The Origin of Biodiversity

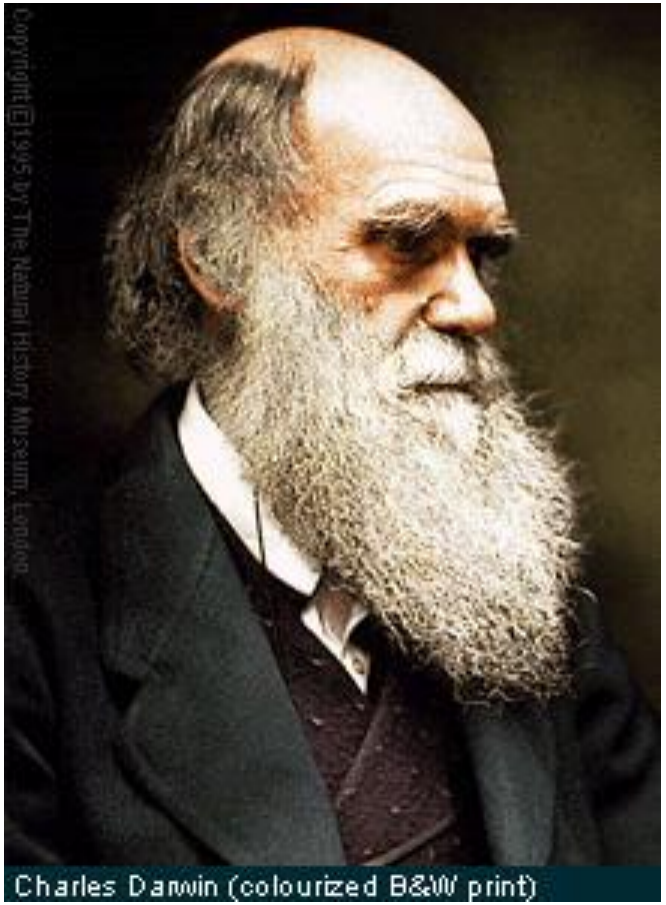
- **Biological evolution:** the process by which life on Earth changes over time through changes in the genes of populations

The Origin of Biodiversity

- **Natural selection:** a credible explanation for how biological evolution happens
- Proposed in 1858 independently by:
  - Charles Darwin (1809 – 1882)
  - Alfred Russel Wallace (1823 – 1913)

Charles Darwin (1809 – 1882)

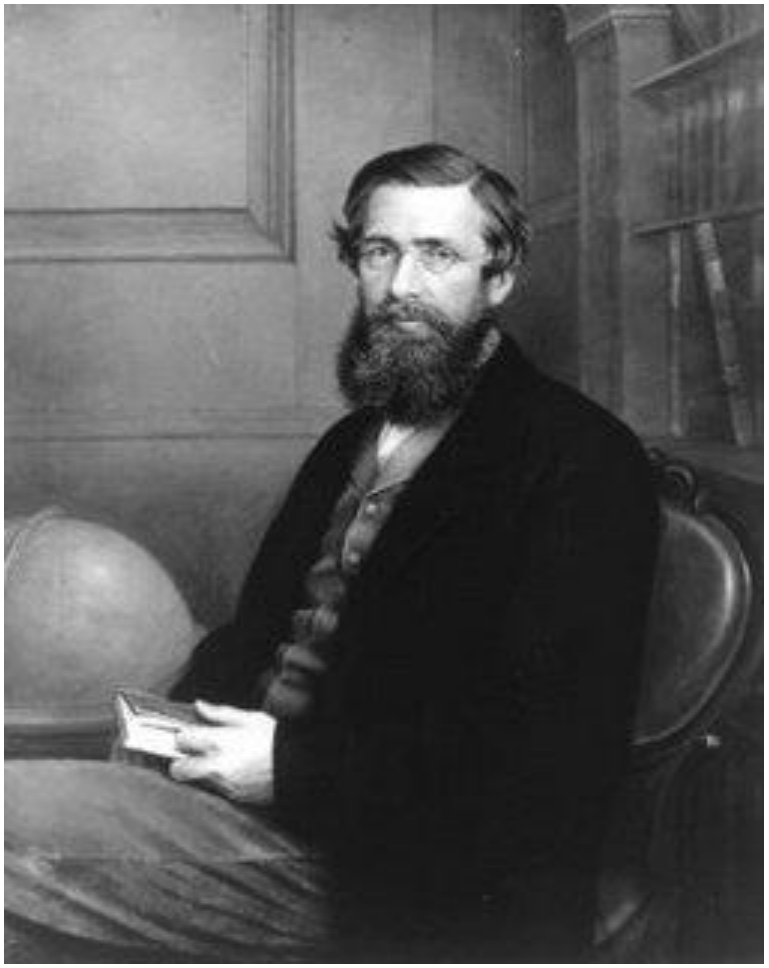
- Meticulously gathered evidence for the Theory of Evolution by Natural Selection



Charles Darwin (colourized B&W print)

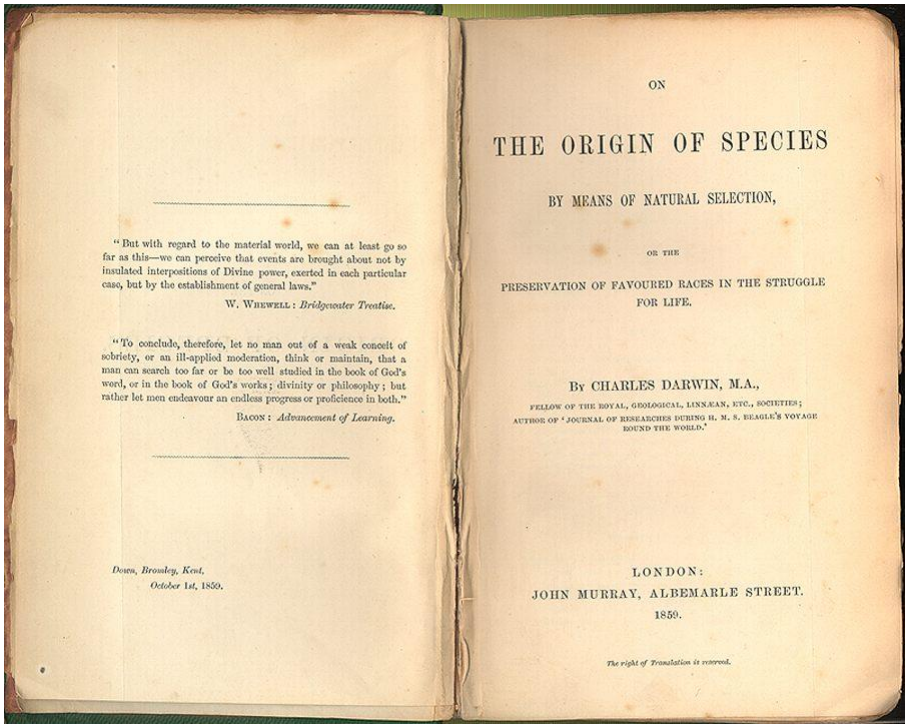
Charles Darwin (1809 – 1882)

Alfred Russel Wallace



Charles Darwin (1809 – 1882)

- 1859: First edition of “The Origin of Species by Means of Natural Selection” published
- Sold out in one day!!



"But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws."

W. Whewell: *Bridgewater Treatise.*

"To conclude, therefore, let no man out of a weak conceit of sobriety, or an ill-applied moderation, think or maintain, that a man can search too far or be too well studied in the book of God's word, or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficience in both."

Bacon: *Advancement of Learning.*

Down, Bromley, Kent,
October 1st, 1859.

ON

THE ORIGIN OF SPECIES

BY MEANS OF NATURAL SELECTION,

OR THE

PRESERVATION OF FAVOURED RACES IN THE STRUGGLE FOR LIFE.

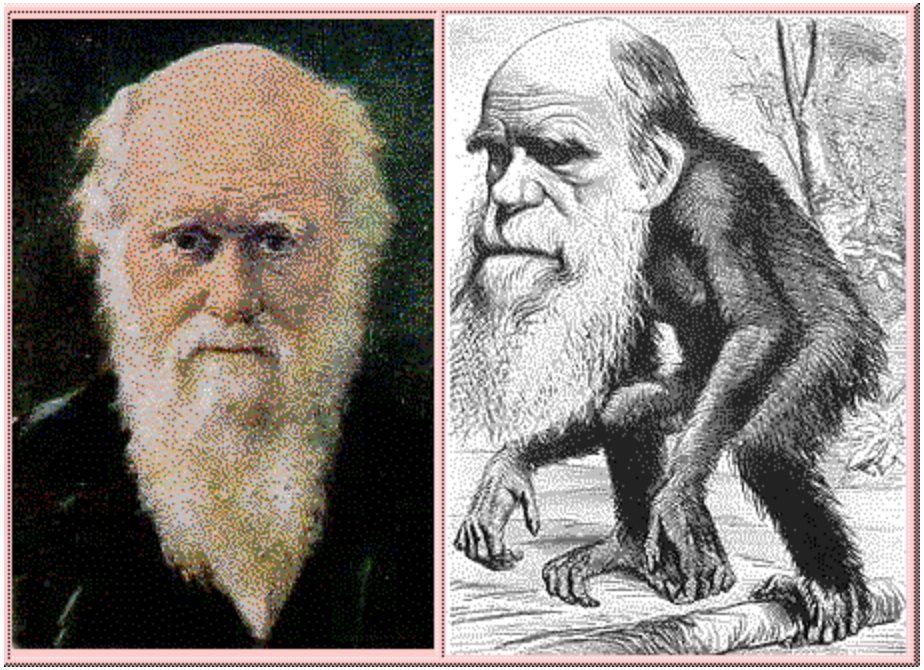
By CHARLES DARWIN, M.A.,

FELLOW OF THE ROYAL, GEOLOGICAL, LINNÆAN, ETC., SOCIETIES;
AUTHOR OF 'JOURNAL OF RESEARCHES DURING H. M. S. BEAGLE'S VOYAGE ROUND THE WORLD.'

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1859.

Charles Darwin (1809 – 1882)

- The book generated controversy!!



Genetic Variability

- First step in biological evolution
- Occurs through **mutations**
  - Random changes in DNA molecules in a cell; can be inherited by offspring
  - Occur due to random changes in coded genetic instructions when DNA molecules are copied each time a cell divides OR due to exposure to mutagens (X-rays, radioactivity…)

Mutations

- Mutations may occur in any cell; only mutations in reproductive cells are passed to offspring.
- Mutations may result in a new genetic trait that gives an individual and its offspring better chances for survival and reproduction under existing environmental conditions or later on when the conditions change.

