Biodiversity and its measurement (MKT1207)

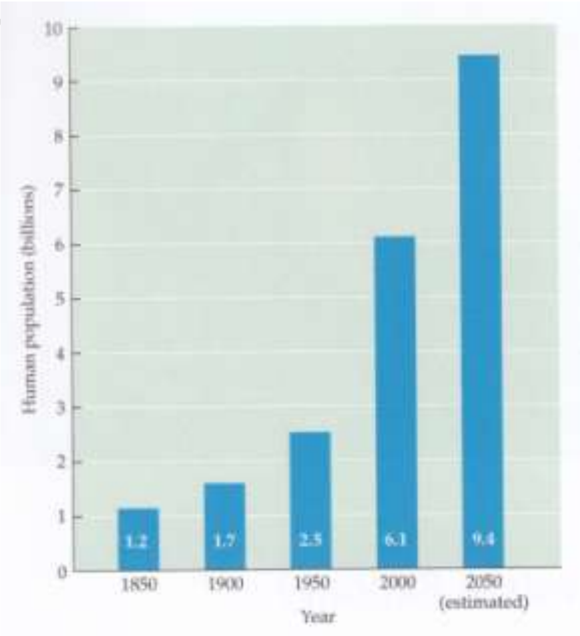
- Books:
  - Primack R. B. 2010. Essentials of Conservation Biology. Macmillan Science
  - Hill D., Fasham M., Tucker G., Shewry M., Shaw P. 2005. Handbook of Biodiversity Methods_ Survey, Evaluation and Monitoring-Cambridge University Press
  - Vorisek P, Klvanova A, Wotton S, Gregory RD (2008) A Best Practice Guide for Wild Bird Monitoring Schemes.
  - Allard A., Carina E., Keskitalo H., and Brown A. (eds) 2023. Monitoring Biodiversity Combining Environmental and Social Data. Routledge/Taylor & Francis.
  - Kindt R and Coe R. 2005. Tree diversity analysis. A manual and software for common statistical methods for ecological and biodiversity studies. Nairobi: World Agroforestry Centre (ICRAF). https://www.worldagroforestry.org/output/tree-diversity-analysis

Information in relation to the course:

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

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)

Concern for Biodiversity

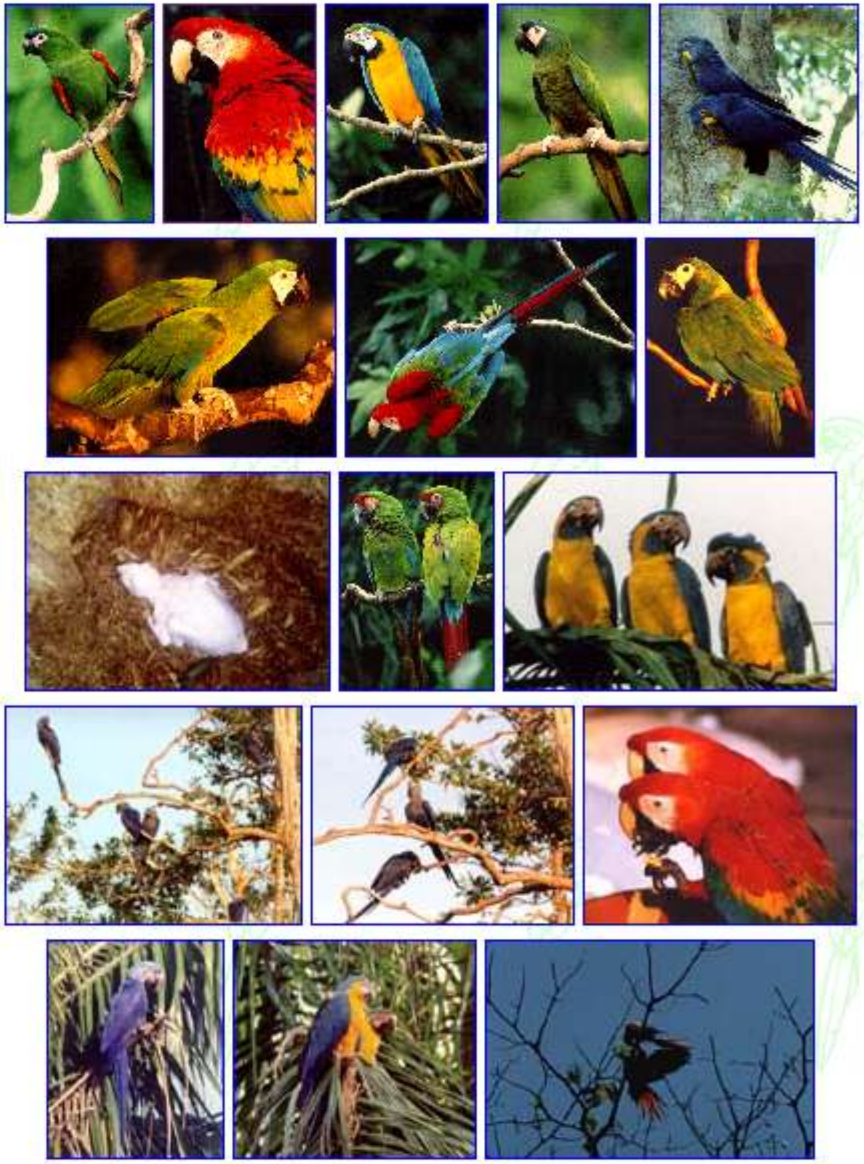
- Present threats to biodiversity is unprecentented
- Threat to biodiversity is accelerated, increasing human population – continued advances in technology
- Threat to biodiversity are synergistic
- People are realizing that what is bad for biodiversity will almost certainly bad for human

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 (indian hunting, trade, mining)
- Researches: key sources, Cainism,
- 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

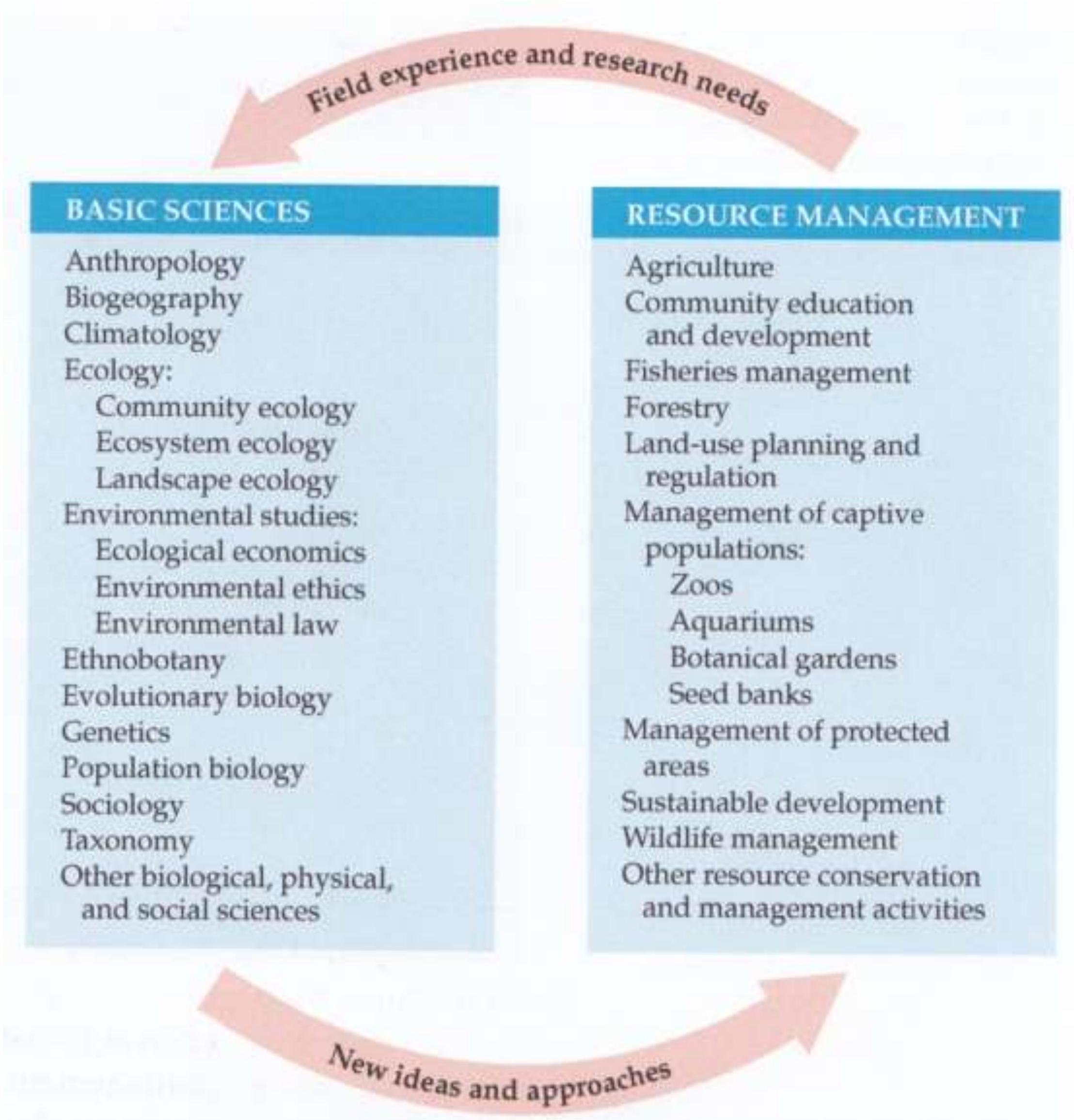
- Legislation passed in 1986 in Brazil that led to the complete protection of sea turtles and the establishment of two new biological reserves and a marine national park to protect important nesting beaches
- Established conservation stations at each of 21 main nesting beaches.
- Each station has a manager, 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



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:

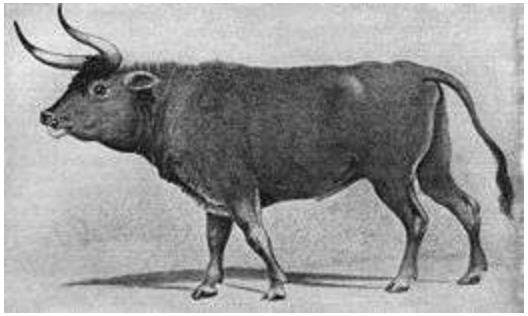
- The diversity of species and ecosystems should be preserved
- The untimely extinction of populations and species should be prevented
- Ecological complexity should be maintained
- Evolution should continue
- Biological diversity has intrinsic value

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

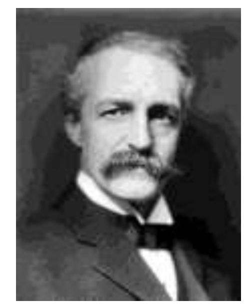


Origins of Conservation Biology

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

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**

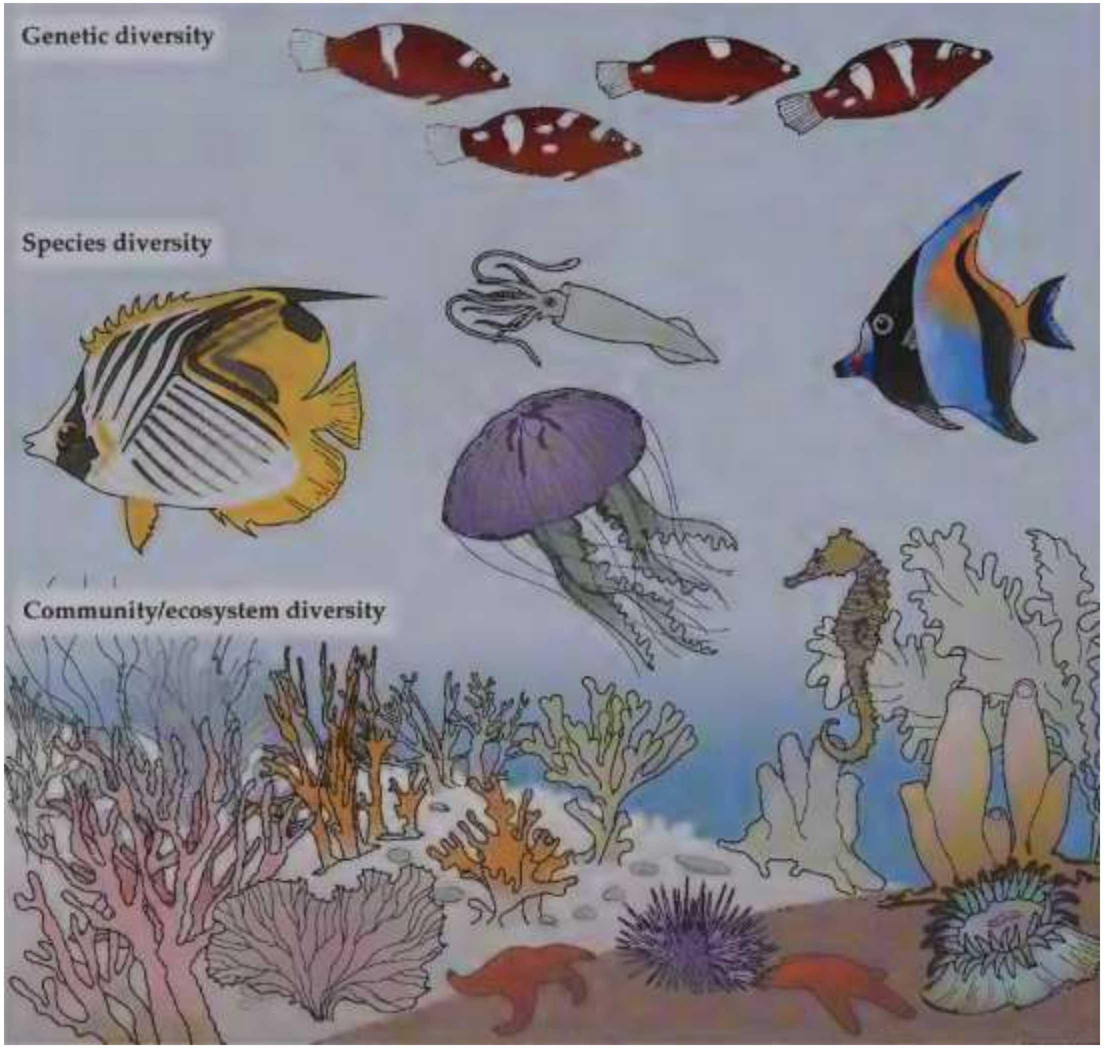
– Scientific field

Level of Biological Diversity

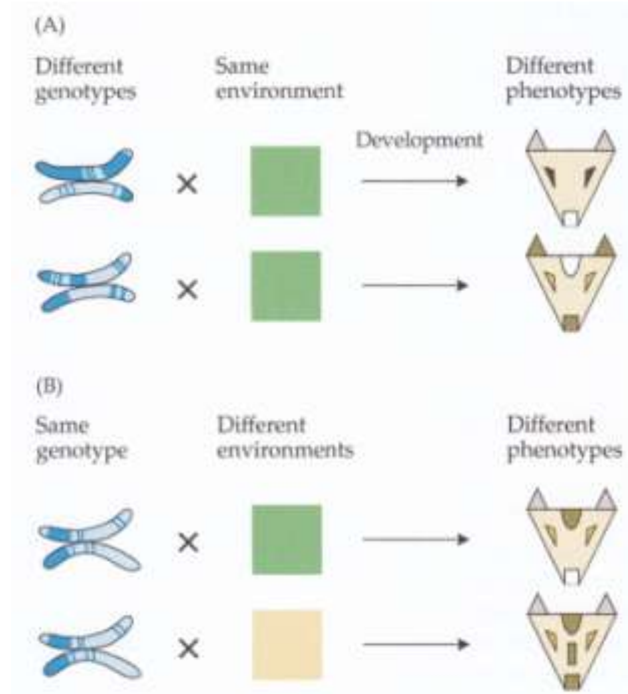
- Genetic diversity

- Taxonomic diversity

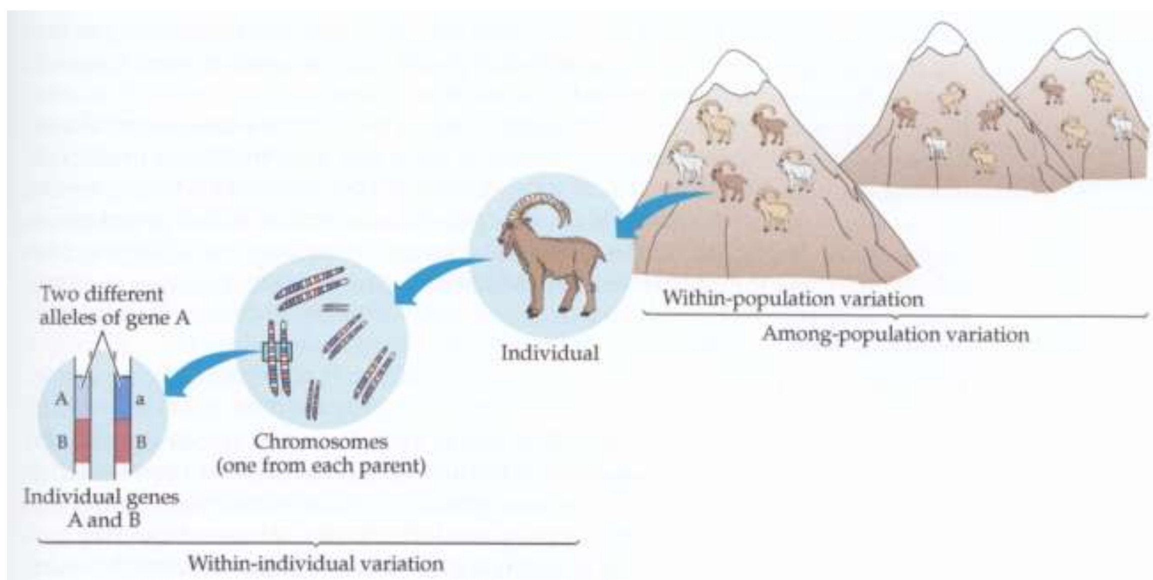
- Community diversity



Genetic diversity



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



Genetic diversity

Measurement

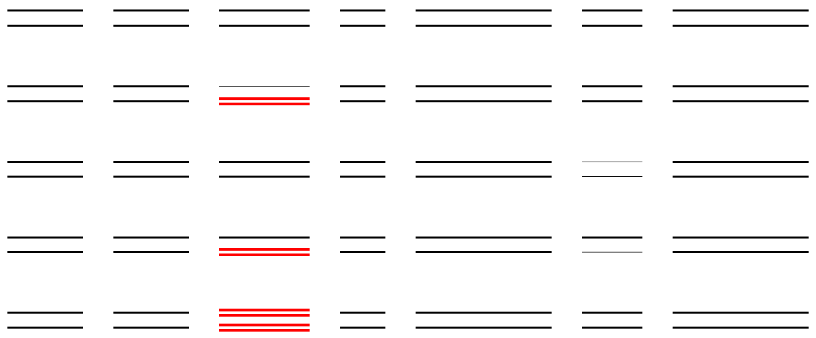
- Phenotypical diversity – e.g. isoensims
- Sequence of DNA

