4 ways to measure populations

- Density = # / area
- Dispersion = spacial arrangement
- Age distribution
- Growth rates =
  - (births+immigrants) – (deaths+ emigrants)

Math Practice

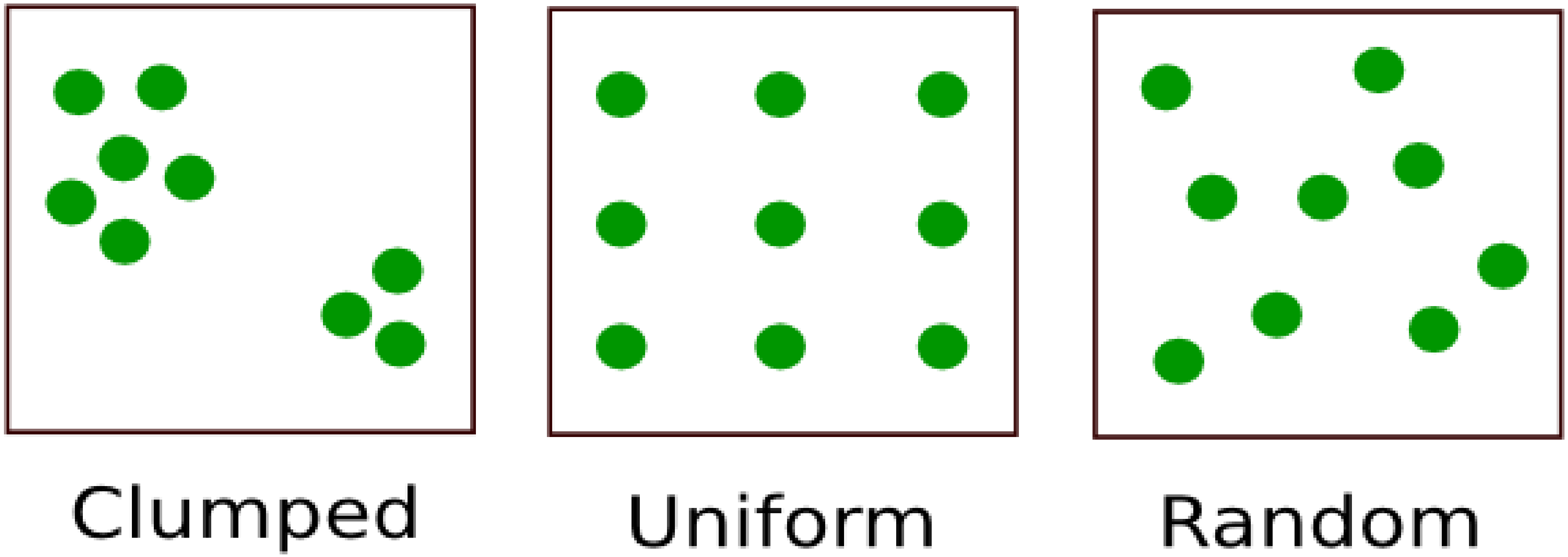
- Use the 2016 population data sheets to determine the population density of each of the following countries in mi^2
- Note that $2.6km^2 = 1mi^2$
  - USA = 9.2 million km^2
  - China = 9.3 million km^2
  - India = 3.0 million km^2
  - Ireland = 69 thousand km^2

Population Dynamics

1) Population Density

- Affected by:
  - Social structure
  - Mating relationships
  - Time of year
  - Availability of resources

2) 3 types of population dispersion patterns =



a) Clumping = most common

- Why?
- <u>Resources are often clumped</u>
- <u>Social organizations</u>
- <u>Ex: flock of birds, herds of herbivores, pack of wolves</u>

b) Uniform spacing is rare

- What causes it
- <u>antagonism or even resource distribution</u>
- <u>Ex: creosote bush = desert shrub → herbicides</u>

C) Random dispersion

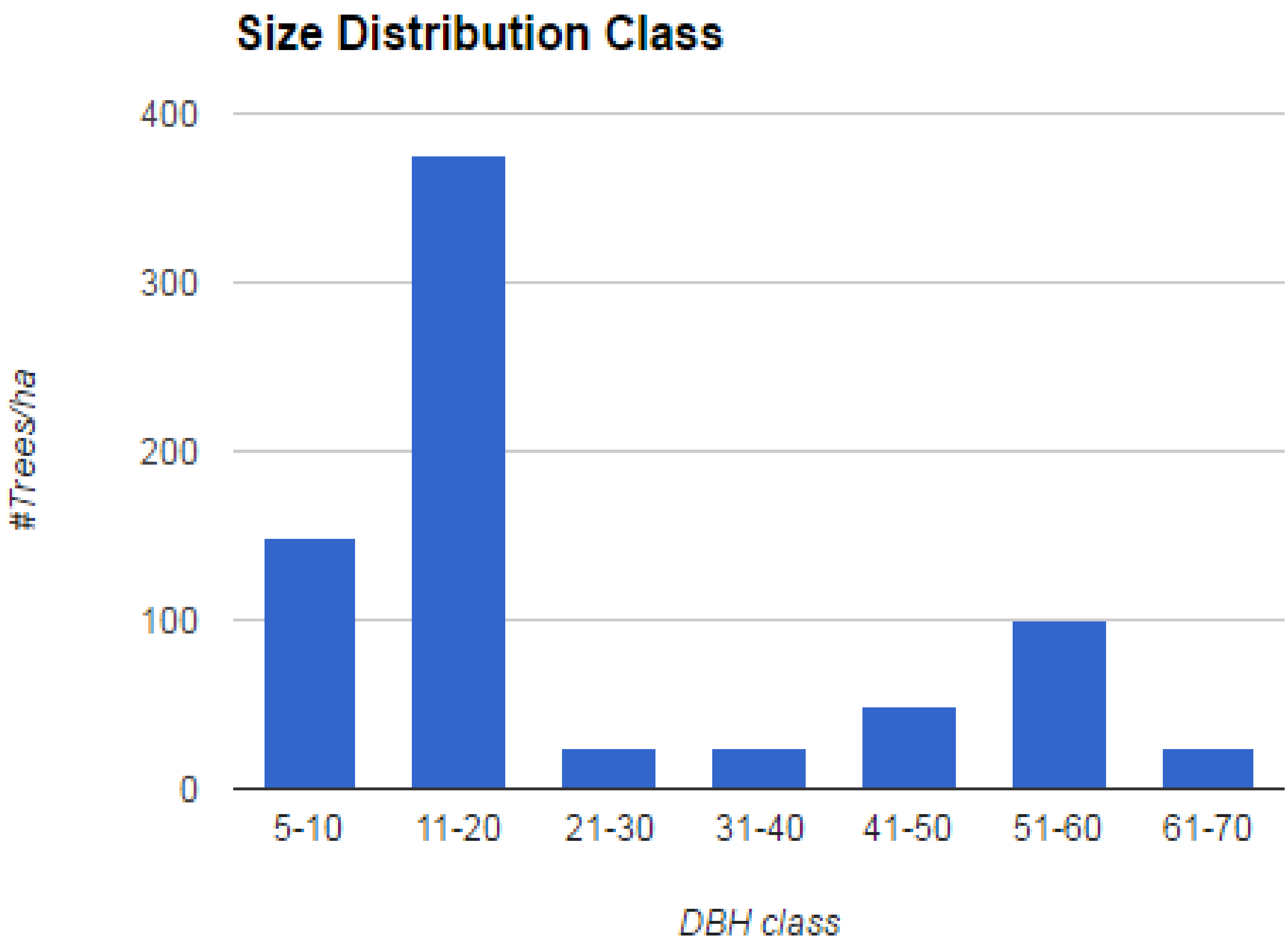
- Due to random distribution of seeds or offspring
- Ex: dandelions

