

Biomes and Biodiversity



There is grandeur in this view of life ...
from so simple a beginning endless forms
most beautiful and most wonderful
have been, and are being, evolved.

Charles Darwin



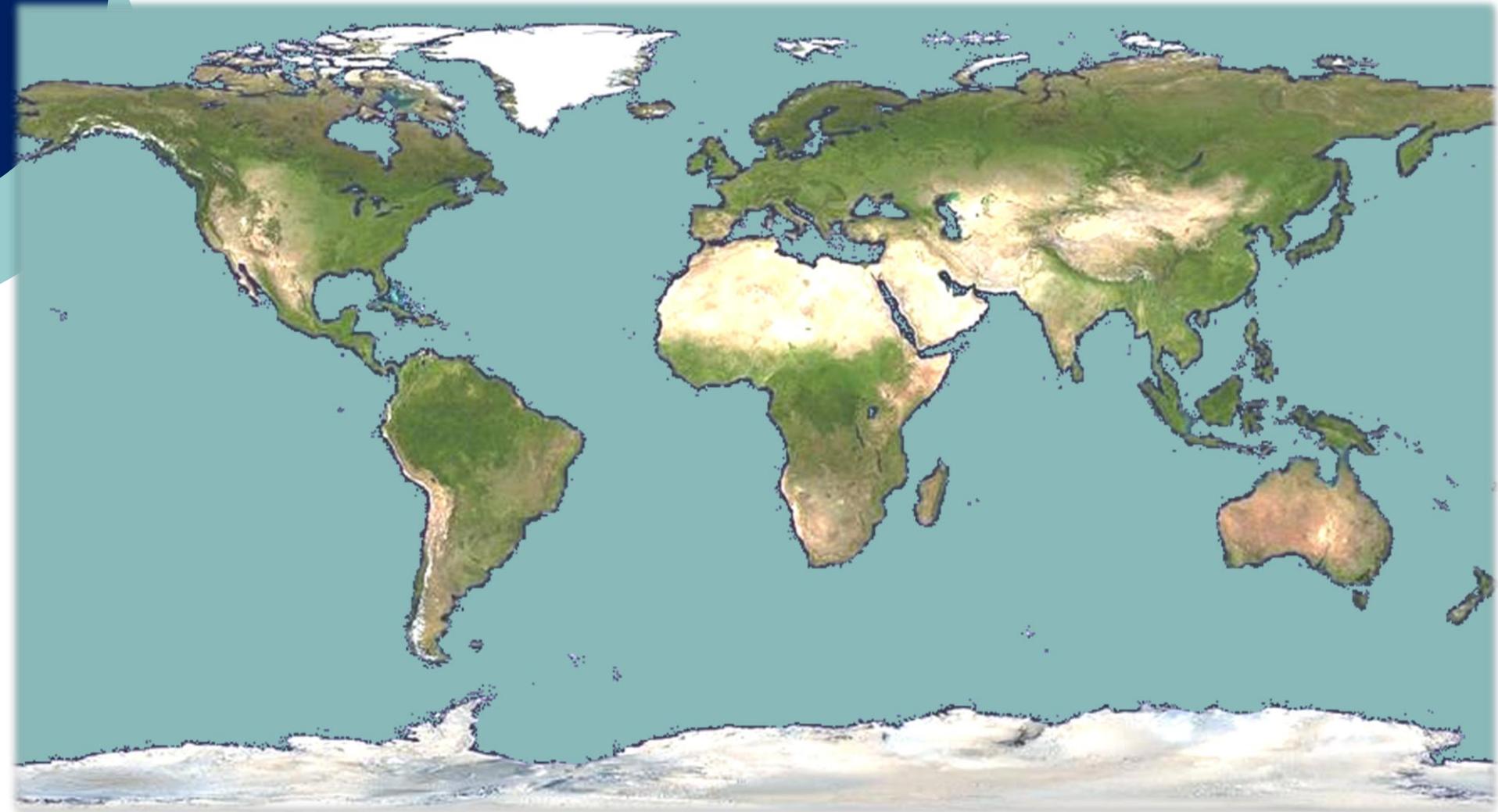


Climate and Weather

- Lands near the **equator** are, on average, warmer. Closer to either **pole** is colder.
- **High elevation** locations are much colder than lower elevations. These areas also receive more precipitation.
- Locations at high latitudes have extreme **seasonality**. Near the equator there are no seasons.
- **Middle latitude areas** (30-60 degrees N or S) have moderate temperatures, but they experience seasons and storms associated with conflicts between cold and warm air masses.
- 20% of the earth is covered with **snow**.
- 30% of the earth is **arid** or desert.
- **Water** is constantly changing states, storing and releasing huge amounts of energy via evaporation, condensation and freezing.



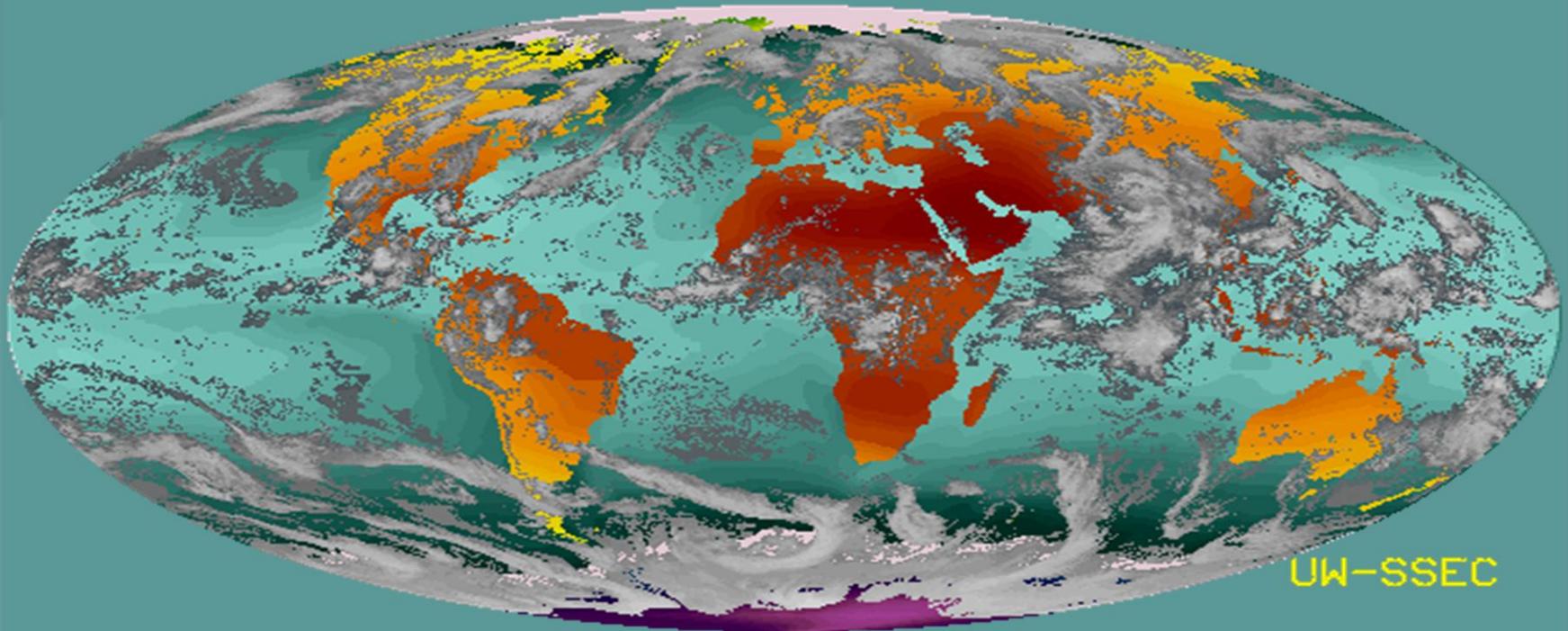
Earth From Space





World Land and Sea Temperatures

LAND/SEA TEMPS & CLOUDS - 6 SEP 07 12:00 UTC - (SSEC:UW-MADISON)