Polymorphism (P)

- Ratio of genes in the population with polymorphic allele

Heterozygousness (H)

The ratio of genes per individual that are polymorphic



Polymorphism and heterozygousness has positive correlation

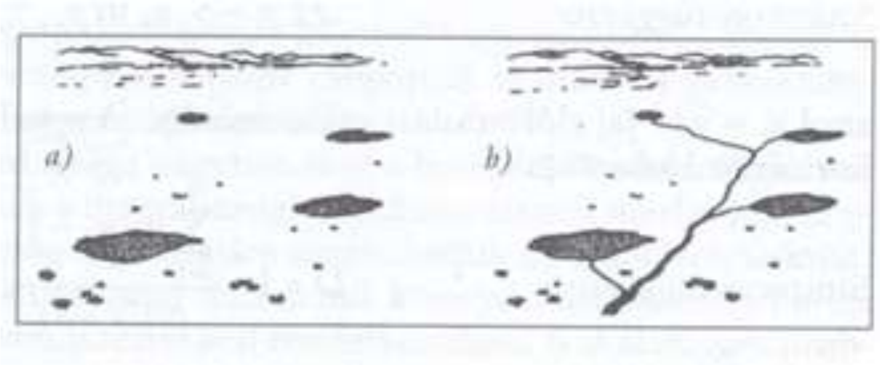
Genetic diversity

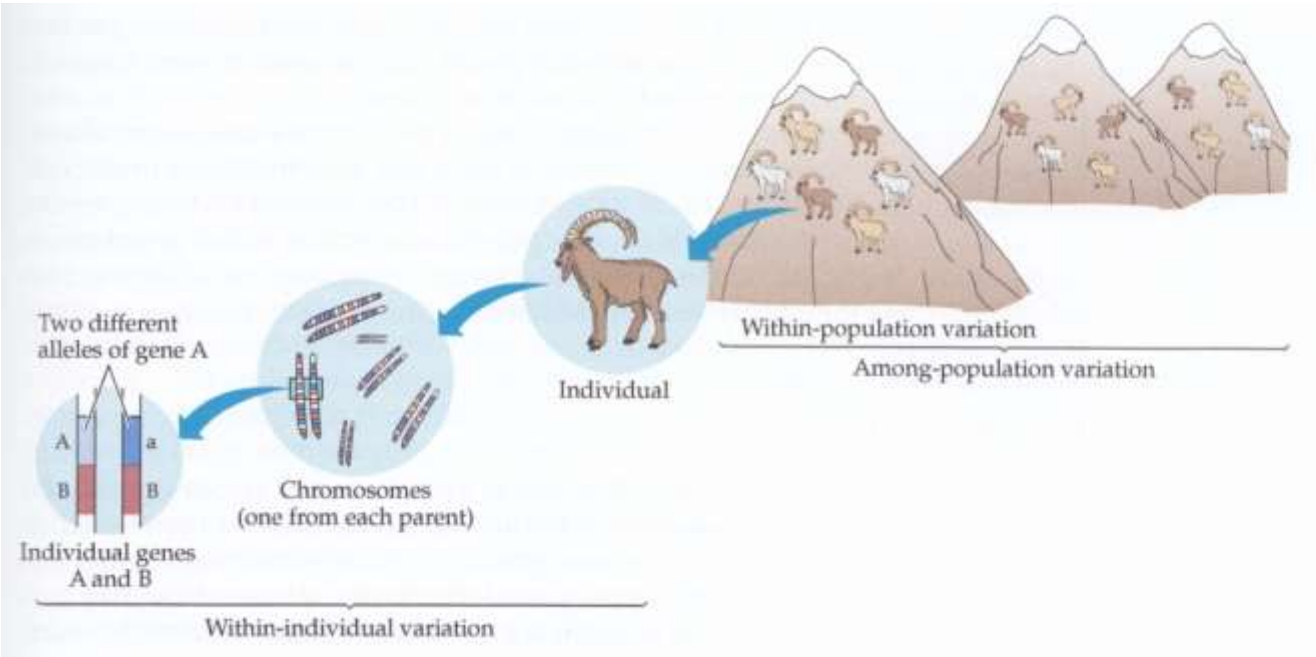
Species genetic diversity(H_t)

$H_t = H_s + D_{st}$

H_s: Diversity within population

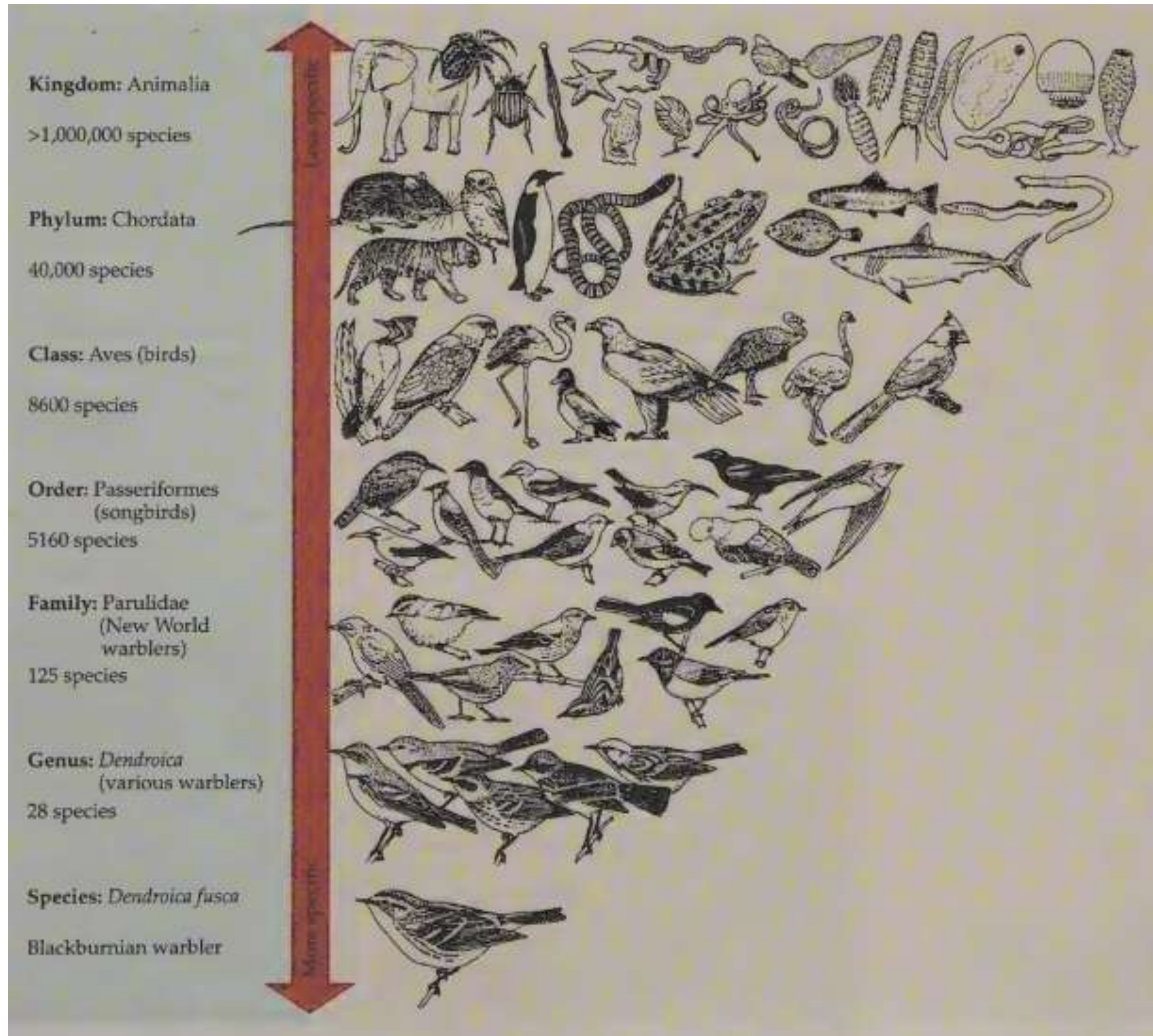
D_{st}: Diversity between populations





Diversity of taxonomic groups

- Species
- Genus
- Family
- Order
- Class
- Phylum



Diversity of taxonomic groups

What Is a Species?

A species is generally defined in one of two ways:

1. A group of individuals that is morphologically, physiologically, or biochemically distinct from other groups in some important characteristic is **the morphological definition** of species

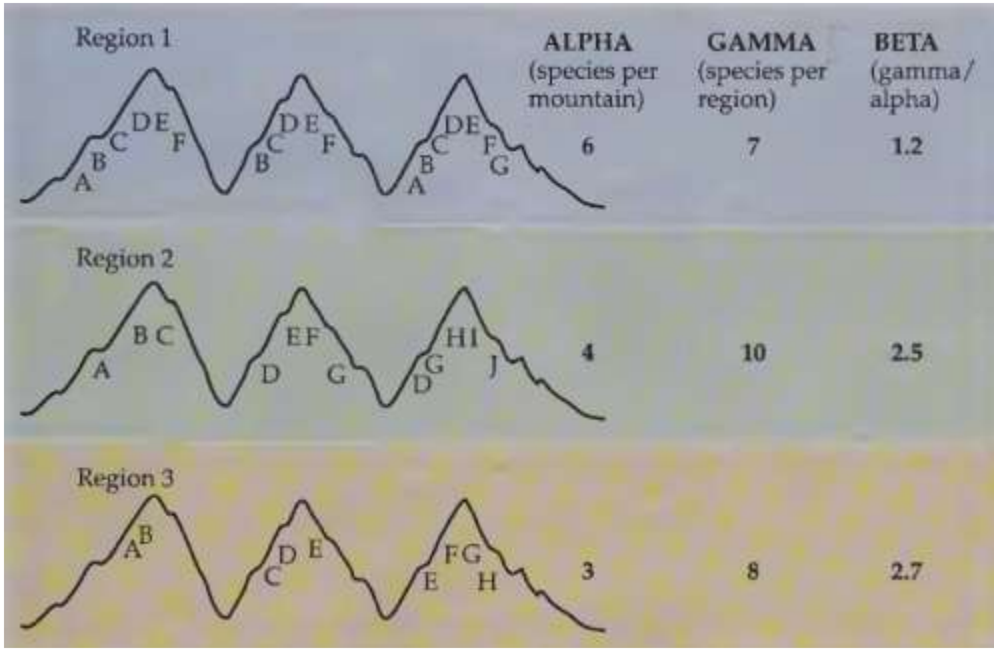
2. A group of individuals that can potentially breed among themselves in the wild and that do not breed with individuals of other groups is **the biological definition** of species

Differences in DNA sequences and other molecular markers distinguish species that look almost identical

Conservation biologists and taxonomists are now developing a system that will identify the species of a living organism based on the DNA from any tissue sample, a method termed **DNA barcoding**

Diversity of taxonomic groups

Diversity of species -> species richness



Alpha diversity: **t**he number of species in a certain community or designated area

Gamma diversity: applies to larger geographical scales. It refers to the number of species in a large region or on a continent

Beta diversity: links alpha and gamma diversity. It represents the rate of change of species composition along an environmental or geographical gradient

Identifying patterns of species diversity helps conservation biologists establish which locations are most in need of protection.

Beta diversity is sometimes calculated as the gamma diversity of a region divided by the average alpha diversity, though other measures also exist

Diversity of taxonomic groups

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

- Species richness

- Diversity index

Shannon-Wiener

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

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

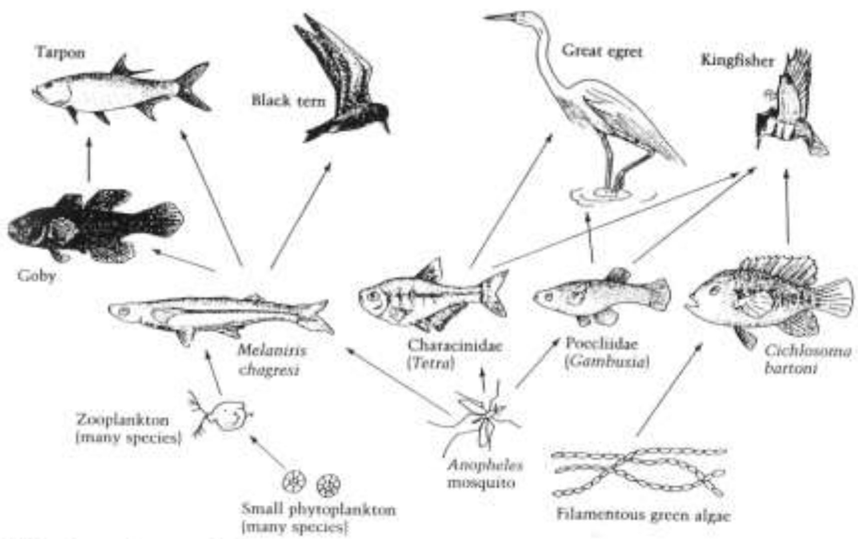
Species	Ni	pi (frequency)	ln pi	pi * ln pi	1/S	ln (1/S)	(1/S) * ln (1/S)
Great tit	13	0.406	-0.901	-0.366	0.143	-1.946	-0.278
Blue tit	8	0.250	-1.386	-0.347	0.143	-1.946	-0.278
Blackbird	4	0.125	-2.079	-0.260	0.143	-1.946	-0.278
Nuthatch	3	0.094	-2.367	-0.222	0.143	-1.946	-0.278
Great spotted woodpecker	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