3) Age structure diagrams

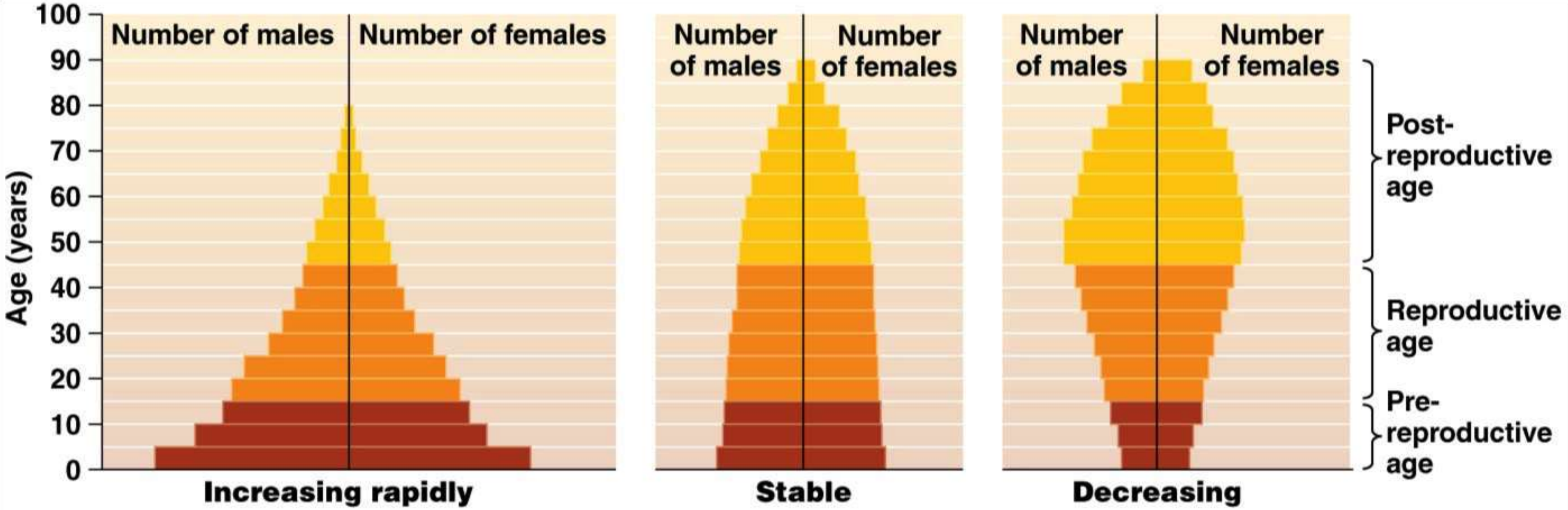
- Populations divided into 3 age categories

