Introduction à l’écologie

Biologie Générale - BioEng-110 - CG 7

Camille Goemans - 2025

Plan

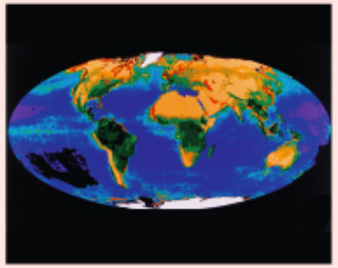
- Les différents niveaux d’écologie
- Ecologie planétaire
- Ecologie des populations
- Ecologie des communautés

Les différents niveaux d'écologie

"Étude des milieux où vivent les êtres vivants, ainsi que des rapports de ces êtres entre eux et avec le milieu"

Organismes, populations et communautés : Dans cette forêt, chaque pin est un organisme. Tous les pins vivant dans la région constituent une population. Toutes les populations de différentes espèces de la région forment une communauté.

Écosystèmes : Cet écosystème côtier du sud-est des États-Unis comprend une communauté d'organismes vivants et son environnement physique.



La biosphère : La biosphère est composée de tous les écosystèmes de la Terre, pris ensemble.

Plan

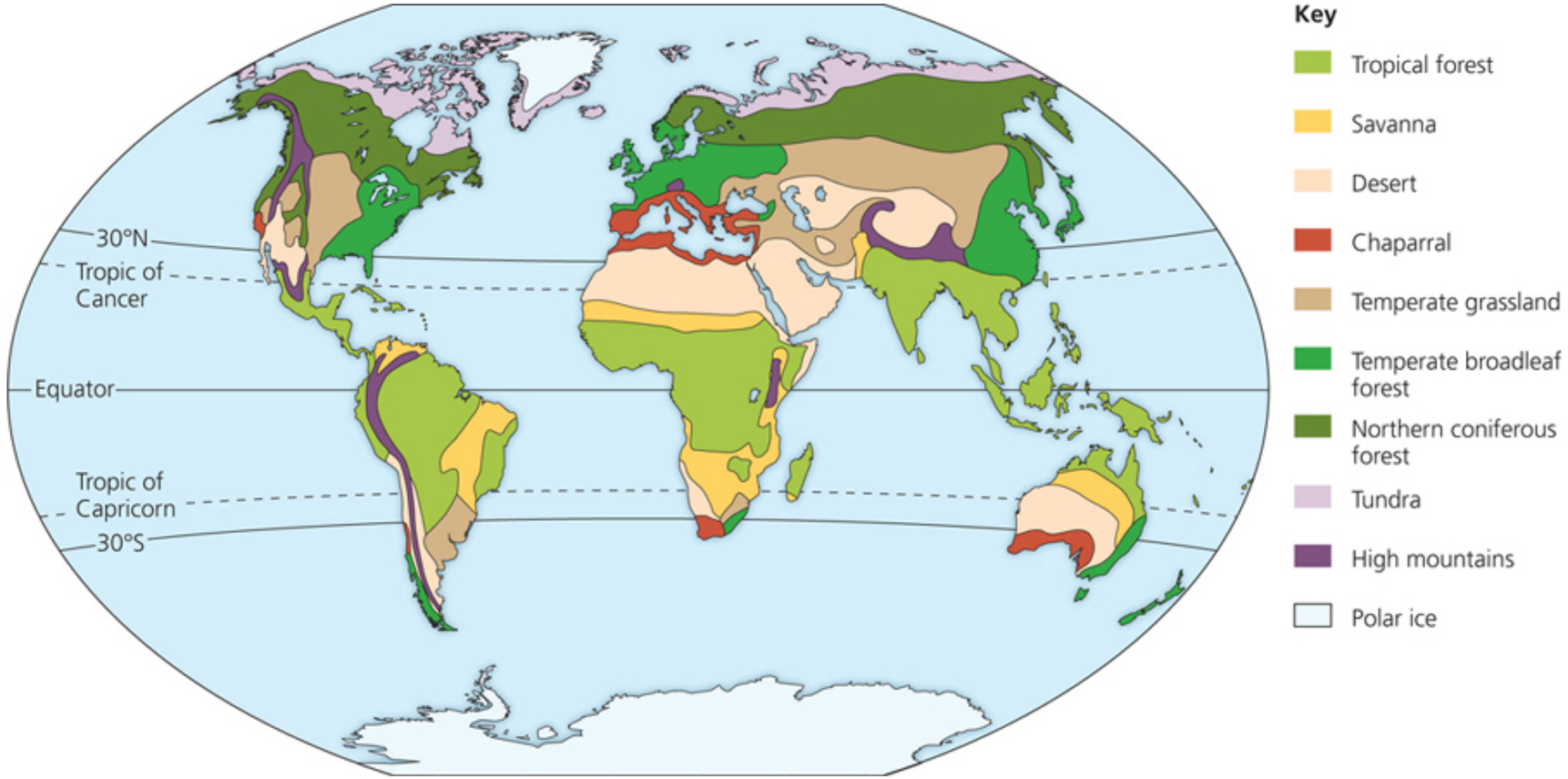
- Les différents niveaux d’écologie
- **Ecologie planétaire**
- Ecologie des populations
- Ecologie des communautés

Ecologie planétaire

La **biosphère** constitue l'écosystème planétaire, qui englobe l'**ensemble des écosystèmes** de la planète. L'écologie planétaire analyse la façon dont les **échanges régionaux de matière et d'énergie** influent sur le **fonctionnement et la répartition des organismes** dans la biosphère.

Ecologie planétaire - le climat

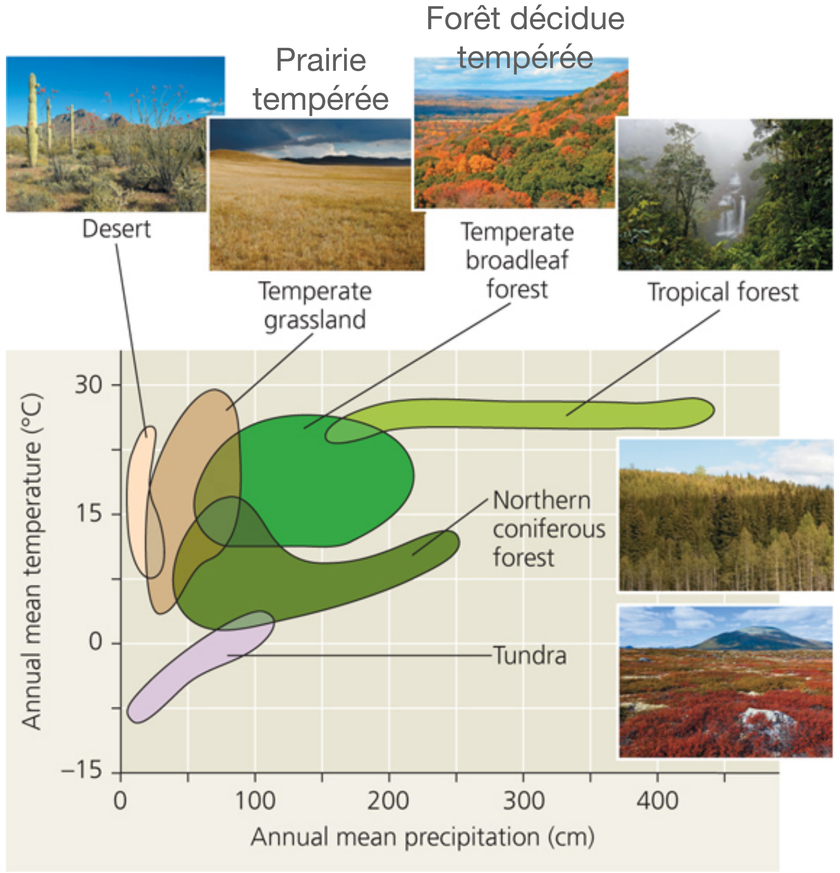
- Le **climat** est le facteur qui influence le plus la répartition des organismes sur terre et dans les océans
- Le climat comprends **4 facteurs abiotiques:** la températures, les précipitations, la lumière et le vent



Ecologie planétaire - les biomes terrestres

- Le **climat** varie en fonction de la **latitude** terrestre

- On peut se rendre compte de l'effet du climat sur la répartition des espèces en construisant un **climatogramme** (représentation graphique des températures et précipitations dans une région donnée)



Ecologie planétaire - les biomes terrestres

- Les biomes sont **dynamiques** et peuvent être **perturbés** (tempête, incendie, activité humaine) qui transforment les communautés, font disparaître certains organismes ou modifient les ressources disponibles

Ecologie planétaire - les biomes terrestres

Pour info!

Tropical Forest

Distribution Tropical forest occurs in equatorial and subequatorial regions.

Precipitation In **tropical rain forests**, rainfall is relatively constant, about 200–400 cm annually. In **tropical dry forests**, precipitation is highly seasonal, about 150–200 cm annually, with a six- to seven-month dry season.

Temperature High year-round, averaging 25–29°C with little seasonal variation.

A tropical rain forest in Costa Rica

Plants Tropical forests are vertically layered, and competition for light is intense. Layers in rain forests include trees that grow above a closed canopy, the canopy trees, one or two layers of subcanopy trees, and layers of shrubs and herbs (small, nonwoody plants). There are generally fewer layers in tropical dry forests. Broadleaf evergreen trees are dominant in tropical rain forests, whereas many tropical dry forest trees drop their leaves during the dry season. Epiphytes such as bromeliads and orchids generally cover tropical forest trees but are less abundant in dry forests. Thorny shrubs and succulent plants are common in some tropical dry forests.

Animals Earth's tropical forests are home to millions of species, including an estimated 5–30 million still undescribed species of insects, spiders, and other arthropods. In fact, animal diversity is higher in tropical forests than in any other terrestrial biome. The animals, including amphibians, birds and other reptiles, mammals, and arthropods, are adapted to the vertically layered environment and are often inconspicuous.

Human Impact Humans have long had thriving communities in tropical forests. Many tropical forests are now being cut down and converted to farmland, urban areas, and other types of land use.

Ecologie planétaire - les biomes terrestres

Pour info!

Desert

Distribution **Deserts** occur in bands near 30° north and south latitude or at other latitudes in the interior of continents (for instance, the Gobi Desert of north-central Asia).

Precipitation Precipitation is low and highly variable, generally less than 30 cm per year.

Temperature Temperature is variable seasonally and daily. Maximum air temperature in hot deserts may exceed 50°C; in cold deserts air temperature may fall below –30°C.

Plants Deserts are dominated by low, widely scattered vegetation; the proportion of bare ground is high compared with other biomes. The plants include succulents such as cacti or euphorbs, deeply rooted shrubs, and herbs that grow during the infrequent moist periods. Desert plant adaptations include tolerance of heat and dessication, water storage, and reduced leaf surface area. Physical defenses, such as spines, and chemical defenses, such as toxins in the leaves of shrubs, are common. Many of the plants exhibit C_4 or CAM photosynthesis.

Animals Common desert animals include snakes and lizards, scorpions, ants, beetles, migratory and resident birds, and seed-eating rodents. Many species are nocturnal. Water conservation is a common adaptation, with some species surviving solely on water obtained from breaking down carbohydrates in seeds.

Human Impact Long-distance transport of water and deep groundwater wells have allowed humans to maintain substantial populations in deserts. Urbanization and conversion to irrigated agriculture have reduced the natural biodiversity of some deserts.

Organ Pipe Cactus National Monument, Arizona

Ecologie planétaire - les biomes terrestres

Pour info!

Savanna

Distribution Savanna occurs in equatorial and subequatorial regions.

Precipitation Seasonal rainfall averages 30–50 cm per year. The dry season can last up to eight or nine months.

Temperature The **savanna** is warm year-round, averaging 24–29°C, but with somewhat more seasonal variation than in tropical forests.

Plants The scattered trees found at different densities in the savanna often are thorny and have small leaves, an apparent adaptation to the relatively dry conditions. Fires are common in the dry season, and the dominant plant species are fire-adapted and tolerant of seasonal drought. Grasses and small nonwoody plants called forbs, which make up most of the ground cover, grow rapidly in response to seasonal rains and are tolerant of grazing by large mammals and other herbivores.

A savanna in Kenya

Animals Large plant-eating mammals, such as wildebeests and zebras, and predators, including lions and hyenas, are common inhabitants. However, the dominant herbivores are actually insects, especially termites. During seasonal droughts, grazing mammals often migrate to parts of the savanna with more forage and scattered watering holes.

