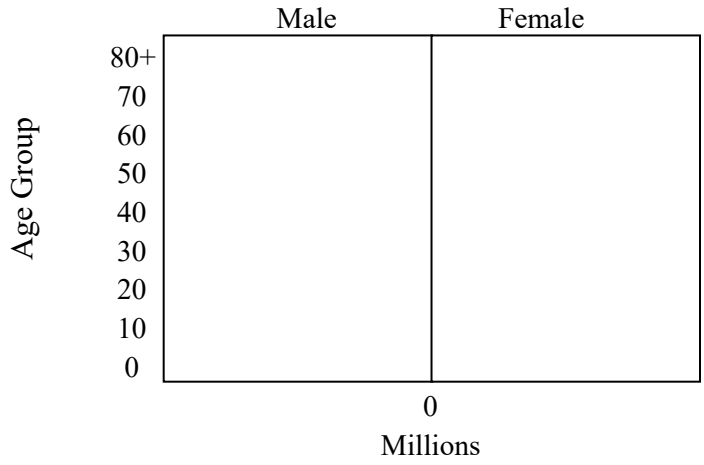
14) What is the Average Birth Rate (# of children/female) in Italy? _____

15) What is the Average Death Rate (% per year) in Italy? _____

16) Click on the death rate box to see the death rates for different age classes. What is the death rate (%) for children ages 0-4 in Italy? _____

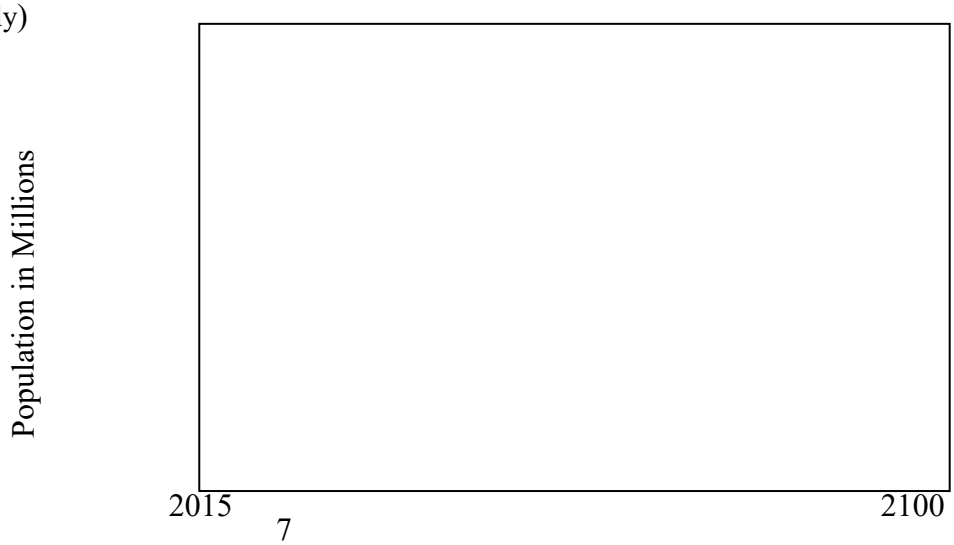
17) Why is the overall death rate in Italy so much higher than Nigeria's, when its infant & childhood mortality rates are so much lower? Hint: compare their population age distributions.

18) Sketch the "Population by Age Group" graph for Italy in 2015:
(Label the x-axis appropriately)



Click "Run" twice to model the about 100 years population shrinkage, then answer questions 19-23.

19) Sketch the (simulated) decline in Italy's population from 2015-2100:
(Label the y-axis appropriately)



20) What is the simulated population of Italy in 2100, given current birth & death rates?

21) What are some benefits of a shrinking population?

22) What are some problems caused by a shrinking population?

23) Imagine you are a leader in the *Previdenza Sociale* (the Italian Social Security System). After seeing the population projections, would you recommend that the government raise taxes, reduce benefits, raise the retirement age, and/or provide incentives to increase family size? (Note: You have already tried borrowing lots of money from other E.U. countries. That didn't work out so well. ☹)

Part C: Population Momentum

Now we are going to look at what might happen if drastic measures were taken to curb rapid population growth. Choose “Nigeria” again. Before you run the simulation, change the birth and death rates so they match those of Italy (click on the rate box, then in the pop-up window, choose "Use rates from:” and select “Italy" from the drop-down menu). This will apply much lower age-specific birth and death rates to the current population age distribution of Nigeria. This will model the effects of a massive investment in family planning and healthcare infrastructure on a very short time scale. Run the simulation until 2050 years and answer questions 24-28.

24) How did Nigeria's population change between 2015 and 2050 when birth and death rates were changed to match Italy's?

25) Wait a minute…how can the population still be increasing if the average birth rate is less than 2 children per female? (Hint: look at the age structure graph and track how it changes over time.)

26) How long will it take for the population of Nigeria to get back to its 2015 level in this scenario? (The "Step" button might be helpful here.)