- Pre-reproductive
- Reproductive
- Post-reproductive

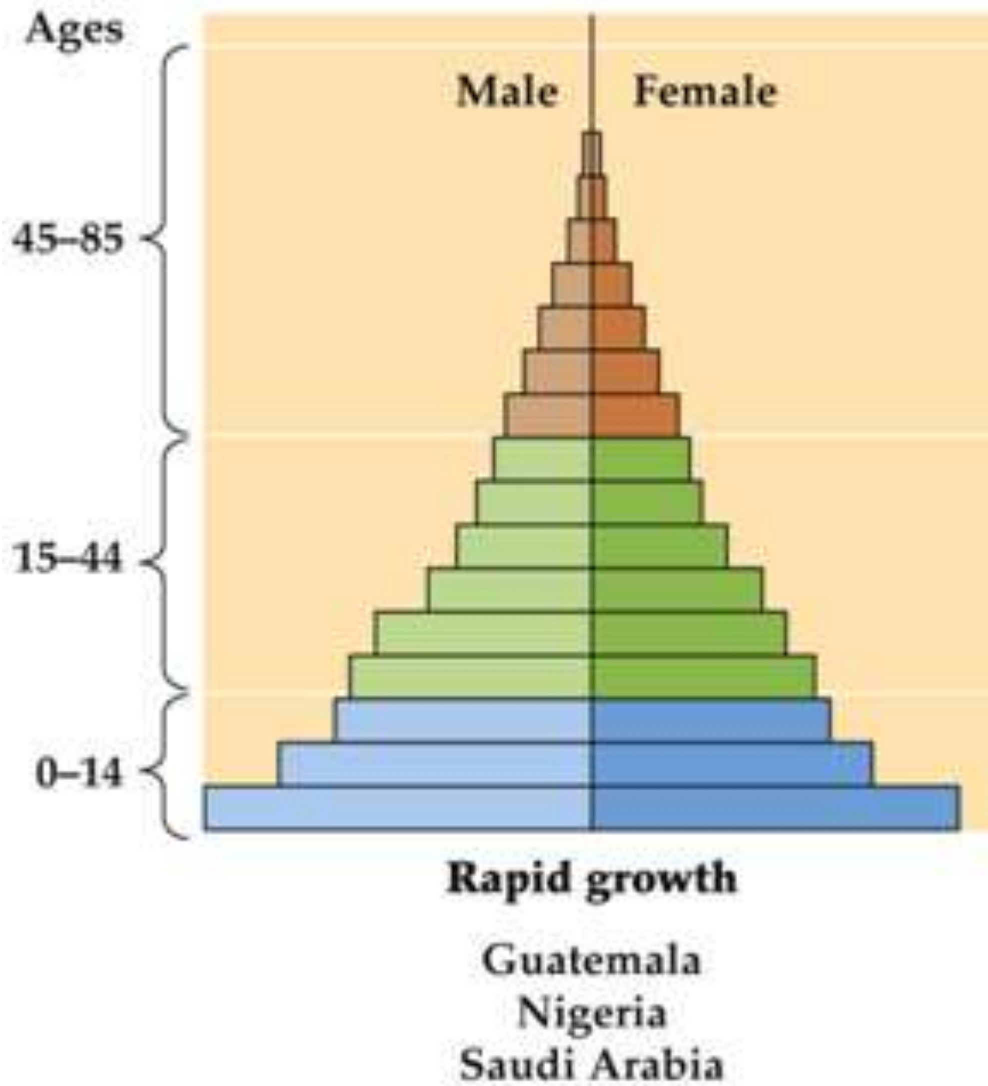
Old growth lab



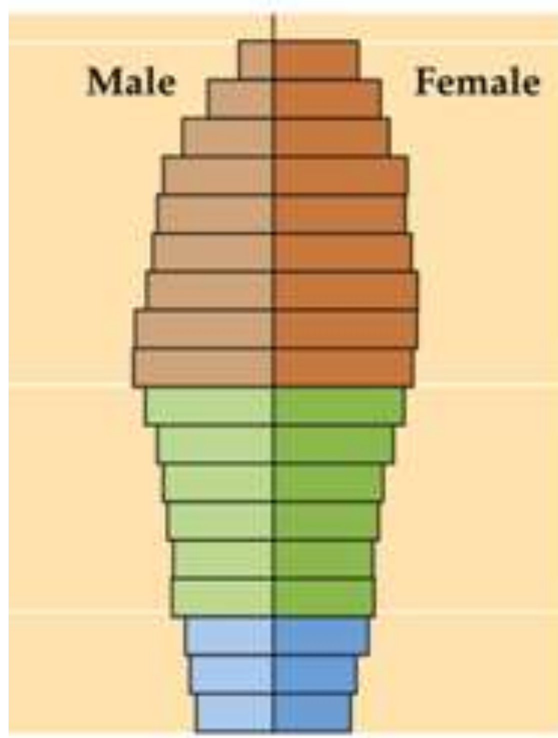
Age Structure Diagrams



High # pre-reproductive and reproductive age → growth



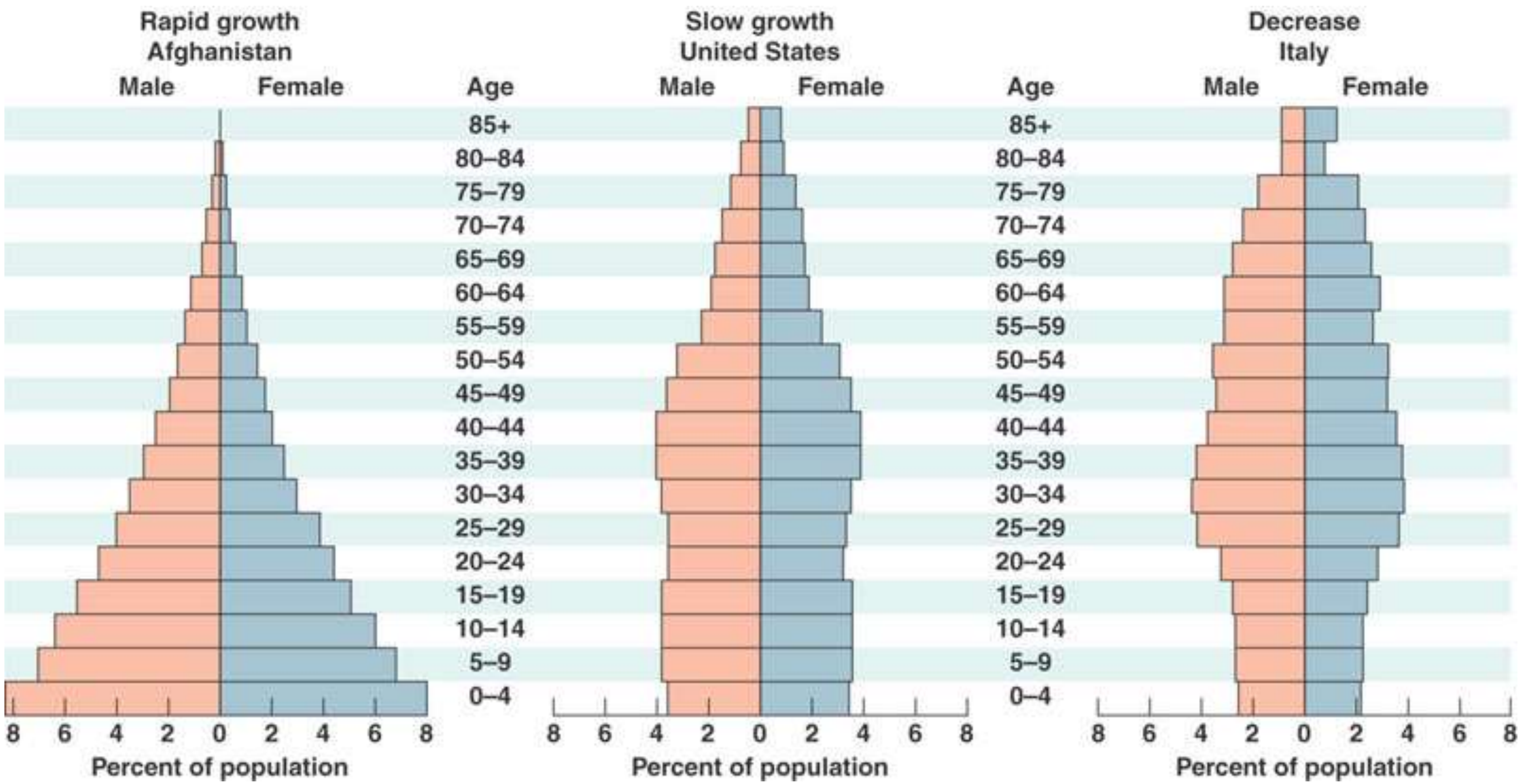
Mostly post-reproductive → no growth or declines



