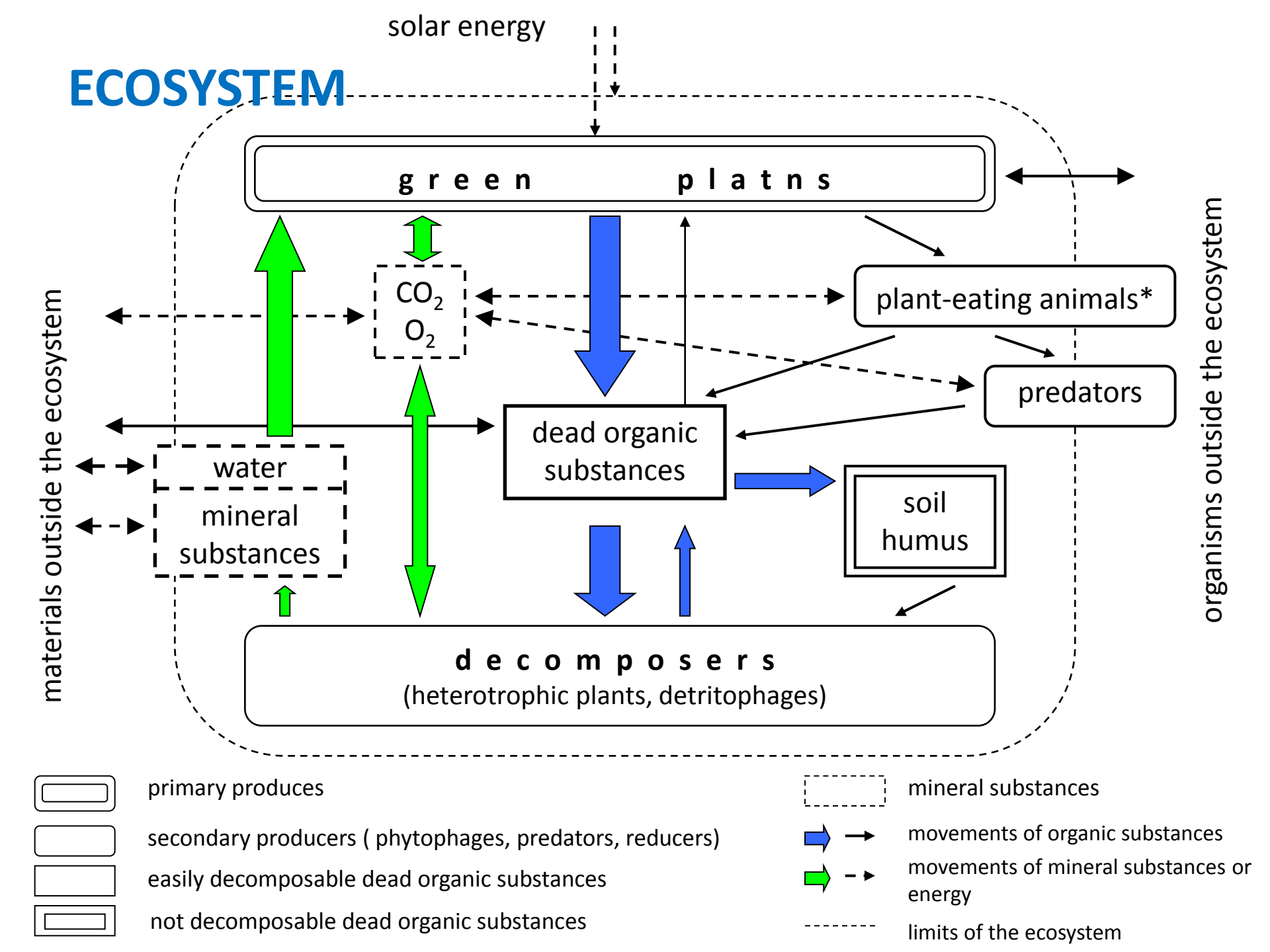
Biotic Interaction and Biodiversity in Forest Ecosystem

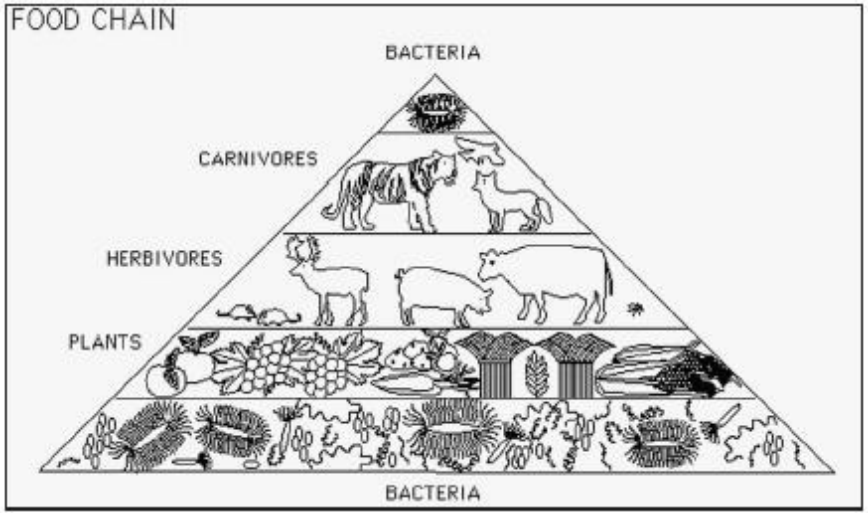
Tento projekt je spolufinancován Evropským sociálním fondem a Státním rozpočtem ČR InoBio – CZ.1.07/2.2.00/28.0018

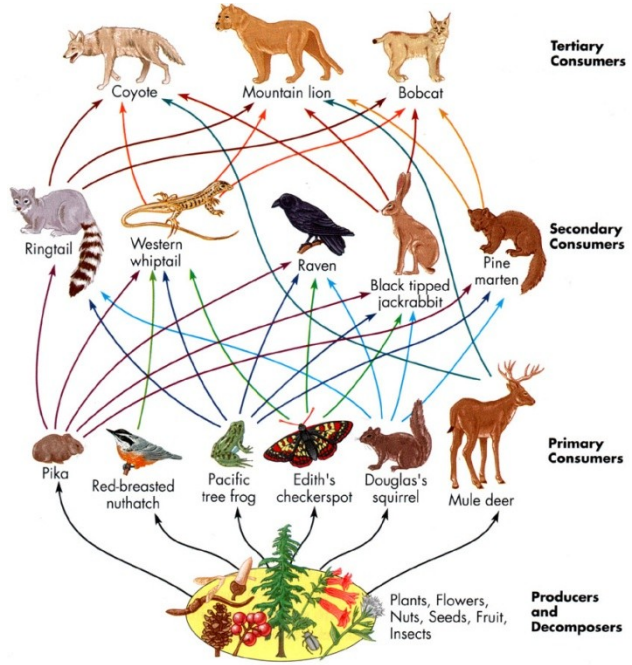
Content

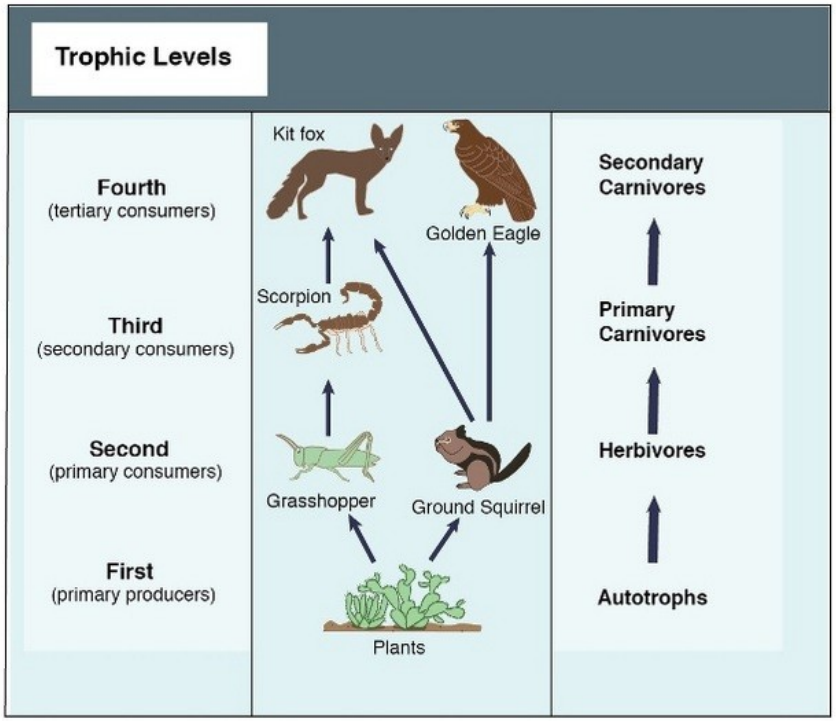
- Producers and consumers
- Trophic relations, food chains and pyramids, interspecies (interspecific) interactions
- The importance of animals in forest ecosystems
- Secondary productivity
- Biodiversity at organism, population and habitat level
- Changes in diversity over time
- Methods for evaluation
- Conservation
- Applications in ecology and forestry