Human Impact The earliest humans may have lived in savannas. Fires set by humans may help maintain this biome, though overly frequent fires reduce tree regeneration by killing the seedlings and saplings. Cattle ranching and overhunting have led to declines in large-mammal populations.

Ecologie planétaire - les biomes terrestres

Pour info!

Chaparral

Distribution This biome occurs in midlatitude coastal regions on several continents, and its many names reflect its far-flung distribution: **chaparral** in North America, *matorral* in Spain and Chile, *garigue* and *maquis* in southern France, and *fynbos* in South Africa.

Precipitation Precipitation is highly seasonal, with rainy winters and dry summers. Annual precipitation generally falls within the range of 30–50 cm.

Temperature Fall, winter, and spring are cool, with average temperatures in the range of 10–12°C. Average summer temperature can reach 30°C, and daytime maximum temperature can exceed 40°C.

Plants Chaparral is dominated by shrubs and small trees, along with many kinds of grasses and herbs. Plant diversity is high, with many species confined to a specific, relatively small geographic area. Adaptations of the woody plants to drought include their tough evergreen leaves, which reduce water loss. Adaptations to fire are also prominent. Some of the shrubs produce seeds that will germinate only after a hot fire; food reserves stored in their fire-resistant roots enable them to resprout quickly and use nutrients released by the fire.

Animals Native mammals include browsers, such as deer and goats, that feed on twigs and buds of woody vegetation, and a high diversity of small mammals. Chaparral areas also support many species of amphibians, birds and other reptiles, and insects.

Human Impact Chaparral areas have been heavily settled and reduced through conversion to agriculture and urbanization. Humans contribute to the fires that sweep across the chaparral.

An area of chaparral in California

Ecologie planétaire - les biomes terrestres

Pour info!

Temperate Grassland

Distribution The veldts of South Africa, the *puszta* of Hungary, the pampas of Argentina and Uruguay, the steppes of Russia, and the plains and prairies of central North America are examples of **temperate grasslands**.

A grassland in Mongolia

Precipitation Precipitation is often highly seasonal, with relatively dry winters and wet summers. Annual precipitation generally averages between 30 and 100 cm. Periodic drought is common.

Temperature Winters are generally cold, with average temperatures falling below –10°C. Summers, with average temperatures often approaching 30°C, are hot.

Plants The dominant plants are grasses and forbs, which vary in height from a few centimeters to 2 m in tallgrass prairie. Many grassland plants have adaptations that help them survive periodic, protracted droughts and fire. For example, grasses can sprout quickly following fire. Grazing by large mammals helps prevent establishment of woody shrubs and trees.

Animals Native mammals include large grazers such as bison and wild horses. Temperate grasslands are also inhabited by a wide variety of burrowing mammals, such as prairie dogs in North America.

Human Impact Deep, fertile soils make temperate grasslands ideal places for agriculture, especially for growing grains. As a consequence, most grassland in North America and much of Eurasia has been converted to farmland. In some drier grasslands, cattle and other grazers have turned parts of the biome into desert.

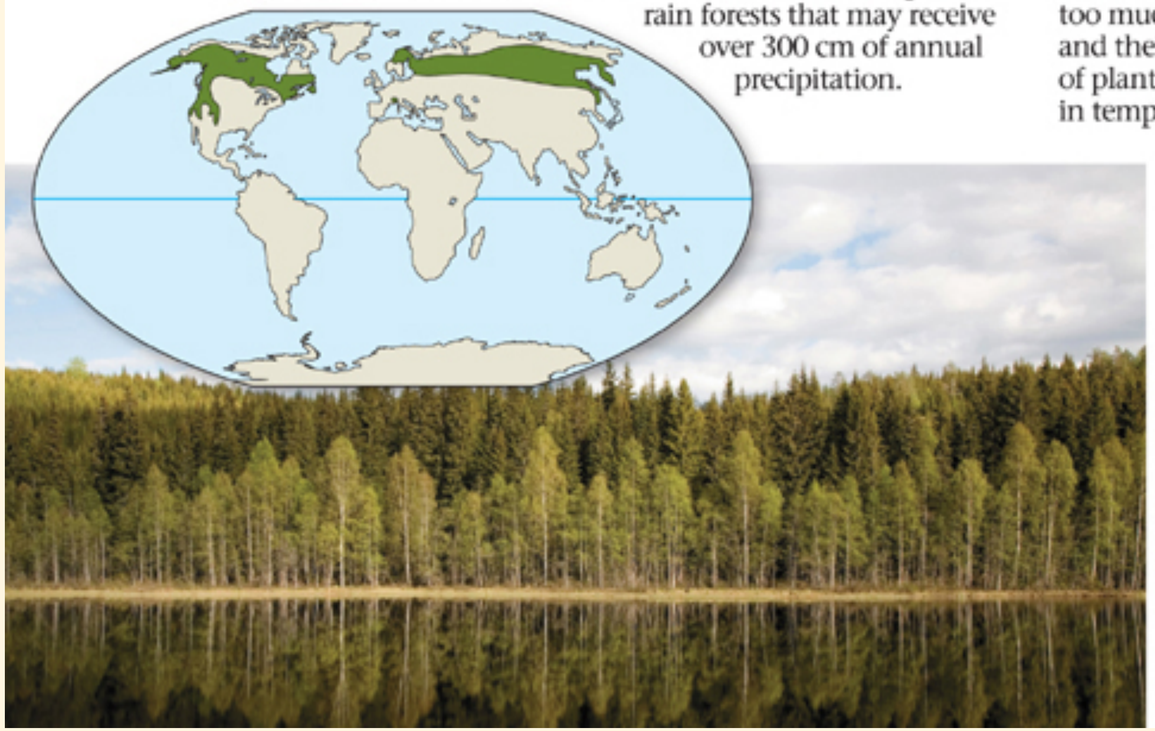
Ecologie planétaire - les biomes terrestres

Pour info!

Northern Coniferous Forest

Distribution Extending in a broad band across northern North America and Eurasia to the edge of the arctic tundra, the **northern coniferous forest**, or *taiga*, is the largest terrestrial biome on Earth.

Precipitation Annual precipitation generally ranges from 30 to 70 cm, and periodic droughts are common. However, some coastal coniferous forests of the U.S. Pacific Northwest are temperate rain forests that may receive over 300 cm of annual precipitation.



Temperature Winters are usually cold; summers may be hot. Some areas of coniferous forest in Siberia typically range in temperature from –50°C in winter to over 20°C in summer.

Plants Northern coniferous forests are dominated by cone-bearing trees, such as pine, spruce, fir, and hemlock, some of which depend on fire to regenerate. The conical shape of many conifers prevents too much snow from accumulating and breaking their branches, and their needle- or scale-like leaves reduce water loss. The diversity of plants in the shrub and herb layers of these forests is lower than in temperate broadleaf forests.

Animals While many migratory birds nest in northern coniferous forests, other species reside there year-round. The mammals of this biome, which include moose, brown bears, and Siberian tigers, are diverse. Periodic outbreaks of insects that feed on the dominant trees can kill vast tracts of trees.

Human Impact Although they have not been heavily settled by human populations, northern coniferous forests are being logged at an alarming rate, and the old-growth stands of these trees may soon disappear.

A coniferous forest in Norway

Ecologie planétaire - les biomes terrestres

Pour info!

Temperate Broadleaf Forest

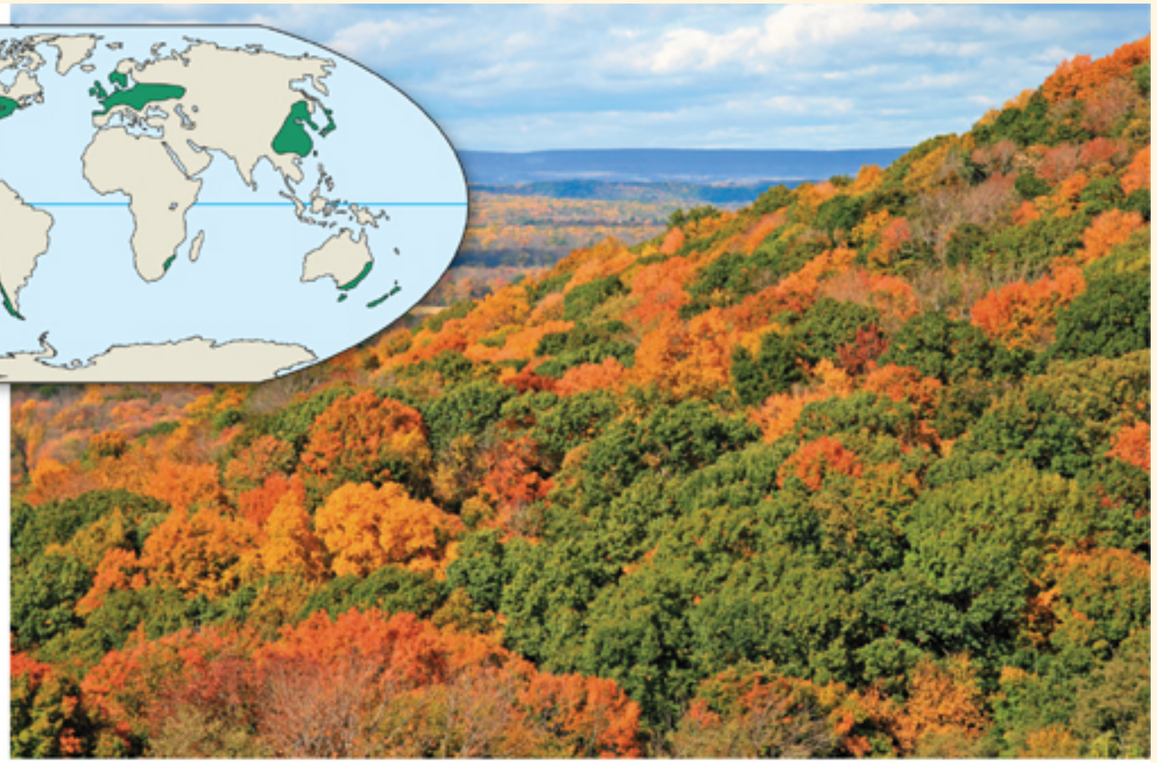
Distribution Temperate broadleaf forest is found mainly at midlatitudes in the Northern Hemisphere, with smaller areas in Chile, South Africa, Australia, and New Zealand.

Precipitation Precipitation can average from about 70 to over 200 cm annually. Significant amounts fall during all seasons, including summer rain and, in some forests, winter snow.

Temperature Winter temperatures average 0°C. Summers, with temperatures up to 35°C, are hot and humid.

Plants A mature **temperate broadleaf forest** has distinct vertical layers, including a closed canopy, one or two strata of understory trees, a shrub layer, and an herb layer. There are few epiphytes. The dominant plants in the Northern Hemisphere are deciduous trees, which drop their leaves before winter, when low temperatures would reduce photosynthesis and make water uptake from frozen soil difficult. In Australia, evergreen eucalyptus trees dominate these forests.

Animals In the Northern Hemisphere, many mammals hibernate in winter, while many bird species migrate to warmer climates. Mammals, birds, and insects make use of all the vertical layers of the forest.



A temperate broadleaf forest in New Jersey

Human Impact Temperate broadleaf forest has been heavily settled on all continents. Logging and land clearing for agriculture and urban development cleared virtually all the original deciduous forests in North America. However, owing to their capacity for recovery, these forests are returning over much of their former range.

Ecologie planétaire - les biomes terrestres

Pour info!

Tundra

Distribution **Tundra** covers expansive areas of the Arctic, amounting to 20% of Earth's land surface. High winds and low temperatures produce similar plant communities, called *alpine tundra*, on very high mountaintops at all latitudes, including the tropics.

Precipitation Precipitation averages from 20 to 60 cm annually in arctic tundra but may exceed 100 cm in alpine tundra.

Temperature Winters are cold, with averages in some areas below –30°C. Summer temperatures generally average less than 10°C.

Plants The vegetation of tundra is mostly herbaceous, consisting of a mixture of mosses, grasses, and forbs, along with some dwarf shrubs and trees and lichens. A permanently frozen layer of soil called permafrost restricts the growth of plant roots.

Animals Large grazing musk oxen are resident, while caribou and reindeer are migratory. Predators include bears, wolves, and foxes. Many bird species migrate to the tundra for summer nesting.

