Important Word Roots

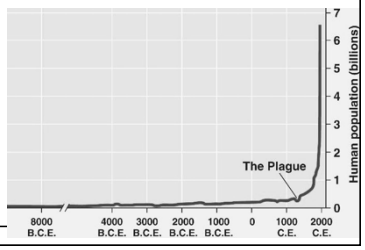
Cryptic	Aposematic	Herbivory	Trophic
• Greek kryptikós = hidden	• Apo = Away • Sema = sign • AKA WARNING COLORS	• herba "a herb" + vorare "devour, swallow"	• trophē nourishment

Endemic	Biodiversity	Interspecific
• Greek endēmia action of dwelling • Opposite of introduced	• Bio = Life • Diversity = Difference	• Competition between 2+ species

Biology and Society: Why Biodiversity Matters

- The expanding human population threatens
  - biodiversity and
  - the loss of natural ecosystems.

What Kind of Population Growth is this?



Biology and Society: Why Biodiversity Matters

- Healthy ecosystems
  - purify air and water,
  - decompose wastes, and
  - recycle nutrients.

IN A HEALTHY ECOSYSTEM NOTHING GOES TO WASTE.

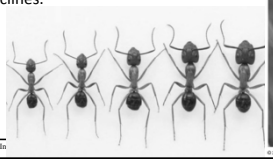
THE LOSS OF BIODIVERSITY

– Biological diversity, or **biodiversity**, includes
  - genetic diversity,
  - species diversity, and
  - ecosystem diversity.

Genetic Diversity

– The genetic diversity within populations of a species is the raw material that makes microevolution and adaptation to the environment possible.

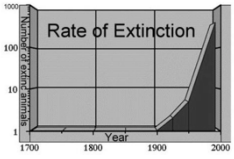
– Genetic resources for that species are lost if
  1. local populations are lost and/or
  2. the number of individuals in a species declines.



Species Diversity

We are in the midst of the 6th mass extinction

- Ecologists believe that we are pushing species toward extinction at an alarming ra
- The present rate of species loss may
  – be 100 times higher than at a time in the past 100,000 year and
  – result in the loss of half of all living plant and animal species by the end of this century.

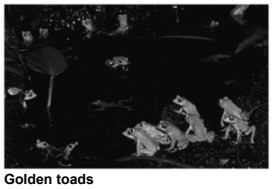


Species Diversity

– Two recent victims of human-caused extinctions are
  - Chinese river dolphins and
  - golden toads.

Figure 20.2

A Chinese river dolphin



Golden toads

Ecosystem Diversity

- The local extinction of one species can have a negative effect on the entire ecosystem.
- The disappearance of natural ecosystems results in the loss of **ecosystem services**, functions performed by an ecosystem that directly or indirectly benefit people, including
  – air and water purification,
  – climate regulation, and
  – erosion control.

Ecosystem Diversity

– Coral reefs are rich in species diversity, yet
  - an estimated 20% of the world's coral reefs have been destroyed by human activities and
  - a 2011 study found that 75% of the remaining reefs are threatened, climbing to 90% by 2030 if current abuse continues.

PLAY Video: Coral Reef

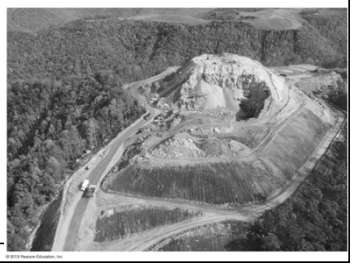
Causes of Declining Biodiversity

– Ecologists have identified four main factors responsible for the loss of biodiversity:

1. Habitat destruction and fragmentation,
2. Invasive species,
3. Overexploitation, and
4. Pollution.

Habitat Destruction

– Biodiversity is threatened by the destruction and fragmentation of habitats by
  - agriculture,
  - urban development,
  - forestry, and
  - mining.



Invasive Species

– Invasive species have
  - competed with native species,
  - preyed upon native species, and
  - parasitized native species.

Overexploitation

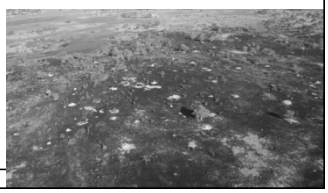
- People have overexploited wildlife by harvesting at rates that exceed the ability of populations to rebound. *(Food, Pets and Fear)*
- Overharvesting has greatly affected populations of
  - Tigers, the American bison, and Galápagos tortoises.

