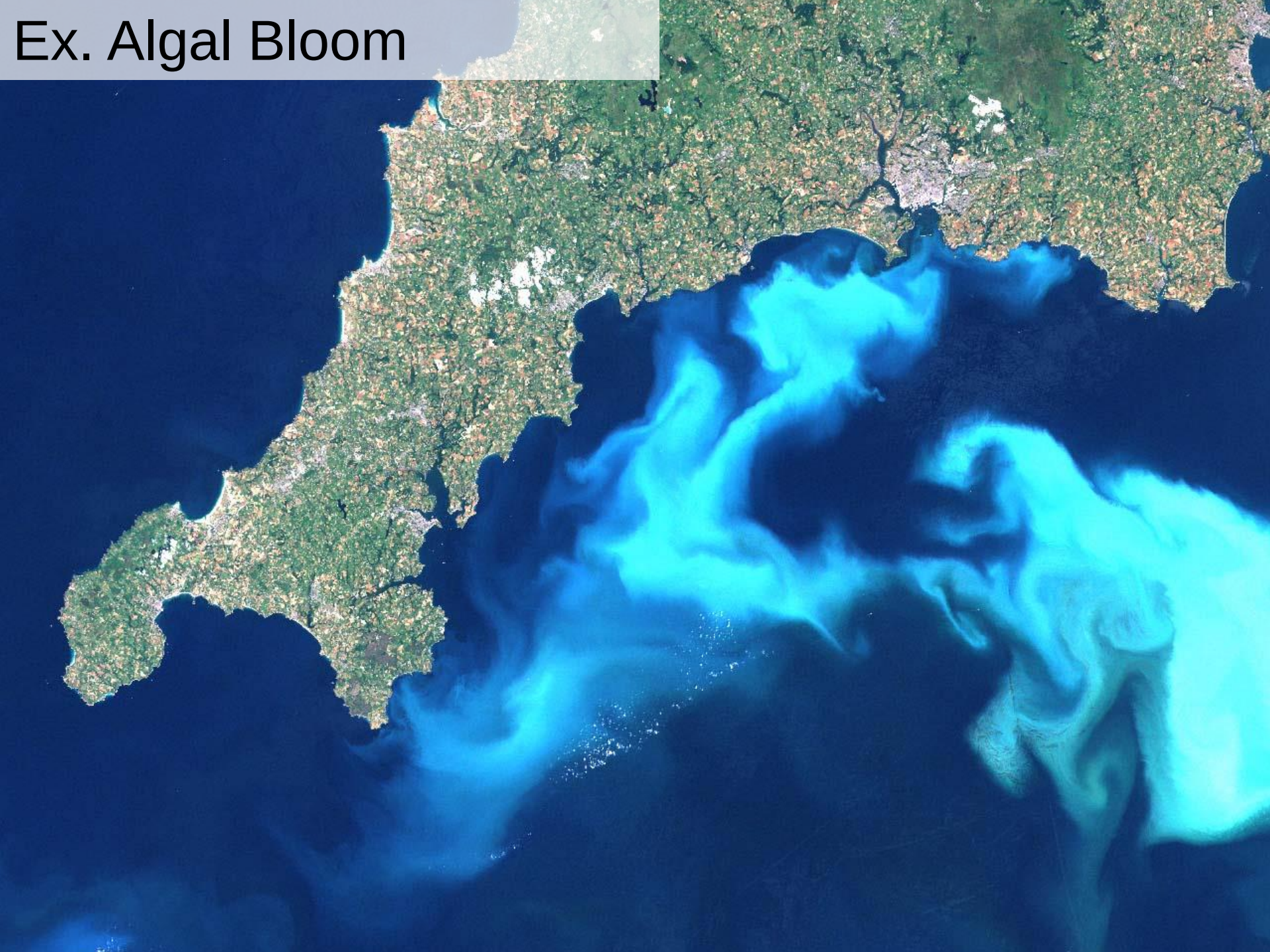
Ex. Algal Bloom



In All Cases

Biotic and abiotic interactions both play roles in affecting biological systems at all levels of organization.

These affects can be beneficial, detrimental, or variable in their effects on the system and its state at the time of the interaction.

7.5: The level of variation in a population affects population dynamics.

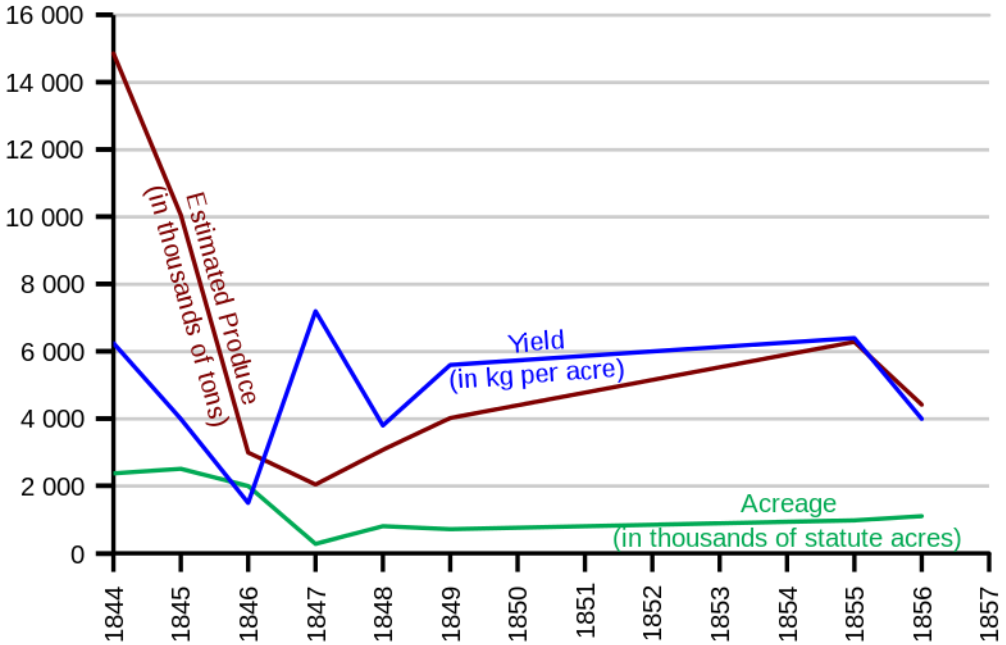
1. POPULATION DIVERSITY

Genetic Diversity & Resilience

The ability of a population to respond to changes in its environment (its "**resilience**") is directly related to its genetic diversity.