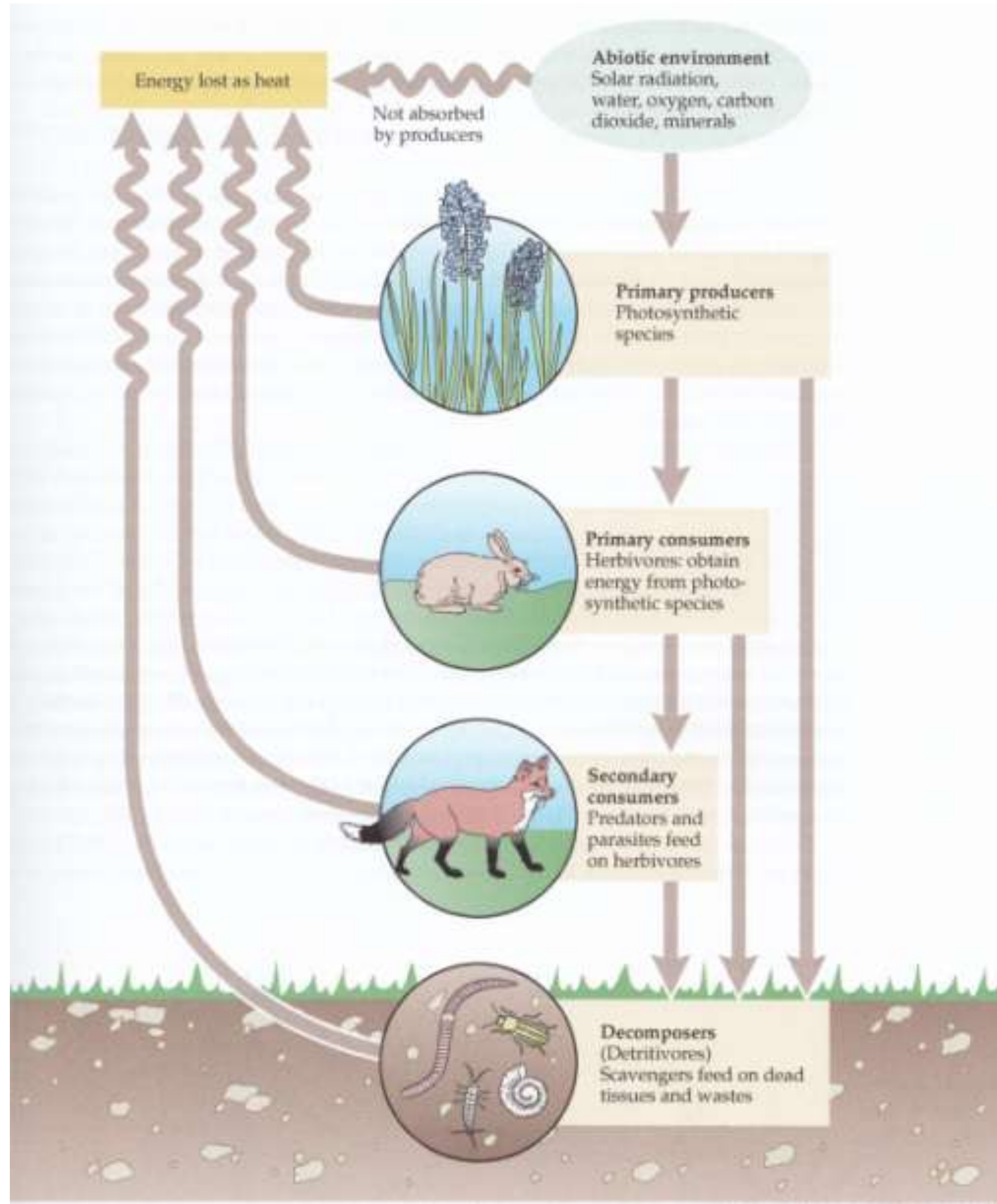
Species	Ni	pi (frequency)	ln pi	pi * ln pi	1/S	ln (1/S)	(1/S) * ln (1/S)
Great tit	20	0.625	-0.470	-0.294	0.143	-1.946	-0.278
Blue tit	5	0.156	-1.856	-0.290	0.143	-1.946	-0.278
Blackbird	3	0.094	-2.367	-0.222	0.143	-1.946	-0.278
Nuthatch	1	0.031	-3.466	-0.108	0.143	-1.946	-0.278
Great spotted woodpecker	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

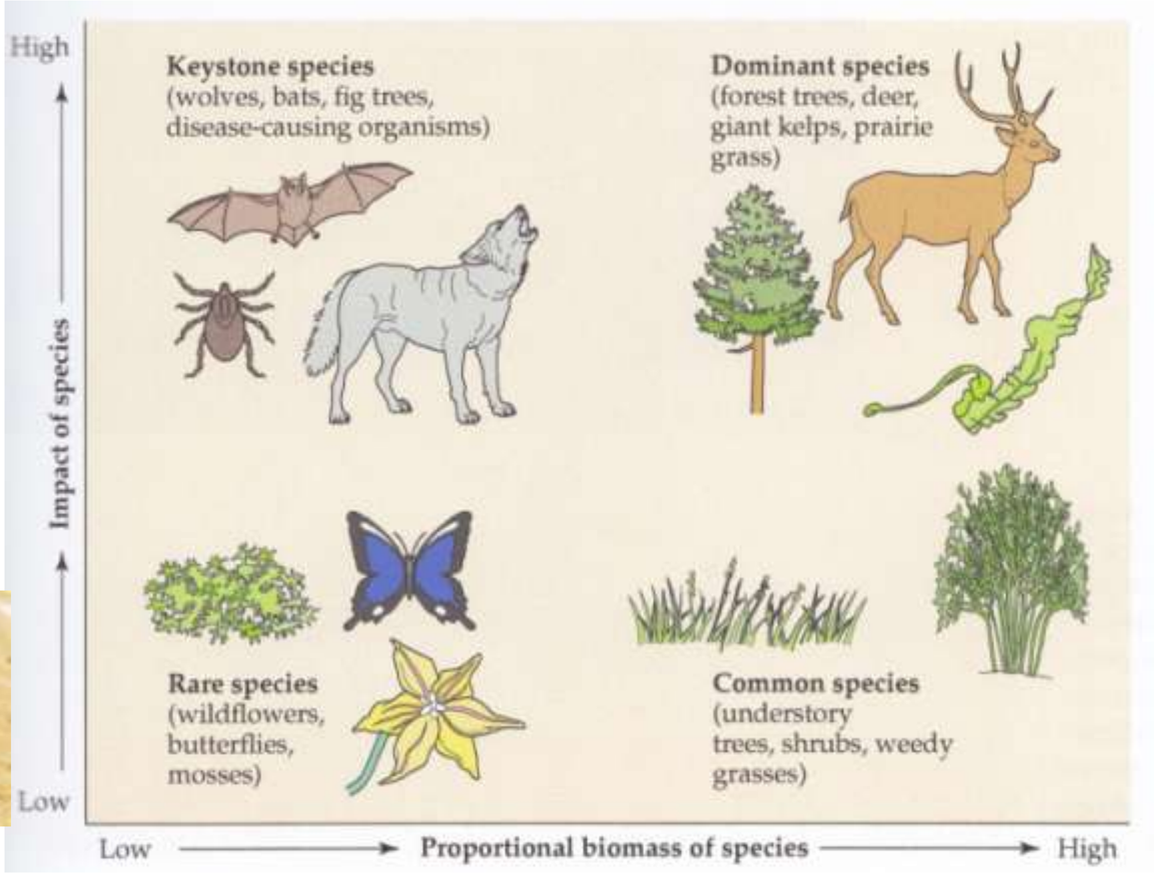
The importance of species varies in the nature

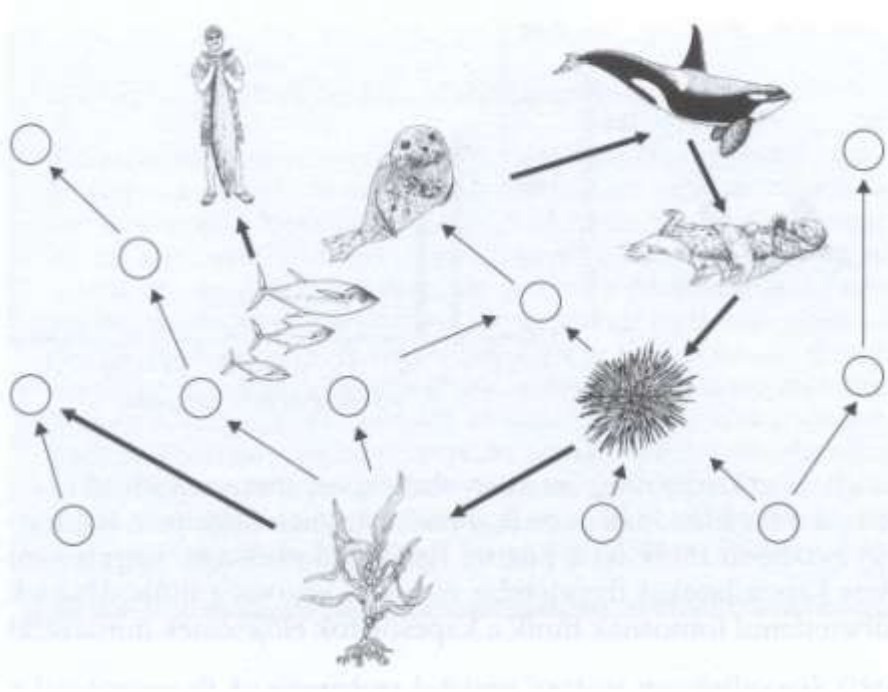
Naturalness – rarity - threateness

Keystone species

- Top predators– e.g. wolf

- Flying foxes
- See otters
- Ecosystem engineers – beaver, elephant, dung beetles,





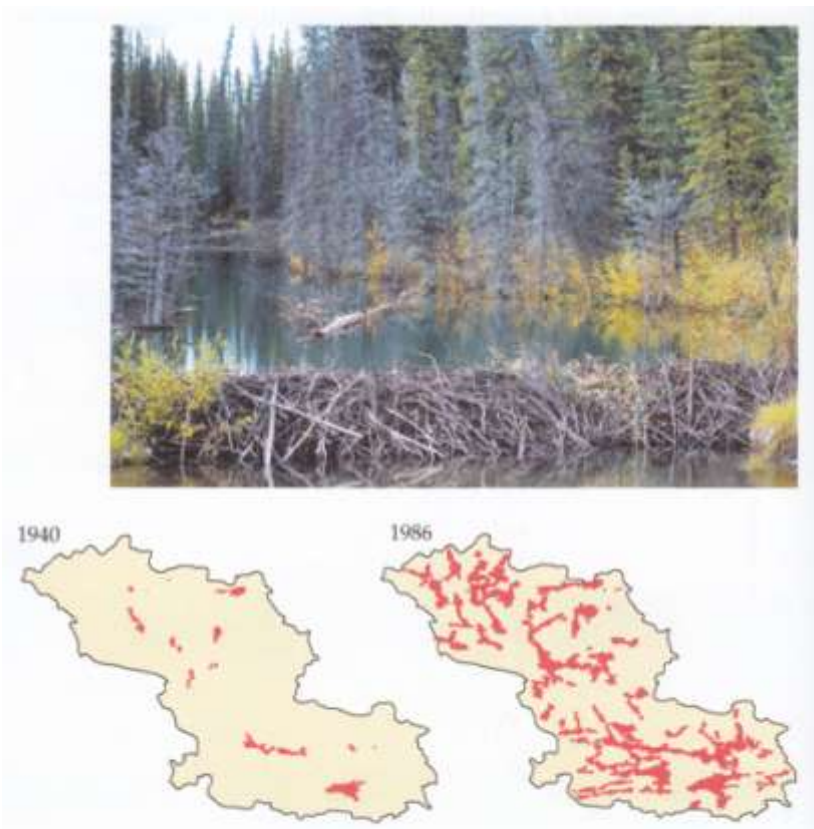
7. ábra Egy meglepően hosszú hatásláncolat a fontos fajok kiemelésével. A körök a nem kiemelt fajokat jelölik (ESTES és mtsai 1998 nyomán).

Trophic cascade

- More intense fishing along the coast of Alaska 1980-1990
- Less fish – less Seals – less Orca
- Orca hunt more southern part of the ocean, predated more sea otter which is the main predator of sea urchin
- Sea urchin number is increased
- Seaweed forests (kelp forests) disappeared

Ecosystem engineers

- Beavers



Ecosystem engineers

- Elephant

Keystone Resources

- Salt-licks and mineral pools
- Deep pools
- Hollow tree trunks
- Rotting wood
- 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

