Nature Conservation III.
BBI1122 en

- Books:
  - Primack R.B. 2018. Essentials of Conservation Biology. Sinauer AS.
  - Sodhi N.S. And Ehrlich P.R. 2010. Conservation Biology for All https://www.mongabay.com/conservation-biology-for-all.html

Information in relation to the course:

http://zeus.nye.hu/~szept/kurzusok.htm

Themes

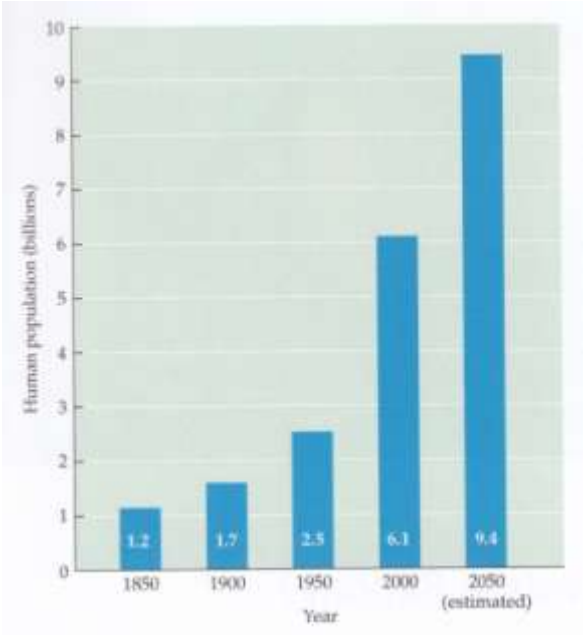
1. What is Conservation Biology
2. What is Biodiversity
3. Where is the World's Biodiversity found
4. Valuing Biodiversity
5. Extinction. Vulnerability to Extinction
6. Habitat Destruction, Fragmentation and Degradation
7. Overexploitation. Invasive Species. Disease
8. Conservation at the Population and Species levels
9. Establishing New Populations. Ex Situ conservation
10. Establishing and Managing Protected Areas
11. Conservation Outside Protected Areas. Restoration Ecology
12. Conservation and Human Societes

What is Conservation Biology

Importance of Conservation Biology

- Catastrophic lost of species – Increasing averness
- The level of species lost similar or larger than the large extinction in the geological past
- Behind the recent extinction - activity of a „smart”species

The largest threats because of the overpopulation and extended resource usage:



- Habitat destruction, fragmentation, pollution
- Overharvesting of plants and animals (fishing, hunting, trade)
- Endemic fauna/flora of islands (introduction exotic species)
- Technological development and its consequences (dams, modern agriculture, industries, transportation)

video: (Netflix) **A Life on Our Planet**

Concern for Biodiversity

- Present threats to biodiversity is unprecentented
- Threat to biodiversity is accelerated, increasing human population – continued advances in technology
- Threat to biodiversity are synergistic
- People are realizing that what is bad for biodiversity will almost certainly bad for human

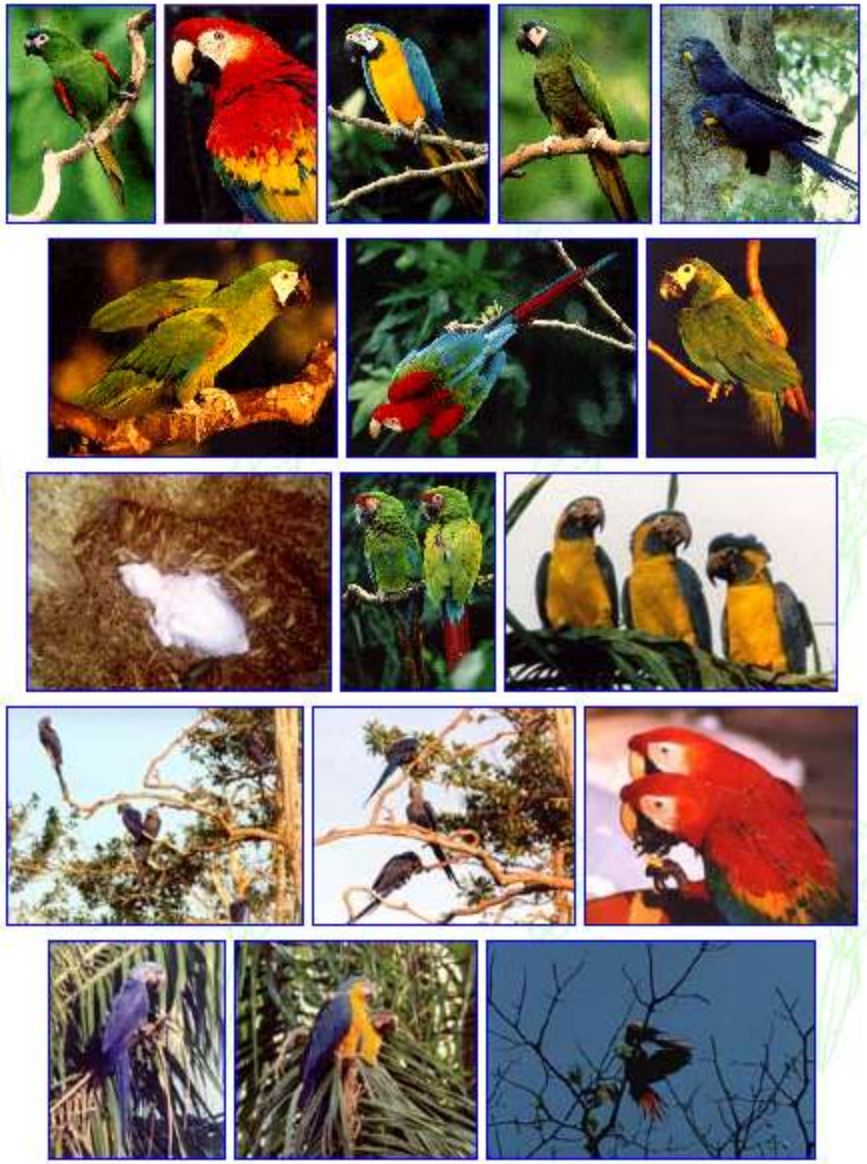
Conservation Biology

- Multidisciplinary science
- aims:
  - Investigate human impact on biodiversity
  - Develop practical approaches to prevent extinction of species

Case study

- Neotropical parrot
- 16 species in South American tropical forests, 9 endangered, 1 near extinct
- Threats: Hunting, trade, habitat destruction
- Researches: key sources, Cainism, (indian hunting, trade, mining)

- Action: protected areas, involving local people, ecoturism
- https://en.wikipedia.org/wiki/Neotropical_parrot



Case study

Sea Turtles - Brasil

- Many sea turtle populations have shrunk to less than 1% of their original sizes
- Devastated by a combination of factors that includes destruction of their nesting habitat, hunting of adult turtles and collecting of turtle eggs for food, and high mortality due to entanglement in fishing gear
- When the Brazilian government set out to design a conservation program, planners discovered:
  - no one knew exactly which species of sea turtles were found in Brazil
  - how many turtles there were
  - where they laid their eggs
  - how local people were affecting them



In 1980 the Brazilian government established the National Marine Turtle Conservation Program, called Projeto **TAMAR**

The project began with a 2-year survey of Brazil's 6000 kilometers of coastline, using boats, horses, and foot patrols, combined with hundreds of interviews with villagers. TAMAR divers aided in these efforts by tagging and monitoring sea turtle populations in the water.

Sea Turtles - Brasil

- The TAMAR survey found that turtle nesting beaches fell into three main zones along 1100 km of the coastline between Rio de Janeiro and Recife
- Loggerhead turtles (Caretta caretta) the most abundant species and four other species also present
- The green turtle (Chelonia mydas) was the only species nesting on Brazil's offshore islands
- Adult turtles and turtle eggs were being harvested intensively, with people often collecting virtually every turtle egg laid
- The construction of resorts, houses, commercial developments, and beach roads had damaged and reduced the available nesting area on beaches
- Shadows cast by the buildings changed the temperature of the sand in which the eggs incubated, which biologists now know to be a critical factor in determining the sex of a developing turtle embryo
- Additionally, the light from the buildings at night disoriented emerging hatchlings: instead of heading straight to the ocean, they often wandered in wrong directions and became exhausted
- Of the young turtles that did make it to sea, many were caught in the nets of fishermen, where they suffocated and died

Sea Turtles - Brasil

- Legislation passed in 1986 in Brazil that led to the complete protection of sea turtles and the establishment of two new biological reserves and a marine national park to protect important nesting beaches
- Established conservation stations at each of 21 main nesting beaches.
- Each station has a manager, several university interns, and local employees
- More than 85% of TAMAR's 1000 employees live on the coast; many are former fishermen who bring their knowledge of sea turtles to bear on conservation.
- These local employees have become strong advocates for the turtles because their wages from Projeto TAMAR and the related tourist industry are linked to the continuing presence of these animals.

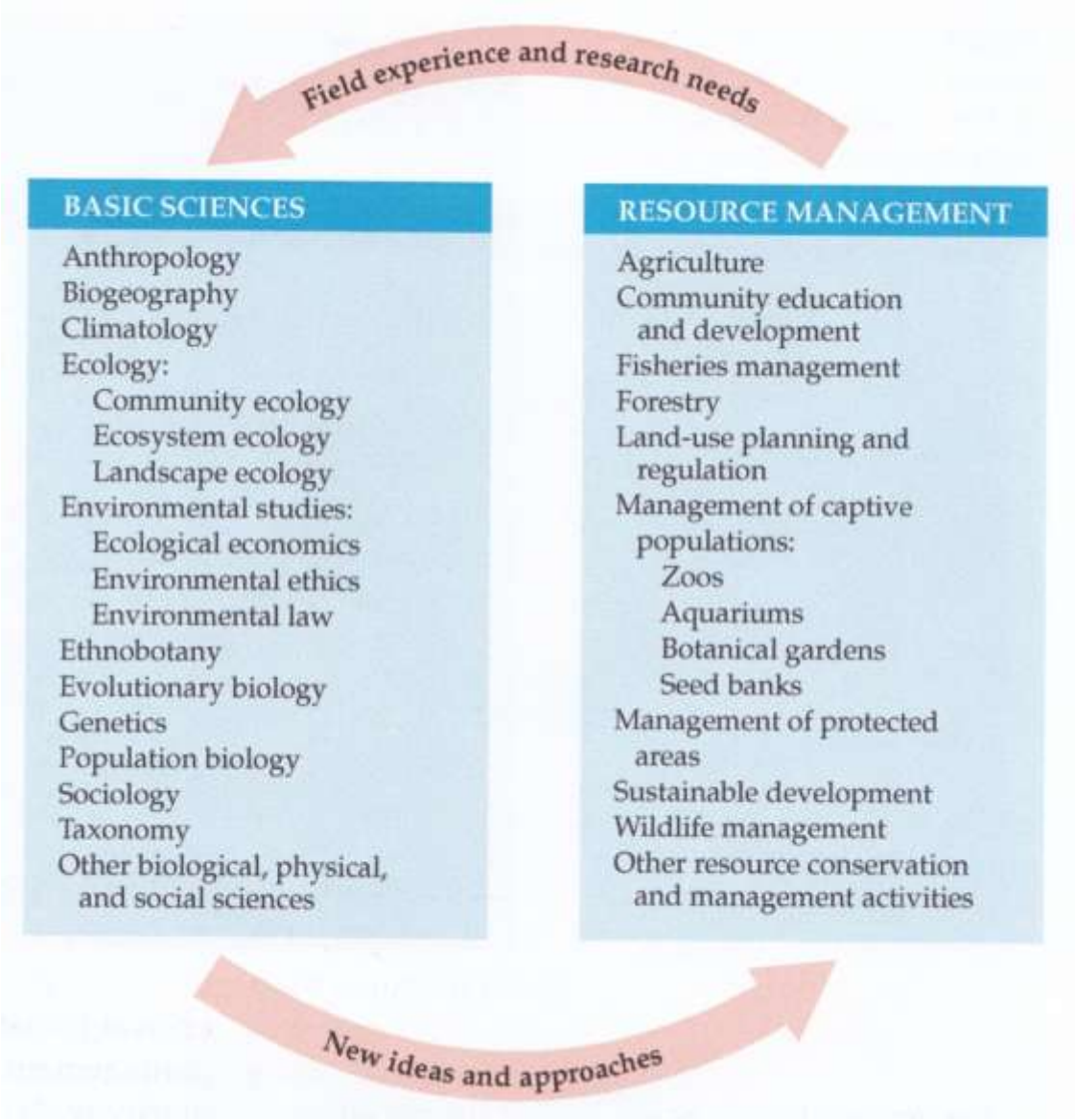


TAMAR provides fishermen with information about the importance of turtles and about fishing gear designed to prevent turtle capture. Fishermen are also taught techniques for reviving turtles caught in their nets so the turtles will not suffocate

TAMAR protects over 4000 turtle nests each year and has protected around 100,000 nests and approximately 7 million hatchlings in the years since its inception.

On average, the number of turtle nests on the beaches has also been increasing by an impressive 20% a year

Conservation biology represents a synthesis of many basic and applies science



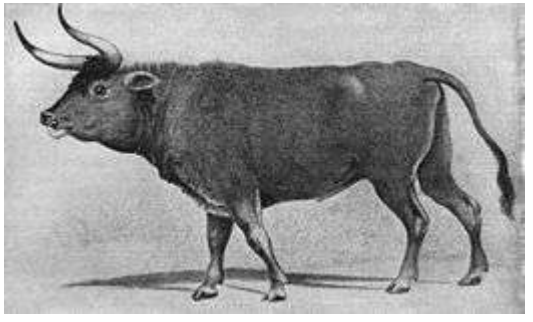
Origins of Conservation Biology

- Chinese Taoist, Japanese Shinto Philosophies
- Jainist and Hindu religions
- Hunting and gathering societies



European Origins

- Judeo-Christian tradition, Story of Noah's Ark
- Colonial practice – Mauritius, Tobago islands, India – „reserved forest" XVIII century
- „Protected area" for wild cattle, 1627
- Late XIX. Century: UK RSPB, National Trust



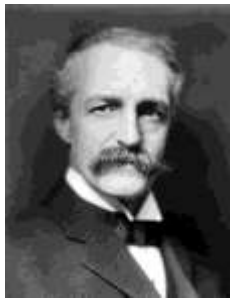
Origins of Conservation Biology

American origins

XIX century

- Ralph Waldo Emerson, Henry David Thoreau „Nature could viewed as a temple” – spiritual values
- John Muir – Preservation Ethic





XX. Century

- Gifford Pinchot – Resource Conservation Ethic
- Aldo Leopold – Evolutionary – Ecological Land Ethic
- Rachel Carson – Silent Spring – role of pesticides





Conservation Biology

Looking answers for:
- The best strategies for protecting species
- Establish effective protected areas
- Preserving genetic diversity of small populations
- Nature protection and local people

Tasks:
- Discovering problems
- Preserving natural values
- Restoration

Conservation Biology

Conservation Biology is a Crisis Discipline

Ethical Principles:

- The diversity of species and ecosystems should be preserved
- The untimely extinction of populations and species should be prevented
- Ecological complexity should be maintained
- Evolution should continue
- Biological diversity has intrinsic value

Conservation Biology

Ecologist Michael Soule organized the First International Conference on Conservation Biology in 1978

- Conservation biology has resulted in government action, both nationally and internationally
- Conservation biology programs and activities are being funded as never before
- Conservation biology's goals have been adopted by traditional conservation organisations
- Conservation biology's goals are being incorporated into international scientific activities and policy
- Conservation biology's aims and goals are reaching a broader audience through increased media coverage
- Conservation biology courses and curricula are expanding
- Conservation biology has a ra idly expanding professional society

What is Biodiversity

What is Biological Diversity?

– Conception

– **Measurable entity**

– Scientific field

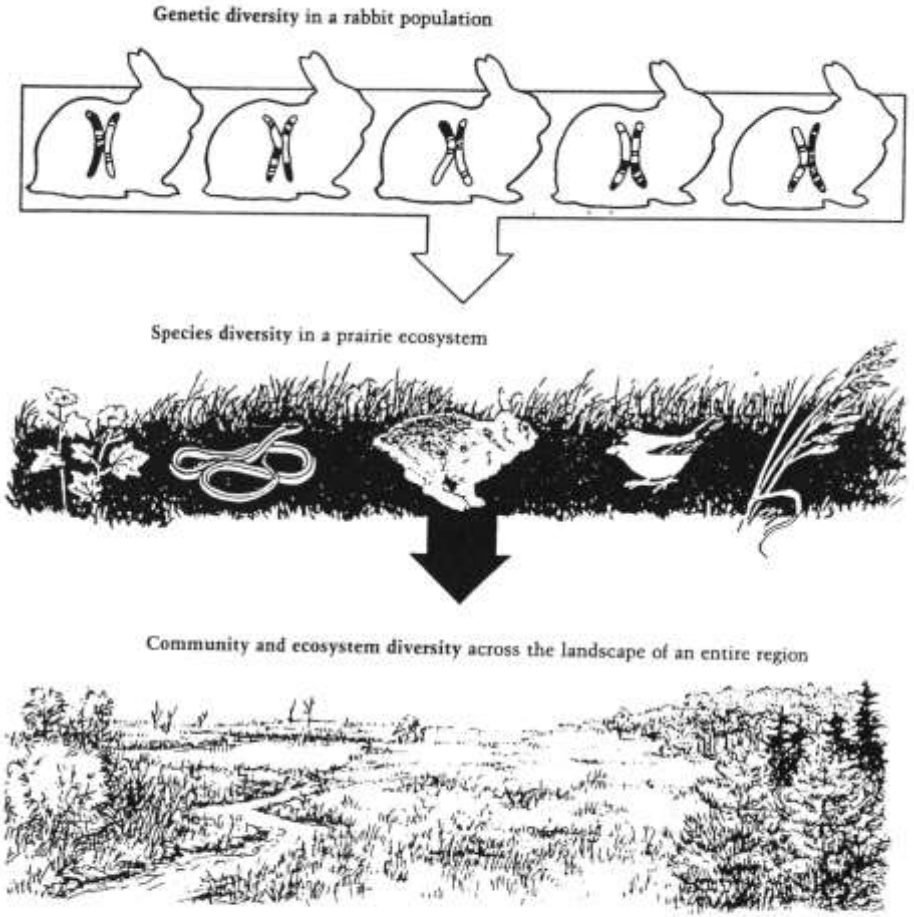


Level of Biological Diversity

- Genetic diversity

- Taxonomic diversity

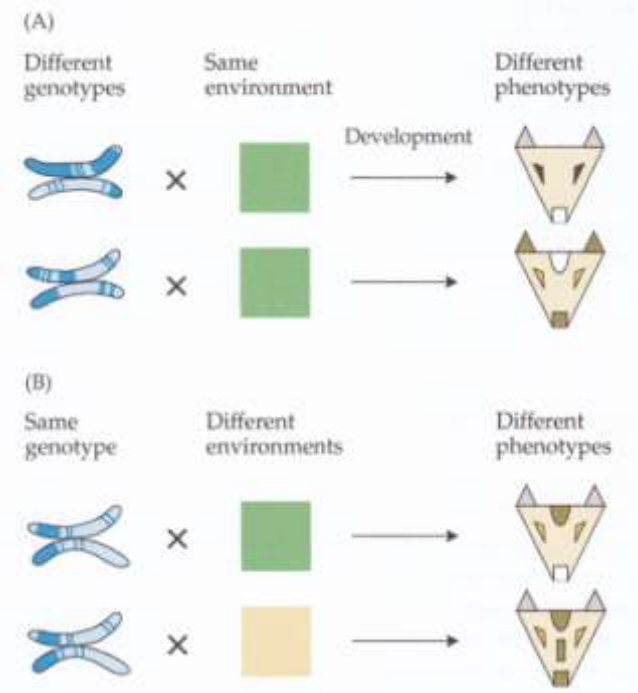
- Community diversity



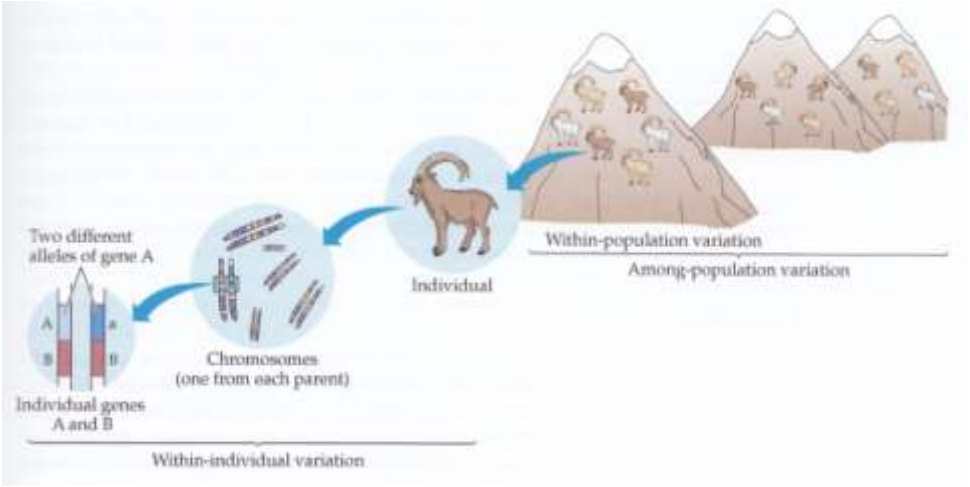
2.1 Biological diversity includes genetic diversity (the genetic variation found within each species), species diversity (the range of species in a given ecosystem), and community/ecosystem diversity (the variety of habitat types and ecosystem processes extending over a given region. (From Temple 1991; drawing by T. Sayre.)

Genetic diversity





- Among species (sibling species – Drosophila)
- Within species, among populations (e.g. dogs,)



Genetic diversity

Measurement

- Phenotypical diversity – e.g. isoensims
- Sequence of DNA

Polymorphism (P)

- Ratio of genes in the population with polymorphic allele

Heterozygousness (H)

The ratio of genes per individual that are polymorphic



Genetic diversity

Species genetic diversity(H_t)

$H_t=H_s+D_{st}$

H_s: Diversity within population

D_{st}: Diversity between populations

Polymorphism and heterozygousness has positive correlation

Diversity of taxonomic groups

Diversity of species, genus, family, order, class, phylum,,….

Number of species

Diversity index

Shannon-Wiener $$H = -\sum_{i-1}^{S} pi * \ln pi$$

ahol S: number of species, pi: frequency of the i-th species

Evenness

E= H/Hmax, H/lnS

There are several types of diversity index – Diversity ordering used nowadays

A

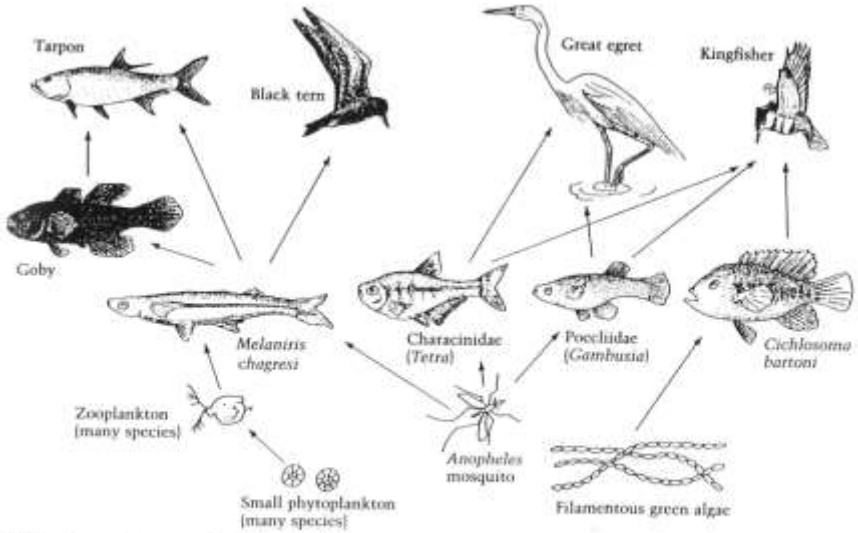
Species	Ni	pi (frequency)	ln pi	pi * ln pi	1/S	ln (1/S)	(1/S) * ln (1/S)
Great tit	13	0.406	-0.901	-0.366	0.143	-1.946	-0.278
Blue tit	8	0.250	-1.386	-0.347	0.143	-1.946	-0.278
Blackbird	4	0.125	-2.079	-0.260	0.143	-1.946	-0.278
Nuthatch	3	0.094	-2.367	-0.222	0.143	-1.946	-0.278
Great spotted woodpecker	2	0.063	-2.773	-0.173	0.143	-1.946	-0.278
Jay	1	0.031	-3.466	-0.108	0.143	-1.946	-0.278
Buzzard	1	0.031	-3.466	-0.108	0.143	-1.946	-0.278
S	**7**						
N	32						
H				**1.584**			
Hmax							1.946
E							**0.814**

B

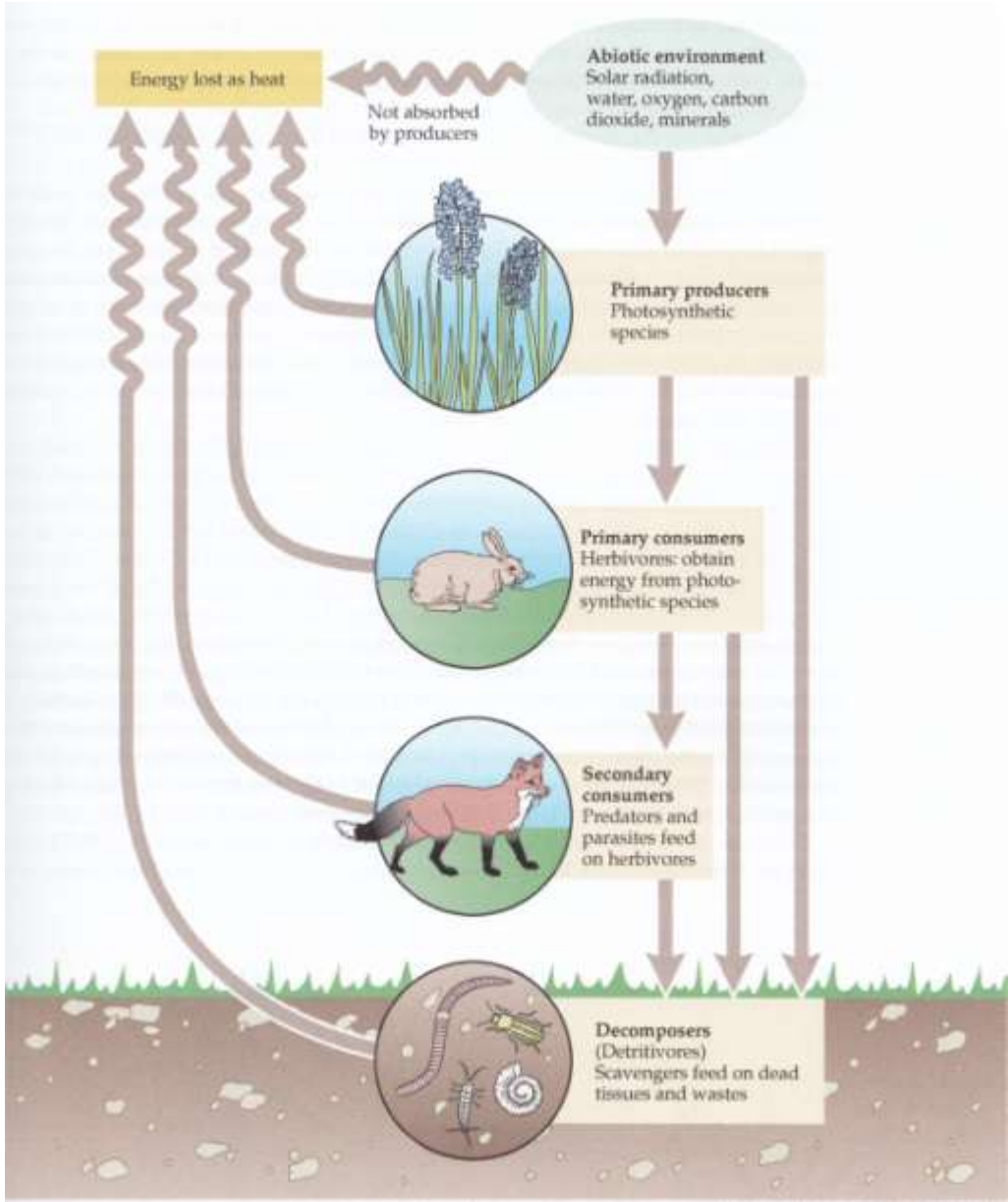
Species	Ni	pi (frequency)	ln pi	pi * ln pi	1/S	ln (1/S)	(1/S) * ln (1/S)
Great tit	20	0.625	-0.470	-0.294	0.143	-1.946	-0.278
Blue tit	5	0.156	-1.856	-0.290	0.143	-1.946	-0.278
Blackbird	3	0.094	-2.367	-0.222	0.143	-1.946	-0.278
Nuthatch	1	0.031	-3.466	-0.108	0.143	-1.946	-0.278
Great spotted woodpecker	1	0.031	-3.466	-0.108	0.143	-1.946	-0.278
Jay	1	0.031	-3.466	-0.108	0.143	-1.946	-0.278
Buzzard	1	0.031	-3.466	-0.108	0.143	-1.946	-0.278
S	**7**						
N	32						
H				**1.239**			
Hmax							1.946
E							**0.637**

Community ecosystem diversity

- Diversity of functional groups



2.9 Diagram of an actual food web studied in Gatun Lake, Panama. Phytoplankton ("floating plants") such as green algae are the primary producers at the base of the web. Zooplankton are tiny, often microscopic, floating animals; they are primary consumers, not photosynthesizers, but they, along with insects and algae, are crucial food sources for fish in aquatic ecosystems. (Courtesy of G. H. Orians.)



Community ecosystem diversity

- Diversity of habitats
- Diversity of habitat patches



Biodiversity

The importance of species varies in the nature

Naturalness – rarity - threateness

Keystone species

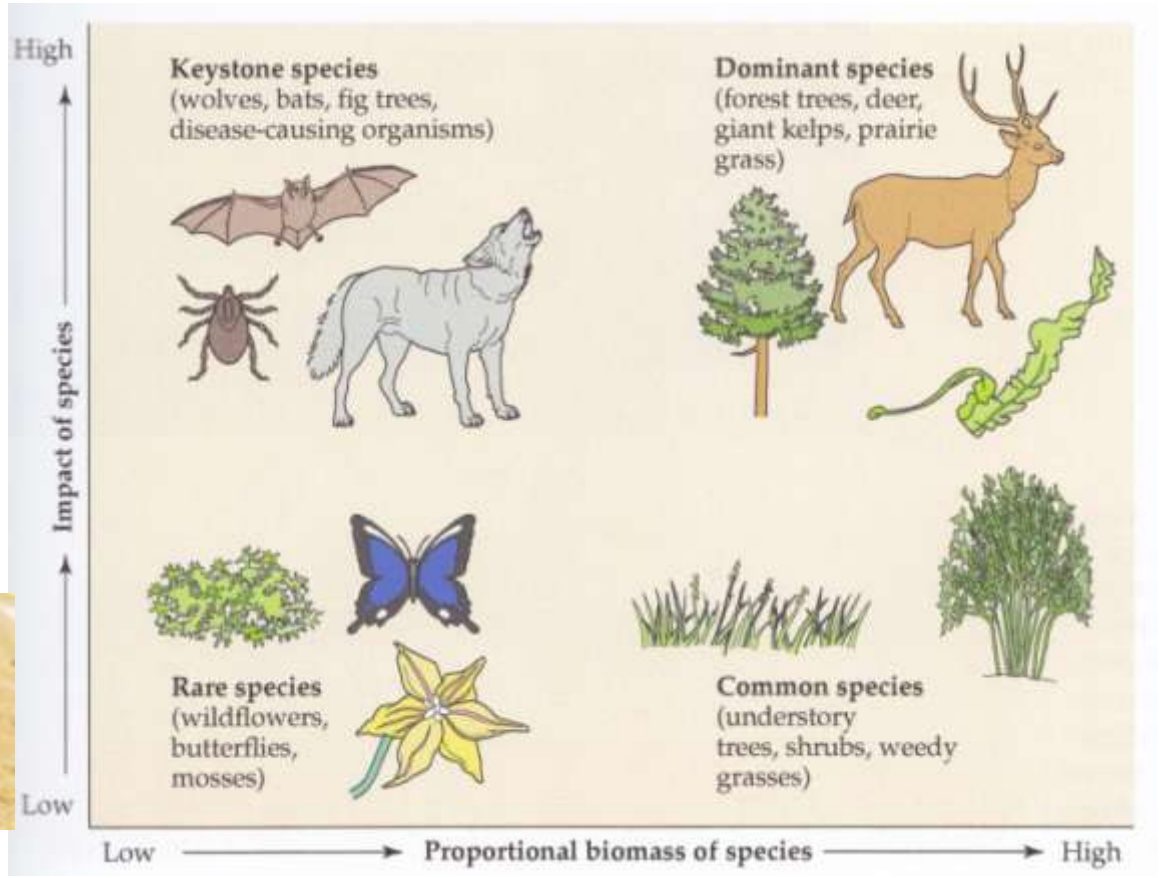
- Top predators– e.g. wolf

- Flying foxes

- Ecosystem engineers – beaver, elephant, dung beetles



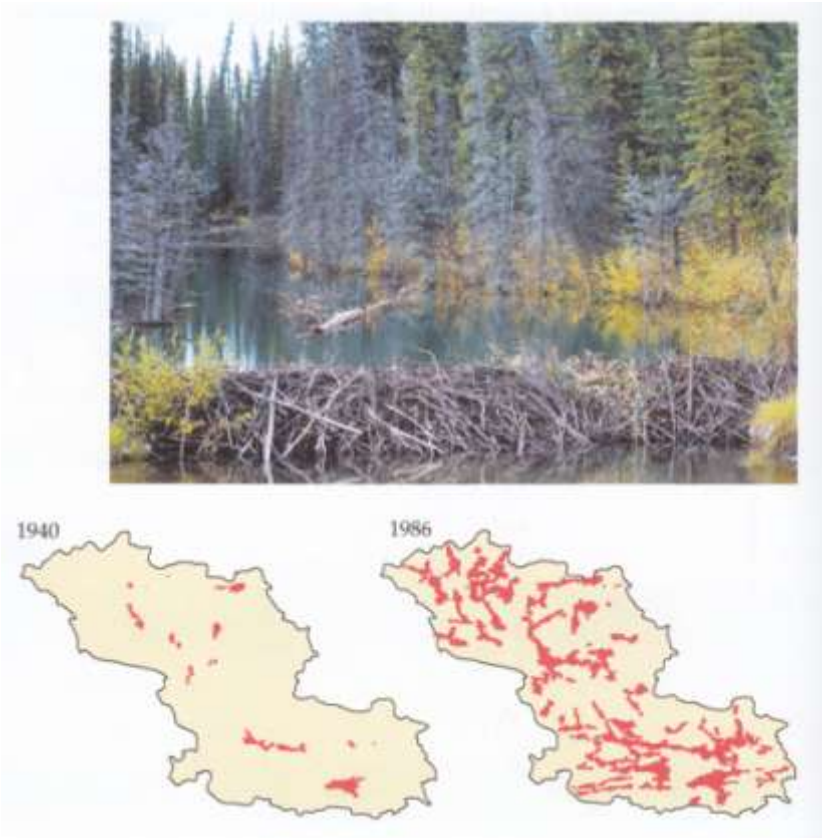




Ecosystem engineers

- Beavers







Ecosystem engineers

- Elephant















Keystone Resources

- Salt-licks and mineral pools
- Deep pools
- Elevational gradients
- Mangroves

Indicators

- Flagship species (Panda, Californian Condor)

http://wwf.panda.org/what_we_do/endangered_species/

- Umbrella species (e.g. Grizzly Bears)