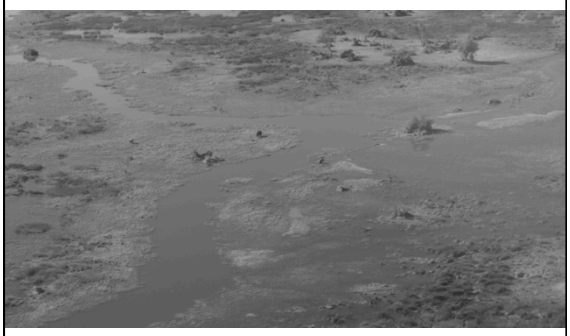
Pollution

- Air or water pollution is a contributing factor in declining populations of hundreds of species.
  - Acid precipitation is a threat to ecosystems.
  - The global water cycle can transport pollutants from terrestrial to aquatic ecosystems hundreds of miles away.

COMMUNITY ECOLOGY

- An organism's biotic environment includes
  - other individuals in its own population and
  - populations of other species living in the same area.
- An assemblage of species living close enough together for potential interaction is called a **community.**





Interspecific Interactions

– **Interspecific interactions** are interactions between species.

Interspecific Interactions

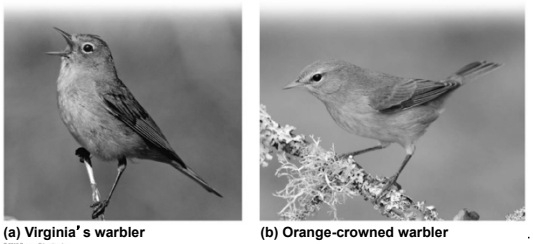
– Interspecific interactions can be classified according to the effect on the populations concerned.
  - **Competition: -/-** interactions occur when two populations in a community compete for a common resource.
  - **Mutualism: +/+** interactions are mutually beneficial, such as between plants and their pollinators.
  - **Predation: +/-** interactions occur when one population benefits and the other is harmed, such as in predation.

Interspecific Competition (-/-)

– In **interspecific** (between-species) **competition**, the population growth of a species may be limited
  - by the population densities of competing species and
  - by the density of its own population.

Interspecific Competition (-/-)

- An ecological **niche** is an organism's total use of the
  - abiotic and
  - biotic resources in its environment.



(a) Virginia's warbler (b) Orange-crowned warbler

Interspecific Competition (-/-)

– The **competitive exclusion principle** states that if two species have an ecological niche that is too similar, the two species cannot coexist in the same place.
  - So they separate and segregate niches

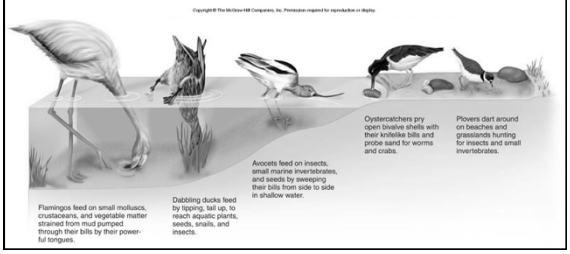
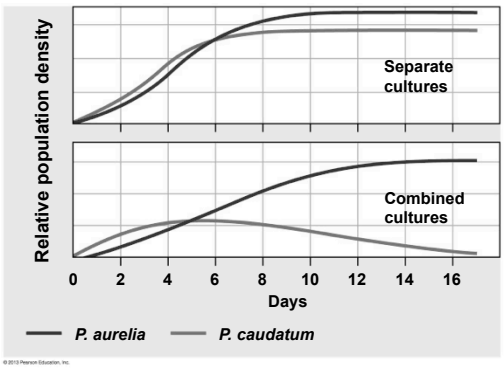
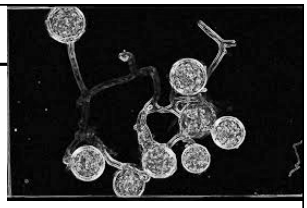


Figure 20.8a



Mutualism (+/+)



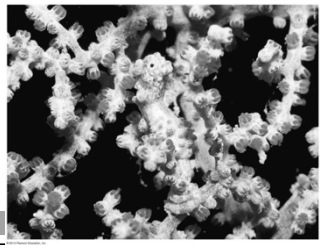
- In **mutualism**, both species benefit from an interaction.
- One example is the root-fungus associations known as mycorrhizae.

