

Laboratory 2A
Population Growth Modeling

Objectives

1. Review the mathematical basis of exponential and logistic growth
2. Plot world human population as a function of year to determine which model of population growth best describes humans.
3. Conduct the “Isle Royale” population growth simulation and complete the workbook for this simulation

Introduction

Binary fission is the simplest form of reproduction in living things and this kind of reproduction occurs in a remarkably rapid cycle in *Escherichia coli* bacteria. Under ideal conditions, *E. coli* can fission (this is not mitosis since *E. coli* has only one circular chromosome but it is a duplication division) every 20 minutes, resulting in a population doubling. This type of reproduction can yield geometric population increases, also known as Exponential Growth (Equation 1) in which the rate of growth is a function of the number of individuals in a population (N) and the per capita rate of change (r).

Equation 1
$$\frac{dN}{dt} = rN$$

Exponential growth is growth without limitation, and bacteria can experience such growth for short periods of time. Eventually, some limiting factors force a decrease in the rate of growth and can even cause a decrease in the absolute population size. A simple model of limited growth is the Logistic Growth Model (Equation 2) in which a population is limited to a maximum sustainable size called the carrying capacity of the environment (K). Thus, $\frac{K - N}{K}$

is the proportion of carrying capacity yet to be filled by a growing population.

Equation 2
$$\frac{dN}{dt} = r_m \left[\frac{K - N}{K} \right] N$$

Bacteria are not the only living things in which exponential and logistic growth may be observed. How do world human populations appear to be growing? Does the aggregate pattern of human population growth apply to individual countries?

Methods

Prepare an Excel file of world human population numbers from 8000 BC to 1992 AD (Table 1) and graph those data as a function of year.

Table 1. World Human Population 8000 BC to 1992 AD. The data shown in the table are the approximate total world human numbers. The first entry for the variable “year” is -8000 for the calendar year 8000 BC or approximately 10,000 years ago. The data in this table are from Illustrated Atlas of the World. Rand McNally and Co., 1992, and Managing Planet Earth, Scientific American Reader, W.H. Freeman and Co., 1990.

Year	Population
-8000	10000000
1650	550000000
1750	725000000
1800	900000000
1850	1175000000
1900	1600000000
1920	1810000000
1939	2230000000
1950	2490000000
1992	5491000000

Isle Royale Simulation

This week you will also conduct the SimBiotic Software “Isle Royale” computer simulation. The simulation and workbook for Isle Royale may be completed entirely outside of class time and will be due next week. The workbook and software CD must be purchased at the Morehouse College Bookstore. Your completed workbook (the original that you purchase) must be submitted for this assignment. Photocopies will not be accepted.

Acknowledgements

Written by L. Blumer 4/2005 and revised 8/2007.