## Population Biology

- The study of populations
- Chapter 10
- Biotic Potential
- Emphasize on the consequences human population growth

## Current Human Population Data

- http://opr.princeton.edu/popclock/popupclock.html
  - 6.58 Billion and growing

| | B | D | ΔN |
|---|---|---|---|
| TIME UNIT | BIRTHS | DEATHS | Natural Increase |
| Year | 133,201,704 | 55,490,538 | 77,711,166 |
| Month | 11,100,142 | 4,624,212 | 6,475,931 |
| Day | 364,936 | 152,029 | 212,907 |
| Hour | 15,206 | 6,335 | 8,871 |
| Minute | 253 | 106 | 148 |
| Second | 4.2 | 1.8 | 2.5 |
| | | | |
| source: http://www.census.gov/cgi-bin/ipc/pcwe | | | |

## US POPULATION GROWTH

About 301,000,000 and growing

US

| TIME UNIT | BIRTHS | DEATHS | NET IMMIGRA | ΔN | ΔN - I |
|---|---|---|---|---|---|
| Year | 97200000 | 64774080 | 28771200 | 61197120 | 32425920 |
| Month | 1620000 | 1079568 | 479520 | 1019952 | 540432 |
| Day | 27000 | 17993 | 7992 | 16999 | 9007 |
| Hour | 450 | 300 | 133 | 283 | 150 |
| Minute | 7.5 | 5.0 | 2.2 | 4.7 | 2.5 |
| Second | 0.125 | 0.0833 | 0.037 | 0.0787 | 0.0417 |

source: http://www.census.gov/population/www/popclockus.html.

March 2007 --(assumed 1 birth/8secs, 1death/12secs, 1 immigrant/27 secs)

## A Mathematical Approach to Understanding Population Growth

**1. The initial size of the population = $N_o$**
**2. The number of Births = B**
**3. The number of Deaths = D**
**4. The number of Immigrants = I**
**5. The number of Emigrants =E**
**6. The size of the population at time “t” = $N_t$**

**The population at any time time can be determined with the following equation**

$$N_t = N_o + B - D + I - E$$

$$Nt = No + B - D$$

**Rates vs Absolutes**

**A “rate” is a value divided by time**

**The number of Births and Deaths per unit time is at least part a function of the size of the population.**

**Birth and Death rates are often calculated on a per capita bases i.e.**

**$b=B*\text{unit time}^{-1}*N^{-1}$ (read- birth rate equals Births per year per individual)**

**$d=D*\text{unit time}^{-1}*N^{-1}$ (read- death rate equals Deaths per year per individual)**

**Growth rates on per capita bases can ve calculated by subtracting d from b. e.g. r = b-d**

**Where is per capita growth rate of the population.**

Changes in N (assume I and E=0)

$\Delta N = B-D$

the number of B’s and D’s for some discrete unit of time can be estimated by --- B-D=rN

$$\frac{dN}{dt} = (b - d)N = rN$$

Note:

1: *r* = the intrinsic rate of natural increase.

2: Does not predict $N_t$ only *ΔN*

3. *ΔN* is a function of N

4. Assumes *r* represents per capita growth rate for some discrete time period.

DISCRETE VS CONTINUOUS GROWTH

**Discrete assumes that the population growth only occurs periodically (annually or monthly).**

**Continuous means that the population is growing all the time.**

**Analogy to interests rates**

**if the r=0.05 new individuals per week per old** individuals and we start with 100 individuals.

Week 0 =100, Week 1= 105, week 52= 1264.28

**if r=1.05 new individ per 2 weeks per individ.**

Week 0=100, Week 2=105, week 52=355.57

**if r=1.05 new individ per 52 weeks per individ.**

Week 0=100, Week 2=100, week 52=105

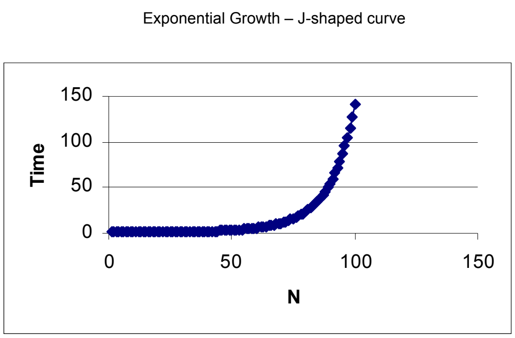
Mathematically:

For discrete growth

$$N_t = N_0 + No*r$$

For Continuous growth

$$N_t = N_0 e^{rt}$$

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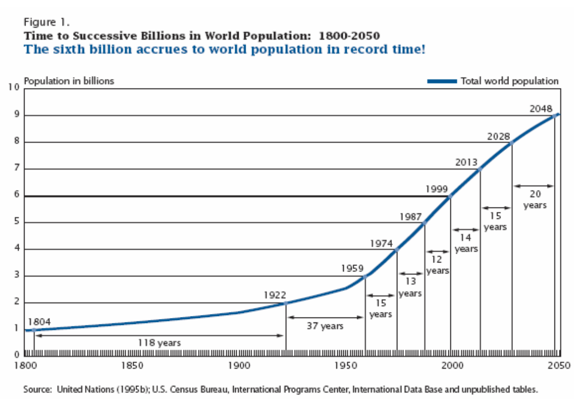
## Properties of Exponential Growth

- Population will always increase by the same Percent in any two periods of time of the same length
  - Simplest example assume population doubles each year
    - 2 → 4→ 8 → 16→ 32 →64 →128→256→512
    - If r=0.05
    - 2→2.10→2.21→2.32→ 2.43→2.55→2.68 →2.81
  - Still J-shaped.



**Slide 9**

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**KJW1** Kevin Williams, 4/4/2005