

## Chapter 7 Project: Human Population and Migration

Name \_\_\_\_\_ Name \_\_\_\_\_

In this project, you will access population data for various countries, and make predictions about how those populations will grow. The data are found at the U.S. Census Bureau's International Data Base web site. Follow the directions carefully below.

(1) Go to

[www.census.gov/population/international/data/idb/informationGateway.php](http://www.census.gov/population/international/data/idb/informationGateway.php)

Alternatively, search on “Census Bureau International Data Base”.

(2) The web site should appear as below. Select **Components of Population Growth**, change the year to **2010** and the country to **Canada**. Then press Submit.

The screenshot shows the U.S. Census Bureau International Data Base website. The page title is "International Programs" and the main heading is "International Data Base". The navigation menu includes "Main", "About", "Training", "Software", "Data", "Publications", "Related Sites", and "Contact Us". The search results section shows the following options:

- Select Report:** Components of Population Growth
- Select Year(s):** 2007, 2008, 2009, 2010 (selected), 2011, 2012, 2013, 2014, 2015, 2016
- Select Country(ies):** Bulgaria, Burkina Faso, Burma, Burundi, Cambodia, Cameroon, Canada (selected), Cape Verde, Cayman Islands, Central African Republic
- Select Region(s):** UN Regions (selected), Legacy Regions, Special Regions. The list includes World, More Developed Countries, Less Developed Countries (LDCs), LDCs, without Least Developed Countries, Least Developed Countries, and Africa (Eastern Africa, Middle Africa, Northern Africa, Southern Africa).
- Aggregation Options:**
  - Show individual Region/Country data only
  - Show aggregated Region/Country data
  - Show both individual and aggregated data
- Submit** button

After you press Submit, a page of data will appear for Canada. Go to the next page of this project to record results and make a few calculations.

**1. CANADA (year 2010)** Record and compute the following:

- a) Record the
- population**
- of Canada for year 2010.

Canada's 2010 population = \_\_\_\_\_

- b)
- Record the birth rate:**
- births per 1,000 = \_\_\_\_\_

Write the birth rate in decimal form and in percent form:

Birth Rate = \_\_\_\_\_ = \_\_\_\_\_ %

- c)
- Record the death rate:**
- deaths per 1,000 = \_\_\_\_\_

Write the death rate in decimal form and in percent form:

Death Rate = \_\_\_\_\_ = \_\_\_\_\_ %

- d)
- Compute:**
- Use the information from above to compute Canada's natural growth rate using the formula: Natural Growth Rate = Birth Rate – Death Rate.

Write the answer in both decimal and percent form.

Natural Growth Rate = \_\_\_\_\_ = \_\_\_\_\_ %

*Check to see that your answer matches the data base column "Rate of Natural Increase (Percent)." Does it?*

- e)
- Record the net migration rate:**
- Net migrants per 1,000 = \_\_\_\_\_

Write the net migration rate in decimal form and in percent form:

Net Migration Rate = \_\_\_\_\_ = \_\_\_\_\_ %

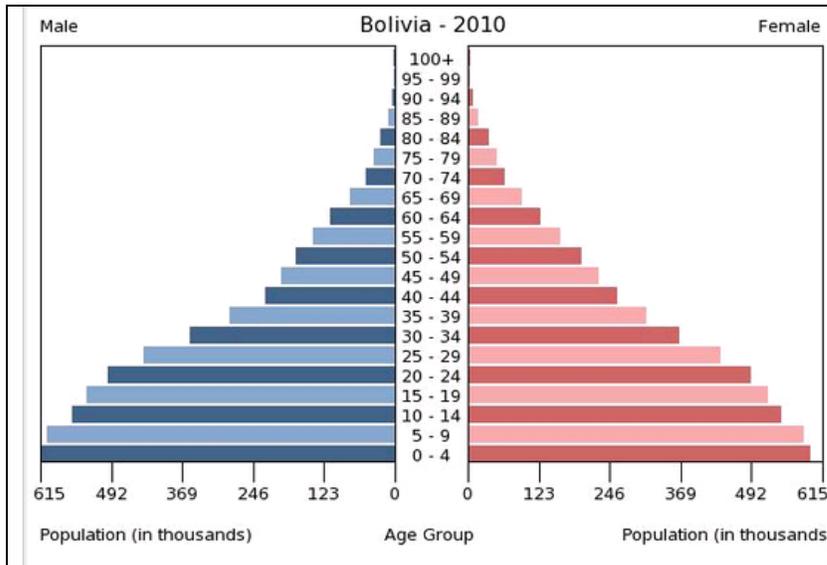
- f)
- Compute:**
- Using the information from above, compute Canada's growth rate with the formula: Growth Rate = Natural Growth Rate + Net Migration Rate. Write the answer in both decimal and percent form.