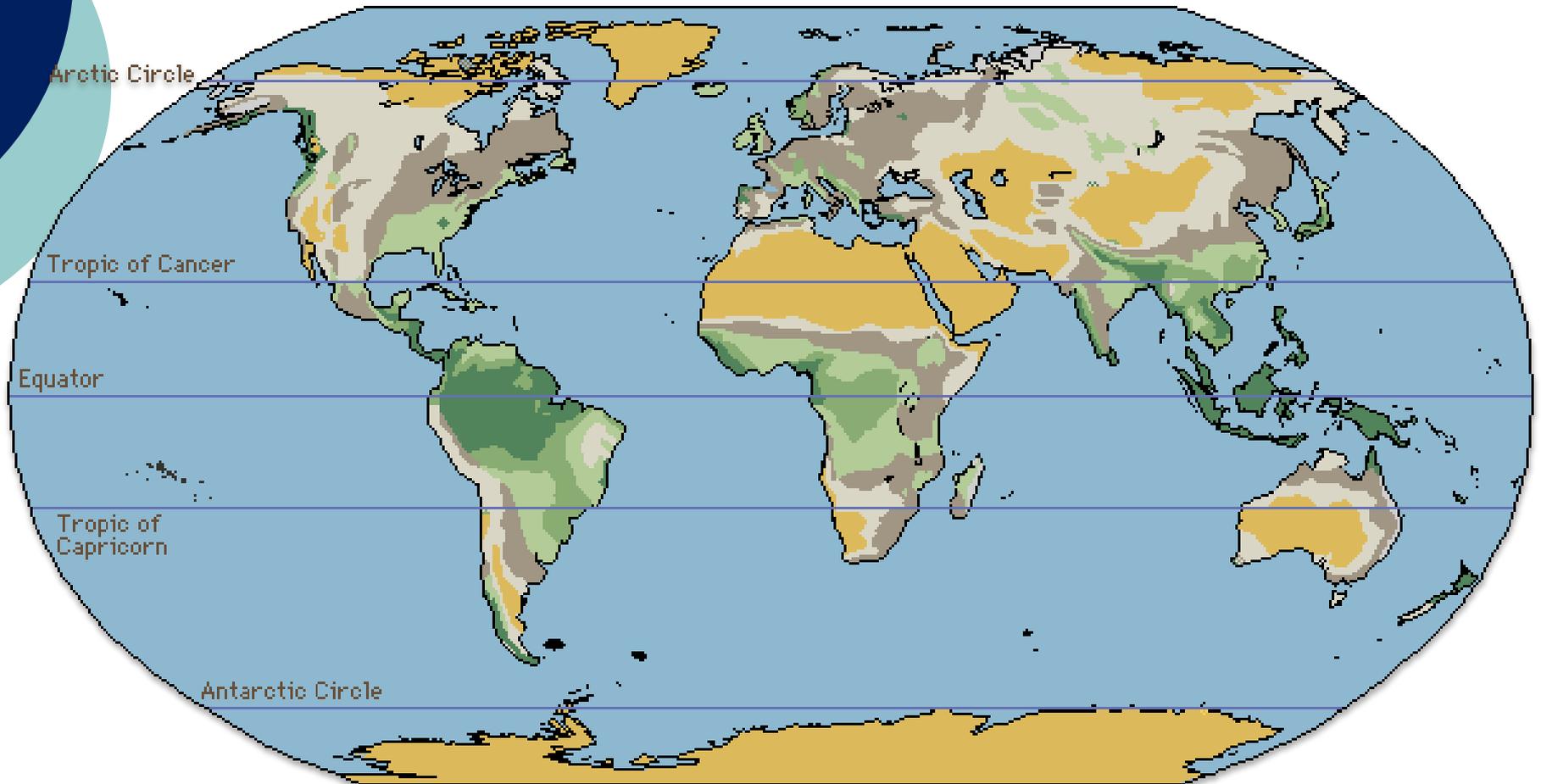
T (C) 5 15 25 -55 -25 5 35

ICE SEA SURFACE SYNOPTIC OBS CLOUD TOP

LAND/SEA TEMPS & CLOUDS - 6 SEP 07 12:00 UTC - (SSEC:UW-MADISON)



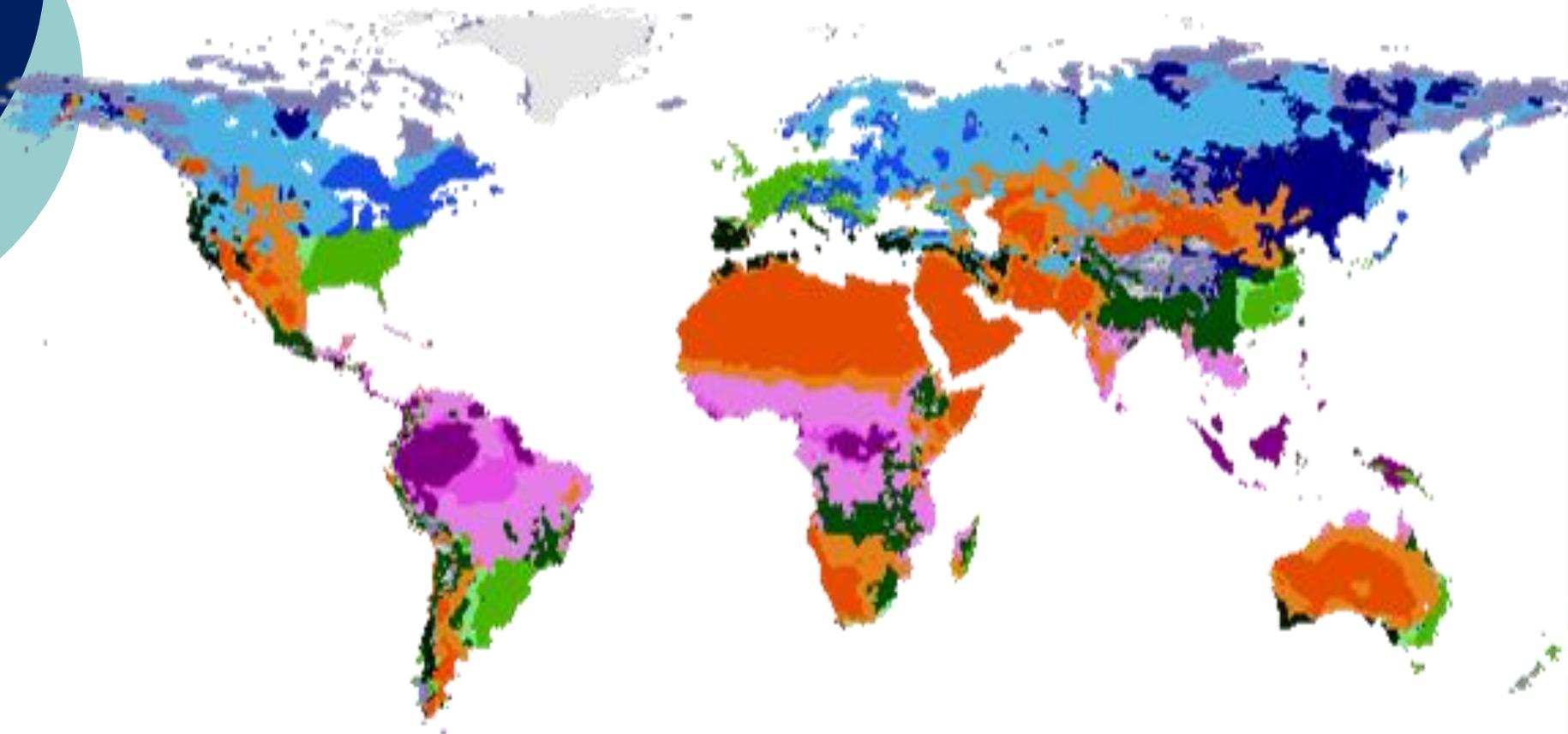
World Precipitation



| | | | | | | |
|----------------------|--------------|-------------|----------------|------------|----------------|------------|
| PRECIPITATION | under 250 mm | under 10 in | 500 - 1000 mm | 20 - 40 in | 1500 - 2000 mm | 60 - 80 in |
| | 250 - 500 mm | 10 - 20 in | 1000 - 1500 mm | 40 - 60 in | over 2000 mm | over 80 in |



World Climates



Koeppen's Climate Classification
by FAO - SDRN - Agrometeorology Group - 1997



World Climates

A Tropical Wet: hot equatorial regions, cover app $\frac{1}{3}$ earth's surface, rains nearly every day, no or little seasons, precipitation app 80-100"/yr, frequent thunderstorms, hurricanes



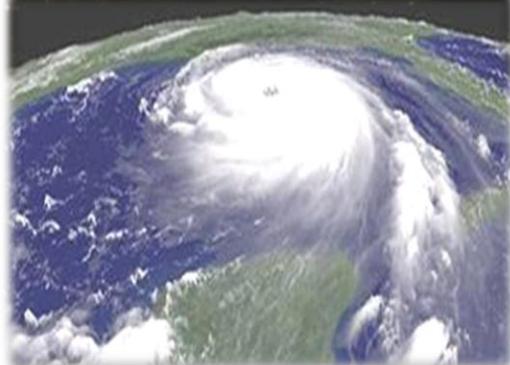
B Dry: arid/semi-arid deserts/steppes, evaporation exceeds precipitation, US example: Albuquerque NM, 9"/yr precipitation, rainfall infrequent but powerful summer thunderstorms