Natural Selection

- Second step in biological evolution
- Occurs when some individuals of a population have genetically based traits that enhance their ability to survive and reproduce; Natural selection therefore acts on individuals in a population.

Adaptation

- Adaptation
  - **Adaptive trait:** Any heritable trait that enables an individual organism to survive and reproduce more than other individuals under prevailing environmental conditions
  - The adaptive trait has to be **heritable** and must lead to **differential reproduction**.

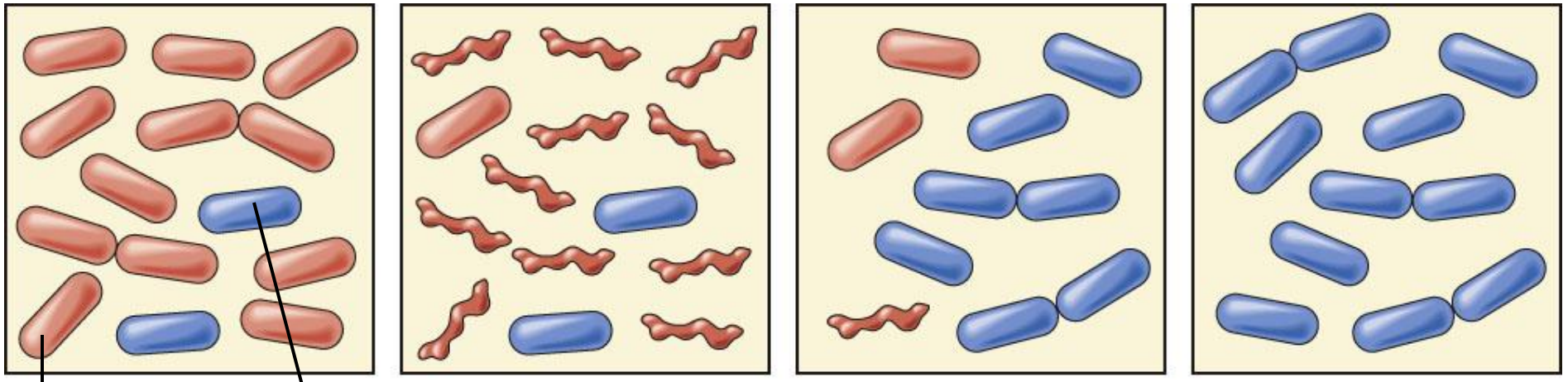
Genetic Resistance: the ability of one or more organisms in a population to tolerate a chemical designed to kill it!

A group of bacteria, including genetically resistant ones, are exposed to an antibiotic

Most of the normal bacteria die

The genetically resistant bacteria start multiplying

Eventually the resistant strain replaces the strain affected by the antibiotic



Normal bacterium

Resistant bacterium

Biological Evolution

- Populations **(NOT INDIVIDUALS)** evolve by becoming genetically different
- Biological evolution by natural selection:
  - Genes mutate.
  - Individuals are selected.
  - Populations evolve that are better adapted to survive and reproduce under existing environmental conditions.
- When environmental conditions change, populations
  - adapt.
  - migrate.
  - become extinct.

Adaptation through Natural Selection Has Limits

- Will we adapt to changes in the environment in the near future?
  - Only if genetic change precedes change in the environmental conditions (Favorable genetic trait already in gene pool or results from mutation)
  - Reproductive capacity – Weeds, bacteria, mosquitoes, rats, cockroaches will most probably adapt to changes in environmental conditions quickly.

Common Myths about Evolution by Natural Selection

- “Survival of the fittest” is not “survival of the strongest”
- Organisms do not develop traits out of need or want
- No grand plan of nature for perfect adaptation

“Stool Pigeon”??

Passenger Pigeons

- Good to eat
- Feathers for making pillows
- Bones used as fertilizer

Passenger Pigeons

- 1813: A single huge flock took three days to fly past Audubon, famous bird expert!!
- 1858: Passenger pigeon hunting a big business
- 1878: One trapper killed 3 million birds at their nesting grounds in Michigan!!
- March 24, 1900: Last wild passenger pigeon shot by a young boy in Ohio!!

Passenger Pigeon

- Extinct!!
- Uncontrolled commercial hunting
- Habitat loss: Forests cleared to make room for farms and cities

Extinction

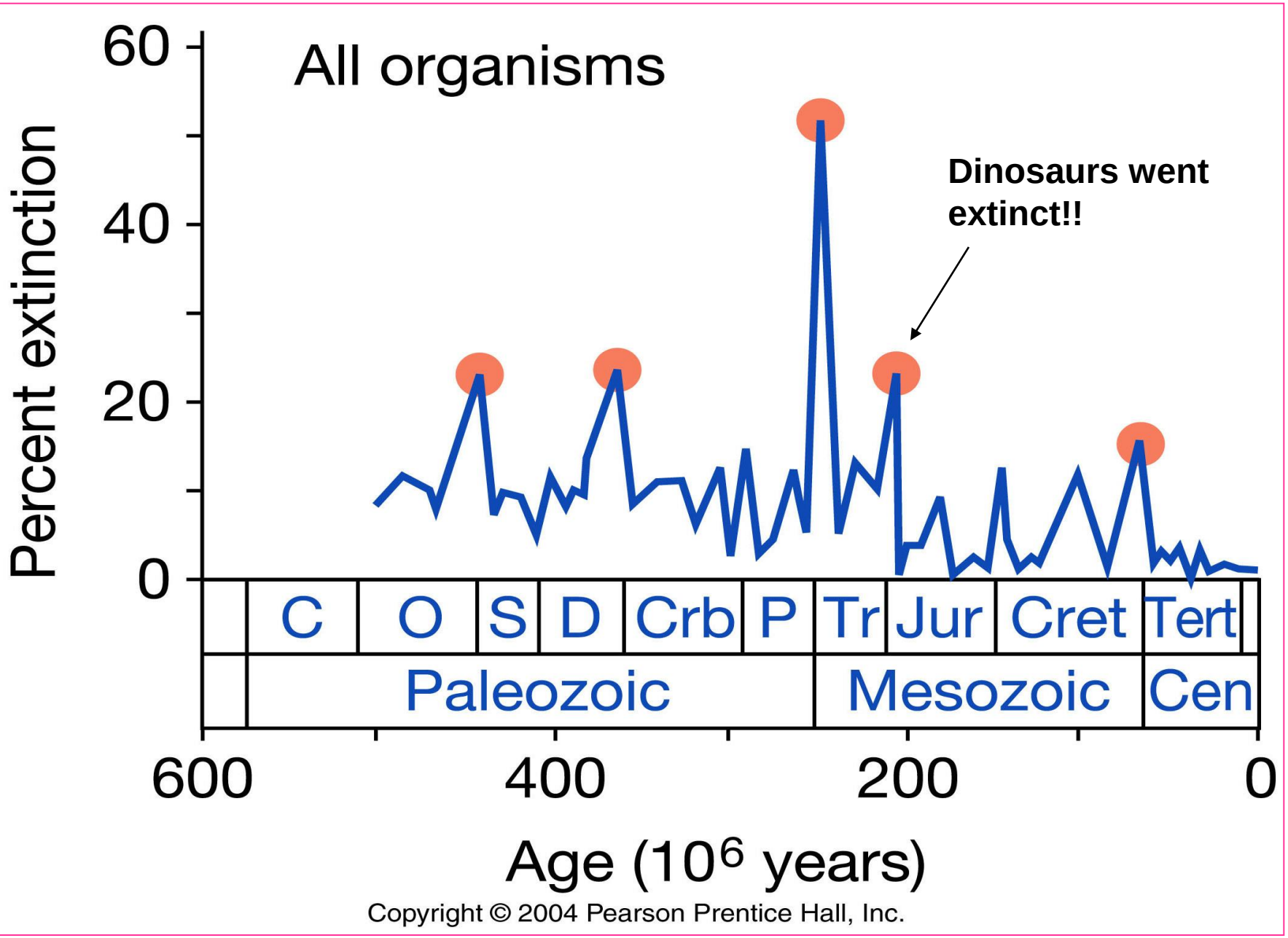
- Complete disappearance of a species from earth
- Occurs when a species cannot adapt and successfully reproduce under new environmental conditions
- Natural but sometimes increase sharply

Extinction

- All species on earth are destined to become extinct!!
- **Background extinction:** continuous low level extinction of species, occurring throughout the history of life on earth

Extinction

- **Mass extinction:** extinction of many species in a relatively short period of geologic time
- Fossil record shows five mass extinctions!!
- Due to each mass extinction, 50 to 95% of all species on earth became extinct!!
- Biodiversity returned to higher levels after each mass extinction!!