Human Impact Tundra is sparsely settled but has become the focus of significant mineral and oil extraction in recent years.

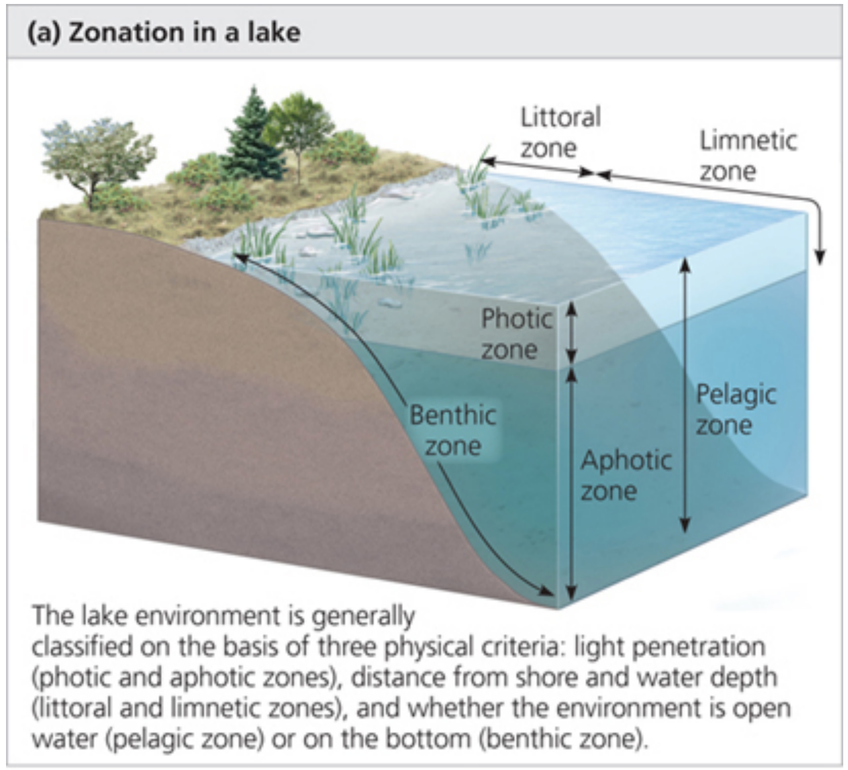
Dovrefjell-Sunndalsfjella National Park, Norway, in autumn

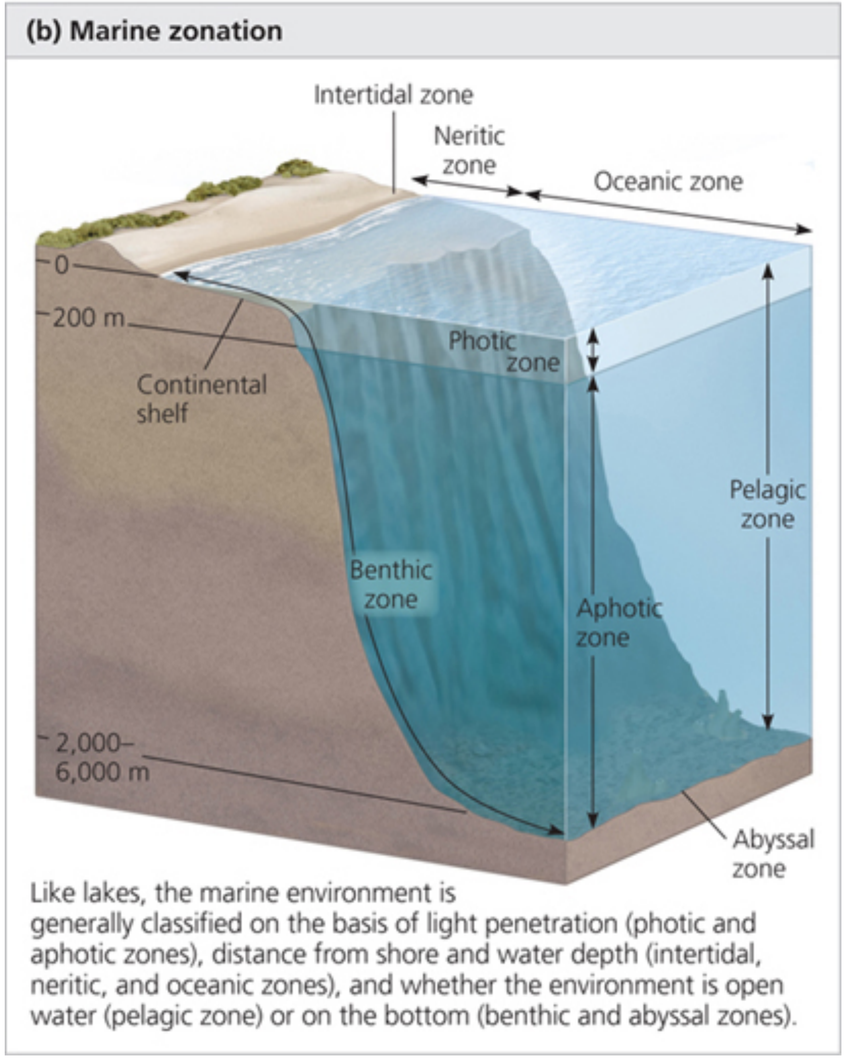
Ecologie planétaire - les biomes aquatiques

- Les biomes **aquatiques** sont caractérisés par leur environnement **physique et chimique** (ex: concentration en sel)
- Ils varient moins en fonction de la **latitude**
- Les océans couvrent **75% de la surface terrestre** et représentent le plus **large** biome aquatique
- Les **algues et bactéries** photosynthétiques produisent la plus grande partie de l'**oxygène** terrestre et consomment beaucoup de **dioxide de carbone** atmosphérique
- La température des océans a un **impact majeur** sur le **climat** global et sur les **vents**

Ecologie planétaire - les biomes aquatiques

- Ils sont souvent stratifiés **horizontalement** et **verticalement**





Ecologie planétaire - les biomes aquatiques

- Ils sont souvent stratifiés **horizontalement** et **verticalement**
  - Zone **euphotique**: la lumière pénètre et permet la photosynthèse
  - Zone **aphotique**: zone sans lumière
  - Zone **abyssale**: de 2000 à 6000m
  - Zone **benthique**: substrat qui se trouve au fond de tous les biomes aquatiques
  - La température de l'eau varie en fonction de la profondeur

Ecologie planétaire - les biomes aquatiques

Pour info!

Lakes

Physical Environment Standing bodies of water range from ponds a few square meters in area to lakes covering thousands of square kilometers. Light decreases with depth, creating stratification. Temperate lakes may have a seasonal thermocline; tropical lowland lakes have a thermocline year-round.

Chemical Environment The salinity, oxygen concentration, and nutrient content differ greatly among lakes and can vary with season. **Oligotrophic lakes** tend to be nutrient-poor and generally oxygen-rich; **eutrophic lakes** are nutrient-rich and often depleted of oxygen in the deepest zone in summer and if covered with ice in winter. The amount of decomposable organic matter in bottom sediments is low in oligotrophic lakes and high in eutrophic lakes; high rates of decomposition in deeper layers of eutrophic lakes cause periodic oxygen depletion.

Geologic Features Oligotrophic lakes tend to have less surface area relative to their depth than eutrophic lakes. Oligotrophic lakes may become more eutrophic over time as runoff adds sediments and nutrients.

Photosynthetic Organisms Rooted and floating aquatic plants in lakes live in the

An oligotrophic lake in Canada

littoral zone, the shallow, well-lit waters close to shore. Farther from shore, where water is too deep to support rooted aquatic plants, the **limnetic zone** is inhabited by a variety of phytoplankton, including cyanobacteria.

Heterotrophs In the limnetic zone, small drifting heterotrophs, or zooplankton, graze on the phytoplankton. The benthic zone is inhabited by assorted invertebrates whose species composition depends partly on oxygen levels. Fishes live in all zones with sufficient oxygen.

A eutrophic lake in the Okavango Delta, Botswana

Human Impact Runoff from fertilized land and dumping of wastes lead to nutrient enrichment, which can produce large numbers of algae (an algal "bloom") oxygen depletion, and fish kills.

Ecologie planétaire - les biomes aquatiques

Pour info!

Wetlands

Physical Environment A **wetland** is a habitat that is inundated by water at least some of the time and that supports plants adapted to water-saturated soil. Some wetlands are inundated at all times, whereas others flood infrequently.

Chemical Environment Because of high organic production by plants and decomposition by microbes and other organisms, both the water and the soils are periodically low in dissolved oxygen. Wetlands have a high capacity to filter dissolved nutrients and chemical pollutants.

Geologic Features *Basin wetlands* develop in shallow basins, ranging from upland depressions to filled-in lakes and ponds. *Riverine wetlands* develop along shallow and periodically flooded banks of rivers and streams. *Fringe wetlands* occur along the coasts of large lakes and seas, where water flows back and forth because of rising lake levels or tidal action. Thus, fringe wetlands include both freshwater and marine biomes.

A basin wetland in the United Kingdom

Photosynthetic Organisms Wetlands are among the most productive biomes on Earth. Their water-saturated soils favor the growth of plants such as pond lilies and cattails, many sedges, bald cypress, and black spruce, which have adaptations enabling them to grow in water or in soil that is periodically anaerobic owing to the presence of unaerated water. Woody plants dominate the vegetation of swamps, while bogs are dominated by sphagnum mosses.

Heterotrophs Wetlands are home to a diverse community of invertebrates, birds, and many other organisms. Herbivores, from crustaceans and aquatic insect larvae to muskrats, consume algae, detritus, and plants. Carnivores are also varied and may include dragonflies, otters, frogs, alligators, and herons.

Human Impact Wetlands help purify water and reduce peak flooding. Draining and filling have destroyed up to 90% of wetlands in Europe.

Ecologie planétaire - les biomes aquatiques

Pour info!

Streams and Rivers

Physical Environment The most prominent physical characteristic of streams and rivers is the speed and volume of their flow. Headwater streams are generally cold, clear, swift, and turbulent. Farther downstream, where numerous tributaries may have joined, forming a river, the water is generally warmer and more turbid because of suspended sediment. Streams and rivers are stratified into vertical zones.

Chemical Environment The salt and nutrient content of streams and rivers increases from the headwaters to the mouth. Headwaters are generally rich in oxygen. Downstream water may also contain substantial oxygen, except where there has been organic enrichment. A large fraction of the organic matter in rivers consists of dissolved or highly fragmented material that is carried by the current from forested streams.

Geologic Features Headwater stream channels are often narrow, have a rocky bottom, and alternate between shallow sections and deeper pools. The downstream stretches of rivers are generally wide and meandering. River bottoms are often silty from sediments deposited over long periods of time.

A headwater stream in Washington

Photosynthetic Organisms Headwater streams that flow through grasslands or deserts may be rich in phytoplankton or rooted aquatic plants.

Heterotrophs A great diversity of fishes and invertebrates inhabit unpolluted rivers and streams, distributed according to, and throughout, the vertical zones. In streams flowing through temperate or tropical forests, organic matter from terrestrial vegetation is the primary source of food for aquatic consumers.

The Loire River in France, far from its headwaters

Human Impact Municipal, agricultural, and industrial pollution degrade water quality and kill aquatic organisms. Damming and flood control impair the natural functioning of stream and river ecosystems and threaten migratory species such as salmon.

Ecologie planétaire - les biomes aquatiques

Pour info!

Estuaries

Physical Environment An **estuary** is a transition area between river and sea. Seawater flows up the estuary channel during a rising tide and flows back down during the falling tide. Often, higher-density seawater occupies the bottom of the channel and mixes little with the lower-density river water at the surface.

Chemical Environment Salinity varies spatially within estuaries, from nearly that of fresh water to that of seawater. Salinity also varies with the rise and fall of the tides. Nutrients from the river make estuaries, like wetlands, among the most productive biomes.

Geologic Features Estuarine flow patterns combined with the sediments carried by river and tidal waters create a complex network of tidal channels, islands, natural levees, and mudflats.

Photosynthetic Organisms Saltmarsh grasses and algae, including phytoplankton, are the major producers in estuaries.

Heterotrophs Estuaries support an abundance of worms, oysters, crabs, and many fish species that humans consume. Many marine invertebrates and fishes use estuaries as a breeding ground or migrate through them to freshwater habitats upstream. Estuaries are also crucial feeding areas for waterfowl and some marine mammals.