Populations with the least genetic diversity are most at risk for extinction in an ecosystem.

Ex. Potato Blight

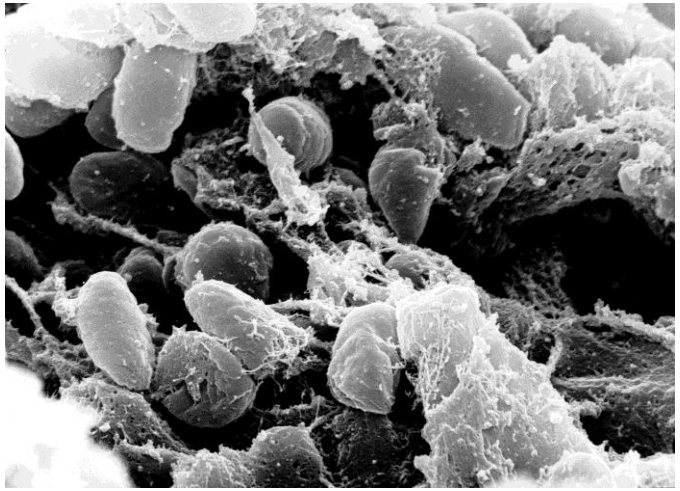


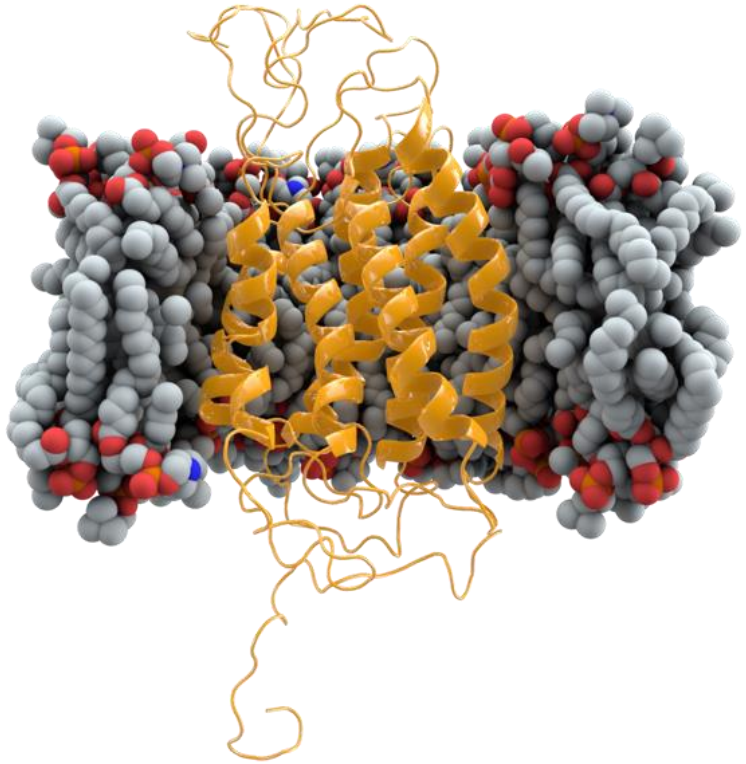
Genetic Diversity & Responses

Genetic diversity leads to a diversity of responses among individuals in a population to the same environmental changes.

This diversity can be physiological or behavioral.

Ex. Black Plague Survival



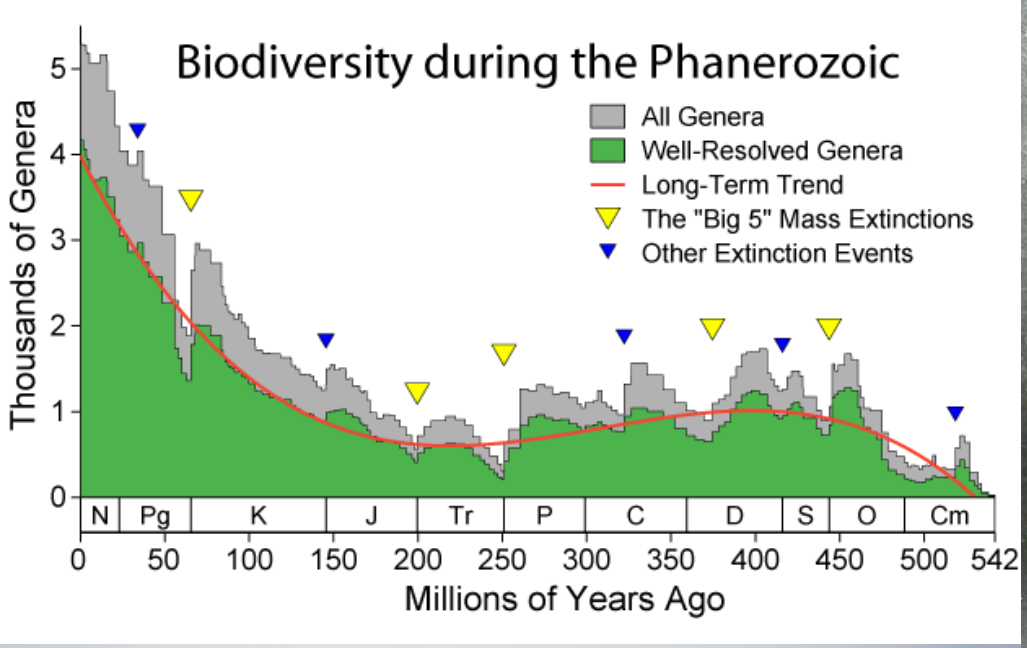


Ex. Stampede Behavior

Modeling Diversity

Various models can be used to estimate the genetic diversity in a population:

- Hardy-Weinberg Equilibrium
- Direct Genetic Sampling
- Direct Phenotype Sampling
- Fossil Record Analysis


Biodiversity during the Phanerozoic
All Genera
Well-Resolved Genera
Long-Term Trend
The "Big 5" Mass Extinctions
Other Extinction Events
Thousands of Genera
0
1
2
3
4
5
N
Pg
K
J
Tr
P
C
D
S
O
Cm
0
50
100
150
200
250
300
350
400
450
500
542
Millions of Years Ago


3dham.com
Split ammonite

7.6: Interactions between and within populations influence patterns of species distribution and abundance.