ECOSYSTEM
solar energy
g r e e n p l a t n s
CO_2
O_2
plant-eating animals*
predators
dead organic substances
soil humus
water
mineral substances
d e c o m p o s e r s
(heterotrophic plants, detritophages)
materials outside the ecosystem
organisms outside the ecosystem
primary produces
secondary producers (phytophages, predators, reducers)
easily decomposable dead organic substances
not decomposable dead organic substances
mineral substances
movements of organic substances
movements of mineral substances or energy
limits of the ecosystem

Producers and consumers, trophic relations, food chains and pyramids

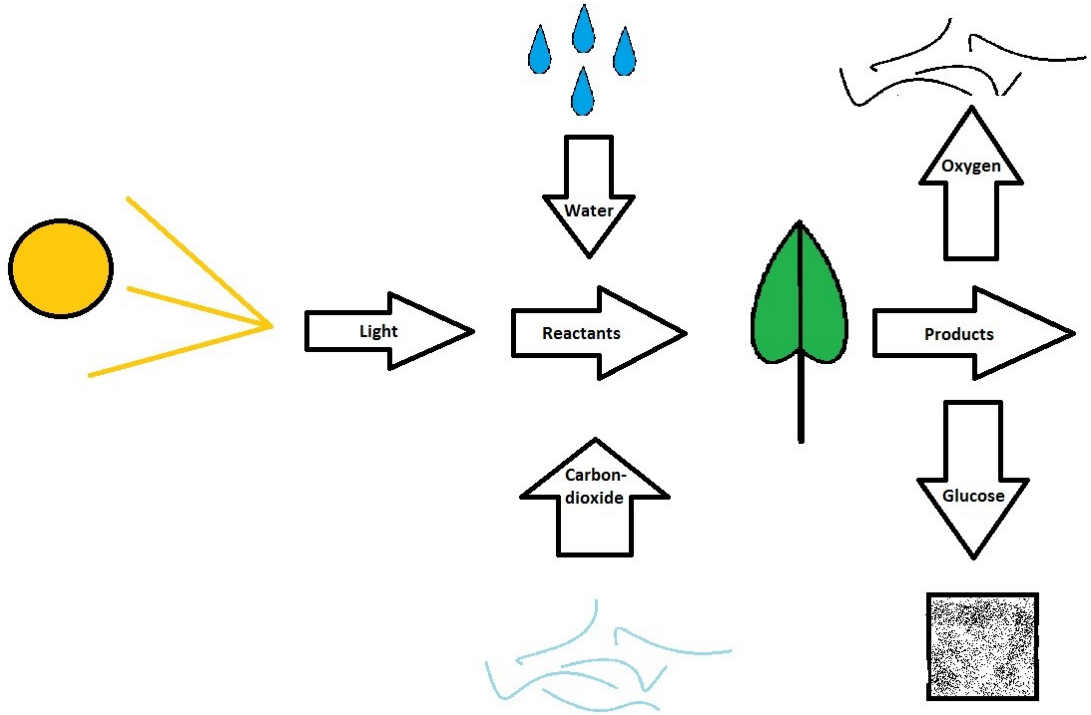






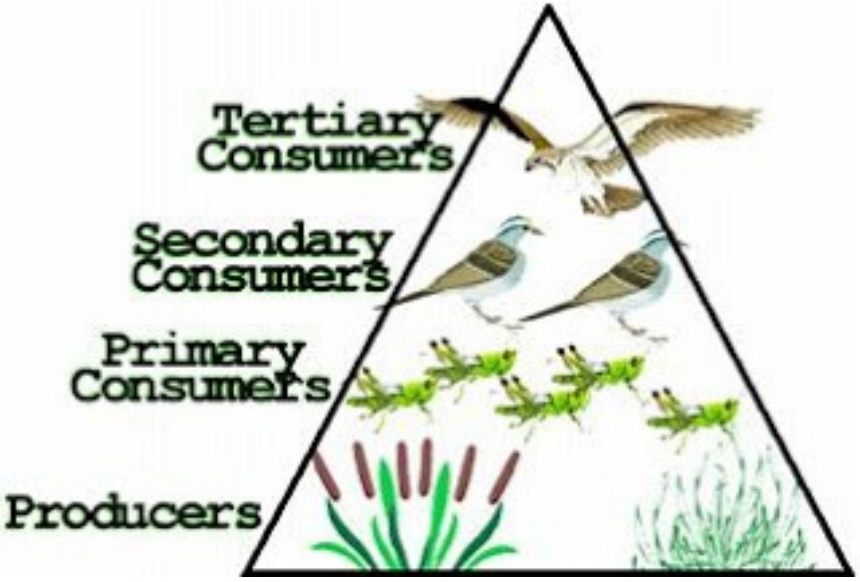
Producers

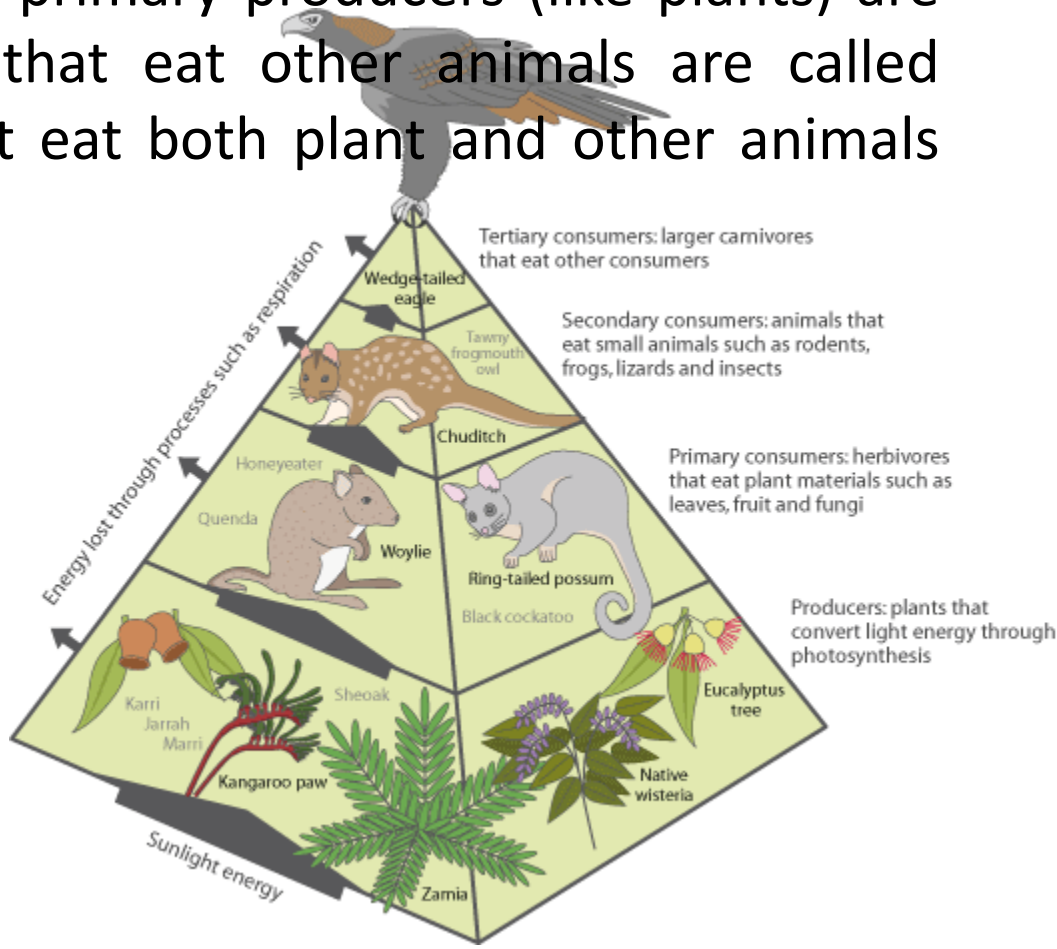
Producers (*autotrophs*) - *plants* or *algae*. Plants and algae do not usually eat other organisms, but pull nutrients from the soil or the ocean and manufacture their own food using *photosynthesis*. For this reason, they are called ***primary producers***. In this way, it is energy from the sun that usually powers the base of the food chain. An exception occurs in deep-sea *hydrothermal ecosystems*, where there is no sunlight. Here primary producers manufacture food through a process called *chemosynthesis*.



Consumers

Consumers (*heterotrophs*) are species which cannot manufacture their own food and need to consume other organisms. Animals that eat primary producers (like plants) are called *herbivores.* Animals that eat other animals are called *carnivores,* and animals that eat both plant and other animals are called *omnivores.*





Decomposers

Decomposers (*detritivores*) break down dead plant and animal material and wastes and release it again as energy and nutrients into the ecosystem for recycling. Decomposers, such as *bacteria* and *fungi* (mushrooms), feed on waste and dead matter, converting it into inorganic chemicals that can be recycled as mineral nutrients for plants to use again.