Human Impact Filling, dredging, and pollution from upstream have disrupted estuaries worldwide.

An estuary in southern Spain

Ecologie planétaire - les biomes aquatiques

Pour info!

Intertidal Zones

Physical Environment An **intertidal zone** is periodically submerged and exposed by the tides, twice daily on most marine shores. Upper zones experience longer exposures to air and greater variations in temperature and salinity. Changes in physical conditions from the upper to the lower intertidal zones limit the distributions of many organisms to particular strata, as shown in the photograph.

Chemical Environment Oxygen and nutrient levels are generally high and are renewed with each turn of the tides.

Geologic Features The substrates of intertidal zones, which are generally either rocky or sandy, select for particular behavior and anatomy among intertidal organisms. The configuration of bays or coastlines influences the magnitude of tides and the relative exposure of intertidal organisms to wave action.

Photosynthetic Organisms A high diversity and biomass of attached marine algae inhabit rocky intertidal zones, especially in the lower zone. Sandy intertidal zones exposed to vigorous wave action generally lack attached plants or algae, while sandy intertidal zones in protected bays or lagoons often support rich beds of seagrass and algae.

Heterotrophs Many of the animals in rocky intertidal environments have structural adaptations that enable them to attach to the hard substrate. The composition, density, and diversity of animals change markedly from the upper to the lower intertidal zones. Many of the animals in sandy or muddy intertidal zones, such as worms, clams, and predatory crustaceans, bury themselves and feed as the tides bring sources of food. Other common animals are sponges, sea anemones, echinoderms, and small fishes.

Human Impact Oil pollution has disrupted many intertidal areas. The construction of rock walls and barriers to reduce erosion from waves and storm surges has disrupted this zone in some locations.

A rocky intertidal zone on the Oregon coast

Ecologie planétaire - les biomes aquatiques

Pour info!

Oceanic Pelagic Zone

Physical Environment The **oceanic pelagic zone** is a vast realm of open blue water, constantly mixed by wind driven oceanic currents. Because of higher water clarity, the photic zone extends to greater depths than in coastal marine waters.

Chemical Environment Oxygen levels are generally high. Nutrient concentrations are generally lower than in coastal waters. Because they are thermally stratified year-round, some tropical areas of the oceanic pelagic zone have lower nutrient concentrations than temperate oceans. Turnover between fall and spring renews nutrients in the photic zones of temperate and high-latitude ocean areas.

Geologic Features This biome covers approximately 70% of Earth's surface and has an average depth of nearly 4,000 m. The deepest point in the ocean is more than 10,000 m beneath the surface.

Photosynthetic Organisms The dominant photosynthetic organisms are phytoplankton, including photosynthetic bacteria, that drift with the oceanic currents. Spring turnover renews nutrients in temperate oceans, producing a surge of phytoplankton growth. Because of this biome's large size, photosynthetic plankton account for about half of the photosynthetic activity on Earth.

Heterotrophs The most abundant heterotrophs in this biome are zooplankton. These protists, worms, copepods, shrimp-like krill, jellies, and small larvae of invertebrates and fishes graze on photosynthetic plankton. The oceanic pelagic zone also includes numerous free-swimming animals, such as large squids, fishes, sea turtles, and marine mammals.

Human Impact Overfishing has depleted fish stocks in all Earth's oceans; marine life has also been harmed by pollution, ocean acidification, and global warming.

Continued on next page

Open ocean near Iceland

Ecologie planétaire - les biomes aquatiques

Pour info!

Coral Reefs

Physical Environment **Coral reefs** are formed largely from the calcium carbonate skeletons of corals. Shallow reef-building corals live in the photic zone of relatively stable tropical marine environments with high water clarity, primarily near islands and along the edge of some continents. They are sensitive to temperatures below about 18–20°C and above 30°C. Deep-sea coral reefs, found between 200 and 1,500 m deep, are less known than their shallow counterparts but harbor as much diversity as many shallow reefs do.

Chemical Environment Corals require high oxygen levels and are excluded by high inputs of fresh water and nutrients.

Geologic Features Corals require a solid substrate for attachment. A typical coral reef begins as a *fringing reef* on a young, high island, forming an offshore *barrier reef* later in the history of the island and becoming a *coral atoll* as the older island submerges.

Photosynthetic Organisms Unicellular algae live within the tissues of the corals, forming a mutualistic relationship that provides the corals with organic molecules. Diverse multicellular red and green algae growing on the reef also contribute substantial amounts of photosynthesis.

A coral reef in the Red Sea

Heterotrophs Corals, a diverse group of cnidarians, are themselves the predominant animals on coral reefs. However, fish and invertebrate diversity is exceptionally high. Overall animal diversity on coral reefs rivals that of tropical forests.

Human Impact Collecting of coral skeletons and overfishing have reduced populations of corals and reef fishes. Global warming and pollution may be contributing to large-scale coral death. Development of coastal mangroves for aquaculture has also reduced spawning grounds for many species of reef fishes.

Ecologie planétaire - les biomes aquatiques

Pour info!

Marine Benthic Zone

Physical Environment The **marine benthic zone** consists of the seafloor below the surface waters of the coastal, or **neritic**, zone and the offshore pelagic zone. Except for shallow, near-coastal areas, the marine benthic zone receives no sunlight. Water temperature declines with depth, while pressure increases. As a result, organisms in the very deep benthic, or abyssal, zone are adapted to continuous cold (about 3°C) and very high water pressure.

Chemical Environment Except in areas of organic enrichment, oxygen is usually present at sufficient concentrations to support diverse animal life.

Geologic Features Soft sediments cover most of the benthic zone. However, there are areas of rocky substrate on reefs, submarine mountains, and new oceanic crust.

Autotrophs Photosynthetic organisms, mainly algae, are limited to shallow benthic areas with sufficient light to support them. Unique assemblages of organisms live near deep-sea **hydrothermal vents** on mid-ocean ridges. In these dark, hot environments, the food producers are chemoautotrophic prokaryotes that obtain energy by oxidizing H_2S formed by a reaction of the hot water with dissolved sulfate (SO_4^{2-}).

Heterotrophs Neritic benthic communities include numerous invertebrates and fishes. Beyond the photic zone, most consumers depend entirely on organic matter raining down from above. Among the animals of the deep-sea hydrothermal vent communities are giant tube worms (pictured), some more than 1 m long. They are nourished by chemoautotrophic prokaryotes that live as symbionts within their bodies. Many other invertebrates, including arthropods and echinoderms, are also abundant around the vents.

Human Impact Overfishing has decimated important benthic fish populations, such as the cod of the Grand Banks off Newfoundland. Dumping of organic wastes has created oxygen-deprived benthic areas.

A deep-sea hydrothermal vent community

Mastering Biology Video: Tubeworms

Plan

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- Ecologie des communautés

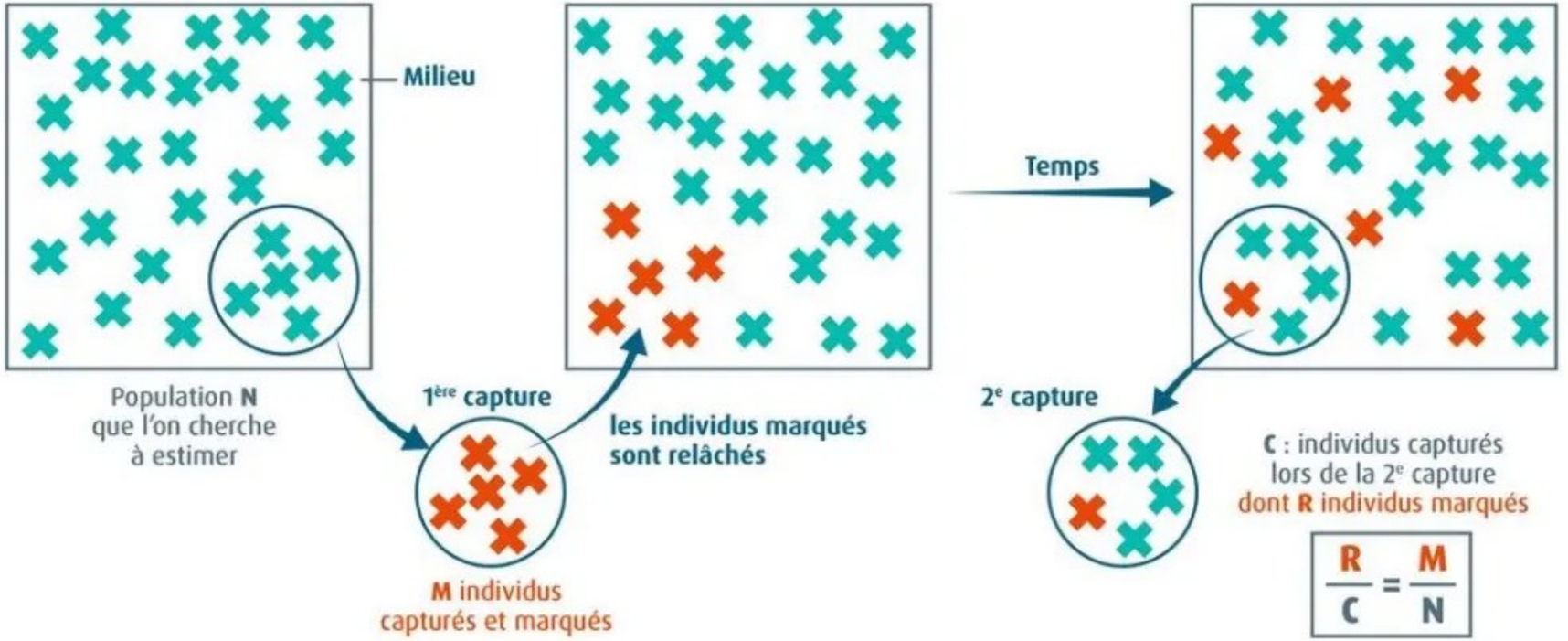
Ecologie des populations

Une **population** est un groupe d'individus de la même espèce vivant dans une aire géographique donnée, à un moment précis. Ces individus consomment les mêmes ressources et sont influencés par les mêmes facteurs écologiques. Ils se reproduisent entre eux et interagissent.

Ecologie des populations - densité

La **densité** d'une population est le nombre d'individu par unité d'aire ou de volume

Comment la mesurer? Technique de **capture-recapture**



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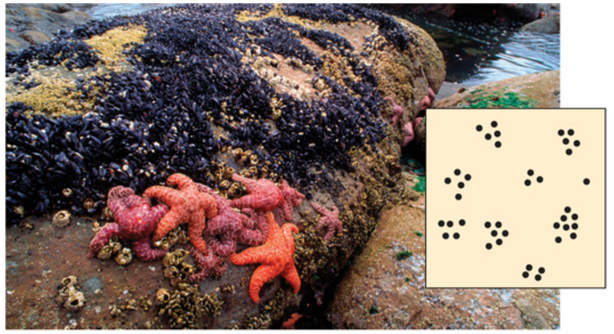
Ecologie des populations - densité

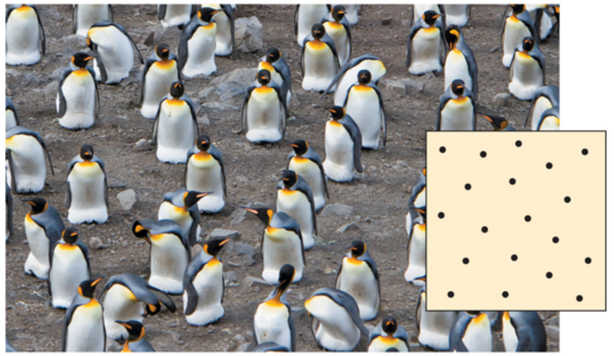
La **densité** d'une population n'est pas statique

Ecologie des populations - dispersion

La **dispersion** d'une population dépend de nombreux facteurs



(a) Clumped. Sea stars group together where food is abundant.



(b) Uniform. King penguins and other birds that nest on small islands often exhibit uniform spacing, maintained by aggressive interactions between neighbors.

(c) Random. Dandelions grow from windblown seeds that land at random and later germinate.