Negative growth

Germany
Bulgaria
Italy

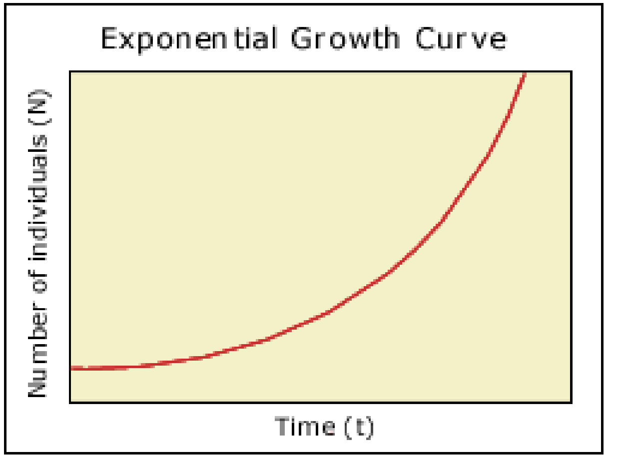
Practice math in notes



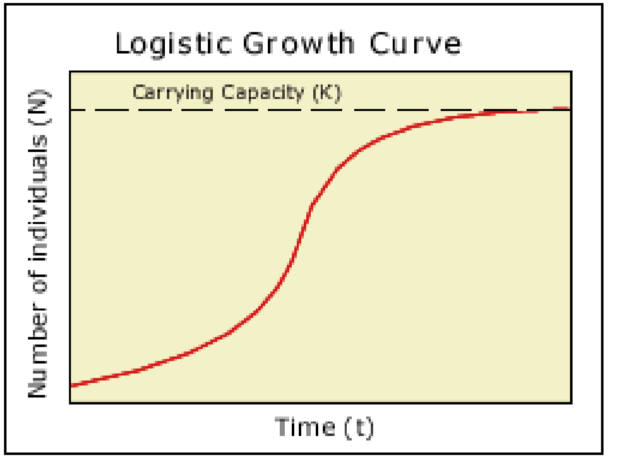
Measuring population growth

2 Types of growth curves

- Exponential (J shaped curves)

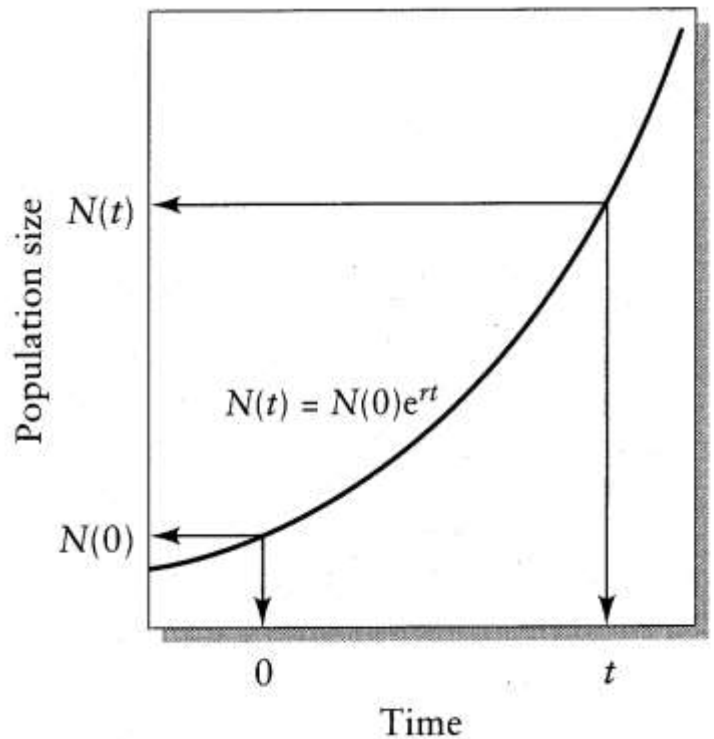


- Logistic (S shaped curves)



Exponential Growth

- Occurs in the absence of limiting factors
- Independent of population density
- Cannot continue forever



Biotic potential =

- Maximum rate of increase for a population in a limitless environment

- Biotic potential = exponential in a limitless environment

Examples of species with a high biotic potential

- <u>Any species that reproduce early and rapidly</u>
- <u>Mice</u>
- <u>Rabbits</u>
- <u>Insects</u>

Name a species with a low biotic potential

- Elephants (22 month gestation period)
- Whales (15-18 months)

Doubling time/ Rule of 70

- Doubling time = time that it takes for an exponentially growing population to double
- D.T. = 70 / percent increase
- Ex. What is the doubling time of a rabbit population that is increasing at a rate of = 150%