C Mesothermal Humid: subtropical, may have dry summers, warmest month above 50°F, coldest month 32°F to 64°F, US example: New Orleans LA, mid-latitude storms and thunderstorms common

D Microthermal Humid: climate, long winters, mild summers, warmest month above 50°F, coldest month below 32°F, US example: Flint MI, most rain falls in mid-latitude frontal storms

E Polar: no true summer, warmest month avg temp below 50°F, always cold, US example: Barrow, northern AK, very short growing season, no thunderstorms

H Highland: lower temps, more precipitation, US example: Blue Canyon, Sierra Nevada CA, 68"/yr precipitation, very short growing season



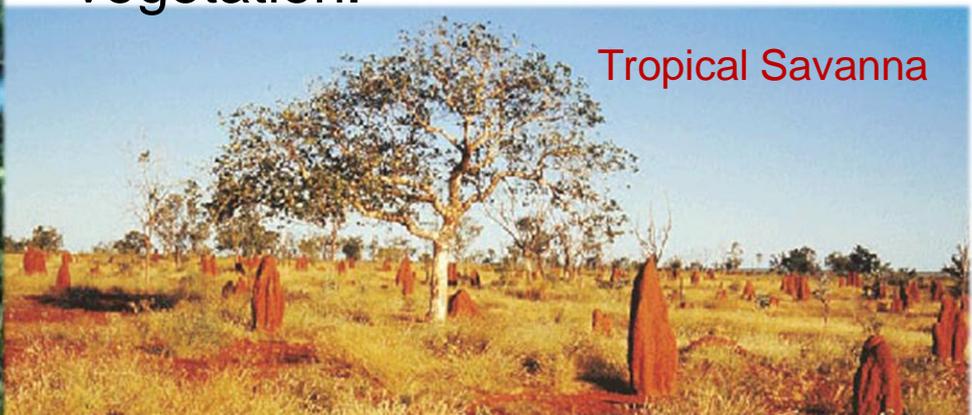


Biomes

A biome is a major class of ecologically similar **communities of plants, animals and soil organisms**, often referred to as **ecosystems**. Biomes are defined based on factors such as plant structures (trees, shrubs, grasses), leaf types (broadleaf, needleleaf), plant spacing (forest, woodland, savanna) and other factors like climate. Biomes are often identified with particular patterns of ecological succession and climax (final stage) vegetation.



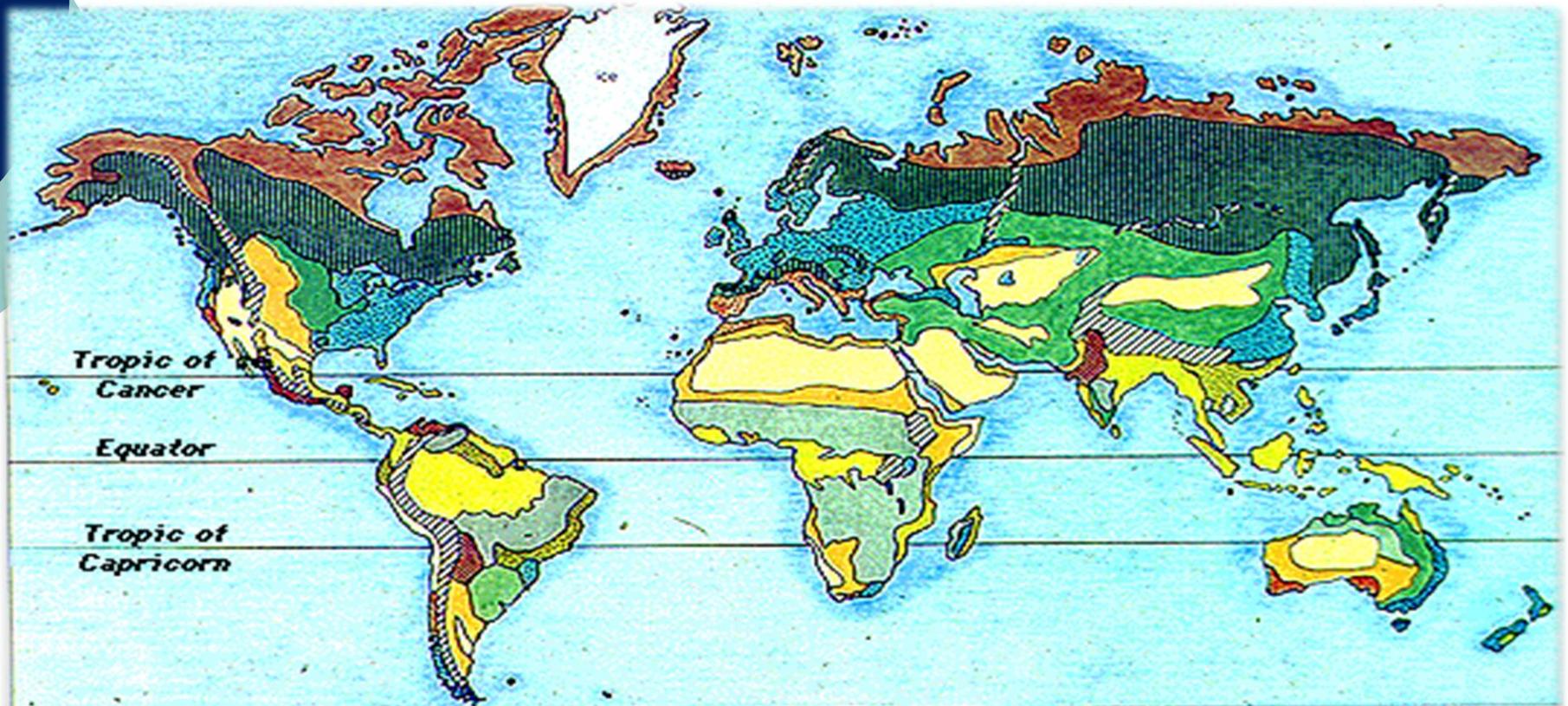
Boreal Forest (Taiga)