Ecologie des populations - démographie

L'étude quantitative d'une population et de ses variations au cours du temps est appelée **démographie.** Elle s'intéresse aux **taux de natalité** et **mortalité**

Table de survie

Tableau 53.1 Table de survie d'une cohorte de spermophiles de Belding (*Spermophilus beldingi*) de Tioga Pass, dans la chaîne de la Sierra Nevada, en Californie*

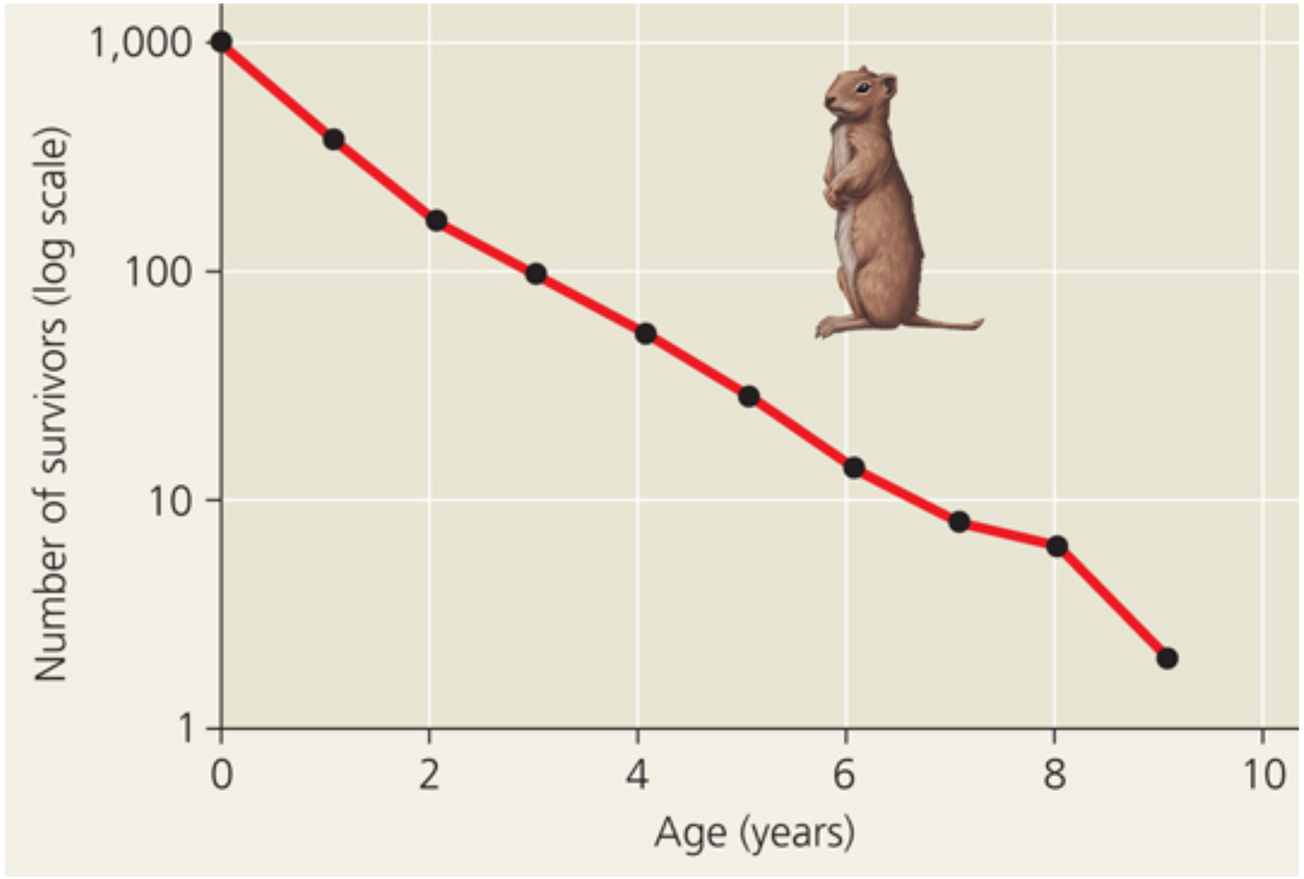
	FEMELLES					MÂLES				
Âge (années)	Nombre d'individus vivants au début de l'intervalle	Proportion de survivants au début de l'intervalle	Nombre de morts pendant l'intervalle	Taux de mortalité†	Espérance de vie additionnelle moyenne (années)	Nombre d'individus vivants au début de l'intervalle	Proportion de survivants au début de l'intervalle	Nombre de morts pendant l'intervalle	Taux de mortalité†	Espérance de vie additionnelle moyenne (années)
0-1	337	1,000	207	0,61	1,33	349	1,000	227	0,65	1,07
1-2	252‡	0,386	125	0,50	1,56	248‡	0,350	140	0,6	1,12
2-3	127	0,197	60	0,47	1,60	108	0,152	74	0,69	0,93
3-4	67	0,106	32	0,48	1,59	34	0,048	23	0,68	0,89
4-5	35	0,054	16	0,46	1,59	11	0,015	9	0,82	0,68
5-6	19	0,029	10	0,53	1,50	2	0,003	0	1,00	0,50
6-7	9	0,014	4	0,44	1,61	0				
7-8	5	0,008	1	0,20	1,50					
8-9	4	0,006	3	0,75	0,75					
9-10	1	0,002	1	1,00	0,50					

Source : P. W. Sherman et M. L. Morton, Demography of Belding's Ground Squirrel, *Ecology* 65 : 1617-1628 (1984).
* La longévité étant différente pour les mâles et les femelles, on a établi une table de survie pour chaque sexe.
† Le taux de mortalité est la proportion d'individus qui meurent dans un intervalle de temps donné.
‡ Comprend 122 femelles et 126 mâles qui ont été capturés la première fois à l'âge de 1 an et qui ne sont donc pas inclus dans le nombre d'individus ayant entre 0 et 1 an.

Ecologie des populations - démographie

L'étude quantitative d'une population et de ses variations au cours du temps est appelée **démographie.** Elle s'intéresse aux **taux de natalité** et **mortalité**

Courbe de survie



Ecologie des populations - démographie

L'étude quantitative d'une population et de ses variations au cours du temps est appelée **démographie.** Elle s'intéresse aux **taux de natalité** et **mortalité**

Taux de reproduction - table de fécondité

Tableau 53.2 **Table de fécondité d'une cohorte de spermophiles de Belding (*Spermophilus beldingi*) de Tioga Pass**

Âge (années)	Proportion de femelles ayant une portée	Nombre moyen d'individus par portée (mâles + femelles)	Nombre moyen de femelles par portée	Nombre moyen de rejetons femelles*
0-1	0,00	0,00	0,00	0,00
1-2	0,65	3,30	1,65	1,07
2-3	0,92	4,05	2,03	1,87
3-4	0,90	4,90	2,45	2,21
4-5	0,95	5,45	2,73	2,69
5-6	1,00	4,15	2,08	2,08
7-8	1,00	3,85	1,93	1,93
8-9	1,00	3,85	1,93	1,93
9-10	1,00	3,15	1,58	1,58

Source : P. W. Sherman et M. L. Morton, Demography of Belding's Ground Squirrel, *Ecology* 65 : 1617-1628 (1984).

* Le nombre moyen de rejetons femelles est la proportion de femelles ayant une portée multipliée par le nombre moyen de femelles par portée.

Ecologie des populations - démographie

Accroissement démographique

Variation de la population = Naissances - morts

$$\frac{\Delta N}{\Delta t} = B - M$$

B est le **nombre de naissance** survenu pendant la période

b est le **taux moyen de naissances** par individu pendant une période donnée

Ex: 34 naissances pour 1000 individus en 1 an = 0,034

$$B = bN$$

Ecologie des populations - démographie

Accroissement démographique

Variation de la population = Naissances - morts

$$\frac{\Delta N}{\Delta t} = B - D$$

D est le **nombre de morts** survenu pendant la période

d est le **taux moyen de mort** par individu pendant une période donnée

Ex: 34 morts pour 1000 individus en 1 an = 0,034

$$D = dN$$

Ecologie des populations - démographie

Accroissement démographique

Variation de la population = Naissances - morts

$$\frac{\Delta N}{\Delta t} = bN - dN$$

r est le **taux d'accroissement** par individu

$$r = b - d$$

Si r > 0, la population s'accroît

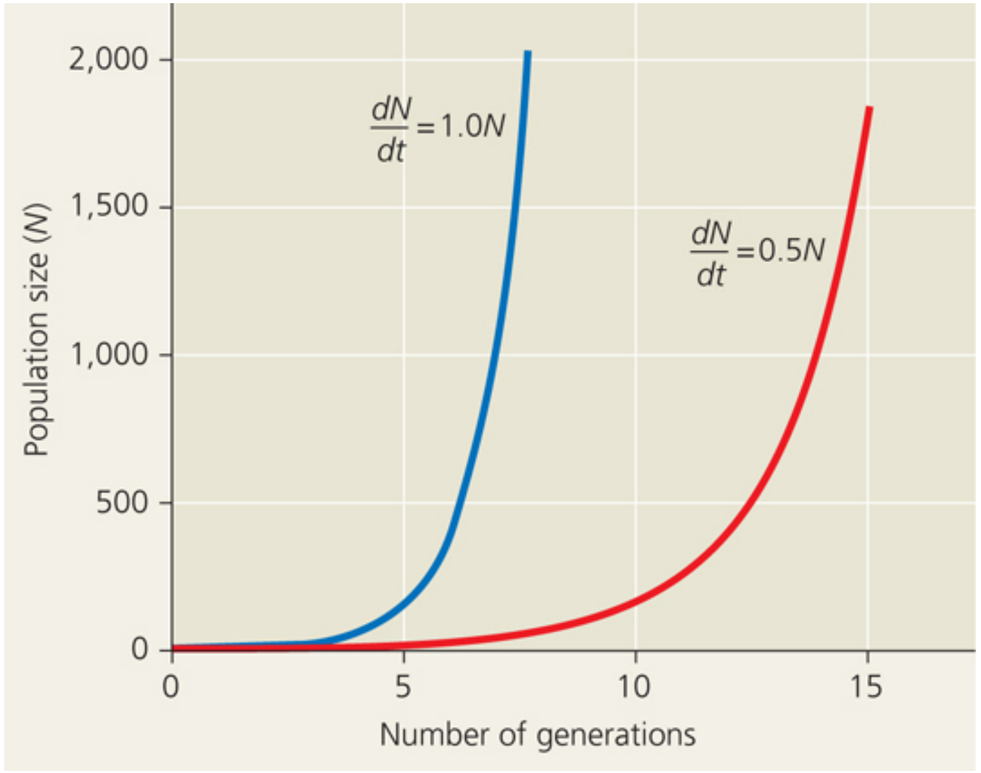
Si r< 0, la population décroît

Ecologie des populations - démographie

Accroissement démographique exponentiel (ressources illimitées)