27) Globally, the population age distribution is more similar to Nigeria's than Italy's. What, if anything, should people do to manage human population growth over the next 50-100 years? Do you consider this a localized problem that each country needs to solve, or is it a global concern that needs a well-coordinated global response? (Hint: there is no single right answer here, but 'have more wars' is incorrect for the purposes of this assignment.)

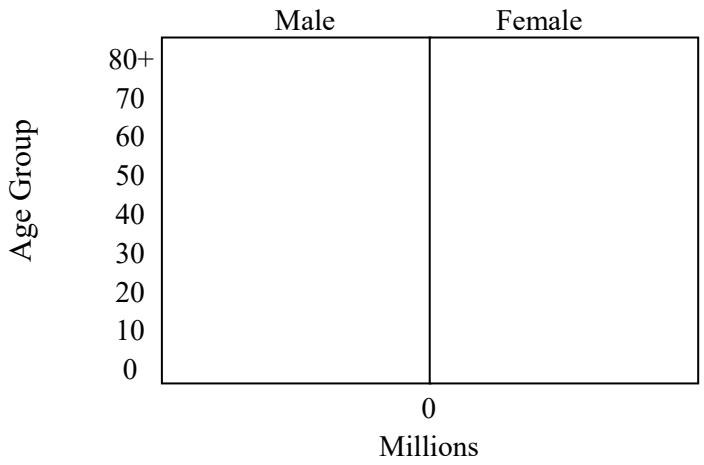
28) Developed countries like the U.S. frequently cast blame on less affluent nations like Nigeria for failing to control their birth rates. Yet we consume a disproportionately large fraction of the world's resources. Do you think affluent nations should put more effort into curbing population growth elsewhere in the world or should we focus on reducing our own resource use?

Part D: Independent Population Investigations (optional—ask your instructor)

Choose any other country from the menu and answer the following:

29) What country did you pick?

30) Sketch this country's population age structure:



31) Is this country's population growing, stable, or shrinking?

32) Describe the change(s) in age-specific birth and/or death rates needed to make the population size remain constant from 2050-2150 (and beyond). (If you country is experiencing rapid change in 2015, you may have to tweak these rates as you go…)

33) Should zero population growth be the goal of human population policies? Why or why not?

Exercise 2: Population Changes in the Real World

Video: World in the Balance: *The Population Paradox*. 2004. Runtime 1hour.

We will be watching a video on the changing demographics of several populations throughout the world. As you watch the video, use the following questions to help keep track of what you are learning about. You may find it useful to read through the questions prior to the movie.

Part I: India

a) What is the total fertility rate in India right now?

b) How does the North compare to the South?

c) What are some of the factors that contribute to India's fertility rates?

d) What does the age structure of India look like? (draw India's population pyramid)

Part II: Japan

a) What is the total fertility rate in Japan right now?

b) What are some of the factors that contribute to these fertility rates?

c) How is this causing problems in Japan?

d) What is happening to U.S. populations? How is immigration affecting U.S. population?

e) How much **more** will an American child consume and pollute over their lifetime as compared to an Indian?

Part III: Kenya

a) What is the total fertility rate in Kenya right now?

b) What are some of the factors that contribute to these fertility rates?

c) What other factor is changing population structures in sub-Saharan Africa?

d) What does the current age structure of Kenya look like? (draw Kenya's population pyramid)

e) Prior to the rise of HIV, Kenya was on the verge of having birth rates and death rates match. How has HIV impacted the young and the working adults?

Post video: Meet with your group and fill in any gaps in your lab manual. What did you and your group find most interesting in the video? Example: what do you think the new restrictions on immigration will have on USA demographics?

Supplemental: Since this video's original airing in 2004: World human population has increased by over 1 billion from 6,435,705,595 to 7,498,667,525. September, 2018
That is over 15% increase in 14 years. That's like adding the whole population in the USA, **3 times!**

Germany has taken in move Syrian refugees than any other European country. Yet their population is still declining due to low fertility rates.

Japan:
The "lone Japanese boy", Daiki Sato, now in his 20's, is in college studying Health Administrations. He has not yet started a family.

- There has been no relaxation on immigration policies and populations continue to shrink.
- TFR has moved up from 1.3 to 1.4 (still far below replacement level)

Kenya:
The Kenyan girl, Florence Akinyifi, was last contacted in 2009. At that time she was doing well. No more resent information could be found for her or for the orphans she was taking care of.

- Although family planning is again funded by the Obama administration, funding levels remain low.
- New research as of 2016, shows the vaginal gel microbicides helps prevent transmission of HIV (depending upon what species of bacteria are found natively in the vagina). Worldwide, 67% of all new infections of HIV still occur in sub-Saharan Africa. However, new cases of HIV have come down and more people are living longer with HIV due to antiretroviral therapy.
- TFR in 2004 was 5.0 and is now 3.1

India:

- India's fertility rate has come down slightly but still sees unprecedented growth due to population momentum- The potential for increased population growth as children reach reproductive age.
- Current population of India, 1.3 billion
- TFR has gone from 3.0 to 2.5 (India is still expected to add over 500 million new people by 2050)