Tropical Savanna



World Biomes

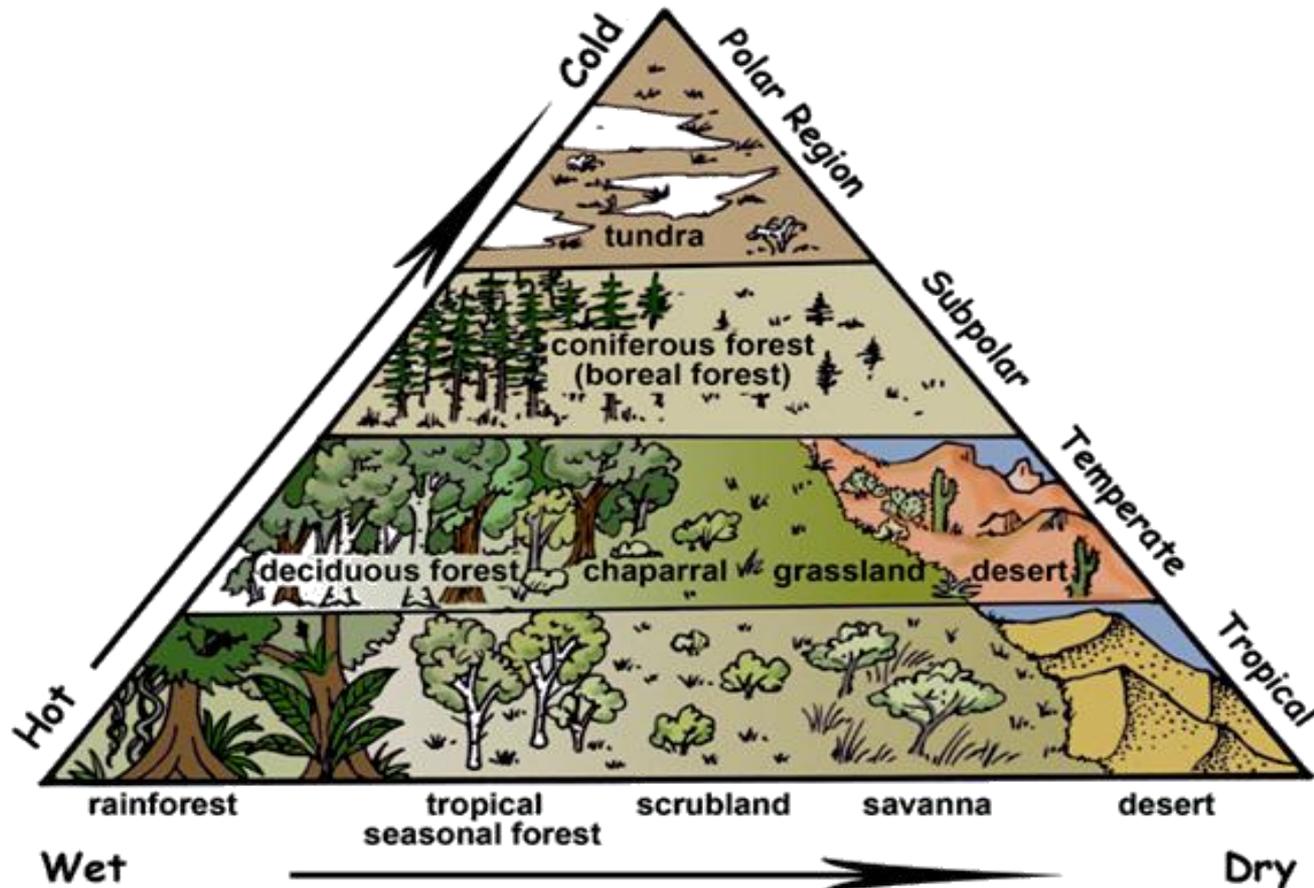


- | | | |
|--|---|--|
|  tundra |  chaparral/Mediterranean |  tropical scrub forest |
|  boreal forest (taiga) |  desert |  tropical savanna |
|  temperate forest |  tropical rainforest |  thorn forest |
|  temperate grassland |  tropical evergreen forest |  semi desert and grassland |
| |  deciduous forest |  mountains (complex zonation) |



Terrestrial Biomes

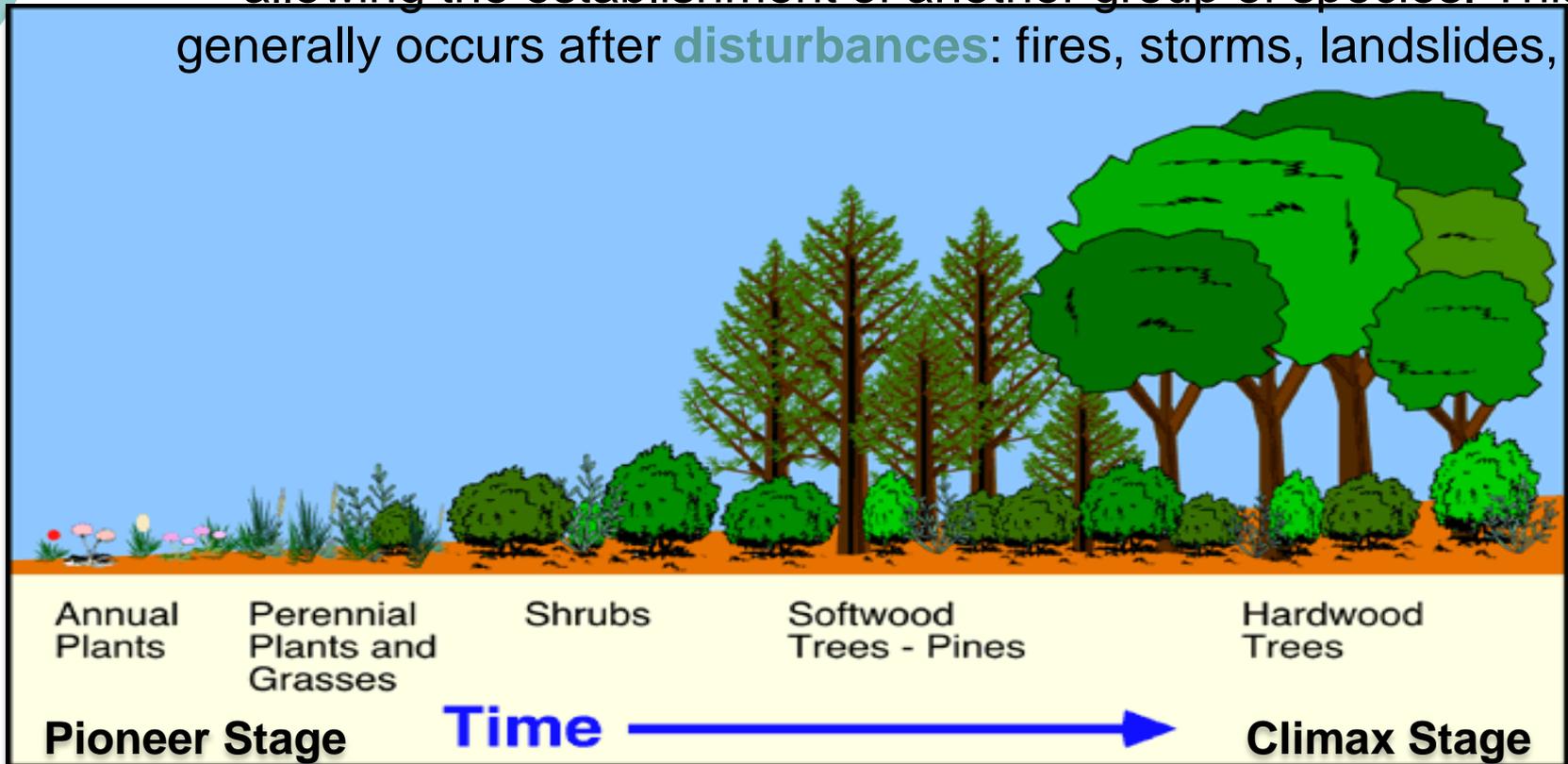
Biomes are formed by climate (rain and temperature) and location (tropics to polar). Can you see the pattern?





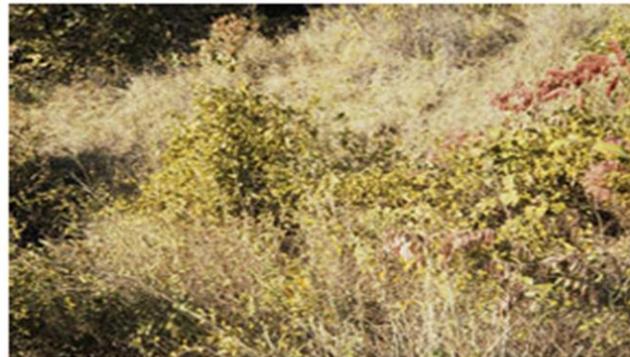
Vegetation Succession

...the evolution of plant communities at a site over time - from **pioneer species** to **climax vegetation** ... At each stage of succession the plant community alters the soil and microclimate, allowing the establishment of another group of species. This generally occurs after **disturbances**: fires, storms, landslides, etc.





Vegetation Succession



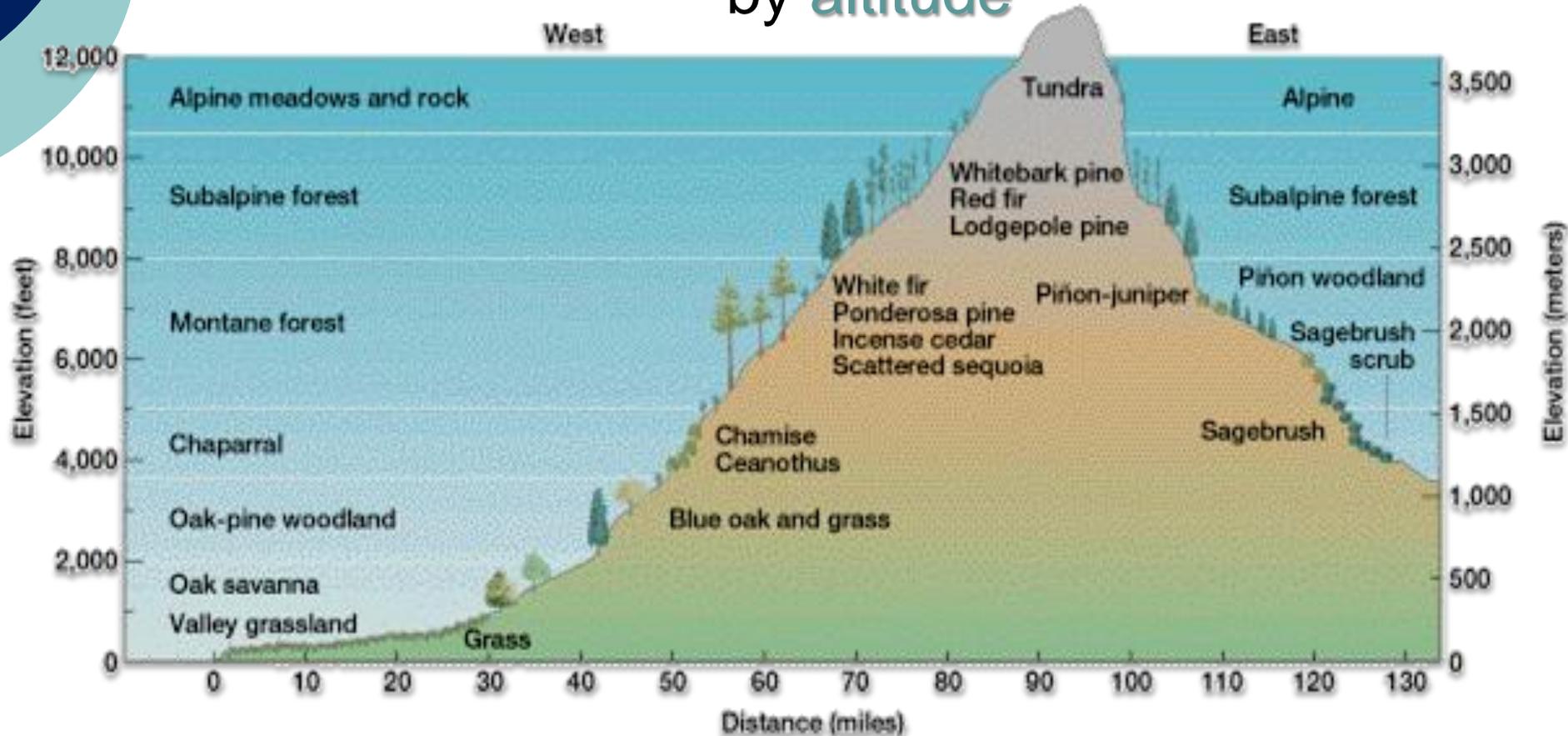
examples of
successional
stages from
bare soil to
timber