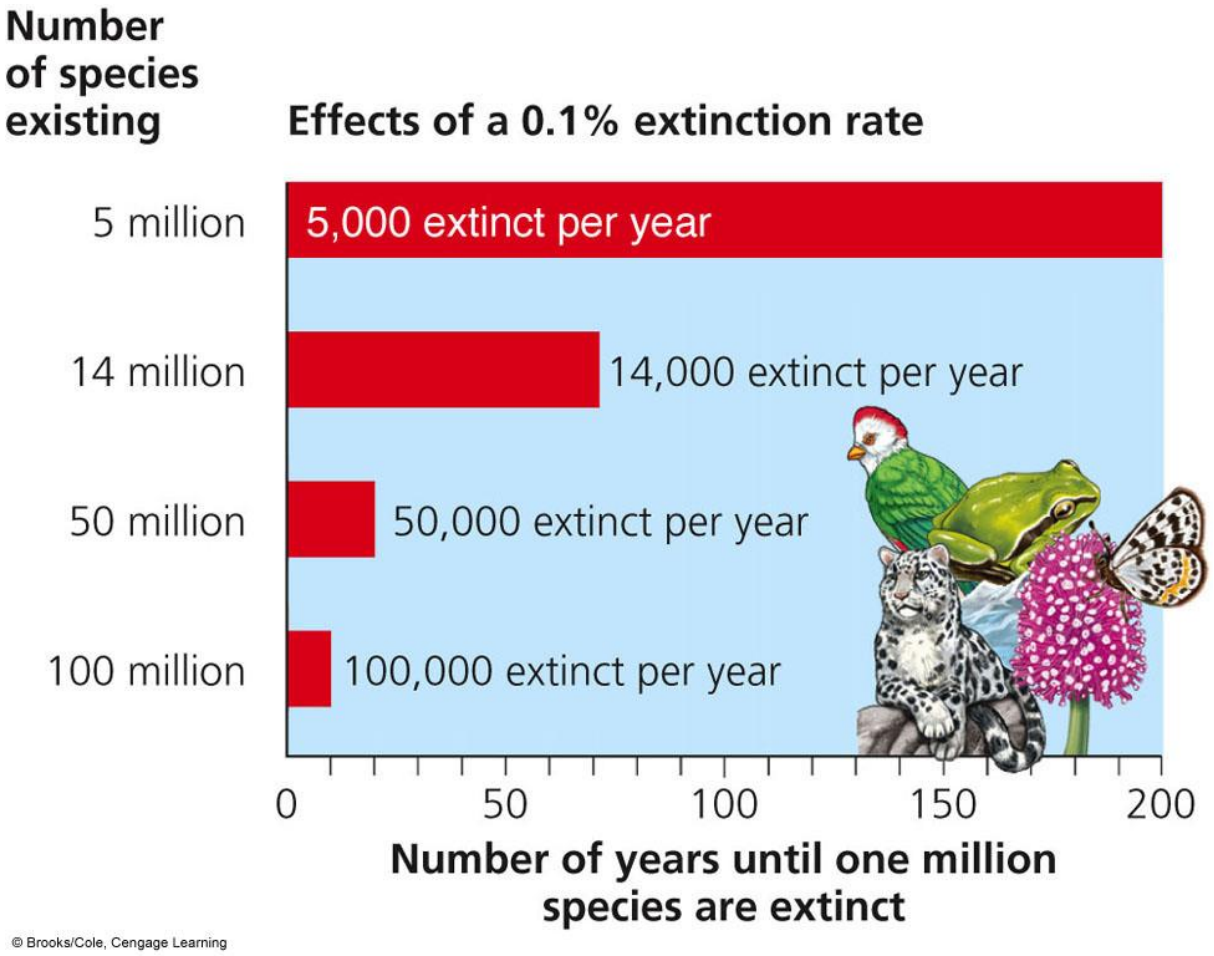
Extinction

- Causes of past mass extinctions poorly understood
- Major climate change
- Large scale catastrophes (The earth being hit by a comet or a large asteroid)

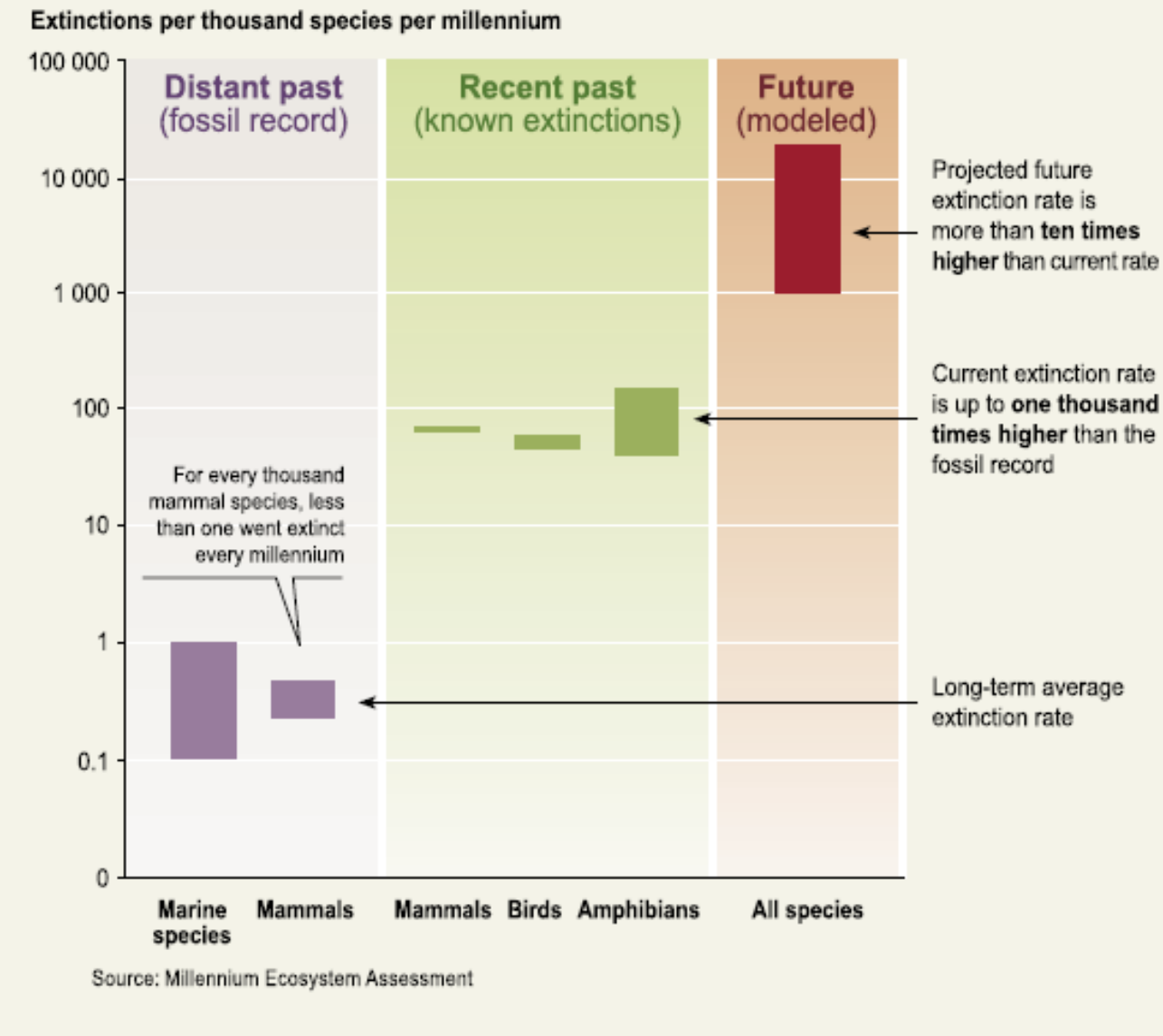
Extinction Rate

- Percentage (or number of species) that go extinct within a certain time period
- Estimated background extinction rate: 1 per million species per year or 0.0001%
- Current annual rate of species extinction: one hundred to one thousand times the background rate!!

Extinction Rate

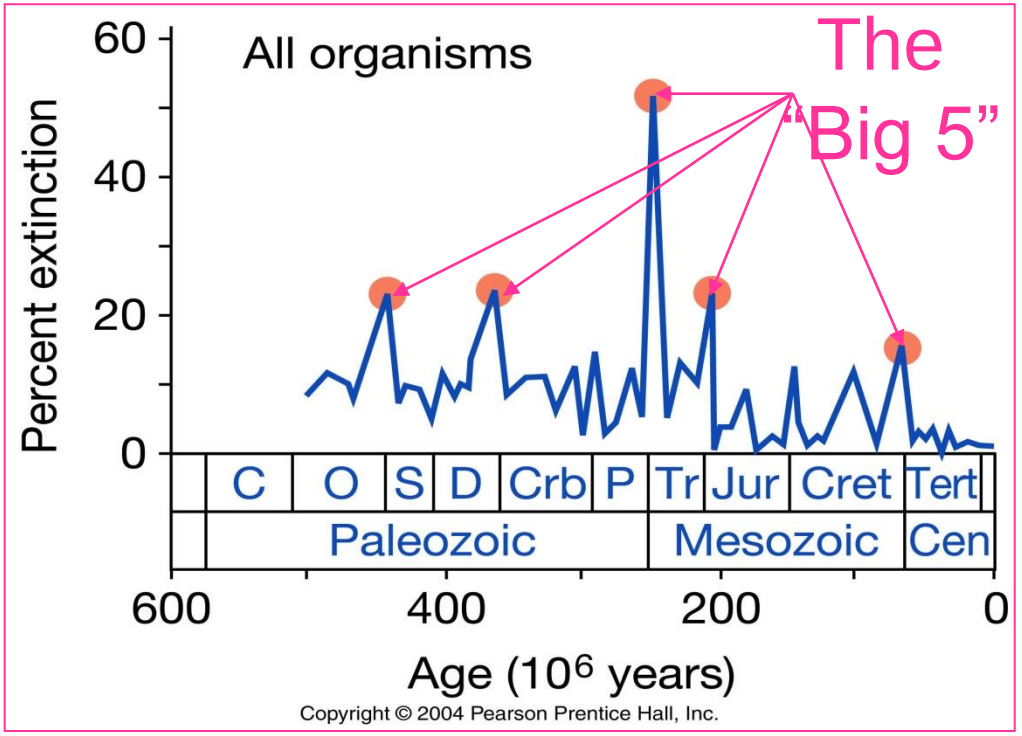


Extinction Rate



Extinction

- Extinction decreases biodiversity.
- Current rate may constitute mass extinction!!