Where is the World's Biodiversity found

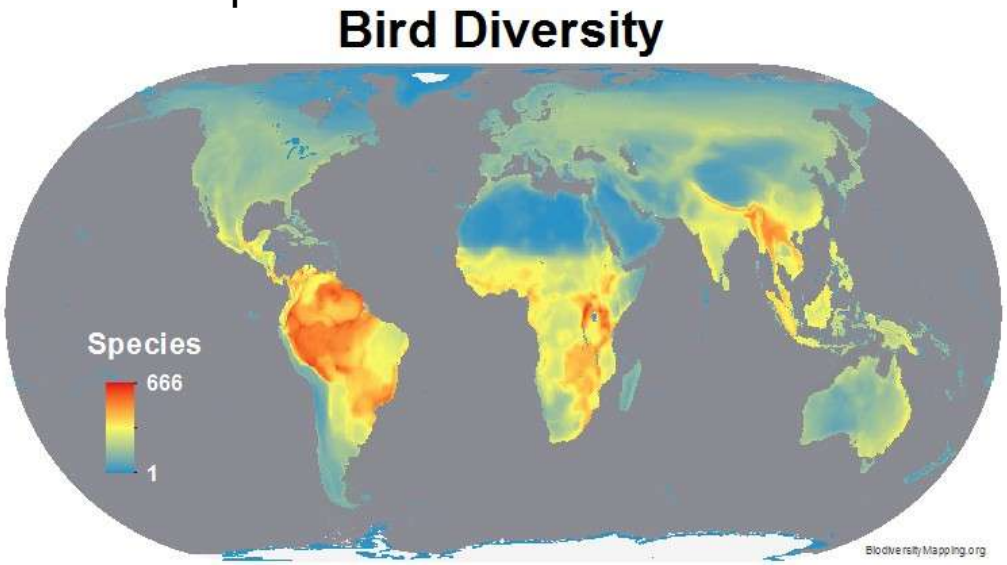
Biological diversity in the Earth

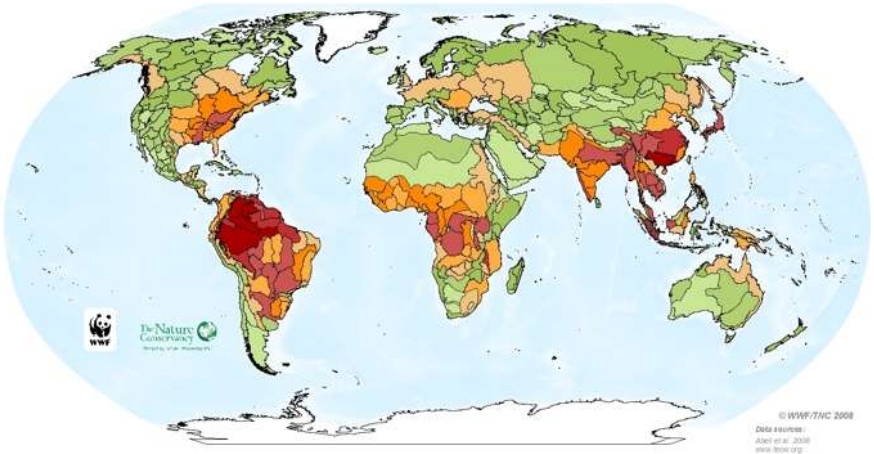
Bird

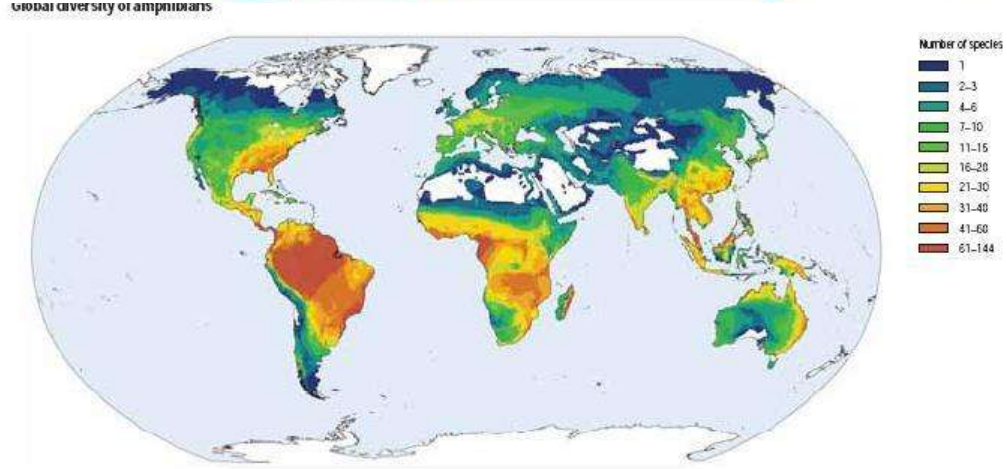
Fish

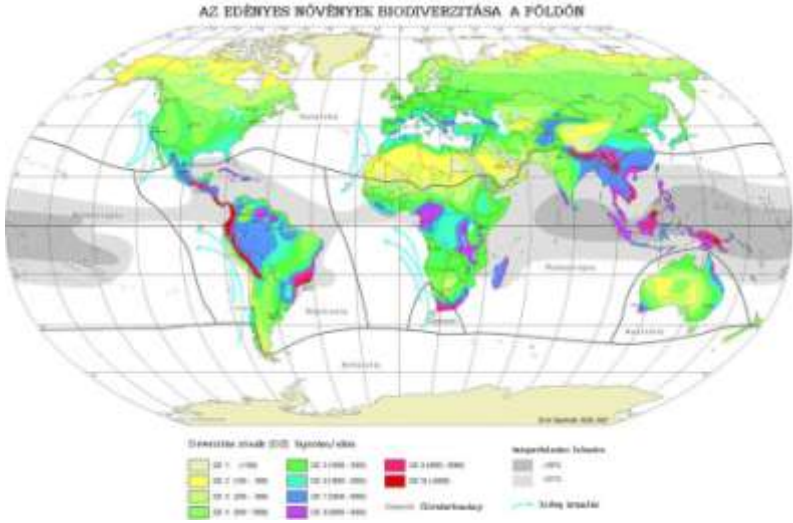
Amphibians

Vascular Plants









Source: GAA 2004

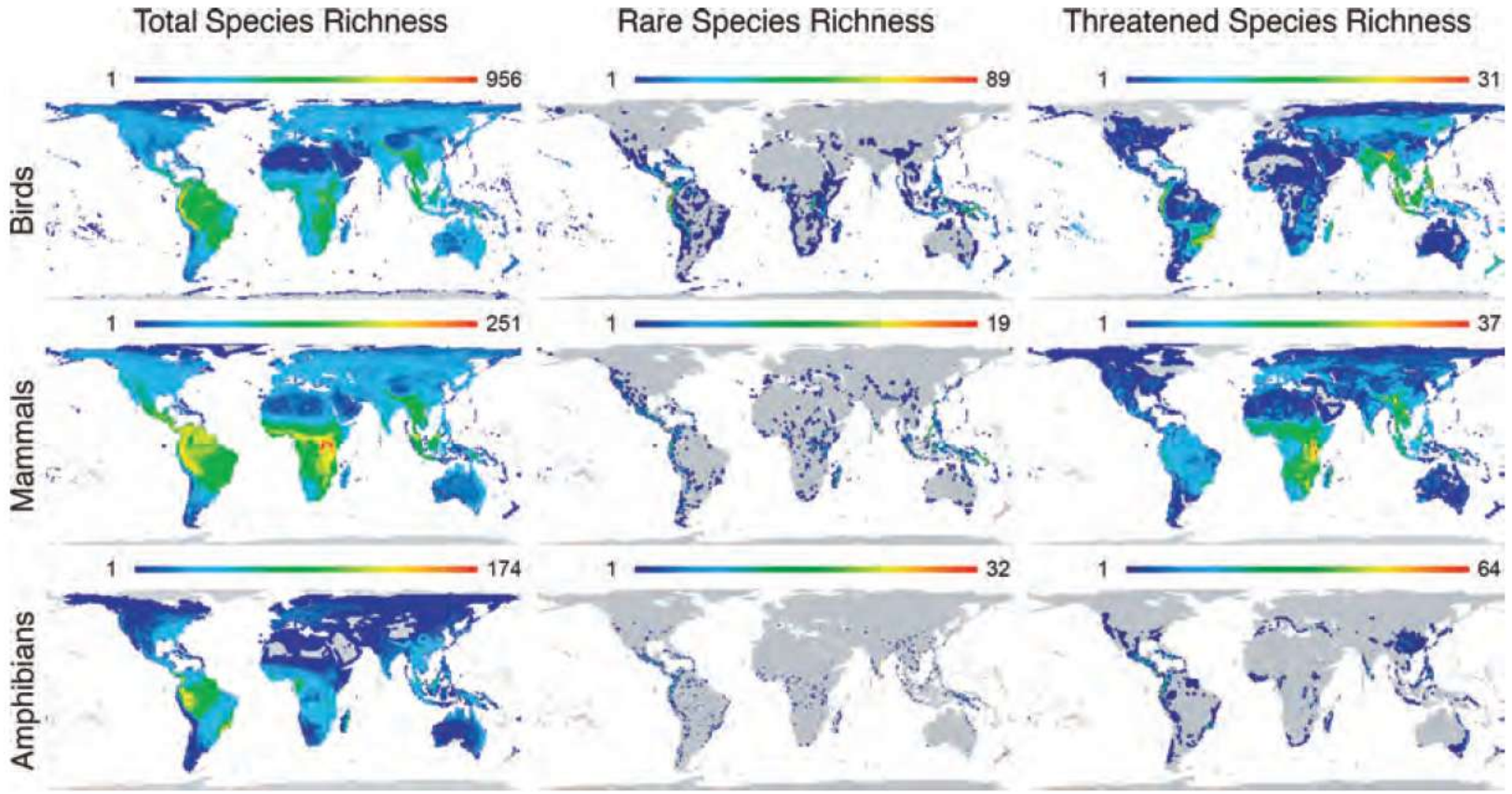
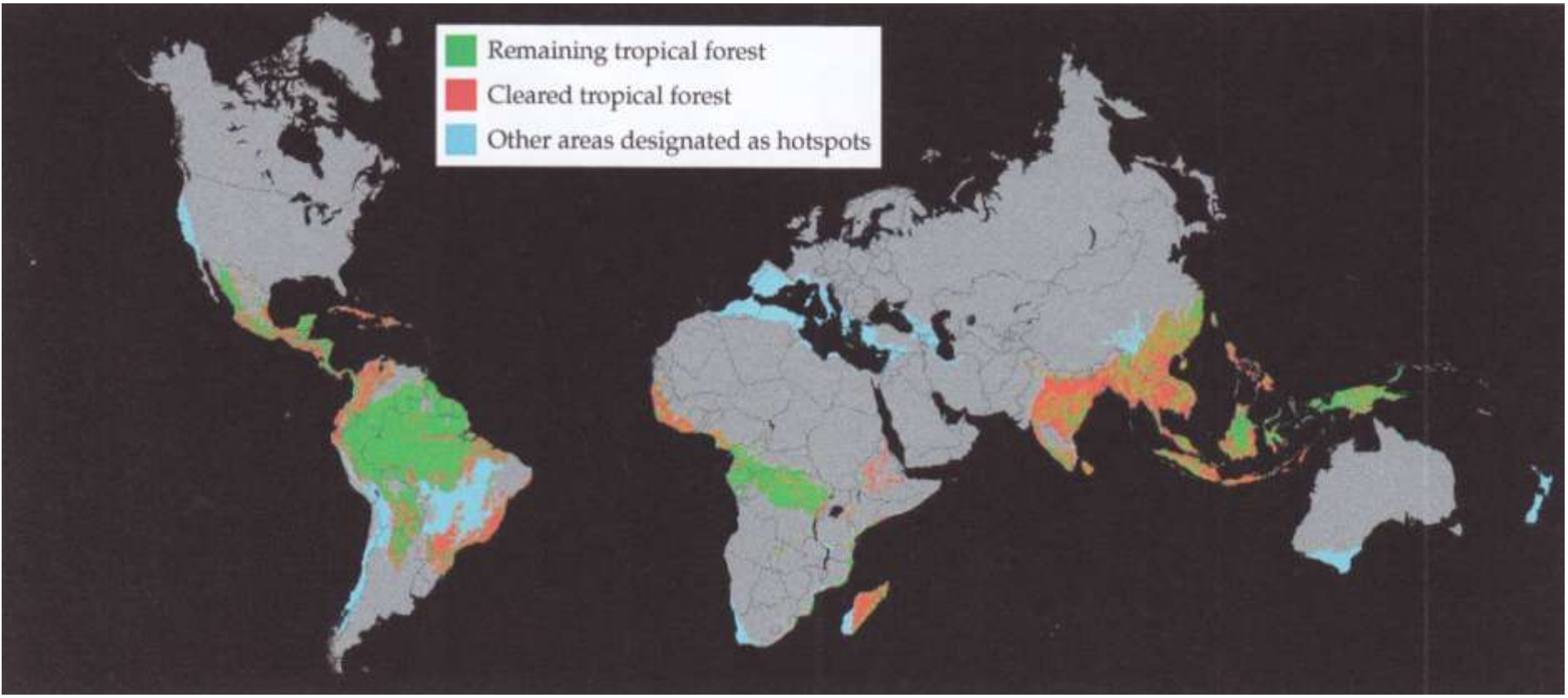


Figure 2.4 Global species richness patterns of birds, mammals, and amphibians, for total, rare (those in the lower quartile of range size for each group) and threatened (according to the IUCN criteria) species. Reprinted from Grenyer *et al.* (2006).

Biological diversity in the Earth

The most diverse areas:
- Tropical rainforests, very large number of insect species




Remaining tropical forest
Cleared tropical forest
Other areas designated as hotspots

Biological diversity in the Earth

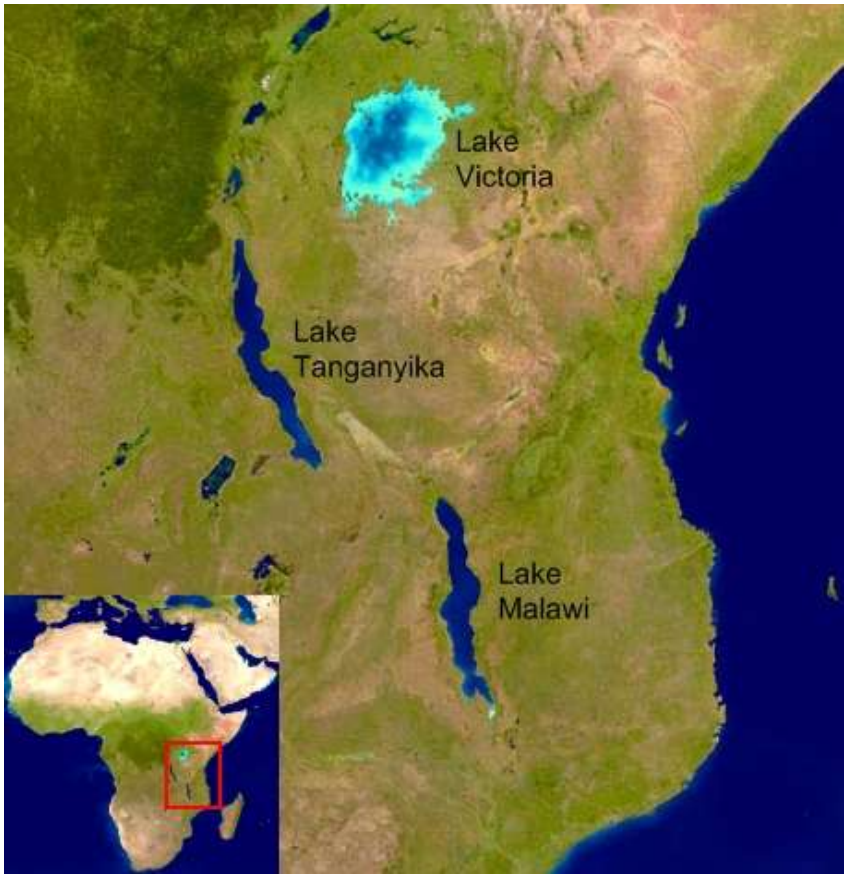
The most diverse areas:
- Coral reefs



Biological diversity in the Earth

The most diverse areas:

- Large tropical lakes, fast evolutionary radiation of fish and other species



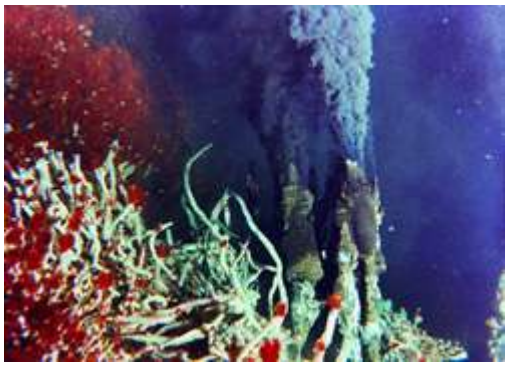


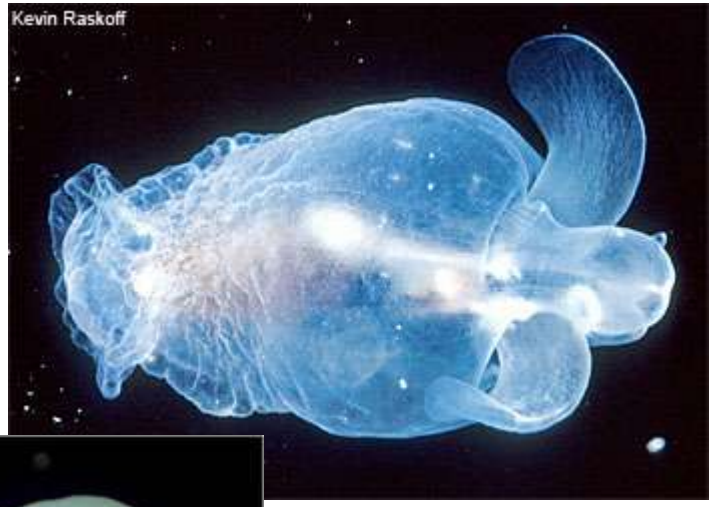


Biological diversity in the Earth

The most diverse areas:

- Deep seas, large and stable environment









Biological diversity in the Earth

The most diverse areas:

- Tropical and subtropical dry broadleaf forests, shrubs, meadow and semideserts
- Mediterranean forests, woodlands, and scrub



Biological diversity in the Earth

Information on the base of zoologist, botanist

Still limited information

In Panama, during one field project 80% of collected insect species were new for the science, this country is one of the most studied tropical area in the World

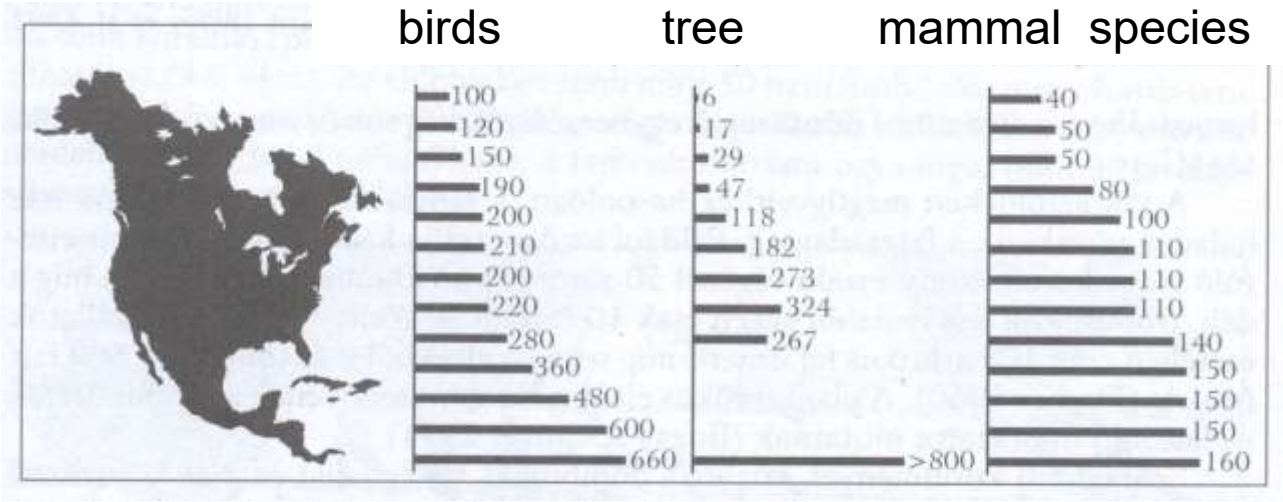


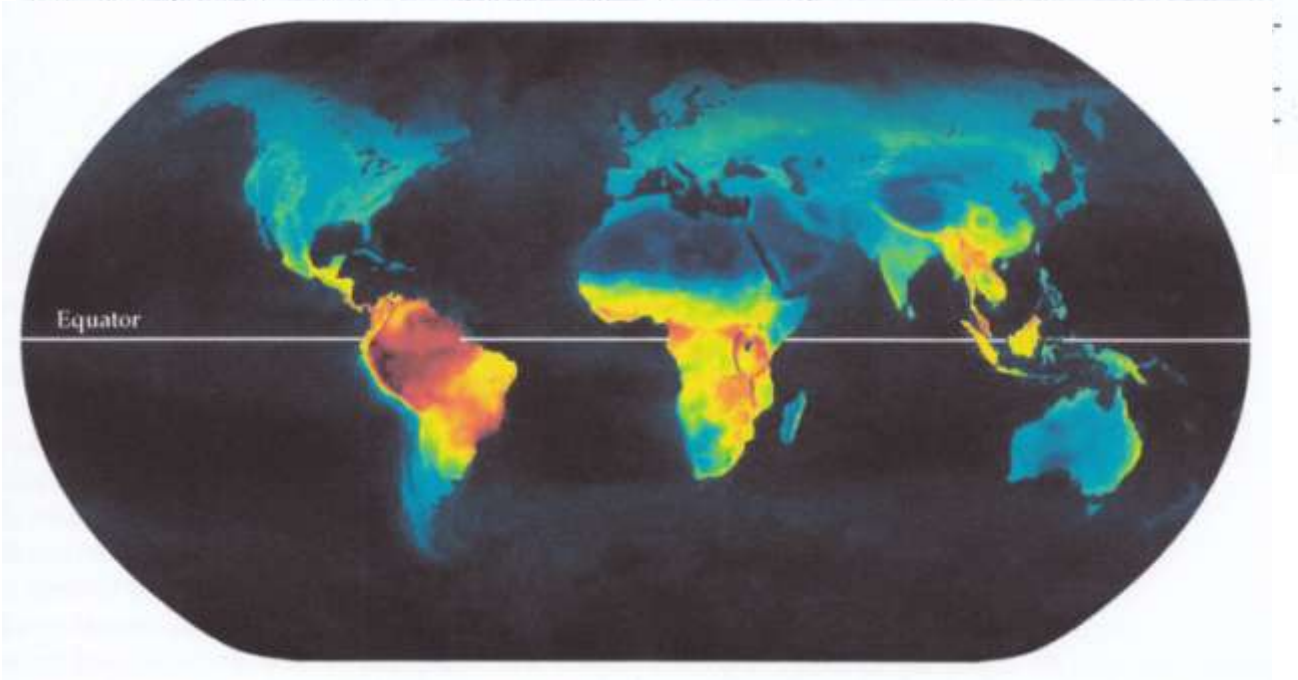




Biological diversity in the Earth

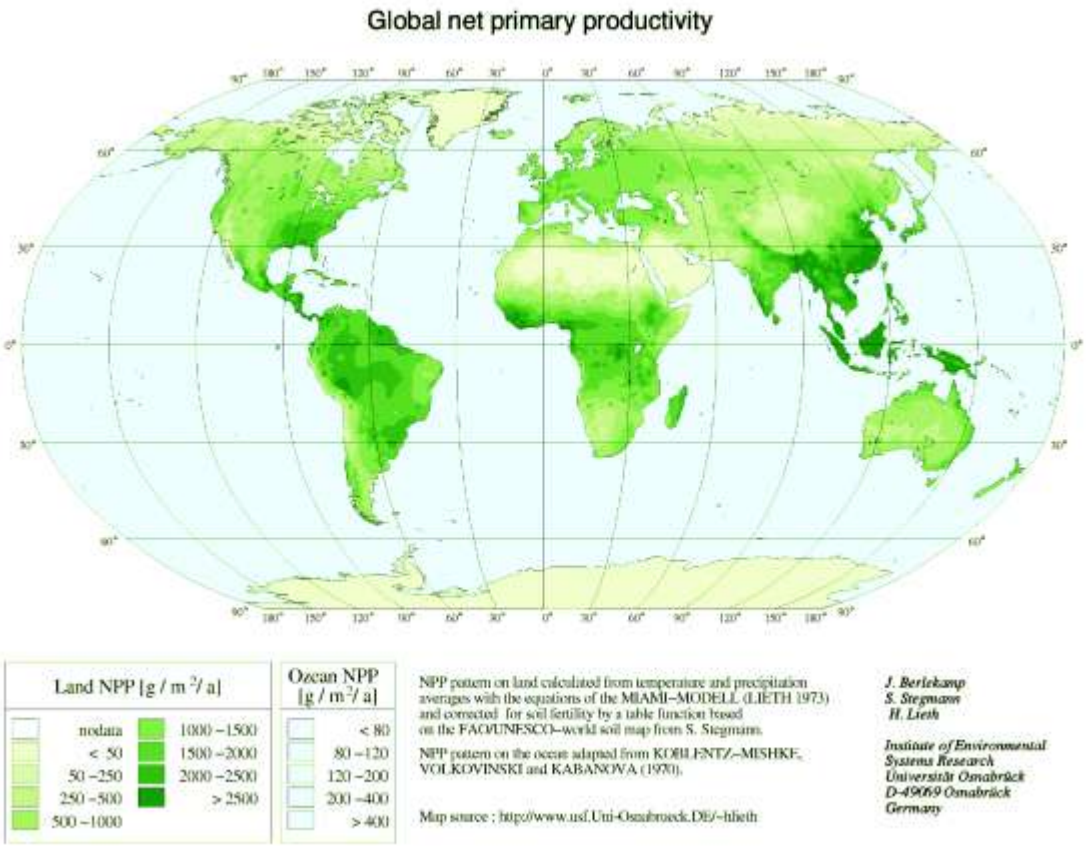
Species diversity increasing toward the equator





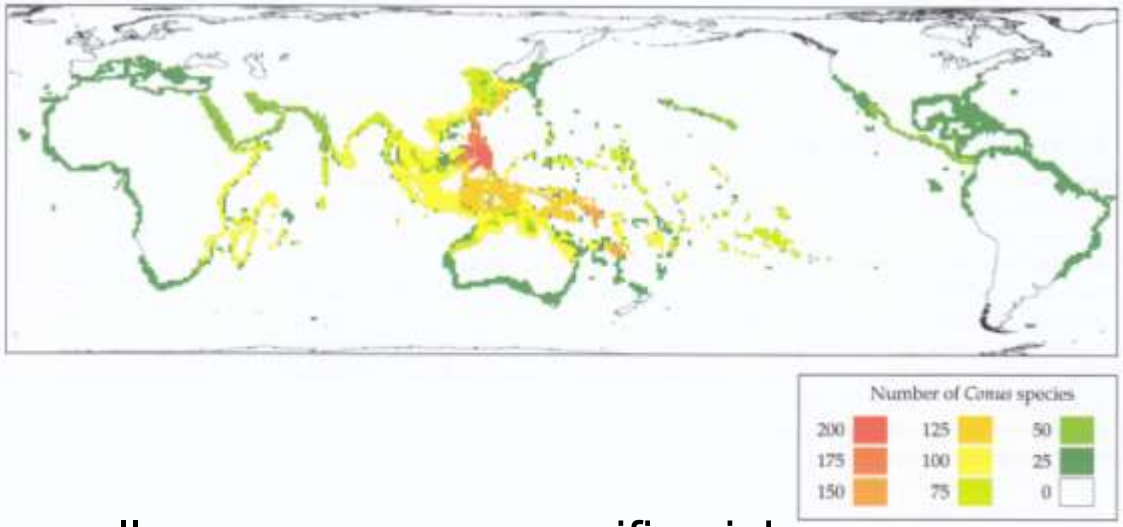
Why are there so many species in the tropics?

- High level of primary production



Why there is the largest biodiversity in the tropical areas?

- High level of primary production
- More time for speciation



- Rapoport-rule – species with smaller areas, more specific niche
- More stable climate than temperate regions – proper for speciation
- Largest effects of parasites and predators
- Low level of self fertilisation

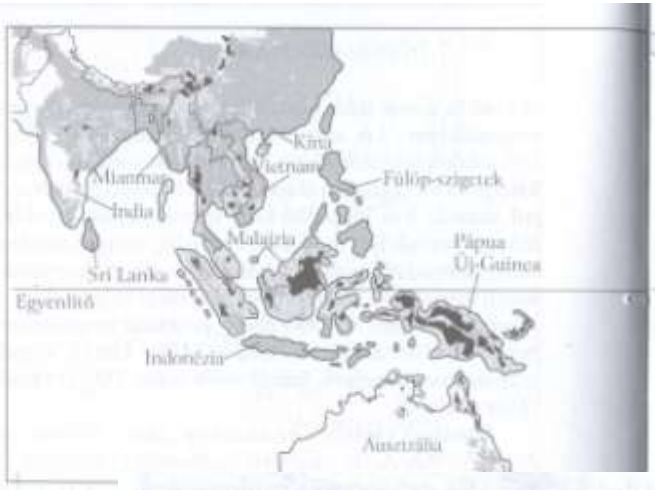
Tropical forests

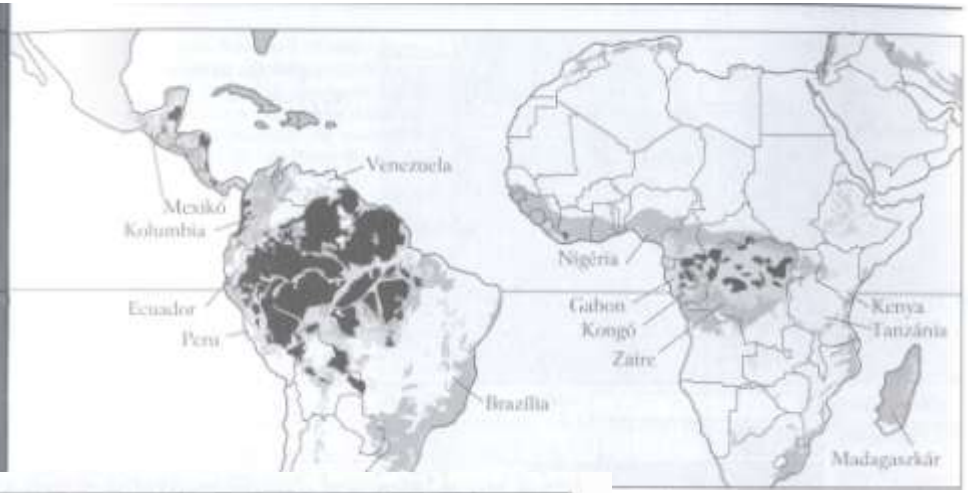
7%-of the Earth, 50% of known species. In the case of insects 90%, plants 66%, birds 30%. In tropical islands, 78% of non marine bird species

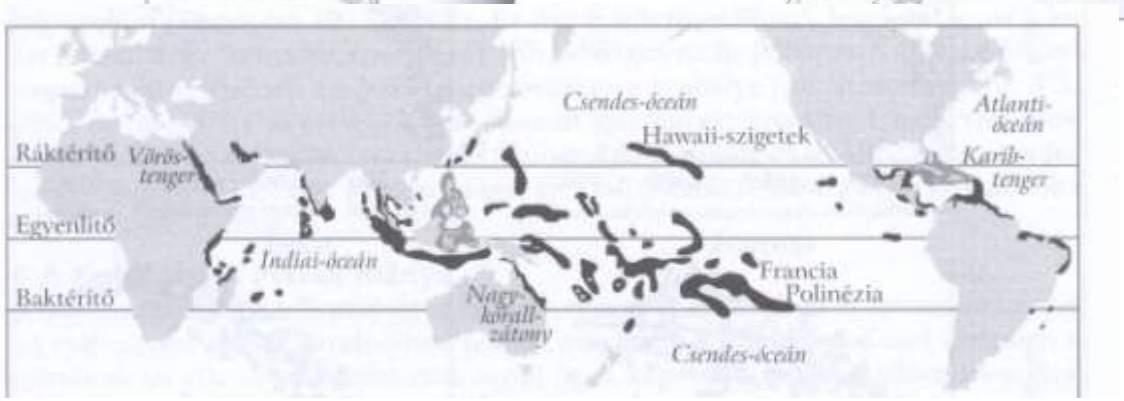
Coral reefs

High productivity 2500g/m^2/year, open waters: 125g m^2/year

Important regions with tropical forests



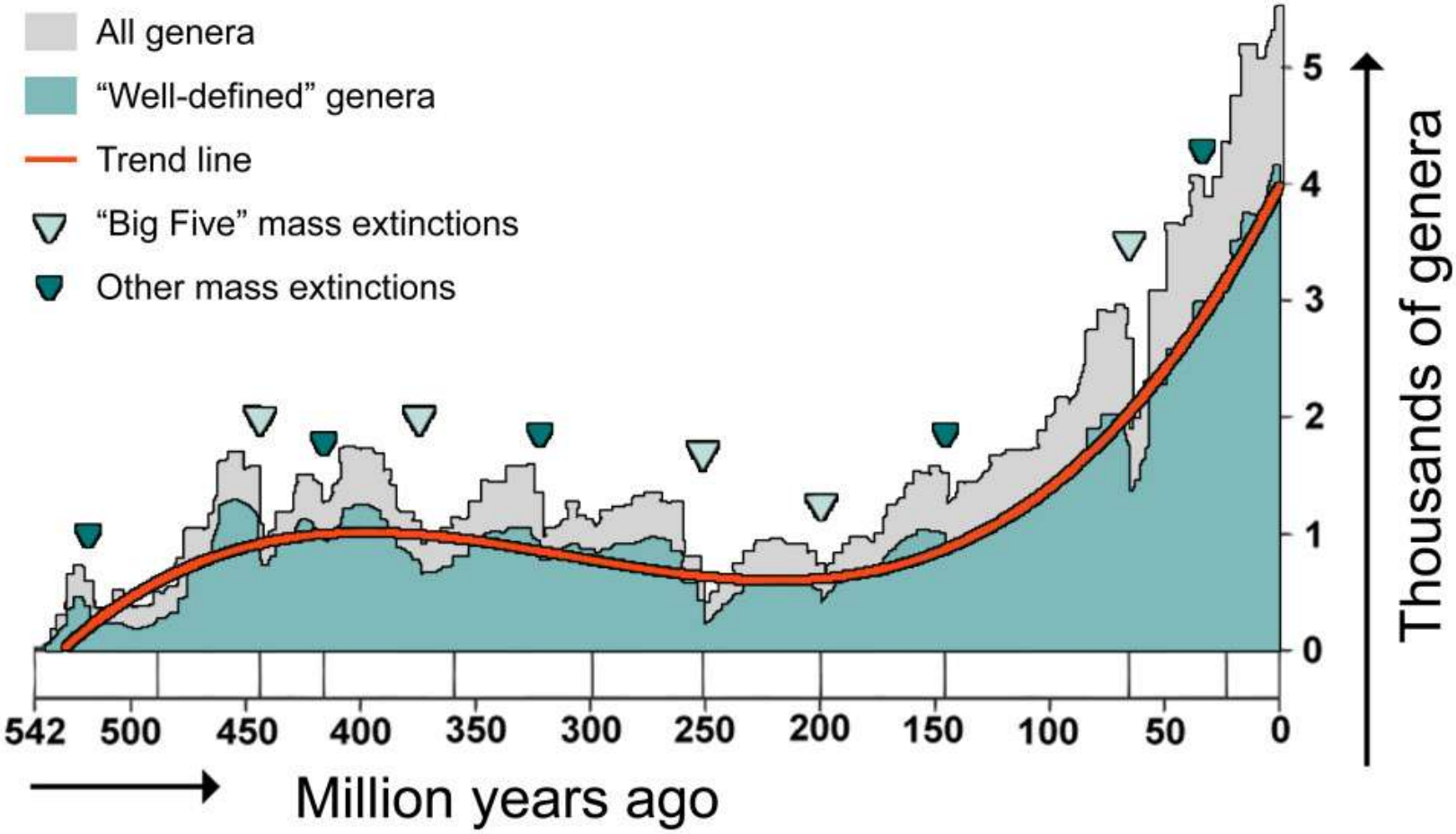




Distribution of coral reefs

How many species live in the Earth?