State of the
World's
Plants, 2016



Vertical Zonation of Vegetation

... a term applied to vegetation zones defined by **altitude**





Riparian Vegetation



...vegetation that grows **along water courses**

Often supports a much richer **diversity** of plant and animal life, including more trees in a dry environment.

Sespe Wilderness near Ojai CA



Ecosystems: Food Chains

Energy flows up the chain.

More and more heat is lost at each **trophic level** (hierarchical level in an ecosystem comprised of organisms that share the same function in the food chain and the same nutritional relationship to the primary sources of energy).



Carnivore



Carnivore



Carnivore



Herbivore



Plant

Quaternary consumers

Tertiary consumers

Secondary consumers

Primary consumers

Primary producers



Carnivore



Carnivore



Carnivore



Zooplankton



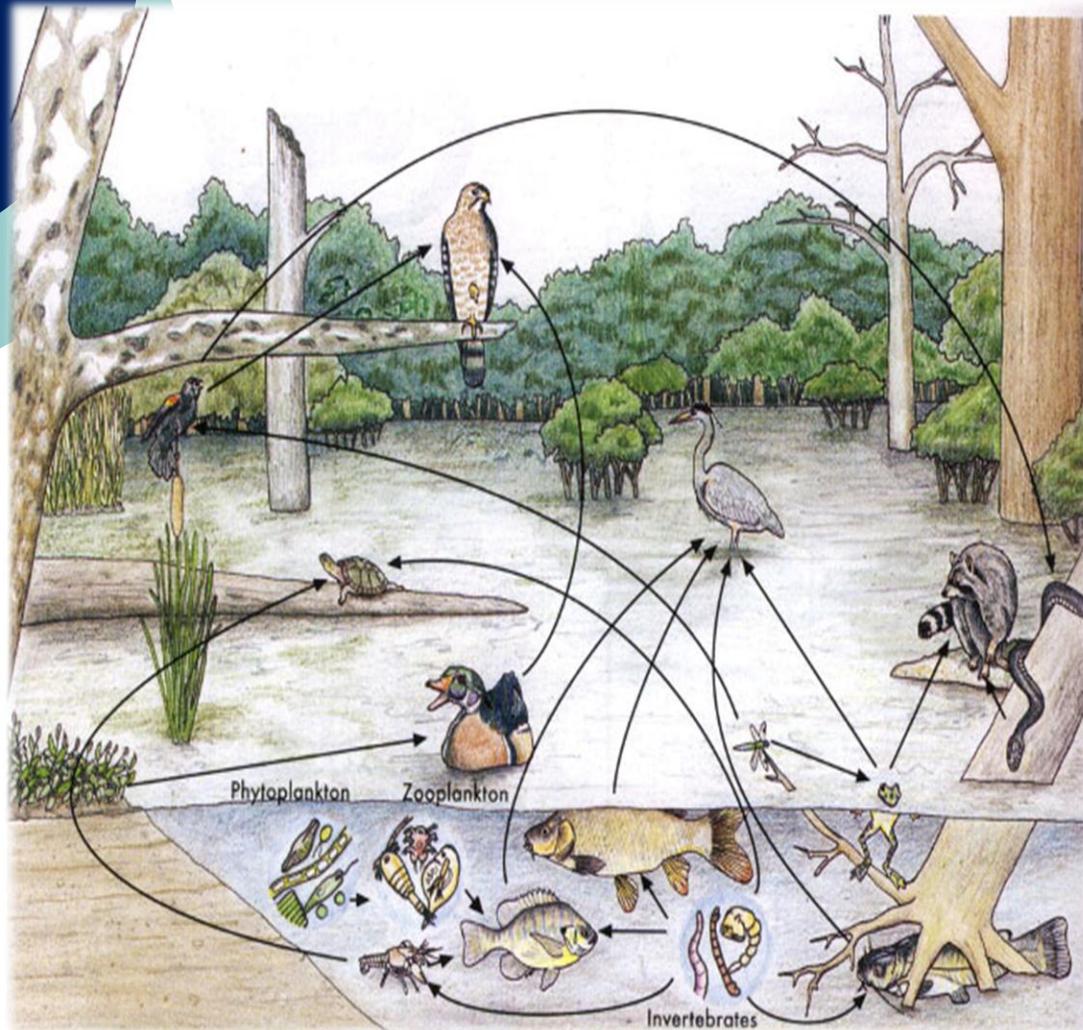
Phytoplankton

A TERRESTRIAL FOOD CHAIN

A MARINE FOOD CHAIN



Ecosystems: A Simple Food Web



“When you cut a forest, an ancient forest in particular, you are not just removing a lot of big trees and a few birds fluttering around in the canopy. You are drastically imperiling a vast array of species within a few square miles of you. The number of these species may go to tens of thousands ... Many of them are still unknown to science and science has not yet discovered the key role they undoubtedly played in the maintenance of that ecosystem.”

E O Wilson, American biologist, researcher, theorist, naturalist and author, 2000