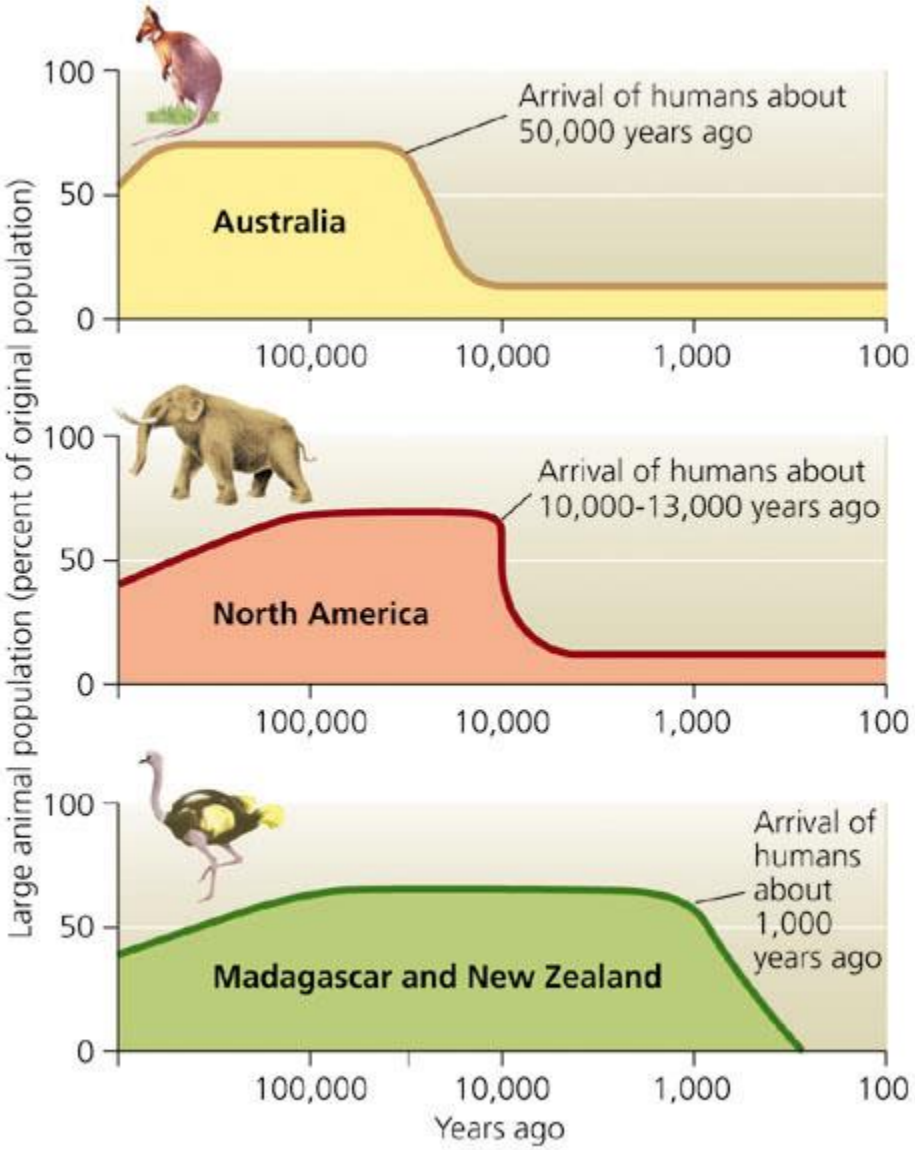


Millions of years to recover

Anthropogenic Extinction

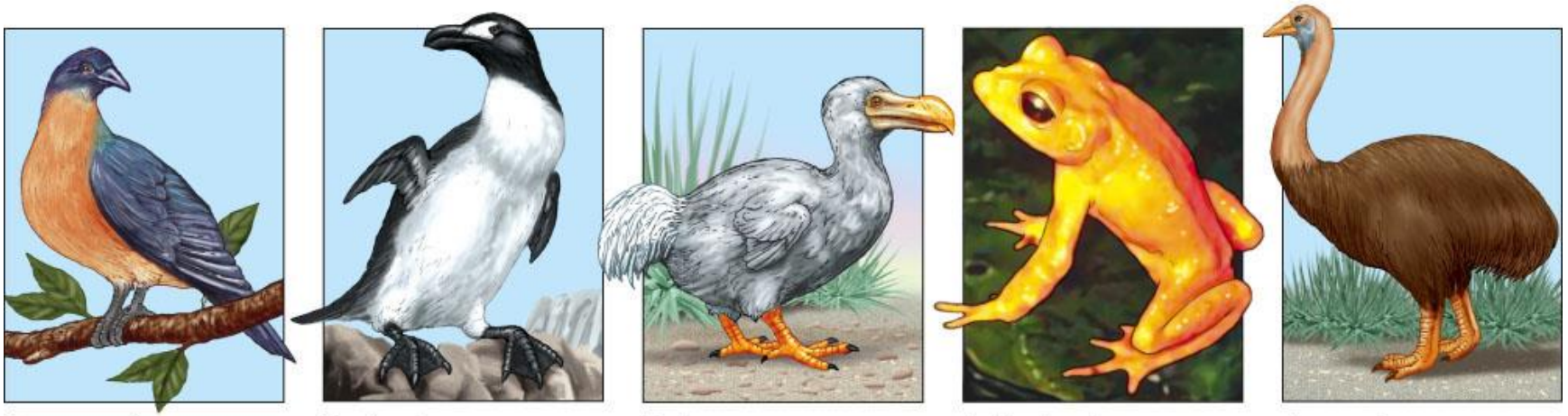
- We are destroying and degrading biodiversity!!
- We have disturbed at least half the earth's land surface!!
- We are also degrading aquatic biodiversity.

Anthropogenic Extinction



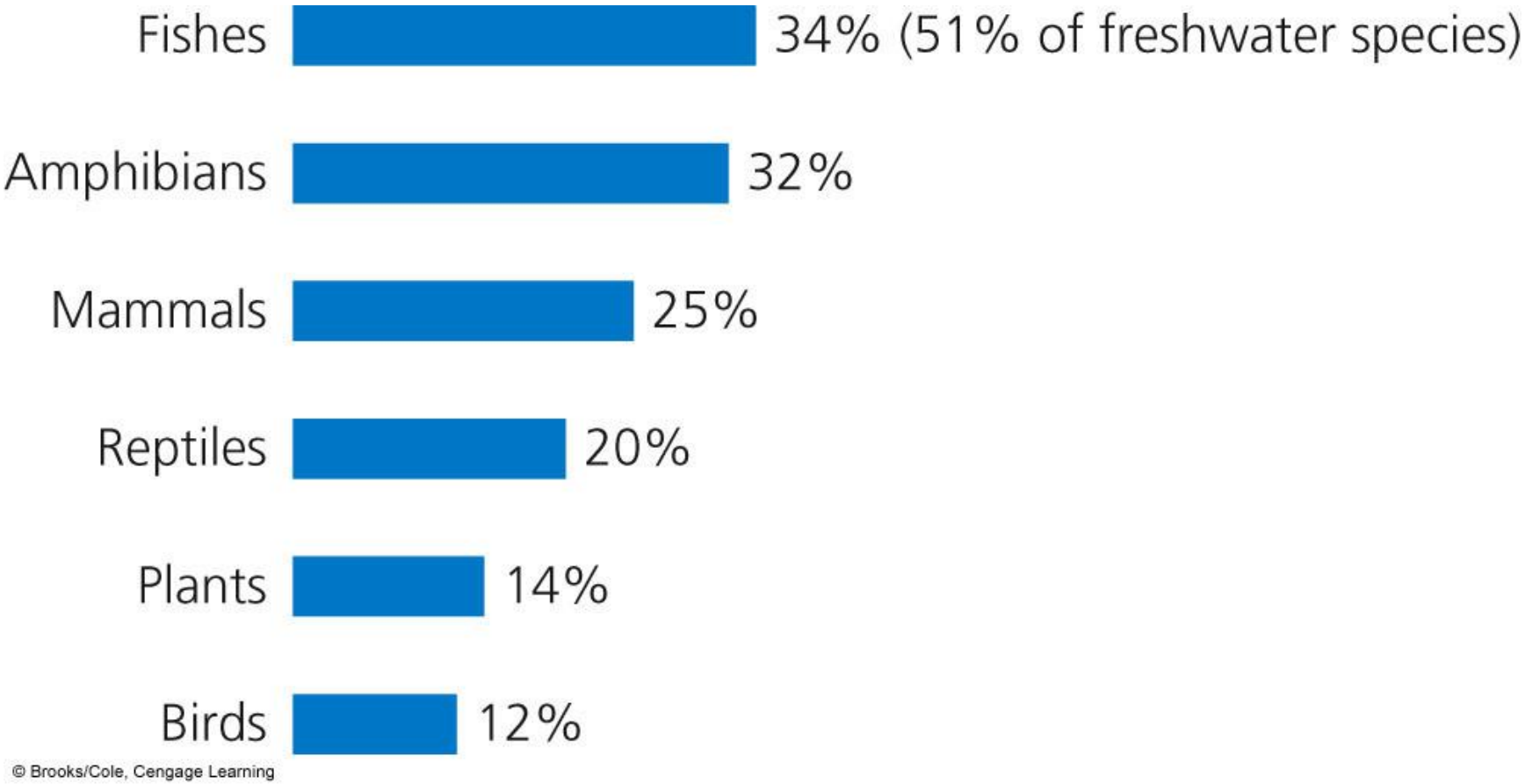
Anthropogenic Extinction

Animal species prematurely extinct due to human activities, mainly habitat destruction and overhunting!!

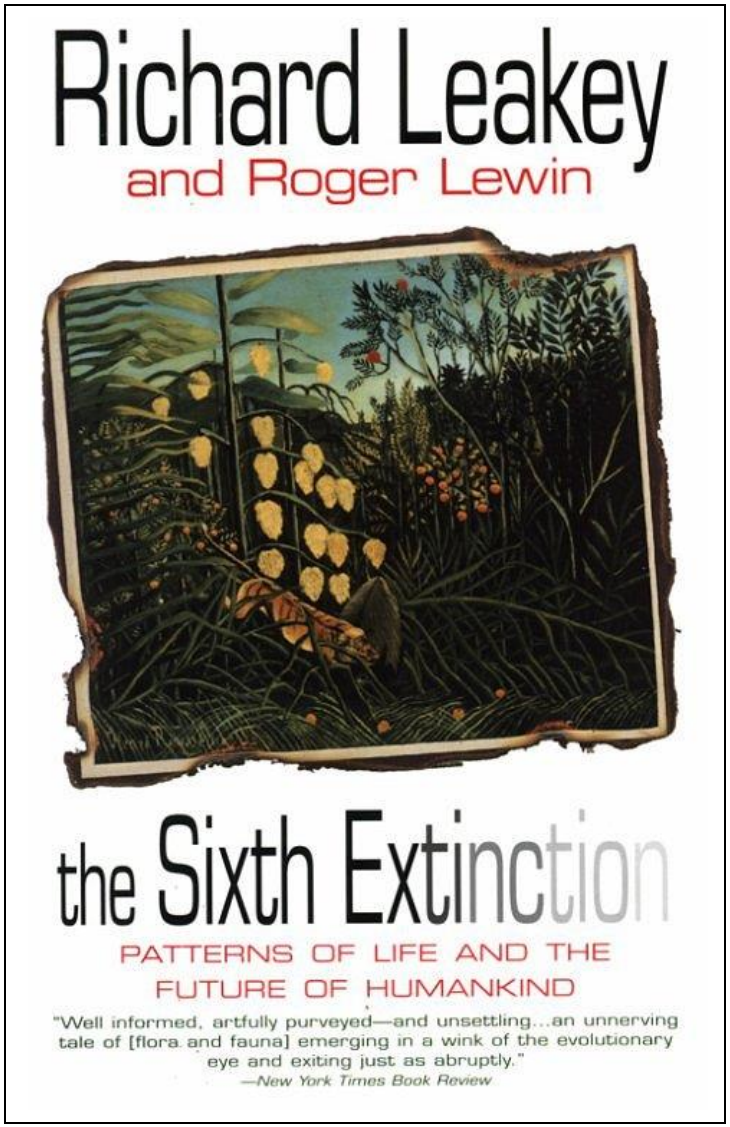


Passenger pigeon | Great auk | Dodo | Golden toad | Aepyornis (Madagascar)

Percentage of Various Species Threatened with Premature Extinction



Sixth Mass Extinction!!