1. COMMUNITY INTERACTIONS

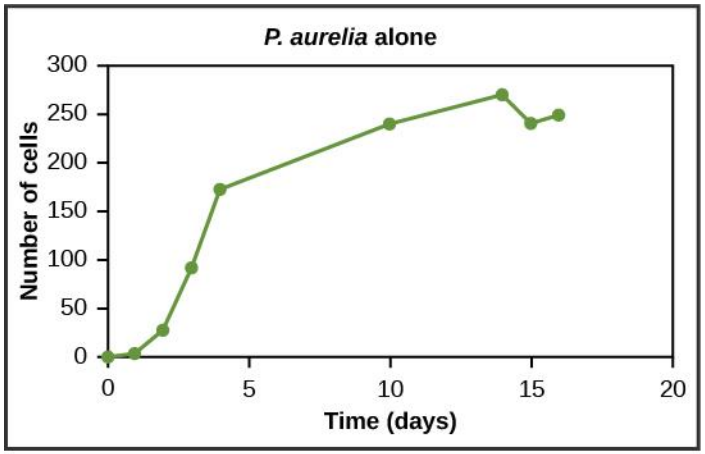
Populations Interact

Interactions between populations affects the **distribution** and **abundance** of organisms.

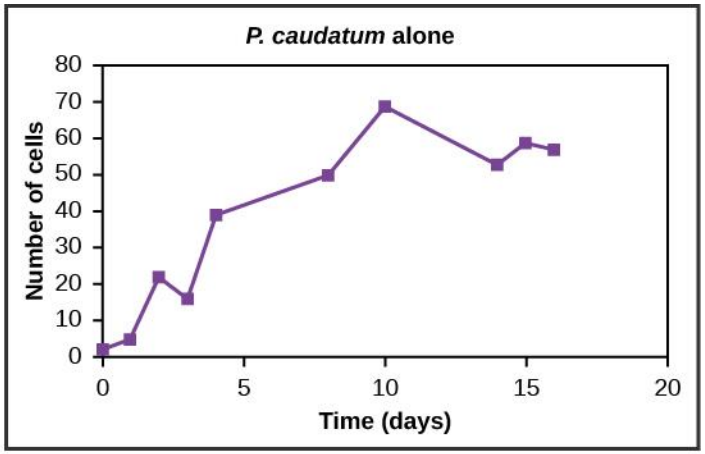
Niche: the total interactions of an organism with its environment.

Competition, and **predation** can limit the distribution and abundance of a population.

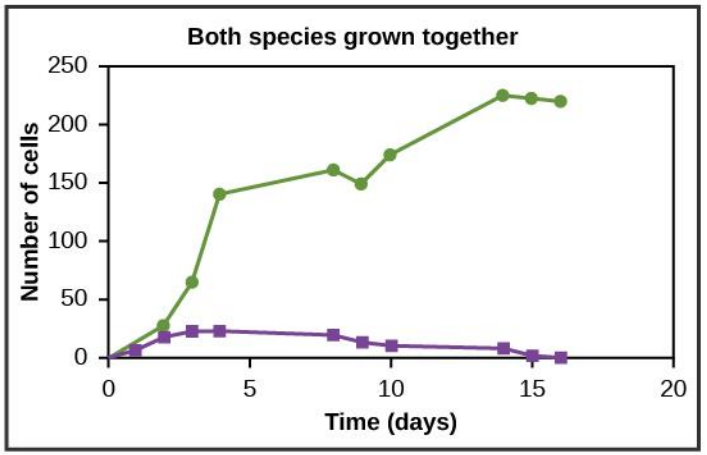
Competitive exclusion principle: When two species have overlapping requirements in the same ecosystem, one species will outcompete the other for those overlapping resources.



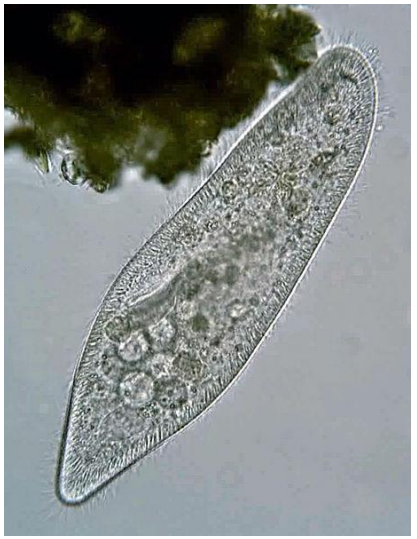
(a)



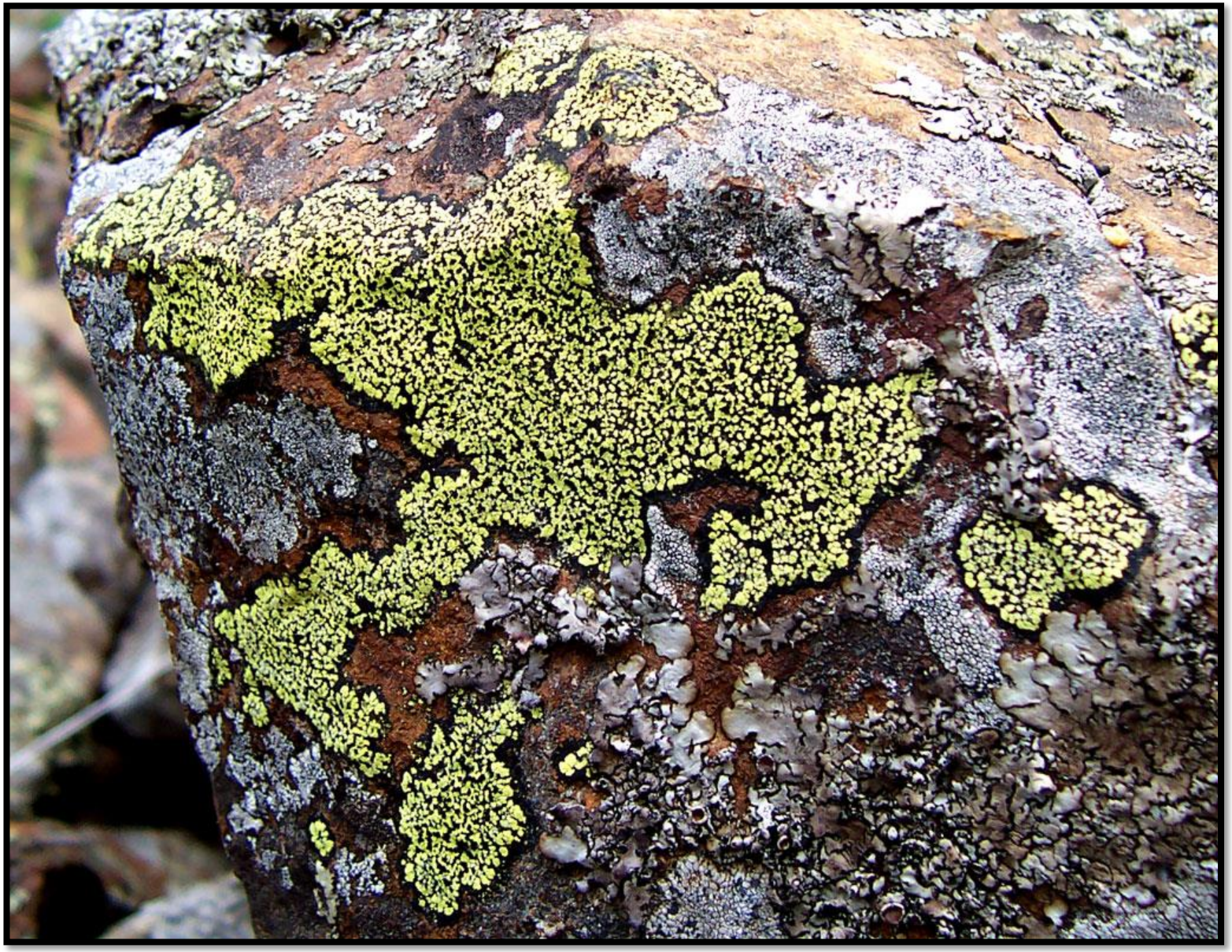
(b)



