"The more I read, the more I acquire, the more certain I am that I know nothing."
– Voltaire

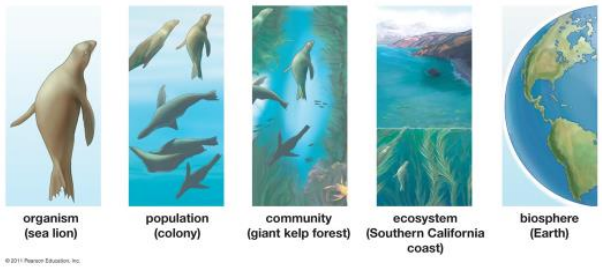
"Suburbia is where the developer bulldozes out the trees, then names the streets after them."
- Bill Vaughan

Population and Community Ecology

Chapter 10

Studying Ecosystems

Ecology: Study of _____ that living things have with each other and with their environment



Different Levels of Study

Individuals: study of individual organisms within an environment

Population: all the members of a single species living in the same geographic area at the same time

_____: populations of all species that interact with one another in the same geographic area

Ecosystem: community of organisms and the _____ environment with which they interact

- Biotic and abiotic factors

Factors that Influence Population Growth

Demography: the study of factors that determine the size and structure of populations through time

Four factors that determine the actual size of a population

- Natality: birth rate
- Mortality: death rate
- Immigration: migrate into a population
- Emigration: migrate out of an area

Fecundity: the number of _____ produced by each female in the population

- Actual reproductive rate of the population

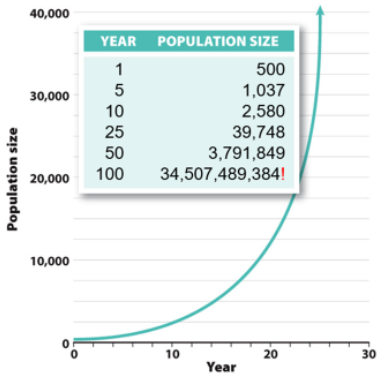
Population Growth

_____ **(*r*):** the change in the number of individuals in the population over some unit of time (year)

- Growth rate = natality – mortality

Population growth = *r* x *N*

- where *N* equals the current number of individuals in the population



YEAR	POPULATION SIZE
1	500
5	1,037
10	2,580
25	39,748
50	3,791,849
100	34,507,489,384!

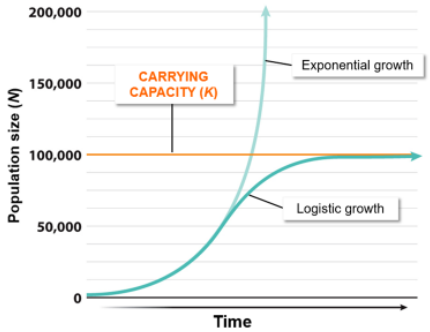
Types of Population Growth

Exponential growth: when the population's per capita (per individual) growth rate remains constant regardless of the population size

- J-shaped curve

Logistic growth: the density-_____ decrease in growth rate as population size reaches the carrying capacity

- S-shaped curve

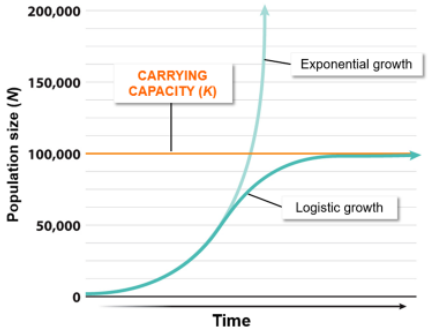


Types of Population Growth

Carry capacity (*K*): the maximum population size of a certain species that a given habitat can support

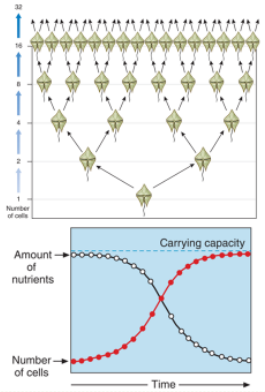
Environmental resistance: forces of the environment that act to _____