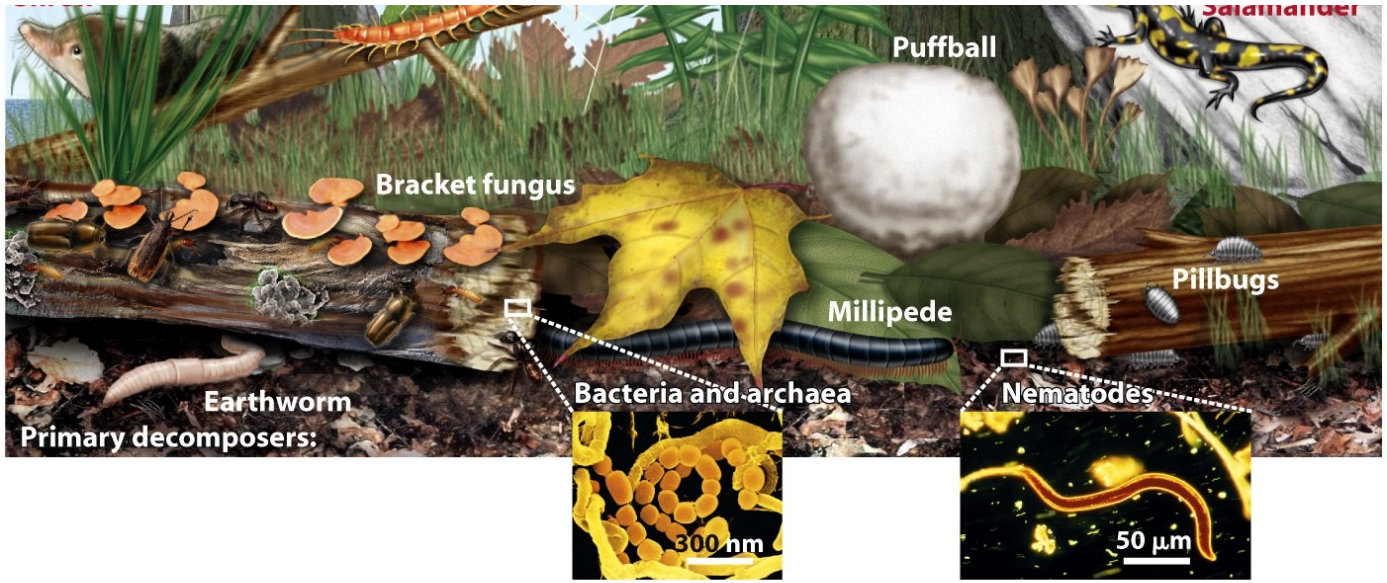
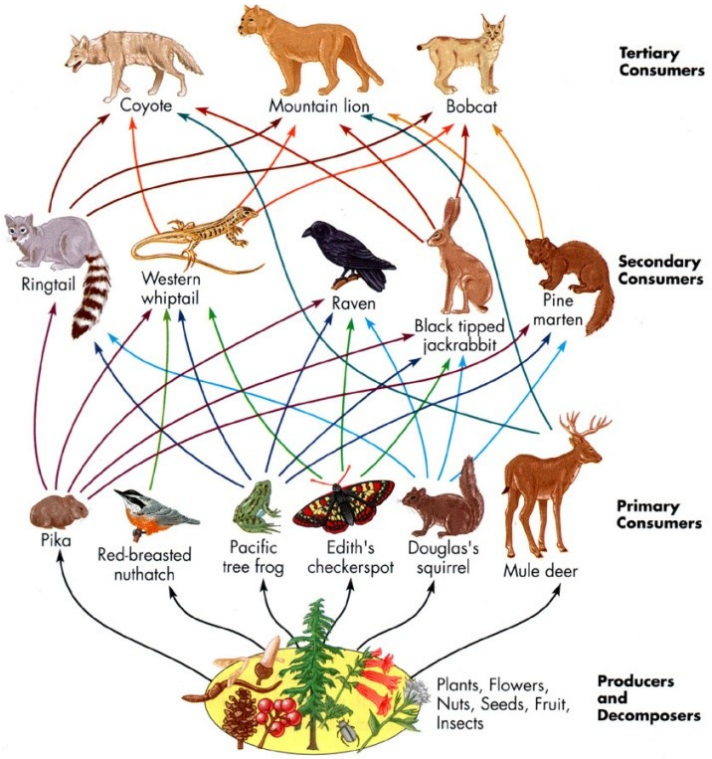
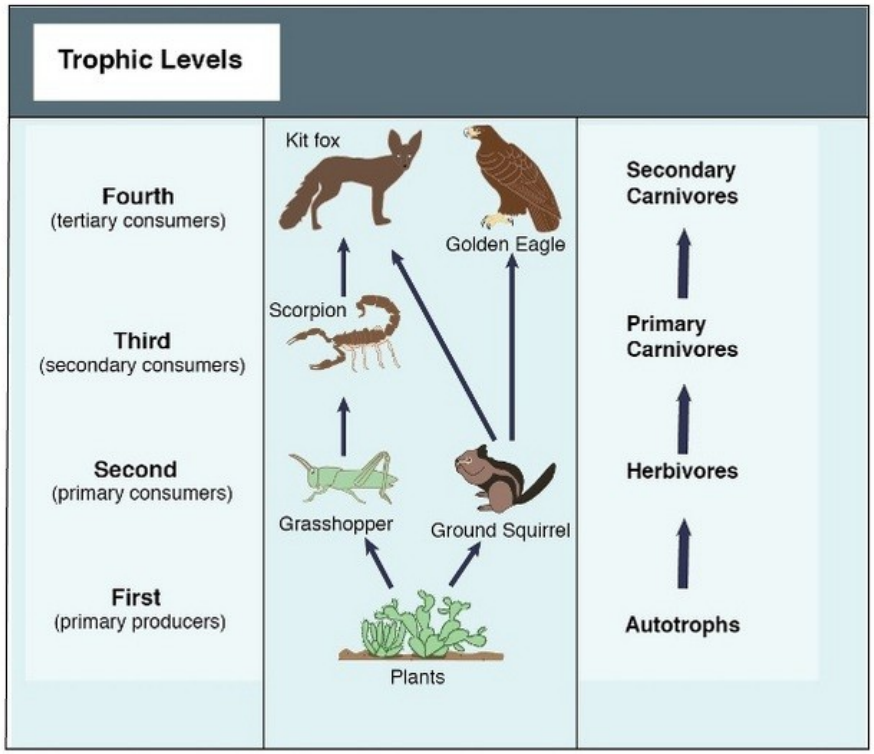


Figure 54-6 Biological Science, 2/e

Food chains

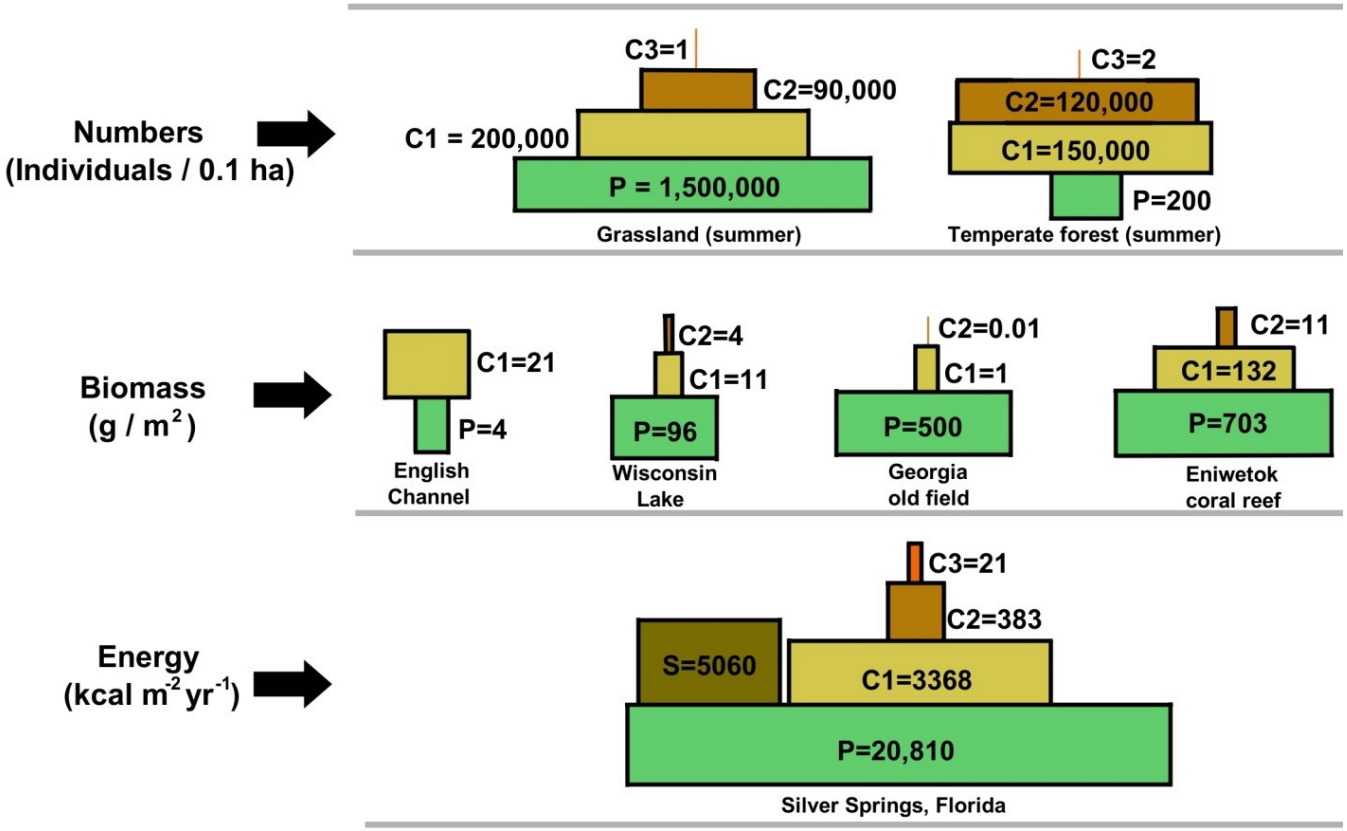
- A **food chain/web** is a linear consequence of links in a ***food web*** starting from a species that are called producers in the web and ends at a species that is called decomposers species in the web.