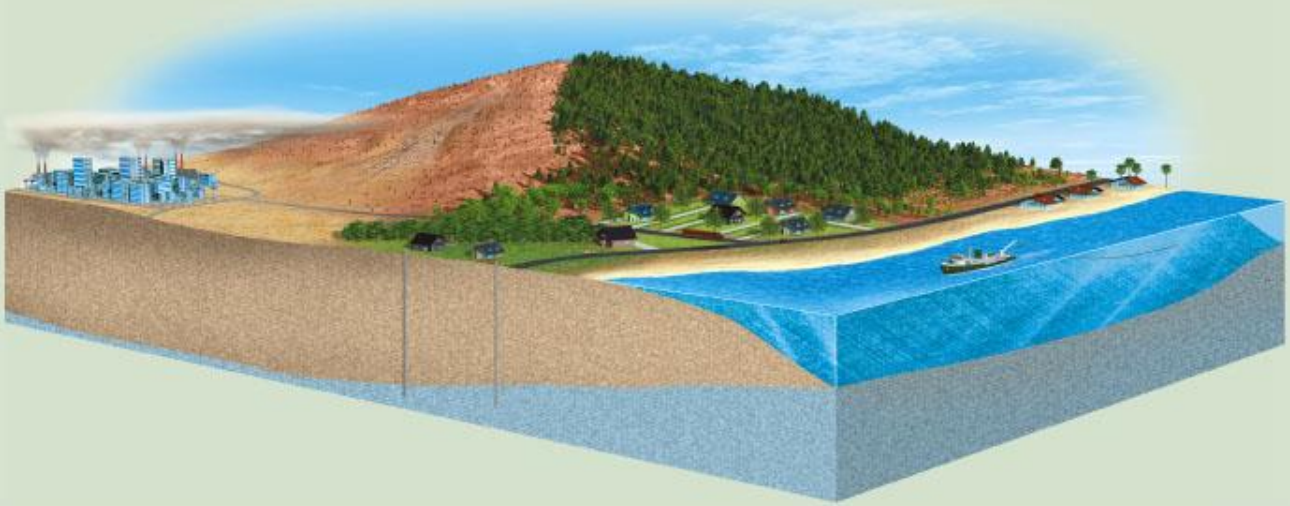
Anthropogenic Extinction

NATURAL CAPITAL DEGRADATION

Causes of Depletion and Premature Extinction of Wild Species

Underlying Causes

- Population growth
- Rising resource use
- Undervaluing natural capital
- Poverty



Direct Causes

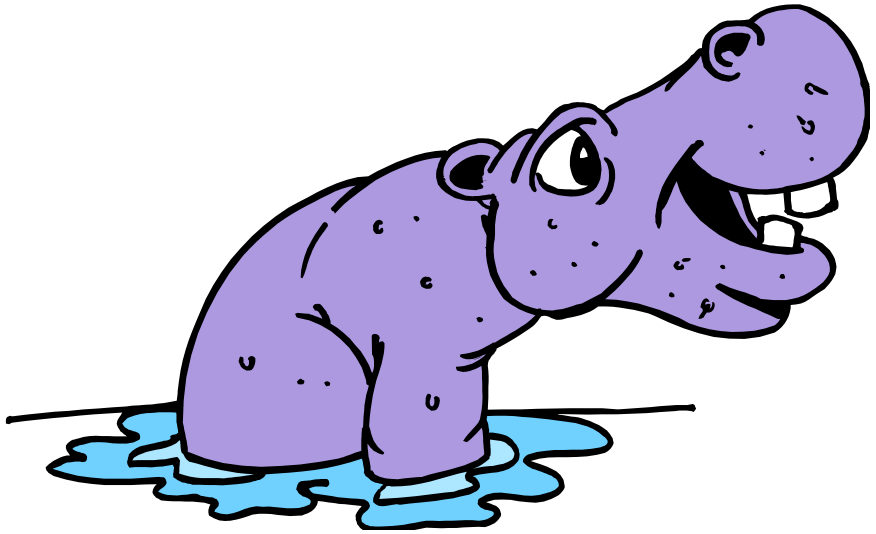
- Habitat loss
- Habitat degradation and fragmentation
- Introduction of nonnative species
- Pollution
- Climate change
- Overfishing
- Commercial hunting and poaching
- Sale of exotic pets and decorative plants
- Predator and pest control

Anthropogenic Extinction

Anthropogenic extinction is driven by HIPPO:

Habitat Loss & Degradation

Introduced, Invasive Species



Population Growth

Pollution

Overexploitation

HIPPO and HIPPCO

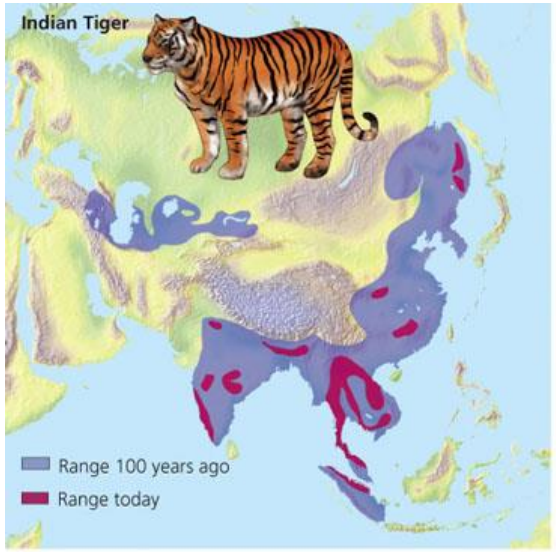
- **H**abitat destruction, degradation, and fragmentation
- **I**nvasive (nonnative) species
- **P**opulation and resource use growth
- **P**ollution
- **C**limate change
- **O**verexploitation

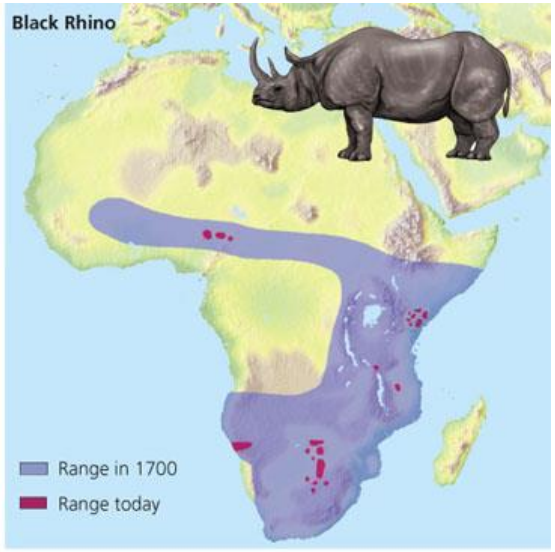
Habitat Loss

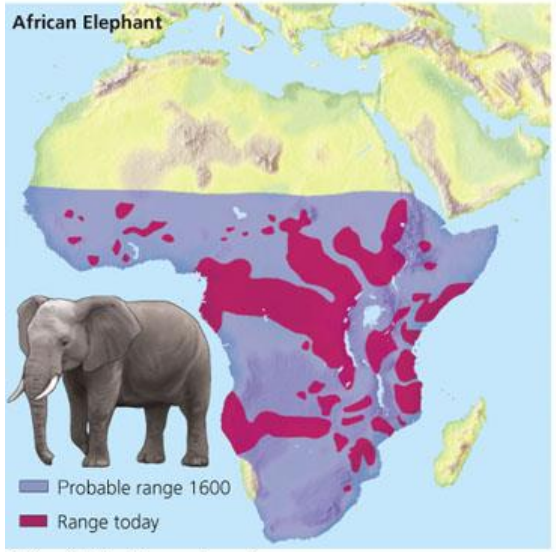
Habitat is lost due to human use!!

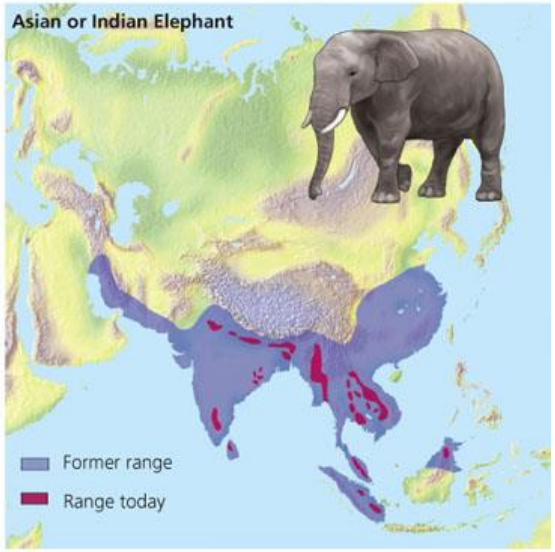
- Urbanization
- Agriculture, grazing
- Desertification
- Global Climate Change

Habitat Destruction, Degradation, and Fragmentation





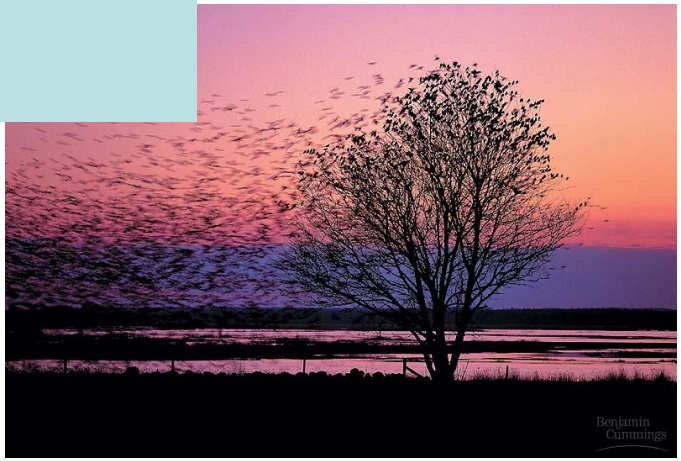




Invasive (Nonnative) Species

Invasive species are introduced by humans!!