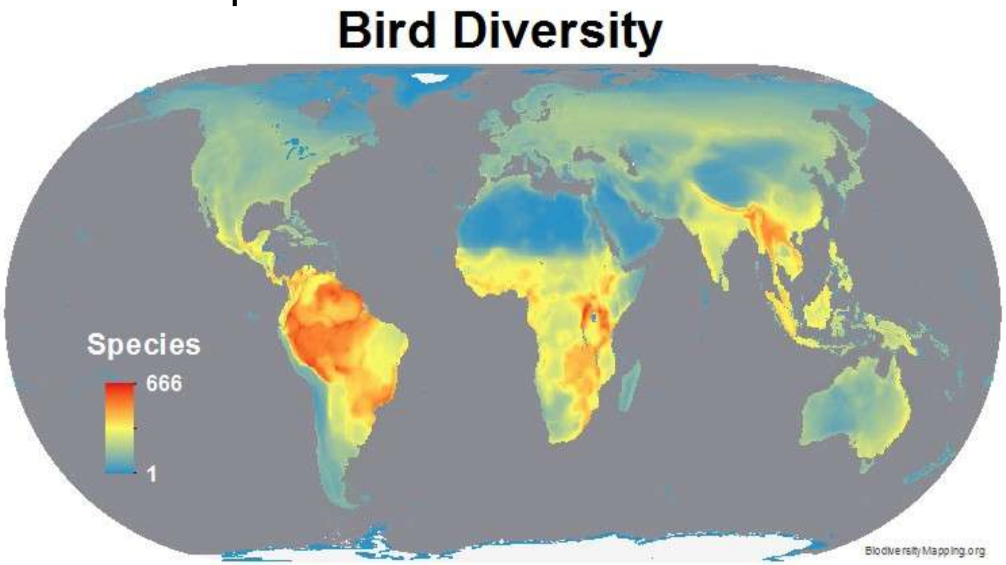
Biological diversity in the Earth

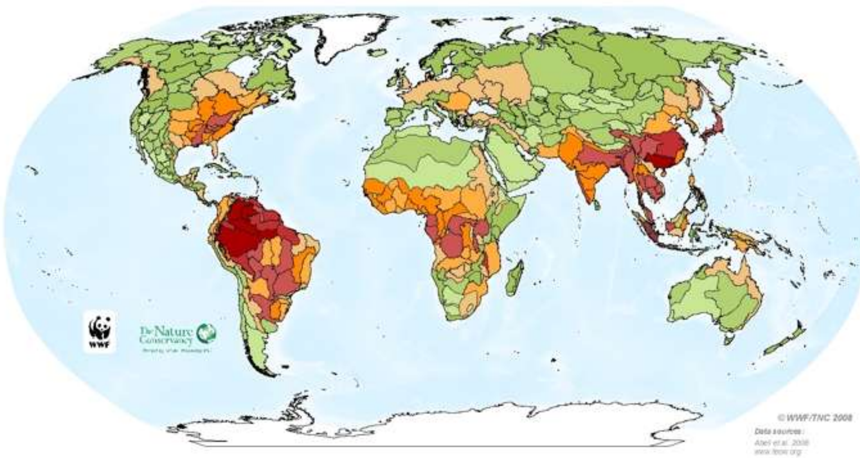
Bird

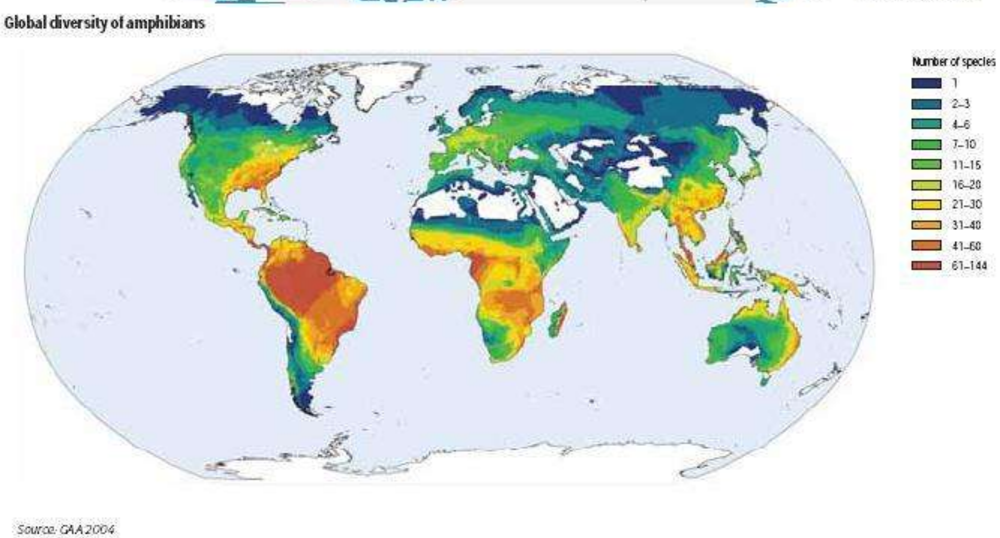
Fish

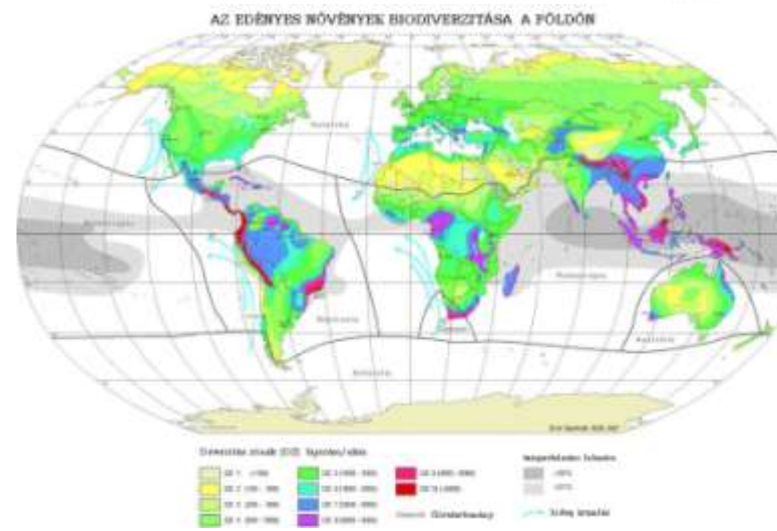
Amphibians

Vascular Plants









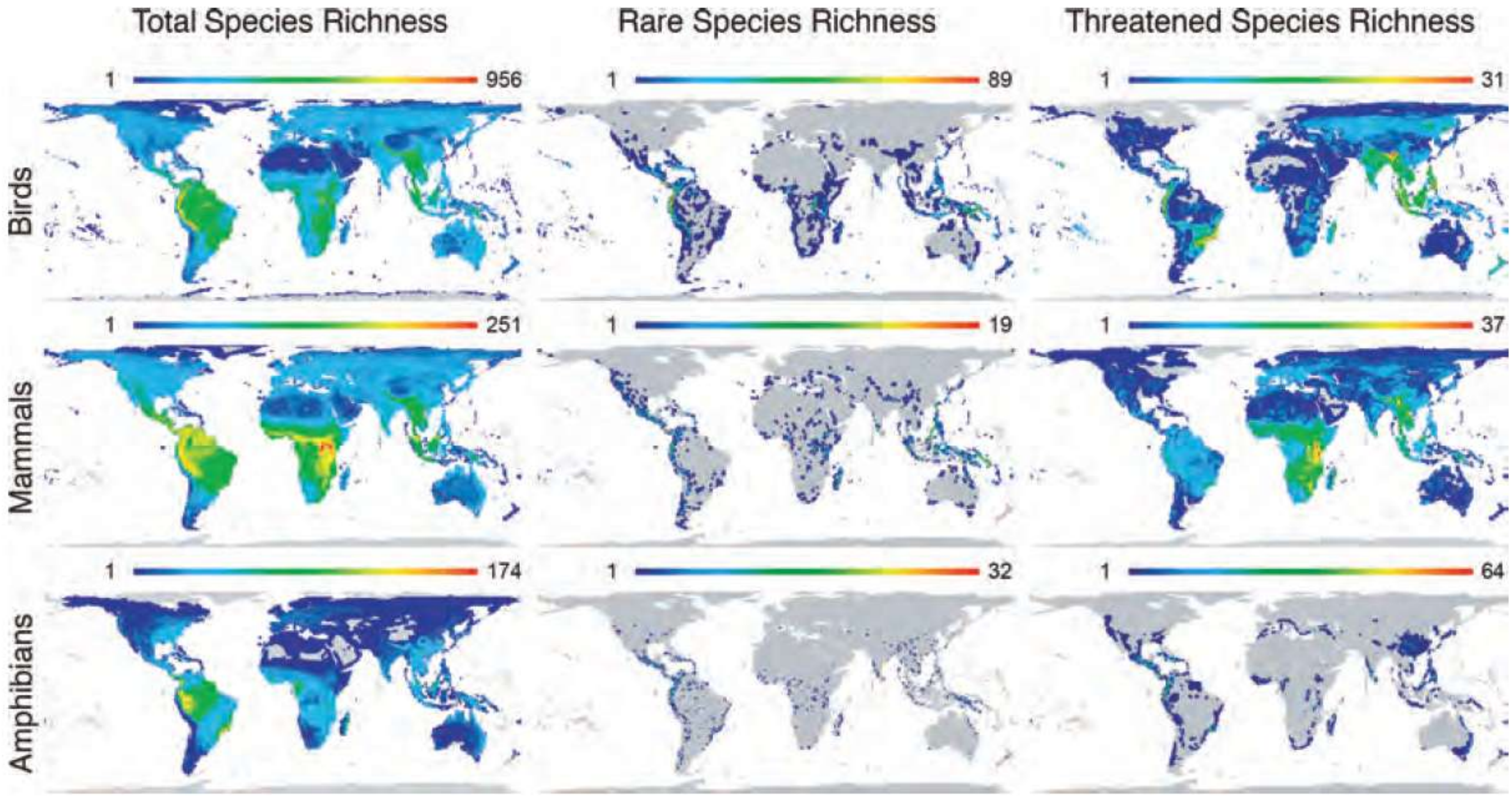
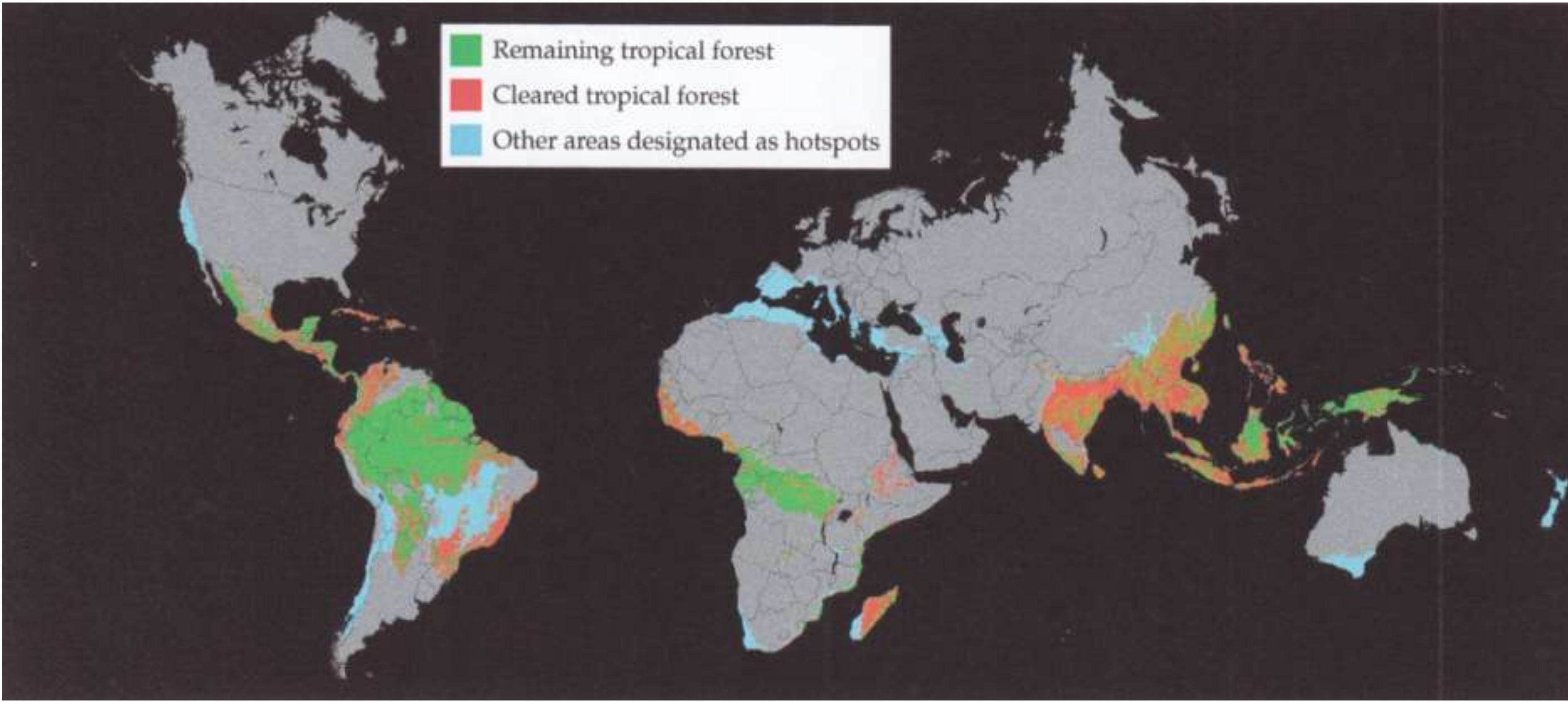


Figure 2.4 Global species richness patterns of birds, mammals, and amphibians, for total, rare (those in the lower quartile of range size for each group) and threatened (according to the IUCN criteria) species. Reprinted from Grenyer *et al.* (2006).

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

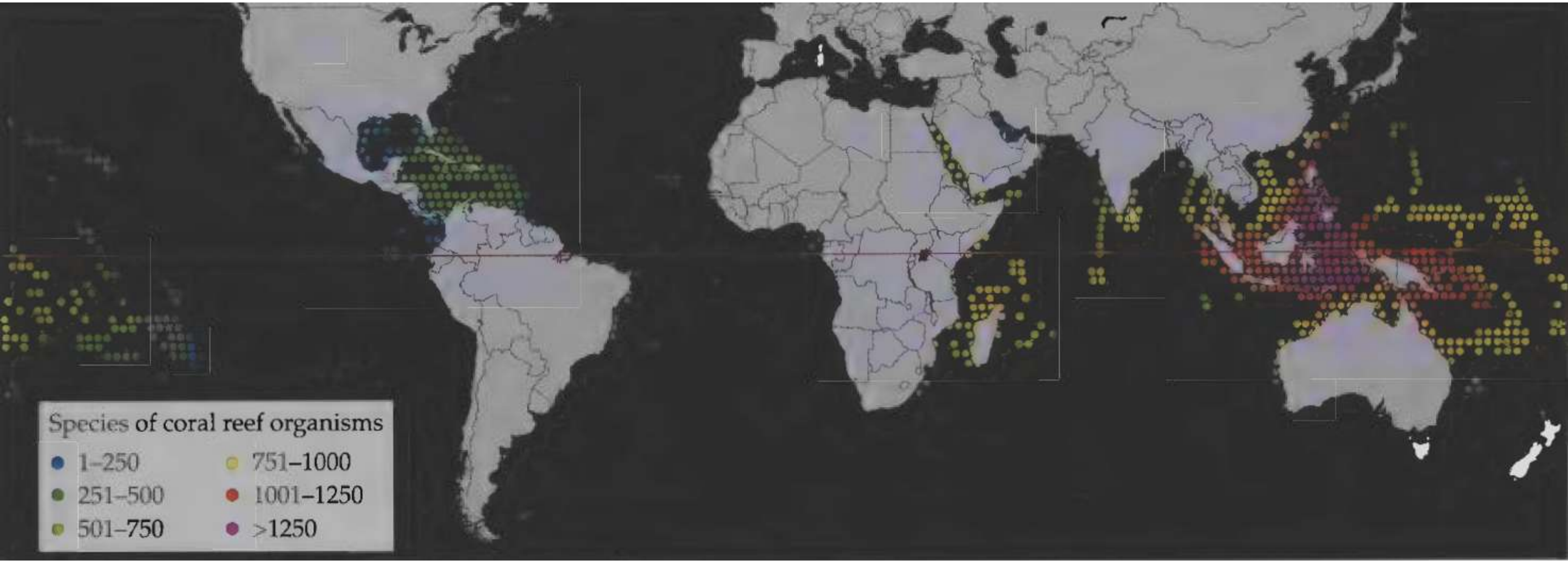
Biological diversity in the Earth

The most diverse areas:
- Coral reefs

Biological diversity in the Earth

The most diverse areas:

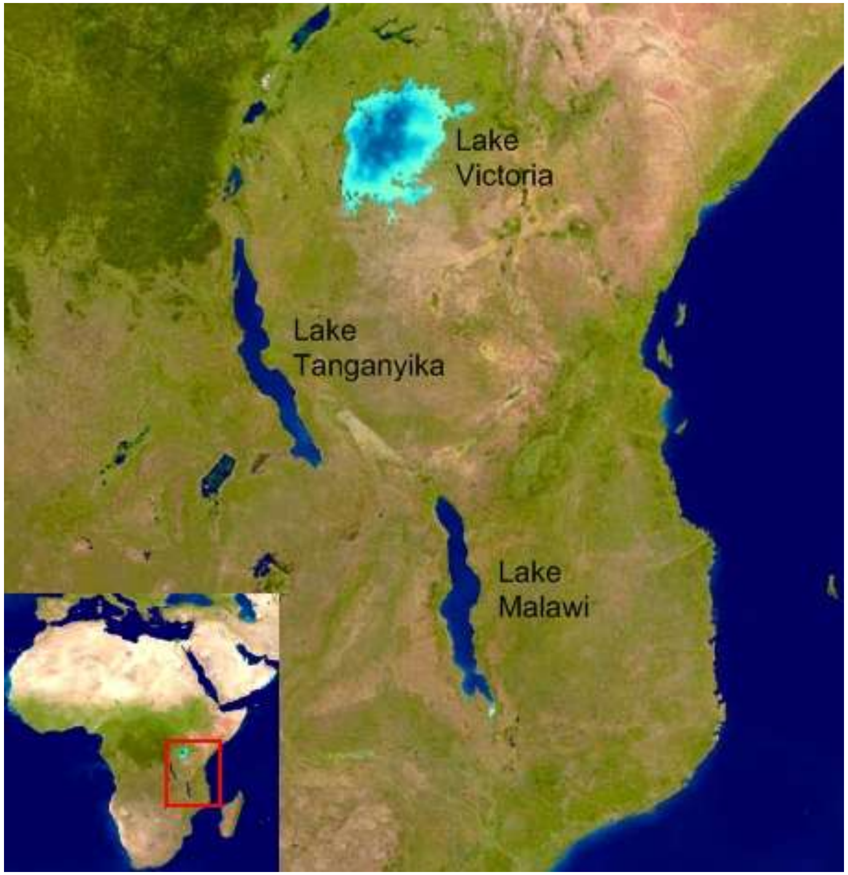
- Coral reefs



Biological diversity in the Earth

The most diverse areas:

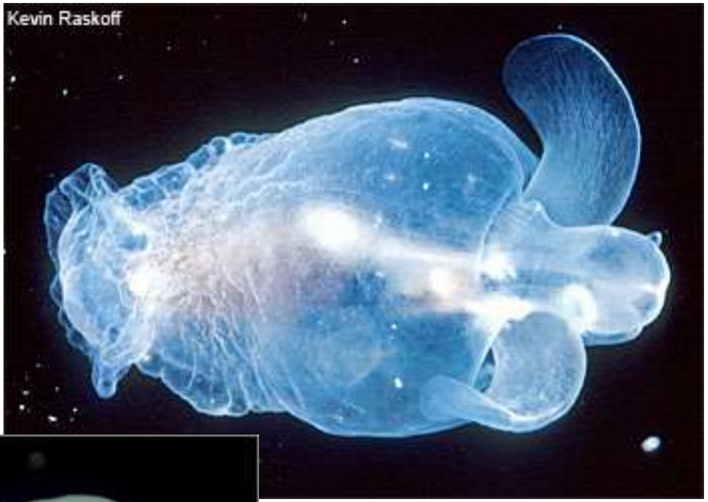
- Large tropical lakes, fast evolutionary radiation of fish and other species

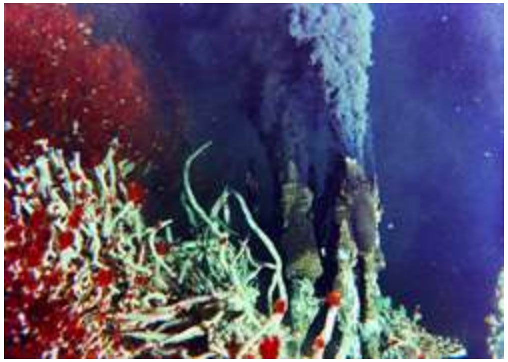


Biological diversity in the Earth

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

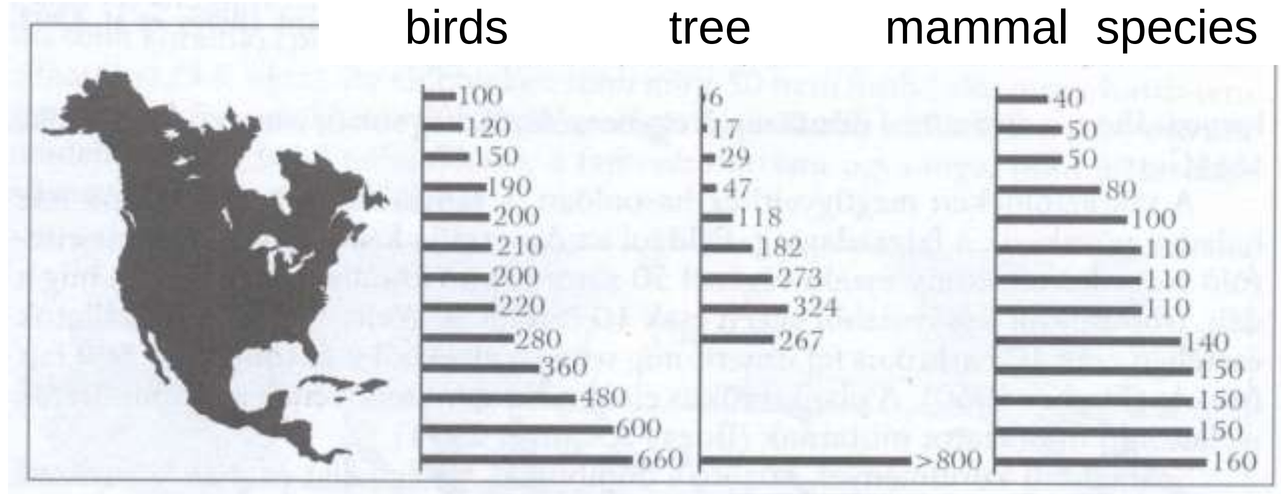
Information on the base of zoologist, botanist