Biodiversity





Biodiversity

Biodiversity refers to diversity of

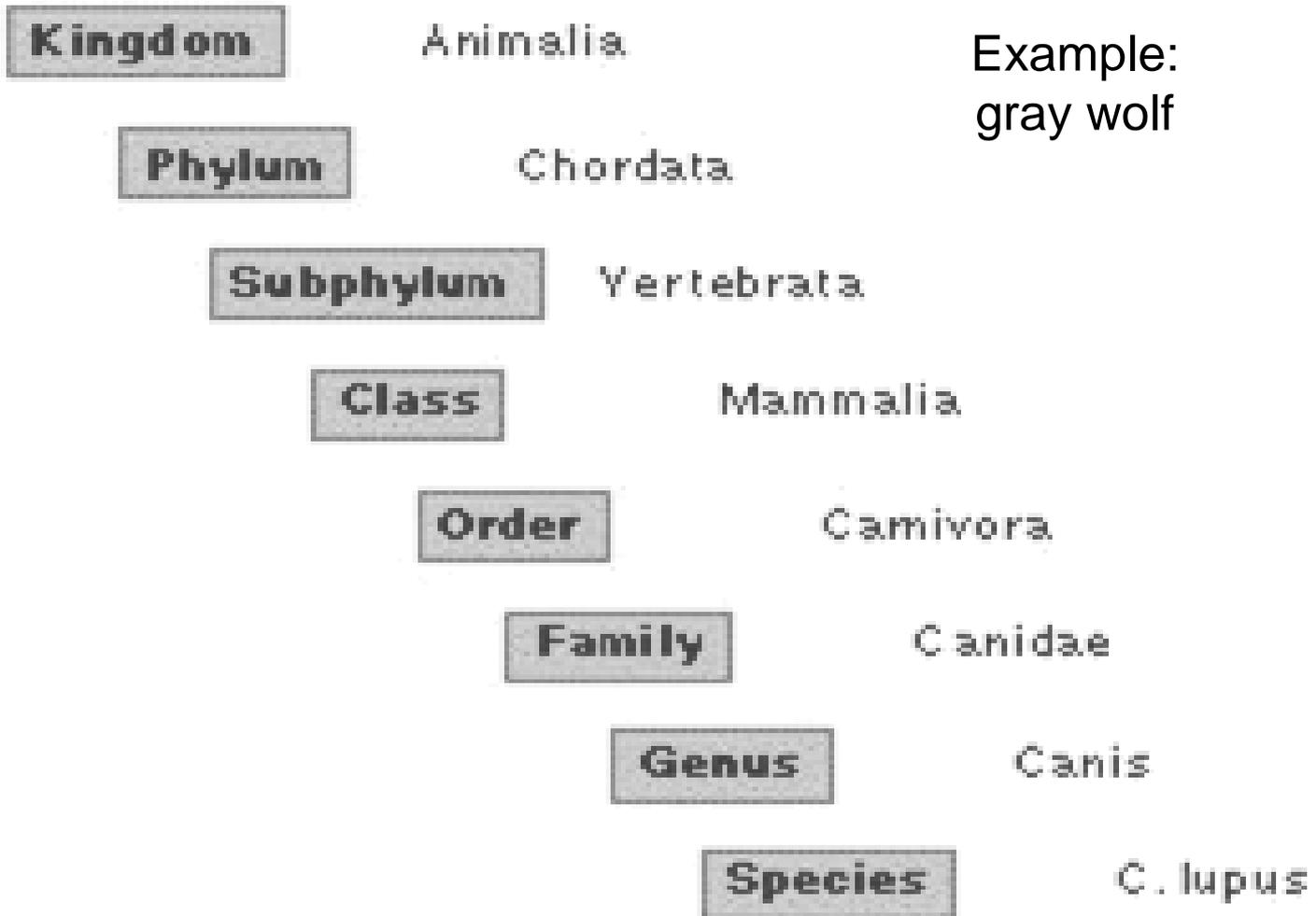
- **species**
- **habitat**
- **genetic** (diversity within a species)

Some scientists also include community and landscape diversity.

Scientists estimate that 10 million to over 100 million different species inhabit the Earth, each uniquely adapted to a particular habitat. They have discovered and named only 1.75 million species - less than 20% of those estimated to exist.



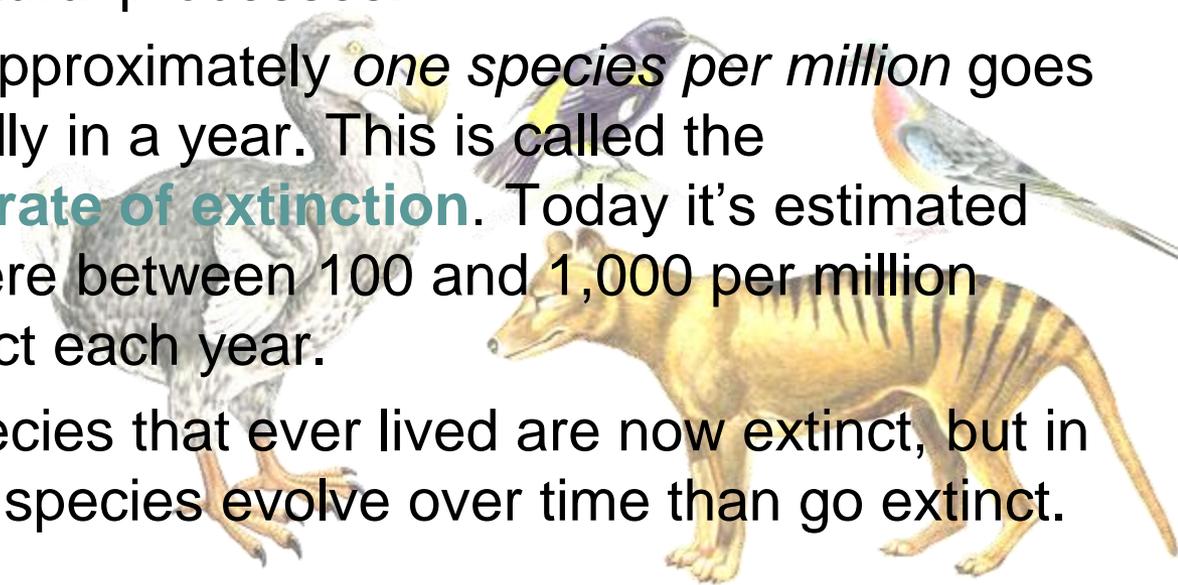
Taxonomic Categories



Biodiversity Loss and Species Extinction



- **extinction**: last member of a species dies and the species vanishes forever from Earth
- **extirpation**: disappearance of a particular population, but not the entire species globally ... This is still a loss of biodiversity and ecosystem stability.
- These are *natural* processes.
- On average approximately *one species per million* goes extinct naturally in a year. This is called the **background rate of extinction**. Today it's estimated that somewhere between 100 and 1,000 per million become extinct each year.
- 99% of all species that ever lived are now extinct, but in general more species evolve over time than go extinct.



Biodiversity Loss and Species Extinction



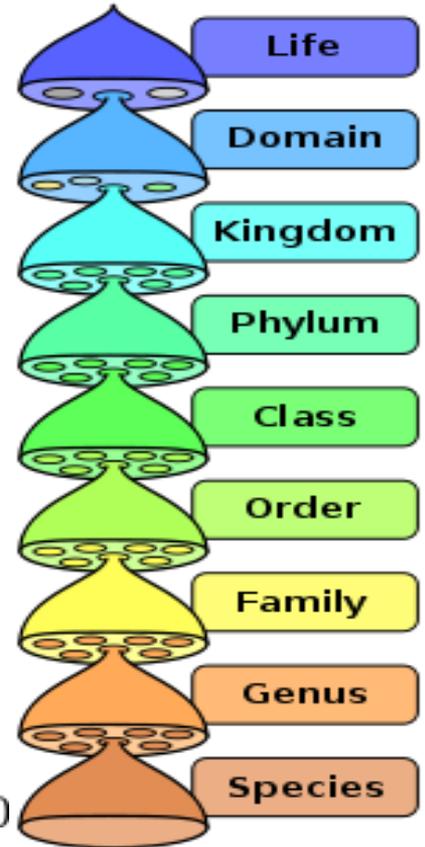
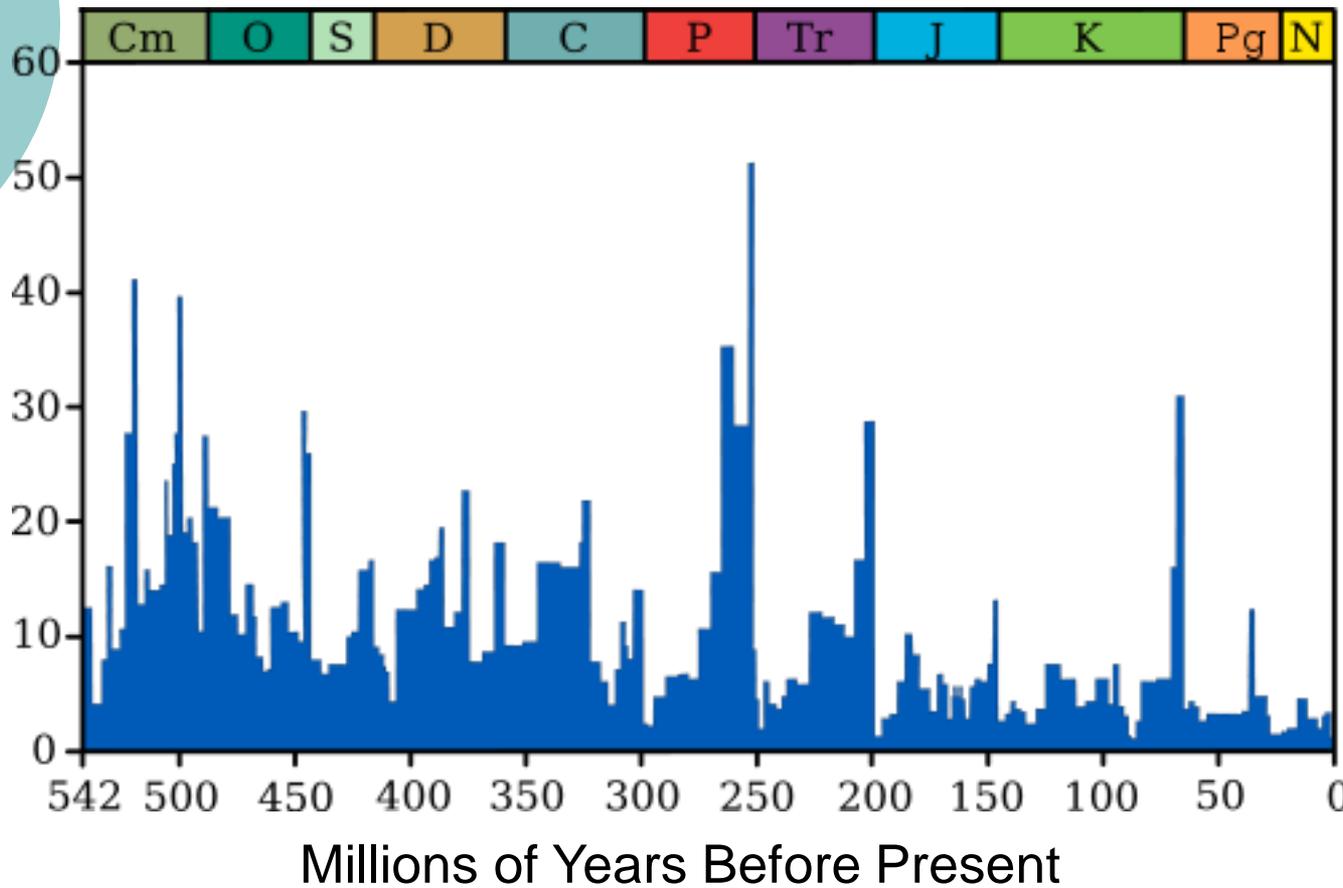
- There were more species on Earth at the beginning of civilization than the Earth had ever had before.
- Currently Earth is undergoing its **sixth mass extinction** because of us.
- Humans have increased the **extinction rate** by a factor of somewhere between 100 and 1,000.
- 1,100 species are known to have gone extinct in the past 400 years.
- The **Red List**, from the IUCN, lists species that today are facing high risks of extinction. The total number of known threatened species is currently above 10,500. Over 3,300 of these are vertebrates.