Food pyramids

- An ecological pyramid (also **trophic pyramid** or **energy pyramid**) is a graphical representation designed to show the biomass or biomass productivity at each trophic level in a given ecosystem.
- ***pyramid of numbers, pyramid of biomass, pyramid of productivity (energy)***

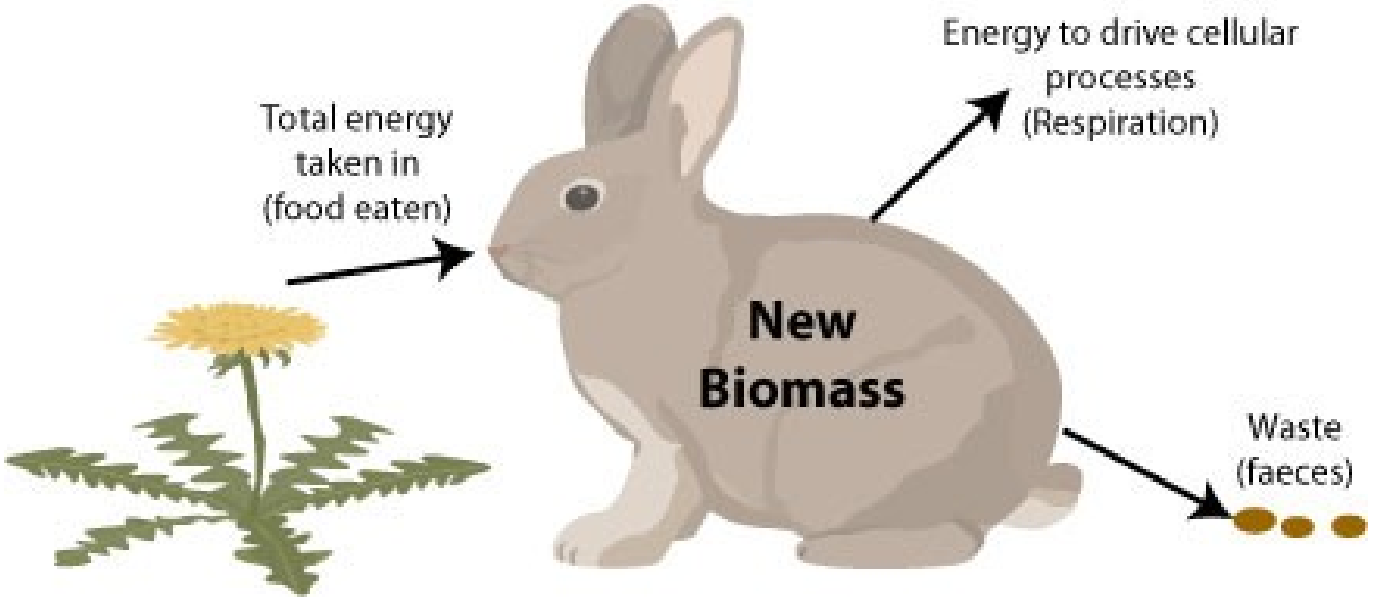


Secondary productivity

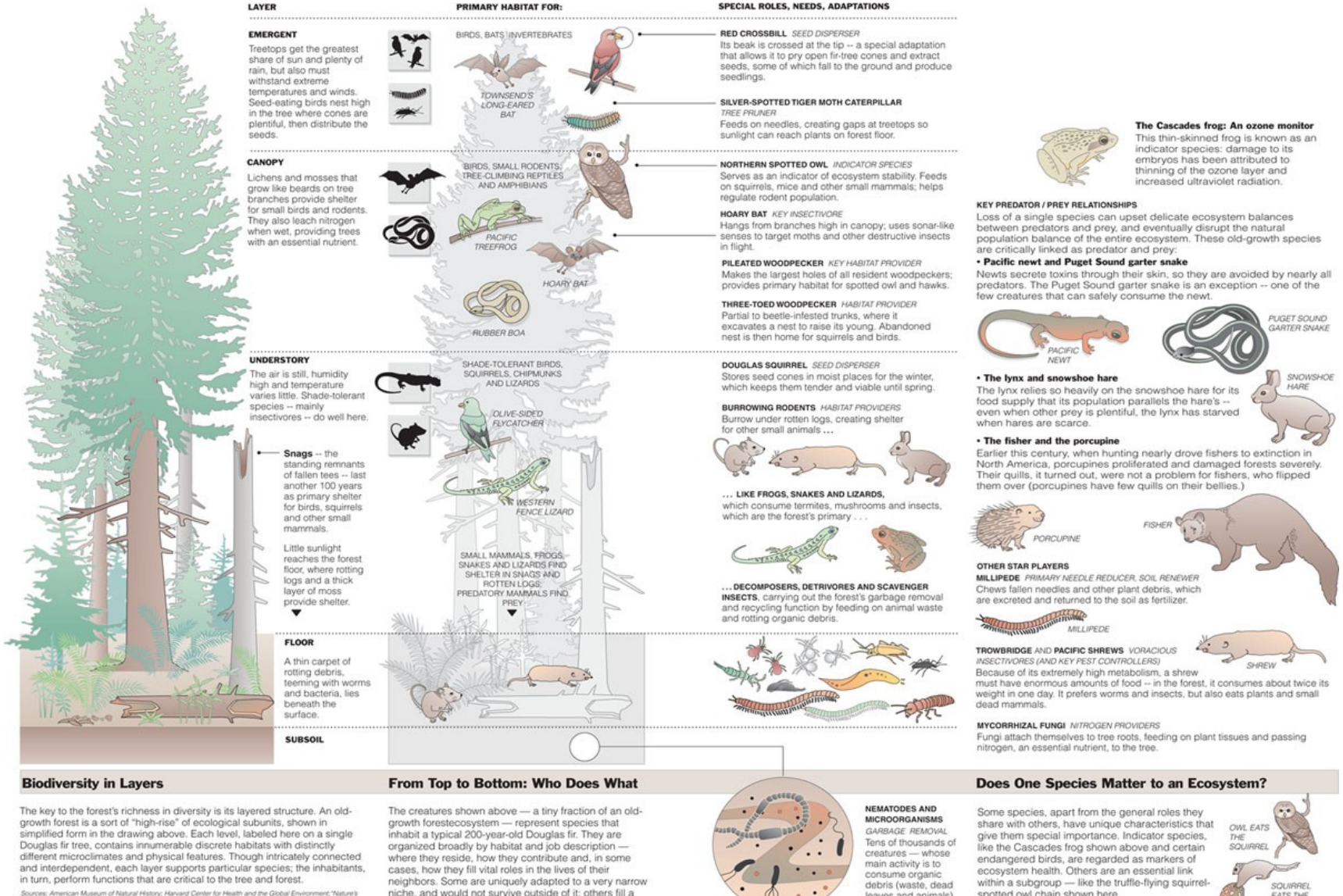
Secondary production is the generation of ***biomass of heterotrophic (consumer) organisms*** in a system - animals, protists, fungi and many bacteria

NSP = GSP - R

(Food eaten - Energy in faeces) - Respiration



Biodiversity at organism, population and habitat level



Biodiversity in Layers

The key to the forest's richness in diversity is its layered structure. An old-growth forest is a sort of "high-rise" of ecological subunits, shown in simplified form in the drawing above. Each level, labeled here on a single Douglas fir tree, contains innumerable discrete habitats with distinctly different microclimates and physical features. Though intricately connected and interdependent, each layer supports particular species; the inhabitants, in turn, perform functions that are critical to the tree and forest.