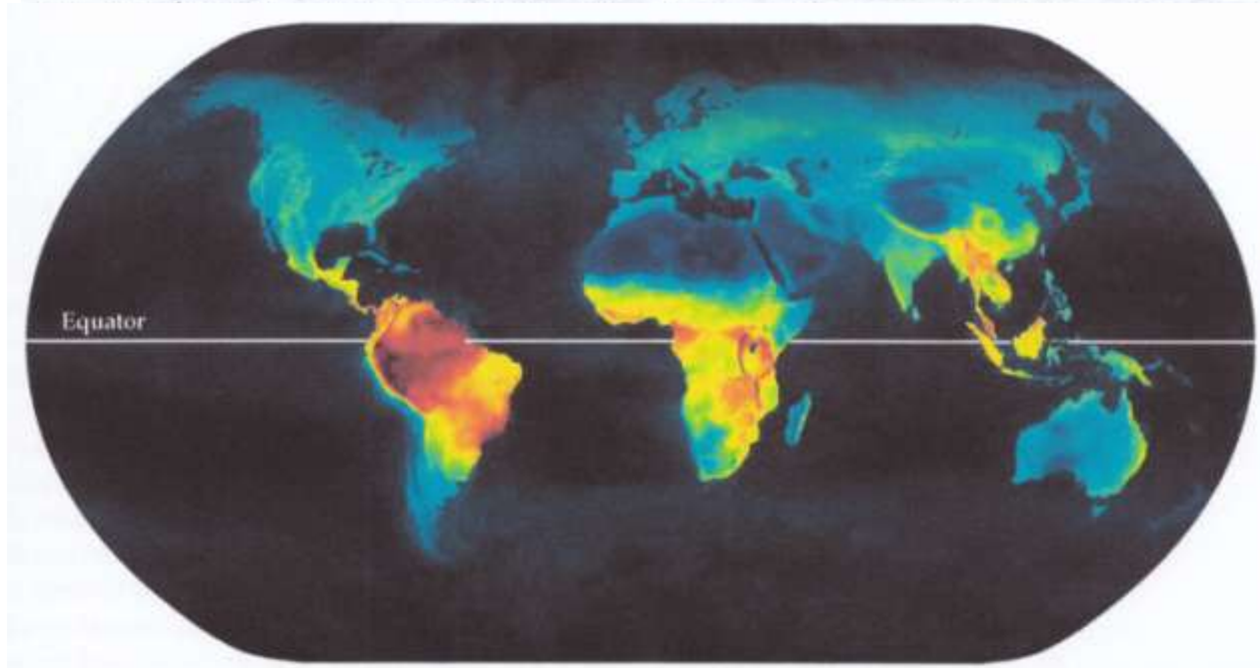
Still limited information

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

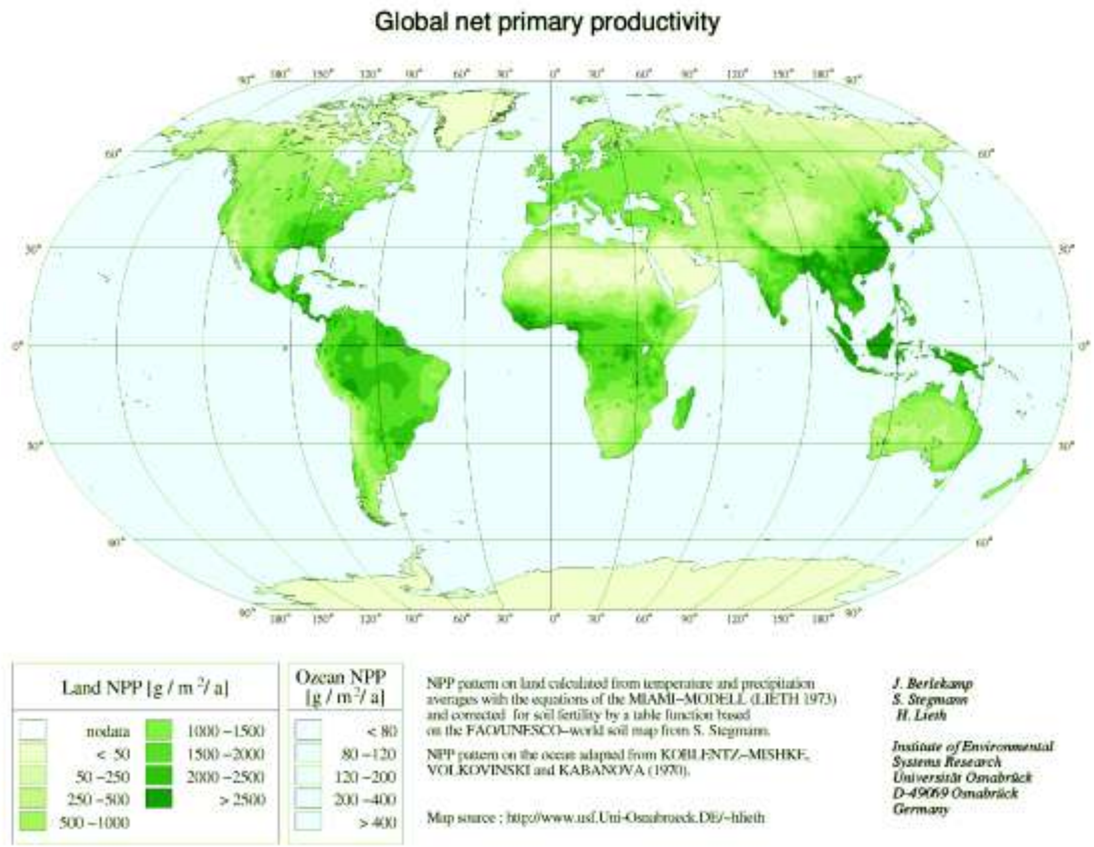
Species diversity increasing toward the equator





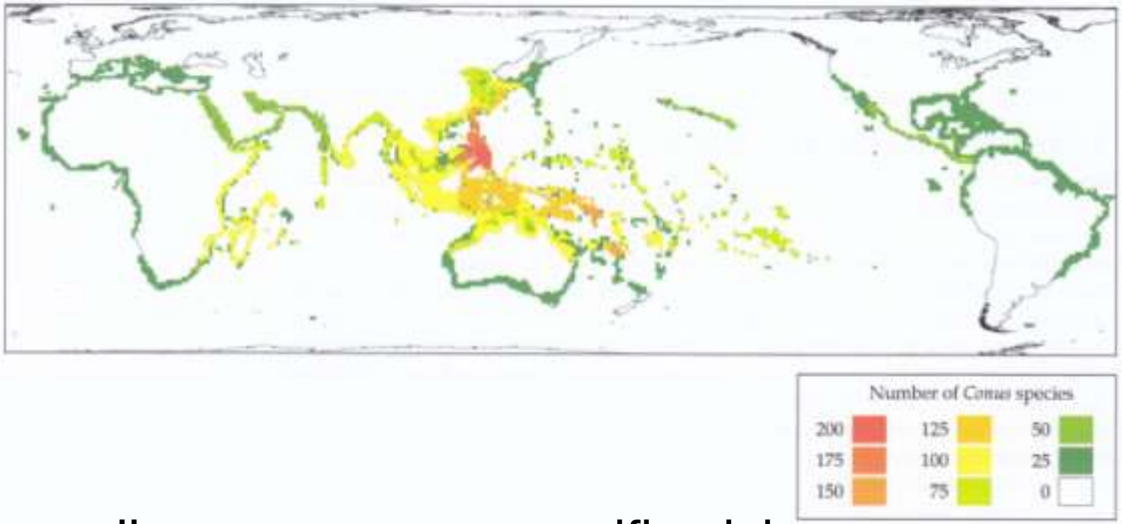
Why are there so many species in the tropics?

- 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

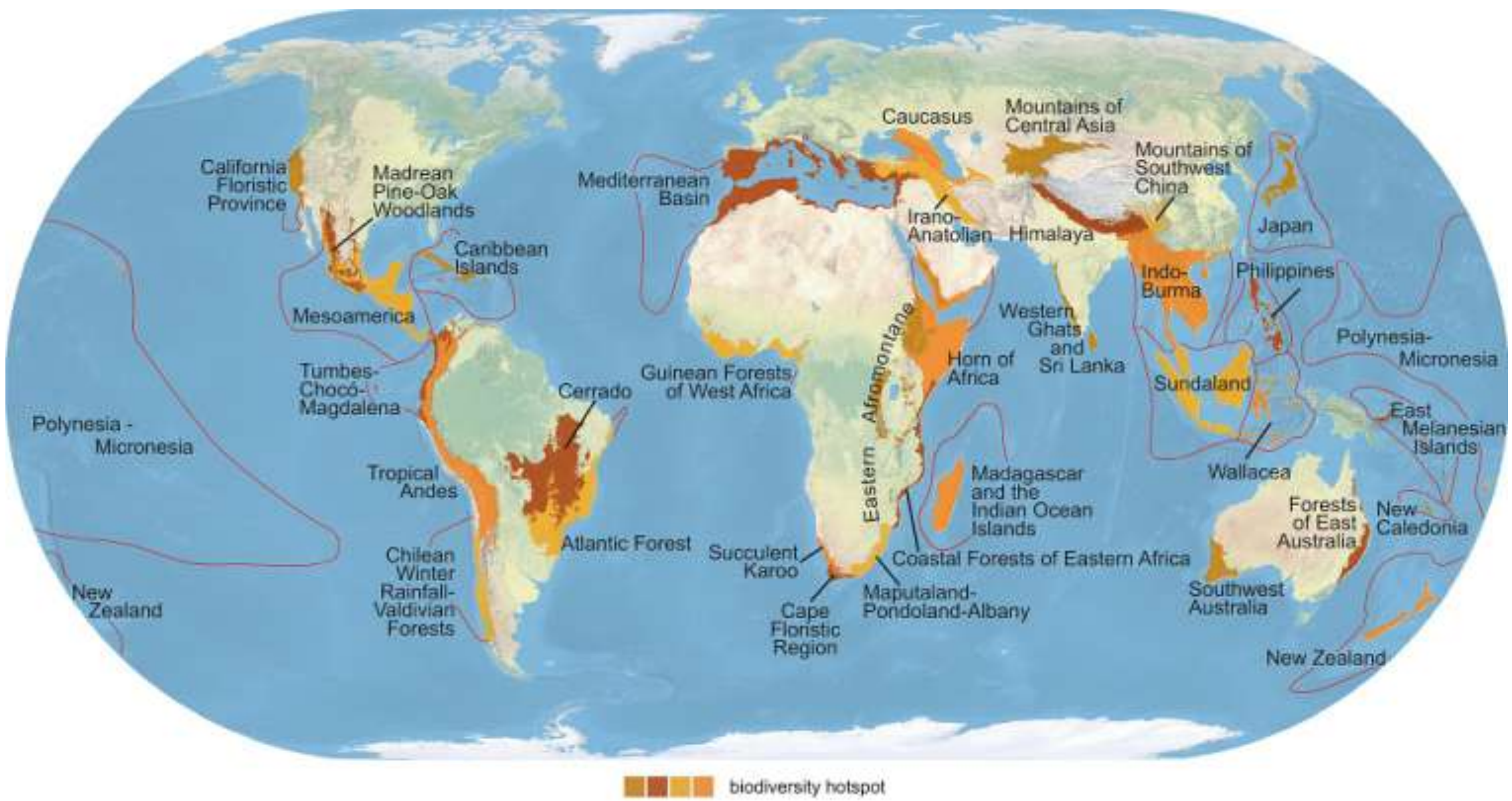
Tropical forests

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

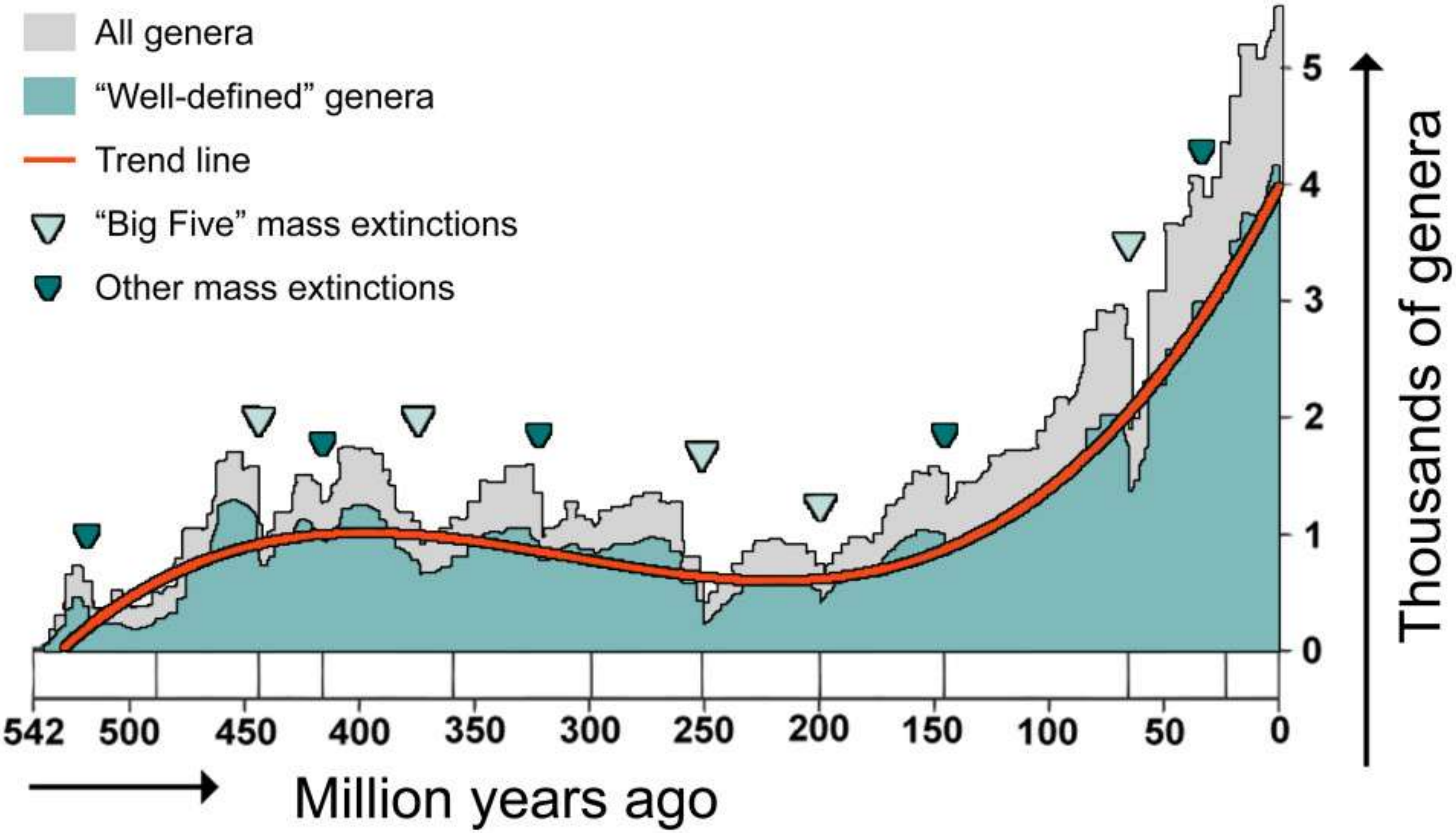


Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

Distribution of coral reefs

How many species live in the Earth?

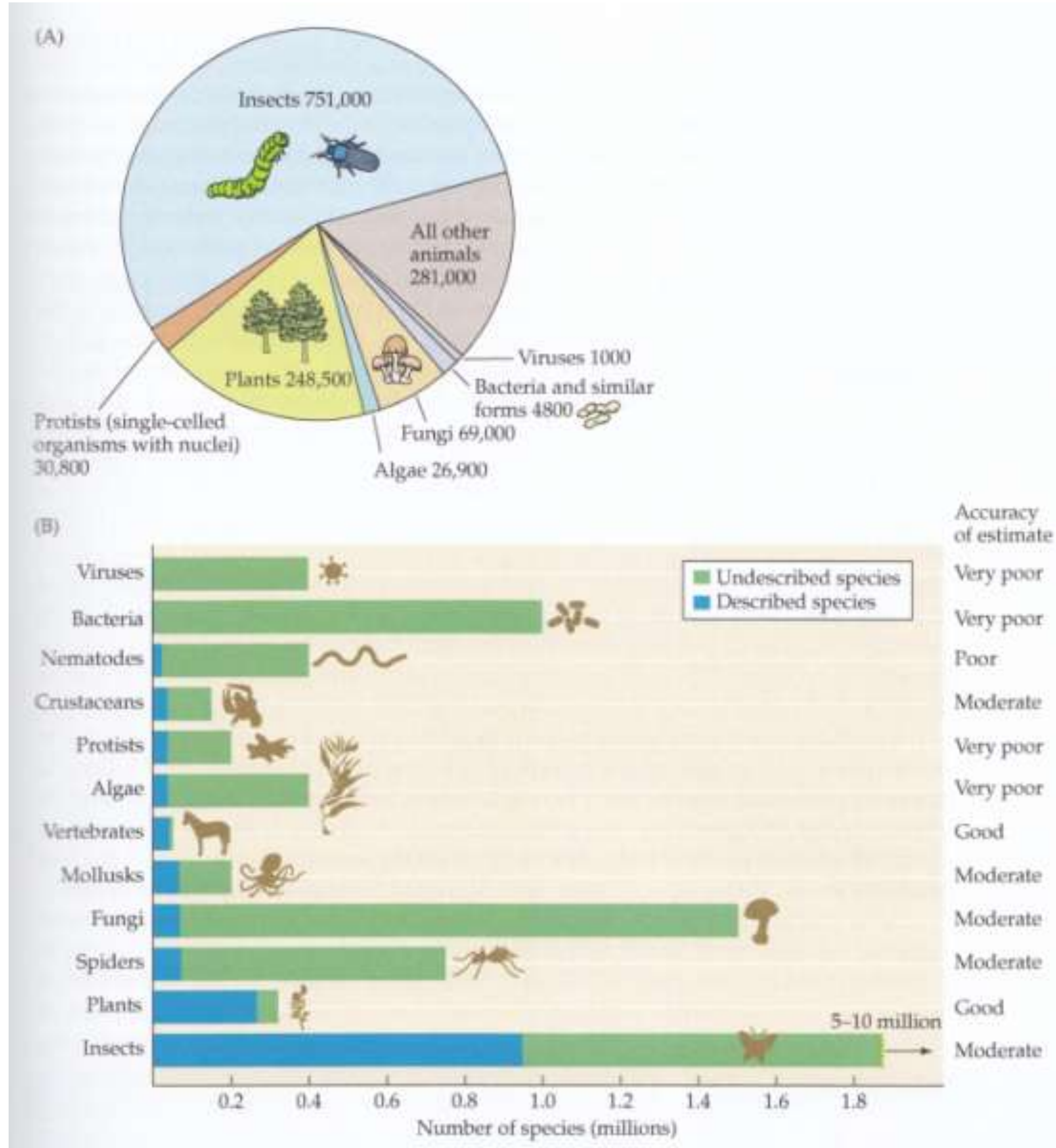
The most species lived until the spread of the human population



How many species live in the Earth?