(c)



Symbiosis can limit or expand the distribution of a population.



Mutualism: +/+

Commensalism: +/0

Parasitism: +/-

Population Level Emergence

A population has properties unique to its level of organization. These properties emerge from the interactions among the individuals who comprise the population with each other and the ecosystem.

The interactions between populations can be analyzed at the individual level and at the population level.

Distribution and Abundance

Two major population properties.

Distribution and abundance of organisms are affected by community interactions and environmental changes.

Ex. Natural Disasters

Ex. Changes in Resource Availability

Ex. Human Impact

Modeling Community Interactions

Interactions among populations can be modeled and those models can be used to inform predictions abou

Recipient

Donor

− / + Altruism	− / − Spite
+ / + Cooperation	+ / − Selfishness

But Don’t Forget

“You cannot do only one thing”

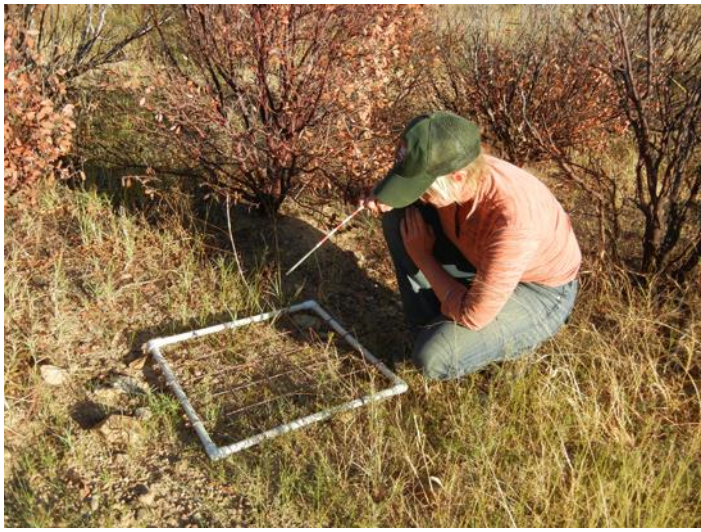
-Garret Hardin

7.7: Communities are composed of populations of organisms that interact in complex ways.