Growth Rate = \_\_\_\_\_ = \_\_\_\_\_ %

*Check to see that your answer matches the printout in the data base column "Growth Rate (Percent)." Does it?*

## 2. Population Pyramids

Click the orange Search tab to return to the data base home page. Now select the report called Population Pyramid Graph. Again select year **2010** and then change the country to **Bolivia**. Press **Submit**. The population pyramid for Bolivia in 2010 is displayed below.



a) Again press the orange Search tab. To see how Bolivia's population pyramid might change over time, **select the years 2010, 2015, 2020, 2025, etc. until you reach 2050**. You will need to hold down the CTRL key as you click each of these years. Then press **Submit**. The database will display the population pyramids for these years side by side. Above the 2010 pyramid you will find Animation Controls. Press the play button ► to view the animation.

What is the most significant aspect of change in the *overall population structure* for Bolivia?

b) Make a quick sketch of Bolivia's population pyramids in years 2010, 2030, and 2050, paying attention to general shape only. Label the year below each sketch.

**3. Country of Choice** Find a country whose year 2010 population pyramid resembles that of Bolivia in 2010 (the first pyramid you sketched earlier) **AND** whose year 2010 net migration rate is negative ( $< 0$ ). *Hint: first find a similar population pyramid, then check if the net migration rate is negative using the Components of Population Growth option used previously. If the net migration rate is zero or positive, choose another country!*

Your country : \_\_\_\_\_ **Print** your country's population pyramid for the year 2010 and attach it to the project.

For your country of choice, access *Components of Population Growth* to record and compute the following information for your country in year 2010.

a) **Record the birth rate:** births per 1,000 = \_\_\_\_\_

Write the birth rate in decimal form and in percent form: \_\_\_\_\_ = \_\_\_\_\_%

b) **Record the death rate:** deaths per 1,000 = \_\_\_\_\_

Write the death rate in decimal and percent forms: \_\_\_\_\_ = \_\_\_\_\_%

c) **Compute:** Natural Growth Rate = Birth Rate – Death Rate. Write your answer in both decimal and percent form.

Natural Growth Rate = \_\_\_\_\_ = \_\_\_\_\_%

*Check to see that your answer matches the data base. Does it?*

d) **Record the net migration rate:** Net migrants per 1,000 = \_\_\_\_\_

Write this rate in decimal and percent forms: \_\_\_\_\_ = \_\_\_\_\_%

e) **Compute:** Growth Rate = Natural Growth Rate + Net Migration Rate. Write the answer in both decimal and percent form.

Growth Rate = \_\_\_\_\_ = \_\_\_\_\_%

*Check to see that your answer matches the data base. Does it?*

f) Now switch reports to **Midyear Population and Density** for your country of choice. Select the years from **2010 to 2050**, jumping **every 5 years**. Print and attach the results.

#### **4. Interpreting Rates**

Explain in your own words the terms **natural growth rate**, **net migration rate**, and **growth rate**. Then explain how they relate to one another.

#### **5. Exponential modeling of Canada's population**

In this section we will use the population growth rate (natural growth rate plus migration rate) in a simple exponential model of future population.

a) Let  $p(n)$  represent the population, and  $n$  the number of years elapsed since 2010. Assume the population grows according to the growth rate calculated on the Canada worksheet (page 2). Write the difference equation relating  $p(n)$  to  $p(n-1)$ ; also write the initial condition.

b) Write the solution equation.

c) Complete the table below to predict Canada's population through the year 2050 using your exponential model. Use either the difference equation and initial condition or the solution equation. Round population values to the nearest 1 person.