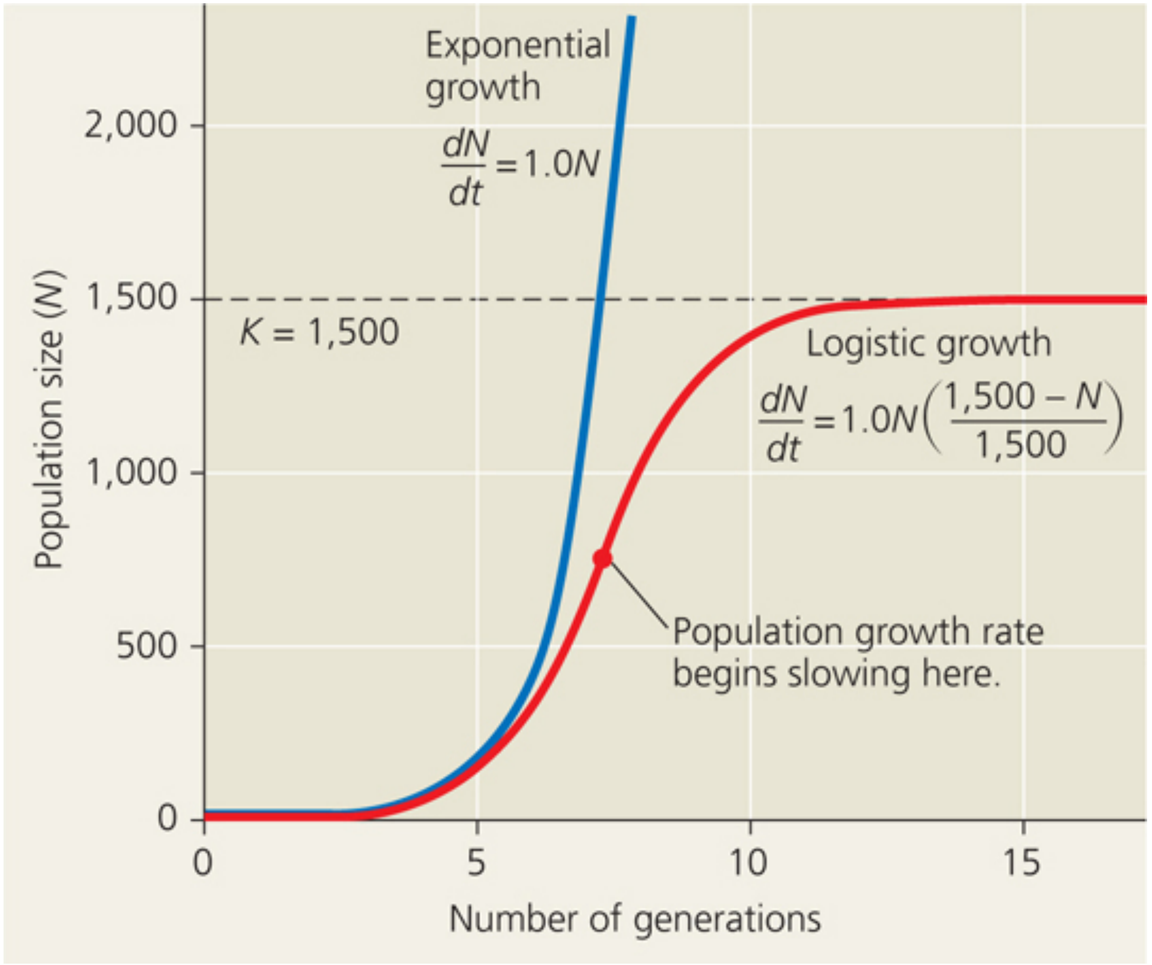
$$\frac{dN}{dt} = r_m N$$

où r_m est l'accroissement maximum



Ecologie des populations - démographie

Le modèle logistique = l'accroissement diminue quand une population atteint la capacité limite du milieu



$$\frac{dN}{dt} = r_m N \frac{(K - N)}{K}$$

où r_m est l'accroissement maximum

où K est la capacité limite du milieu

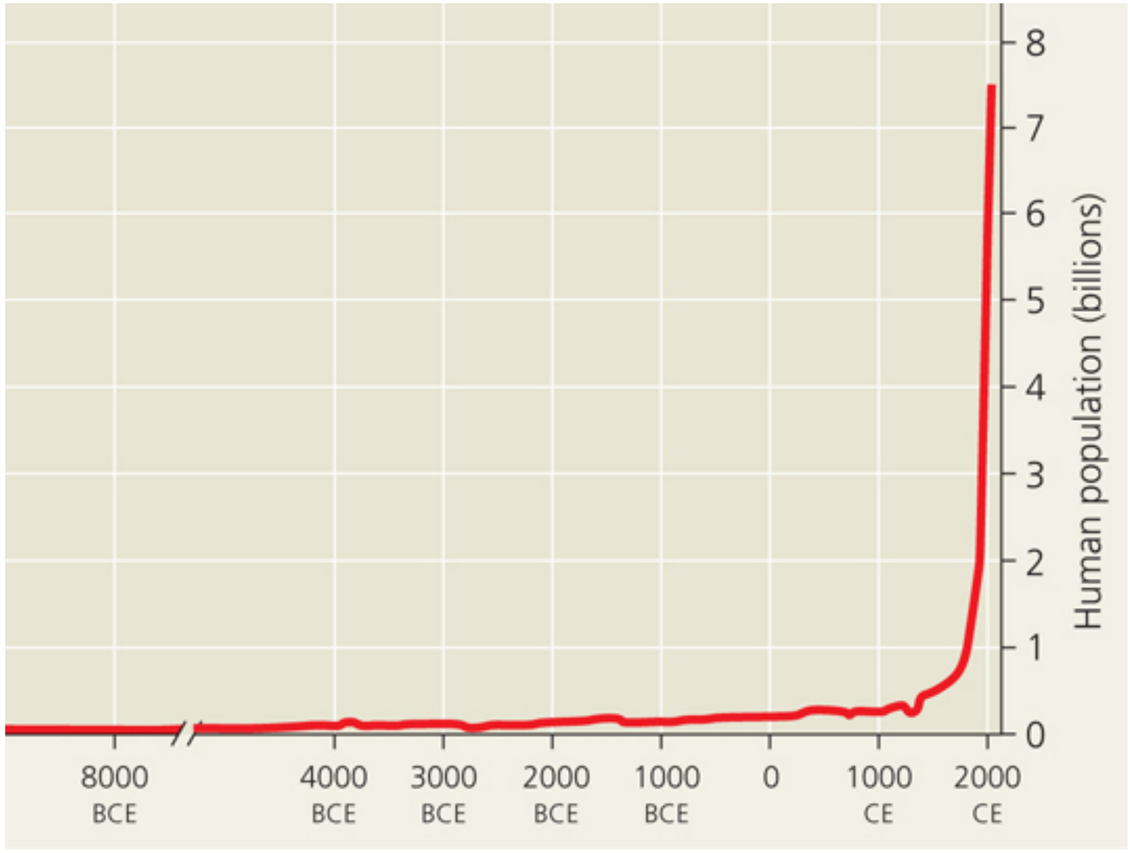
- nombre d'individus max capable de vivre dans un milieu, sans dégradation du milieu)
- varie dans le temps et l'espace en fonction de l'abondance des ressources

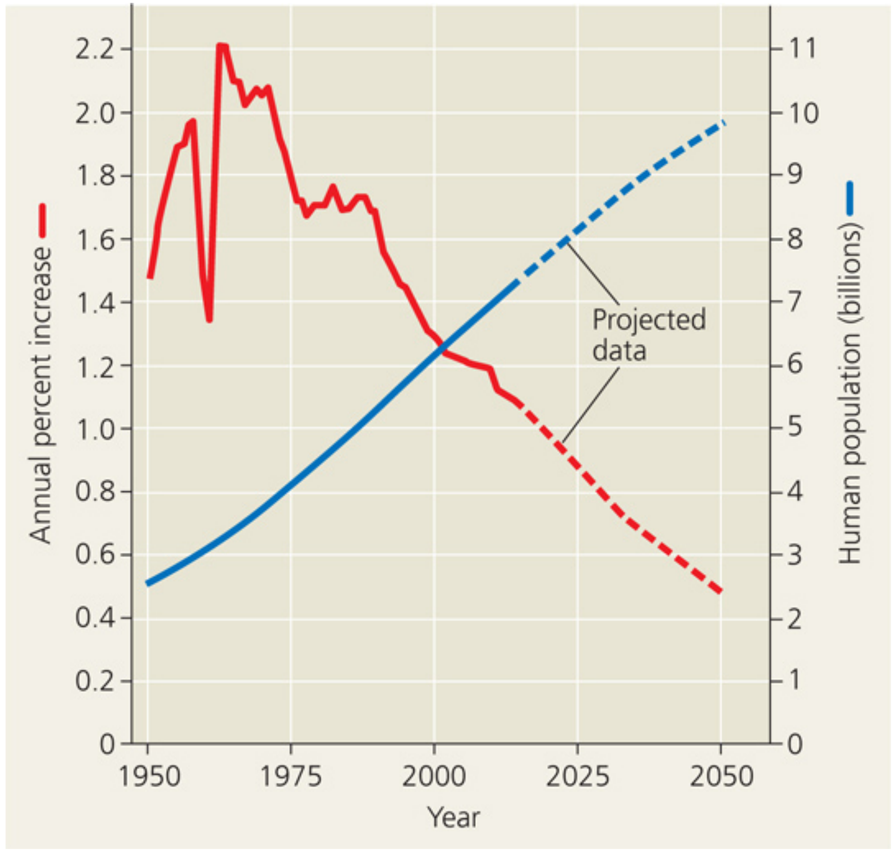
où N est la taille de la population à l'instant t

Le taux d'accroissement diminue quand N augmente

La population humaine

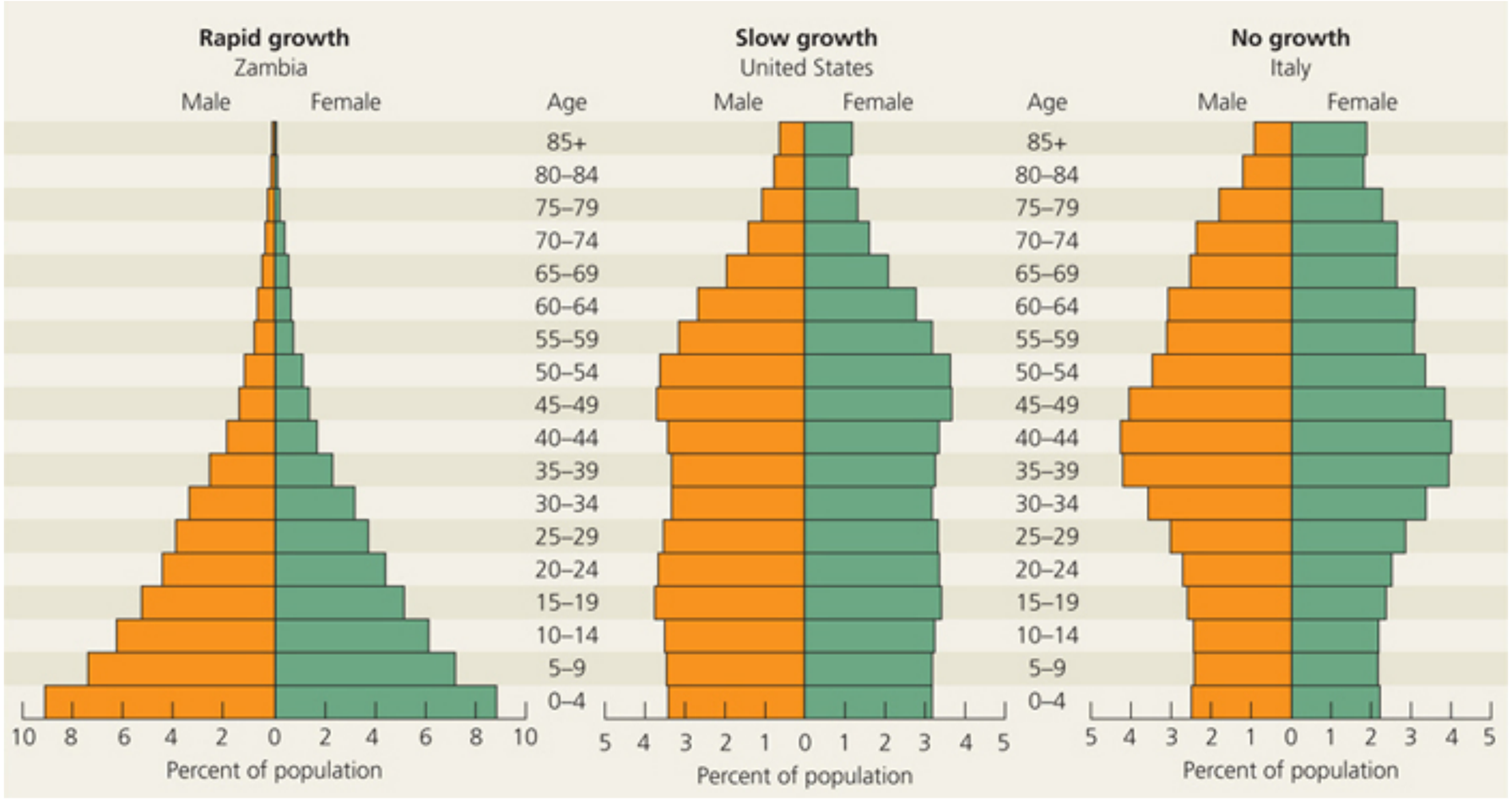
Le taux d'accroissement de la population humaine diminue actuellement et la croissance n'est plus exponentielle





La population humaine

Le taux d'accroissement de la population humaine diminue actuellement et la croissance n'est plus exponentielle



Données de 2010

Plan

- Les différents niveaux d’écologie
- Ecologie planétaire
- Ecologie des populations
- **Ecologie des communautés**

Ecologie des communautés

L'étude des **interactions** entre populations d'**espèces différentes**.