1. MEASURING COMMUNITIES

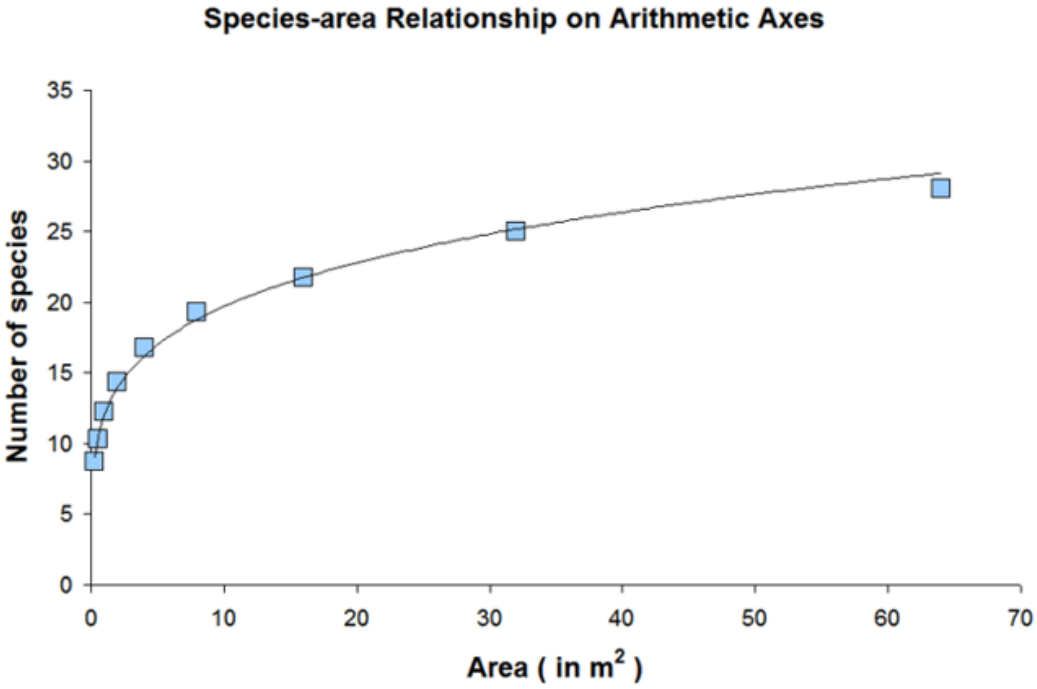
Quantifying Communities

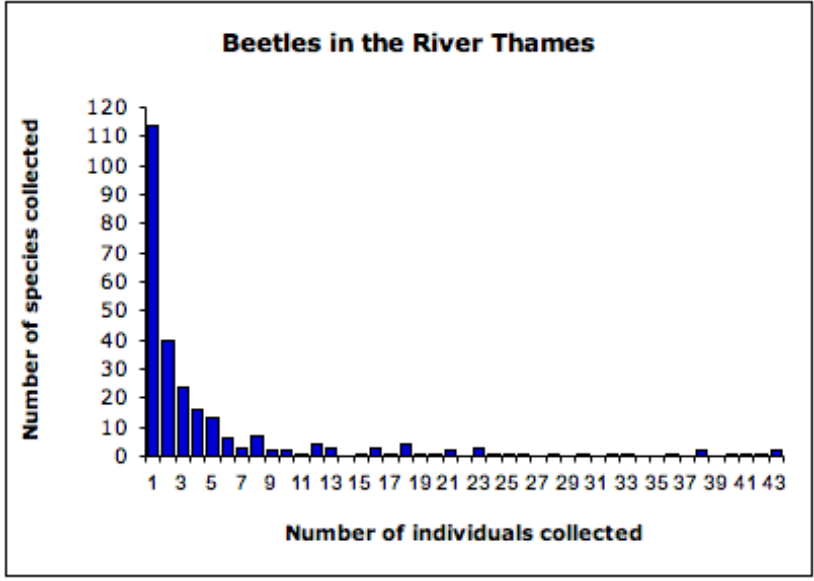
Community structure is measured in different ways.

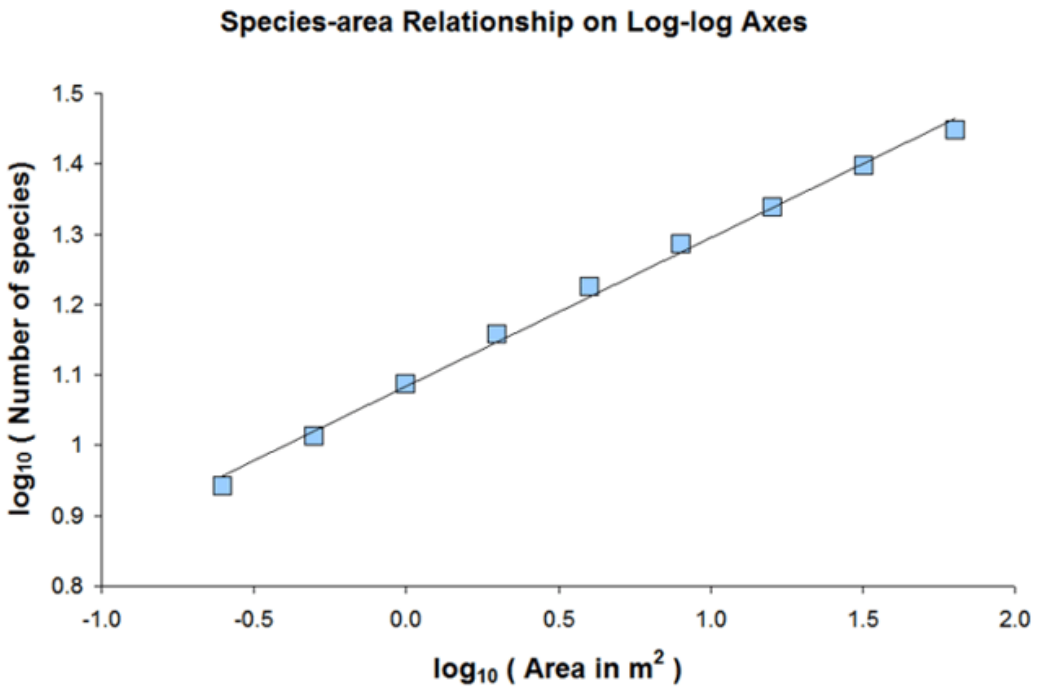


Species Richness: The number of species in the community

Species Diversity: The number and distribution of species in the community


Species-area Relationship on Arithmetic Axes
Number of species
Area (in m2)
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70


Beetles in the River Thames
Number of species collected
Number of individuals collected
0
10
20
30
40
50
60
70
80
90
100
110
120
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43


Species-area Relationship on Log-log Axes
log10 (Number of species)
log10 (Area in m2)
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0

Quantifying Populations

Population growth patterns can be modeled according to several different representations

Exponential model: assumes unlimited resources

Logistic model: accounts for the effect of the "**carrying capacity**" on population growth.

Demographic Representations: Analyze the age structure of a population

These models can be used to represent different aspects of populations.

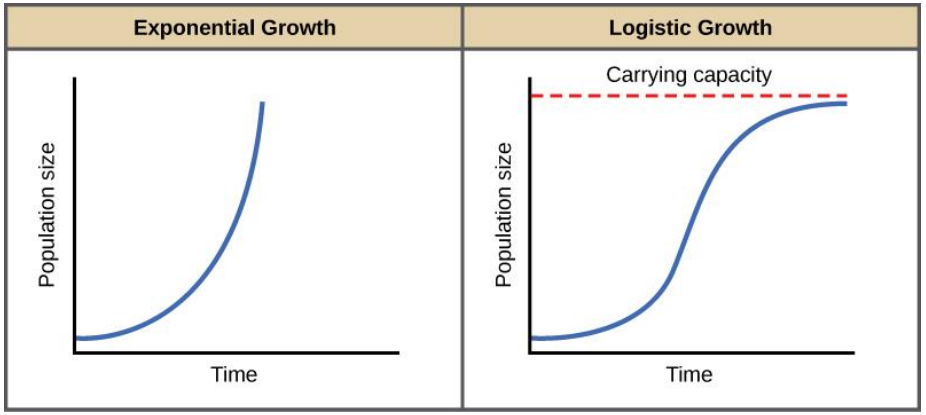
(a)

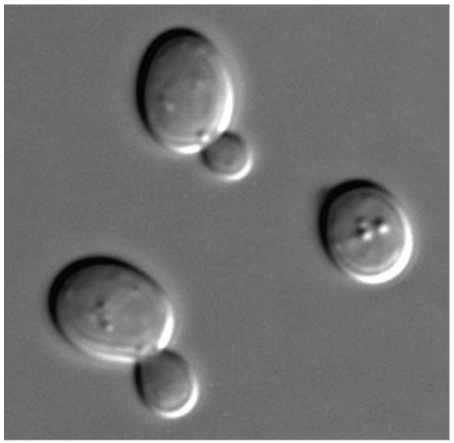
(b)

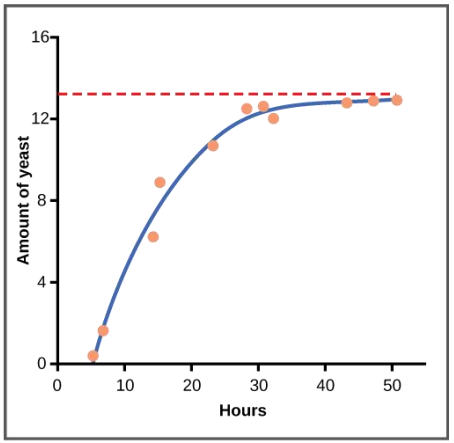
(c)

Population Growth modeled and actual.