- Competition for resources, predation, disease

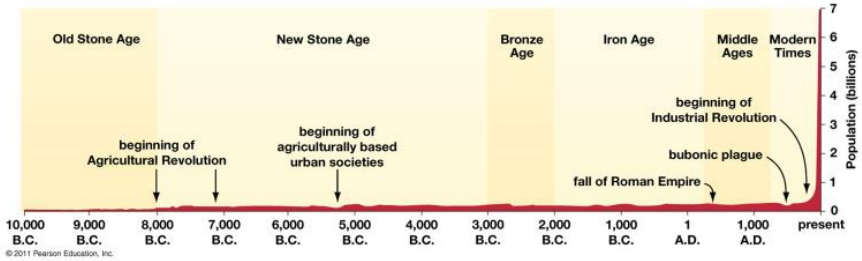


Exponential Population Growth

- Dinoflagellates are single celled organisms. When they replicate their offspring divide and so on resulting in exponential population growth
  - Algal blooms
- As the dinoflagellate population increases the amount of nutrients to support the population decreases



Human Population Growth



Different Life History Strategies

Density dependent: when the density of the population becomes limited by factors that limit population growth

- Food supply, space

***K*-selected species**: one whose population sizes tend to be limited by

_____

- Density dependent

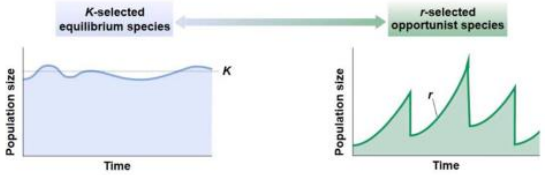
r-selected species: one whose population size is limited by

_____

- Density independent

Population Dynamics

Population size:
- limited by carrying capacity
- density dependent
- relatively stable



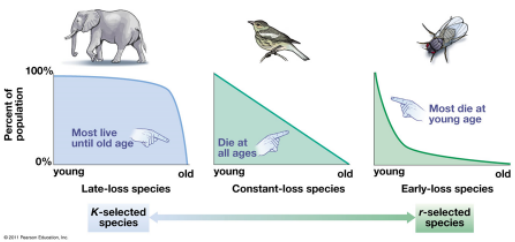
Population size:
- limited by reproductive rate
- density independent
- relatively unstable

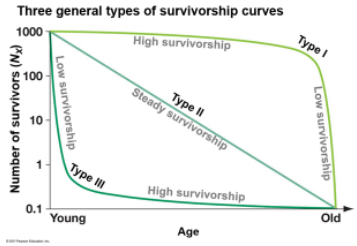
r-Selected and *K*-selected Species

***r*-selected**	***K*-selected**
_____ environment	_____ environment
Small organism size	Large organism size
Little energy used to produce each offspring	Large amount of energy used to produce each offspring
_____ offspring produced	____ offspring produced
Early maturity	Late maturity (long parental care)
Short life expectancy	Long life expectancy
Single reproduction in lifetime	Multiple reproductions in lifetime

Survivorship Curves

- Type I and Type II = *K*-selected species
- Type III = *r*-selected species





Community Ecology

Interactions among different species	Affect on fitness for species 1	Affect on fitness for species 2
Competition: occurs when individuals use the same resources	_____	Negative
Predation and parasitism: occurs when one organism eats or absorbs nutrients from another	Positive	Negative
_____: occurs when two species interact in a way that confers fitness benefits to both	Positive	Positive
Commensalism: occurs when one species benefits but the other species is unaffected	Positive	Unaffected

Community Ecology

Intraspecific competition: completion among members of the <u>same species</u>

- Resources, space, sunlight, food, mates
- Increases as pop. density increases

Interspecific competition: competition among individuals of <u>different species</u> for the same limited resources

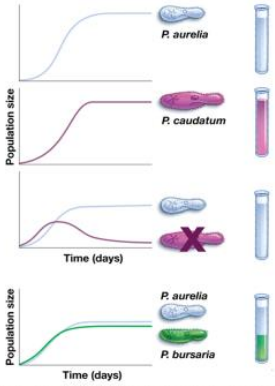
Interaction Through Competition

_____: an organism's place or role within a community

- Space it requires, food it consumes, reproductive requirements

Competitive exclusion principle: two species cannot occupy the same ecological niche in the same area, because one species will always out compete the other

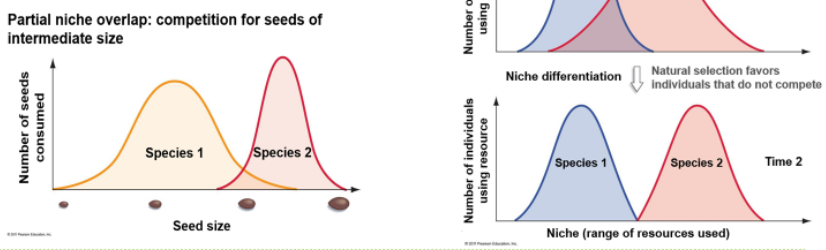
- G.F. Gause – It is not possible for two species to occupy the same ecological niche in the same area