Predation (+/-)

- **Predation** refers to an interaction in which one species (the predator) kills and eats another (the prey).
- Numerous adaptations for predator avoidance have evolved in prey populations through natural selection.

Predation (+/-)

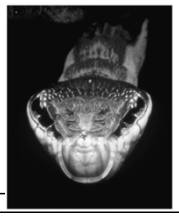
- **Cryptic coloration** is
  - camouflage and
  - a way for prey to hide from predators.



PLAY

Predation (+/-)

– Some insects have elaborate disguises that make them resemble
  - twigs,
  - leaves,
  - bird droppings, and
  - predators.



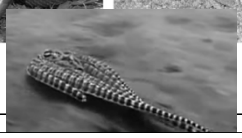

Predation (+/-)

– An **Aposmotic/warning coloration** is
  - a brightly colored pattern and
  - a way to warn predators that an animal has an effective chemical defense.

Predation (+/-)

– Mimicry is a form of defense in which one species looks like another species.



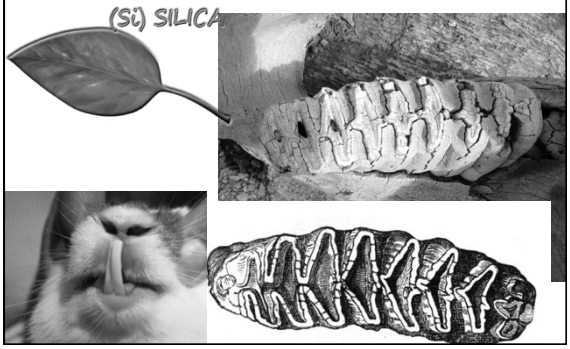


Herbivory (+/-)

- **Herbivory** is the consumption of plant parts or algae by an animal.
- Plants have evolved numerous defenses against herbivory, including
  - spines,\
  - Silica (glass)
  - thorns, and
  - chemical toxins.

Evolutionary Arms Race

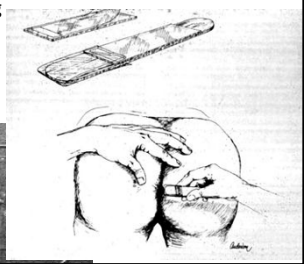
Between plants and herbivores



Parasites and Pathogens (+/-)

Plants and animals can be victims of

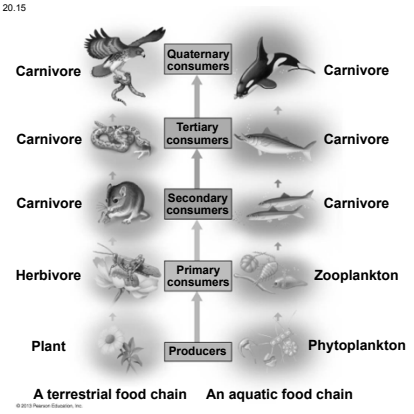
- **parasites**, animals that live in or on a **host** from which they obtain nutrients, or
- pathogens, disease-causing
  - bacteria,
  - viruses,
  - fungi, and
  - protists.



Trophic Structure

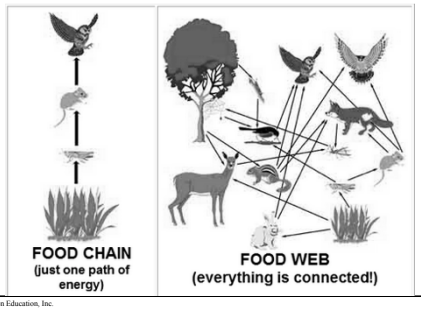
- **Trophic structure** is the feeding relationships among the various species in a community.
- A community's trophic structure determines the passage of energy and nutrients from plants and other photosynthetic organisms
  - to herbivores
  - and then to predators.

Figure 20.15



Trophic Structure

- The sequence of food transfer between trophic levels is called a **food chain**.