D.T. =

70/150 =

0.467 years

Use factor label method to convert → months

0.467 years	**12months**
	1year

Answer = 5.6 months

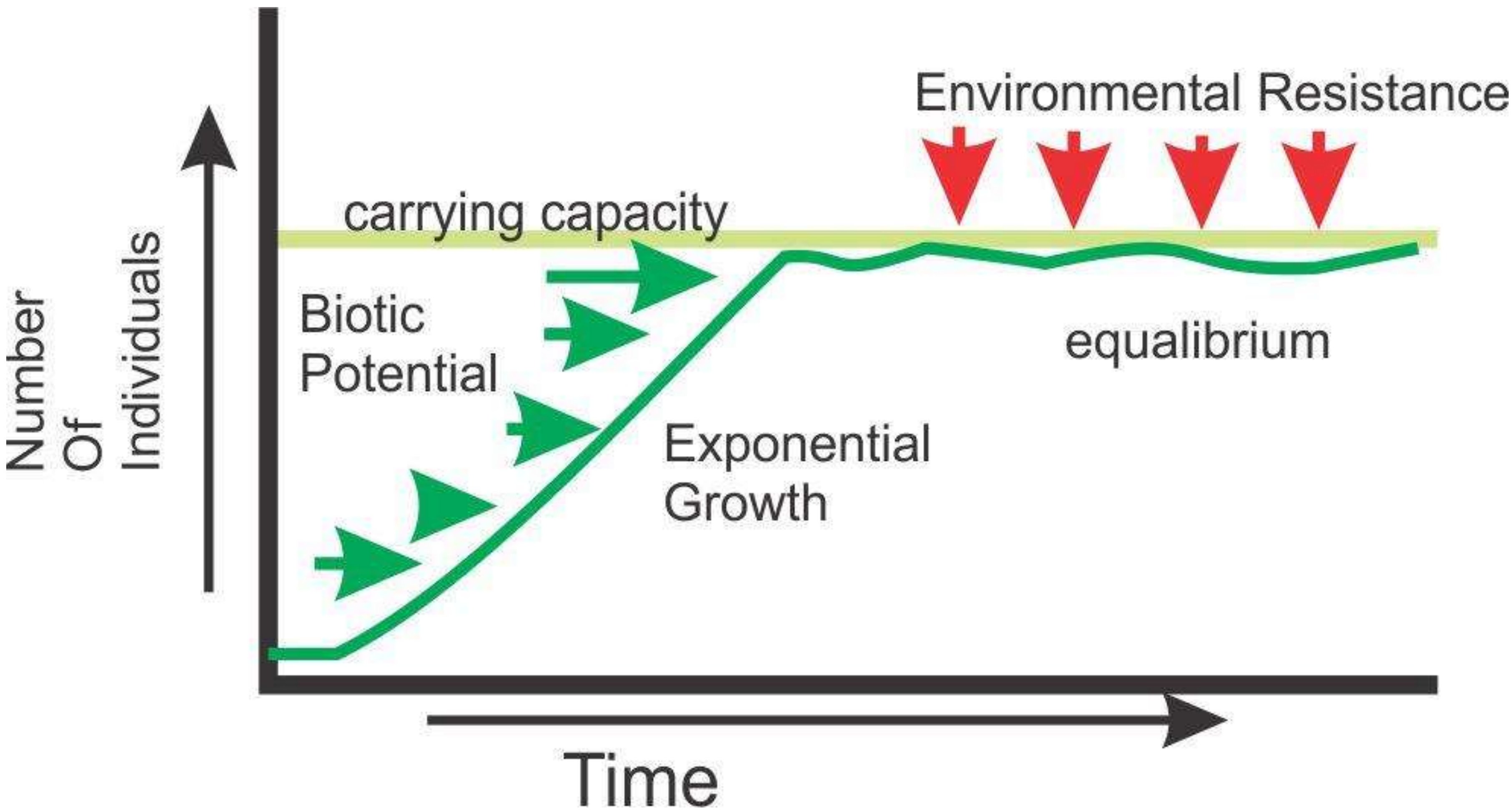
If you had 5 rabbits in the starting population how many would you have in 5.6 months?

How about 11.2 months?

Practice Doubling Time Problems on handouts

Environmental Resistance =

- Limits that prevent organisms from reaching their biotic potential



2 factors that limit population growth

- Density – independent factors
- Density – dependent factors

Density independent factors

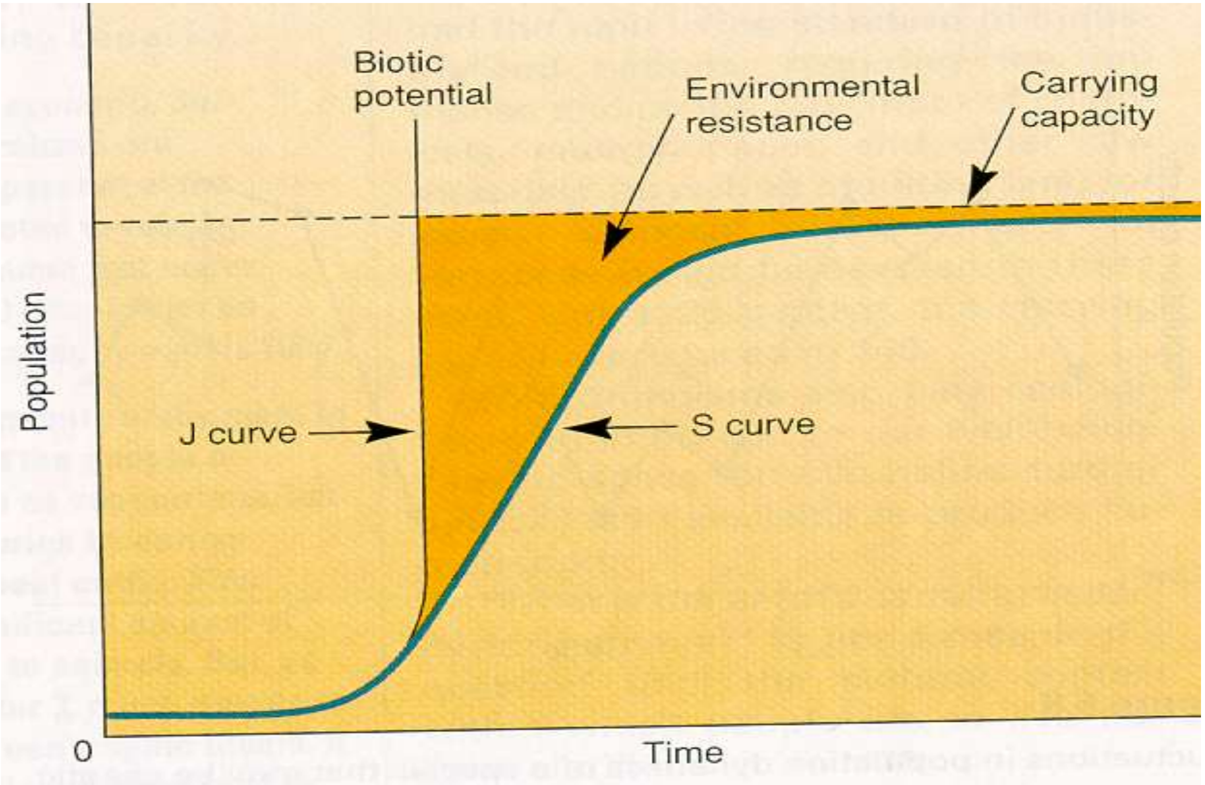
- Affect populations randomly regardless of density
- Physical factors
  - Ex: rainfall, temperature, salinity, acidity…
- Catastrophic events
  - Ex: hurricanes, tornadoes, fire, drought, floods
- Poor regulators of population

Density-dependent factors

- Affect populations when densities are high
- Examples:
  - Disease, competition, predation, parasitism
- Good regulators of populations → stable population

Carrying Capacity (K)