Sources: American Museum of Natural History; Harvard Center for Health and the Global Environment; "Nature's Services: Societal Dependence on Natural Ecosystems" edited by Gretchen C. Daily; "Jungles" edited by Edward S. Ayensu; "The International Book of the Forest"; "The Audubon Society Field Guides to North American Reptiles and Amphibians"; "Diversity of Life" by Edward O. Wilson; Nature

From Top to Bottom: Who Does What

The creatures shown above — a tiny fraction of an old-growth forestecosystem — represent species that inhabit a typical 200-year-old Douglas fir. They are organized broadly by habitat and job description — where they reside, how they contribute and, in some cases, how they fill vital roles in the lives of their neighbors. Some are uniquely adapted to a very narrow niche, and would not survive outside of it; others fill a variety of roles and thrive equally well in several slots.

NEMATODES AND MICROORGANISMS *GARBAGE REMOVAL*
Tens of thousands of creatures — whose main activity is to consume organic debris (waste, dead leaves and animals).

Does One Species Matter to an Ecosystem?

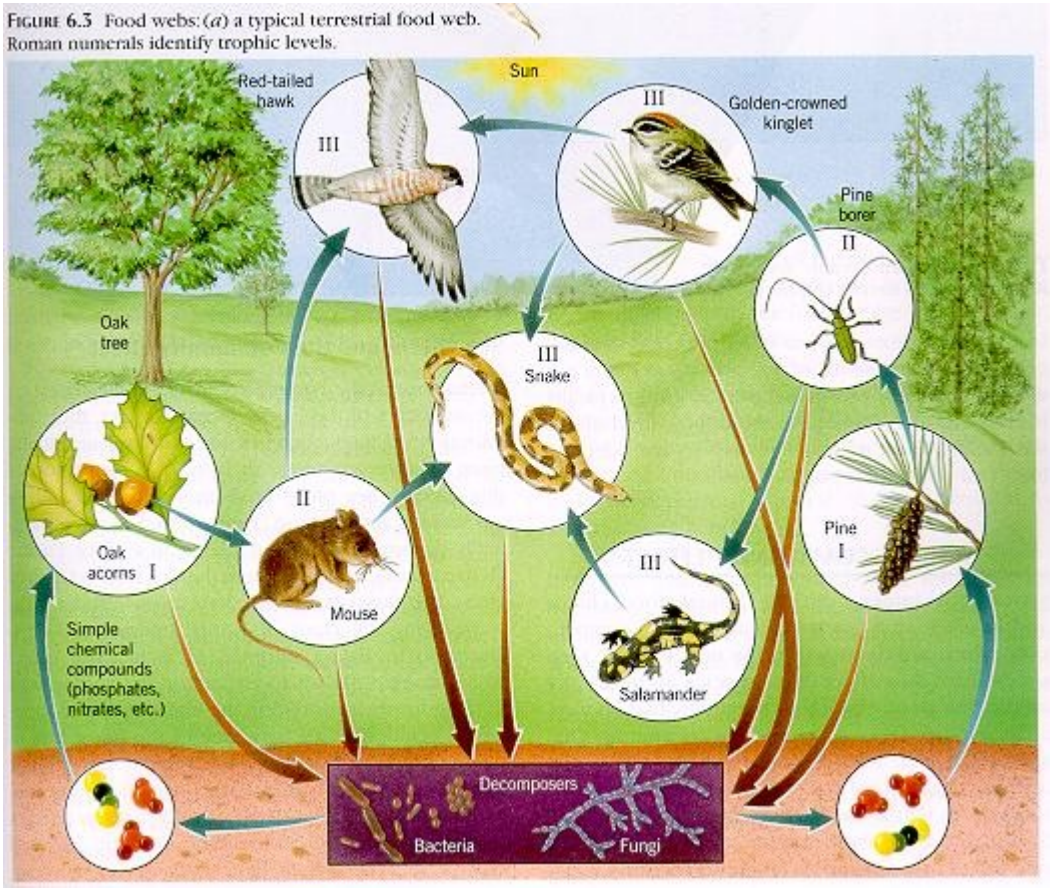
Some species, apart from the general roles they share with others, have unique characteristics that give them special importance. Indicator species, like the Cascades frog shown above and certain endangered birds, are regarded as markers of ecosystem health. Others are an essential link within a subgroup — like the truffle-flying squirrel-spotted owl chain shown here.

Megan Jacgerman/The New York Times

Interspecies interactions

- are the effects *organisms* in a *community* have on one another. In the natural world no organism exists in absolute isolation, and thus every organism must interact with the environment and other organisms.

- Neutralism
- Amensalism
- Comensalism
- Predation
- Herbivory
- Patogenicity
- Parasitismus



Neutralism

- Neutralism describes the relationship between two species which interact but do not affect each other.
- True neutralism is extremely unlikely or even impossible to prove.

Amensalism (Allelopathy)

- It is a relationship in which a product of one organism has a negative effect on another organism.
- It is specifically a population interaction in which one organism is harmed, while the other is neither affected nor benefited.
- Usually this occurs when one organism exudes a chemical compound as part of its normal metabolism that is detrimental to another organism.
- Example: black walnut tree (*Juglans nigra*) - secrete juglone, an allelochemical that harms or kills some species of neighboring plants.



Competition

- is an interaction between organisms or species, in which the fitness of one is lowered by the presence of another. Limited supply of at least one resource (such as food, water, and territory) used by both can be a factor.
- ***intraspecific competition***
- ***interspecific competition***
- ***competitive exclusion principle***

Predation

- biological interaction where a **predator** (an organism that is hunting) feeds on its **prey** (the organism that is attacked)
- Predators may or may not kill their prey prior to feeding on them, but the act of predation often results in the death of its prey and the eventual absorption of the prey's tissue through consumption.
- ***Carnivory (***eating of animals), ***herbivory*** (eating parts of plants), ***mycophagy*** (eating parts of fungi) ***detritivory (***dead organic material)

- ***True predation***
- ***Grazing***
- ***Parasitism***
- ***Parasitoidism***

True predation

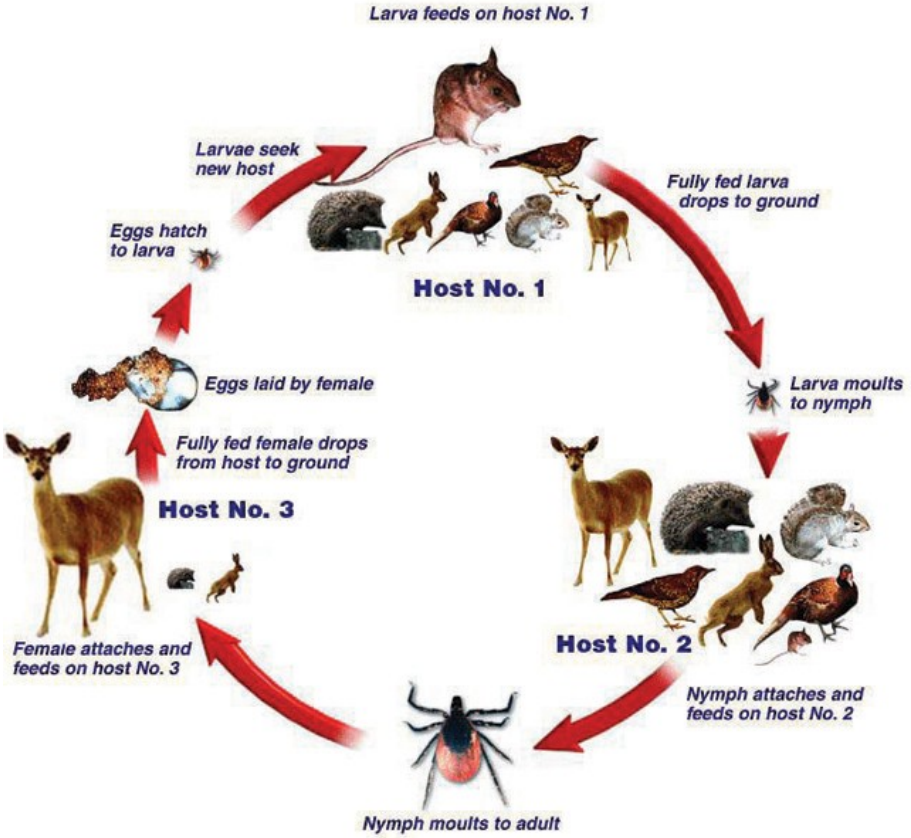
- A true predator can commonly be known as one which kills and eats another living thing.
- Predators may hunt actively for prey, or sit and wait for prey to approach within striking distance, as in *ambush predators*.
- *Seed predation* and *egg predation* are other forms of true predation, as seeds and eggs represent potential organisms.

Grazing

- Grazing organisms may also kill their prey species, but this is seldom the case.
- Grazing livestock may pull some grass out at the roots, but most is simply grazed upon, allowing the plant to regrow once again.
- Animals may also be 'grazed' upon; female mosquitos land on hosts briefly to gain sufficient proteins for the development of their offspring.

Parasitism

- *Parasites* - can at times be difficult to distinguish from grazers. Their feeding behavior is similar in many ways, however they are noted for their close association with their host species.



The relative size of the animals approximates their significance as hosts for the different tick life cycle stages in a typical woodland habitat.