[IUCN Red List](#)



Mass Extinctions

% of Genera Extinct in Period



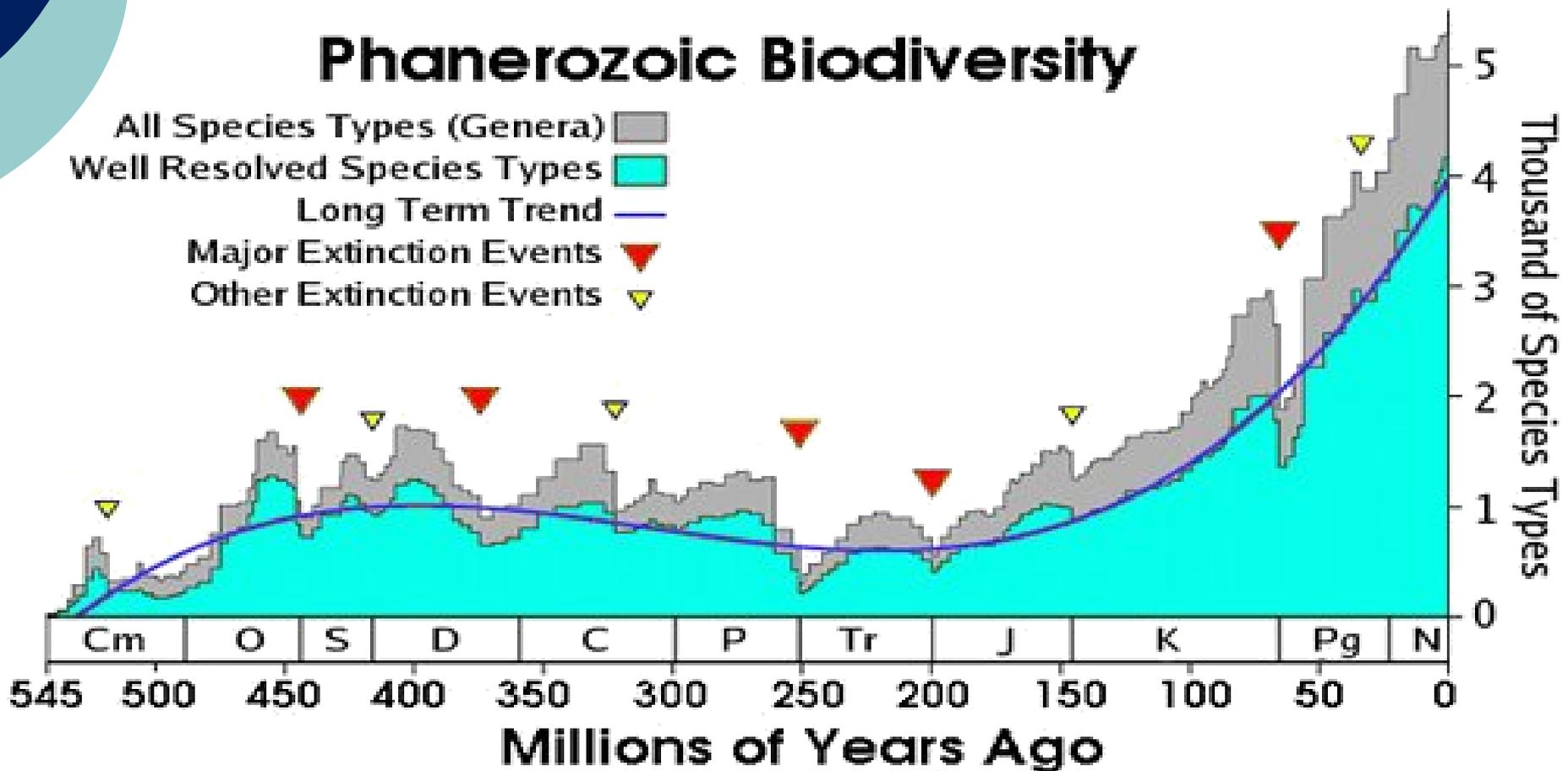
Source: Rohde, R.A. & Muller, R.A. (2005). "Cycles in fossil diversity". *Nature* **434**: 209-210.