Resource Partitioning

Resource partitioning: dividing up of scarce resources among species with similar requirements

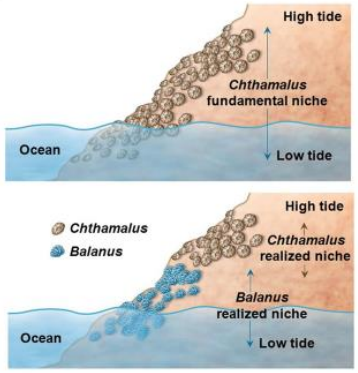
- _____



Fundamental vs. Realized Niche

Fundamental niche: the full range of environmental conditions and resources an organism can possible occupy and use in the absence of competitors

_____ **niche**: the part of the fundamental niche that an organism occupies as a result of competitors in the habitat

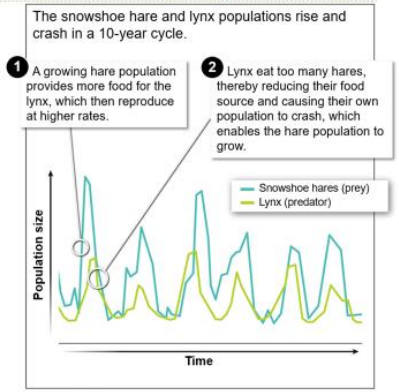


Parasitism

Parasitism: a non-mutual symbiotic relationship, where one species (the parasite) benefits at the expense of the other (the host)

Predator and Prey Relationships

- Predator and prey populations are often linked in a dynamic relationship of population increases and decreases

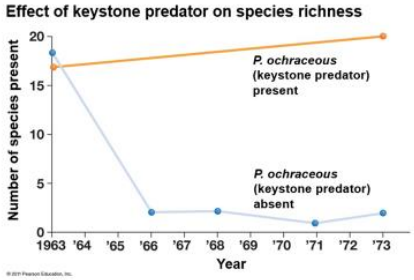


Predator and Prey Relationships

- Predators act to control prey populations
  - _____: a species whose absence in the community would bring about significant change in that community

Predator: *Pisaster ochraceous*

Prey: *Mytilus californianus*



Predatory Defenses

Coevolutionary _____: a repeating cycle of reciprocal adaptation

Camouflage: blending into the background

A leaf insect disappears among the leaves

Schooling: safety in numbers

A school of fish confuses a shark

Weaponry: fighting back

Porcupines use their spines to fight back.

Evolutionary Arms Race

"Arms races . . . it is a colorful way of talking about coevolution, particularly when it is coevolution between enemies: between predator and prey, between parasite and host. Adaptations on one side call forth counter adaptations on the other side, and the counter adaptations call forth more and so on, escalating all the time.
The consequence is that the apparatus that we see gets better but the efficacy of it does not necessarily get better because the other side is getting better at the same time."
-Richard Dawkins

Evolutionary Arms Race

Coevolutionary arms race: a repeating cycle of _____ between predators and prey

The crab is the natural predator of the snail, and can break the snail shell with its large claws

Snails with thicker shells and spines are more likely to survive and reproduce (natural selection)

Through natural selection, crabs evolve more powerful claws that can pierce the snails' thick, spiny shells

In response, natural selection favors snails with even thicker shells and more spines

Mutualism

Mutualism: An interaction between individuals of two species that is <u>beneficial</u> to both individuals

<u>Examples of mutualistic relationships</u>

- Flowers and pollinators
- Mycorrhizal fungi and plants root systems
- Ants and acacia trees
- Cleaner shrimp or fish and larger fish
- E.coli and humans
- Termites and trichonympha

(a) Mutualism between ants and acacia trees

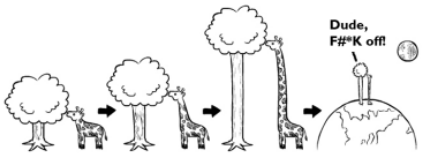
(b) Mutualism between cleaner shrimp and fish

Coevolution

Coevolution: interdependent evolution of two or more species

(a) What we see

(b) What a bee sees



Commensalism

Commensalism: an interaction between individuals of two species in which one benefits while the other is neither harmed nor helped