The most species lived until the spread of the human population



How many species live in the Earth?

- The science know ~2 000 000 species, but this number could be over 10 million

- Number of newly discovered non-vertebrate species growing annually with 1-2%

- The most numerous are the insects, 750,000 species known

- We only can estimate the number of species:

In one tropical tree species could have 600 specialist insect species – in the case of 50,000 tropical tree species could have 30 million insect species

In Europe, there are 6 times more fungi species than plant species, in the case of 270 000 plant species of the Earth it could be 1.7 million fungi species

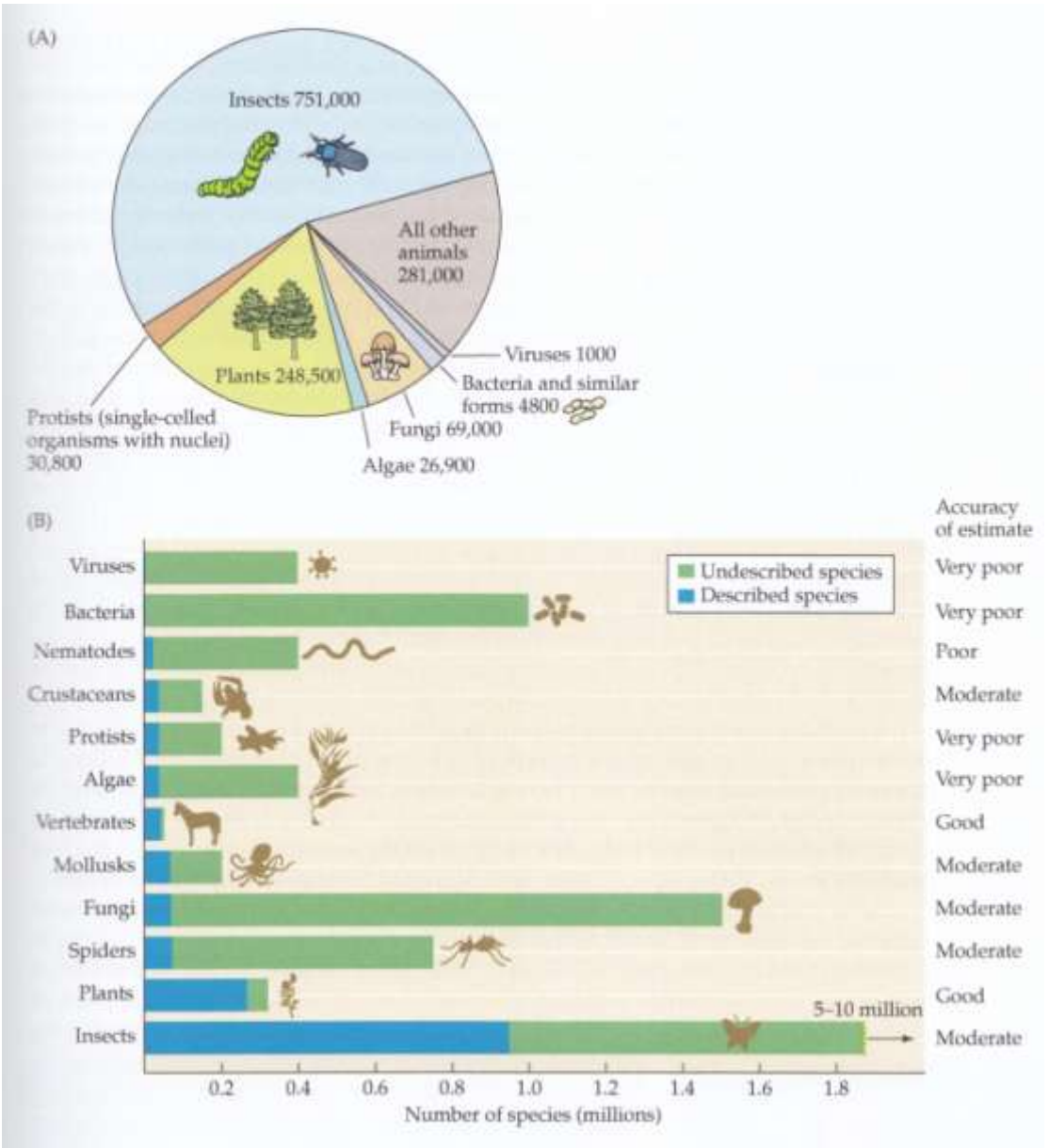
The number of virus, bacteria, unicellular and worm species could over one billion

- The number of species could be 25-150 million or 10^{12} but at least 10 million is very probable

How many species live in the Earth?

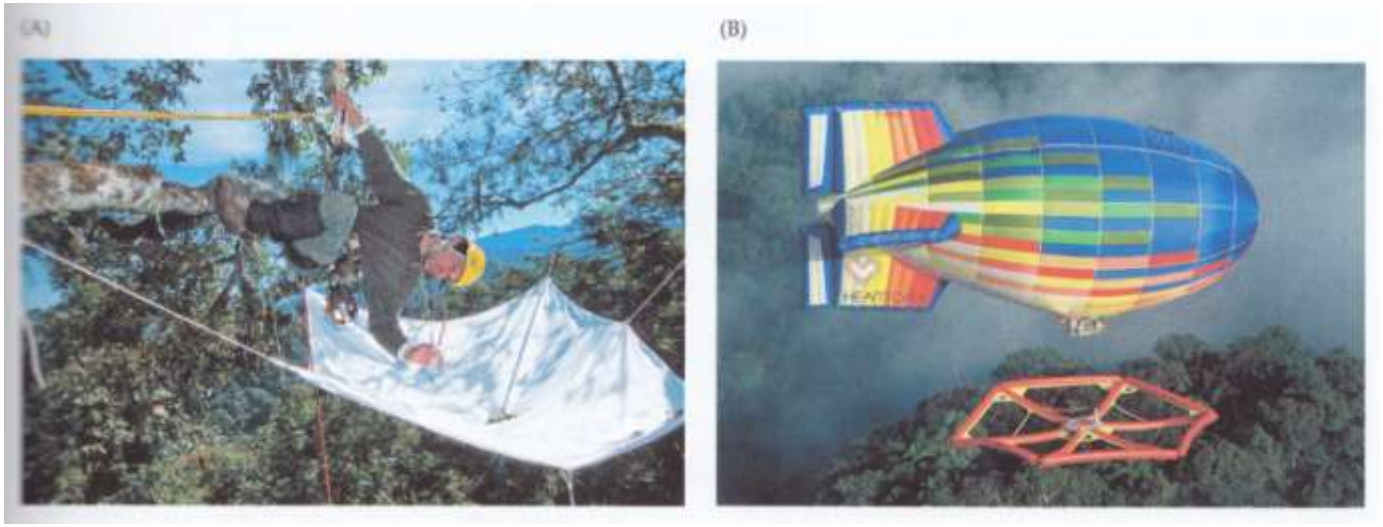
The science know ~2 000 000 species, but this number could be over 10 million

The most species are not known for the science



New discoveries using new methods

- Top layer of the tropical forest using cranes
- Deep water by robots
- Soil investigation in deep level



Problem of knowing species

- Remote areas
- Time and money intensive investigation
- Low number of experts for identification



Valuing Biodiversity. Ecosystem functions and services

Valuing Biodiversity

How much does protection cost?

How much is biodiversity worth?

Public perception – the value of something is determined by how much would be given for it

Traditional economic approaches tend to underestimate the value of natural resources.

Ecological Economics



- The causes are rooted in the economy – thus, the solution must also be found in this area.
- **Business** – based on reciprocity
  Problem – not only the participants in the business benefit from the costs and advantages

– **Externalities** – wastewater/garbage/natural values…
  Market failure – certain groups – benefits from resource use at the expense of society.

- Consideration of damages in cost-benefit calculations – e.g., oil refinery, water pollution.
- Natural values are public resources – regarded as little or no value –
- The tragedy of the commons.
  SOLUTION, VALUE MUST BE ASSIGNED!

The Tragedy of the Commons

There is a common pasture that can sustainably support ten cows, where each cow produces ten liters of milk per day.

One farmer suddenly decides to add another cow to the pasture. As a result, each cow gets less grass, so instead of 10 liters, each produces only 9 liters of milk per day.

However, the farmer who grazes two cows now receives 18 liters of milk instead of 10.

Eventually, another farmer notices this and also adds another cow to the common pasture. Now each cow produces only 8 liters of milk, but the two farmers with extra cows each get 16 liters.

Every farmer benefits from adding another cow to the pasture.

However, once at least six farmers do this, even those with two cows will receive less than the original 10 liters of milk.

Finally, when eight farmers graze two cows, those farmers will only receive four liters of milk compared to the original ten.

(The ninth farmer would gain nothing by adding a second cow.)

Despite this, if a farmer decided to withdraw one of their cows, they would still be at a disadvantage.

https://www.youtube.com/watch?v=jSuETYEgY68

The Tragedy of the Commons

Solution (?!)

(1) How can we prevent group members from engaging in competitive behavior that serves their own short-term interests but threatens the group's well-being through environmental problems?

(2) How can we promote cooperative behavior that serves the group's well-being and takes long-term considerations into account?

- Small community, non-governmental social processes
- Laws, regulations, and incentives
- Changing values and worldview
- Education (changing attitudes and informing about action possibilities)

Cost-Benefit Analysis

TABLE 4.1 | Cost-Benefit Analysis of Three Development Options in Bacuit Bay, Palawan, Philippines

Development option	Amount of revenue[a] generated by			Total revenue
	Tourism	Fisheries	Logging	
Option 1: Intensive logging until timber depleted[b]	$6	$9	$10	$25
Option 2: Logging banned; protected area established[c]	$25	$17	$0	$42
Option 3: Sustainable logging[d]	$24	$16	$4	$44

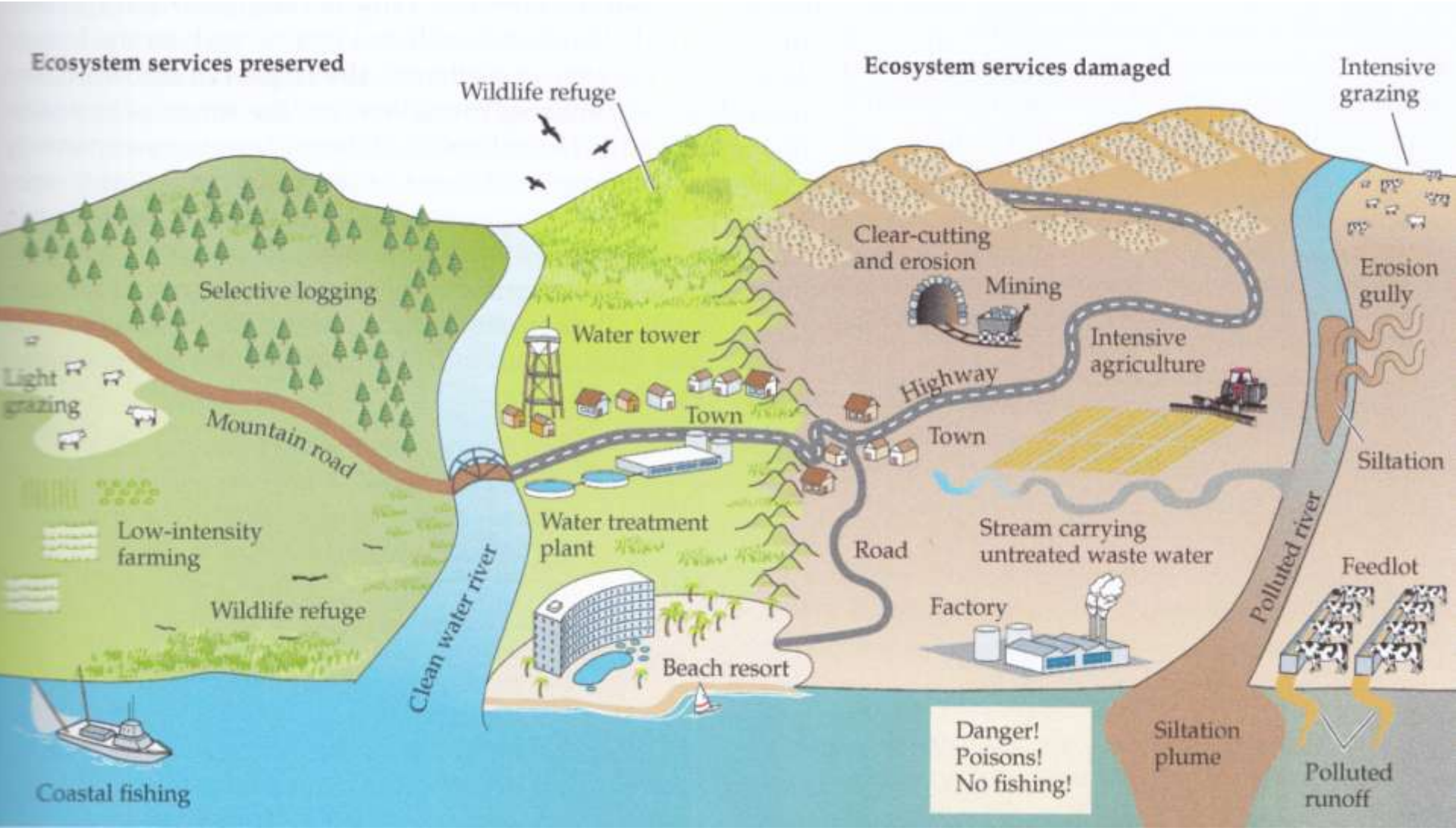
Source: Hodgson and Dixon 1988.

[a]Revenues are in millions of dollars over a 10-year period.

[b]In this option, intensive logging substantially decreases the revenues from tourism and fisheries. Timber is completely depleted after 5 years.

[c]In this option, tourism and fisheries are major sustainable industries; no logging.

[d]In this option, logging is allowed to proceed in an environmentally responsible manner. A buffer of trees is maintained near wetlands and streams, logging does not occur on steep slopes, construction of logging roads is minimized, and hunting is banned. There is minimal impact on fisheries and tourism, and the overall economic benefits are enhanced. (Real-life logging practices are rarely as benign as portrayed here.)


Ecosystem services preserved
Wildlife refuge
Ecosystem services damaged
Intensive grazing
Clear-cutting and erosion
Mining
Erosion gully
Selective logging
Water tower
Intensive agriculture
Highway
Light grazing
Mountain road
Town
Town
Siltation
Water treatment plant
Road
Stream carrying untreated waste water
Low-intensity farming
Polluted river
Feedlot
Wildlife refuge
Clean water river
Factory
Beach resort
Danger! Poisons! No fishing!
Siltation plume
Polluted runoff
Coastal fishing

Natural Resource and Wealth of Societes



Costa Rica:

In 1980, the value of the forests cut down was greater than the amount they received for the sold wood, and soil erosion reduced agricultural performance by 9%.

USA: Soil erosion causes $44 billion in damage annually.

Exxon Valdez disaster, 1989: 42 million liters of oil spilled.Billions spent on cleanup – GDP increased, but the environmental damage is unknown.-
https://www.youtube.com/watch?v=CVm1pB3iJQw
https://www.youtube.com/watch?v=UsBYe68PH







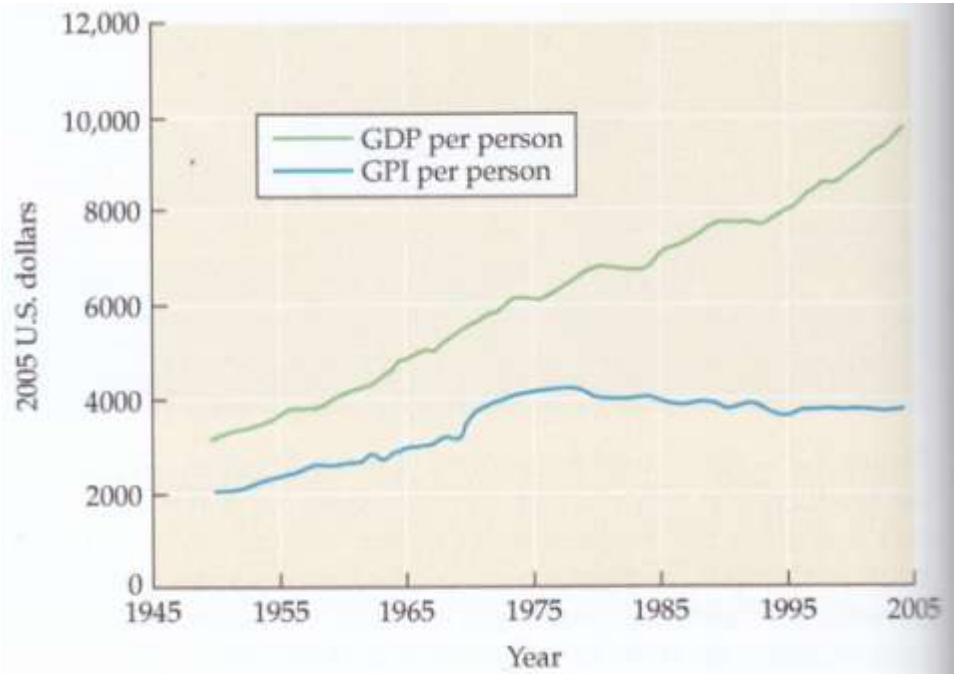


Natural Resource and Wealth of Societes

ISEW – Index of Sustainable Economic Welfare

Considerations, for example: loss of agricultural land, filling of wetlands, environmental pollution, and its impacts on human health.

GPI – Genuie Progress Indicator



Natural Resource and Wealth of Societes

ISEW – Index of Sustainable Economic Welfare

Considerations, for example: loss of agricultural land, filling of wetlands, environmental pollution, and its impacts on human health.

GPI – Genuie Progress Indicator

Can everything be assigned a value?

How can the value of a beautiful landscape be measured?

A breeding ground for corruption.

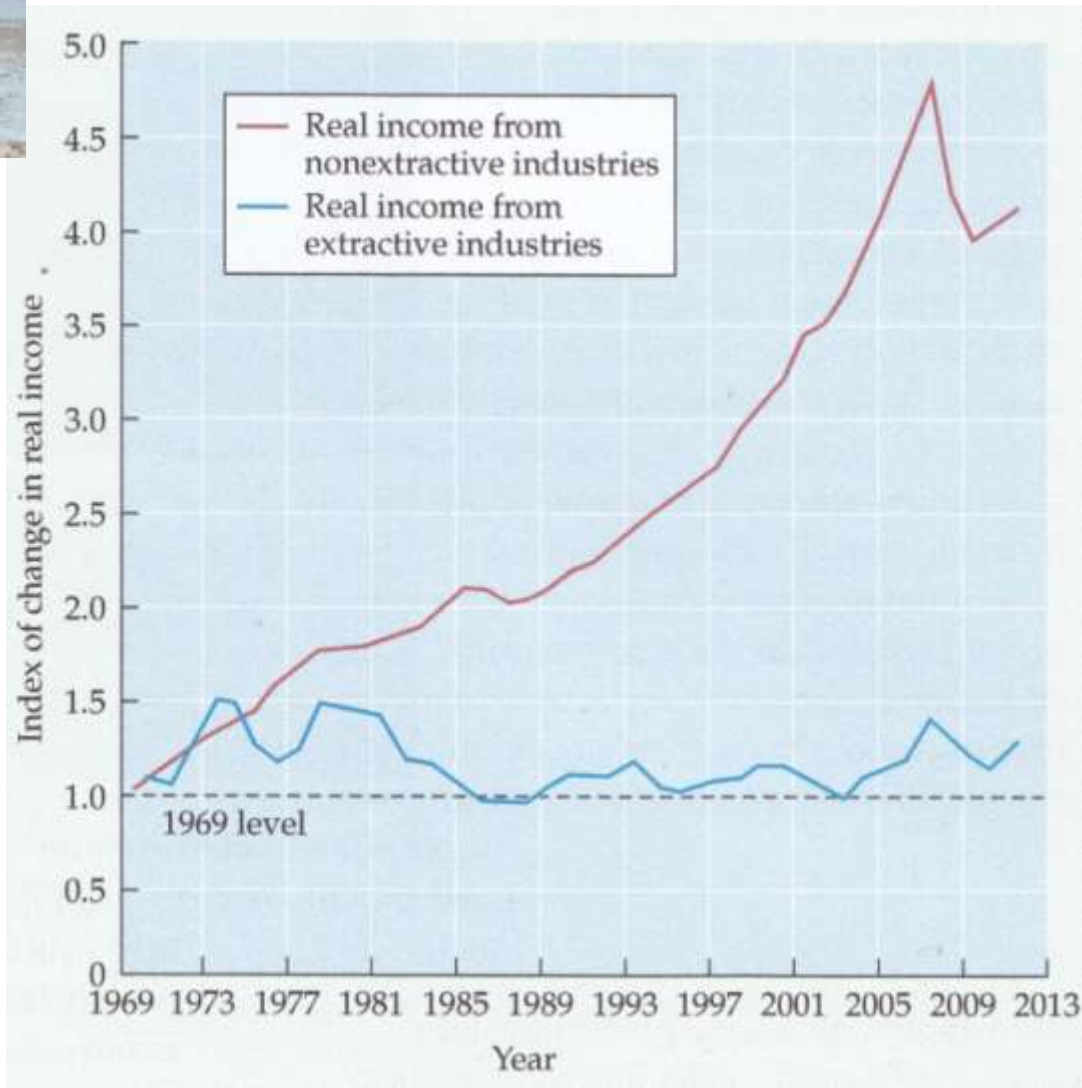
- Direct use values (private goods)
- Indirect use values (public goods)
- Potential value
- Existence value



Economic values of Natural resources

In the Yellowstone region (USA), traditional "productive" business activities (mining, logging, agriculture) are extractive,while ecotourism and related business activities are

By 2011, traditional business activities accounted for only 9% of the region's revenue.



How much is a species worth?

A new lily species on a 25-hectare area:

It has no known value to humans, so no spending is needed ($0).

The value of the species is proportional to the cost of the land ensuring its survival. Existence value: $4,000/ha -> $100,000.

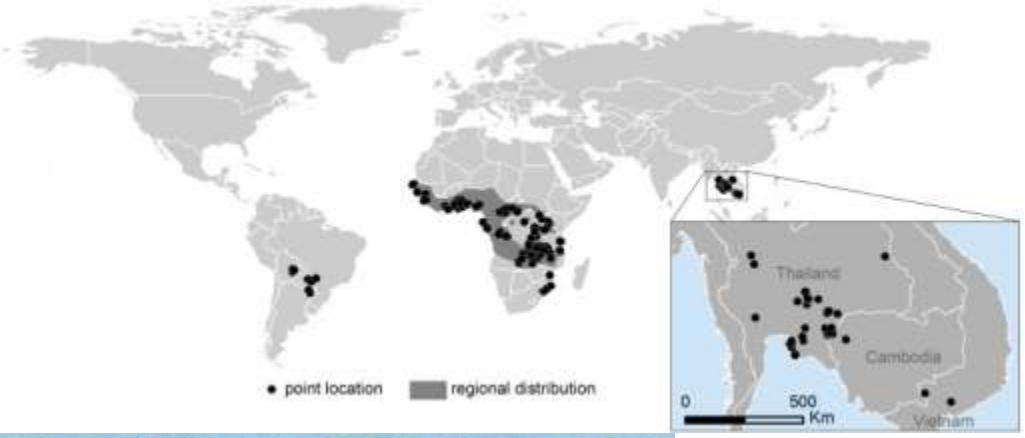
A local gardener would pay for exclusive rights to cultivate 10% of the seeds and sell them over five years. Producer value: $5,000/year -> $25,000/5 years.

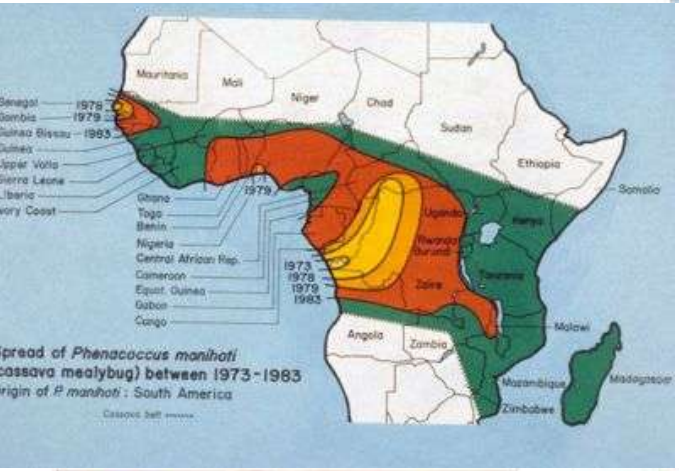
On average, 200 botanists and nature lovers visit the site annually to see the plant, spending $80 locally on food, accommodation, and services. Ecotourism value: 200 * $80 -> $16,000/year -> $80,000/5 years.

In the last 10 years, products worth $100 billion were derived from 250,000 plant species. One plant species can potentially generate a value of $400,000. Potential value: $400,000.

This plant species may be capable of producing a substance that offers enormous benefits to humanity. Estimated value: $100 trillion or infinitely high value.

cassava beetle









(ก) *Phenacoccus manihoti* Matile-Ferrero



(ข) *Anagyrus lopezi*

Cassava (manioc) root

Introduced to Africa

Main daily calorie source for 200 million people

The larger grain borer (cassava beetle) was accidentally introduced

Reduces cassava yields by 80-90%

Pesticides did not help

Spread rate: 300 km/year

After a long search, the parasitoid wasp species Aponagyrus lopezi was found in Paraguay. It lays its eggs in the eggs of the larger grain borer, and the larvae destroy the pest.

It only reproduces in this beetle

Damage caused by the beetle was reduced by 95%

A small insect species with infinite value!







Direct use value (private goods)

Consumer use value – consumed locally

– wild meat (40% of protein intake in Botswana, 80% in Congo), medicine (used by 80% of the world's population, more than 5,000 species in China), firewood.

Producer use value – in the market – (firewood, timber, fish and marine animals, medicinal plants, wild fruits, wild meat, furs, etc.).

For example, the cascara bush: purchase price is $1 million, but the selling price of the medicine (laxative) is $75 million.4.5% of the USA's GDP comes from this ($720 billion in 2012).

Amazonia – in the long run, it is more beneficial to collect fruit and raw rubber than to cut trees or raise cattle ($6,330/ha vs. $490/ha).

Breeding animals, plantsBiological pest control – e.g., larger grain borer (cassava beetle)

Medicines – Madagascar periwinkle – against leukemia and blood cancers, increased survival chances from 10% to 90% – patent royalties.

TABLE 4.2 | Twenty Drugs from the Plant World First Discovered in Traditional Medical Practice

Drug	Medical use	Plant source	Common name
Ajmaline	Treats heart arrhythmia	*Rauwolfia* spp.	Rauwolfia
Aspirin	Analgesic, anti-inflammatory	*Spiraea ulmaria*	Meadowsweet
Atropine	Dilates eyes during examination	*Atropa belladonna*	Belladonna
Caffeine	Stimulant	*Camellia sinensis*	Tea plant
Cocaine	Ophthalmic analgesic	*Erythroxylum coca*	Coca plant
Codeine	Analgesic, antitussive	*Papaver somniferum*	Opium poppy
Digitoxin	Cardiac stimulant	*Digitalis purpurea*	Foxglove
Ephedrine	Bronchodilator	*Ephedra sinica*	Ephedra plant
Ipecac	Emetic	*Cephaelis ipecachuanha*	Ipecac plant
Morphine	Analgesic	*Papaver somniferum*	Opium poppy
Pseudoephedrine	Decongestant	*Ephedra sinica*	Ephedra plant
Quinine	Antimalarial prophylactic	*Cinchona pubescens*	Chinchona
Reserpine	Treats hypertension	*Rauwolfia serpentina*	Rauwolfia
Sennoside A, B	Laxative	*Cassia angustifolia*	Senna
Scopolamine	Treats motion sickness	*Datura stramonium*	Thorn apple
THC	Antiemetic	*Cannabis sativa*	Marijuana
Toxiferine	Relaxes muscles during surgery	*Strychnos guianensis*	Strychnos plant
Tubocurarine	Muscle relaxant	*Chondrodendron tomentosum*	Curare
Vincristine	Treats pediatric leukemia	*Catharanthus roseus*	Rose periwinkle
Warfarin	Anticoagulant	*Melilotus* spp.	Sweet clover

Sources (A)



(B)





Indirect Use Values – Environmental Processes and Ecosystem Services

– Public goods – benefits without the need for harvesting

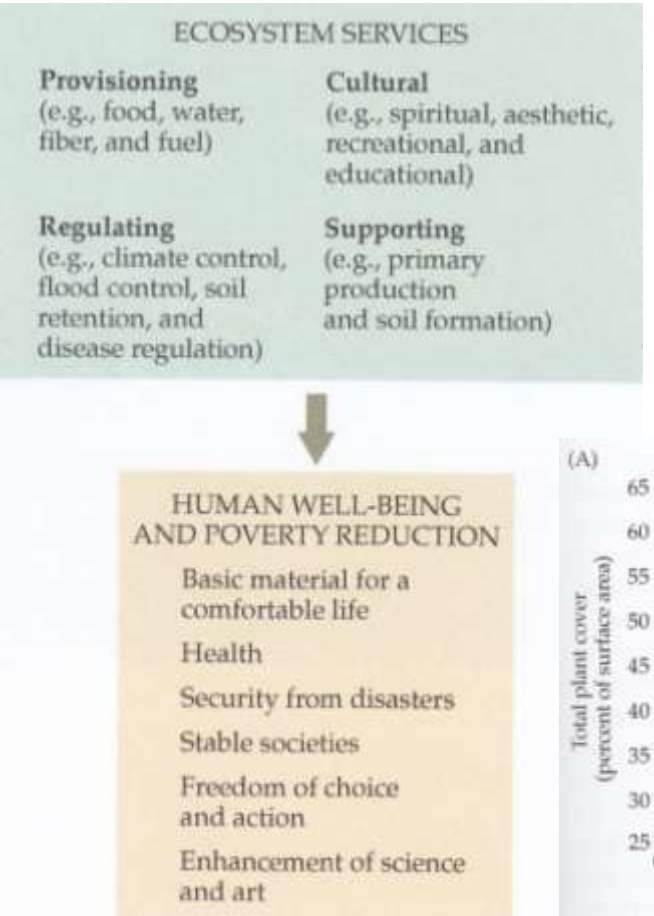
An estimated value of $72 trillion per year (2013), greater than the world's annual aggregated GDP

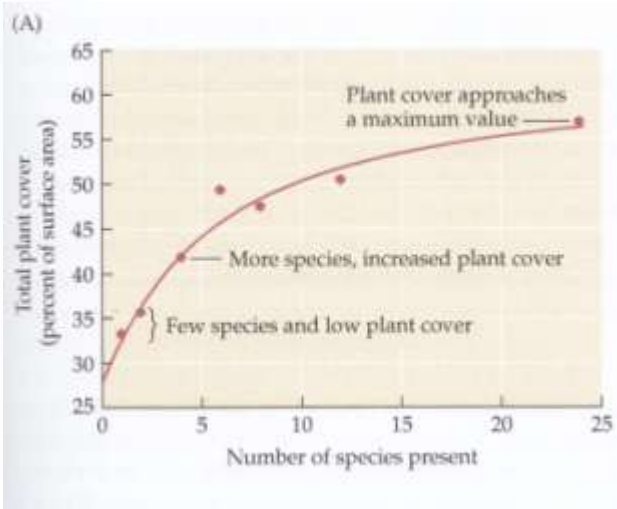
e.g., Forests – erosion protection, Wetlands – water purification

- Non-consumptive use value – pollinating insects, water purification, CO_2 sequestration











Indirect Use Values

Productivity

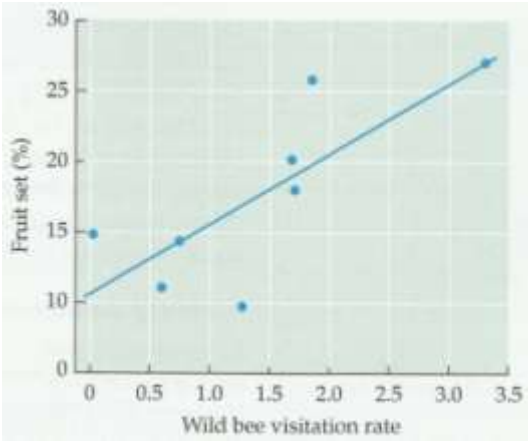
Water and soil protection

Climate

Waste management

Species relationships

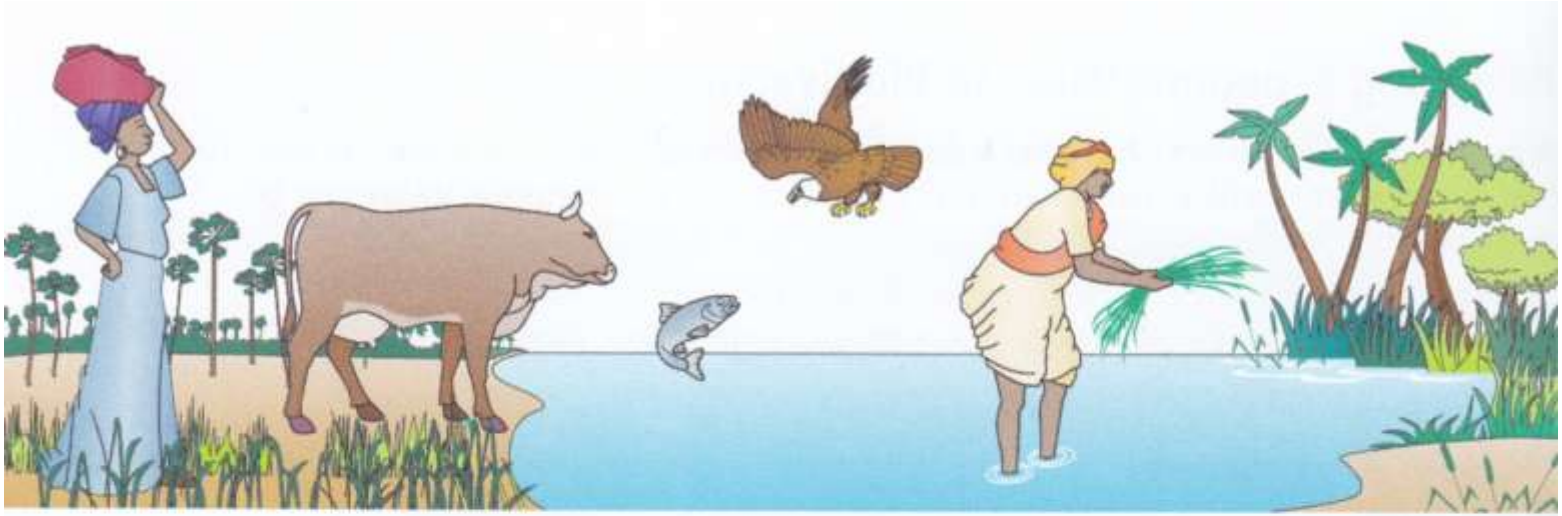












Total Economic Value of a Tropical Wetland Ecosystem

Use Values			Non-Use Value
Direct Use Values	**Indirect Use Values**	**Option Value**	**Existence Value**
Fish and meat	Flood control	Future products:	Protection of biodiversity
Fuelwood	Soil fertility	Medicines	Maintaining culture of local people
Timber and other building materials	Pollution control	Genetic resources	Continuing ecological and evolutionary process
Medicinal plants	Drinking water	Biological insights	
Edible wild fruits and plants	Recreation and tourism (e.g., bird watching)	Food sources	
Animal fodder	Education	Building supplies	
	Biological services (pest control, pollination)	Water supplies	

Indirect Use Values

Amenity value – recreational services for human

US: 250 million people/year in national parks – $84 billion /year income.
Recreational values of US forest is higher than the value of wood being exctracted.