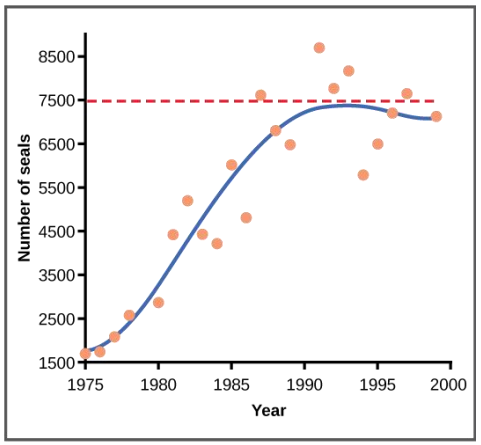
The type of growth shown depends on resource availability and the impact of limiting factors.





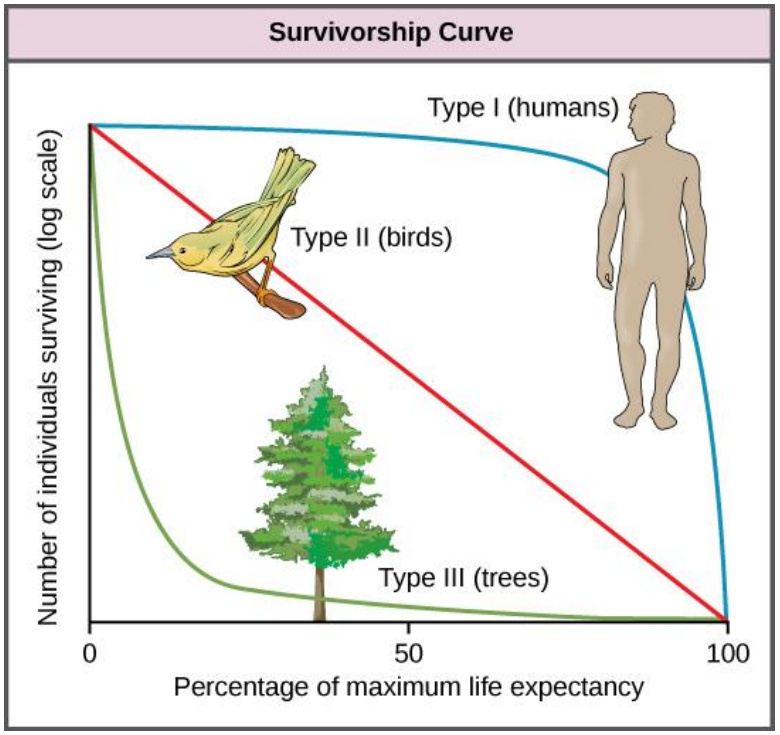


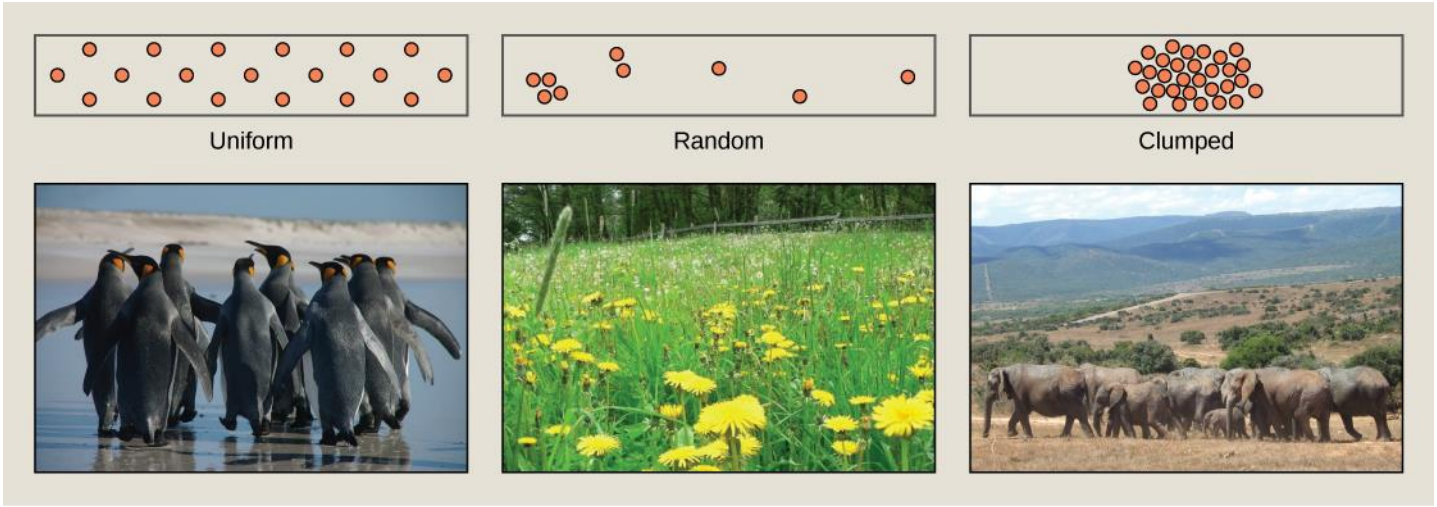
(a)