- Whale poo stimulates phytoplankton growth
- Elephants kicking up insects for cattle egrets

Biodiversity

Biological diversity or biodiversity: the _____ of plants and animals, or other living things, in a particular area or region

<u>Three levels of Biodiversity</u>

_____ diversity

Species diversity

Ecosystem diversity

Genetic Diversity

Genetic diversity: genetic variation among individuals of the _____

- _____ potential
  - Disease resistance
  - Antibiotic resistance

Species Diversity

Species diversity: the variety of species within an ecosystem

- Health of an ecosystem
  - Diverse ecosystems are have a greater adaptive potential

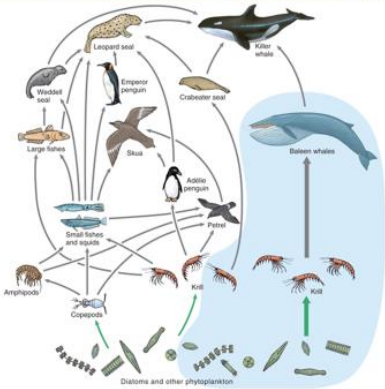
- Potential benefits to humans
  - Medications
    - Approximately 40% of all prescriptions originated from plants and animals
  - Food
    - 80,000 species of edible plants on Earth
  - Products
    - Wood, fibers for clothing and other uses, lotions, oils, etc..

Marine Food Webs

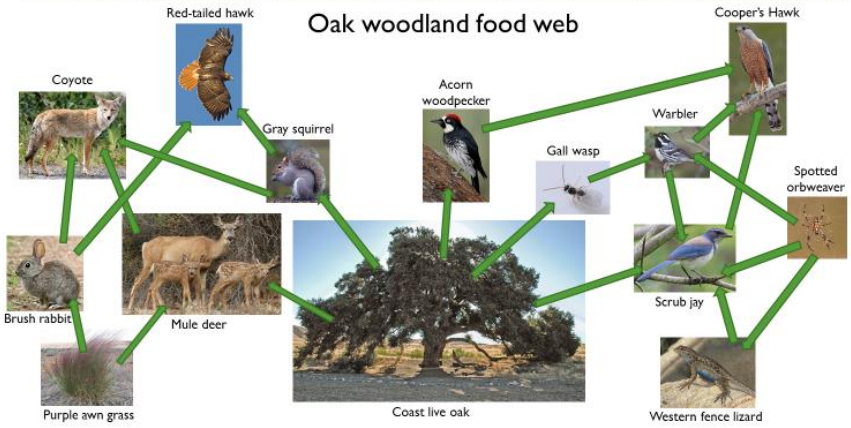
Food chain: the linear transfer of energy between organisms in an ecosystem from producers to consumers

- Phytoplankton → Krill → Whale

Food web: the interconnection of all the food chains within a particular ecosystem



Species Diversity



Species Diversity

Oak woodland food web

Trophic Levels

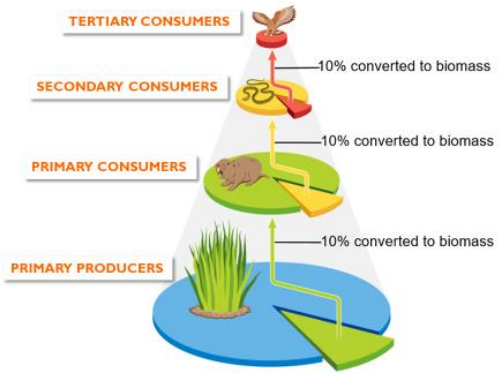
Primary producers: autotrophs (algae) that convert solar energy to chemical energy

Primary consumers: herbivores are animals that eat plants

Secondary consumers: carnivores are animals that eat herbivores

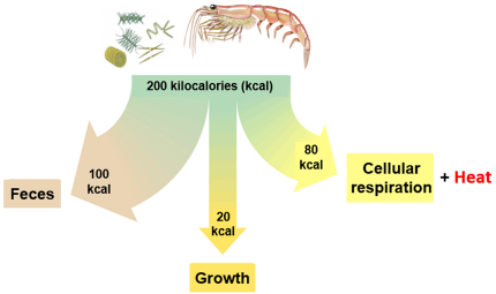
Tertiary consumers: carnivores that eat other carnivores

- Only about ___% of the biomass from one trophic level is converted to biomass in the next trophic level