TABLE 5.1 | Types of Use of Wildlife by Traditional and Modern Societies

Consumptive uses	Low-consumptive uses	Nonconsumptive uses
Commercial hunting, sport hunting, and subsistence hunting	Zoos	Bird watching
Commercial fishing, sportfishing, and subsistence fishing	Animal parks	Whale watching
Fur trapping	Aquariums	Photography trips
Hunting for animal parts and pet trade	Scientific research	Nature walks
Indirect kills[a]		Commercial photography and cinematography
Eradication programs		Wildlife viewing in parks, reserves, and recreational areas

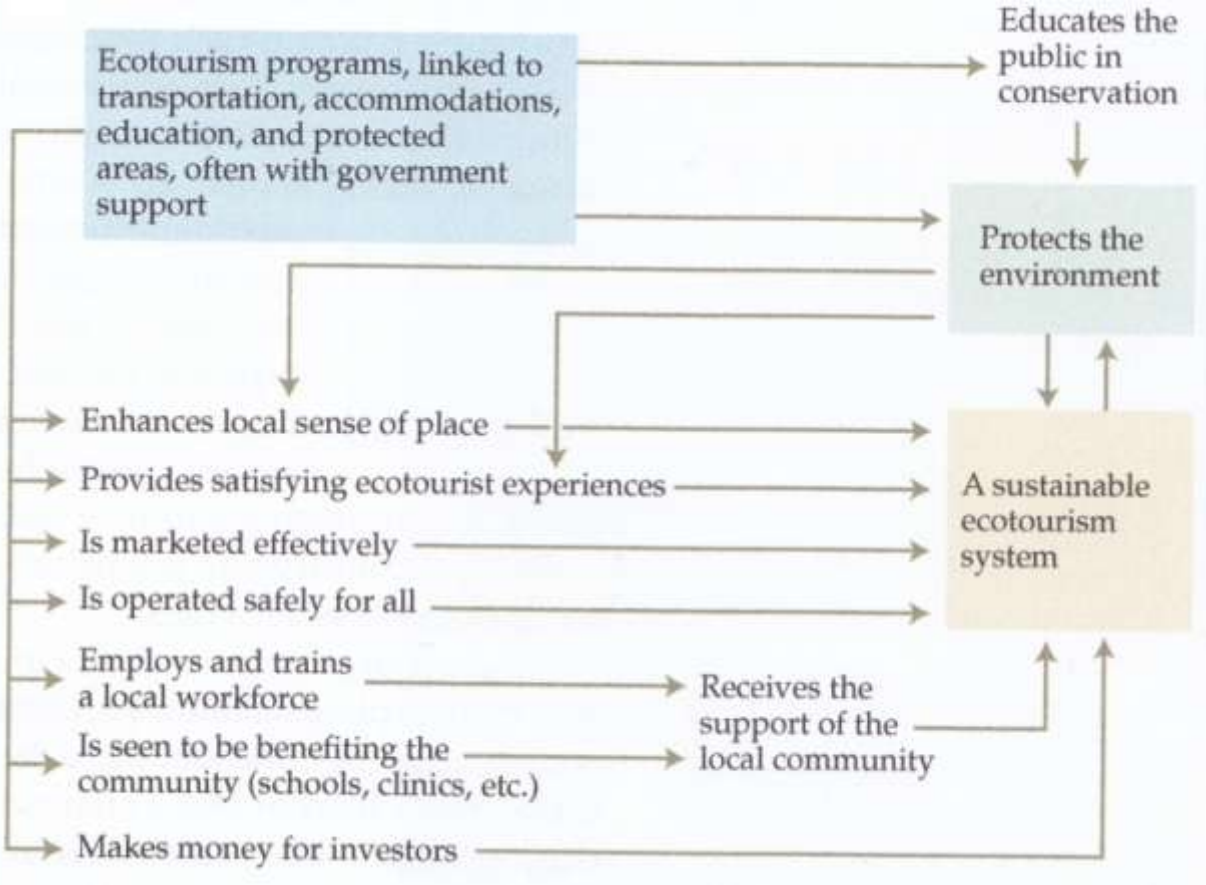
Indirect Use Values

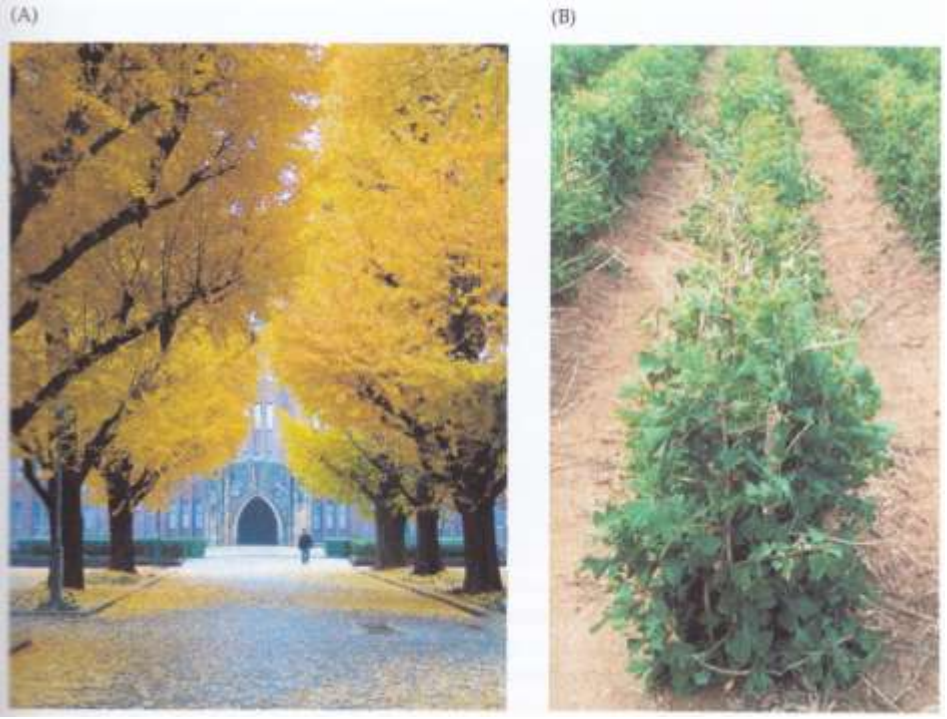
Ecotourism- special category of recreation – visiting spending money wholly or in part to experince unusual biological communities



20% of the global $600 bilion/year tourist industry

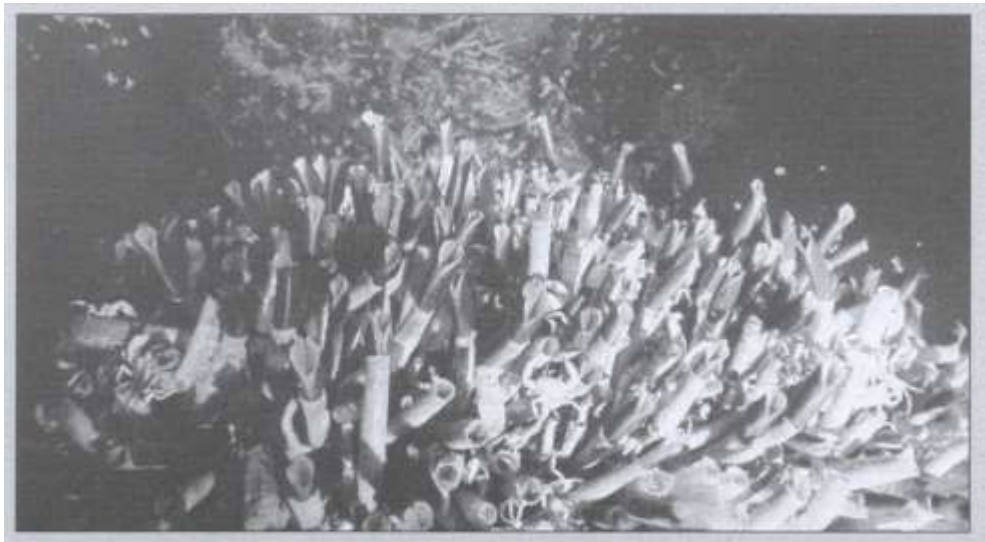
Control of the influence of ecotourism is essential!





Potential Values

- Medicine, yew tree – cancer, ginkgo – circulation
- The enzyme crucial for the PCR method, used in DNA based researches, was extracted from bacteria living in Yellowstone's hot springs.



Existence Values

How much people would pay to preserve it

USA: $2.3 billion annually to conservation organizations

In the USA, individuals would donate up to $31 per person annually for the protection of the bald eagle (Total: $9 billion/year)



4.13. ábra. A fehérfejű rétisas az Amerikai Egyesült Államok szimbóluma; nagyon sok ember kinyilvánította hajlandóságát, hogy fizessen annak érdekében, hogy ez a faj fennmaradhasson (Fotó: Jessie Cohen, National Zoological Park)



4.12. ábra. A legtöbb ember számára egy másik faj egyedével való találkozás új tapasztalatot adó, felemelő élmény (Fotó: Scott Kraus, New England Aquarium)
A képen látható emberek egy halászhálóban fennakadt bálnát „üdvözölnek". A hálóhoz rögzített bója tette lehetővé, hogy kiszabadításáig a hálna a felszínen maradjon, s így levegőhöz jusson. Később sikeresen kiszabadították a bálnát a hálóból. Az ilyen jellegű találkozások (amiért többet kell tenni, mint egy szokásos akváriumi vagy „fotoszafari" élményért) minden ember életét gazdagabbá tehetik.

Ethical values



Each species has a right to exist

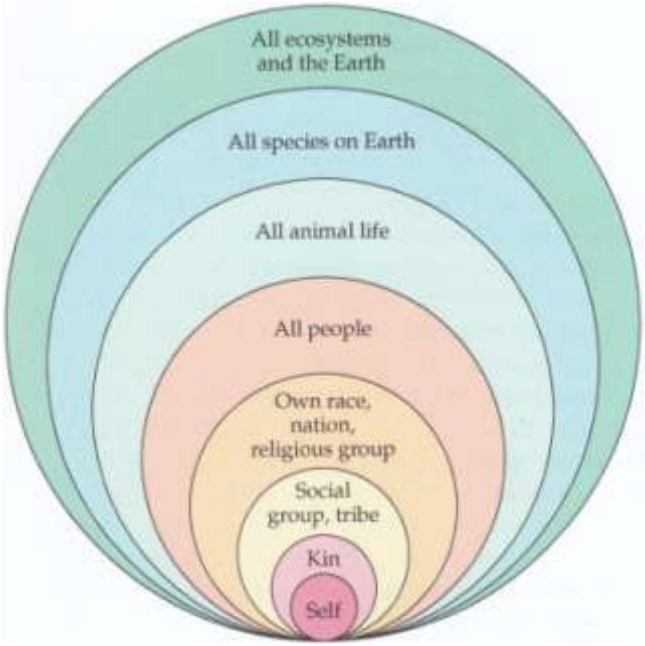
All species are interdependent

People have a responsibility to act as stewards of the Earth

People have duty to their neighbours

People have a responsibility to future generations

Respect for human life and human diversity is compatible with a respect for biodiversity





Deep Ecology



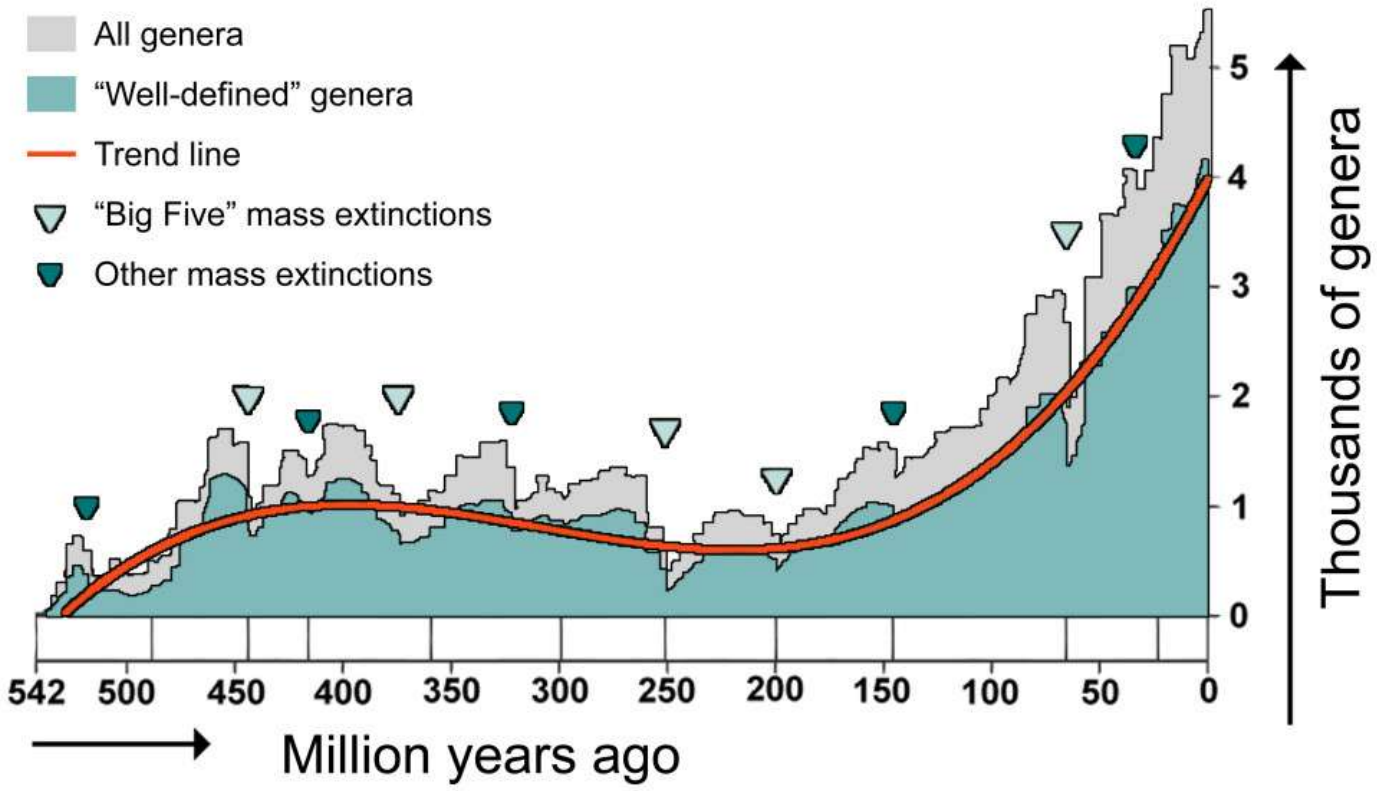
TABLE 6.1 | A Comparison of Beliefs of the Dominant Worldview and Those of Deep Ecology

Dominant worldview	Deep ecology
Humans dominating nature	Humans living in harmony with nature
Natural environment and species as resources	All nature having intrinsic worth, regardless of human needs
A growing human population with a rising standard	A stable human population living simply
Earth providing unlimited resources	Earth providing limited resources, some renewable, others not, that must be used carefully
Ever-higher technology bringing progress and solutions	Appropriate technology being used with respect for the Earth
Material progress as a goal	Spiritual and ethical progress as goals
Strong central government	Local control, organized according to ecosystems or bioregions

Extinction. Vulnerability to Extinction

There are more species on Earth at the present geological time than any other period.

Unfortunately, as a result of human activity, the current rate of extinction of species is greater now than any time in the past.



Extinction of species

Dramatique processes by the increased human activity

50% of the total net primary productivity of terrestrial environment used/wasted by the people

25% of the total net primary productivity of entire Earth used/wasted by the people

Genetic diversity of domesticated species decreas as well

(97% of the vegetable variaties are now extinct in USA)



Level of extinction

-Extinct

-Extinct in the wild

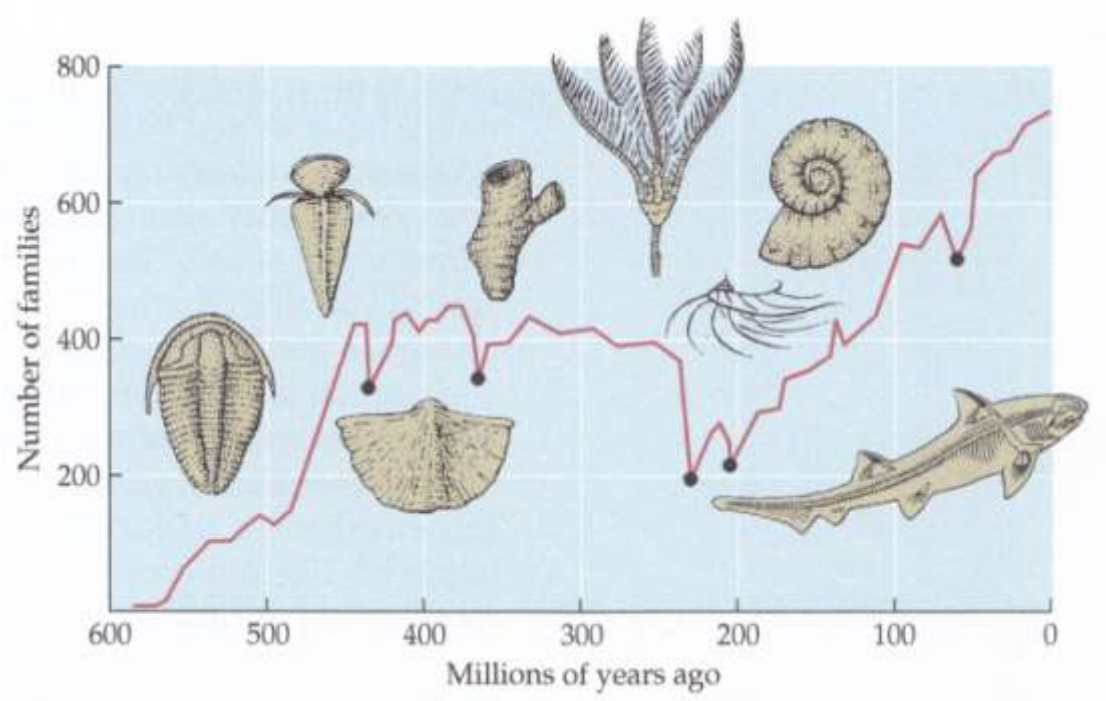
-Locally extinct

-Regionally extinct

-Ecologically extinct

Extinction in the past, before human

Speed of the speciation - 2 family able to evolve around every 1 million year on the base fossil record of marine animals



Extinction in the past, before human

5 natural mass extinction in the past –lenght of it around 27 million year

Ordovicium 50%

Devon 30%

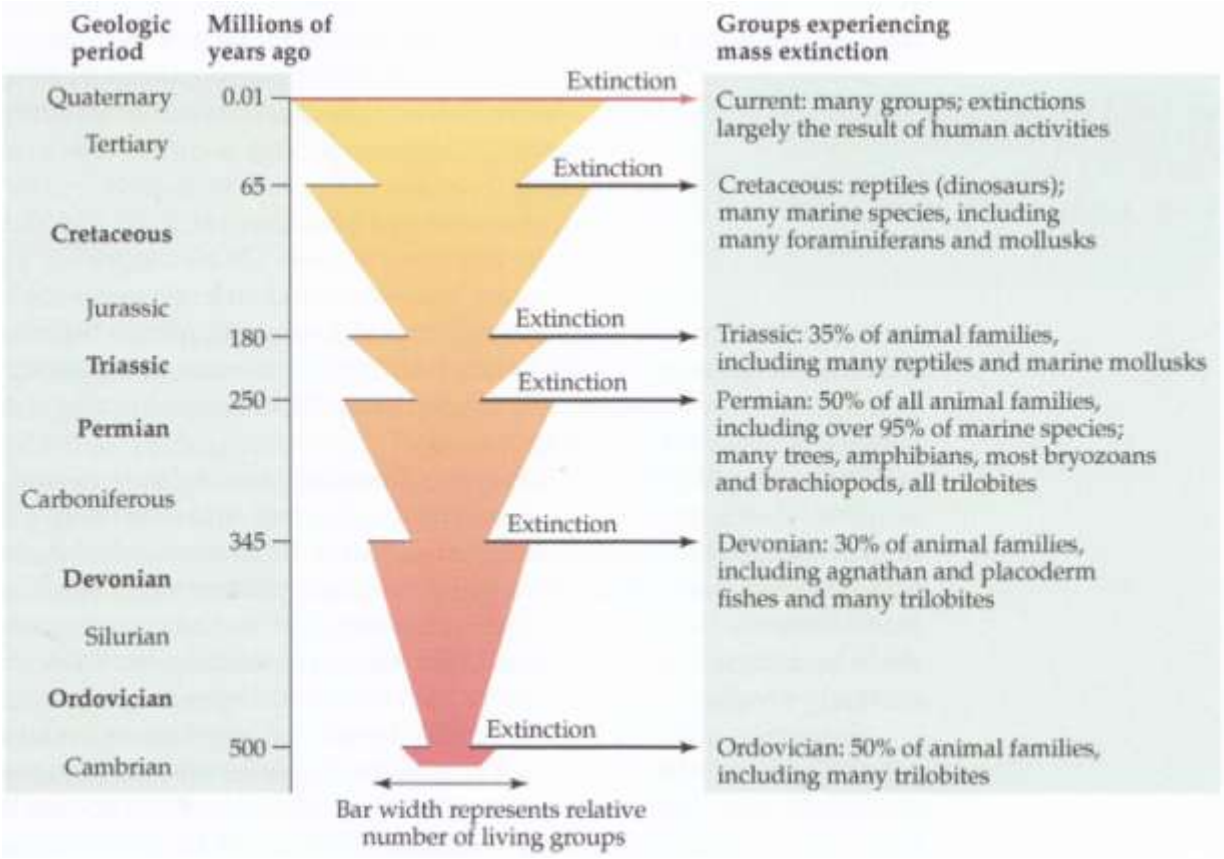
Perm (250 million year before) 95% of marine species loss – the largest mass extiction - 50 million years for recovery

https://www.youtube.com/watch?v=xVz7a8Kkg1Y

Triassic 35%

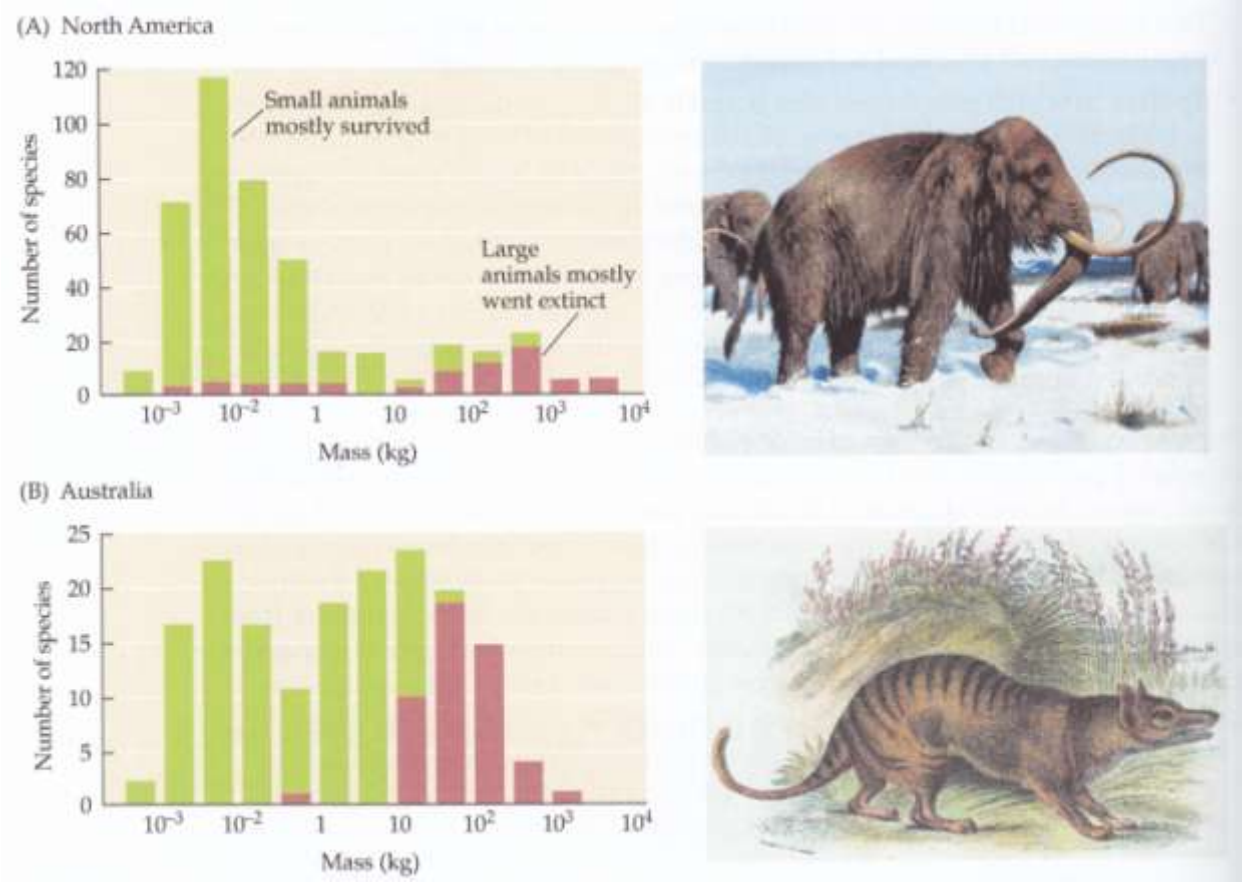
Cretaceous (dinosaurs)

The 6th, Quaternary extinction, early human could have role in it



Human-Caused Extinctions

- Shortly after human arrived to Australia, North and South America, 74-86% of the megafauna (above 44kg) extinct



Human-Caused Extinctions

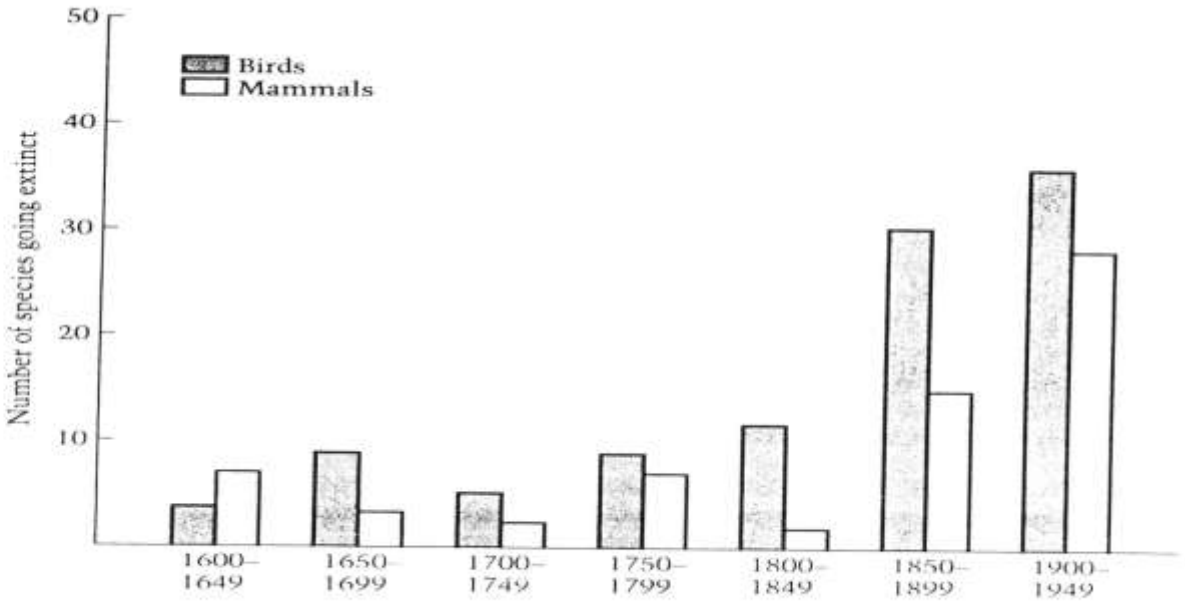
- Extinction rates are best known for bird and mammal species

Since 1600, 85 mammalian and 113 bird species extinct until the XX. Century, 2.1% and 1.3% of known species

1600-1700, one species extinct / 10 years

1750-1850, one species extinct / 1 years

11 % of mammal and bird species are threatened by extinction



4.5 Extinction rates for birds and mammals have been steadily increasing, with the most dramatic increase occurring within the last 150 years. (Data from Nilsson 1983; IUCN 1988.)

TABLE 7.2 | Numbers of Species Threatened with Extinction in Major Groups of Animals and Plants[a]

Group	Approximate number of species	Number of species threatened with extinction	Percent of species threatened with extinction
Vertebrate animals			
Fishes	28,000	2523	9[b]
Amphibians	6409	2339	36
Reptiles	9400	1160	12[b]
Crocodiles	23	10	43
Turtles	228	170	75
Birds	10,065	2196	22
Penguins	18	15	83
Mammals	5506	1467	27
Primates	420	229	54
Manatees, dugongs	5	4	80
Horses, tapirs, rhinos	16	14	88
Plants			
Gymnosperms	1010	567	56[b]
Angiosperms (flowering plants)	260,000	10,686	4[b]
Palms	521	371	71
Fungi	100,000	3	0

Source: IUCN 2013 (www.iucnredlist.org).

[a]Data include the categories critically endangered, endangered, vulnerable, and near threatened.

[b]Low percentages reflect inadequate data due to the small number of species evaluated. For example, 12% of reptiles are listed as endangered, but only about one-third of species have been evaluated. For reptile species that have been evaluated, 31% are considered endangered.

TABLE 7.1 | Some Species and Subspecies That Have Gone Extinct since 1985

Species	Common name	Date of extinction	Original range
Amphibians			
Atelopus ignescens	Jambato toad	1988 (last record)	Ecuador
Bufo baxteri	Wyoming toad	Mid 1990s*	United States
Bufo periglenes	Monteverde golden toad	2004	Costa Rica
Rheobatrachus vitellinus	Northern gastric brooding frog	1985 (last record)	Australia
Cynops wolterstorffi	Yunnan Lake newt	1986 (last record)	China
Birds			
Corvus hawaiiensis	Hawaiian crow	2002*	Hawaiian Islands
Cyanopsitta spixii	Spix's macaw	2000 (last record)	Brazil
Gallirallus owstoni	Guam rail	1987*	Guam
Melamprosops phaeosoma	Black-faced honeycreeper	2004 (last record)	Hawaiian Islands
Moho braccatus	Kaua'i	1987 (last report of vocalizations)	Hawaiian Islands
Myadestes myadestinus	Kama'o	2004	Hawaiian Islands
Tachybaptus rufolavatus	Alaotra Grebe	2010	Madagascar
Mammals			
Diceros bicornis longipes	West African black rhinoceros	2013	Cameroon
Lutra lutra whiteleyi	Japanese river otter	2012	Japan
Neofelis nebulosa brachyuran	Formosan clouded leopard	2013	Taiwan
Oryx dammah	Scimitar-horned oryx	1996*	Chad
Plants			
Argyroxiphium virescens	Silversword	1996	Hawaiian Islands
Commidendrum rotundifolium	Bastard gumwood	1986*	St. Helena Island
Nesiota elliptica	St. Helena olive	2003	St. Helena Island

Source: IUCN 2013 (www.iucnredlist.org).
*Species still exists in captivity.

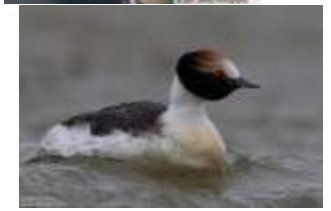








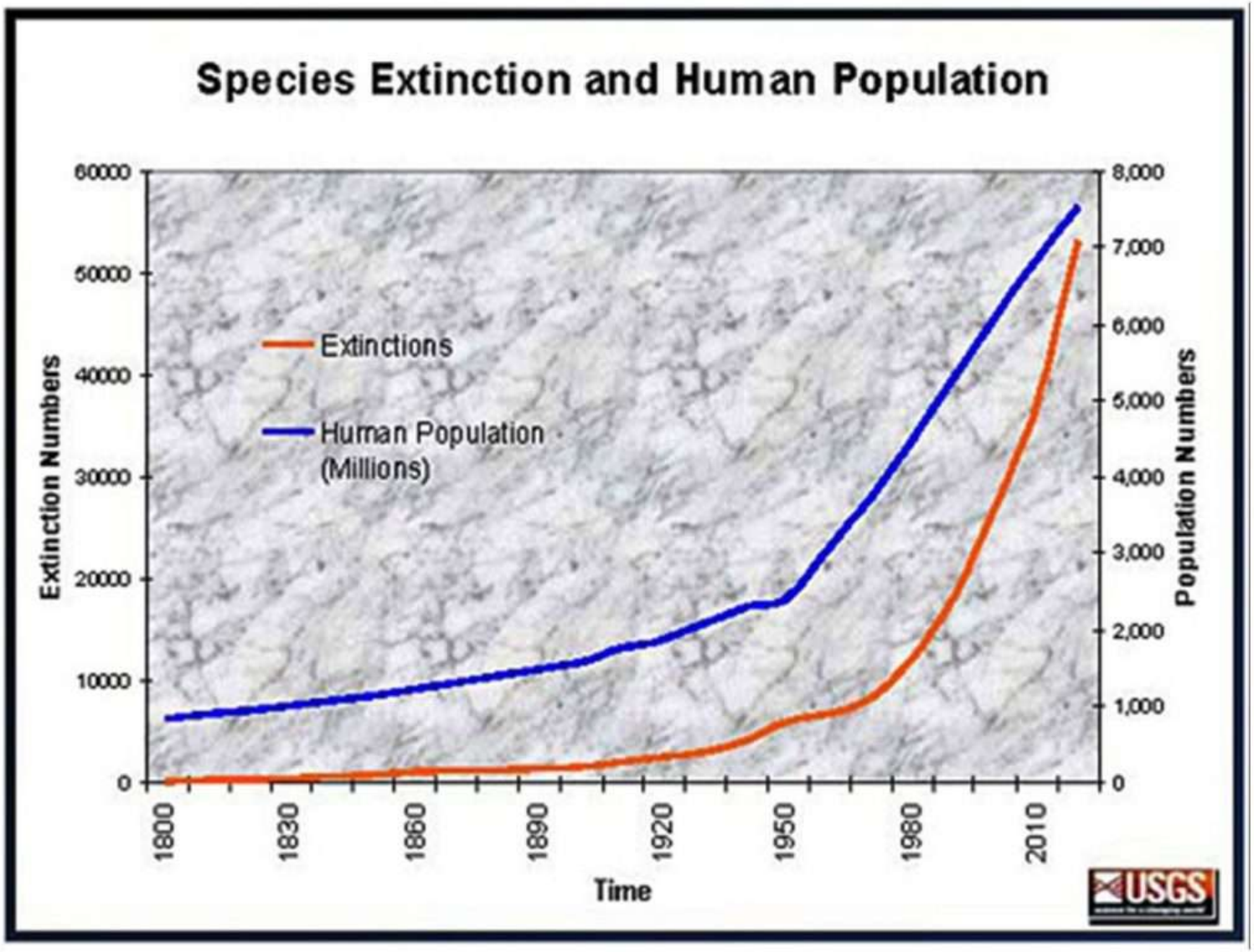


species/subspecies of amphibians, birds, mammals, and plants that have been







Species Extinction and Human Population
Extinction Numbers
60000
50000
40000
30000
20000
10000
0
Extinctions
Human Population
(Millions)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Population Numbers
1800
1830
1860
1890
1920
1950
1980
2010
Time
USGS

Speed of natural extinction, expecting in total 10 million species on the Earth, 1-10 species/year

(Average lifespan of a species is around 1-10 million year before extinct or evolve to other species)

During 1850-1950, 100 bird and mammal species extinct, 1000 times more than one could expect by natural extinction

In most past geological periods, the extinction of existing species was balanced by the evolution of new species

The speed of the speciation very probable decreased because of the human activities

High extinction threat of the island species

Number of bird species extinct since 1500 in islands and mainlands

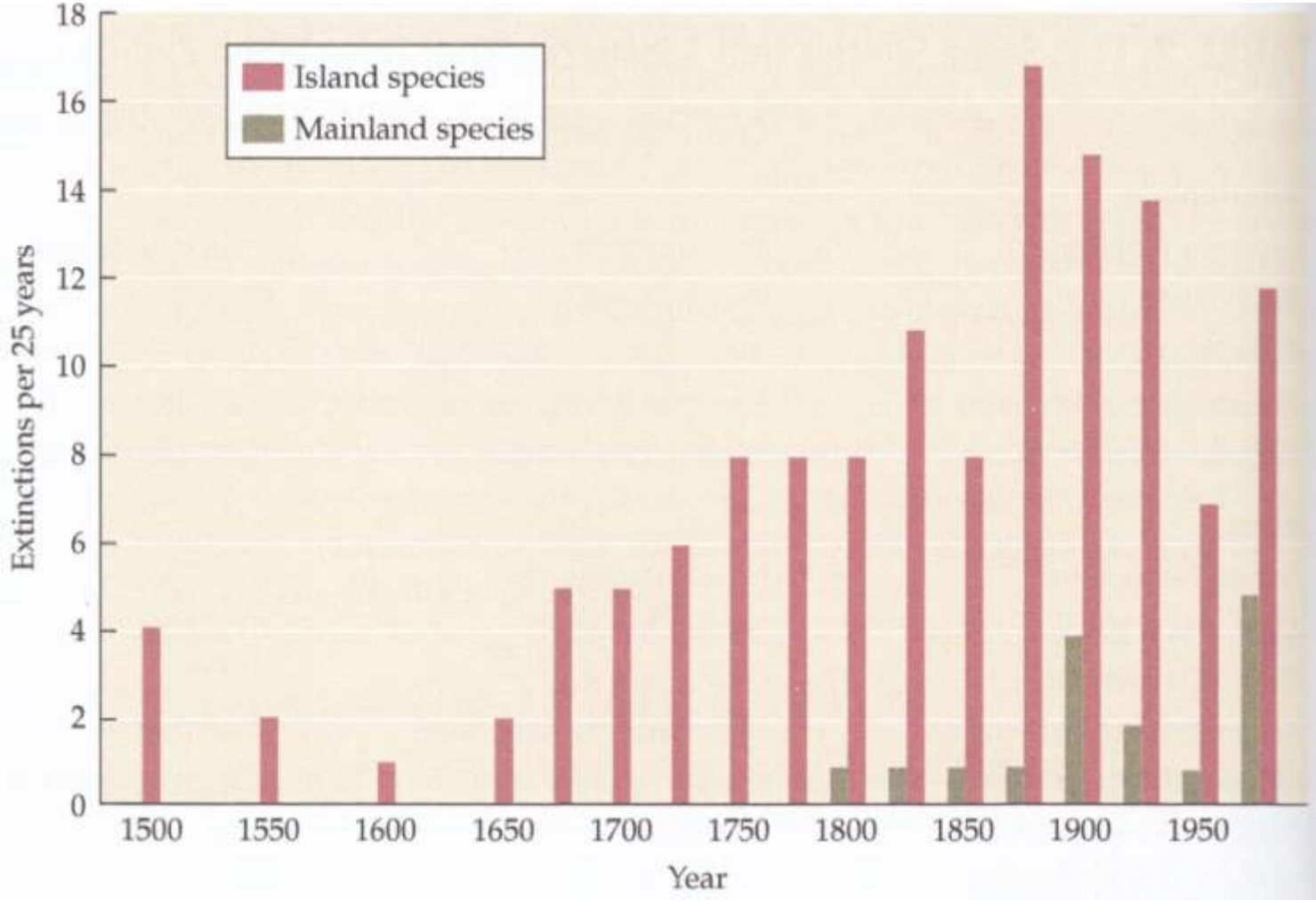


TABLE 7.3 Number of Native Plant Species and Those Species That Are Endemic for Various Islands and Island Groups

Island(s)	Native species	Endemic species	Percent endemic
United Kingdom	1500	16	1
Solomon Islands	2780	30	1
Sri Lanka	3000	890	30
Jamaica	2746	923	33
Philippines	8000	3500	44
Cuba	6004	3229	54
Fiji	1307	760	58
Madagascar	9000	6500	72
New Zealand	2160	1942	90
Australia	15,000	14,074	94

Source: WRI 1998.