50,000 species in U.S. alone!!
Cost over $130 billion annually!!



Invasive (Nonnative) Species

- Why are species introduced?
  - Food
  - Shelter
  - Medicine
  - Aesthetic enjoyment

Invasive (Nonnative) Species

- Why do they become invasive?

  Nonnative species may have no natural predators, competitors, parasites and pathogens.

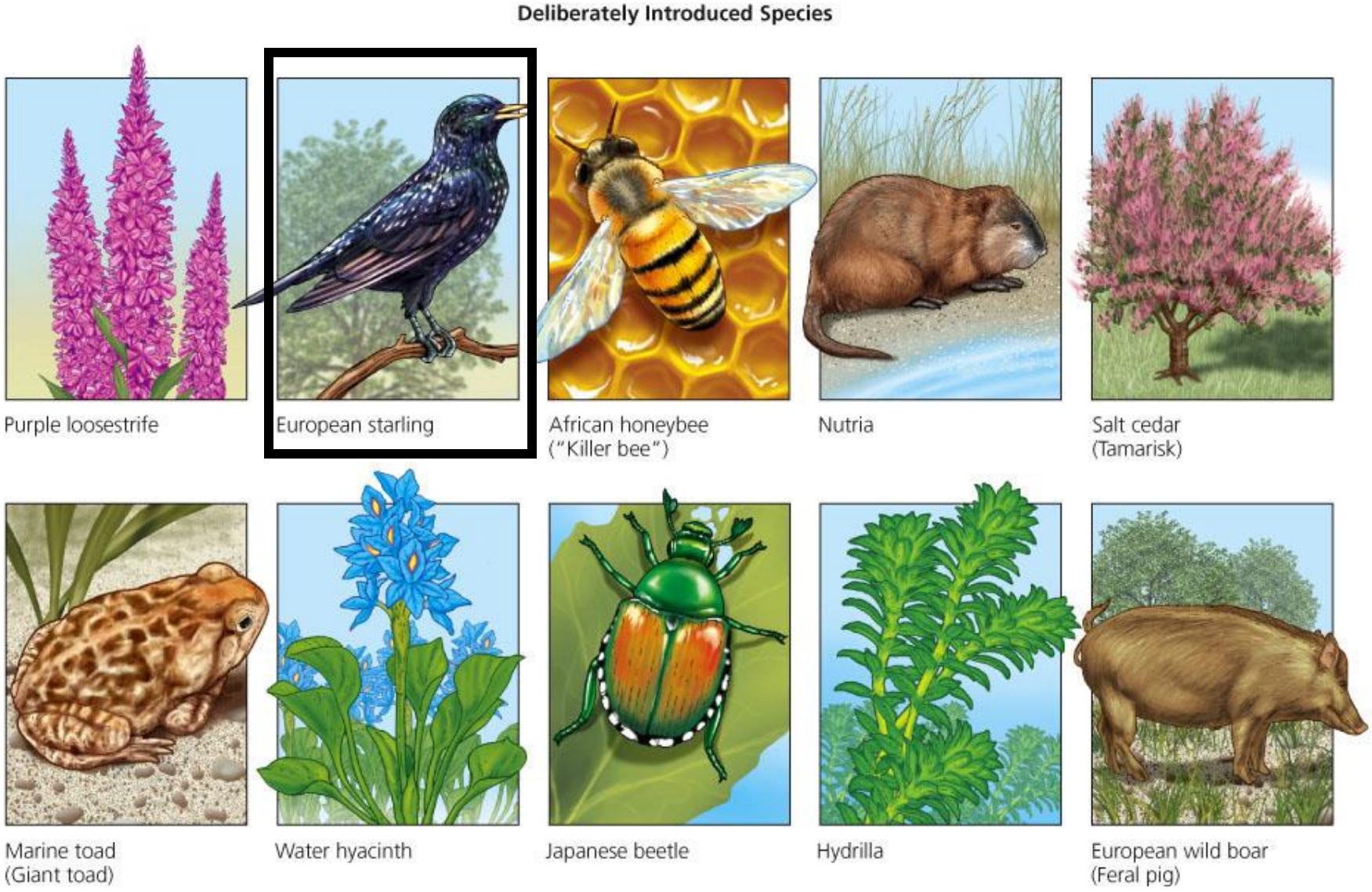
Characteristics of Successful Invader Species

- High reproductive rate, short generation time (r-selected species)
- Pioneer species
- Long lived
- High dispersal rate
- Generalists
- High genetic variability

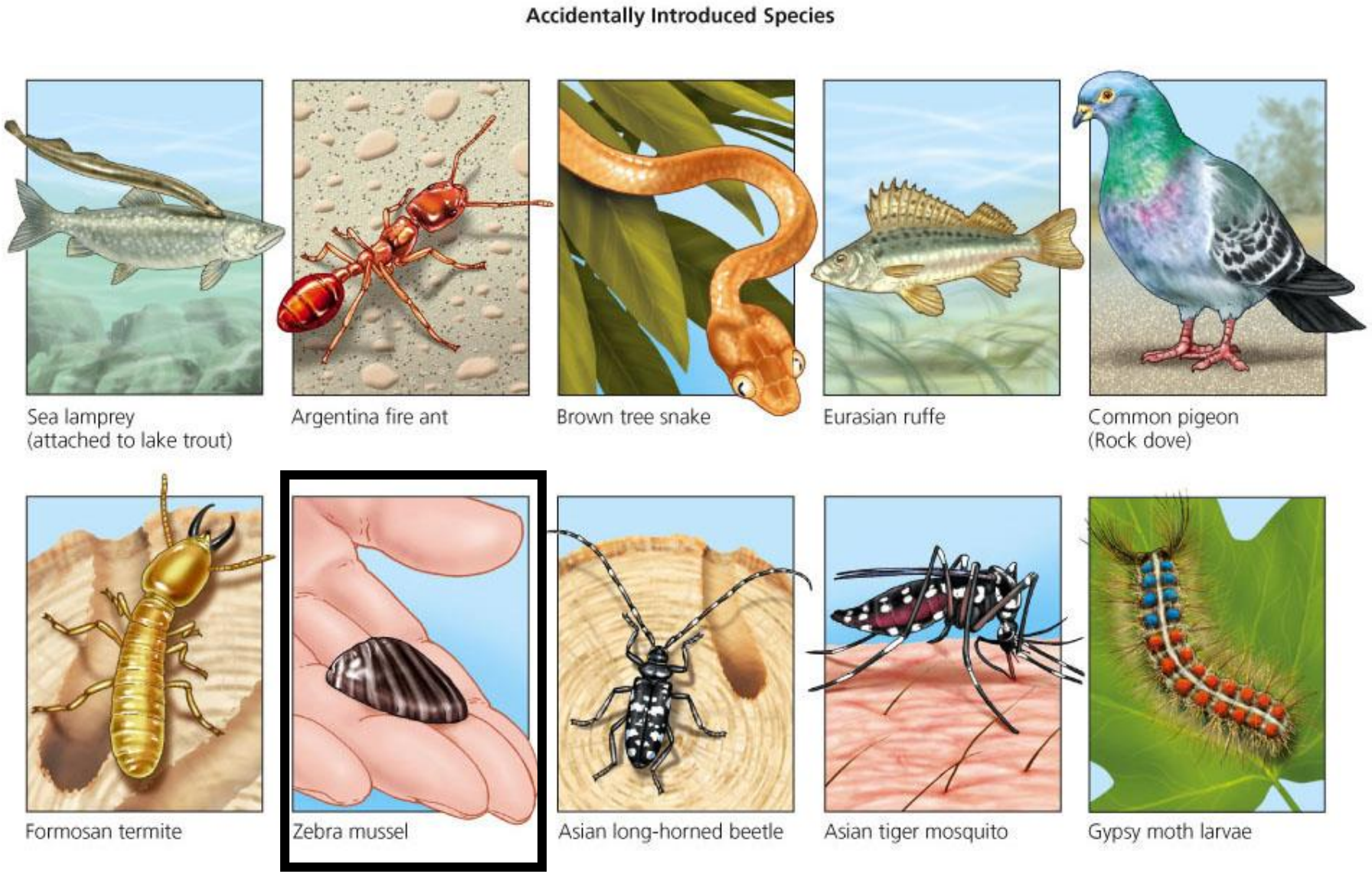
Characteristics of Ecosystems Vulnerable to Invader Species

- Climate similar to habitat of invader
- Absence of predators on invading species
- Early successional systems
- Low diversity of native species
- Absence of fire
- Disturbed by human activities

Invasive (Nonnative) Species



Invasive (Nonnative) Species



Invasive (Nonnative) Species

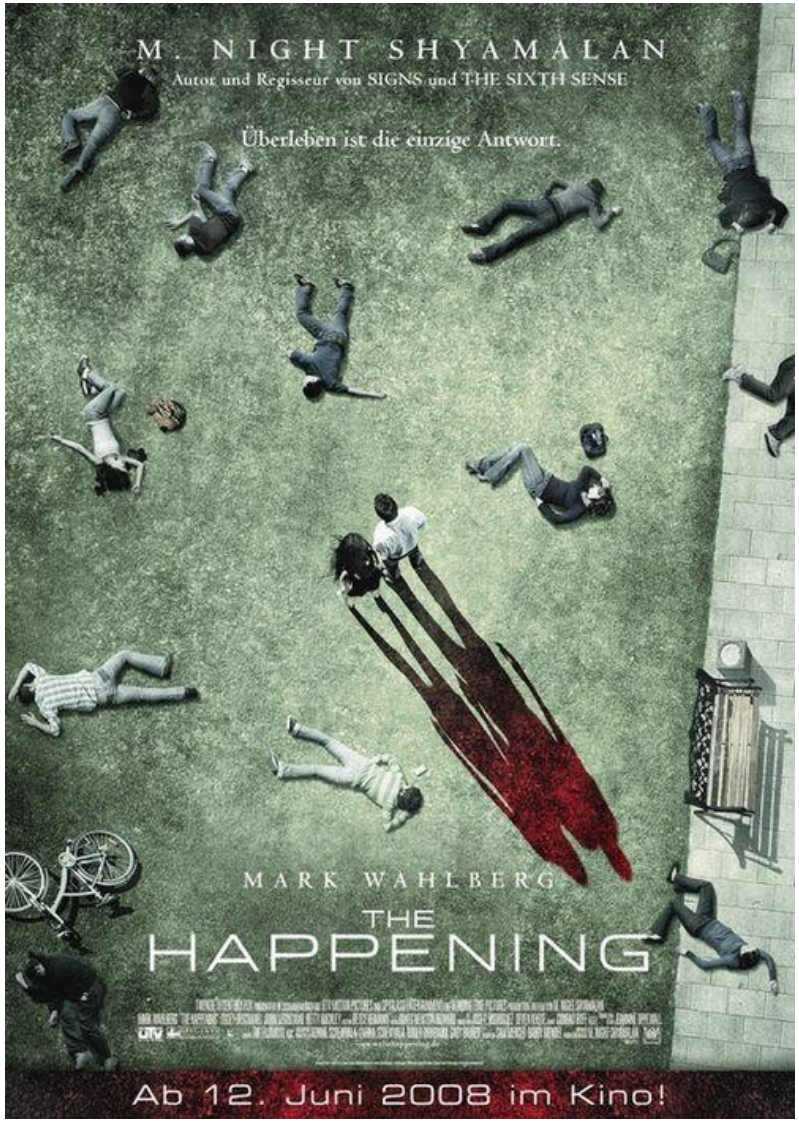
Invasive (Nonnative) Species

- *Colerpa taxifolia*, a tropical green alga, introduced to the Mediterranean in 1984
- Crowds out most plants
- Inedible to most animals
- Tangles boat propellers

WHAT CAN YOU DO?