- Maximum # individuals an ecosystem can support



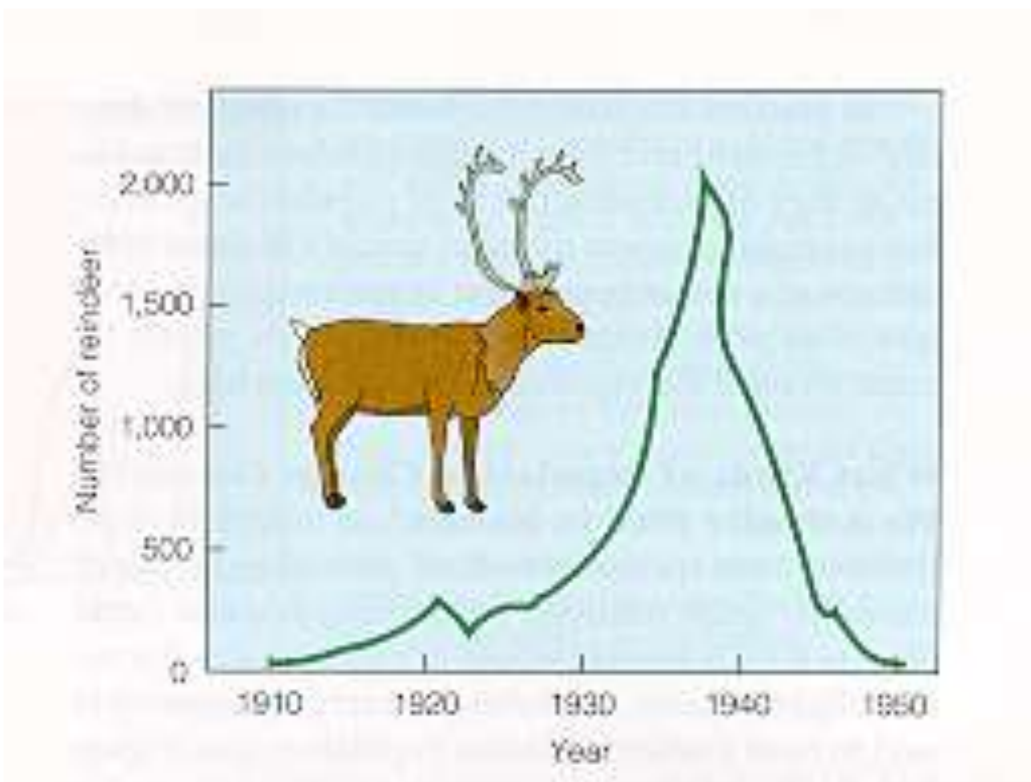
2 scenarios

- As a population approaches carrying capacity → 2 possible outcomes =

- Overshoot then crash -or-
- Stabilize around the carrying capacity

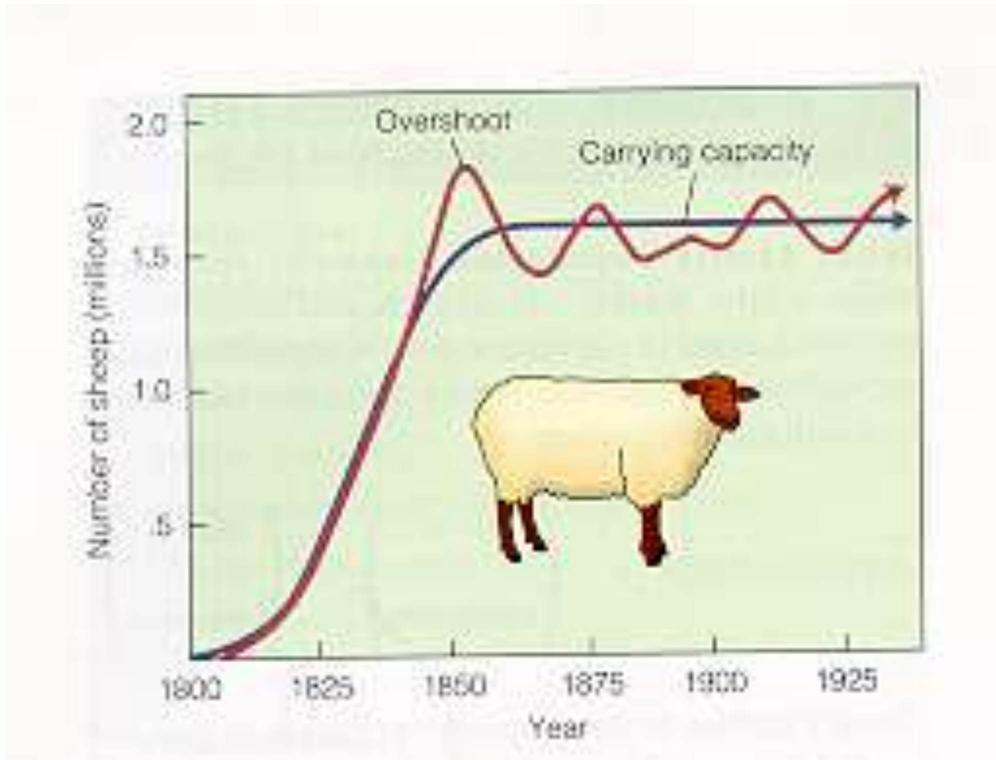
Over-shoot K then crash

- Ex: St. Matthew Island, Alaska
- 1910 = 26 reindeer introduced
- 1935 = 26→ 2000 → overgraze → crash



Populations stabilize near K

- Logistic growth
- Ex: population of sheep introduced to Tasmania in early 1800s



Population Growth Rates

- Depends on:
- Birth rates
- Death rates
- Immigration (in)
- Emigration (out)

Population

= <u>initial population + (B+I) – (D+E)</u>

Birth rates and death rates

- Can be expressed as a percent

  % = #/100

- Crude births or deaths = out of 1000

  CB = births / 1000

Population growth rate (r) is always expressed as a percent

- $r = \frac{\text{Crude births} - \text{Crude deaths}}{10}$ OR

- r = % births - % deaths

Practice math

Percent growth (r)

- If a population growing at a rate of 2% per year = 2 new individuals are added to the population for every 100 already present per year.
- r=b-d if there is no net migration
- Net migration = immigration - emigration

- Population growth rates = (B + I) – (D+E)