Trophic Structure

- **Primary consumers** are called **herbivores**, which eat plants.
- Above the level of primary consumers are **carnivores**, which eat the consumers from the level below.
  - **Secondary consumers** eat primary consumers.
  - **Tertiary consumers** eat secondary consumers.
  - **Quaternary consumers** eat tertiary consumers.

Figure 20.15a

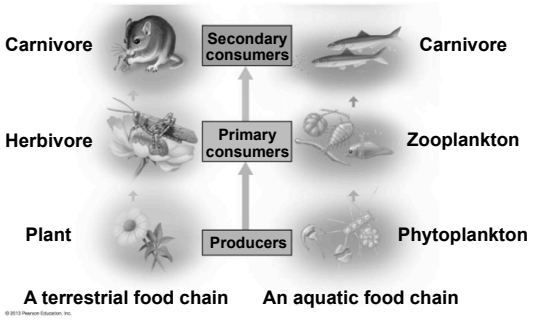
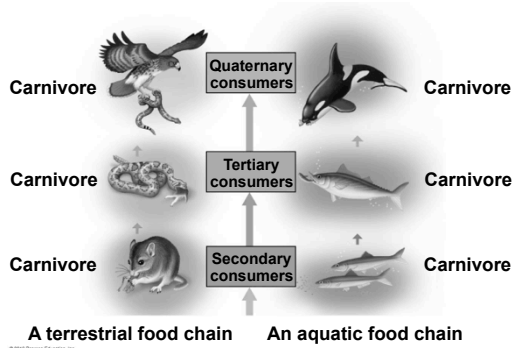


Figure 20.15b



Trophic Structure

- Different organisms consume detritus.
  - **Scavengers**, such as crows and vultures, feast on carcasses.
  - **Detritivores**, such as earthworms and millipedes, primarily consume decaying organic material.
  - **Decomposers**, mainly prokaryotes and fungi, secrete enzymes that digest molecules in organic material and convert organic materials into inorganic forms.

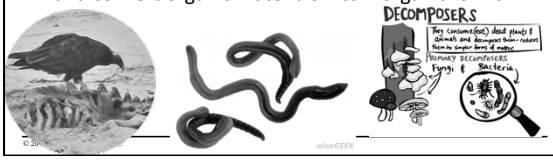
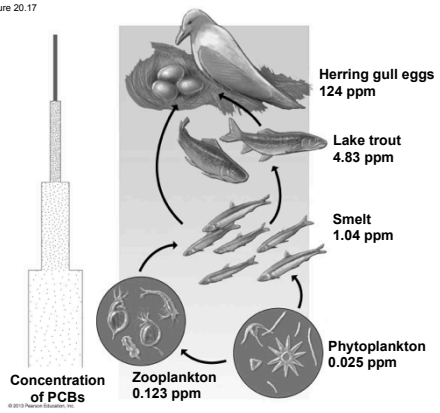


Figure 20.16

Biological Magnification

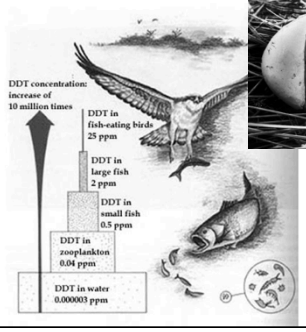
- Toxins become concentrated as they pass through a food chain in a process called **biological magnification**.

Figure 20.17



DDT Food Chain

http://www.learner.org/courses/envsci/visual/visual.php?shortname=ddt



Weakens the shell of top predator birds

Species Diversity in Communities

- A **keystone species** is a species whose impact on its community is much larger than its total mass or abundance indicates.
- Experiments in the 1960s
  - were among the first to provide evidence of the keystone species effect and
  - demonstrated that a sea star functioned as a keystone species in intertidal zones of the Washington coast.

Keystone Species and Their Role in Ecosystems

of a keystone
(Credit:
.com)

Q: What would happen if you removed the keystone?