Controlling Invasive Species

- Do not capture or buy wild plants and animals
- Do not remove wild plants from their natural areas
- Do not dump the contents of an aquarium into waterways, wetlands, or storm drains
- When camping, use wood found near your camp site instead of bringing firewood from somewhere else
- Do not dump unused bait into any waterways
- After dogs visit woods or the water, brush them before taking them home
- After each use, clean your mountain bike, canoe, boat, hiking boots, and other gear before heading for home


M. NIGHT SHYAMALAN
Autor und Regisseur von SIGNS und THE SIXTH SENSE
Überleben ist die einzige Antwort.
MARK WAHLBERG
THE HAPPENING
Ab 12. Juni 2008 im Kino!


COUNTERTHINK
ON STRIKE
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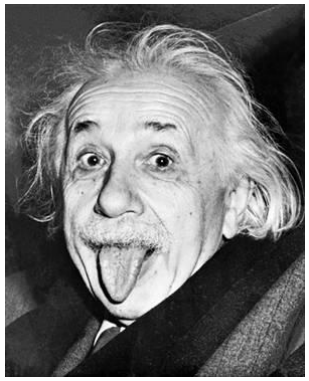
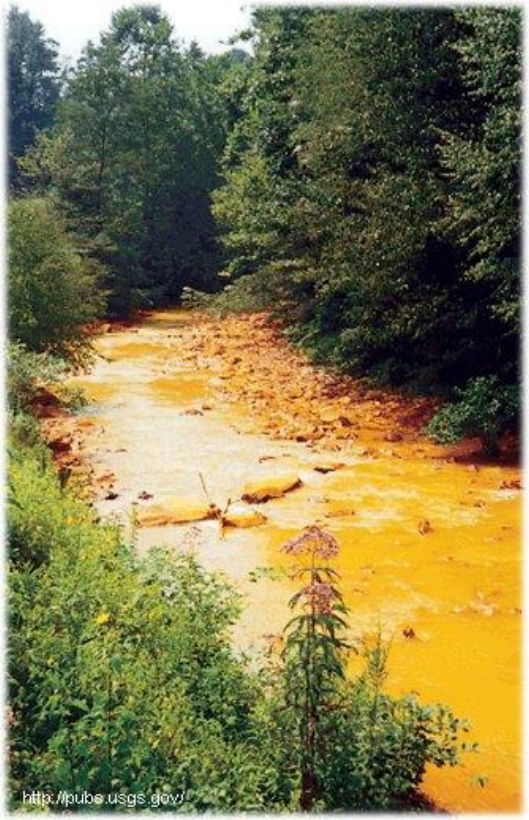


What is Happening to the Honeybees?

- Honeybees responsible for 80% of insect-pollinated plants
- Dying due to
  - Pesticides
  - Parasites
- **Bee colony collapse syndrome**

Pollution

Pollution takes many forms!!



Acid Mine Drainage (coal mines)

Trash

Nutrients

Light

Overexploitation

Overexploitation means using resources unsustainably (spending capital)!!

Forests

Overexploitation

Overexploitation means using resources unsustainably (spending capital)!!

Plant & Animal Populations

What Else?

- Illegal killing, capturing, and selling of wild species threatens biodiversity.
- Poaching and smuggling of animals and plants
  - Animal parts
  - Pets
  - Plants for landscaping and enjoyment

A Rhino, Poached!!

Elephants and Ivory

Protest Against Poaching – Kenya

Endangered Species

- So few individual survivors the species could soon become extinct over all or most of its natural range

Threatened Species

- Vulnerable species
- Still abundant in its natural range
- Likely to become endangered in the near future because of declining numbers

Some Endangered and Threatened Species!!

Characteristic	Examples
Low reproductive rate (K-strategist)	Blue whale, giant panda, rhinoceros
Specialized niche	Blue whale, giant panda, Everglades kite
Narrow distribution	Elephant seal, desert pupfish
Feeds at high trophic level	Bengal tiger, bald eagle, grizzly bear
Fixed migratory patterns	Blue whale, whooping crane, sea turtle

Why are they threatened or endangered??

Rare	African violet, some orchids
Commercially valuable	Snow leopard, tiger, elephant, rhinoceros, rare plants and birds
Large territories	California condor, grizzly bear, Florida panther

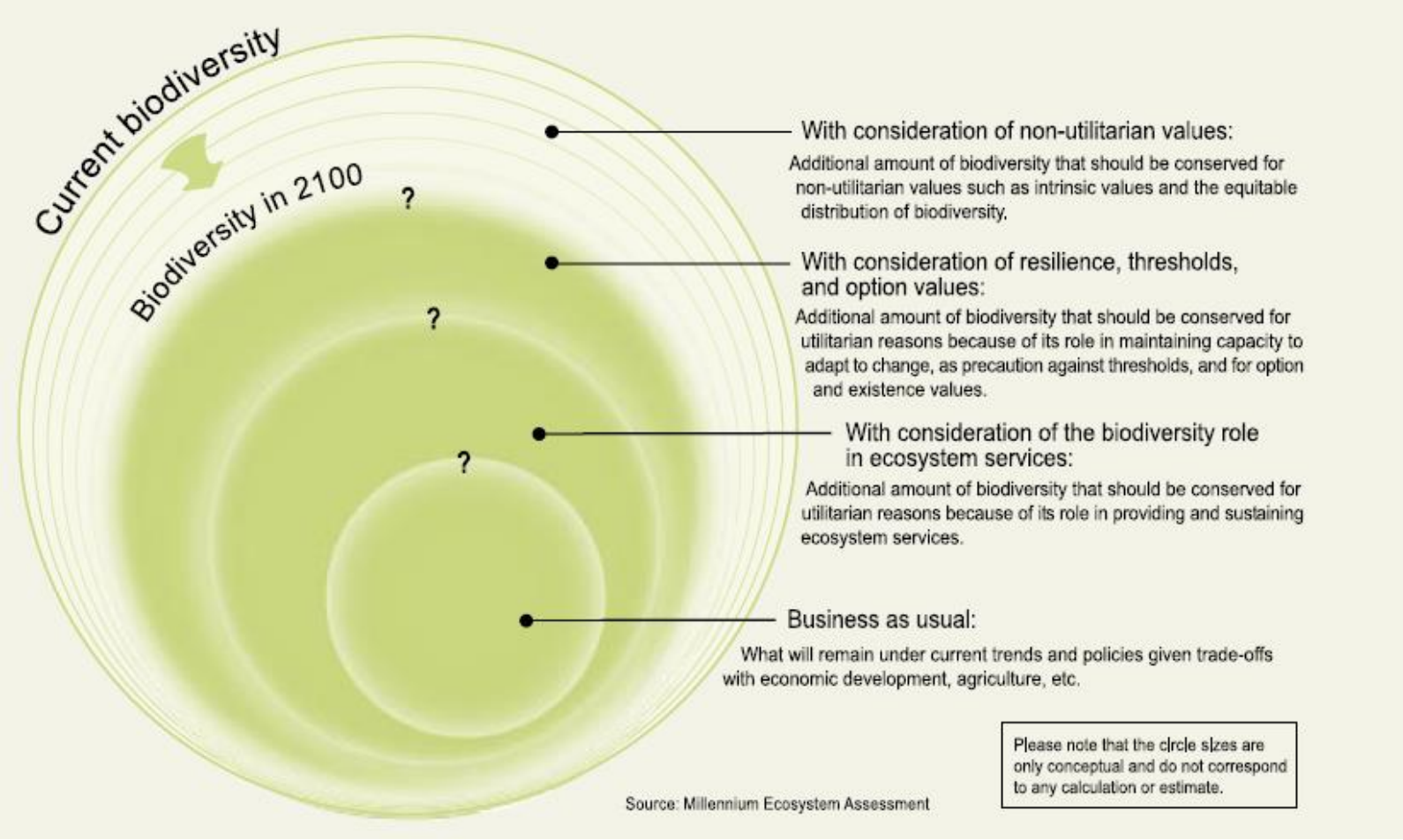
Confiscated Products Made of Endangered Species

International Treaties to Protect Species

- 1975: Convention on International Trade in Endangered Species (CITES)
  - Signed by 172 countries **(NOT Lebanon!!)**
- Convention on Biological Diversity (CBD)
  - Focuses on ecosystems
  - Ratified by 190 countries (Not the U.S.A.)