- Or

- Population growth rates = (B-D) + net migration

Population growth rates

- Growth occurs when $(b+i) > (d+e)$

- Zero population growth (ZPG) occurs when $(b+i) = (d+e)$

- A neg growth rate = shrinking population
  - $(b+i) < (d+e)$

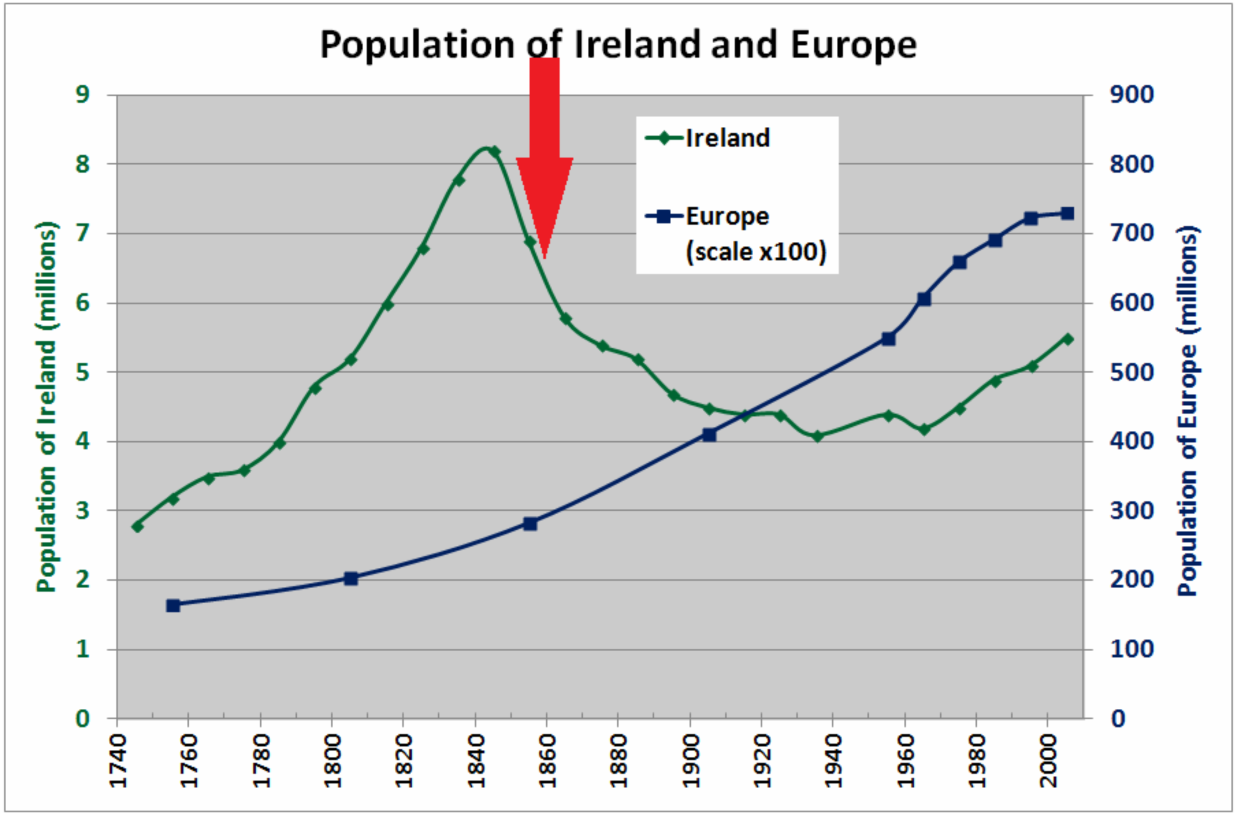
Define tragedy of the commons and give examples

- Unregulated use of commons → unsustainable → degradation of resources

- Examples:
  - overfishing of oceans → many species are commercially extinct
  - Overgrazing in marginal regions → desertification

Tragedy of the commons → human population crashes

- Ex: Irish potato famine 1845 (too many people growing 1 crop) → killed 1 million and forced 3 million to emigrate



Ex: Easter Island in the South Pacific

- Population~10,000 in the 1400s
- Cut down the palm trees faster than they could grow back
- → springs and streams dried up, no trees to build canoes for fishing
- → crashed → 2,000 by 1722

Reproductive (Life History) Strategies

- Species need to produce as many offspring as possible

- Organisms have a limited amount of energy → life and reproduction → trade off

Long life vs. High reproduction rate

Two main types of species:

- r-strategists,
- K-strategists

r - strategists

- Spend most of their time in exponential growth → maximize reproductive rates

Characteristics of r strategists

- Small
- Short life span
- Lots of offspring
- Little to no care of offspring
- Generalists (not picky)
- High birth and high death rates
- ex: dandelions, insects, mice....