Courtesy of Dr Jeremy Gray and Bernard Kaye

Parasitoidism

- *Parasitoids* are organisms living in or on their host and feeding directly upon it, eventually leading to its death.
- They are much like parasites in their close symbiotic relationship with their host or hosts.
- Hymenoptera, Diptera and Coleoptera parasitoids make up as much as 10% of all insect species.

Commensalism

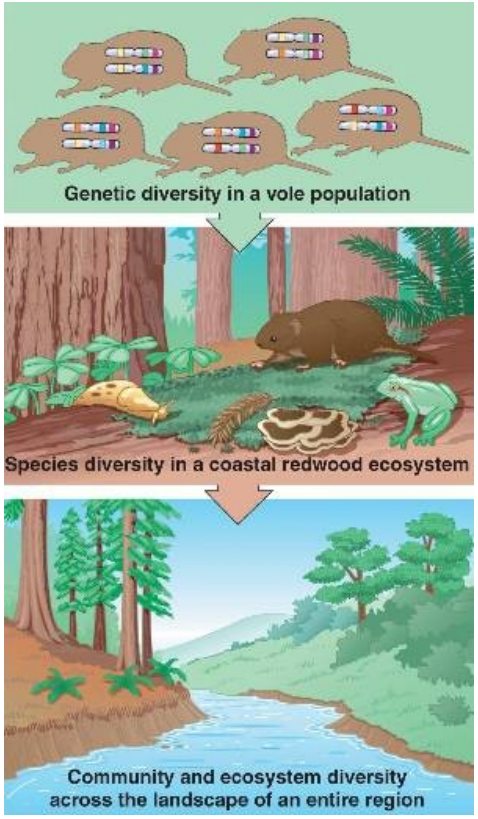
- Commensalism benefits one organism and the other organism is neither benefited nor harmed.
- It occurs when one organism takes benefits by interacting with another organism by which the host organism is not affected.
- Example: *Mus musculus*, *Rattus rattus* vs. humans

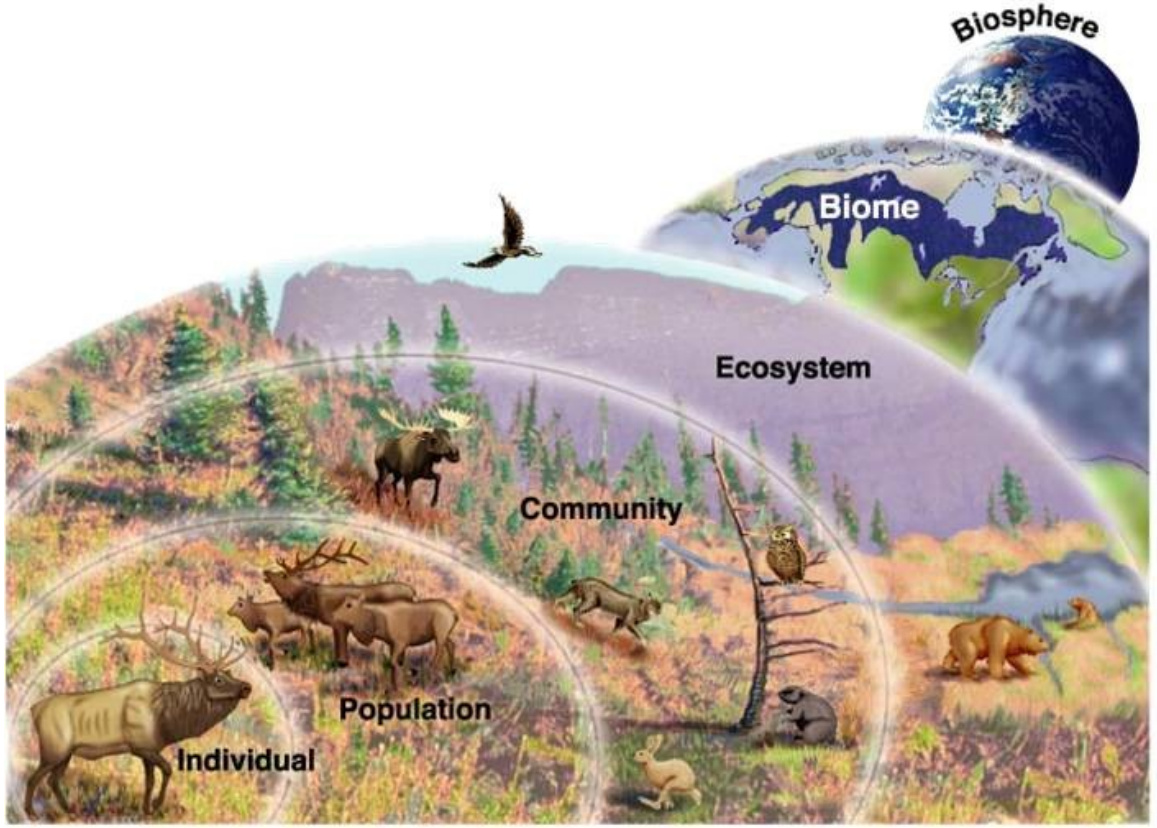
Mutualism

- interaction between two or more species, where species derive a mutual benefit, for example an increased carrying capacity.
- similar interactions within a species = ***co-operation***
- Examples include *cleaner fish*, *pollination* and *seed dispersal*, *gut flora* and *nitrogen fixation by fungi*.

Biodiversity

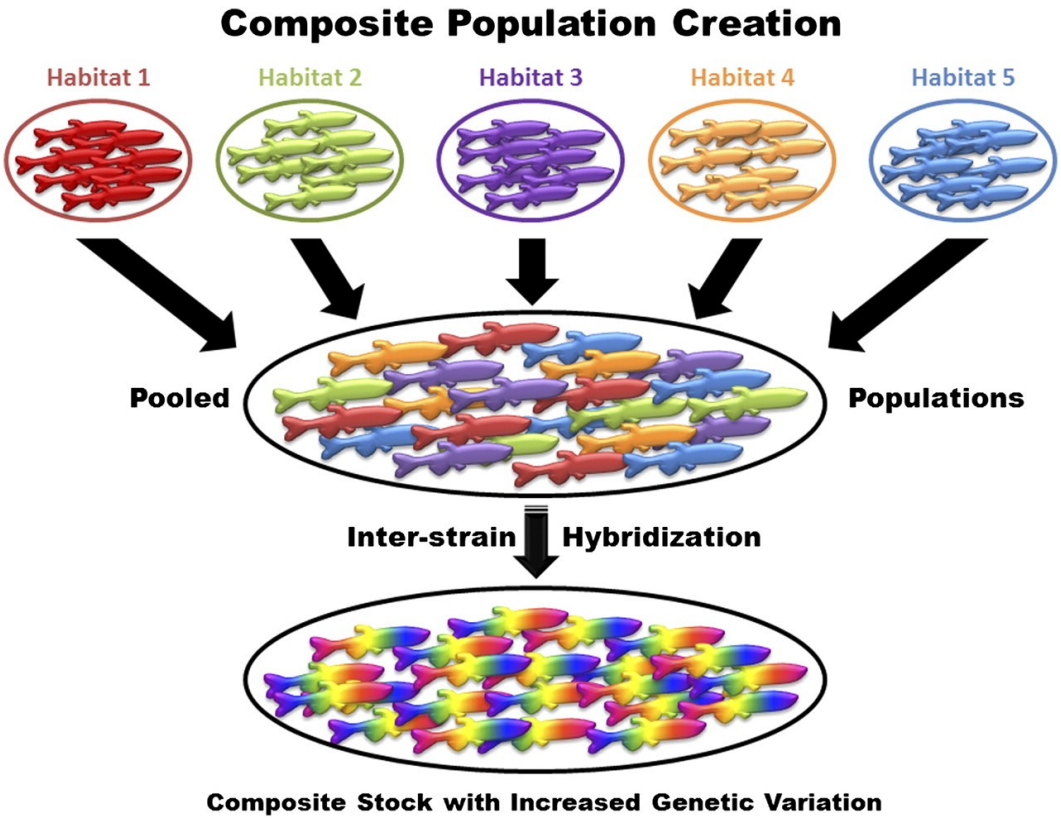
- degree of variation of life
- *genetic diversity*
- *species diversity*
- *ecosystem diversity*