High extinction threat of the endemic species of

Comodo dragon



Madagascar: primate 93%, frogs 99%, plants 65% are endemic

Endemic species in Oceanic region: 80% of them extinct or threathend by extinction

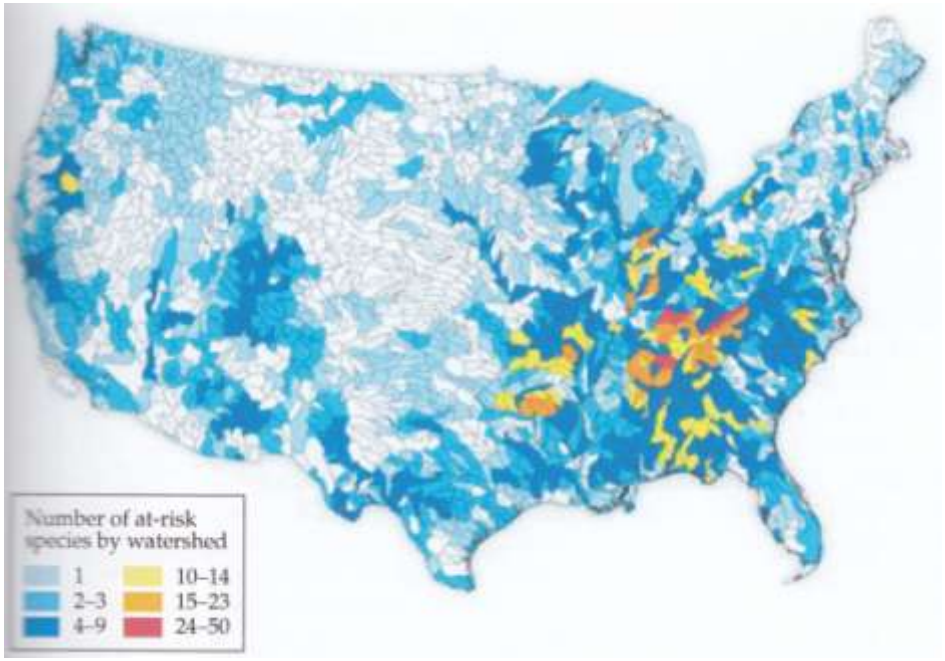
Positive relation between human arrival to the island and extinction:

Hawaii, 98 endemic bird species, 50 of them extinct after Polynesian arrival (~1400) and further 24 species extinct after European arrival (1778), 70% extinct



Stefen island, New-Zealand, endemic bird species, Stephens Island wren, – lighthouse keeper's cat named Tibbles killed the last small population

Extinction rates in Aquatic Environment



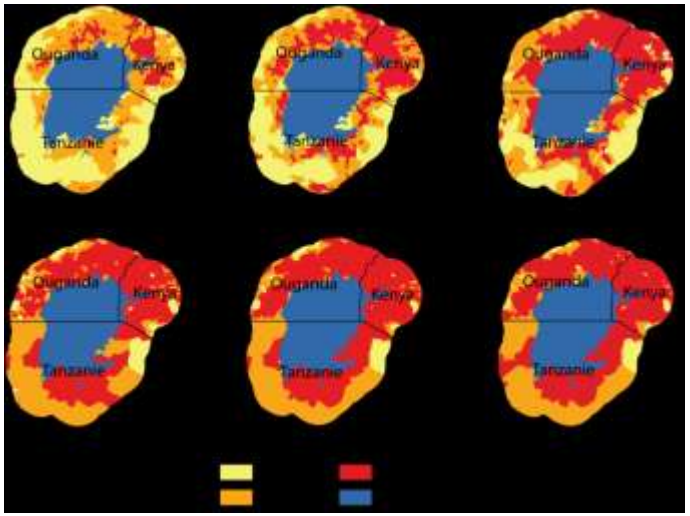
Number of fish and mussel species threatened with extinction in US.

Major threats: dams, irrigation systems, polluted runoff from industry and agriculture, introduced species and habitat destruction.

Lake Victoria– Nile perch

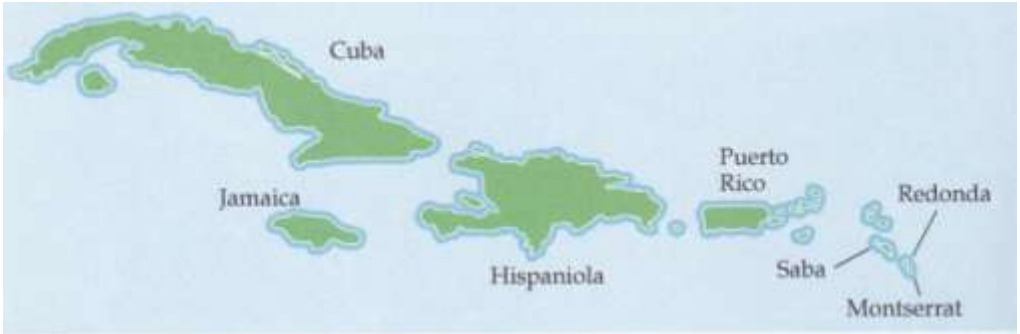


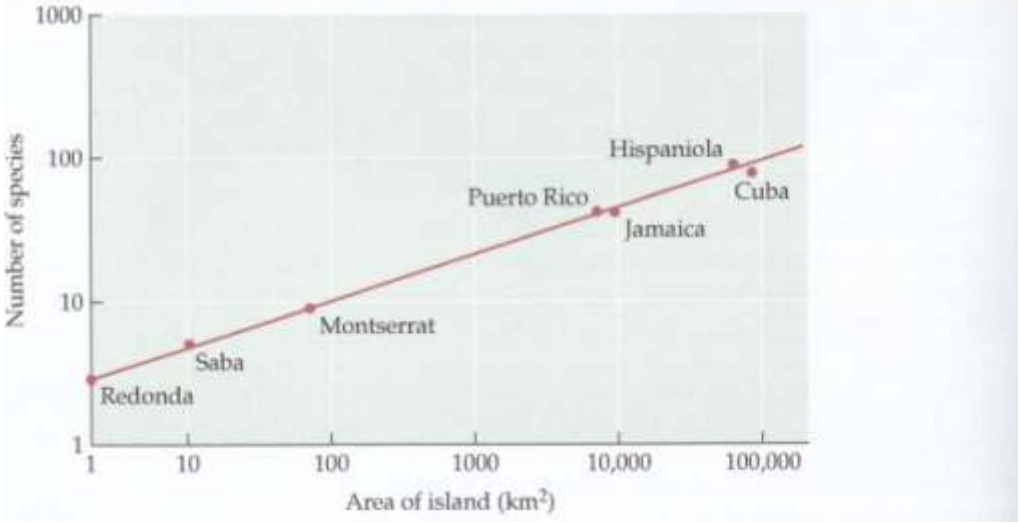


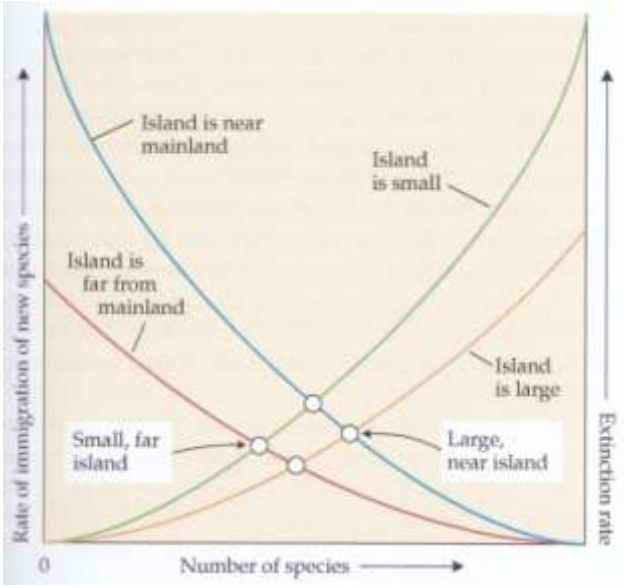


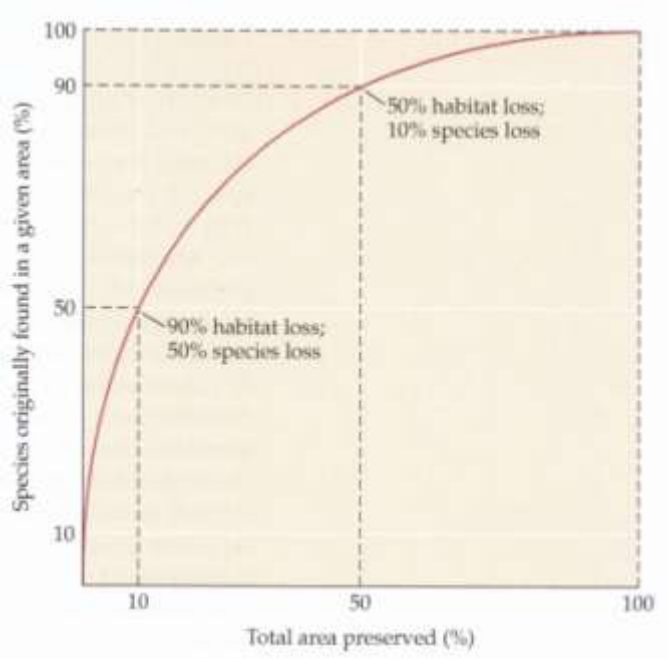
- 400 native fish species
- Introduction of the Nile perch from 1954-1960
- In 1978, 2% of catches were Nile perch
- In 1986, 80%Mass disappearance of native fish species (~200 species)
- Increased frequency of algal blooms – anaerobic conditions already at 25 m depth, previously oxygen-rich even at 60 m
- Appearance of water hyacinth
- Species forced into shallow waters, decline of cichlid species, organic pollution (population growth), more frequent algal blooms

Island Biogeography, a tool to estimate extinction by habitat loss









Estimated speed of extinction recently

Status of the tropical forests has dominant role in the calculation

- Expecting 10 million species in the Earth,
- Around 1% of the tropical forests cutted annually
- 0.2-0.3% of species estimated to extinct annually
  - 20-30 thousands species/year or 68 species/day or 3 species/hour

For the end of the XX. century, there are less extinct species as predicted – however there are more „living dead” species

High rate of local extinction

Vulnerability to Extinction

Rare species are more vulnerabile

But when one species regarded rare?

- Species with narrow geographical range, specific habitat requirements, always found in small population

Categories of rarity for 160 plant species in the British Isles based on geographic distribution, habitat specificity, and local population size[a]

Local population size	Geographic distribution	
	Large	Small
Wide habitat specificity		
Somewhere large	58 spp.	6 spp.
Always small	2 spp.	0 spp.
Narrow habitat specificity		
Somewhere large	71 spp.	14 spp.
Always small	6 spp.	3 spp.

Source: After Rabinowitz 1981 and Rabinowitz et al. 1986.

[a] Based on the three criteria, 58 species are common; 3 species are rare by all criteria; and the remaining 99 species exhibit some traits of rarity.

Vulnerability to Extinction



-Species with very narrow geographical range
-Species with only one or a few populations
-Species which population size is small
-Species with low population density
-Species that need a large home range
-Species that have large body size
-Species with low rates of population increase (K-strategies)
-Species that are not effective dispersers
-Migrating species
-Species with little genetic variability
-Species with specialized niche requirements
-Species that are characteristically found in stable environments
-Species that form permanent or temporary aggregations
-Species that are hunted or harvested by people
-Species avoid humans

TABLE 8.1 | Total Plant Species and Endemic Plant Species in Selected Regions

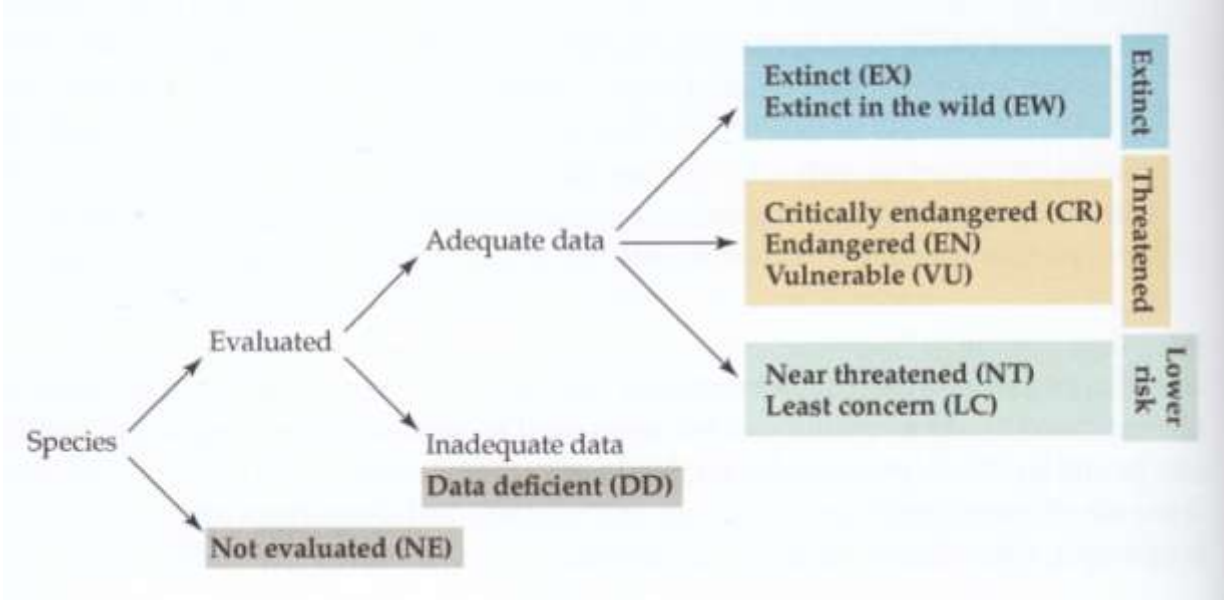
Region	Area (km^2)	Total number of species	Number of endemic species	Percent endemic species
Europe	10,000,000	10,500	±3500	33
Australia	7,628,300	15,000	14,074	94
Texas	751,000	4694	379	8
California	411,000	5647	1517	27
Germany	349,270	2600	6	<1
North and South Carolina	217,000	3586	23	1
Cape Region of South Africa	90,000	8578	5850	68
Panama	75,000	9000	1222	14
Belgium	30,230	1400	1	<1

Sources: Gentry 1986; WRI 2000.

Conservation categories

IUCN (International Union for the Conservation of Nature)

1. Extinct
2. Extinct in the wild
3. Endangered
4. Vulnerable
5. Near threatened
6. Least concern
7. Data deficient
8. Not evaluated



Conservation categories

- Critical endangered, 50% or greater probabilty of extinction within 10 years, 3 generations
- Endangered, 20% or greater probabilty of extinction within 20 years, 5 generations
- Vulnerable, 10% or greater probabilty of extinction within 100 years

Critical endangered, other characteristics
- 250 individuals
- 50 individuals able to reproduce
- 80% decline within 10 years
- 25% decline during the next 3 years or within one generation
- Area is less than 100km^2
- Large habitat destruction
- Commercial exploitation

Red list – Red book – list of endagered-vulnerable species

Blue list – list of species that are not in the red list thank to the conservation activities

TABLE 8.3 Percentage of Terrestrial, Freshwater, and Marine Species in Some Temperate Countries That Are Threatened[a] with Global Extinction

	Mammals		Birds	
	Number of species	Percent threatened	Number of species	Percent threatened
Argentina	380	10	992	5
Canada	205	5	533	3
China	556	13	1236	7
Japan	146	19	435	9
Russia	301	10	927	7
South Africa	300	8	754	6
United Kingdom	75	7	267	1.5
United States	441	8	877	9

Sources: IUCN 2013 (www.iucnredlist.org); NatureServe Explorer 2013 (www.natureserve.org/explorer); Reptile Database 2013 (reptile-database.reptarium.cz); BirdLife International 2014 (www.birdlife.org).

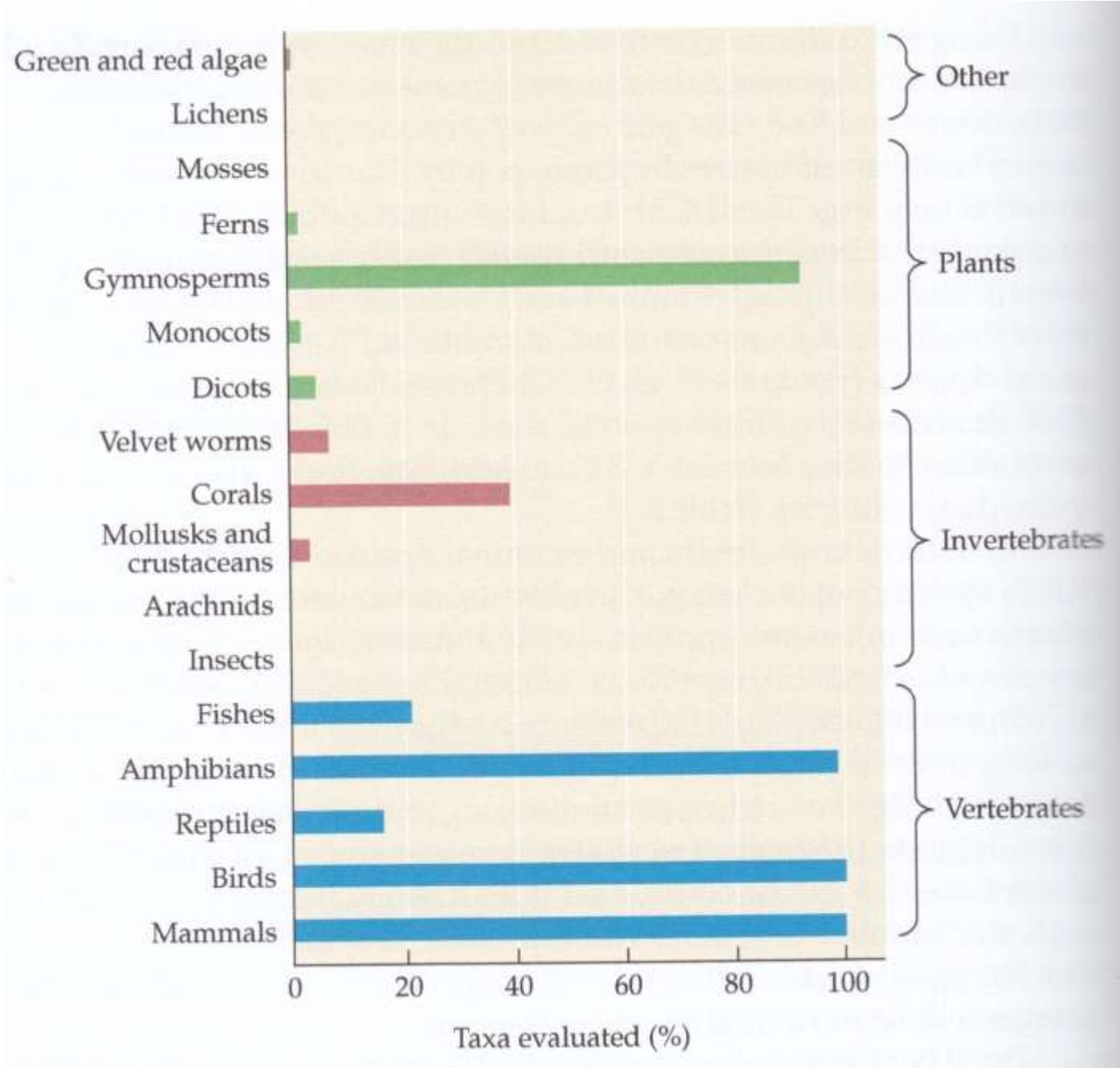
[a]Threatened species include those in IUCN's critically endangered, endangered, and vulnerable categories.

[b]Percentages are low for amphibians in Russia and for plants in all countries because most species have not yet been evaluated using the updated system of assigning categories. Once all species have been evaluated, these percentages will probably increase.

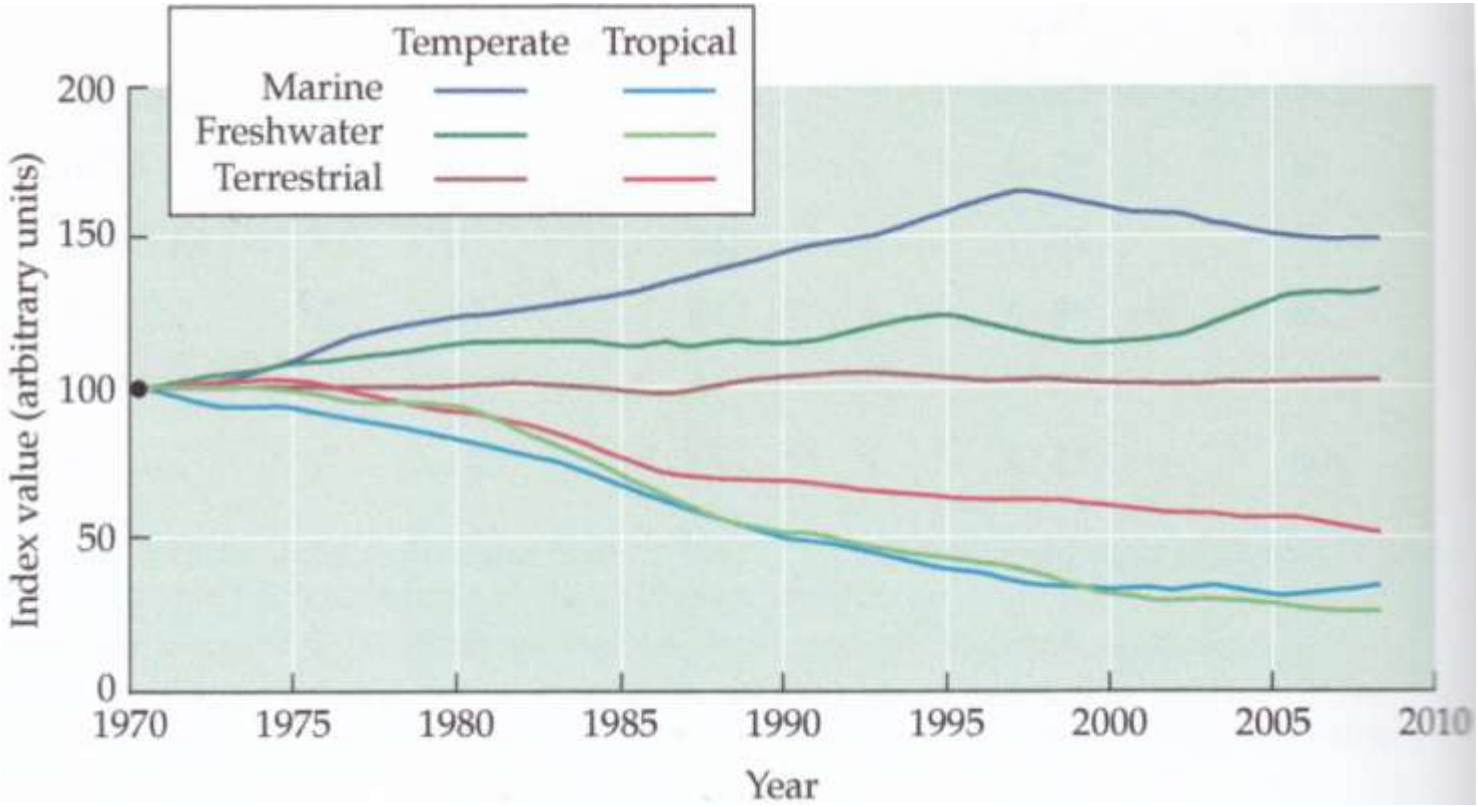
TABLE 8.3 Percentage of Terrestrial, Freshwater, and Marine Species in Some Temperate Countries That Are Threatened[a] with Global Extinction

Reptiles		Amphibians[b]		Plants[b]	
Number of species	Percent threatened	Number of species	Percent threatened	Number of species	Percent threatened
432	1	159	19	9000	<1
39	15	46	2	9705	0
211	18	327	27	30,000	1.5
37	39	56	34	4700	<1
37	24	29	0[b]	11,400	<1
228	6	116	16	23,000	<1
7	14	8	0	1550	<1
300	12	273	21	30,977	1

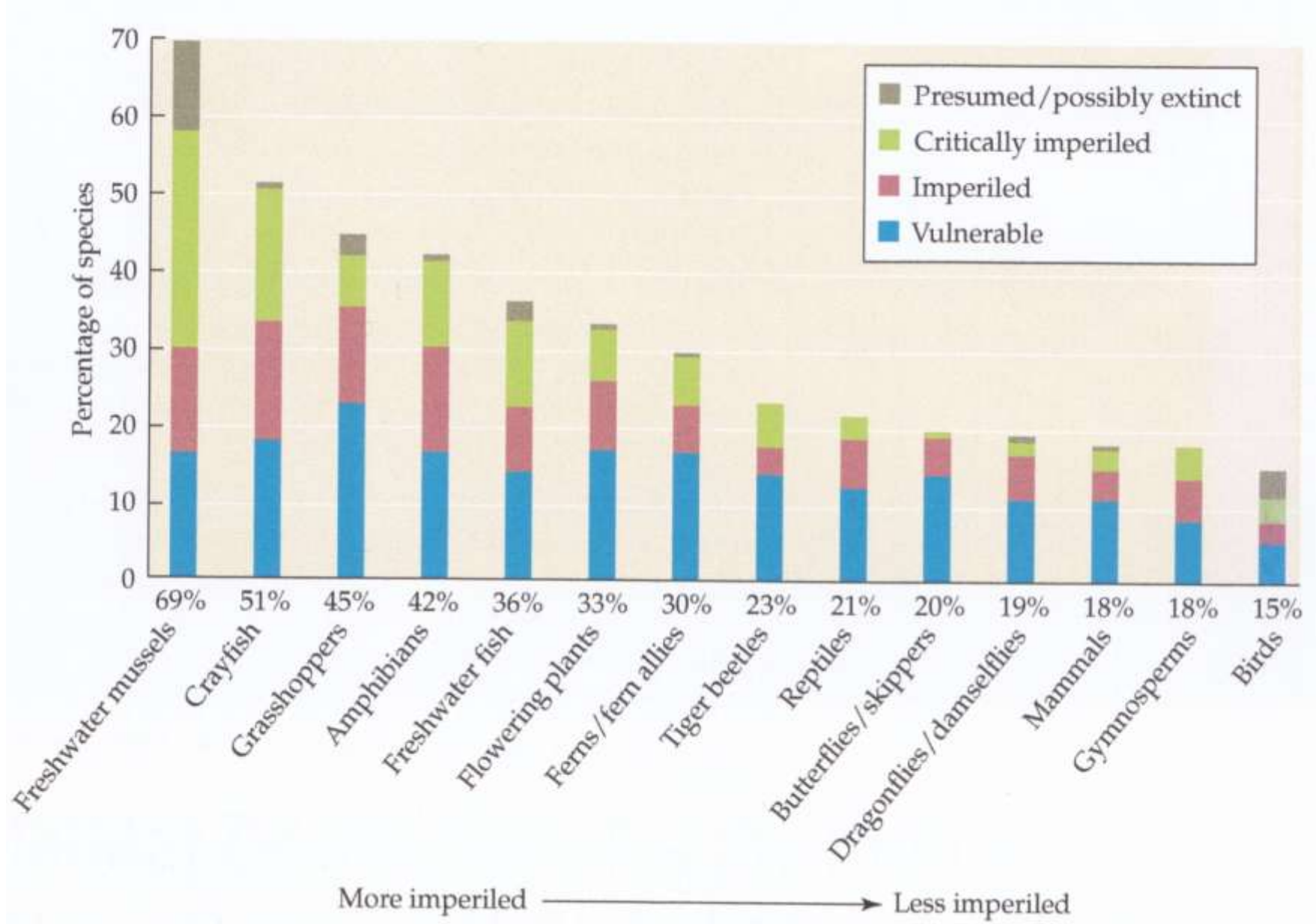
The percentage of species evaluated for IUCN Red List categories



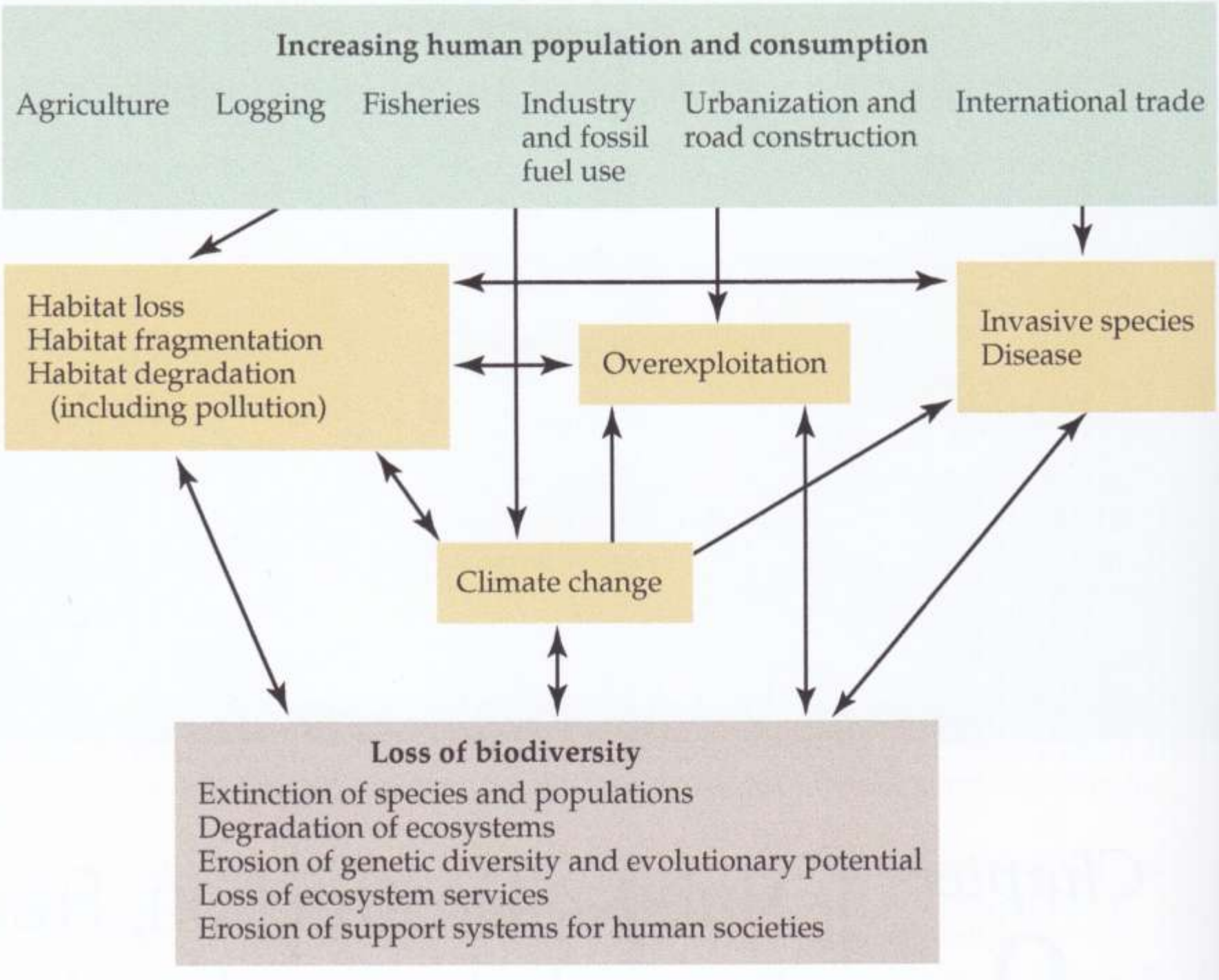
Living Planet Index, follows population size of 2688 vertebrate species



Vulnerable species groups in US



Habitat destruction, Fragmentation and degradation


Increasing human population and consumption
Agriculture
Logging
Fisheries
Industry and fossil fuel use
Urbanization and road construction
International trade
Habitat loss
Habitat fragmentation
Habitat degradation (including pollution)
Overexploitation
Invasive species
Disease
Climate change
Loss of biodiversity
Extinction of species and populations
Degradation of ecosystems
Erosion of genetic diversity and evolutionary potential
Loss of ecosystem services
Erosion of support systems for human societies

Increasing Human Population

Human population number possibly peak at 9.4 billion in 2050.

Human population density is a good predictor of intensity of threat to biodiversity, and this increase is predicted to cause and additional 14% of bird and mammal species threatened with extinction by 2050.

TABLE 9.1 | Three Ways Humans Dominate the Global Ecosystem

1. Land Surface
Human resource needs and land use, mainly agriculture and forestry, have transformed as much as half of the Earth's ice-free land surface.

2. Nitrogen cycle
Each year human activities, such as cultivating nitrogen-fixing crops, using nitrogen fertilizers, and burning fossil fuels, release more nitrogen into terrestrial systems than is added by natural biological and physical processes.