K - strategist

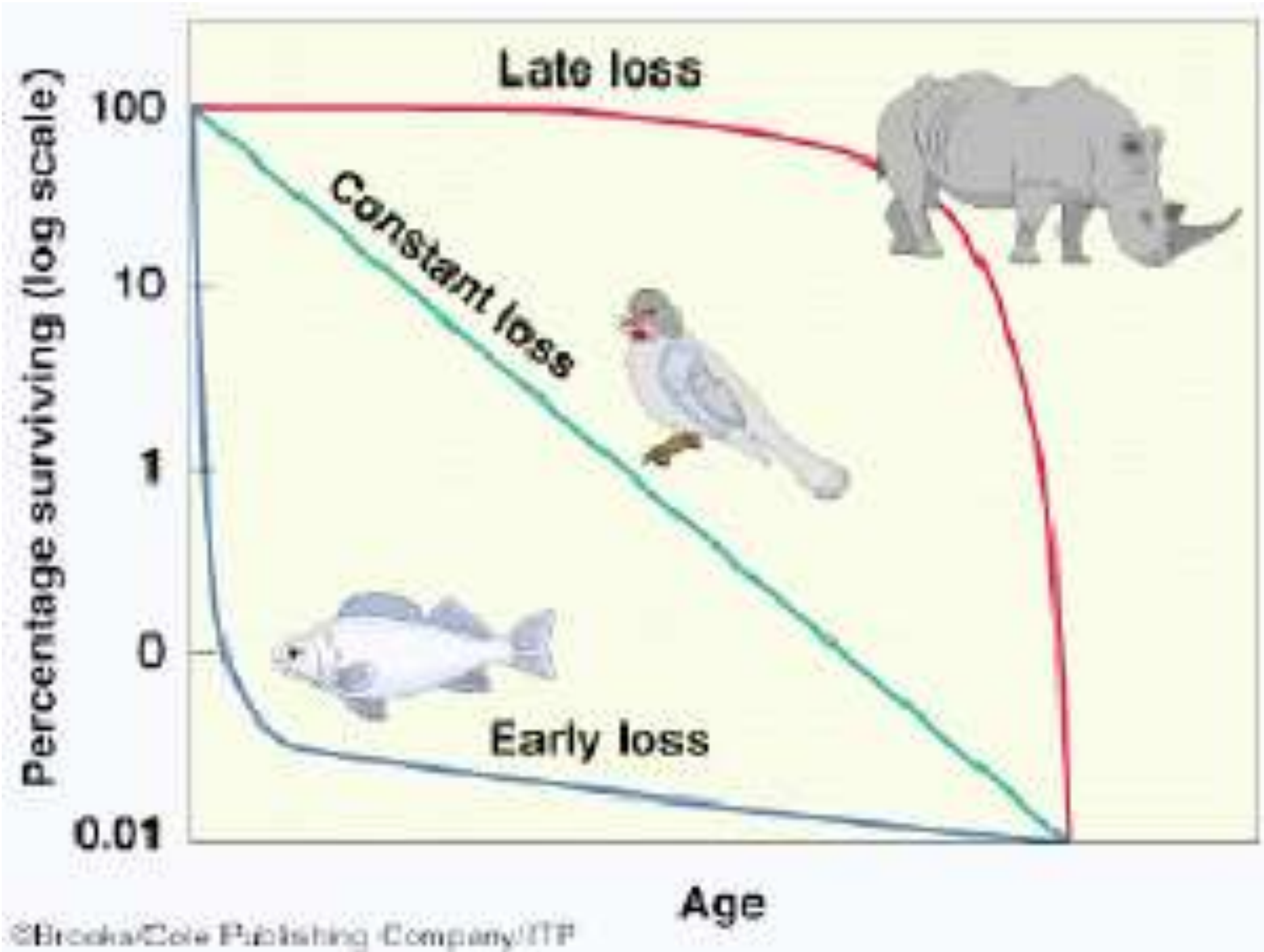
- Species maintain their population levels at the carrying capacity (K)

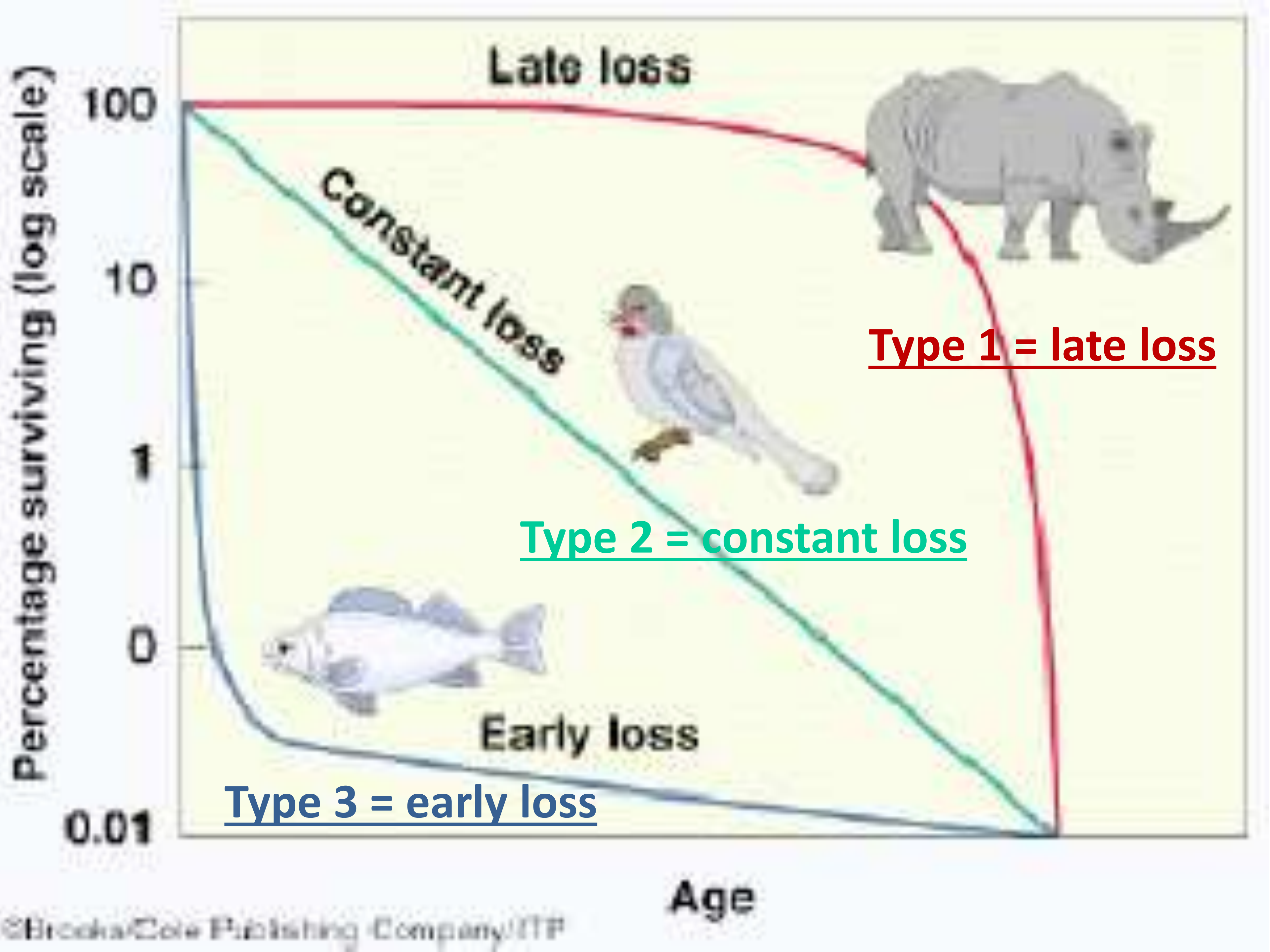
Characteristics of K strategists

- Larger
- Fewer offspring
- Later reproductive age and longer life
- Adults care for young
- Slower growth rates
- Specialized niche
- Highly competitive
- Ex: Elephants, humans, bears


ELEPHANT
BIRTH
Ine Braat
Suely Hinds

Survivorship curves = relationships between age and mortality




Late loss
Constant loss
Early loss
Type 1 = late loss
Type 2 = constant loss
Type 3 = early loss
Percentage surviving (log scale)
100
10
1
0
0.01
Age
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