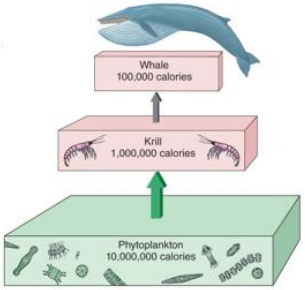
Energy Transfer Between Trophic Levels

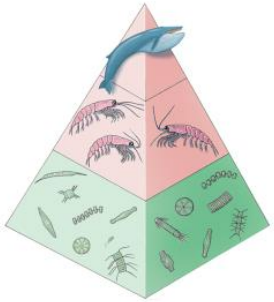
- Most energy consumed is lost as waste or is used in cellular respiration and is lost as heat.
- Only about 10% of consumed energy goes toward growth (stored energy), which can then be passed on to the next trophic level
- _____ available at higher trophic levels



Trophic Levels

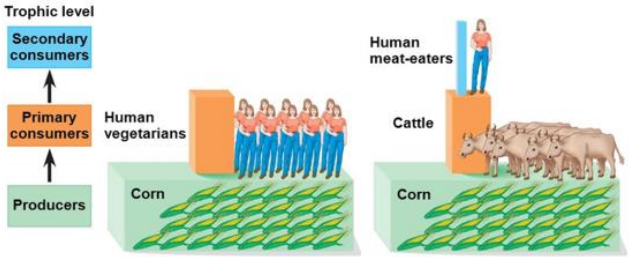
- Only about 10% of the biomass from one trophic level is converted to biomass in the next trophic level, which results in fewer top predators



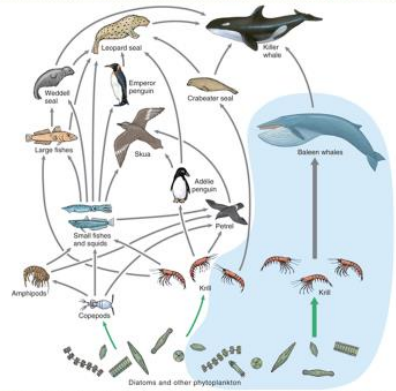


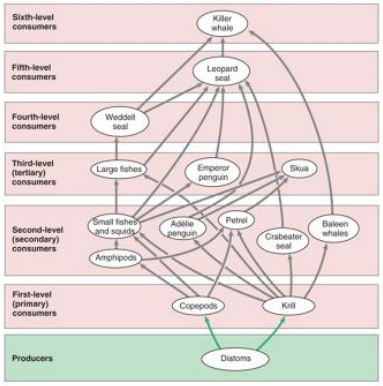
Trophic Levels

- Eating meat is an inefficient way of using the available energy from primary production
  - It takes 10 pounds of feed corn to produce 1 pound of bacon or beef steak



Trophic Levels

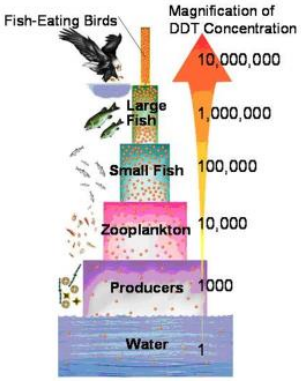




Biomagnification

Biomagnification: toxic substances become increasingly _____ within living things as they move up each trophic level

- Common with DDT, Mercury, and PCB's



Ecosystem Diversity

Ecosystem diversity: variation of types of ecosystems in a given area

- Many ecosystems under threat in developing areas
  - >50% of tropical rainforests on earth have been lost
  - >85% of coastal sage scrub habitat lost in southern California
  - >90% of estuaries and other riparian habitats lost in California

Ecosystem Diversity

- **Ecosystem services**: all the processes through which natural ecosystems benefit human life.
  - Provide water, food and building materials
  - Oxygen production and nutrient cycling
  - Medicinal benefits derived from plants
  - Pollinators
  - Erosion control
  - Water filtration
  - Decomposition of organic material
  - Recreation and cultural services




Check Your Understanding

True or False: population growth in *r*-selected species tends to be limited by carrying capacity

True or False: humans are currently experiencing exponential growth

True or False: Two species with the same ecological niche can coexist within the same area

Check Your Understanding

A(n) _____ consists of all the different species that interact and live within a given area.

a. population
b. community
c. ecosystem
d. demography

Check Your Understanding

Which of the following characterizes the relationship between two species where one species benefits at a cost to the other species?

a. Commensalism
b. Mutualism
c. Predation
d. Competition