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

The most species are not known for the science



How many species live in the Earth?

- The science know less then 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

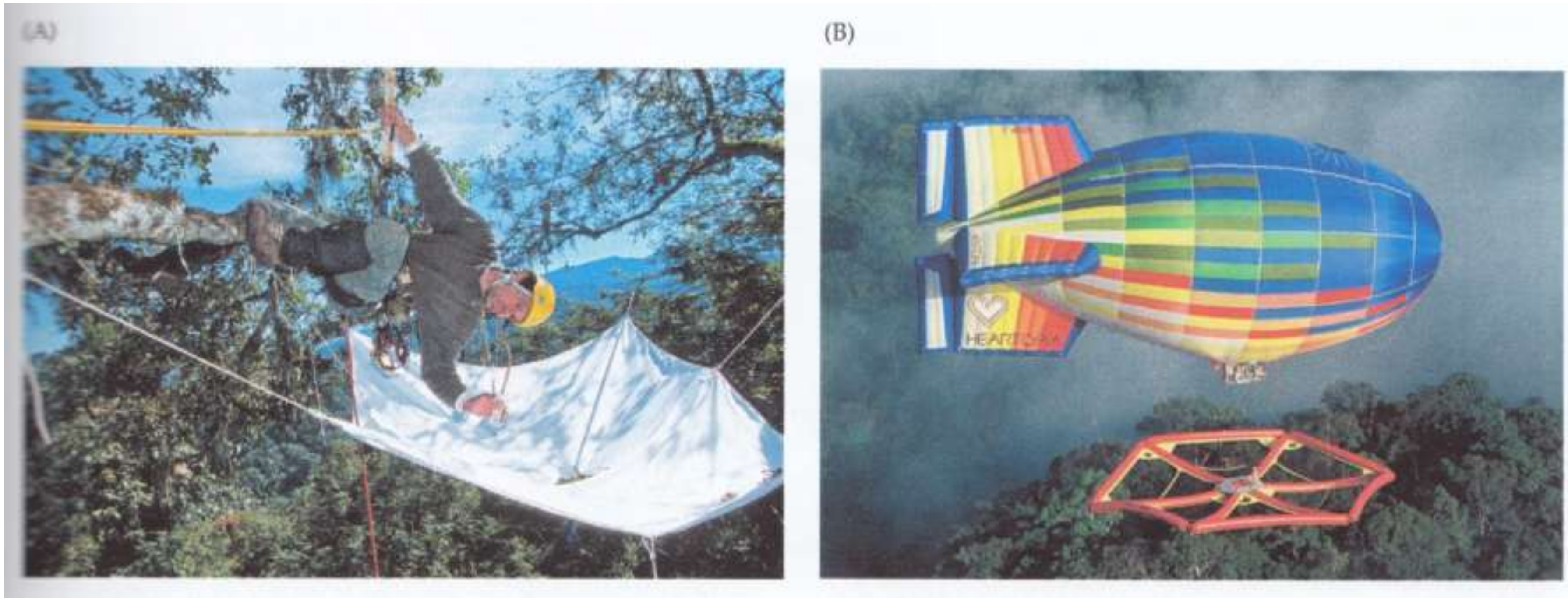
In Europe, there are 6 times more fungi species than plant species, in the case of 270 000 plant species of the Earth it could be 1.7 million fungi species

The number of virus, bactery, unicellular and vorm 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

New discoveries using new methods

- Top layer of the tropical forest using cranes
- Deep water by robots
- DNA barcoding
- 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 (open-access) 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.

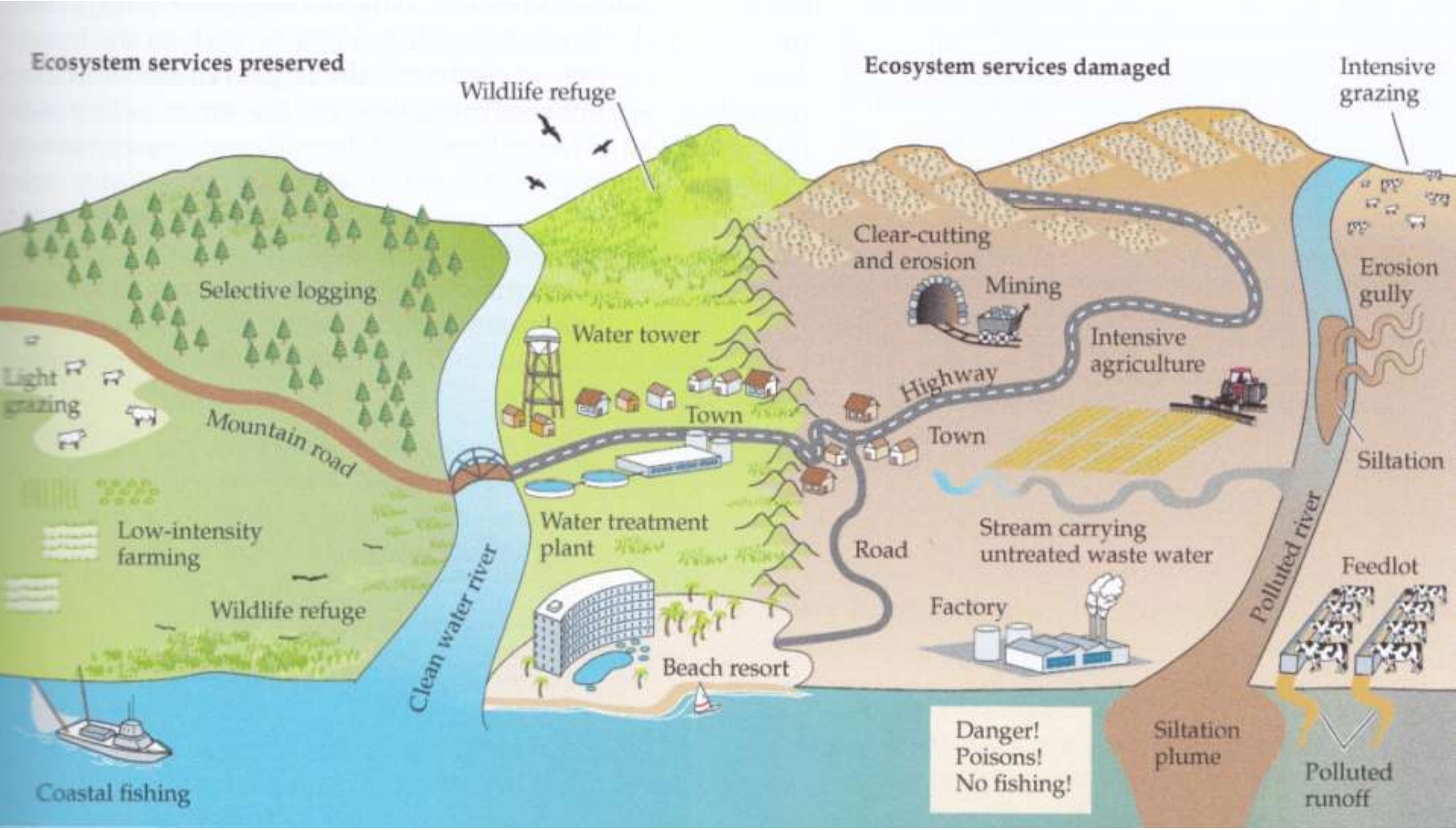
[a]Revenues are in millions of dollars over a 10-year period.

[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.)

the **precautionary principle:** when there is uncertainty about the risks associated with a project, it is better to err on the side of doing no harm to the environment.
In some cases this may mean not approving a project


Ecosystem services preserved
Wildlife refuge
Ecosystem services damaged
Intensive grazing
Selective logging
Clear-cutting and erosion
Mining
Erosion gully
Water tower
Intensive agriculture
Light grazing
Highway
Town
Mountain road
Town
Siltation
Low-intensity farming
Water treatment plant
Stream carrying untreated waste water
Road
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=UsBYe68PHc

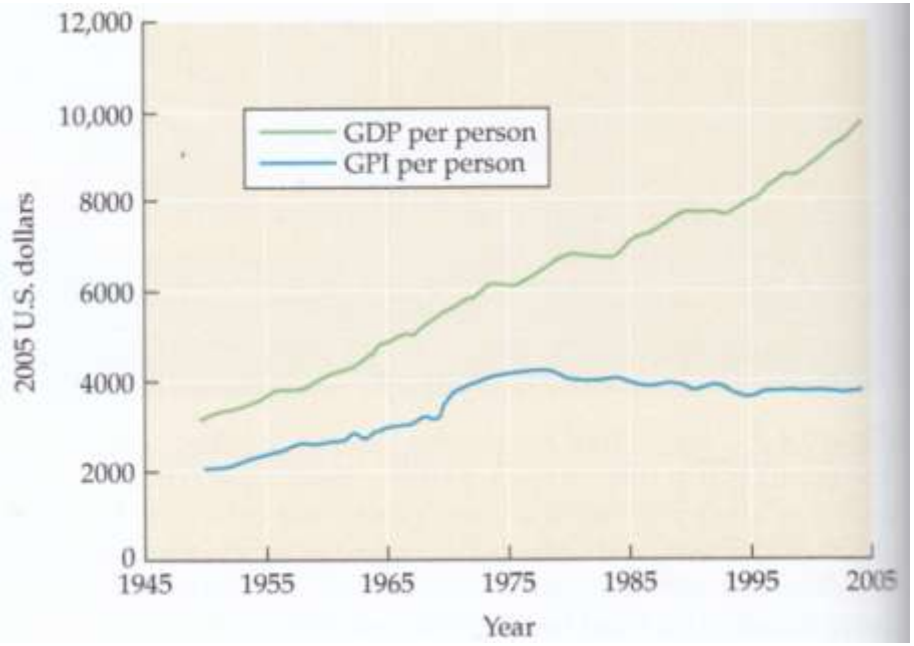
Natural Resource and Wealth of Societes

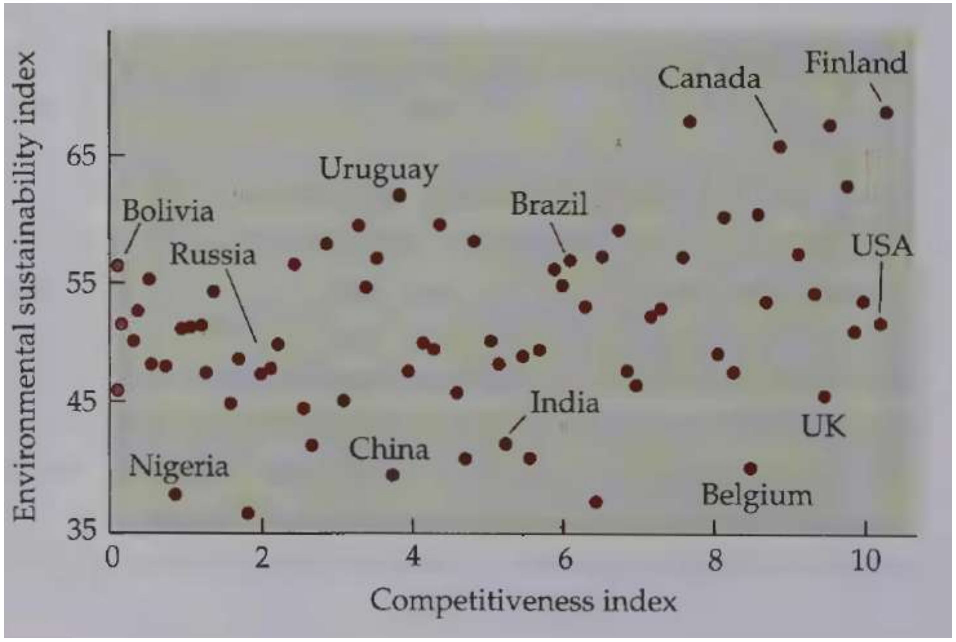
ISEW – Index of Sustainable Economic Welfare

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

GPI – Genuie Progress Indicator

ESI - Environmental Sustainability Index





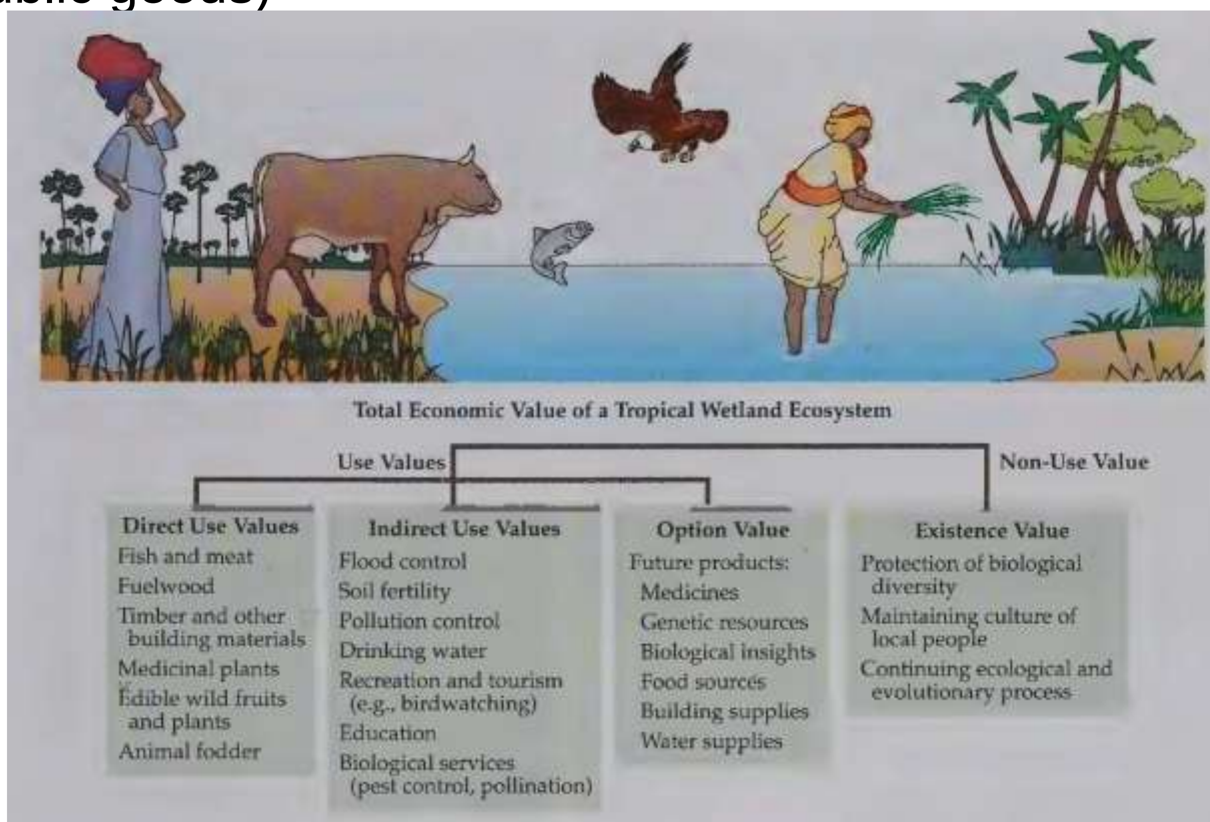
Natural Resource and Wealth of Societes

Can everything be assigned a value?