3. Human use of fossil fuels and deforestation
By the middle of this century, human use of fossil fuels and cutting down forests will have resulted in a doubling of the level of carbon dioxide in the Earth's atmosphere.

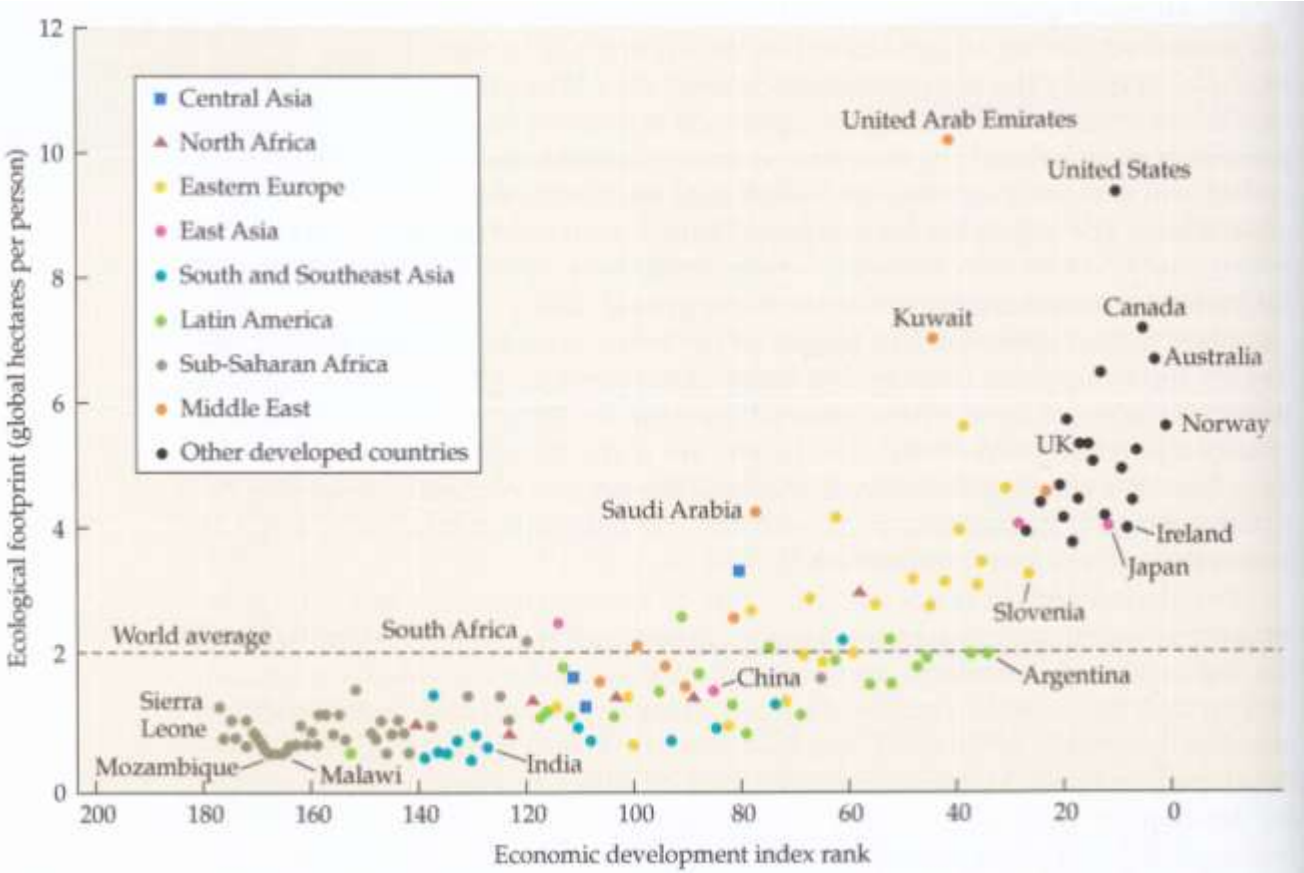
Sources: MEA 2005; Kulkarni et al. 2008.

Consumption

People in industrialized countries consume a disproportionate share of world's energy, minerals, wood products and food.

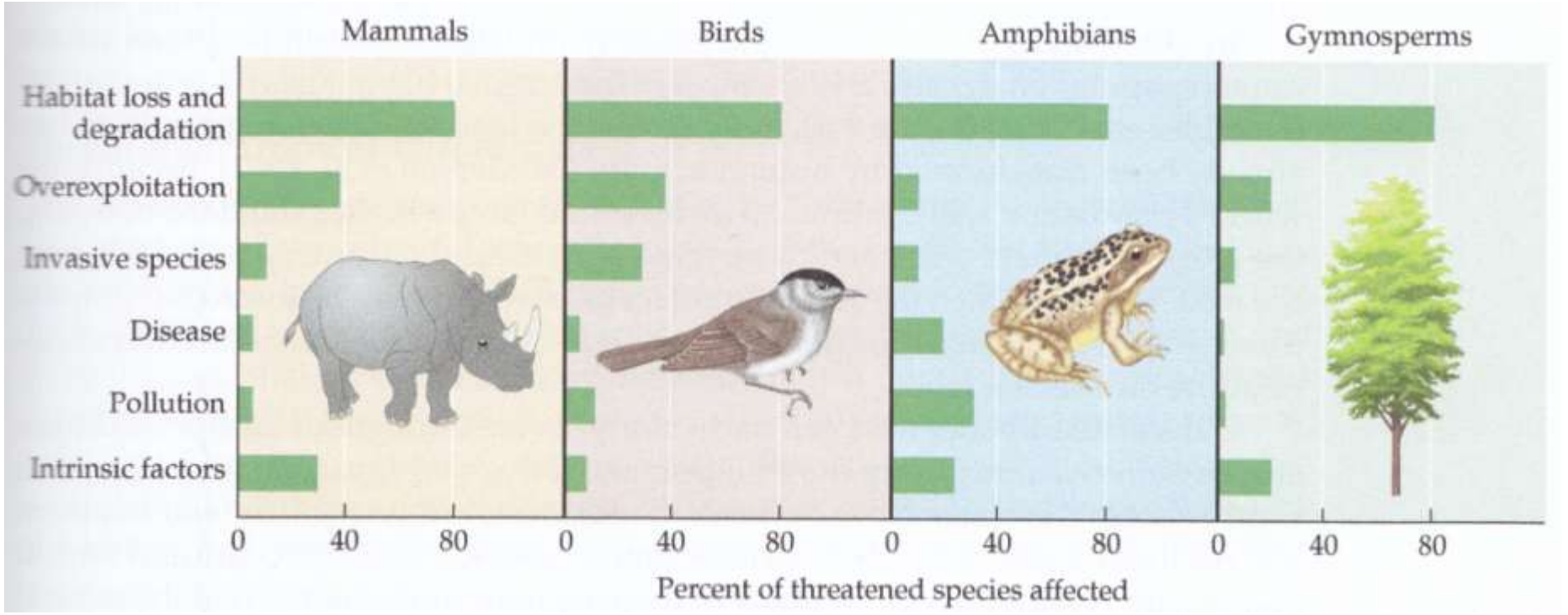
US, only 5% of world's human population, uses roughly 25% of world's natural resources

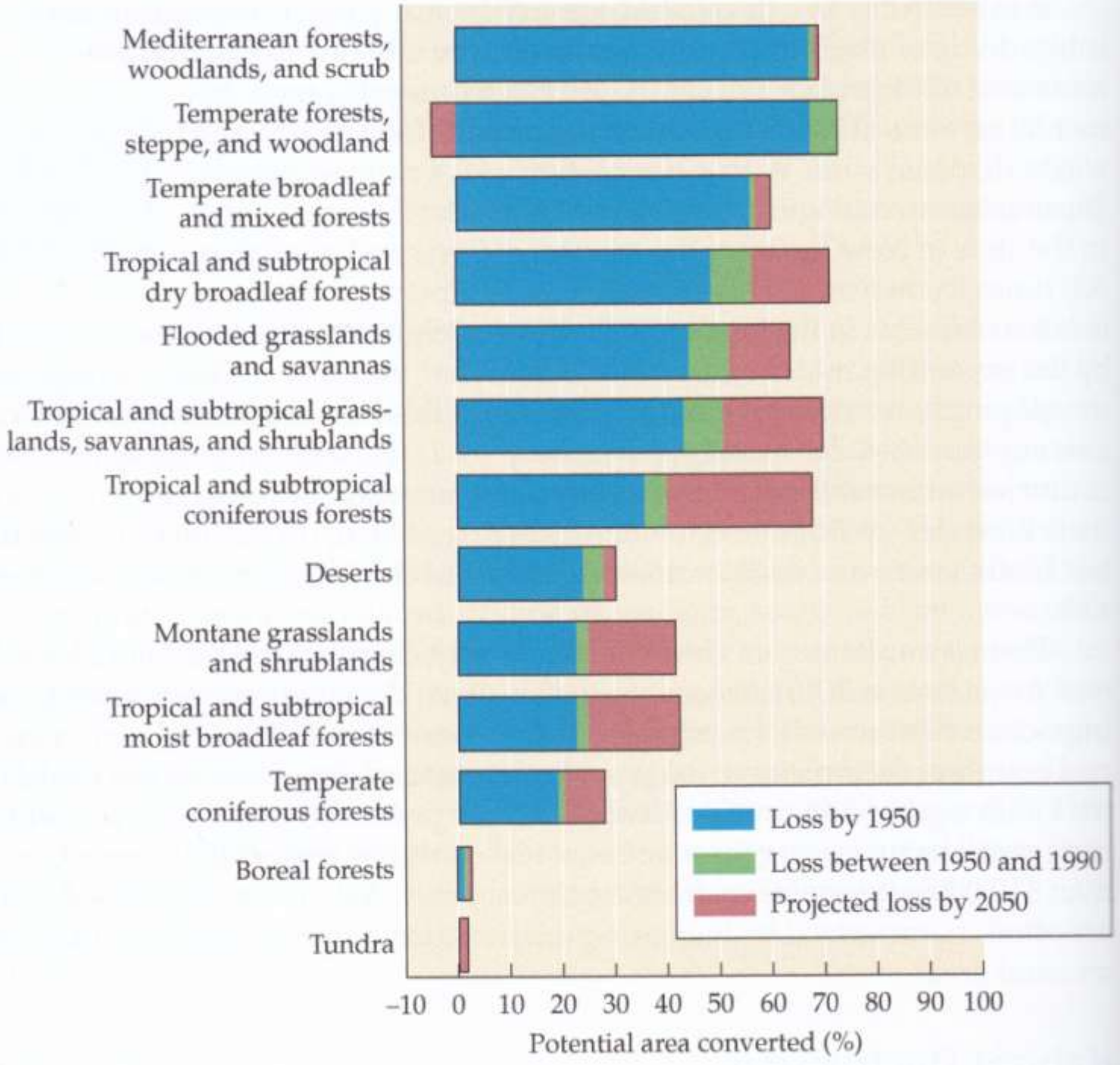
Annually, one US citizen use 25 times more energy, 79 times more paper than an Indian one



Habitat destruction

Primary cause of the loss of biodiversity is the habitat destruction and degradation

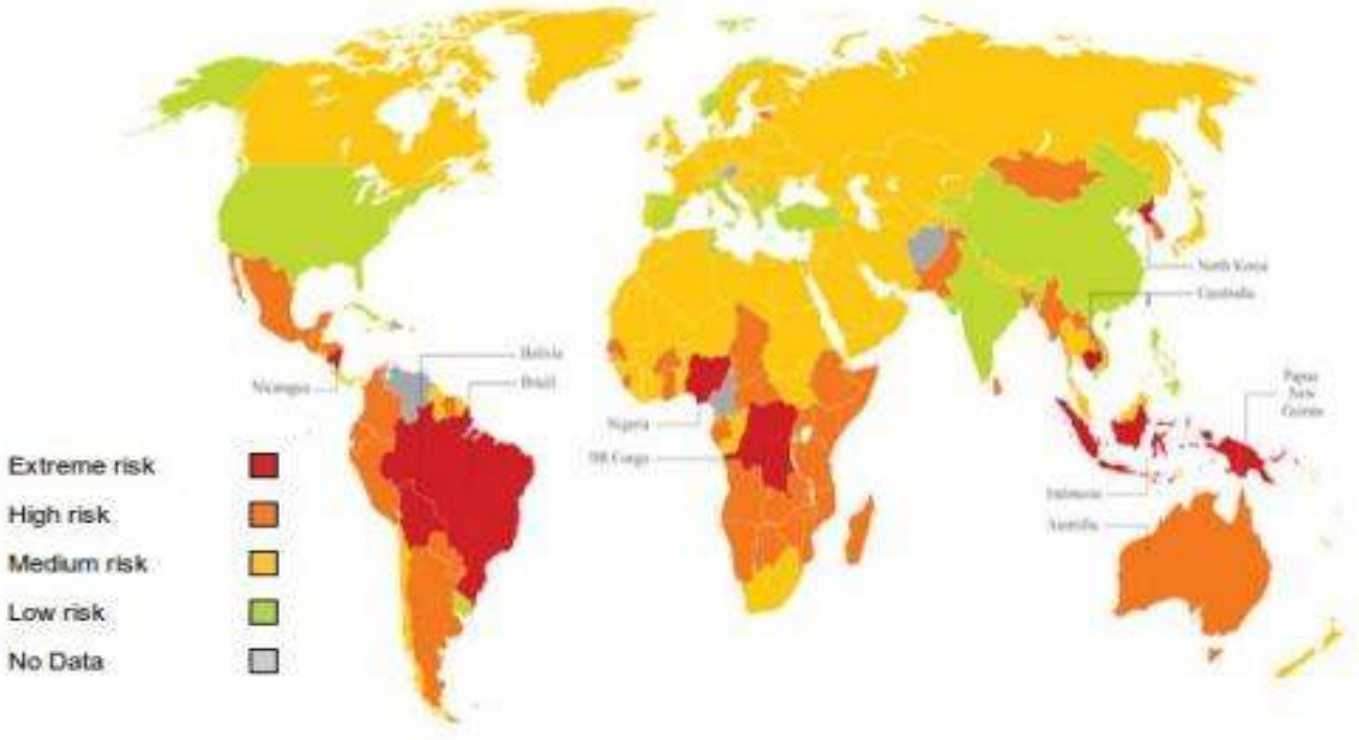



Mediterranean forests, woodlands, and scrub
Temperate forests, steppe, and woodland
Temperate broadleaf and mixed forests
Tropical and subtropical dry broadleaf forests
Flooded grasslands and savannas
Tropical and subtropical grasslands, savannas, and shrublands
Tropical and subtropical coniferous forests
Deserts
Montane grasslands and shrublands
Tropical and subtropical moist broadleaf forests
Temperate coniferous forests
Boreal forests
Tundra
Loss by 1950
Loss between 1950 and 1990
Projected loss by 2050
−10 0 10 20 30 40 50 60 70 80 90 100
Potential area converted (%)

98% of land suitable for agriculture transformed by human activity

.

- Only 15% of the land area in Europe remains unmodifed by human activity
- In the Mediterranean region only 10% of original forest remains
- In US, only 42% of natural vegetation remains
- More than 50% of the wildlife habitat destroyed in many tropical countries



Original extent of tropical rain forests and related moist forests 17 million km^2

For 2010 declined to 11 million km^2 .

TABLE 9.2 | Statistics Relevant for the Future of Rain Forests in Five Major Rain Forest Countries[a]

	Brazil	DRC	Indonesia	PNG	Madagascar
Area of forest (thousand km^2) (2011)[b]	5173	1538	937	286	125
Percentage forest cover (2011)[b]	61	68	52	63	21
Percentage of intact forest landscapes (c. 2000)[c]	32	29	20	35	8
Annual change in forest cover (%) (2005–2010)[d]	–0.4	–0.2	–0.7	–0.5	–0.5
Annual log production (million m^3) (2008)[e]	25	0.3	34	3	0.1
Number of cattle (millions) (2007)[f]	200	1	11	0.1	10
Human population (millions) (2011)[b]	199	66	247	7	22
Population density (per km^2) (2011)[b]	23	28	135	15	37
Human population growth rate (%) (2011)[b]	1.0	2.7	1.2	2.2	2.8
Projected human population in 2050[g]	231	155	321	13	55
Fertility (children per woman) (2011)[b]	1.8	6.1	2.4	3.9	4.6
Mortality before age 5 (per thousand) (2012)[b]	14	146	31	63	58
Life expectancy (2011[b]	73	49	70	62	64
Per capita GDP (PPP) (US$) (2012)[b]	11716	415	4876	2851	962

Source: Corlett and Primack 2010, with updates.

Note: GDP = gross domestic product; PPP = purchasing power parity; DRC = Democratic Republic of the Congo; PNG = Papua New Guinea.

[a]Note the different dates to which the categories apply. What are the greatest threats to forests in each of the countries?

[b]The World Bank 2013.

[c]Potapov et al. 2008.

[d]FAO Global Forest Resources Assessment 2010. Includes all forest types; in the case of Madagascar, most of this is not tropical rain forest.

[e]International Tropical Timber Organization.

[f]FAOSTAT.

[g]United Nations Population Division.

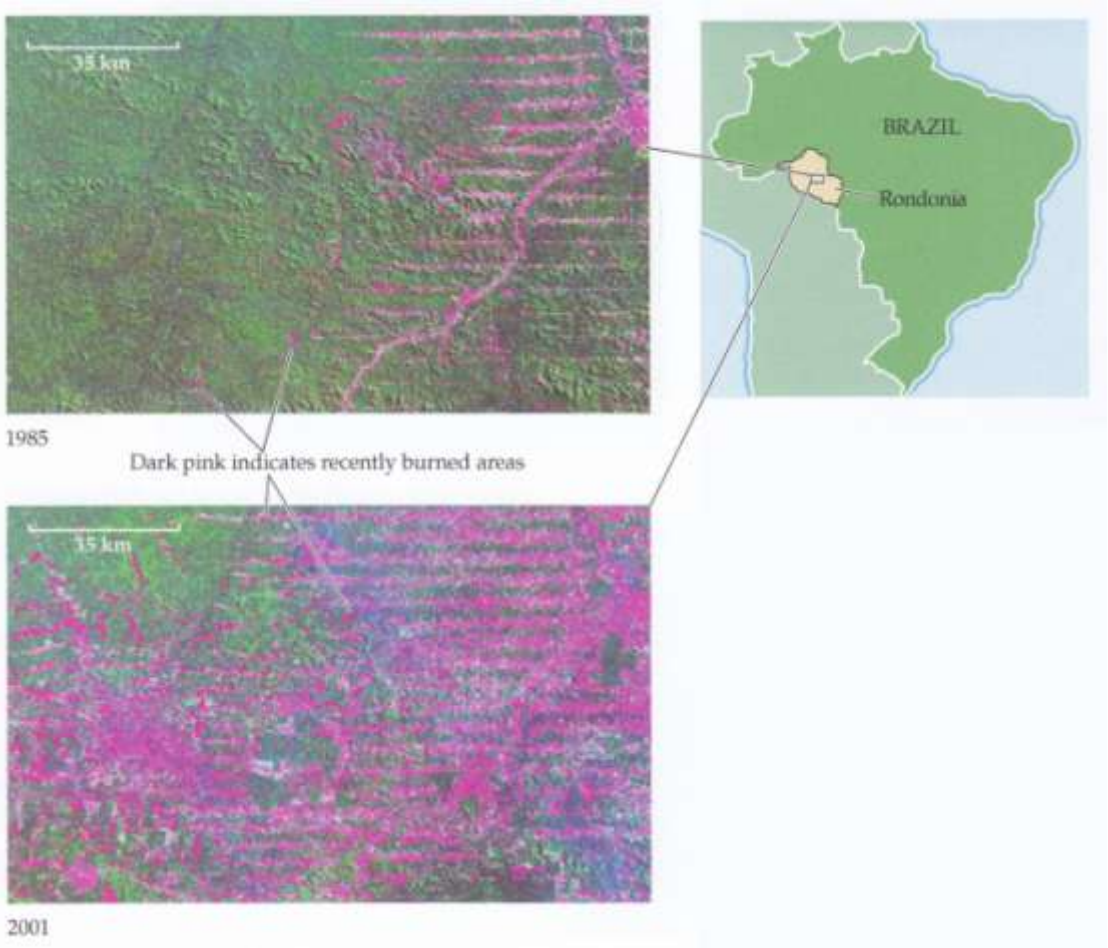
Forest destruction

- Shifting cultivation (slash-and-burn agriculture) farmed only 2-3 years
- Peasant farming
- Fuelwood production (2 billion people)
- Logging
- Commercial agriculture (cattle, oil palm, soybean rubber tree)



Destruction of tropical rain forest frequently caused by demand of industrialized countries for cheap agricultural products (rubber, palm oil, cocoa, soybean, orange juice, beef, low-cost wood products)





Other threatened habitats

Tropical decidous forest

more suitable for agriculture and cattle ranching than tropical rain forest

Grassland

temperate grassland almost completely destroyed by human

(Europe near all grassland converted to farmland

US: 1800-1950 98% of prairie converted to farmland)

Wetlands and Aquatic habitats

Marine coastal areas

Mangroves – 50% of already destroyed

(cleared for rise, shrimp, aquaculture)

Coral reefs

20% destroyed

degradation by overfishing, pollution,

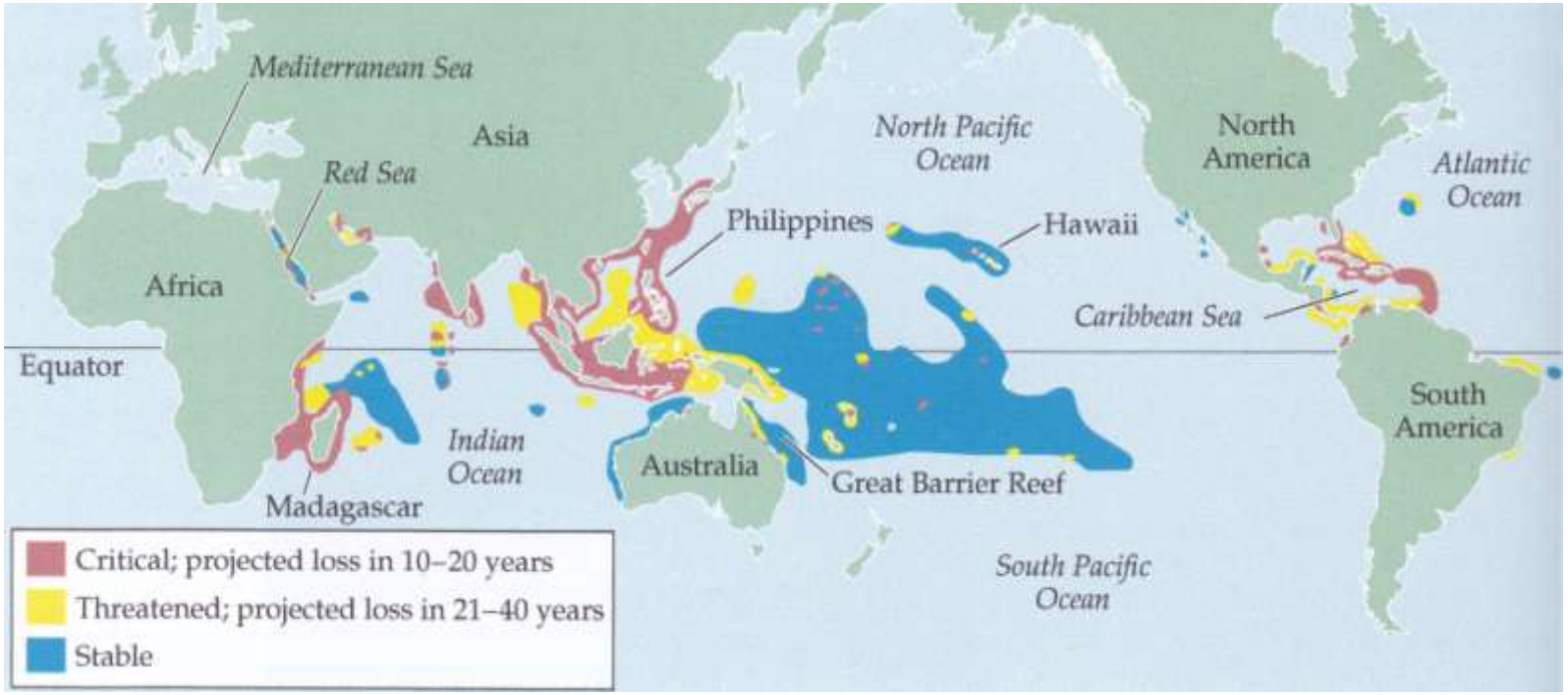
invasive species



Other threatened habitats

Coral reefs

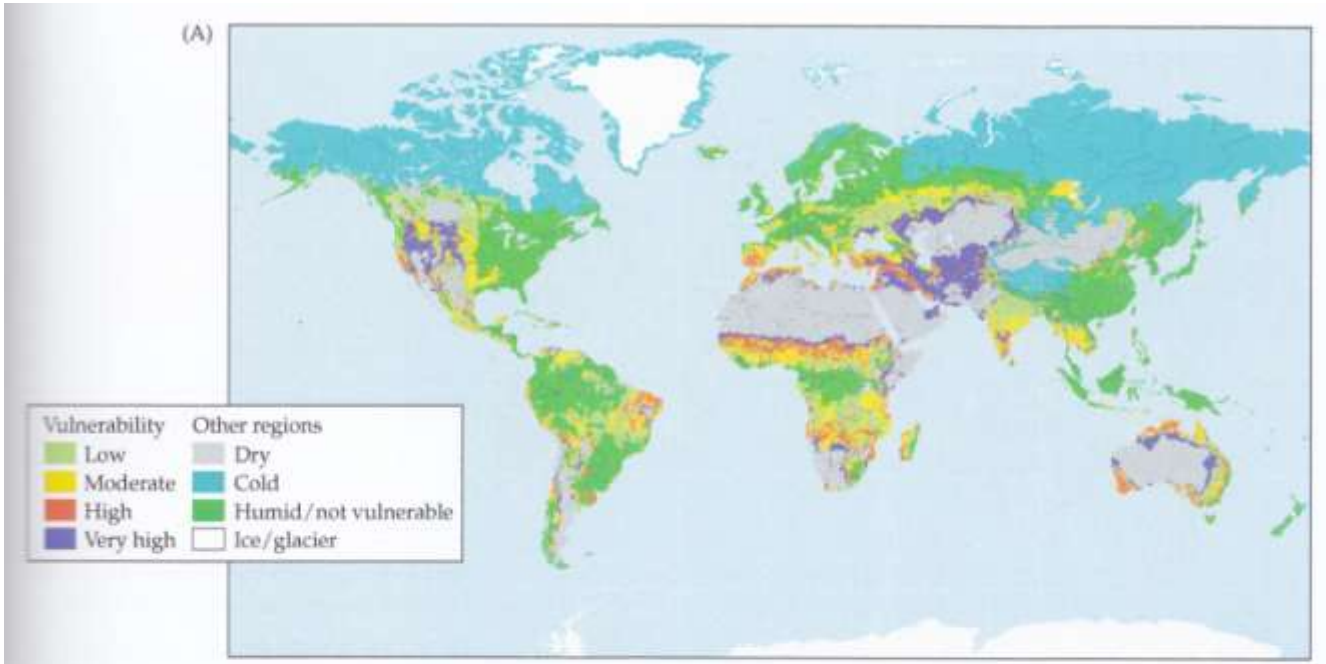
- 20% destroyed
- degradation by overfishing, pollution,
- invasive species
- climate change



Desertification

Dry area covers 41% of world's land area, home of 1 billion people

9 million km^2 converted to man-made desert

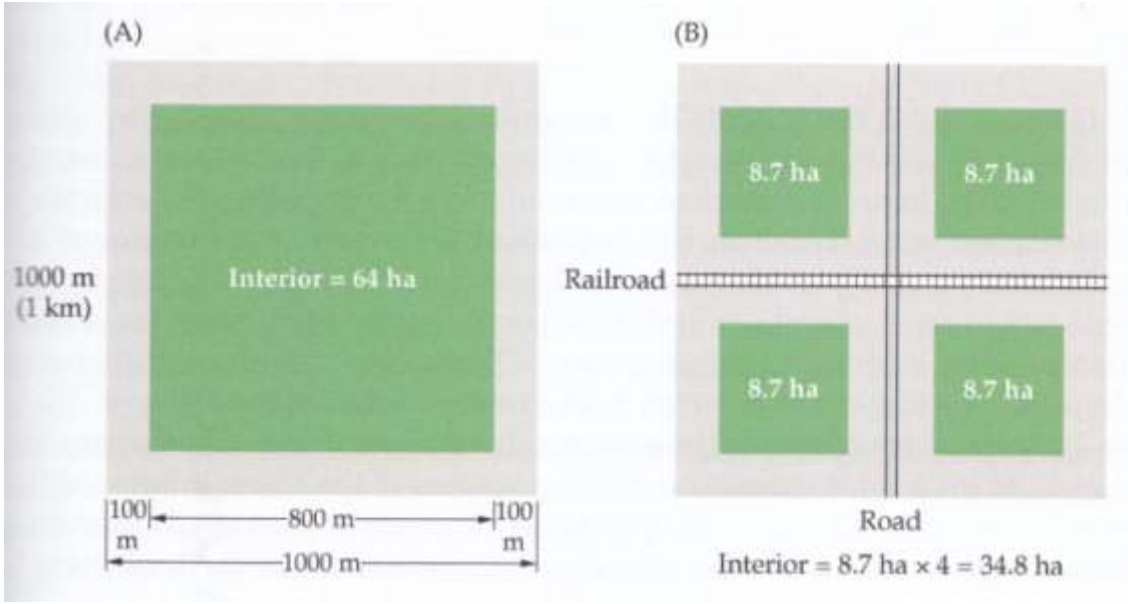




Habitat fragmentation

Habitats fragments differ from the original habitat:

1. Fragments have a greater amount of edge
2. The center of each habitat fragment is closer to an edge
3. A formerly continuous habitat hosting large populations is divided into pieces, with smaller populations



Habitat fragmentation

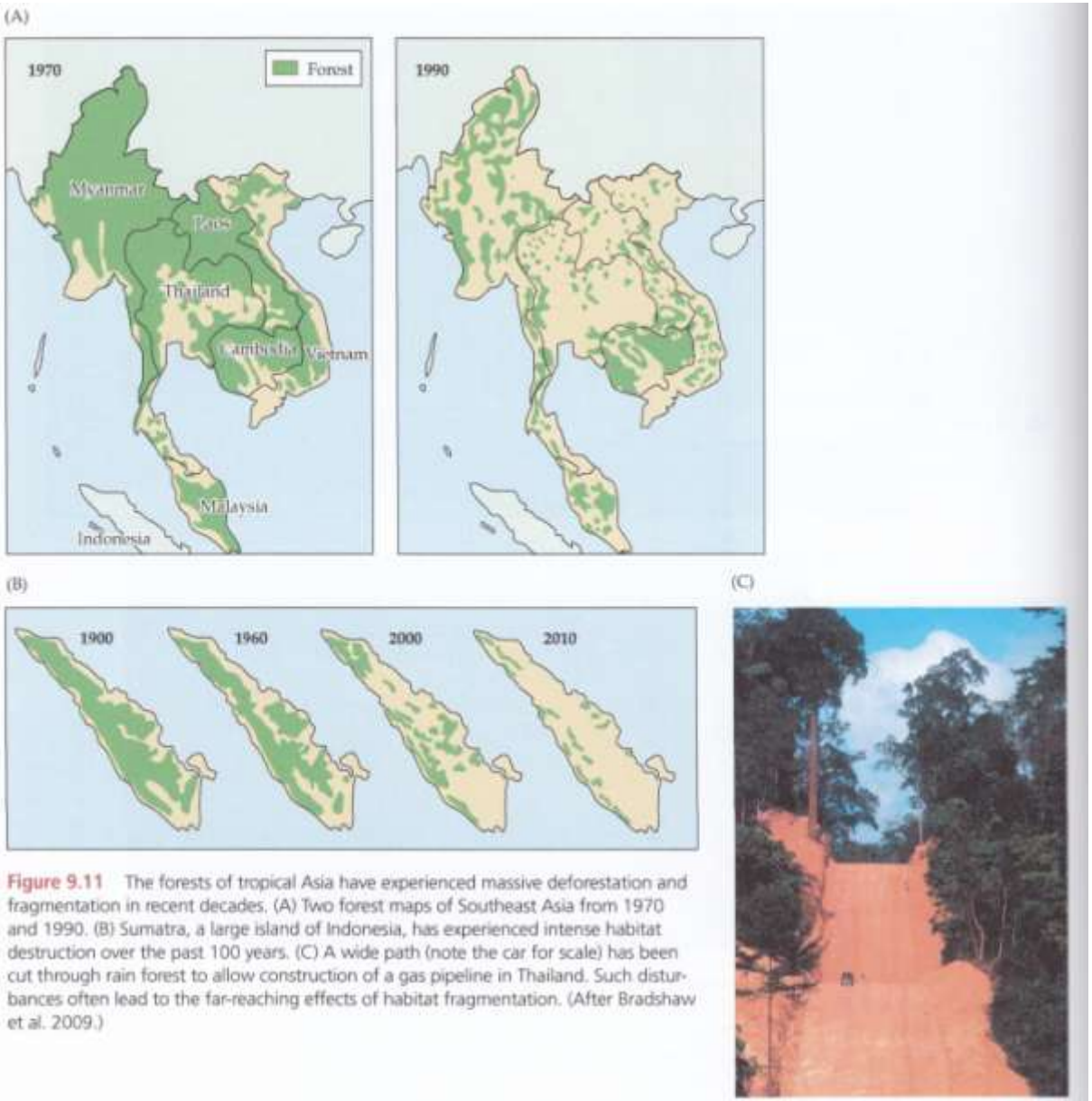
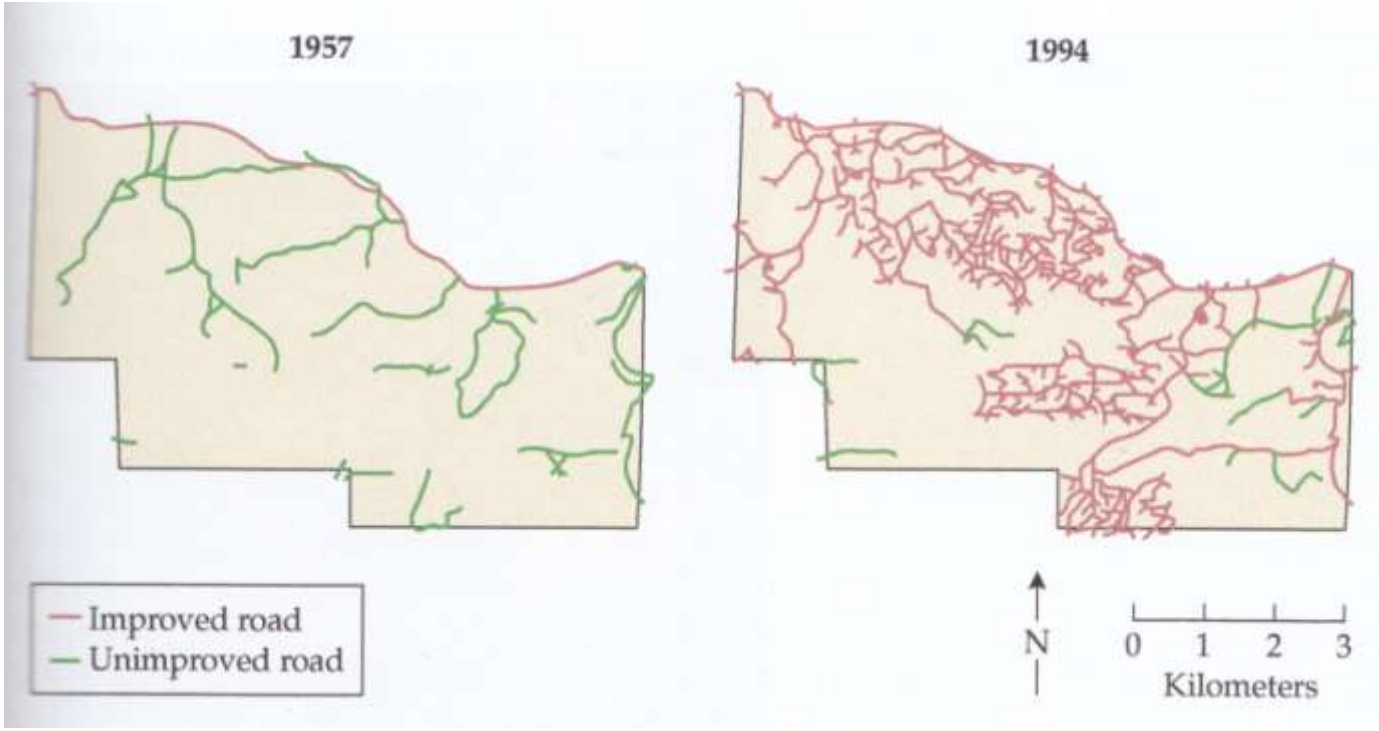


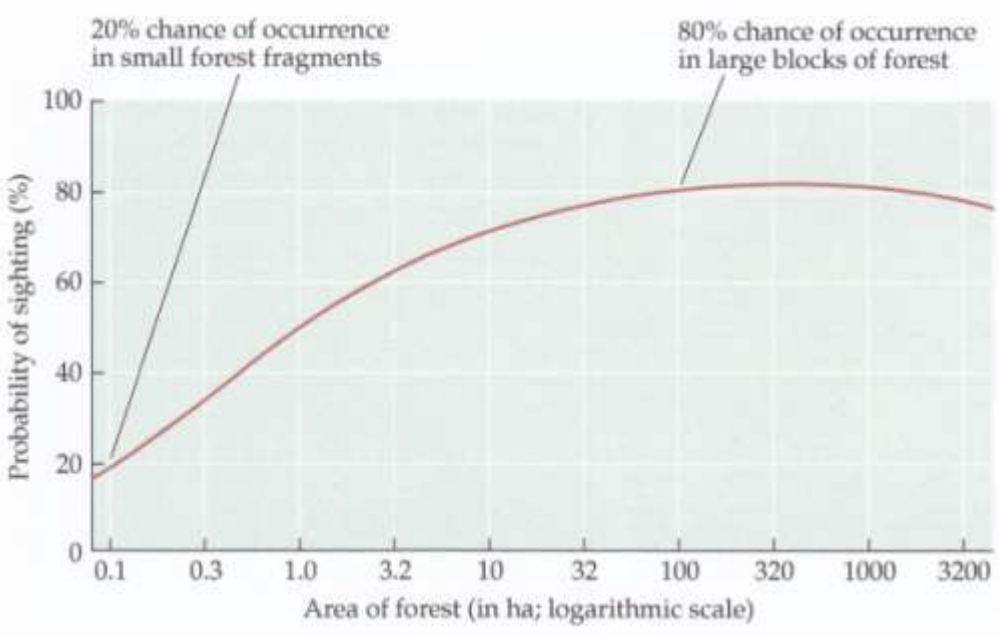
Figure 9.11 The forests of tropical Asia have experienced massive deforestation and fragmentation in recent decades. (A) Two forest maps of Southeast Asia from 1970 and 1990. (B) Sumatra, a large island of Indonesia, has experienced intense habitat destruction over the past 100 years. (C) A wide path (note the car for scale) has been cut through rain forest to allow construction of a gas pipeline in Thailand. Such disturbances often lead to the far-reaching effects of habitat fragmentation. (After Bradshaw et al. 2009.)