<b>Country: Canada</b>						
<b>year</b>	<b>n</b>	<b>exponential equation's predicted population</b>		<b>year</b>	<b>n</b>	<b>exponential equation's predicted population</b>
2010	0			2035	25	
2015	5			2040	30	
2020	10			2045	35	
2025	15			2050	40	
2030	20					

## 6. The Affine Model of Canada's Population

In this section you will split the population growth into its two constituent parts: natural growth and net migration.

- a) The net number of migrants is equal to the net migration rate times total population. Compute Canada's net migration in the year 2010. Show work.

In your own words, explain what your answer represents:

How does your answer compare with the value for "Net Number of Migrants" reported in the *Components of Population Growth*?

- b) It is often the case that a country's government allows only a fixed number of net migrants. So let's assume that net migration is fixed at the year 2010 number you calculated in part (a). Using this number and the *natural* growth rate, write the difference equation relating  $p(n)$  to  $p(n-1)$ . Also state the initial condition.

- c) Complete the table below to predict Canada's population through the year 2050 using your affine model. Round to the nearest 1 person.

Country: Canada						
year	n	affine difference equation predicted population		year	n	affine difference equation predicted population
2010	0			2035	25	
2015	5			2040	30	
2020	10			2045	35	
2025	15			2050	40	
2030	20					

## 7. Model Comparisons for Canada

The U.S. Census has a model that predicts country population values for future years. Their model is a bit more sophisticated than the exponential or affine models that you derived. The population projections for Canada, based on their model, are given below.

Country: Canada						
year	n	Census Bureau predicted population		year	n	Census Bureau predicted population
2010	0	33,759,742		2035	25	39,395,855
2015	5	35,099,836		2040	30	40,070,226
2020	10	36,387,359		2045	35	40,635,090
2025	15	37,558,781		2050	40	41,135,648
2030	20	38,564,870				

- a) On a single set of axes, plot the population predictions for Canada based on 3 models: Census Bureau, your exponential difference equation, and your affine difference equation. Connect each with a smooth curve. *Use a full piece of graph paper and label each of the plots.*
- b) Compare the exponential and affine difference equations for Canada. Also compare the predicted values over the 40-year period from 2010 to 2050.
- c) The affine model and the Census model give somewhat different predictions. By what percent does the affine model exceed that of the Census model after 10 years? After 40 years? *If necessary, consult the Chapter 2 material on percentage difference.*

d) As you can see, the affine and Census Bureau models predict different population values in the year 2050 ( $n = 40$ ). Let's assume that the Census prediction is more reliable. Modify the constants in your affine difference equation so that its population prediction in 2050 is close (within 1,000 people) to that of the Census model. Write your modified affine difference equation below.

### **8. Affine Population Model for your Country of Choice**

a) Compute Net Migration for your country in the year 2010. Interpret your answer.

b) Assume that net migration is fixed at the year 2010 value you computed above. Using this value and the *natural* growth rate, write the affine difference equation relating  $p(n)$  to  $p(n-1)$ . Also state the initial condition.

c) Complete the table below to predict your Choice Country's population until the year 2050 using your affine model. Round to the nearest 1 person.

<b>Country of Choice:</b>						
<b>year</b>	<b>n</b>	<b>affine difference equation predicted population</b>		<b>year</b>	<b>n</b>	<b>affine difference equation predicted population</b>
2010	0			2035	25	
2015	5			2040	30	
2020	10			2045	35	
2025	15			2050	40	
2030	20					

## **9. Analysis of your Country of Choice!**

a) On a single set of axes, plot population predictions for the U.S. Census model (the data that you printed out) and your affine model. Connect each with a smooth curve. *Use a full piece of graph paper and label each plot.*

b) Your affine model assumes that the natural growth rate and net migration will remain constant in the future. The U.S. Census data are derived using different assumptions and equations. Often these equations involve population growth rates which decrease over time. Pick two social or environmental conditions (i.e. variables) that are *likely* to slow your Choice Country's population growth rate in the future. Explain briefly how one condition might affect the natural growth rate, and how the second condition might affect the migration rate.