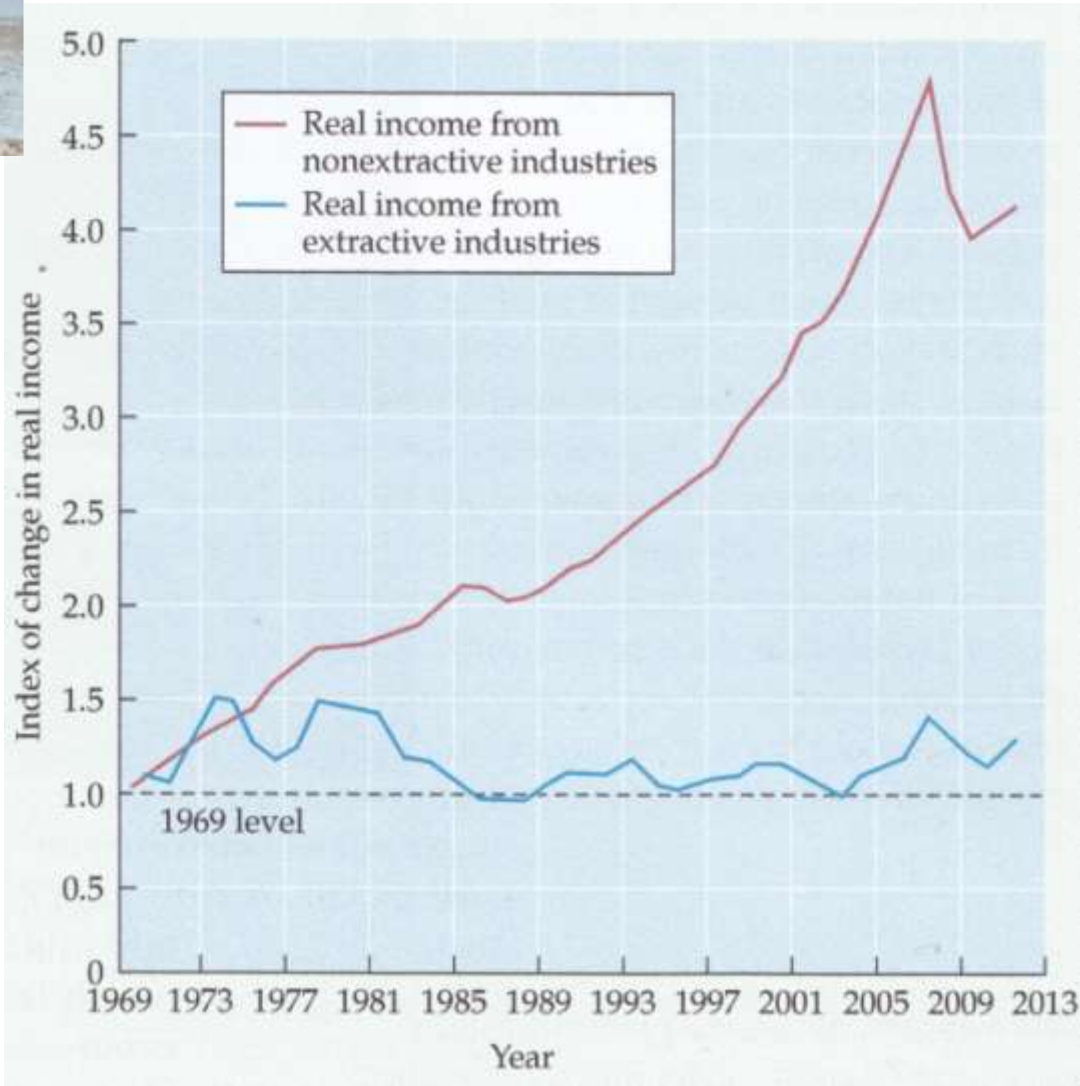
How can the value of a beautiful landscape be measured?

A breeding ground for corruption.

- Direct use values (private goods)
- Indirect use values (public goods)
- Option 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.

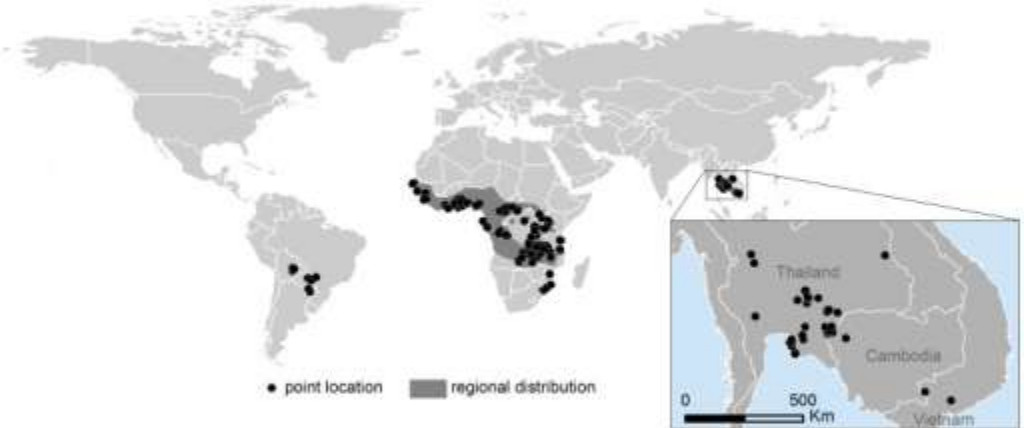
A local gardener would pay for exclusive rights to cultivate 10% of the seeds and sell them over five years. Producer value: $5,000/year -> $25,000/5 years.

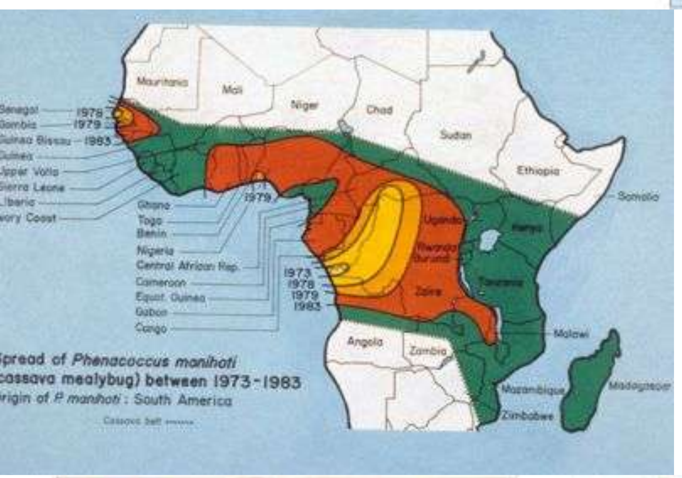
On average, 200 botanists and nature lovers visit the site annually to see the plant, spending $80 locally on food, accommodation, and services. Ecotourism value: 200 * $80 -> $16,000/year -> $80,000/5 years.

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





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!

(ก) *Phenacoccus manihoti* Matile–Ferrero

(ข) *Anagyrus lopezi*

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.

Productive 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, plants Biological 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)

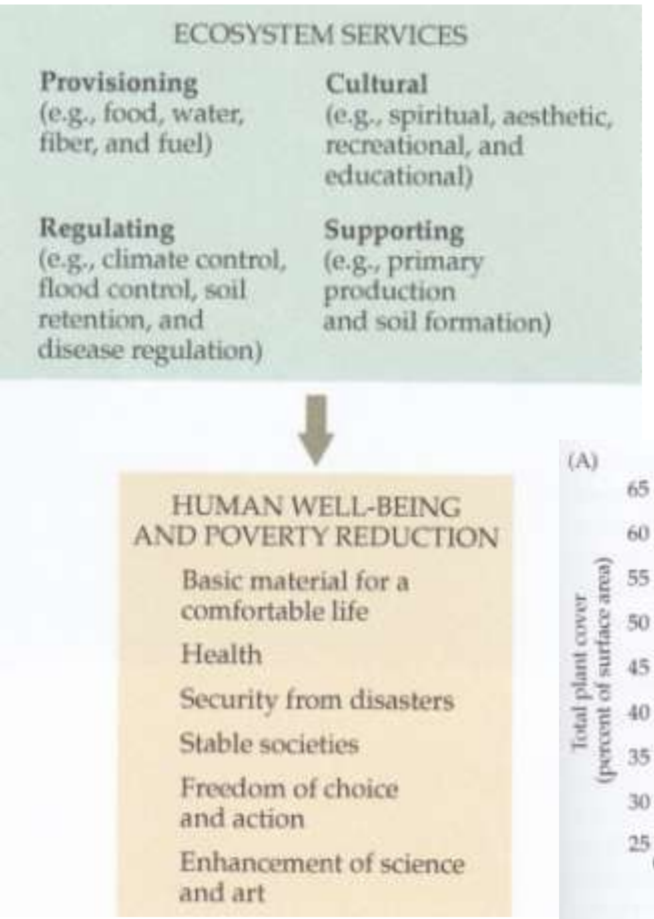
Indirect Use Values – Environmental Processes and Ecosystem Services

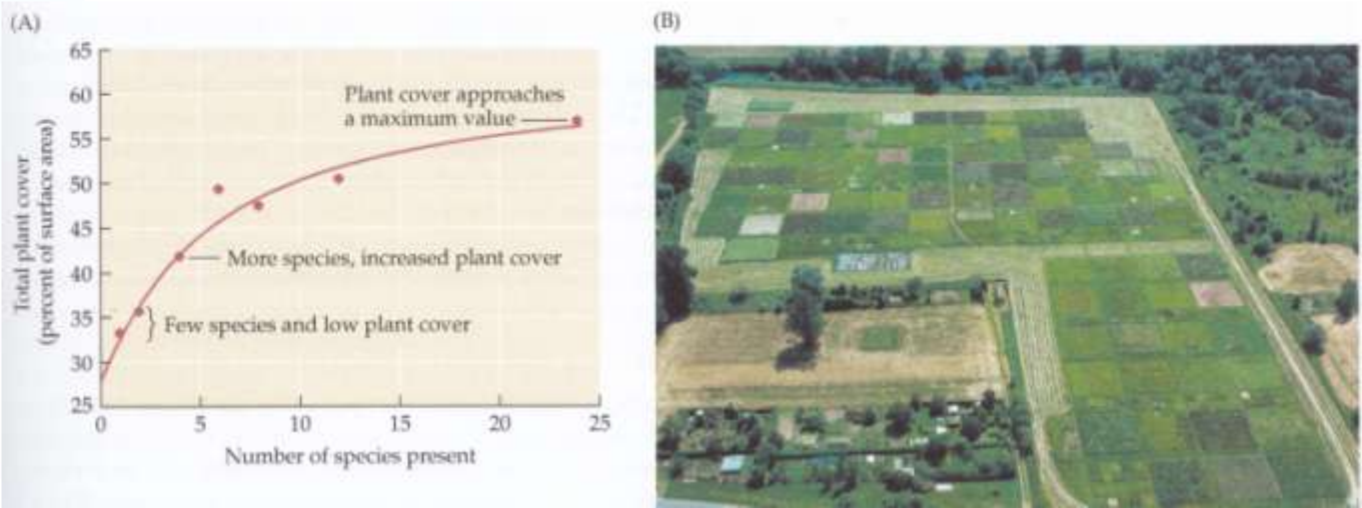
– Public goods – benefits without the need for harvesting

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





Ecosystems services - examples

Providing water for 9 million people of New York

- 5 000 km^2 watershed
- Threats of growing pollutions by settlements and agricultures
- Decision (1996)
  - **Protect the natural ecological system of the watersheds, cost: 1.5 milliard $**
  - Alternative solution> no protection but need to built huge waste-water treatment facility, cost 6 milliard $

https://www.nycwatershed.org/about-us/overview/croton-catskilldelaware-watersheds/

TABLE 5.1 Estimated Value of the World's Ecosystems Using Ecological Economics

Ecosystem[a]	Total area (millions of ha)	Annual local value (dollars/ha/year)	Annual global value (trillions of dollars/year)
Coastal	3102	4052	12.6
Open ocean	33,200	252	8.4
Wetlands	330	14,785	4.9
Tropical forests	1900	2007	3.8
Lakes, rivers	200	8498	1.7
Other forests	2955	302	0.9
Grasslands	3898	232	0.9
Cropland	1400	92	0.1

Source: After Costanza et al. 1997

[a]Desert, tundra, urban, and ice/rock ecosystems not included.

Indirect Use Values

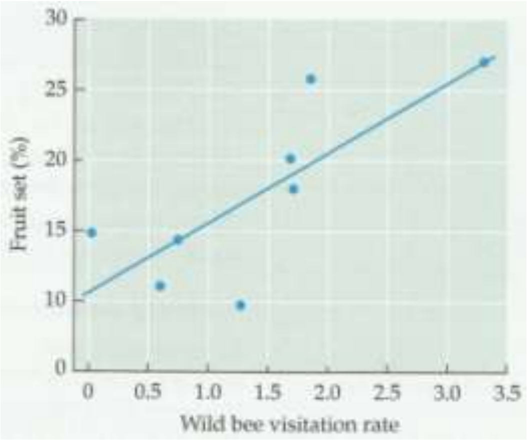
Productivity

Water and soil protection

Climate

Waste management

Species relationships



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

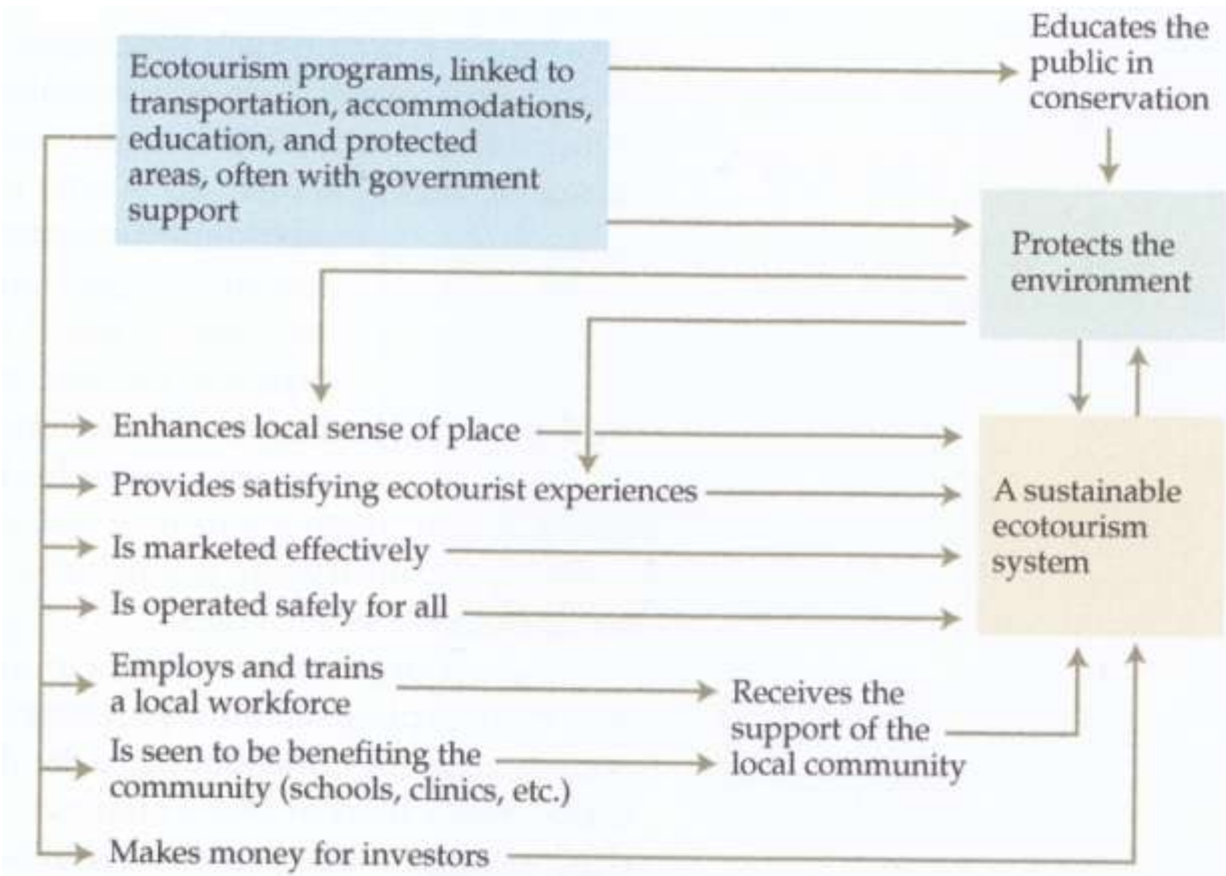
Consumptive uses	Low-consumptive uses	Nonconsumptive uses
Commercial hunting, sport hunting, and subsistence hunting	Zoos	Bird watching
Commercial fishing, sportfishing, and subsistence fishing	Animal parks	Whale watching
Fur trapping	Aquariums	Photography trips
Hunting for animal parts and pet trade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

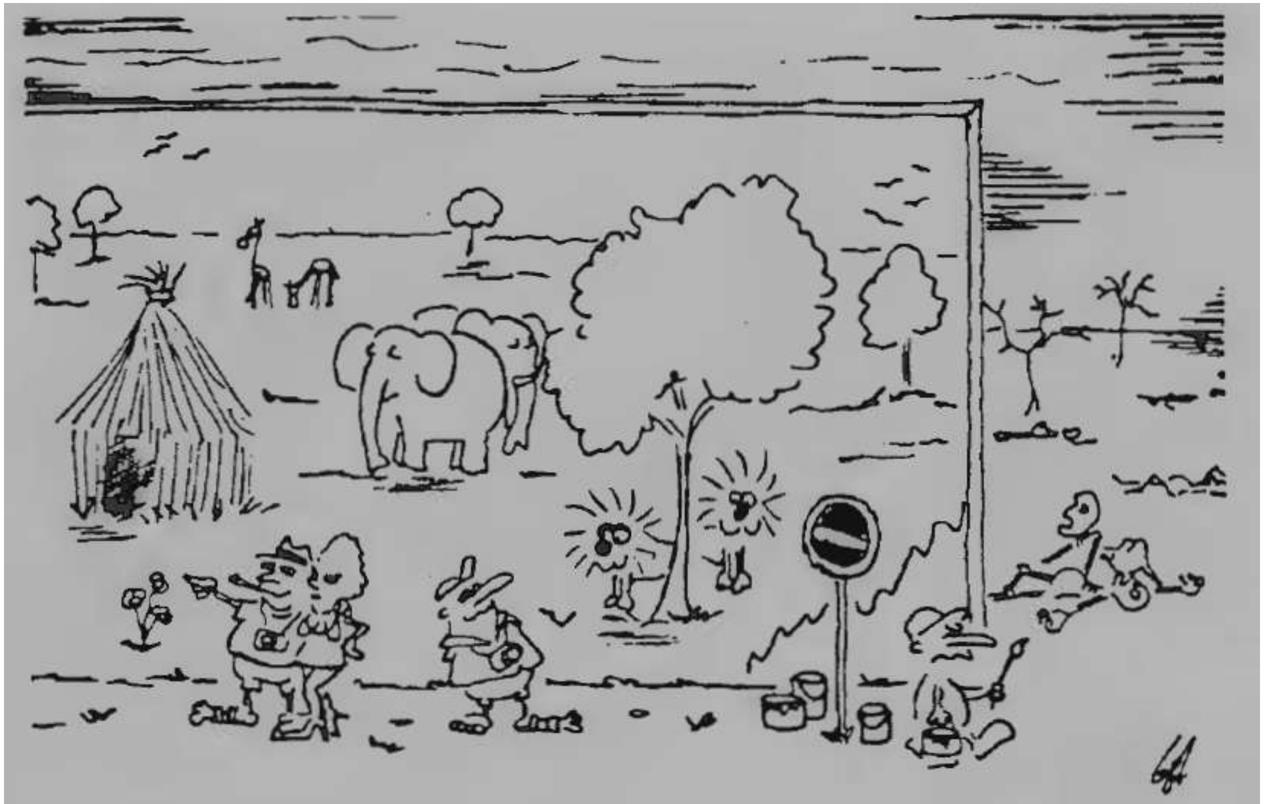
Indirect Use Values

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!