Habitat fragmentation

Dirt roads in Colorado, US



Habitat fragmentation



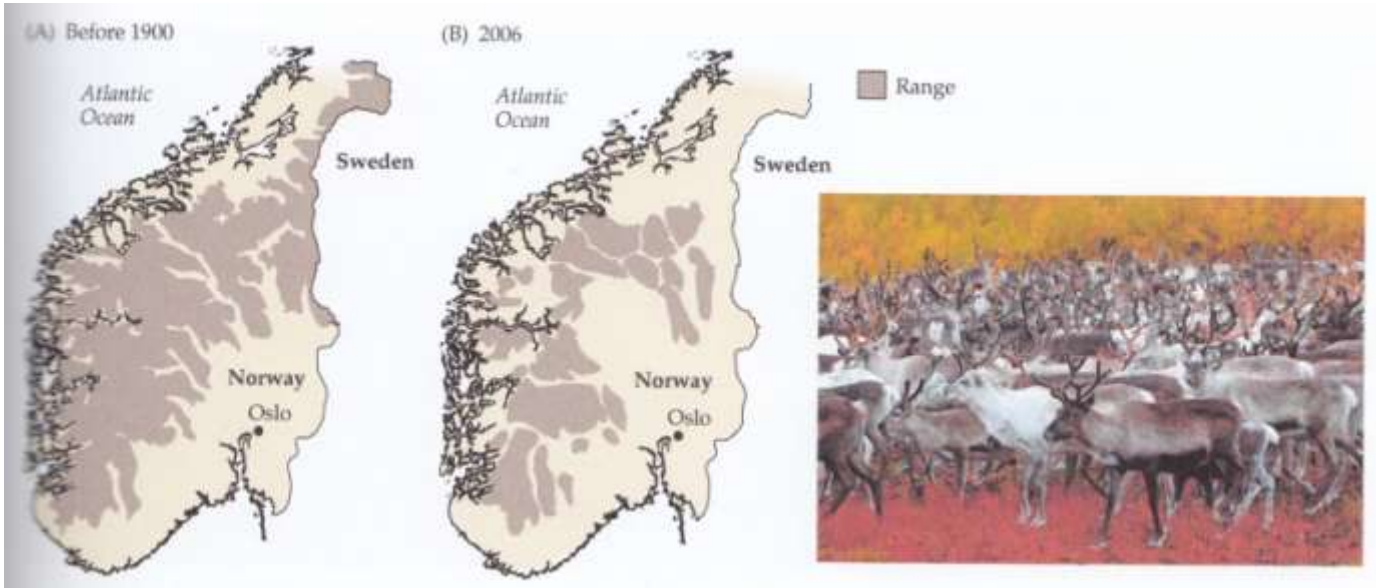


Habitat fragmentation

Population effects:

- Limits to dispersal and colonization
- Restricted access to food and mates
- Division of populations

Wild reindeer population in Southern Norway

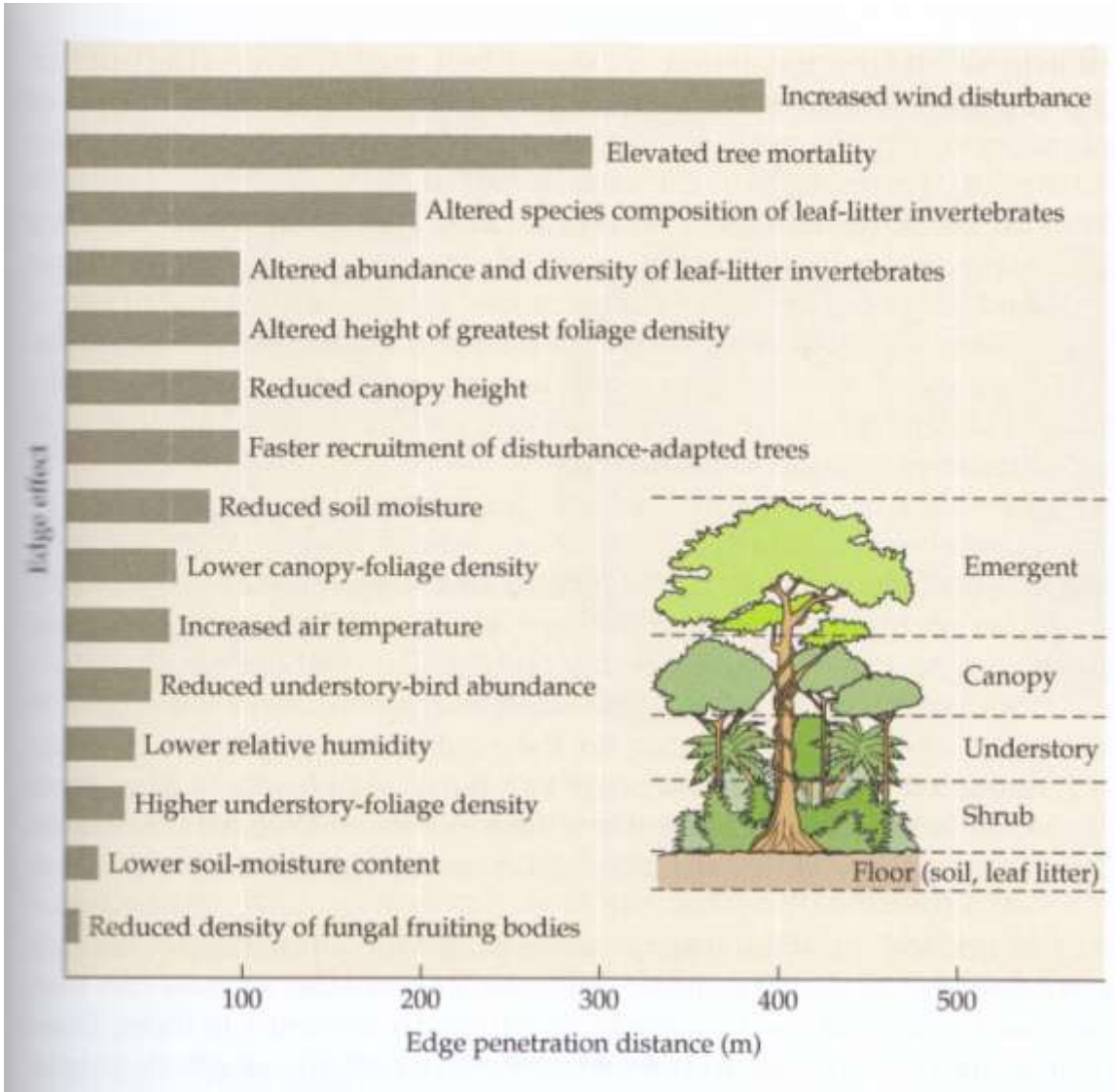


Habitat fragmentation

Edge effects:

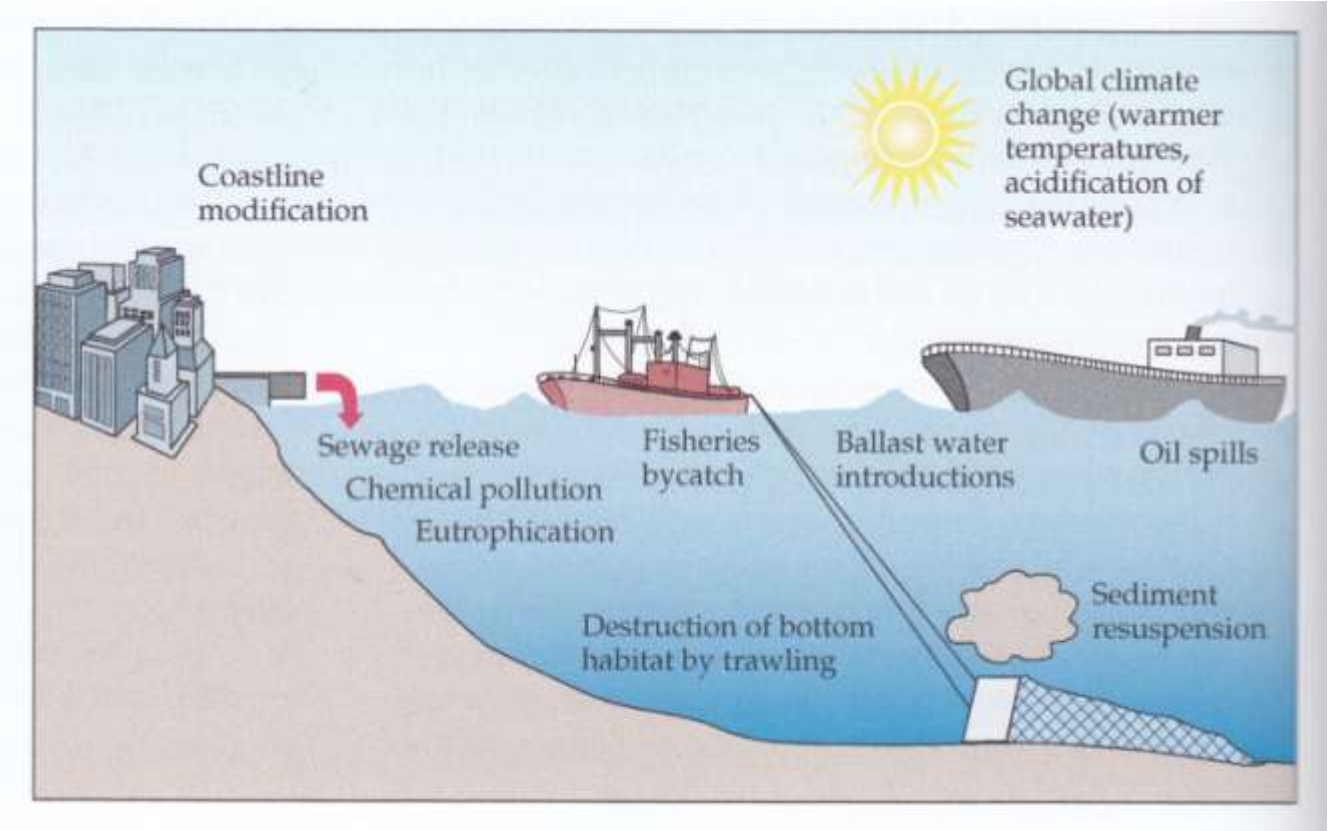
- Microclimate changes
- Increased incidence of fire
- Interspecies interaction
- Potential for disease

Edge effects in the Amazon rain forest



Habitat degradation and Pollution

- Overgrazing and trampling grasslands by too many cattles
- Fishing trawlers across ocean floors

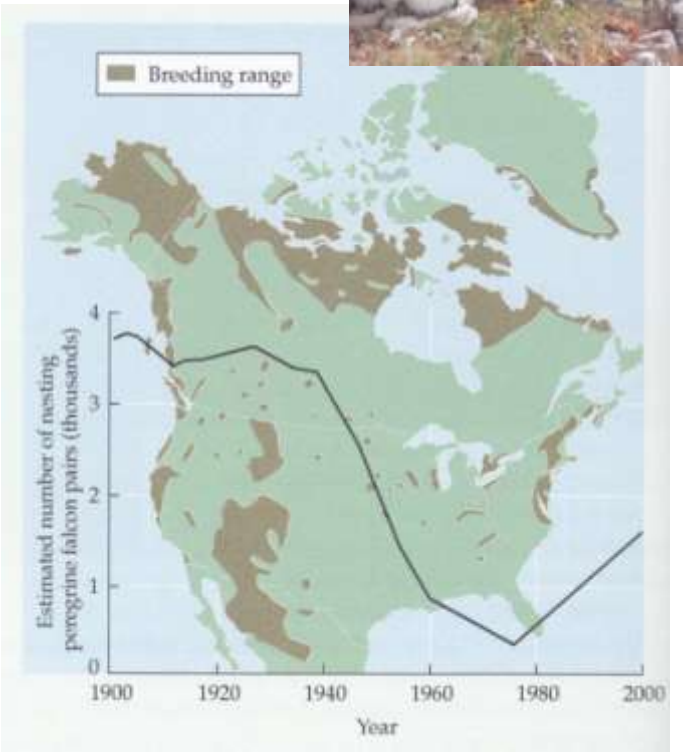


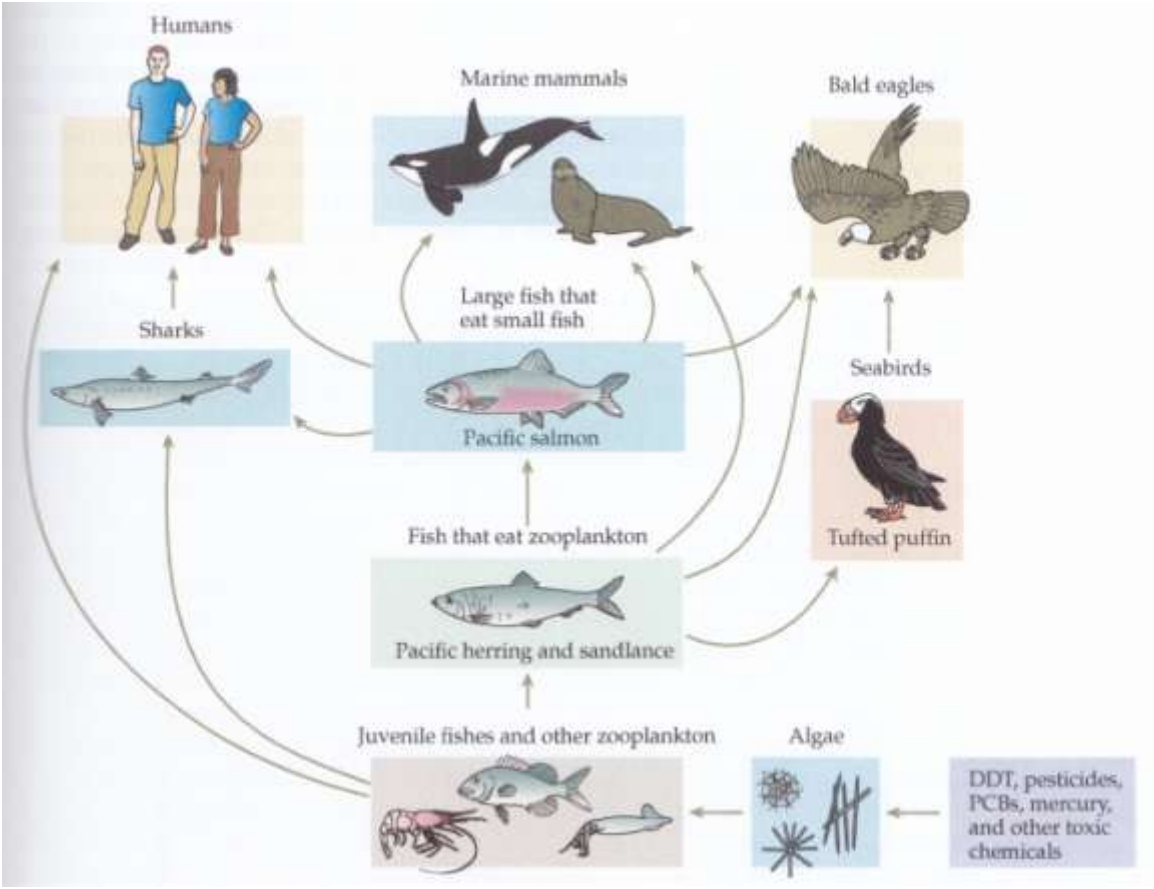
Habitat degradation and Pollution

Pesticide pollution

- bio-magnification through the food chain







Habitat degradation and Pollution

Water pollution

Pesticides, herbicides, oil products, heavy metals, detergents, toxic chemicals, medicines, human sewage, agricultural fertilizers

Eutrophication







Habitat degradation and Pollution

Air pollution

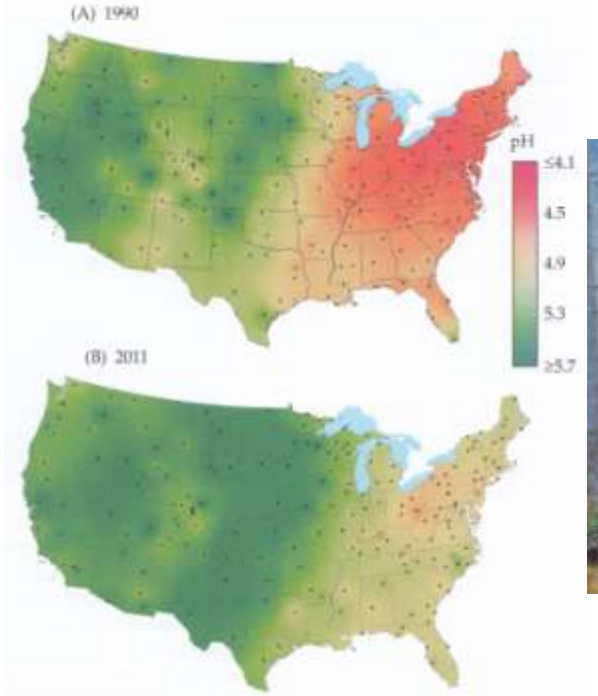
Acid rain

Ozone production

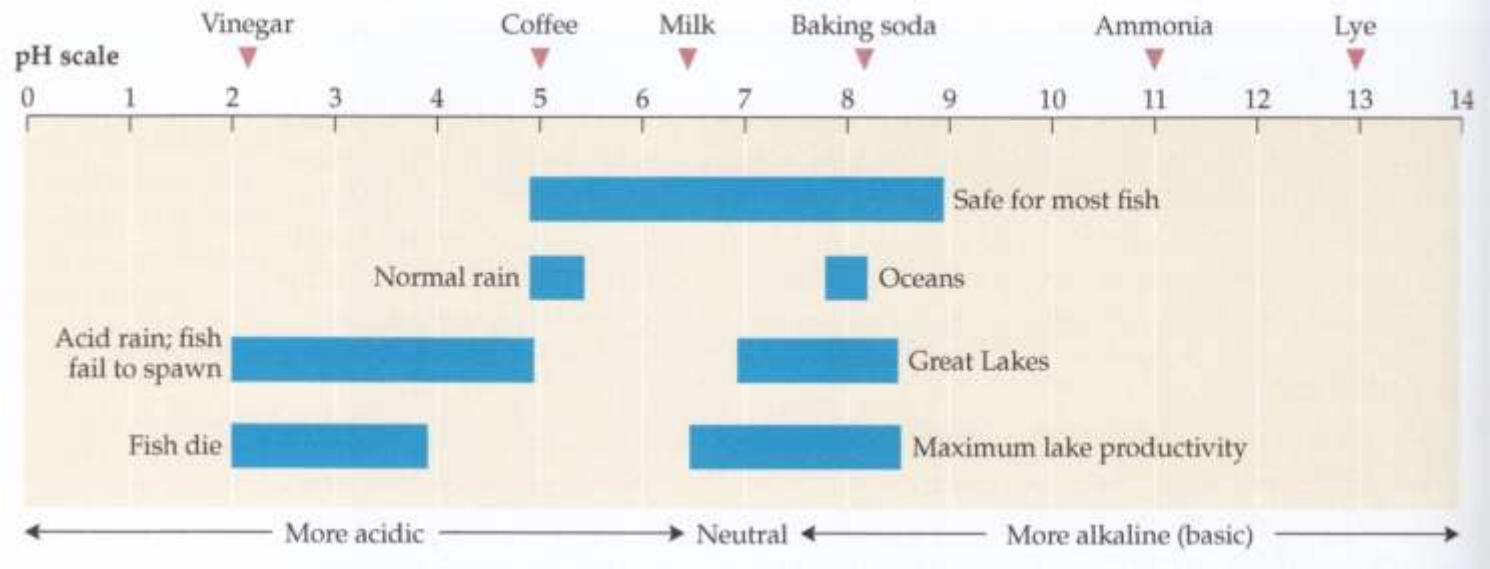
Nitrogen deposition

Toxic metals

leaded gasoline

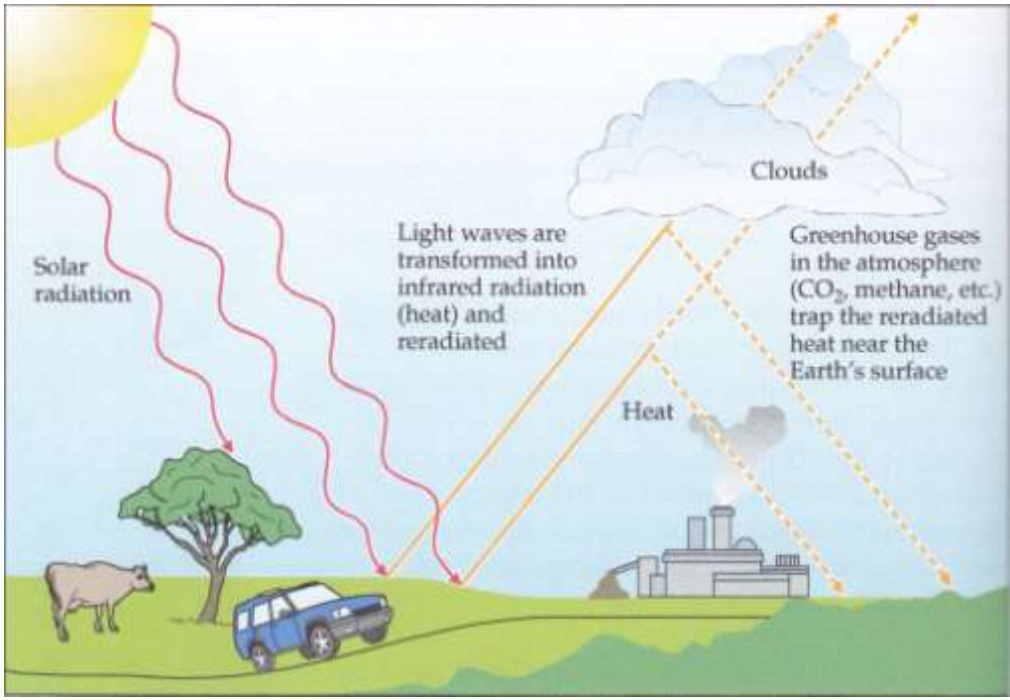


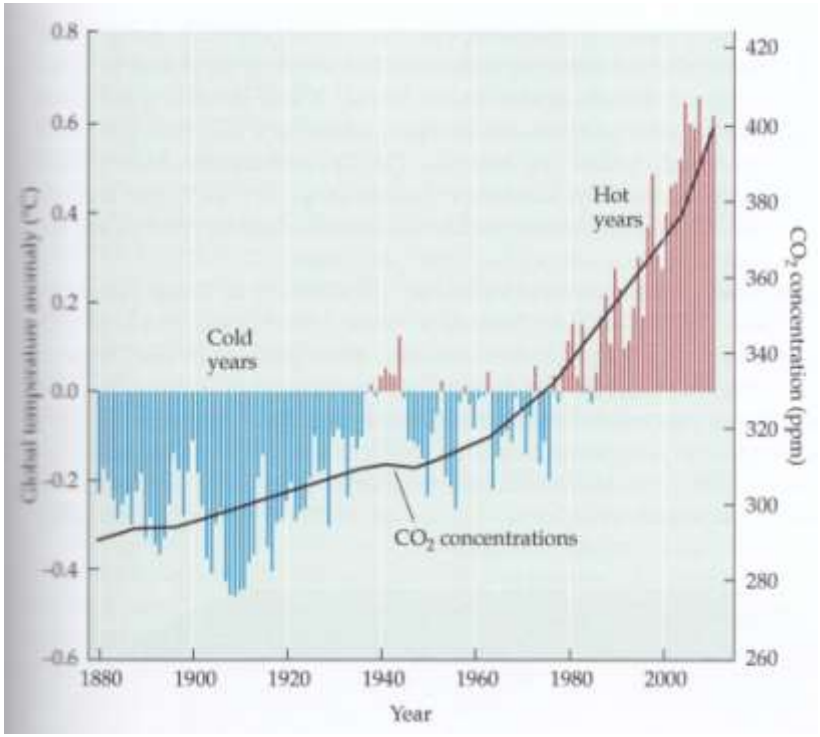




Global Climate Change

Greenhouse effects by greenhouse gases





Global Climate Change

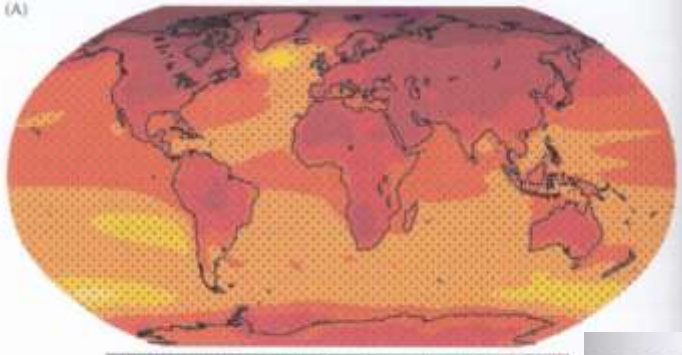


TABLE 9.3 | Some Evidence for Global Warming

1. **Increased temperatures and incidence of heat waves**
Examples: The ten warmest years between 1880 and 2013 have all occurred since 1998. A heat wave across southern China in 2013 was one of the most severe on record in terms of geographical extent, duration, and intensity—more than 300 stations exceeded 40°C (104°F) during the event.

2. **Melting of glaciers and polar ice**
Examples: Arctic Sea summer ice has declined by 11% in area each decade since the 1970s. Of the 150 glaciers in Glacier National Park (Montana) in 1850, only 25 are still larger than 25 acres.

3. **Rising sea levels**
Examples: The rate of sea level rise since the mid-ninteenth century has been faster than during the previous two millennia. Since 1938, one-third of the coastal marshes in a wildlife refuge in Chesapeake Bay have been submerged by rising seawater.

4. **Earlier spring activity**
Examples: Spring now arrives more than 10 days earlier in the Northern Hemisphere than it did in the 1950s. In 2010 and 2012, plants in Massachusetts and Wisconsin flowered earlier than they had in recorded history.

5. **Shifts in species' ranges**
Examples: The ranges of spiders, ground beetles, butterflies, and grasshoppers have shifted northward by more than 50 km (30 miles) over the past 25 years in the United Kingdom. On average worldwide species' ranges are shifting 17 km closer to the poles each decade.

6. **Population declines**
Examples: Climate change has been implicated in the extinction of populations of American pika, desert bighorn sheep, checkerspot butterflies, and several lizard and fish species.

Sources: IPCC; NOAA; NASA; USGS; Union of Concerned Scientists; Chen et al. 2011; Cahill et al. 2013.

Global Climate Change

Rising see levels and warmer waters

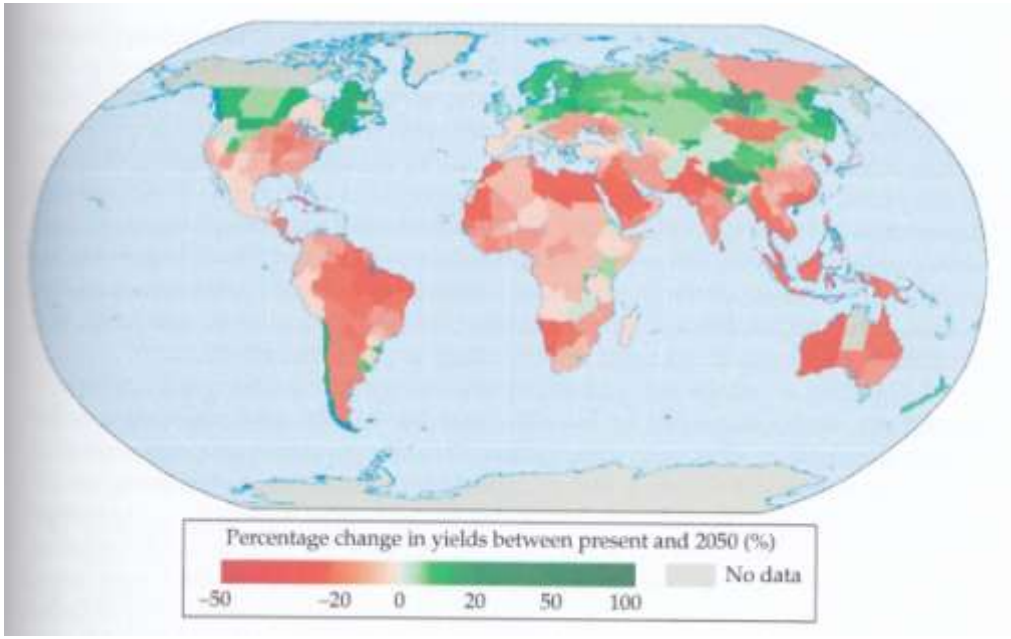
By 2100,see levels rise 40-60 cm or even 100 cm

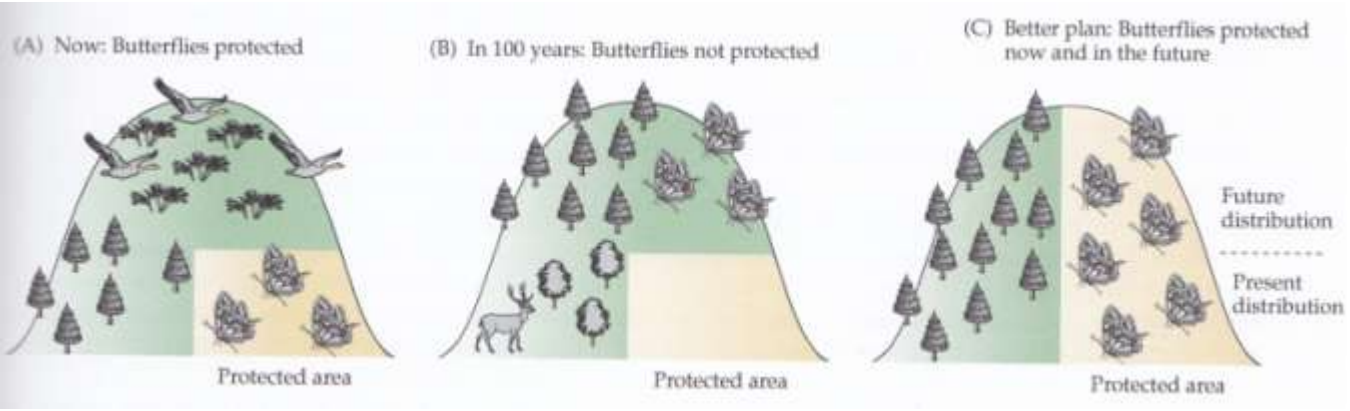




Global Climate Change

Radically restructure ecosystems and change the ranges of many species





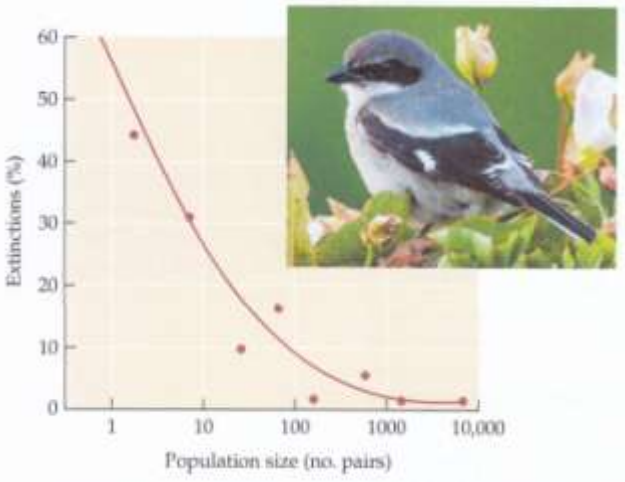
Conservation at the Population and Species level

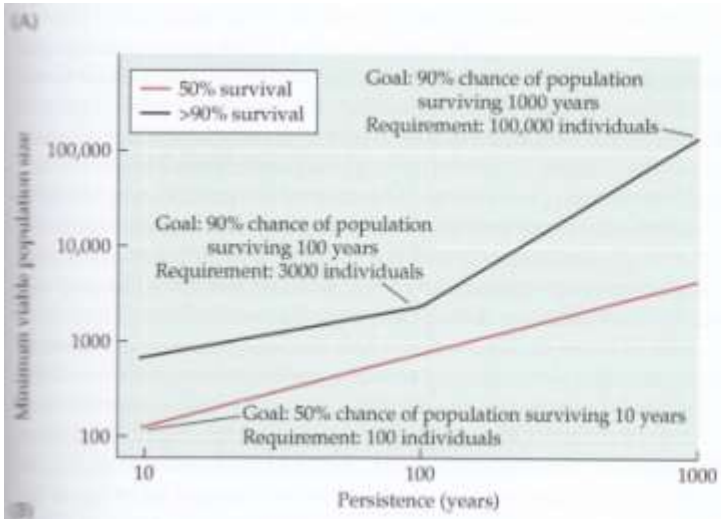


Minimum viable population (MVP)

99% chance of remaining extant for 1000 years despite the foreseeable effects of demographic, environmental, and genetic stochasticity, andnatural catastrophes