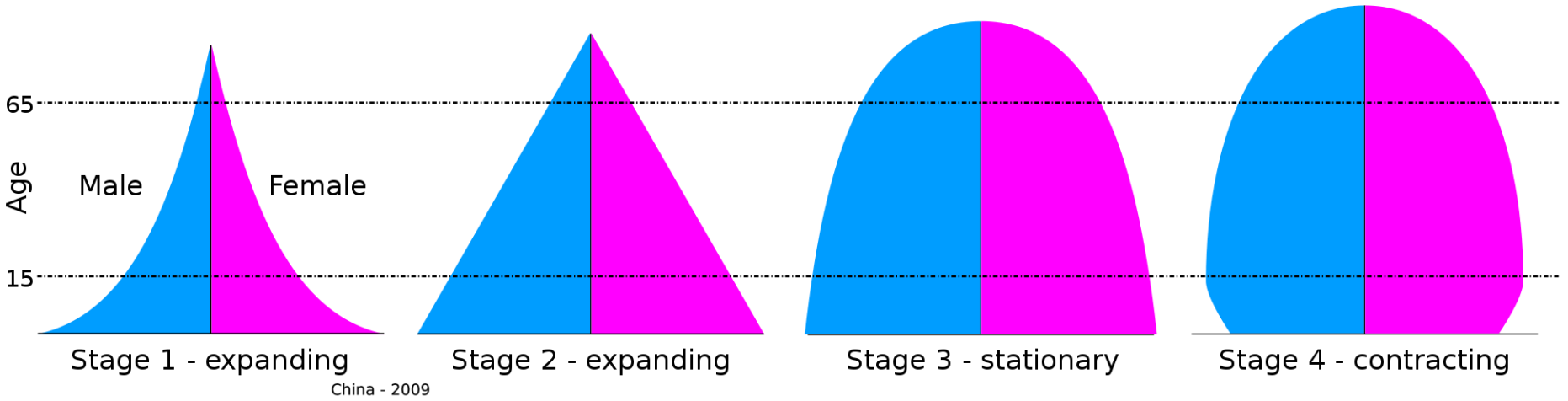
(b)

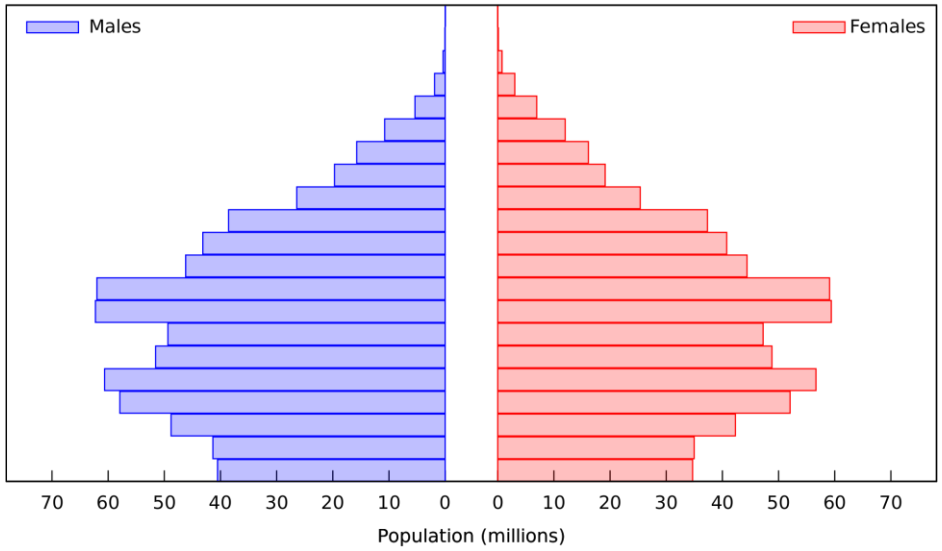
Patterns of **survivorship** and **distribution**