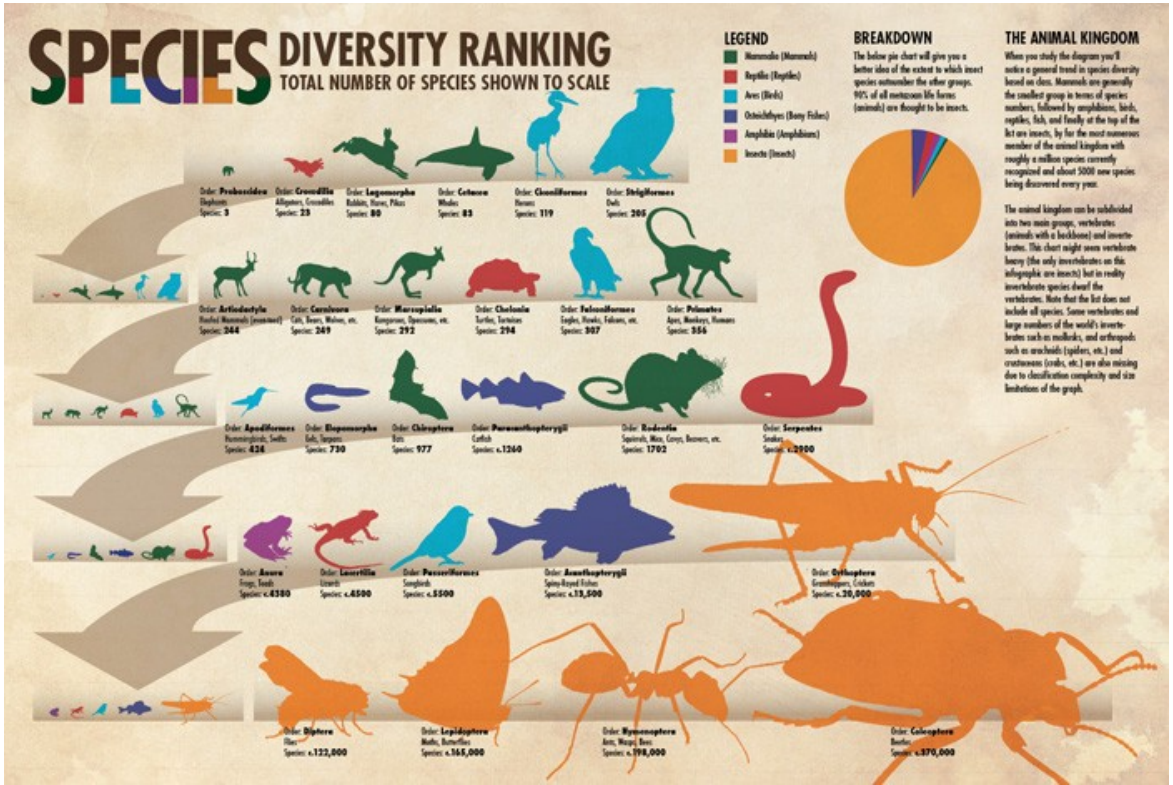
Genetic diversity

- level of biodiversity, refers to the total number of genetic characteristics in the genetic makeup of a species.
- it is distinguished from *genetic variability*, which describes the tendency of genetic characteristics to vary.



Species diversity

- effective number of different species that are represented in a collection of individuals (a dataset).
- Species diversity consists of two components, ***species richness*** and ***species evenness***
- **alpha diversity, beta diversity, Gamma diversity**



Ecosystem diversity

- diversity of a place at the level of *ecosystems*
- variety of ecosystems present in a biosphere
- variety of species and ecological processes that occur in different physical settings.

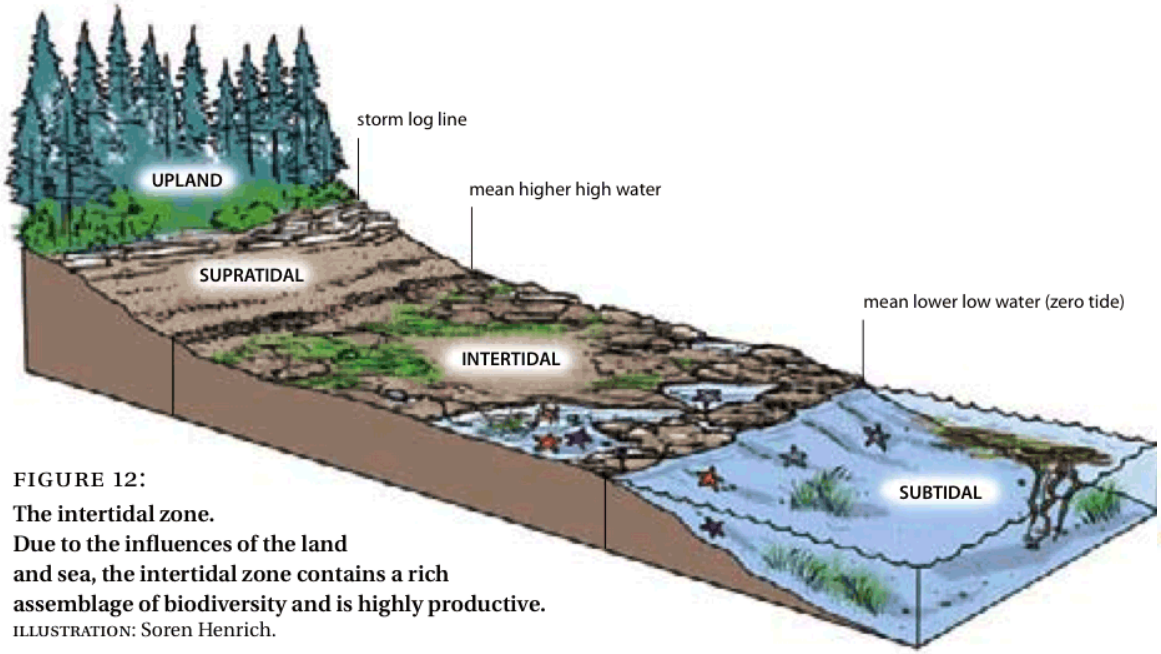
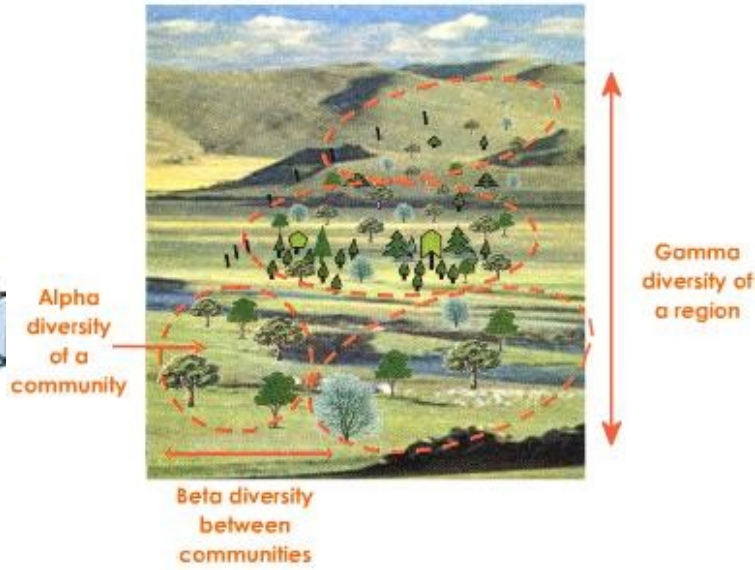


FIGURE 12:
The intertidal zone.
Due to the influences of the land and sea, the intertidal zone contains a rich assemblage of biodiversity and is highly productive.
ILLUSTRATION: Soren Henrich.



Methods for diversity evaluation

Box 15.2
Definitions of class diversity indices

Margalef diversity index: $D_{Mg} = (S-1)/\ln N$

Shannon–Weaver diversity index: $H = -\Sigma p_i(\ln p_i)$

Simpson's index: $D = \sum\left(\frac{n_i(n_i-1)}{N(N-1)}\right)$

Log series diversity α: $S = \alpha \ln(1 + N/\alpha)$

where p_i is the proportion of objects in the ith class, n_i is the number of objects in the ith class, N is the total number of objects and S is the total number of classes

DIVERSITY INDEX

Multi-group diversity measure (E) is calculated using the formula:

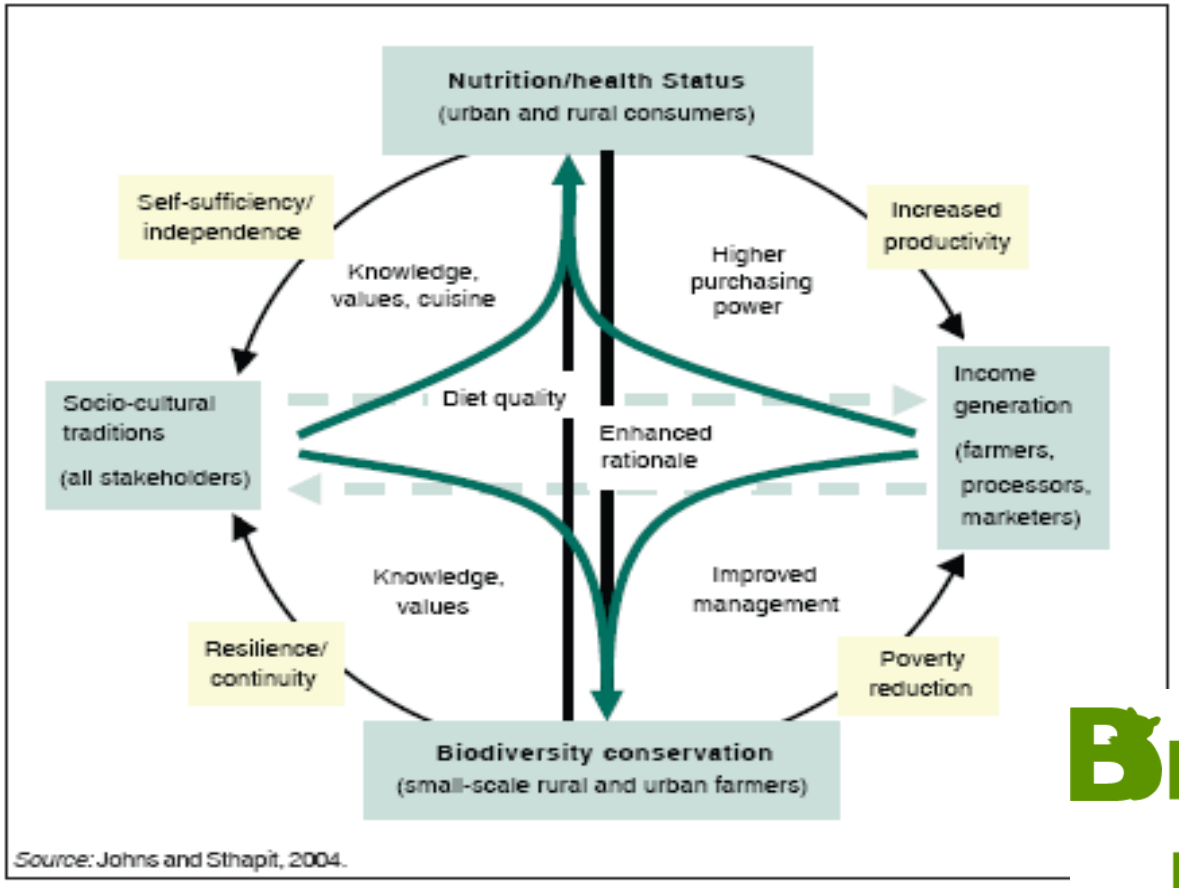
$$E = \sum_{r=1}^{n} Q_r \ln \frac{1}{Q_r},$$

where Qr refers to a specific racial/ethnic group's proportion of a particular geographic area.

Conservation of forest biodiversity

- essential part of sustainable forest management
- Forests cover nearly one-third of the world's total land area and are vital in ensuring environmental functions such as climate regulation and soil conservation in addition to biodiversity.
- habitats for a large array of plants and animals, many of which are rare or threatened
- Biologically diverse forests also contribute to the sustainability of the wider landscape and provide a range of other ecosystem services.

Need for conservation



Source: Johns and Sthapit, 2004.

BIODIVERSITY WITHOUT BOUNDARIES

Celebrating the International Year of Biodiversity

NatureServe Conservation Conference 2010

April 26–28 ~ Austin, Texas

National Biodiversity startegy of the Czech Republic

NATIONAL BIODIVERSITY STRATEGY OF THE CZECH REPUBLIC

Ministry of the Environment of the Czech Republic
2005

CONTENTS

NATURA 2000

- Natura 2000 is the part of **EU nature & biodiversity policy**. It is an EUwide network of nature protection areas established under the 1992 Habitats Directive. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive, and also incorporates Special Protection Areas (SPAs) which they designate under the 1979 Birds Directive. Natura 2000 is not a system of strict nature reserves where all human activities are excluded. Whereas the network will certainly include nature reserves most of the land is likely to continue to be privately owned and the emphasis will be on ensuring that future management is sustainable, both ecologically and economically.The establishment of theis network of protected areas also fulfils a Community obligation under the UN Convention on Biological Diversity.

- The Habitats Directive (together with the Birds Directive) forms the **cornerstone of Europe's nature conservation policy**. It is built around two pillars: the Natura 2000 network of protected sites and the strict system of species protection. All in all the directive protects over 1.000 animals and plant species and over 200 so called "habitat types" (e.g. special types of forests, meadows, wetlands, etc.), which are of European importance.

II

(Acts whose publication is not obligatory)

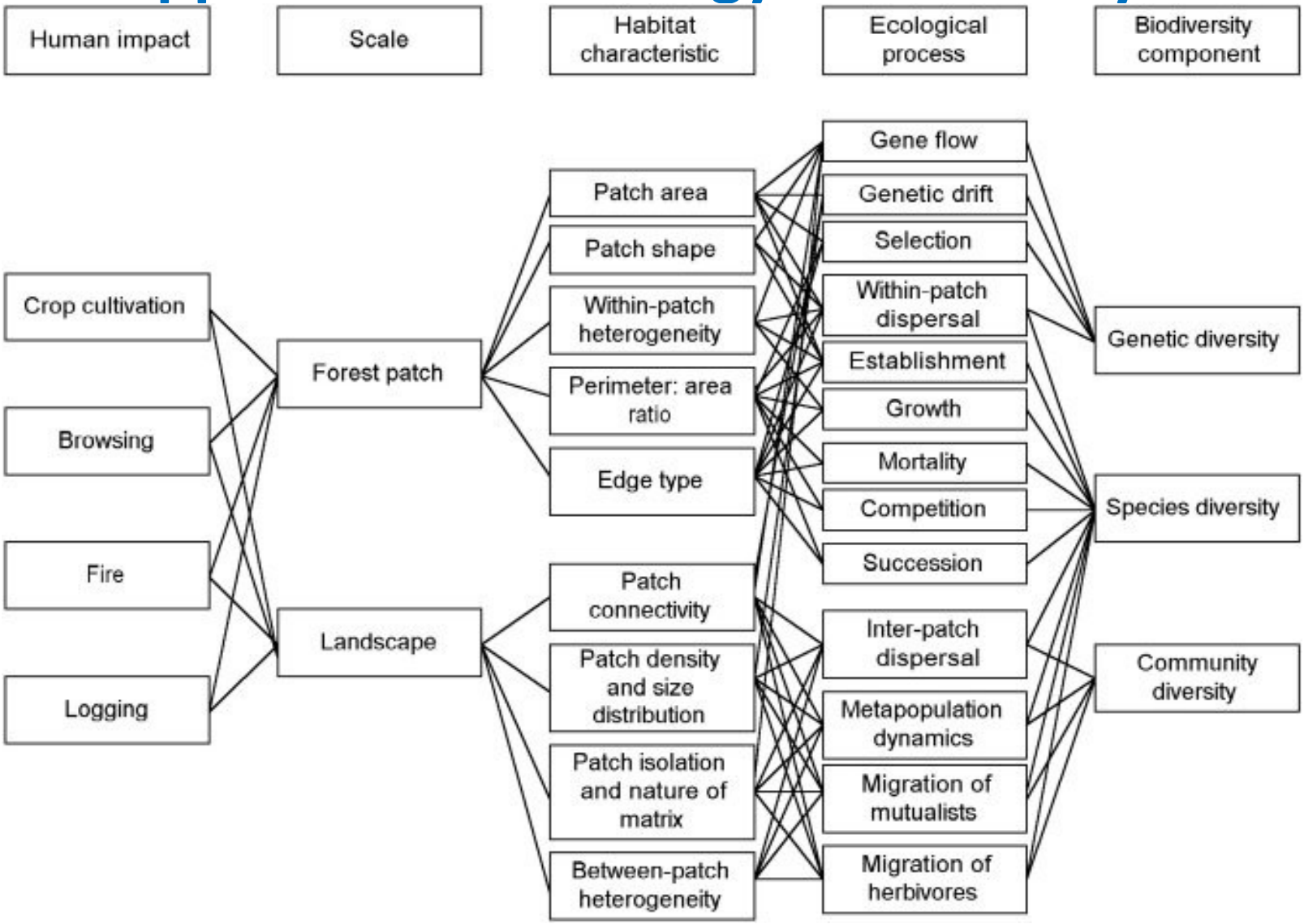
COUNCIL

COUNCIL DIRECTIVE 92/43/EEC

of 21 May 1992

on the conservation of natural habitats and of wild fauna and flora

Applications in ecology and forestry



References

- Barbosa, P., Castellanos I. (eds.), 2004. Ecology of predator-prey interactions. New York: Oxford University Press. 416 pp.
- Begon, M., J.L. Harper, C.R. Townsend, 1996. Ecology: individuals, populations, and communities, Third Edition. Blackwell Science Ltd., Cambridge, USA. 949 pp.
- Magurran A. E., 2004. Measuring biological diversity. Blackwell Science, Oxford, 256 pp.
- Odum E., Barrett G. W., 2004. Fundamentals of Ecology. 5 edition. Cengage Learning. 624 pp.
- Thomas P. A., Packham J. R., 2007. Ecology of Woodlands and Forests. Description, Dynamics and Diversity. Cambridge University Press, 528 pp.
- Thompson I., Mackey B., McNulty S., Mosseler A., 2009. Forest Resilience, Biodiversity, and Climate Change. A Synthesis of the Biodiversity/Resilience/Stability Relationship in Forest Ecosystems. Secretariat of the Convention on Biological Diversity, Montreal. Technical Series no. 43, 67 pp.