➡ Les interactions sont souvent classées en fonction de leur type: **utile, nuisible ou sans effet**

Ecologie des communautés - compétition

La compétition

- La compétition est une **interaction -/-** qui se manifeste quand deux espèces se disputent des **ressources essentielles**

- Si l'une des espèce a un **avantage compétitif**, l'autre disparait (exclusion compétitive)

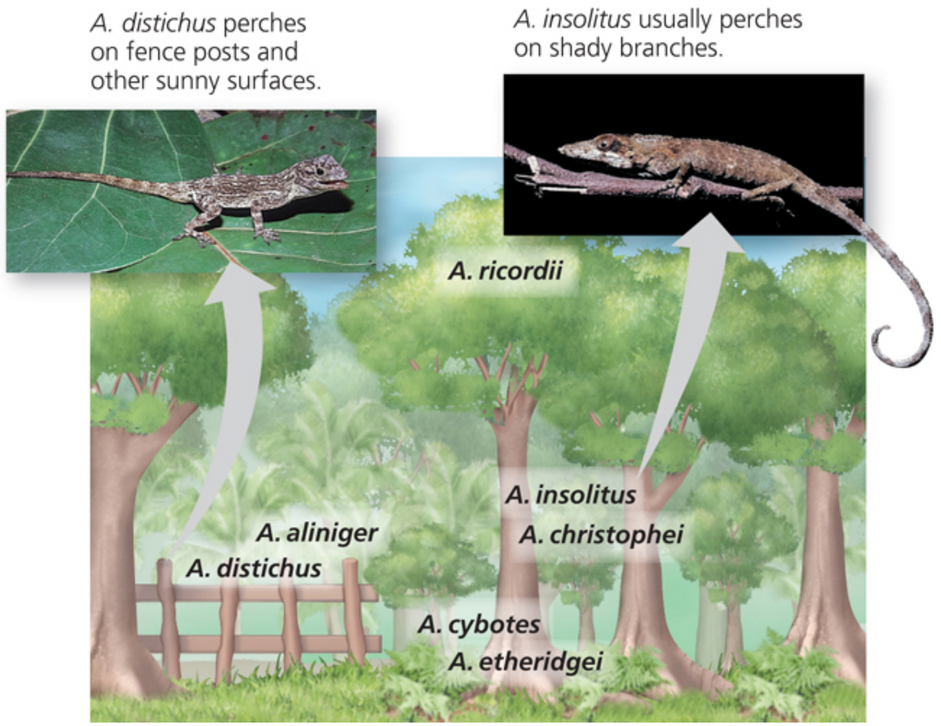
La **niche écologique** est l'utilisation globale qu'une espèce fait des ressources biotiques et abiotiques de son milieu (où il vit, ce qu'il mange, ce dont il a besoin pour se reproduire, etc). L'**exclusion compétitive** a lieu quand deux espèces partagent la même niche écologique.

Ecologie des communautés - compétition

- L'évolution et la sélection naturelle peut amener des espèces à cohabiter en modifiant légèrement leurs besoins

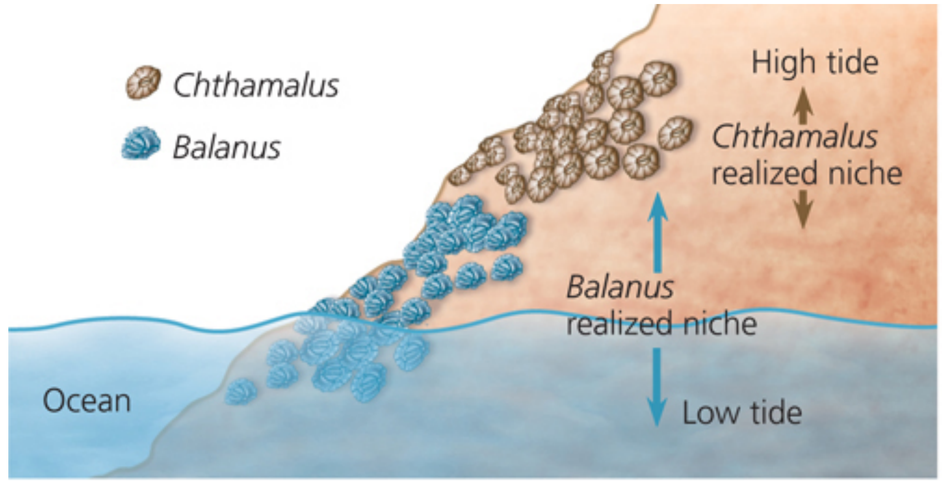
- La différenciation des niches qui permet à des espèces semblables de cohabiter est appelée **partage des ressources**

Les espèces de lézards se nourrissent des même insectes et arthropodes mais la compétition est diminuée par le fait que chaque espèce se niche à des endroits différents donc leur niche est différente

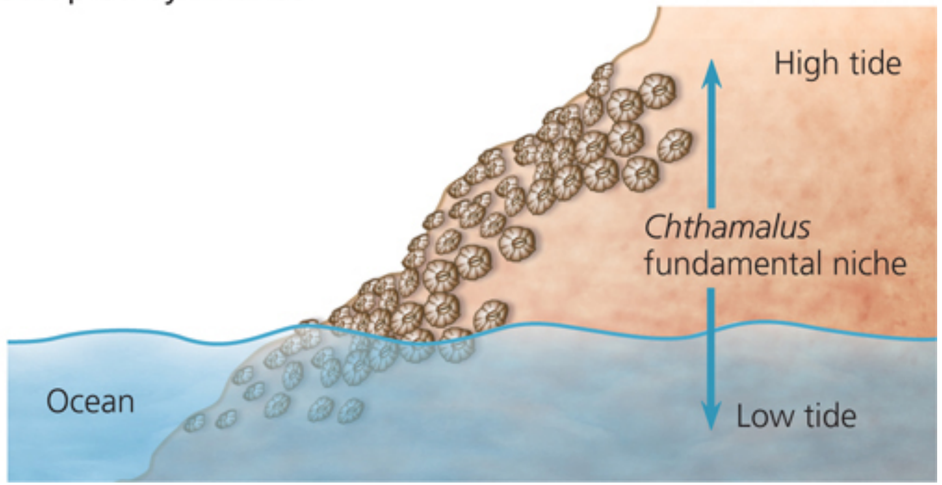


Ecologie des communautés - compétition

- Niche fondamentale vs. niche réelle



Results *Chthamalus* spread into the region formerly occupied by *Balanus*.



Ecologie des communautés - prédation

La prédation

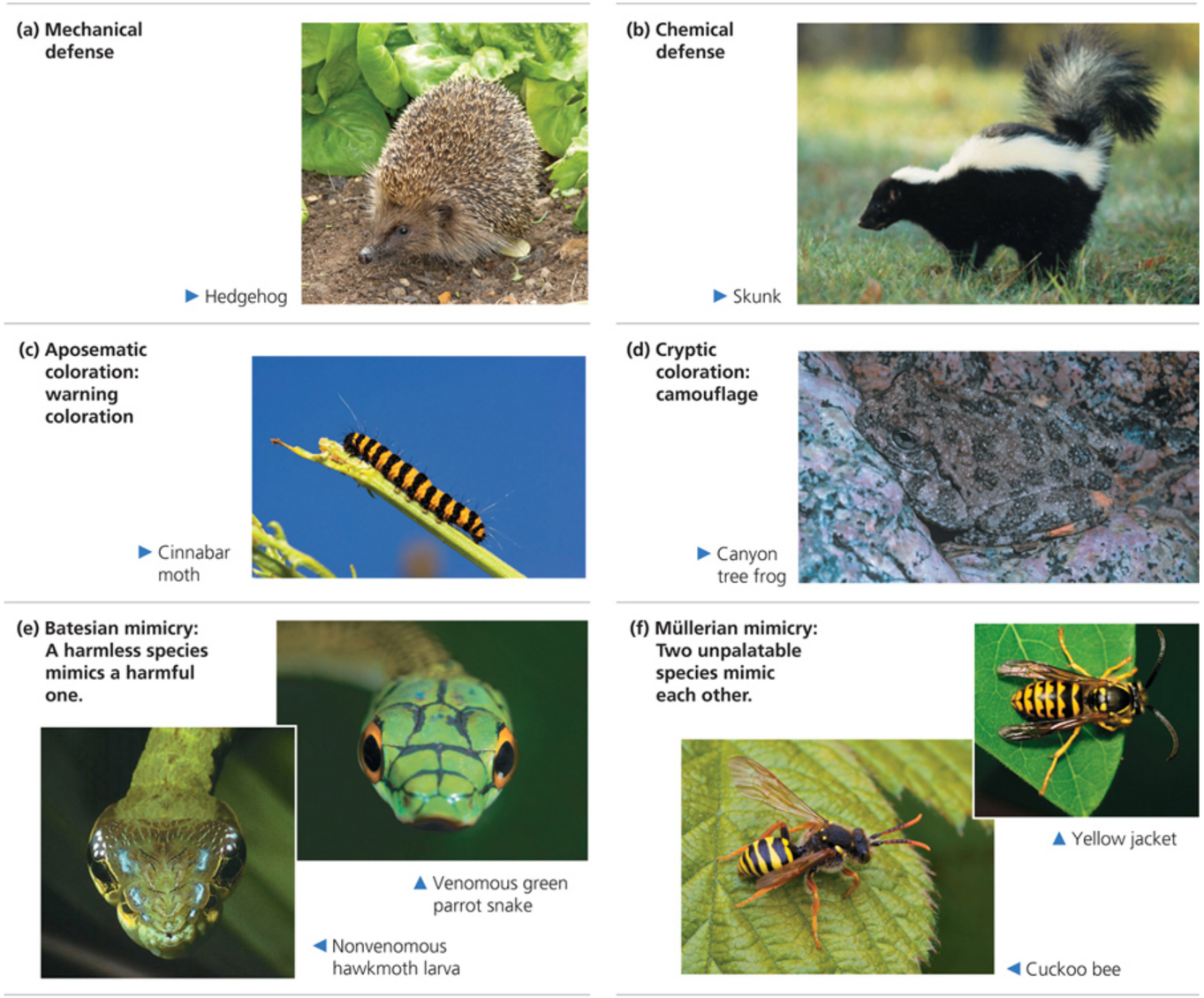
- La prédation est une **interaction +/-** dans laquelle une espèce, le **prédateur**, tue et dévore une autre espèce, la **proie**

- Diverses adaptations évolutives ont permis aux prédateurs de devenir “**meilleurs**” (serres, dents, crochets, venins, becs, etc.)

- Diverses adaptations évolutives ont permis aux proies de mieux se **défendre** (camouflage, regroupement, cris, etc.)

Ecologie des communautés - prédation

La prédation



Ecologie des communautés - herbivorisme

L'herbivorisme

- La prédation est une **interaction +/-** dans laquelle une espèce, l'herbivore, se nourrit de partie de végétaux et d'algues

- Diverses adaptations évolutives ont permis aux prédateurs de devenir "**meilleurs**" (chimiorécepteurs sur les pattes pour distinguer les plantes toxiques, odorat, etc.)

- Diverses adaptations évolutives ont permis aux "proies" de mieux se **défendre** (toxines chimiques ou épines, etc.)