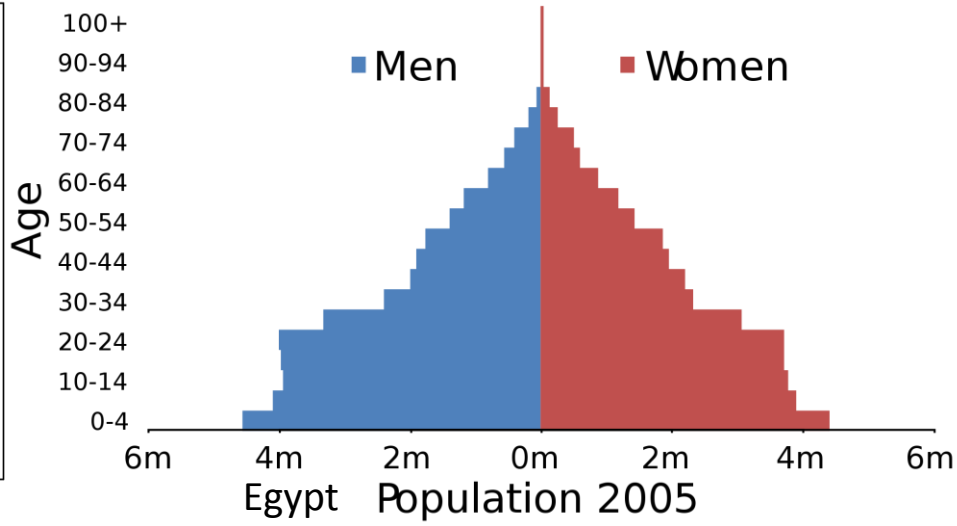


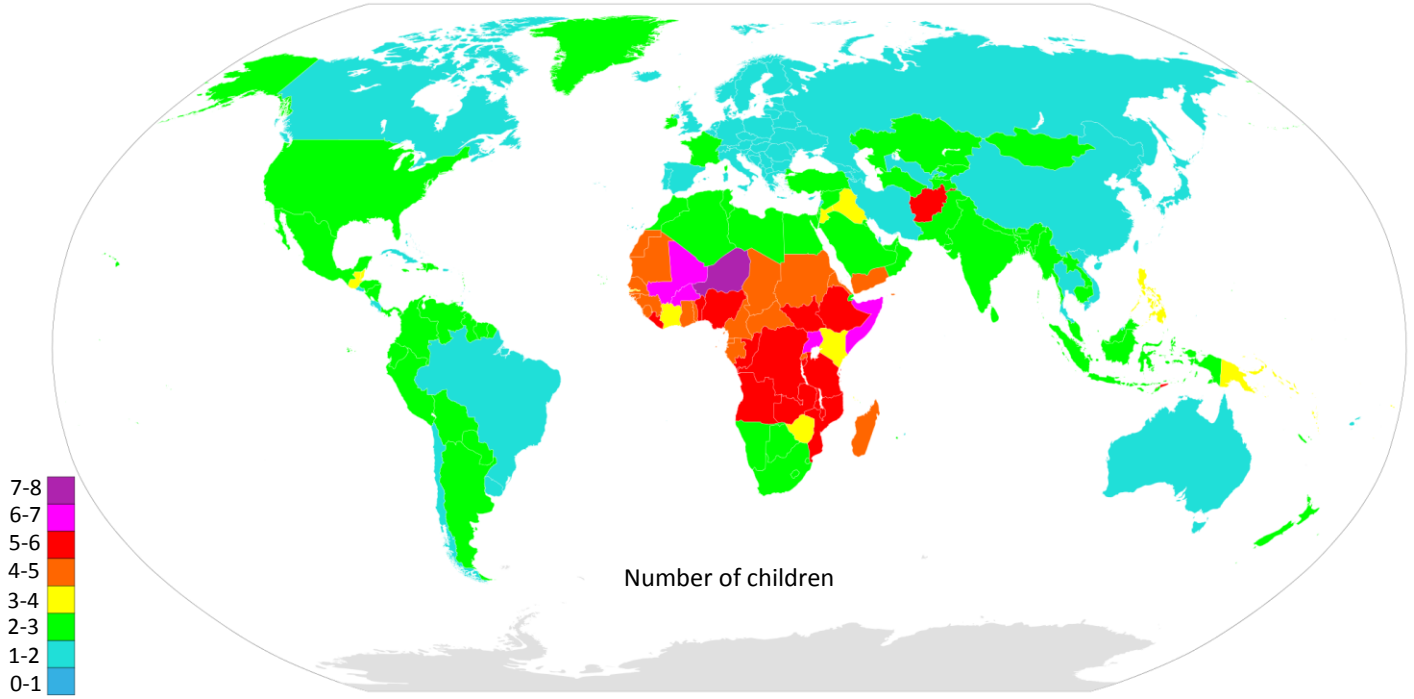


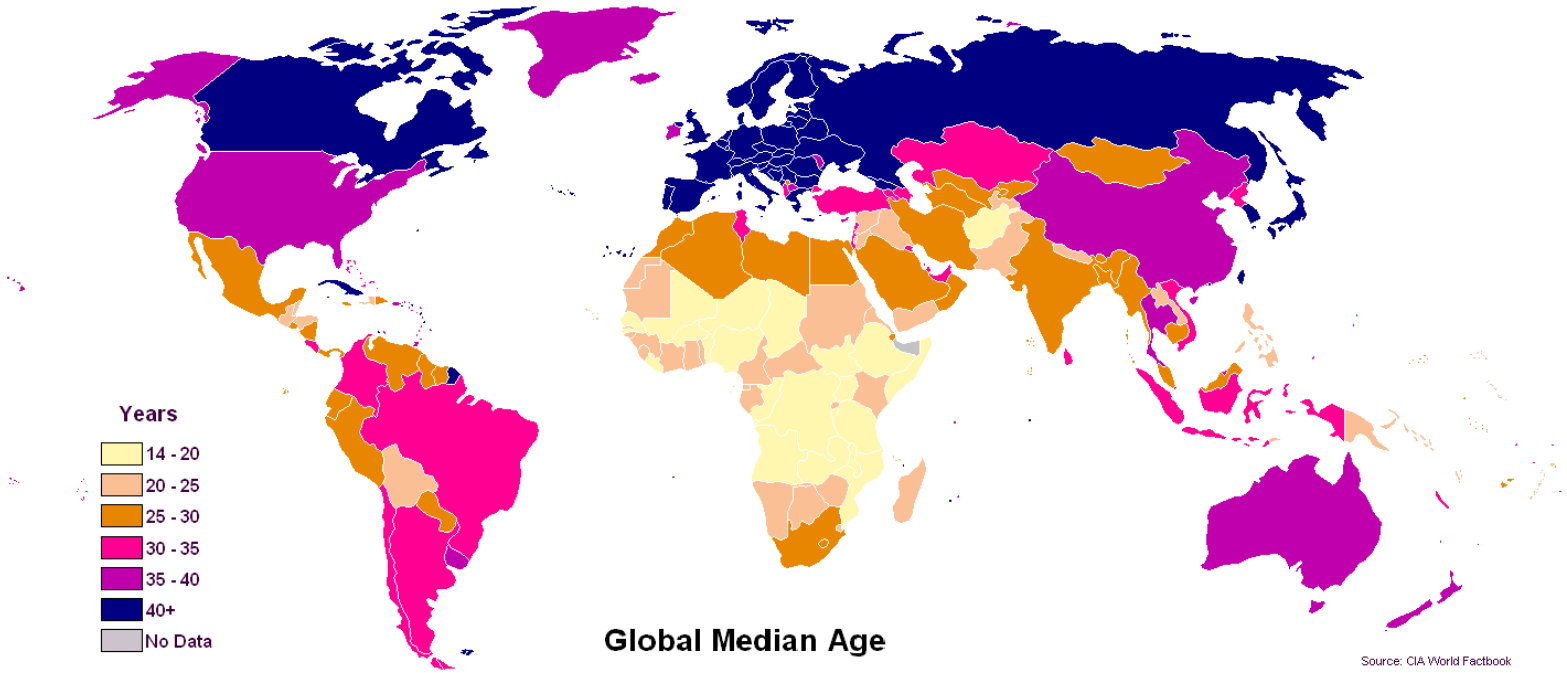
Demographic analysis of the human population








7-8
6-7
5-6
4-5
3-4
2-3
1-2
0-1
Number of children


Years
14 - 20
20 - 25
25 - 30
30 - 35
35 - 40
40+
No Data
Global Median Age
Source: CIA World Factbook

7.7: Communities are composed of populations of organisms that interact in complex ways.

2. MATH SKILLS: POPULATION GROWTH EQUATIONS

What You Have To Do

Use the population growth equations (on the formula sheet) to analyze population growth in situations that you will be presented with.

WATCH OUT FOR SNEAKINESS!

There are four major population growth equations that you need to be familiar with.

Rate Equation

Used to determine the amount of change over a period of time:

$$dY/dt$$

dY = amount of change

dt = time

Population Growth

Used to determine how many individuals will be gained or lost in a population over time.

$$dN/dt = B - D$$

dN = amount of change in the population size

dt = time

B = birth rate

D = death rate

Exponential Growth

Used to determine the maximum growth for a population assuming unlimited resources.

$$\frac{dN}{dt} = r_{max}N$$

dN = amount of change in the population size

dt = time

r_{max}= maximum per capita growth rate of the population

Logistic Growth

Used to determine the growth in a population while accounting for the effect of a carrying capacity

$$\frac{dN}{dt} = r_{max} N \left(\frac{K-N}{K} \right)$$

change in the

population size

dt = time

r_{max}= maximum per capita growth rate of the population

N = population size

K = Carrying capacity

Sample Problem

Over the span of one year, there are 20 deaths and 35 births in a population of 200 African elephants.

- **Determine the maximum per capita growth rate of the population.**
- **If the carrying capacity for the population in the environment is 300 elephants, determine the number of elephants that can be predicted in the population at the end of the next year, if the maximum per capita growth rate does not change.**