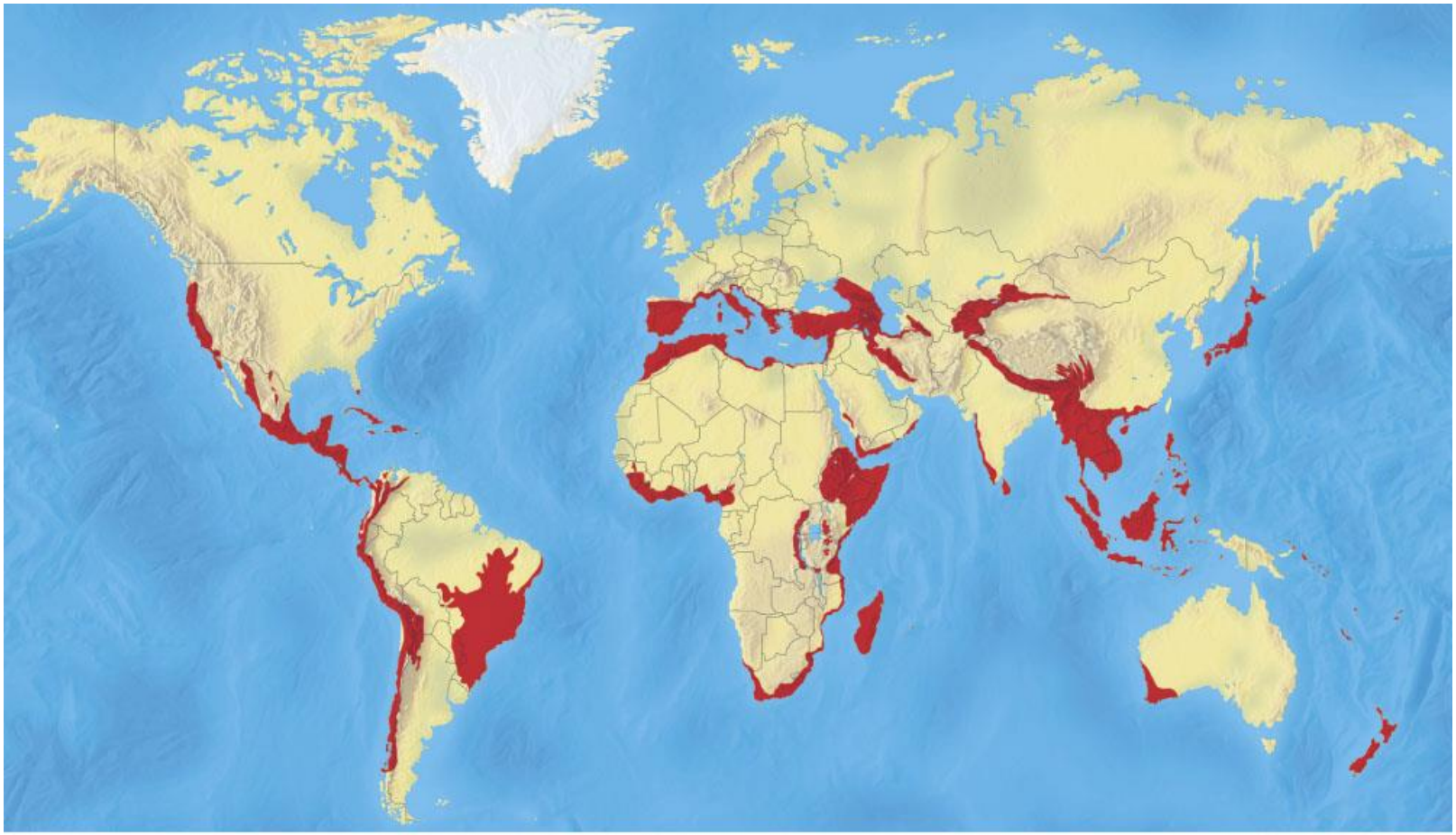
Biodiversity

How many species will there be in the future??

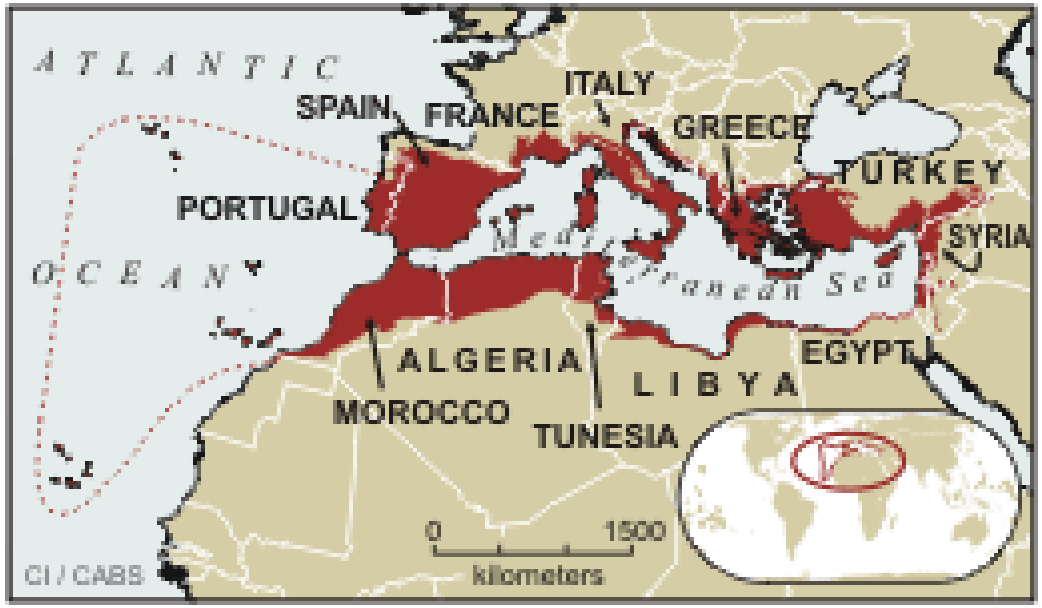


Biodiversity Hotspots

34 spots containing a large number of species not found anywhere else!!



Mediterranean Hotspot



Hotspot Original Extent (Square km): 2,085,292

Hotspot Vegetation Remaining (square km): 98,009

Human Population Density (people/ square km): 111

Area Protected (Square km): 90,242

Endemic Plant Species	11,700
Endemic Threatened Birds	9
Endemic Threatened Mammals	11
Endemic Threatened Amphibians	14
Extinct Species	5

Mediterranean Hotspot

Taxonomic Group	Species	Endemic Species	Percent Endemism
Plants	22,500	11,700	52.0
Mammals	226	25	11.1
Birds	489	25	5.1
Reptiles	230	77	33.5
Amphibians	79	27	34.2
Freshwater Fishes	216	63	29.2

Biodiversity in Lebanon

- Very high level despite relatively small land area
- Three reasons:
  - Lebanon as part of the “Mediterranean Hotspot” for biodiversity
  - Mount. Lebanon as a regional hotspot
  - Lebanon’s proximity to neighboring biogeographical regions

Biodiversity in Lebanon

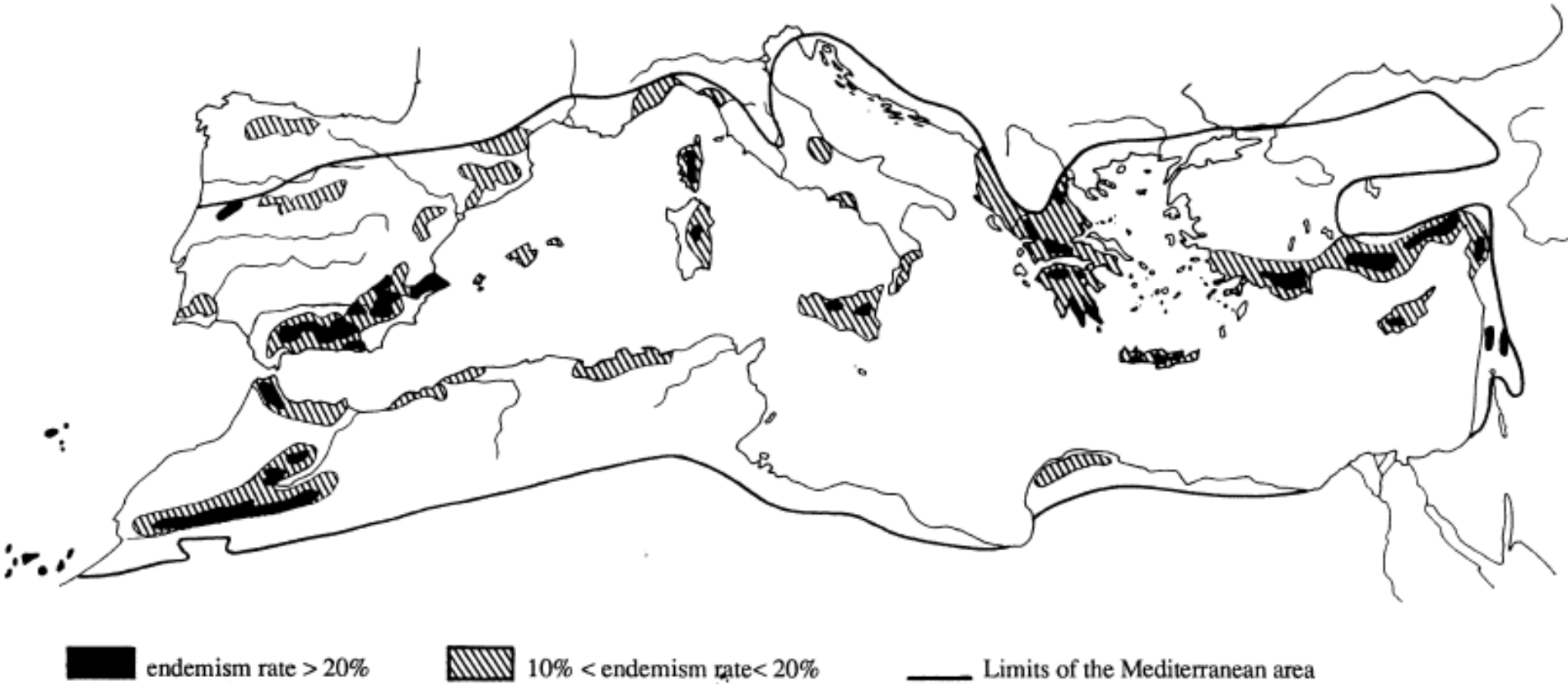


Figure 1. Biogeographical sectors with high incidences of plant endemism in Mediterranean basin.

Biodiversity in Lebanon

Figure 3 Subdivisions of the Mediterranean area and delineation of the major bio-geographical regions and provinces[6]

WHAT CAN YOU DO?

Protecting Species

- Do not buy furs, ivory products, or other items made from endangered or threatened animal species
- Do not buy wood or paper products produced by cutting old-growth forests in the tropics
- Do not buy birds, snakes, turtles, tropical fish, and other animals that are taken from the wild
- Do not buy orchids, cacti, or other plants that are taken from the wild
- Spread the word. Talk to your friends and relatives about this problem and what they can do about it

What Shall We Do?

- Map global ecosystems; identify species
- Locate and protect most endangered species
- Restore degraded ecosystems
- Development biodiversity-friendly
- Are new laws needed?