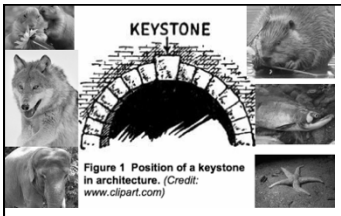


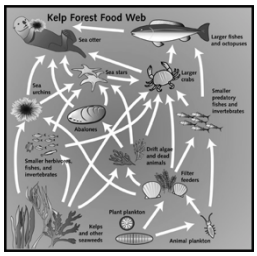
Figure 1 Position of a keystone in architecture. (Credit: www.clipart.com)

Keystone Species

1) A keystone species is a species whose whose **impact** on its community or ecosystem are larger and **greater** than would be **expected** from its relative **abundance or total biomass** in the environment.
2) Keystone species play the same role in many ecological communities by maintaining the structure and integrity of the community.

Keystone Species: Sea Otter

- Food Web Overview:
  1. Sea Otters eat urchins
  2. Urchins eat Kelp



ECOSYSTEM ECOLOGY

– Energy flows *through* and ultimately out of ecosystems.
– Chemicals are recycled *within* and *between* ecosystems.

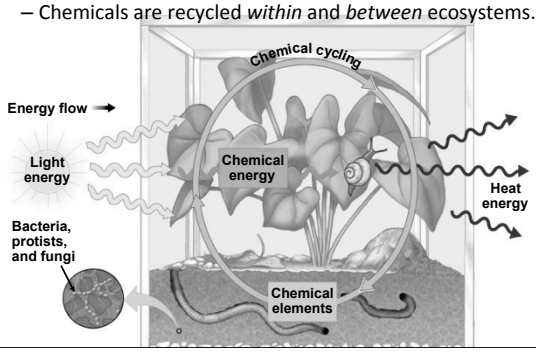


Figure 20.29

Energy Flow in Ecosystems

– All organisms require energy for
  1. growth,
  2. maintenance,
  3. reproduction, and,
  4. in many species, locomotion.

Primary Production and the Energy Budgets of Ecosystems

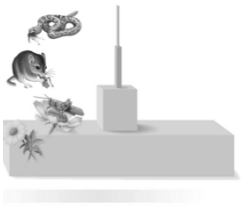
– Each day, Earth receives about 10^{19} kcal of solar energy, the energy equivalent of about 100 million atomic bombs.
– Most of this energy is absorbed, scattered, or reflected by the atmosphere or by Earth's surface.
– About 1% is converted to chemical energy by photosynthesis.

Ecological Pyramids

Figure 20.28

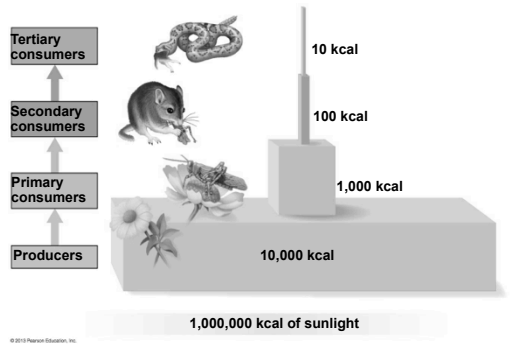
- A **pyramid of production** illustrates the cumulative loss of energy with each transfer in a food chain.

10% Rule



- The energy level available to the next higher level
  – ranges from 5 to 20% and
  – is illustrated here as 10%.

Figure 20.28



Ecological Pyramids

Energy Flow/10% Rule explains why

- top-level consumers require more geographic area and
- most food chains are limited to three to five levels.

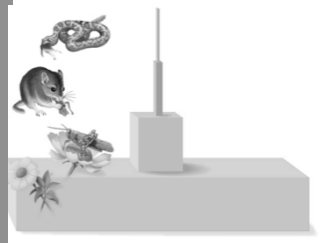
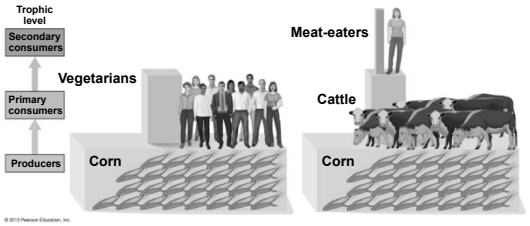


Figure 20.29



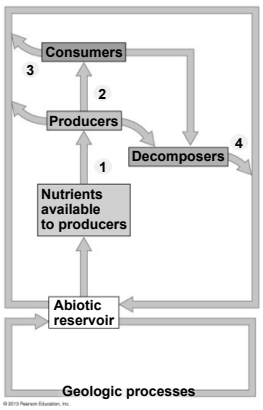
Chemical Cycling in Ecosystems

– Life depends on the recycling of chemicals.
  - Nutrients are acquired and waste products are released by living organisms.
  - At death, decomposers return the complex molecules of an organism to the environment.
  - The pool of inorganic nutrients is used by plants and other producers to build new organic matter.