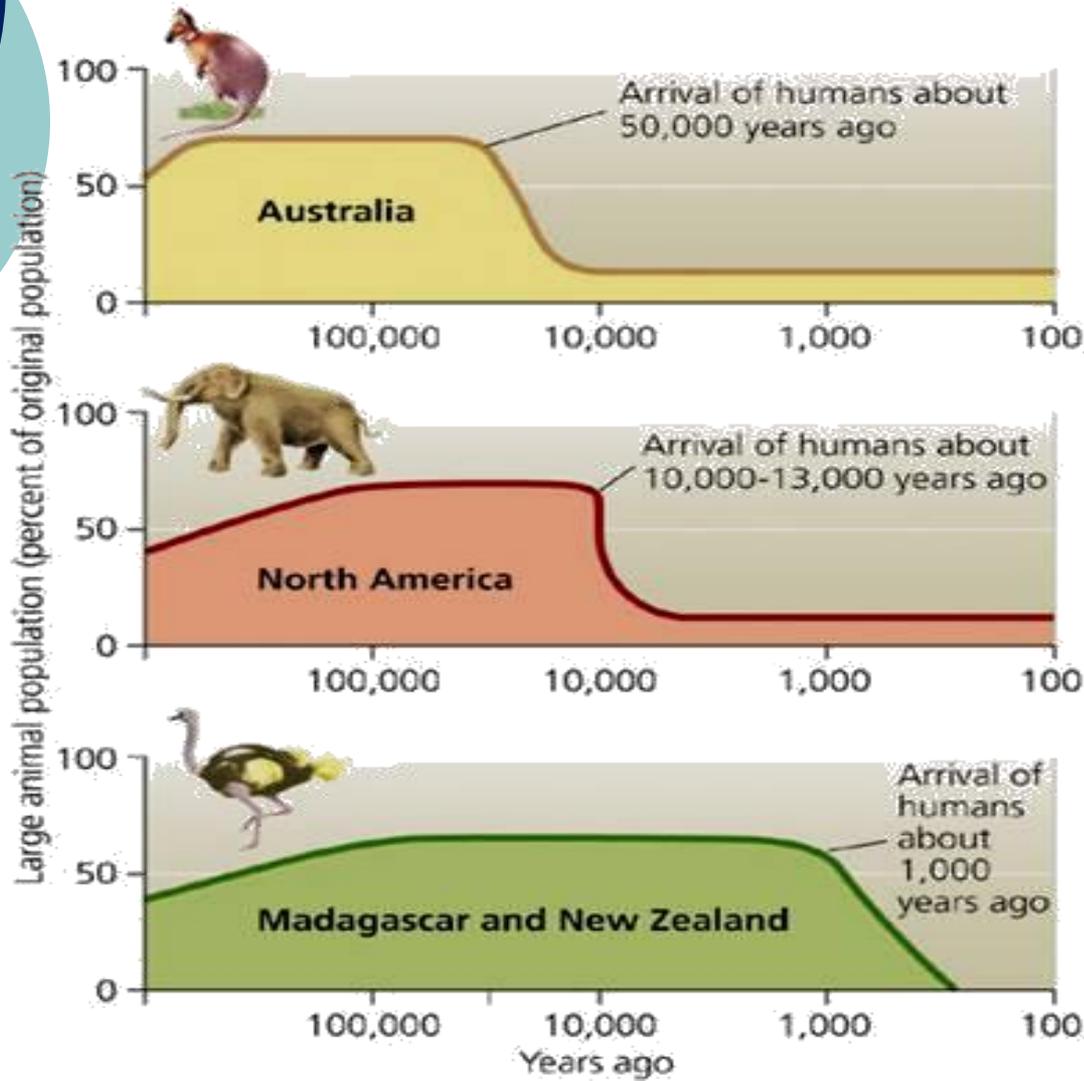
Mass Extinctions: The Sixth Extinction

... the current spasm of plant and animal loss that threatens to eliminate 20% to 50% of all living species on earth within this century

Phanerozoic Biodiversity



Biodiversity Loss and Species Extinction



The numbers of large mammals and birds plummeted with the arrival of humans, independently, on each of three continents ... suggesting that human hunting was the cause.



Causes of Species Extinction

Primary Causes (**HIPPO**):

- **H**abitat alteration
- **I**nvasive species
- **P**ollution
- **P**opulation growth
- **O**verexploitation
- (Recently some have included Climate Change, or HIPPO-C.)





HIPPO: Habitat Alteration

- ...greatest cause of extinction today
- Accounts for 85% of population declines of birds and mammals.
- Habitat change hurts most organisms because they are adapted to an existing habitat.
- Alteration due to:

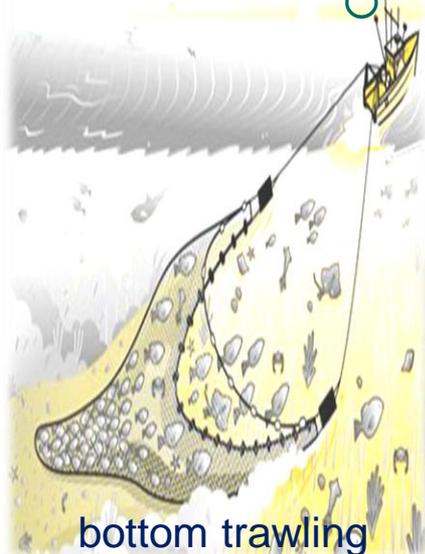
forest clearing

urban development

agriculture

global climate change

etc





HIPPO: Invasive Species

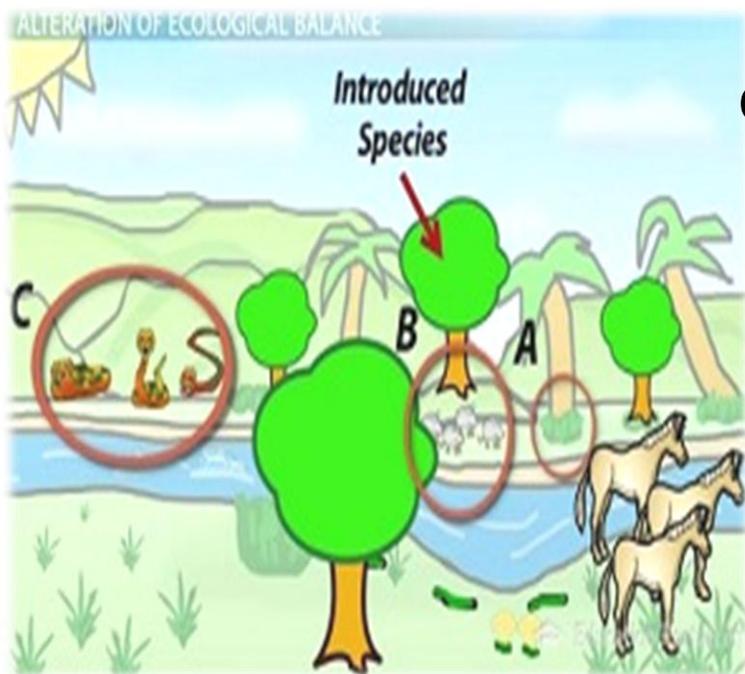
- ...accidental or intentional introduction of exotic species to new areas
- Most do not establish or expand, but some do ... most likely because they are free of limitations imposed by their native predators, parasites and competitors.
- If the species threatens or causes the extinction of **native species** or dominates a landscape, it's usually considered **invasive**.
- In today's globalizing world, invasive species have become perhaps the second-worst threat to native biota.



HIPPO: Invasive Species

There can be a domino effect if an invasive species affects native species A, which in turn affects native species B, which has an impact on native species C, and so on.

If there are native species which cannot survive alongside the invasive species, they will go **locally extinct**, which is when a species ceases to exist in a local area. Local extinction of one or more native species is a likely outcome when an introduced species becomes established.





HIPPO: Invasive Species

| | | | |
|---|---|---|--|
| <p>Mosquito fish (<i>Gambusia affinis</i>)</p>  | <p>Mosquito fish (Australia from SE US)</p> | <p>Gypsy moth (<i>Lymantria dispar</i>)</p>  | <p>Gypsy moth (US from Europe)</p> |
| <p>Zebra mussel (<i>Dreissena polymorpha</i>)</p>  | <p>Zebra mussel (US from Asia)</p> | <p>European starling (<i>Sturnus vulgaris</i>)</p>  | <p>European starling (US from Europe via Shakespeare)</p> |
| <p>Kudzu (<i>Pueraria montana</i>)</p>  | <p>Kudzu (US from Asia)</p> | <p>Indian mongoose (<i>Herpestes auropunctatus</i>)</p>  | <p>Indian mongoose (Hawaii from India)</p> |
| <p>Asian long-horned beetle (<i>Anoplophora glabripennis</i>)</p>  | <p>Asian long-horned beetle (US from China)</p> | <p>A green alga (<i>Caulerpa taxifolia</i>)</p>  | <p><i>Caulerpa</i> algae (Mediterranean from Germany, CA from aquariums)</p> |
| <p>Rosy wolfsnail (<i>Euglandina rosea</i>)</p>  | <p>Rosy wolfsnail (Hawaii from US mainland)</p> | <p>Cheatgrass (<i>Bromus tectorum</i>)</p>  | <p>Cheatgrass (US from Europe)</p> |
| <p>Cane toad (<i>Bufo marinus</i>)</p>  | <p>Cane toad (Australia from Latin America)</p> | <p>Brown tree snake (<i>Boiga irregularis</i>)</p>  | <p>Brown tree snake (Guam from Australia)</p> |
| <p>Bullfrog (<i>Rana catesbiana</i>)</p>  | <p>Bullfrog (US and world from east US)</p> | | |



HIPPO: Pollution

- ...air and water pollution, agricultural runoff, industrial chemicals, etc
- Pollution does serious and widespread harm but is *not* as threatening as the other elements of HIPPO.





HIPPO: Population Growth

- Human population growth **exacerbates every other environmental problem.**
- It magnifies the effects of the other causes. More people means more habitat change, more pollution, more overexploitation...
- Along with increased resource consumption, it is the ultimate reason behind **proximate** (immediate) **threats** to biodiversity





HIPPO: Overexploitation

Two meanings:

- ...**overharvesting** of species from the wild, too much hunting, fishing, etc
- ...**overconsumption** of resources, too much use of timber, fossil fuels, etc
- Usually overexploitation is not the sole cause of extinction, but it often *contributes* in tandem with other causes. It has been more important in some cases in the past.

Known Causes of Animal Extinctions Since 1600





Causes of Species Extinction

- There are 486 **critically endangered** species and 43% of all species are in **decline**.
- In most cases, extinctions occur because of a combination of factors. For example, current global amphibian declines are thought due to a complex combination of:
 - chemical contamination
 - disease transmission (fungus)
 - habitat loss
 - ozone depletion and UV penetrance
 - climate change
 - synergistic interaction of these factors

Monteverde Golden Toad,
Last seen 1989





The Value of Biodiversity

- food
- fuel
- construction
- medicine
- aesthetics (beauty)
- spiritual
- education
- ethics