Ecologie des communautés - symbiose

La symbiose

- Lorsque des organismes de deux espèces vivent en **contact direct et intime**, leur relation relève de la symbiose

- Elles peuvent être nuisibles, bénéfiques ou neutres

Ecologie des communautés - symbiose

La symbiose

- Le **parasitisme** est une interaction symbiotique +/- dans laquelle un organisme, le parasite, se nourrit au dépens de son hôte et lui porte préjudice

- Les parasites qui vivent dans leur hôte (ex: ténia ou vers solitaire) sont des endoparasites

- Les parasites qui vivent à courte durée sur leur hôte sont des exoparasites (ex: moustiques)

Ecologie des communautés - symbiose

La symbiose

- Le **mutualisme** est une interaction symbiotique +/+ Les parasites qui vivent dans leur hôte (ex: ténia ou vers solitaire) sont des endoparasites

- Ex: le microbiote intestinal

Ecologie des communautés - symbiose

La symbiose

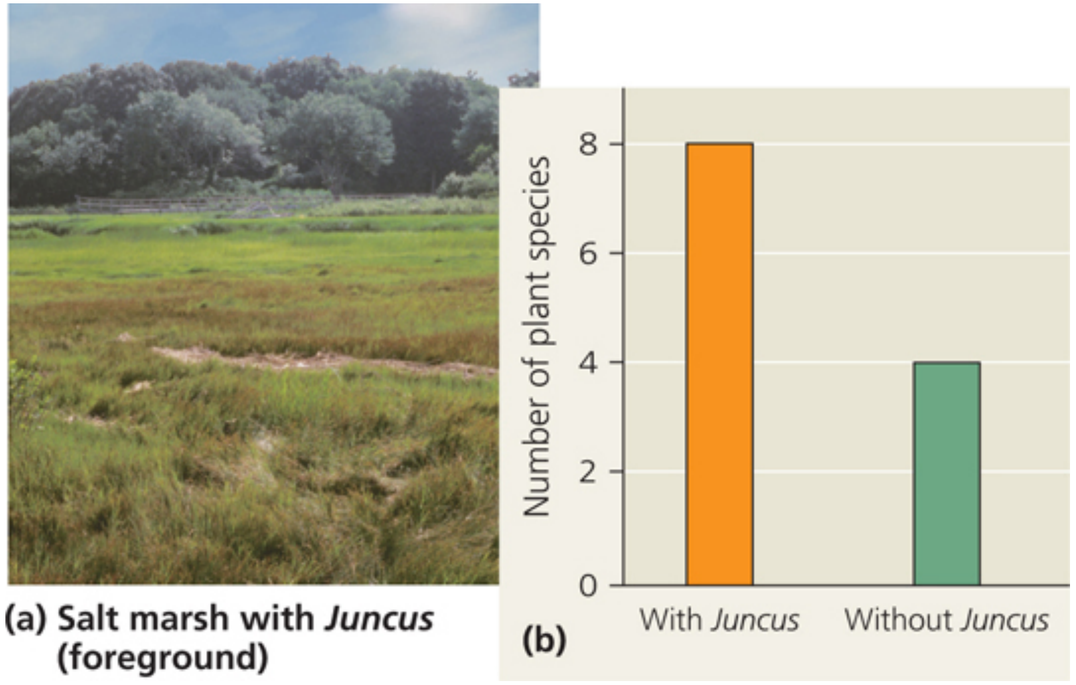
- Le **commensalisme** est une interaction symbiotique +/0

- Difficile à observer dans la nature, car il y a souvent un faible effet, positif ou négatif

Ecologie des communautés - facilitation

La facilitation

- La facilitation est une interaction +/+ (sans symbiose)



Ecologie des communautés - diversité

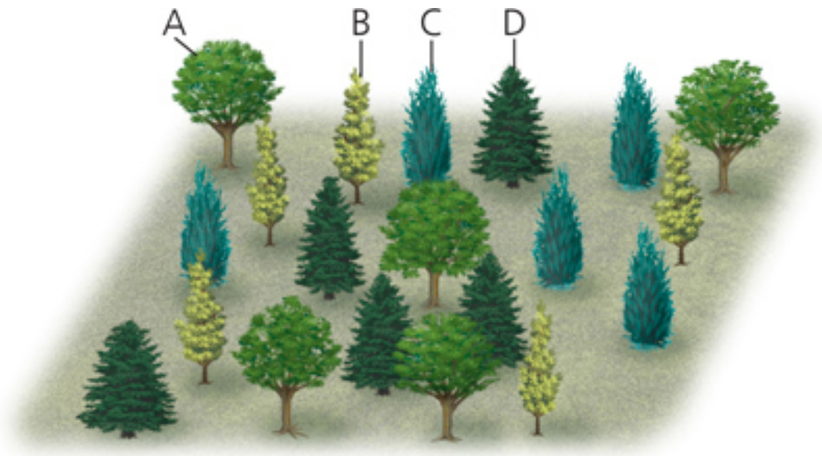
La diversité des espèces

- La diversité des espèces a deux composantes:
  - La richesse en espèce (combien d'espèces différentes)
  - L'abondance relative des espèces (combien par rapport au total)

Ecologie des communautés - diversité

La diversité des espèces

- Quelle forêt est la plus diversifiée?



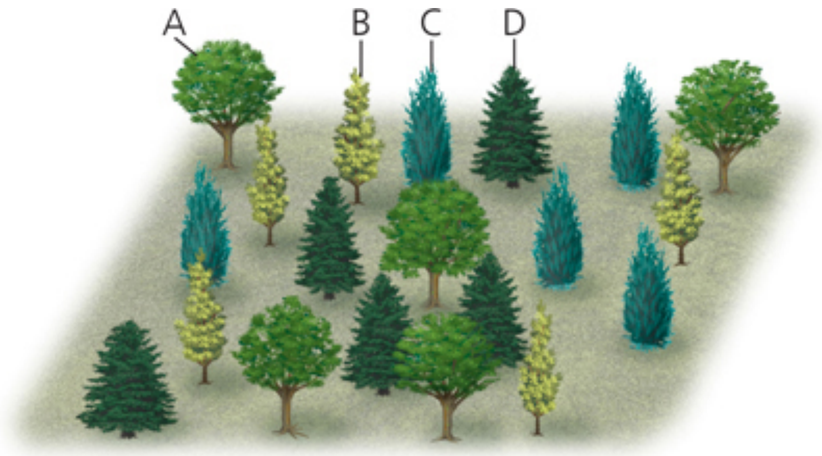
Community 1
A: 25% B: 25% C: 25% D: 25%

Community 2
A: 80% B: 5% C: 5% D: 10%

Ecologie des communautés - diversité

La diversité des espèces

- Quelle forêt est la plus diversifiée?
- Utilisation d'indices qui tiennent compte des deux composantes



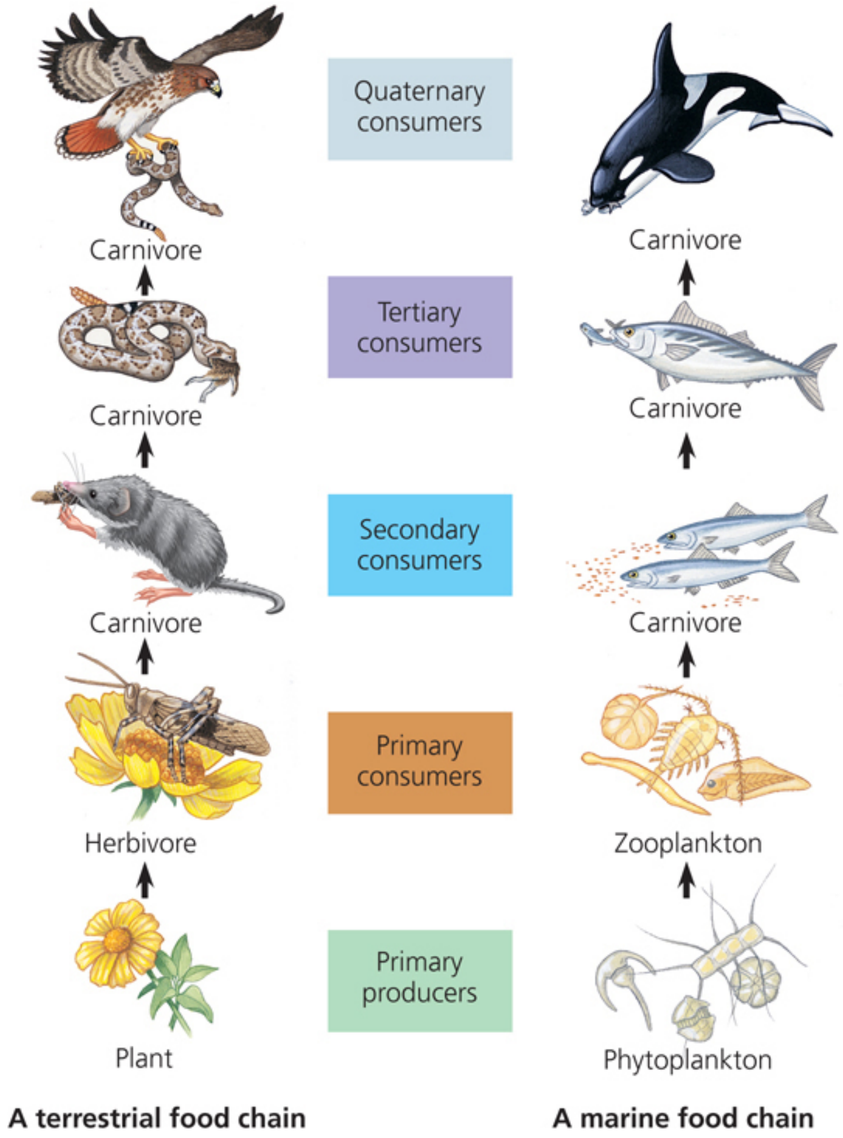
Community 1
A: 25% B: 25% C: 25% D: 25%

Community 2
A: 80% B: 5% C: 5% D: 10%

Ecologie des communautés - chaine alimentaire

La chaine alimentaire

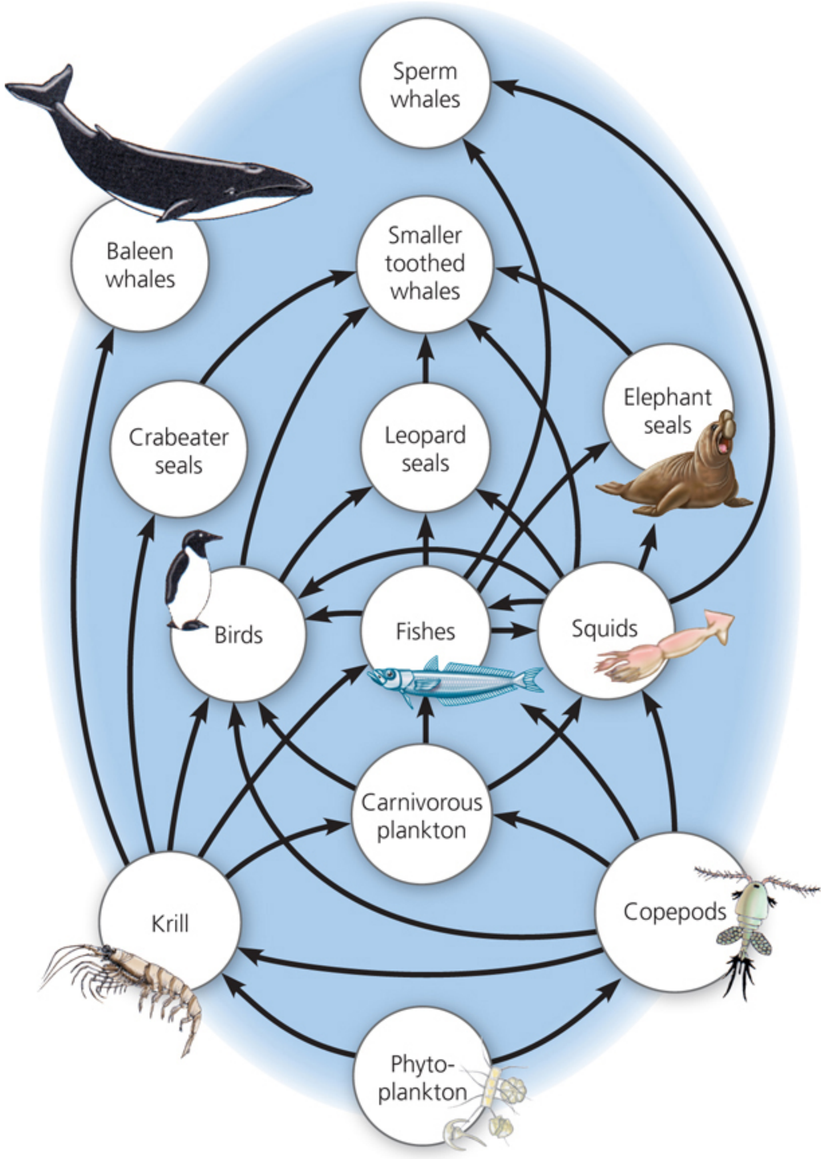
- Les flèches indiquent le flux d'énergie et de nutriments d'un niveau à l'autre



Ecologie des communautés - chaine alimentaire

Le réseau trophique

- Version plus réaliste avec le nombreuses chaines alimentaire inter-connectées



Merci à tous!

Bonne prépa pour les examens!