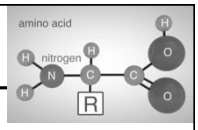
The General Scheme of Chemical Cycling

– **Biogeochemical cycles** involve
  - biotic components and
  - abiotic components from an **abiotic reservoir** where a chemical accumulates or is stockpiled outside of living organisms.

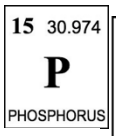
Figure 20.31

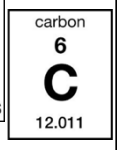


The General Scheme of Chemical Cycling



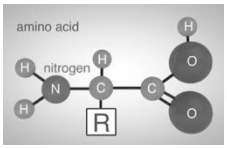
– Three important biogeochemical cycles are
  1. carbon,
  2. phosphorus, and
  3. nitrogen.

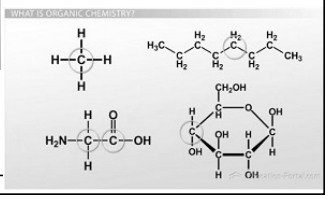




The Carbon Cycle

– Carbon, the major ingredient of all organic molecules,
  • has an atmospheric reservoir and
  • cycles globally.





The Carbon Cycle

– The cycling of carbon between the biotic and abiotic worlds is accomplished mainly by the reciprocal metabolic processes of
  • photosynthesis and
  • cellular respiration.

PLAY Blast Animation: Carbon C

PLAY Bioflix Animation: The Carbo

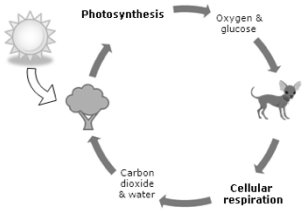
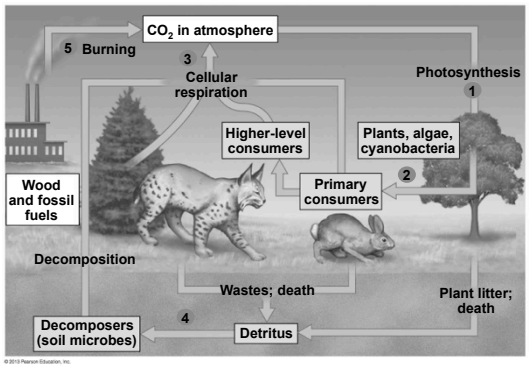


Figure 20.32



CONSERVATION AND RESTORATION BIOLOGY

- **Conservation biology** is a goal-oriented science that seeks to understand and counter the loss of biodiversity.

- **Restoration ecology** uses ecological principles to develop methods of returning degraded areas to their natural state.

Biodiversity "Hot Spots"

- Conservation efforts are often focused on **biodiversity hot spots**, relatively small areas that have
  - a large number of endangered and threatened species and
  - an exceptional concentration of **endemic species,** those that are found nowhere else.

Mouse lemur

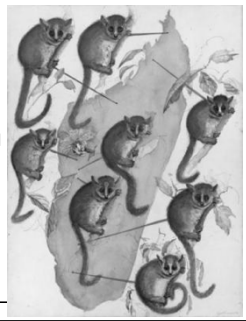
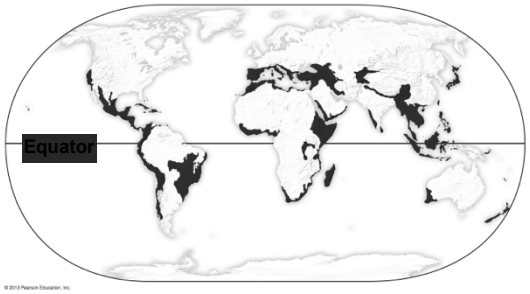


Figure 20.37



Conservation at the Ecosystem Level

- A **movement corridor** is a narrow strip or series of small clumps of suitable habitat that connects otherwise isolated patches.
- Corridors
  - can promote dispersal and help sustain populations and
  - are especially important to species that migrate between different habitats seasonally.