MVP: ~ 10 000 individuals





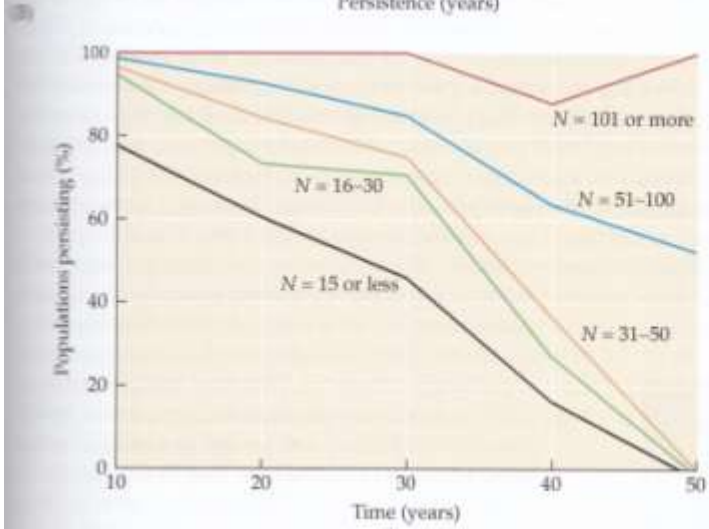
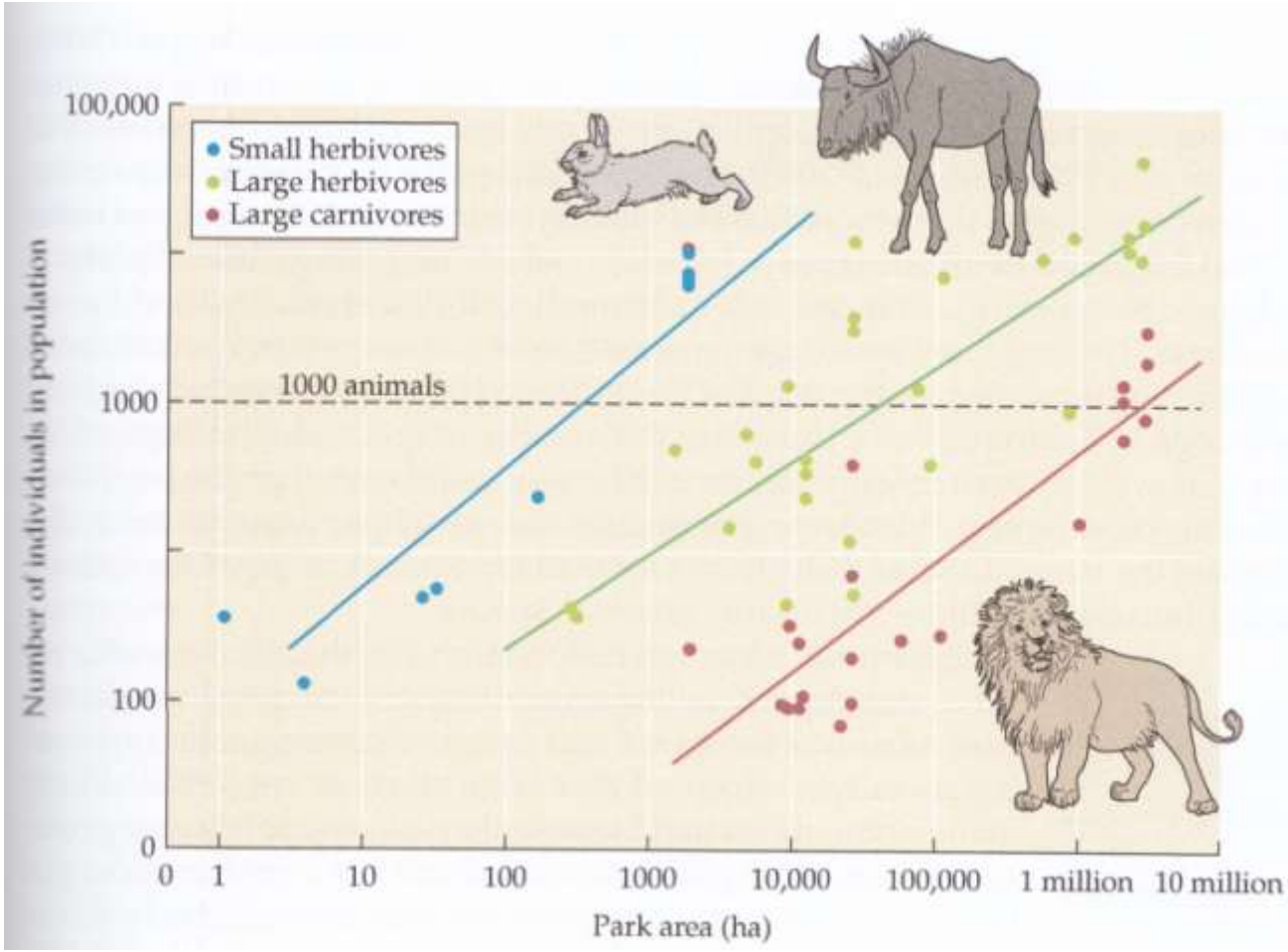


Figure 11.1 (A) If the goal is persistence for a greater number of years, then a larger minimum viable population (MVP) size is needed. A greater MVP is needed to ensure a higher probability of persistence, as illustrated in this case by a 50% probability of survival and a greater than 90% probability of survival. Both axes are on log scales. The values were derived from changes in population size and persistence of 1198 species. (B) The relationship between initial population size (*N*) of bighorn sheep and the percentage of populations that persist over time. Almost all populations with more than 100 sheep persisted beyond 50 years, while populations with fewer than 50 individuals died out within 50 years. Not included are small populations that were actively managed and augmented by the release of additional animals. (A, after Traill et al. 2010; B, after Berger 1990.)



Minimum dynamic are (MDA)

The area of suitable habitat necessary for maintaining the minimum viable population

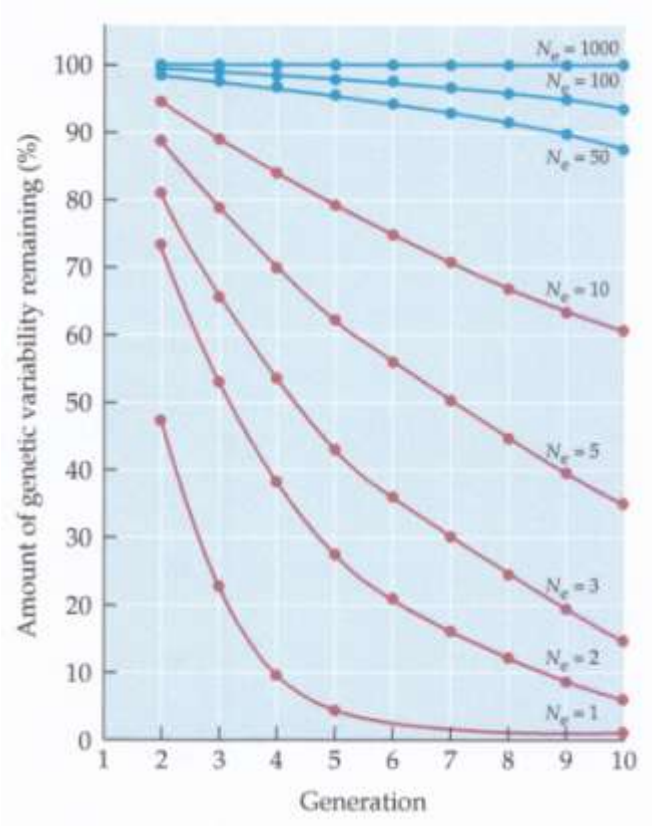


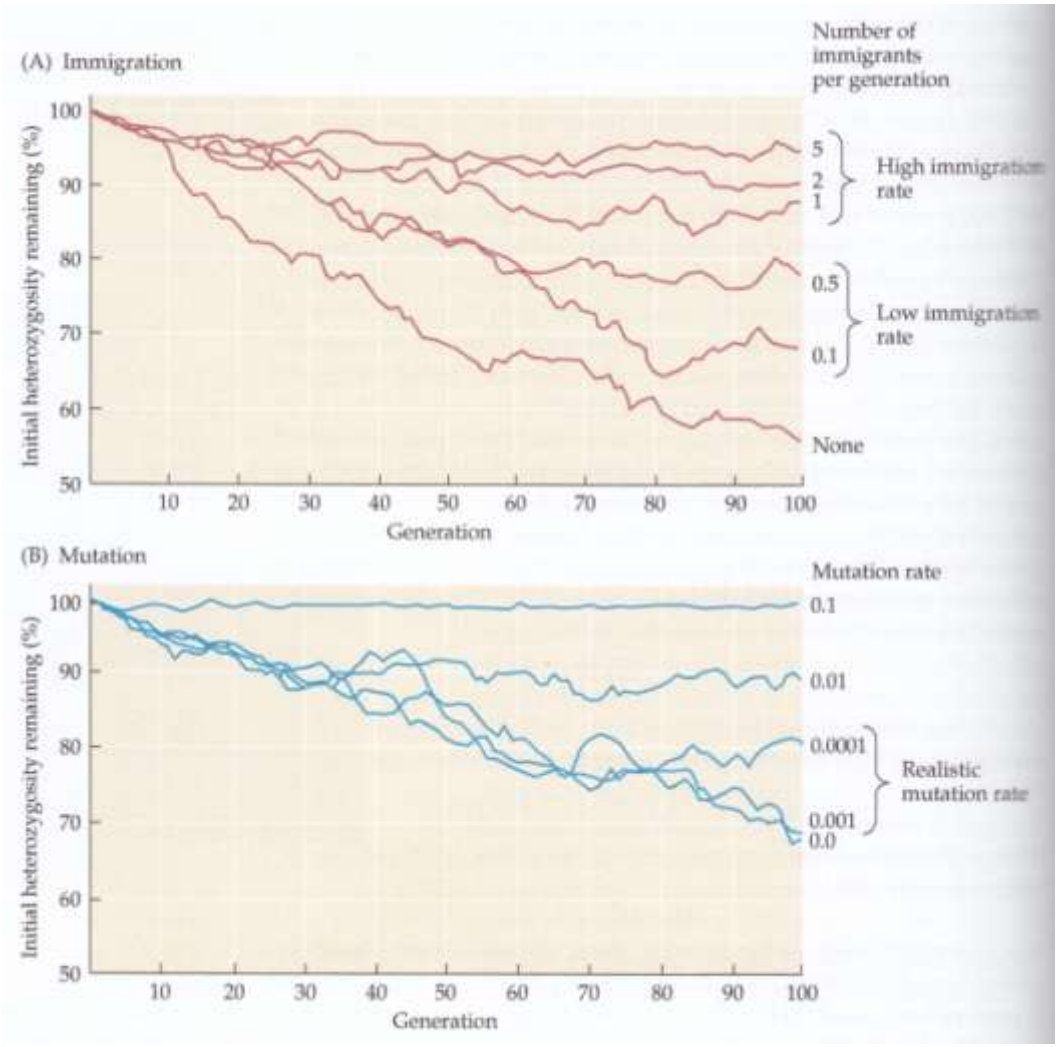
Small population are subject to rapid decline

- Loss of genetic variability and related problems of inbreeding depression and genetic drift
- Demographic fluctuations due to random variations in birth and death rates
- Environmental fluctuations due to variation in predation, competition, disease, and food suply and due to natural catastrophes that occur at regular intervals, such as fires, floods,storms, or drought

Loss of genetic variability

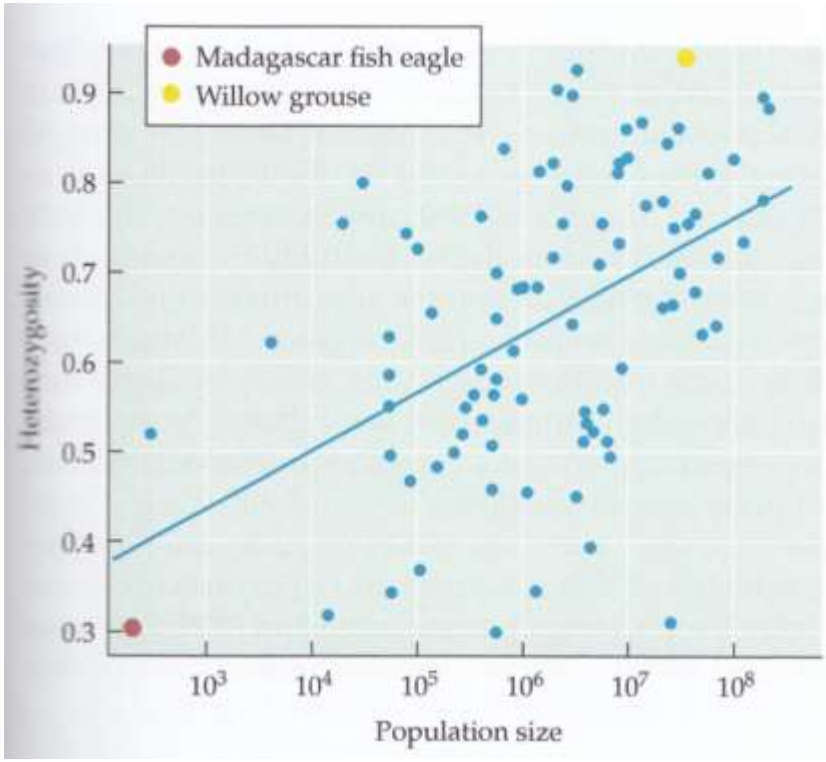
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Loss of genetic variability

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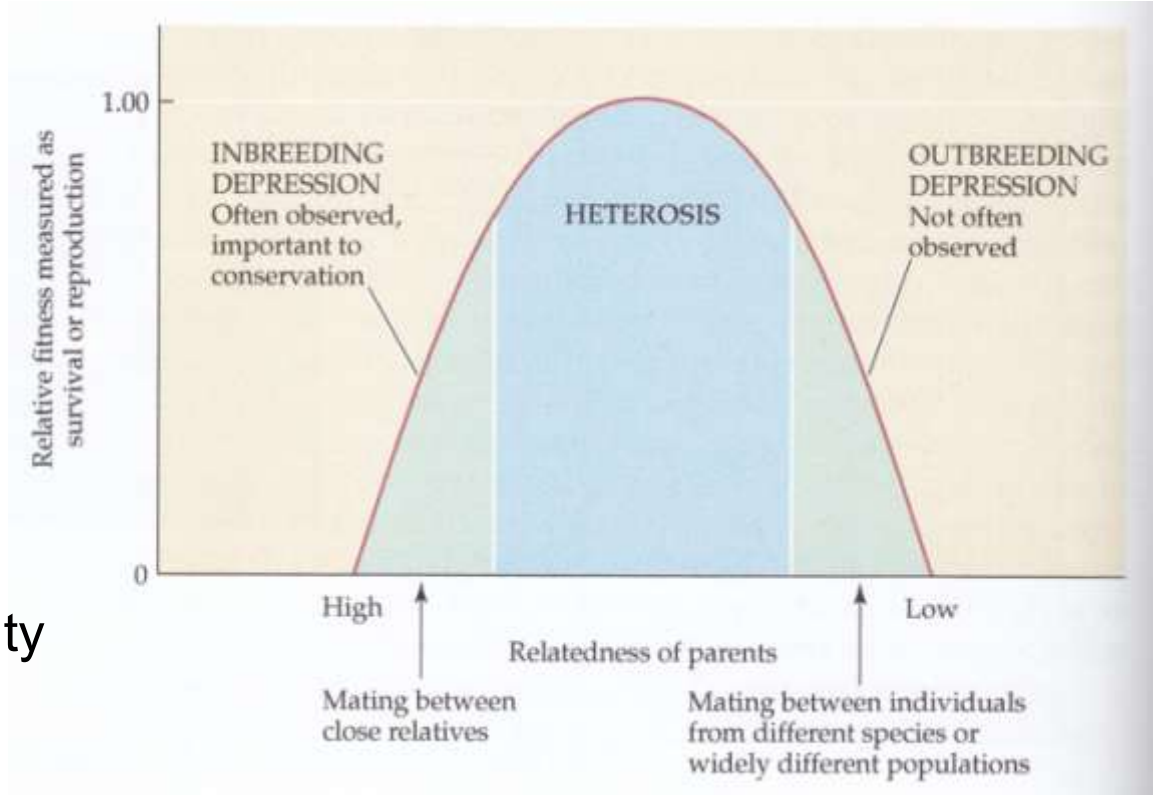




Consequences of reduced genetic variablity

Outbreeding depression

mating with different populations or species

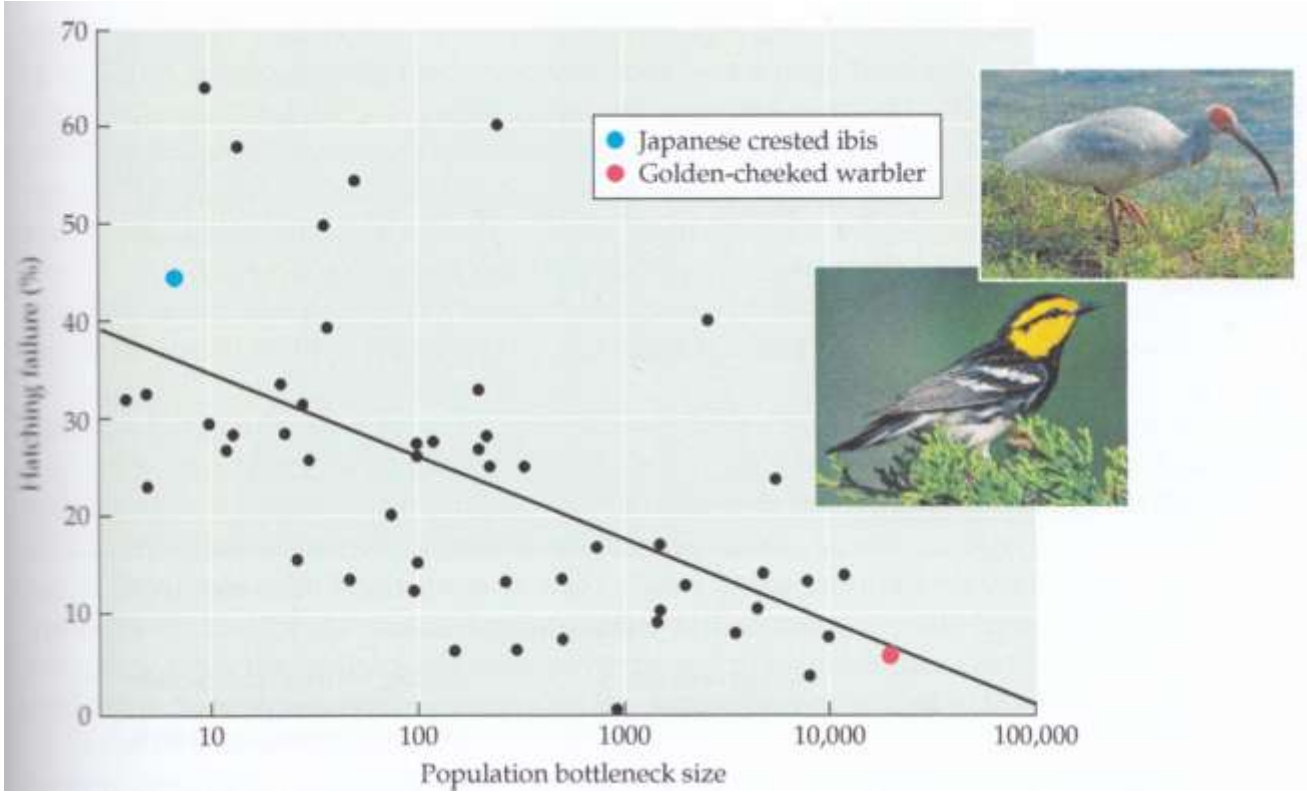


Loss of evolutionary flexibility

Consequences of reduced genetic variablity

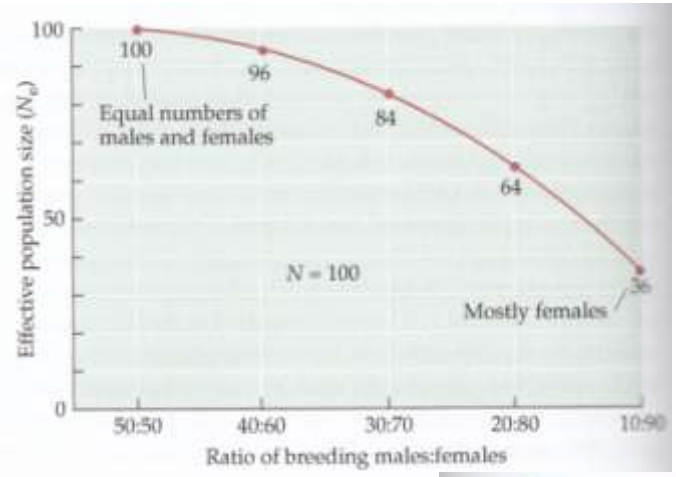
Inbreeding depression

mating among close relatives



Factors that determine effective population size (N_e)

The effective population size N_e will be much smaller than the total population size N when there is a great variation in reproductive output, an unequal sex ratio, or population fluctuations and bottlenecks



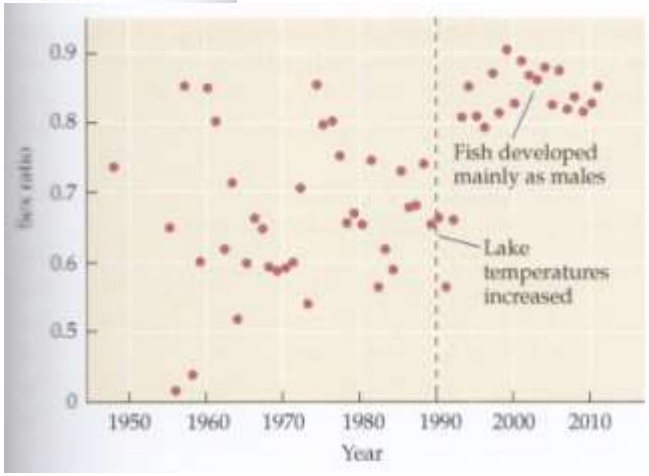


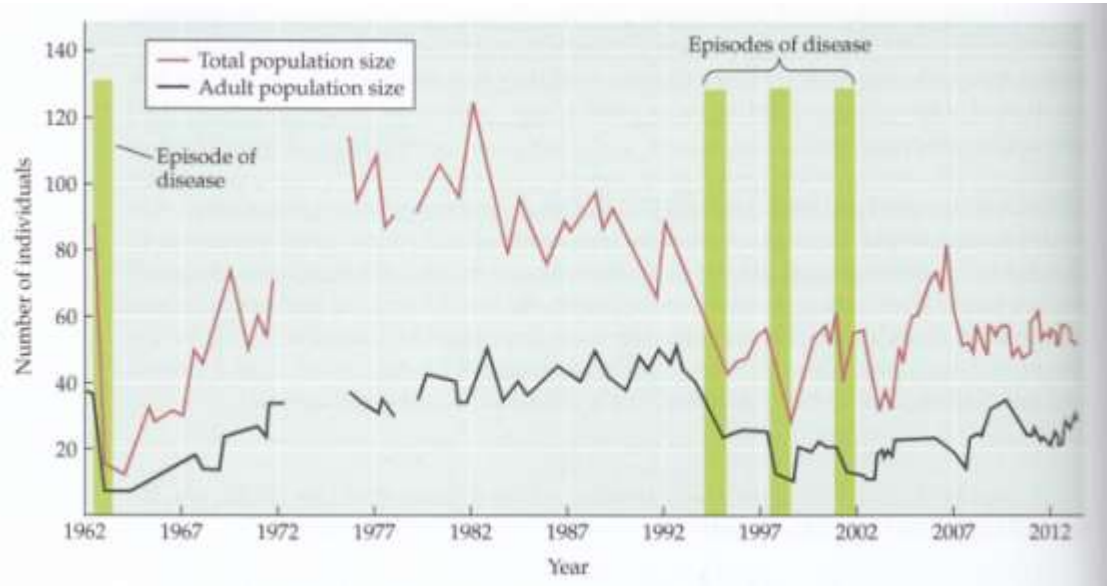


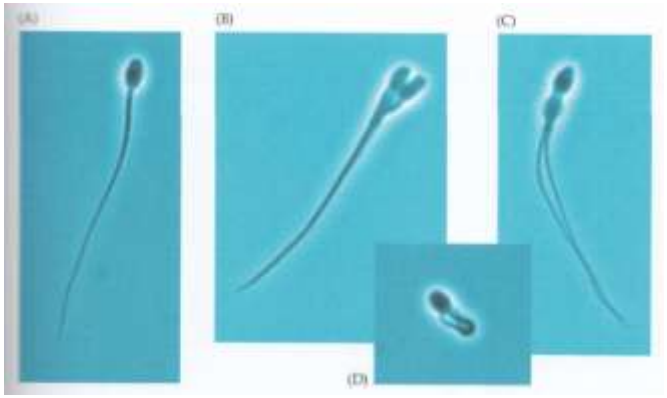
Figure 11.10 (A) The sex ratio of grayling, a fish in the salmon family, in Lake Thun, Switzerland, has shifted from being around 65% male (and highly variable) before 1990, to consistently 80%–90% male after 1990, when lake temperatures increased. The sex ratio is best explained by the temperature fish experience in their first year. (After Wedekind et al. 2013.)

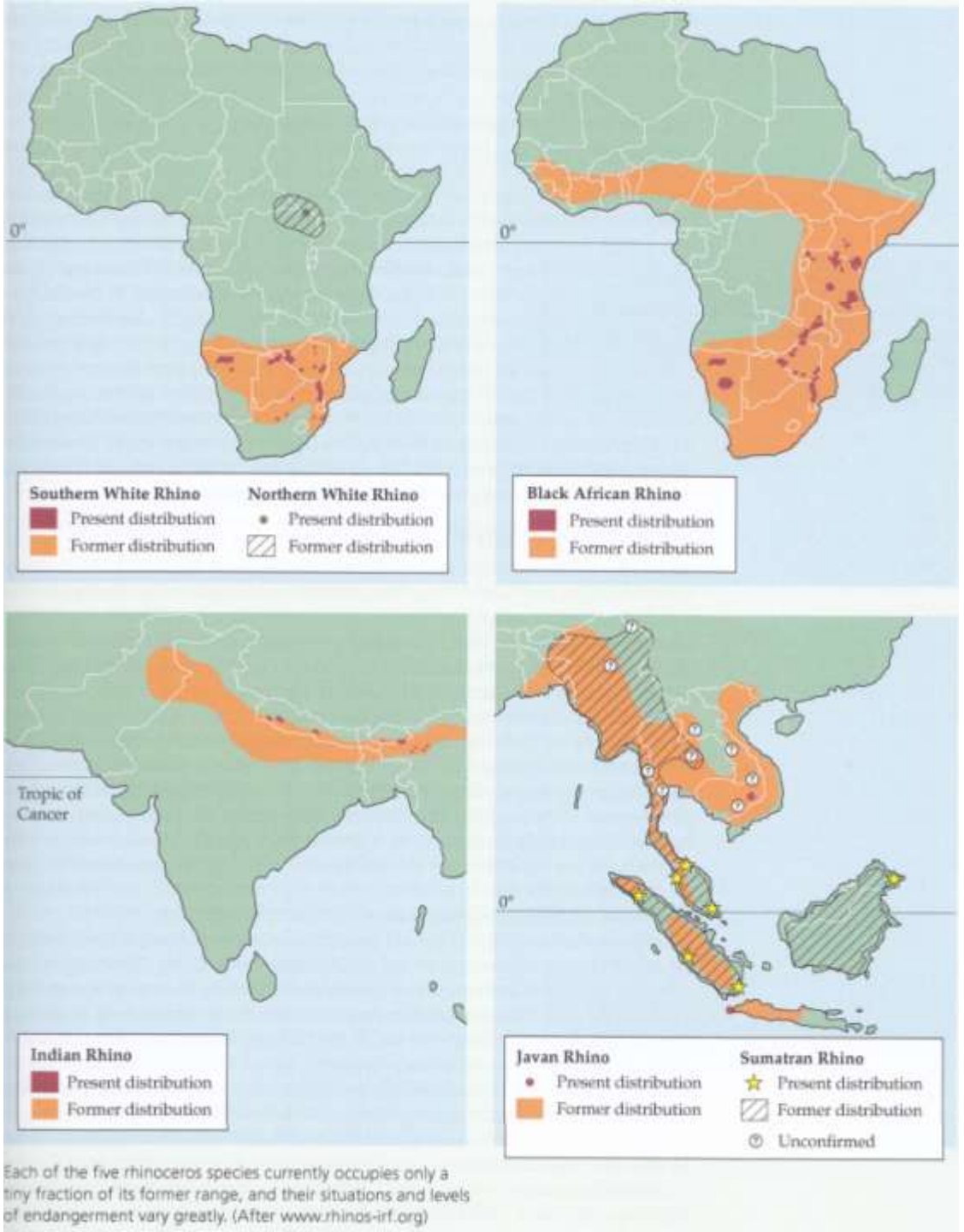
Population bottleneck

Population is greatly reduced in size and loses rare alleles if no individuals posesing those alleles survive and reproduce

The lions of Ngorongoro crater in Tanzania – following large decline because of canin distemper, population is increased but males exhibit high level of sperm abnormalities





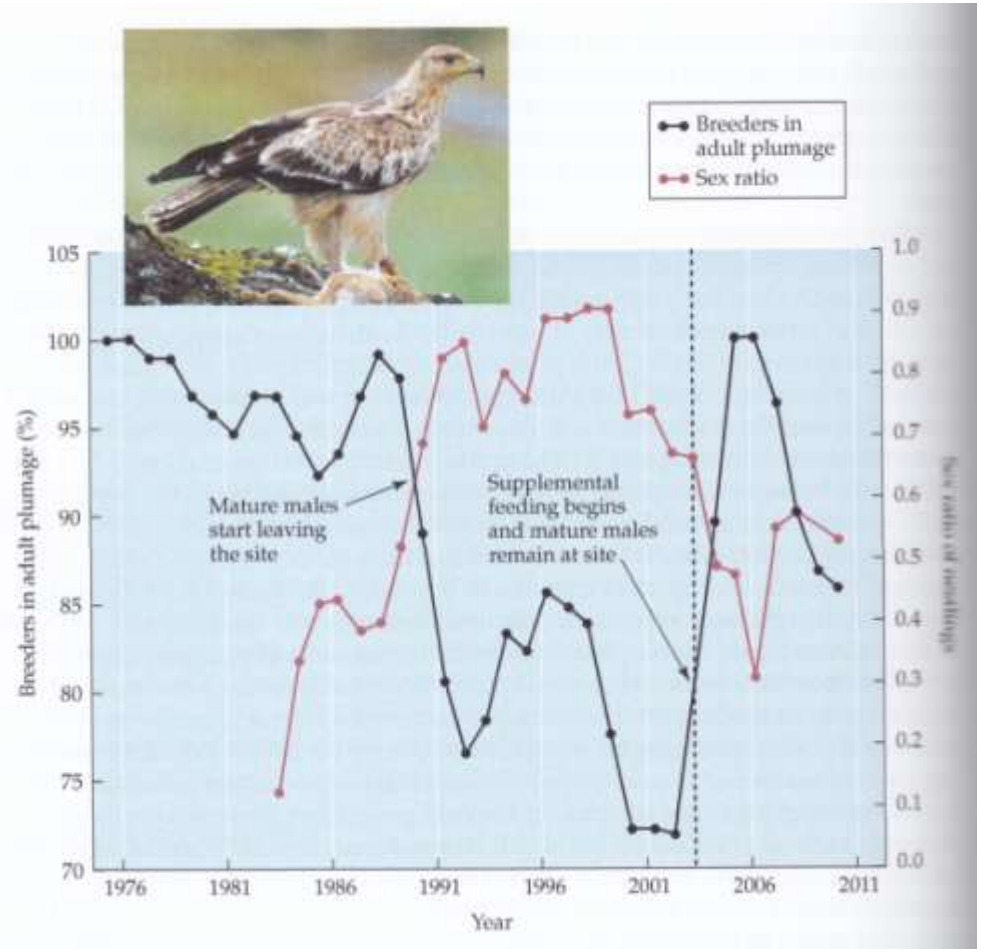


Each of the five rhinoceros species currently occupies only a tiny fraction of its former range, and their situations and levels of endangerment vary greatly. (After www.rhinos-irf.org)

Other factors affect the persistence of small population

Demographic stochasticity

random fluctuations of birth and death rates



Population density and Allee effect

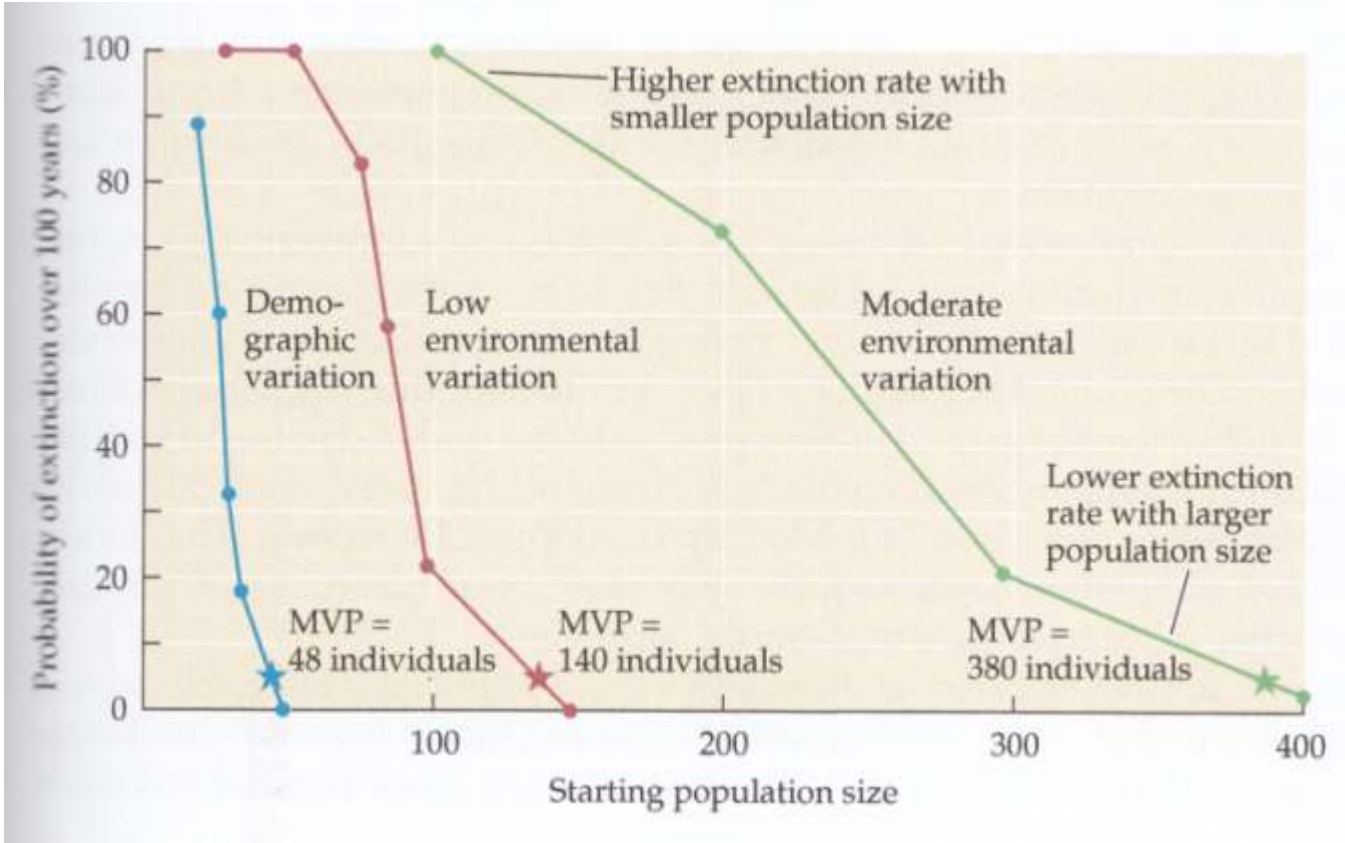
The social and breeding system, efficiency of foraging, antipredation behaviour falls below with decline of the population density

Environmental variation and catastrophes

Even though a population appears to be stable or increasing, an infrequent environmental event or catastrophe can severly reduce population size or even drive it to extinction.

Mexican spiny palm





Extinction Vortices

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