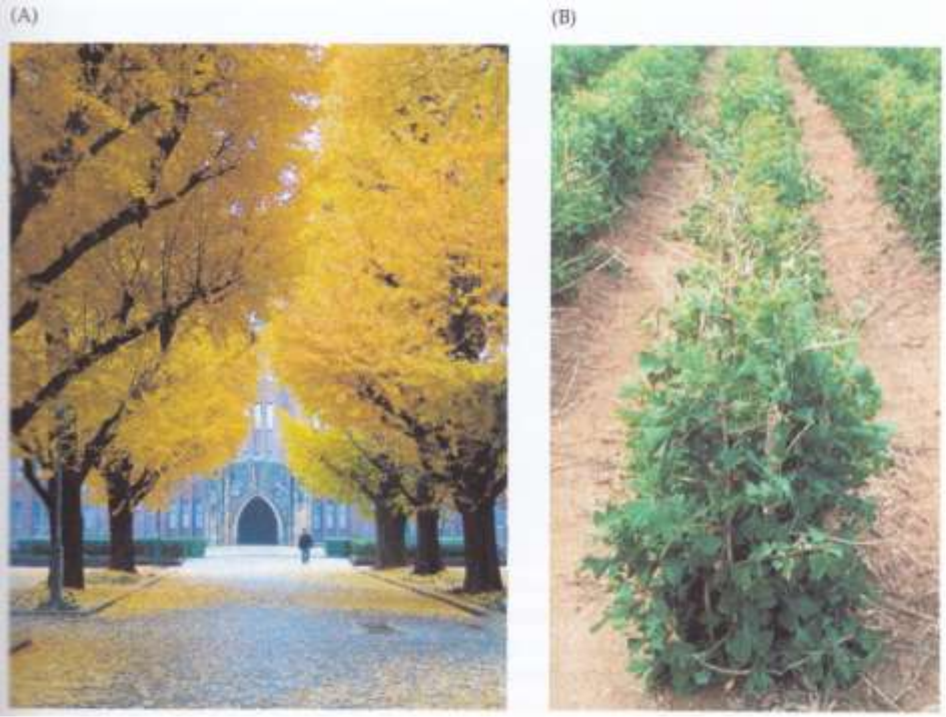


Courtesy: EG Magazin

FIGURE 5.8 In developing countries, facilities for ecotourists sometimes create a fantasyland that disguises and ignores the real problems those countries face. (From E. G. Magazin, Germany.)

Travel companies are promoting measures to minimize their impacts and provide increased benefits to local people.

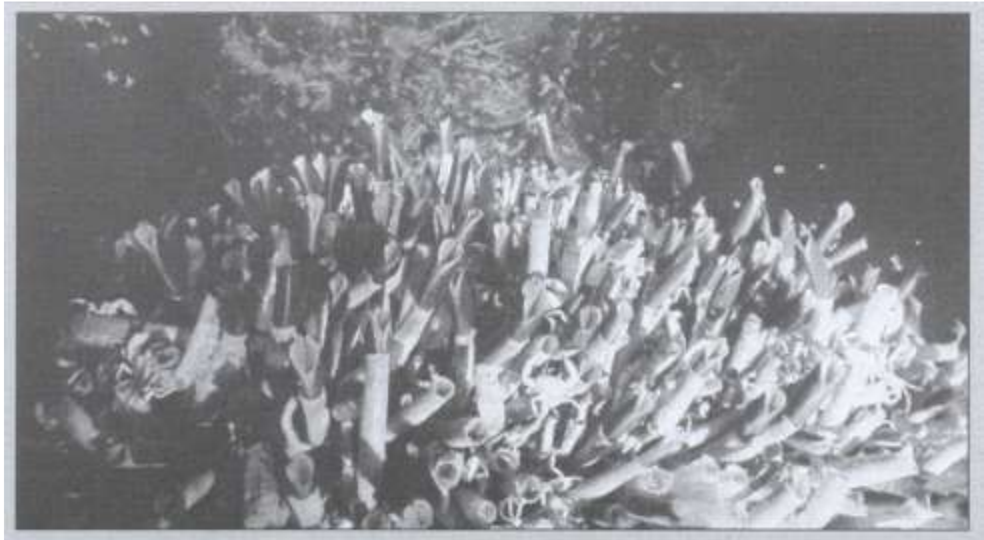
The key to a successful project is making sure that enough tourist money is paid to the local people to maintain and improve their way of life and to park authorities for park protection.



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 bálna 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

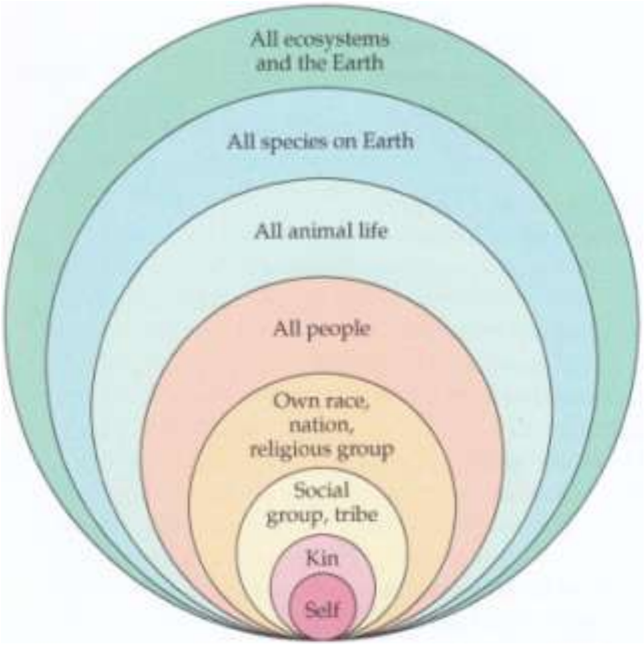
All species are interdependent

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

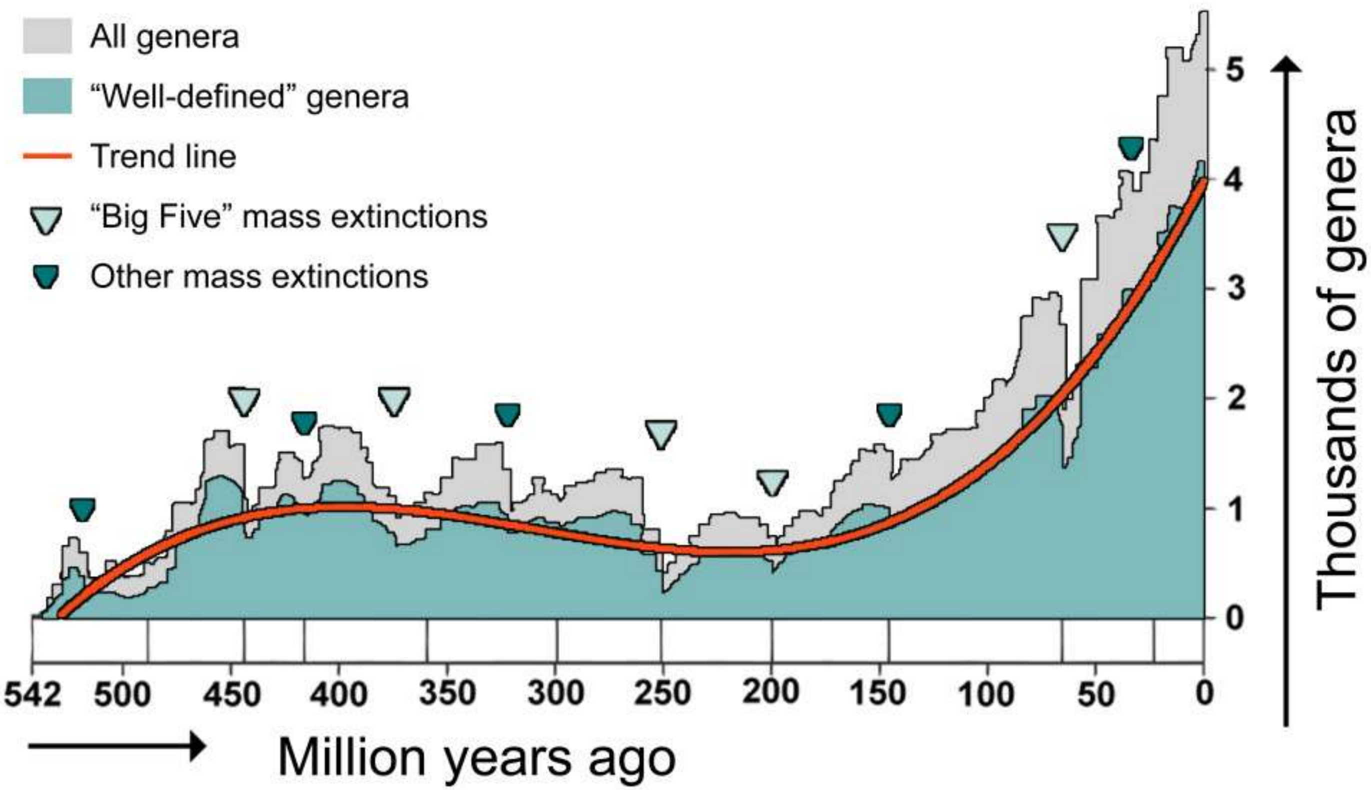
Dominant worldview	Deep ecology
Humans dominating nature	Humans living in harmony with nature
Natural environment and species as resources	All nature having intrinsic worth, regardless of human needs
A growing human population with a rising standard	A stable human population living simply
Earth providing 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

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

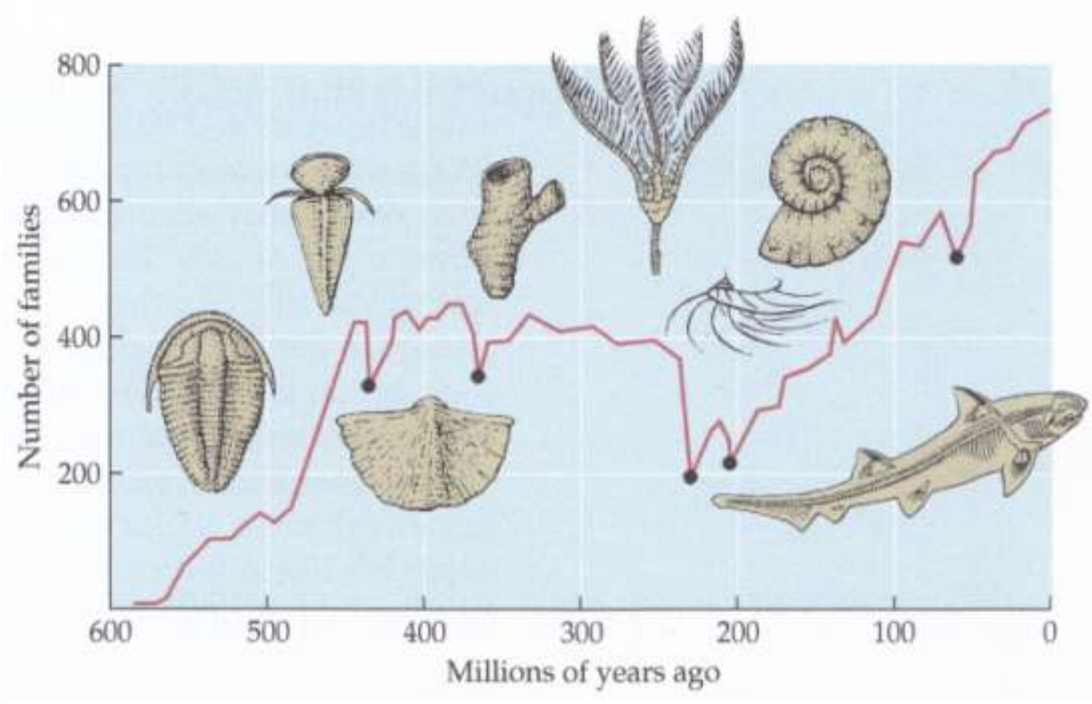
25% of the total net primary productivity of entire Earth used/wasted by the people

Genetic diversity of domesticated species decrease 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%

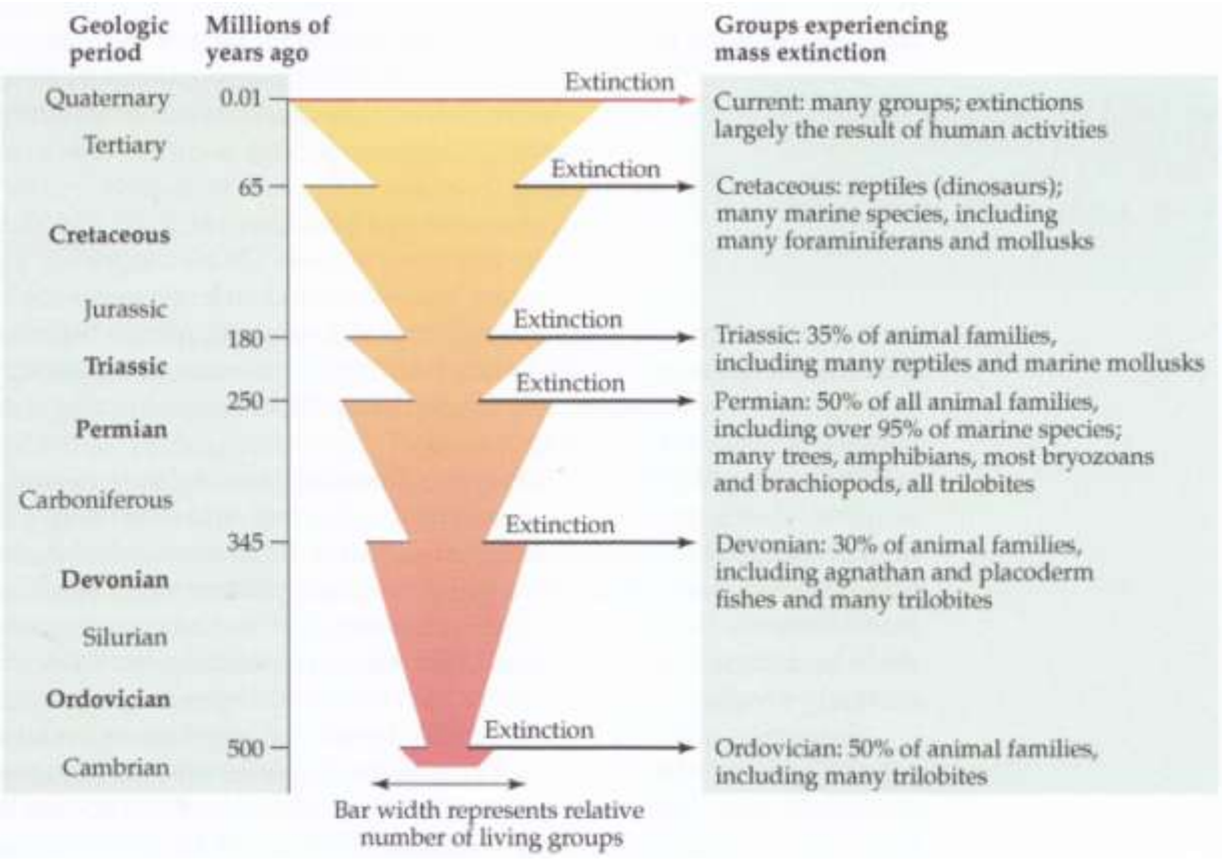
Perm (250 million year before) 95% of marine species loss – the largest mass extiction - 50 million years for recovery

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

Triassic 35%

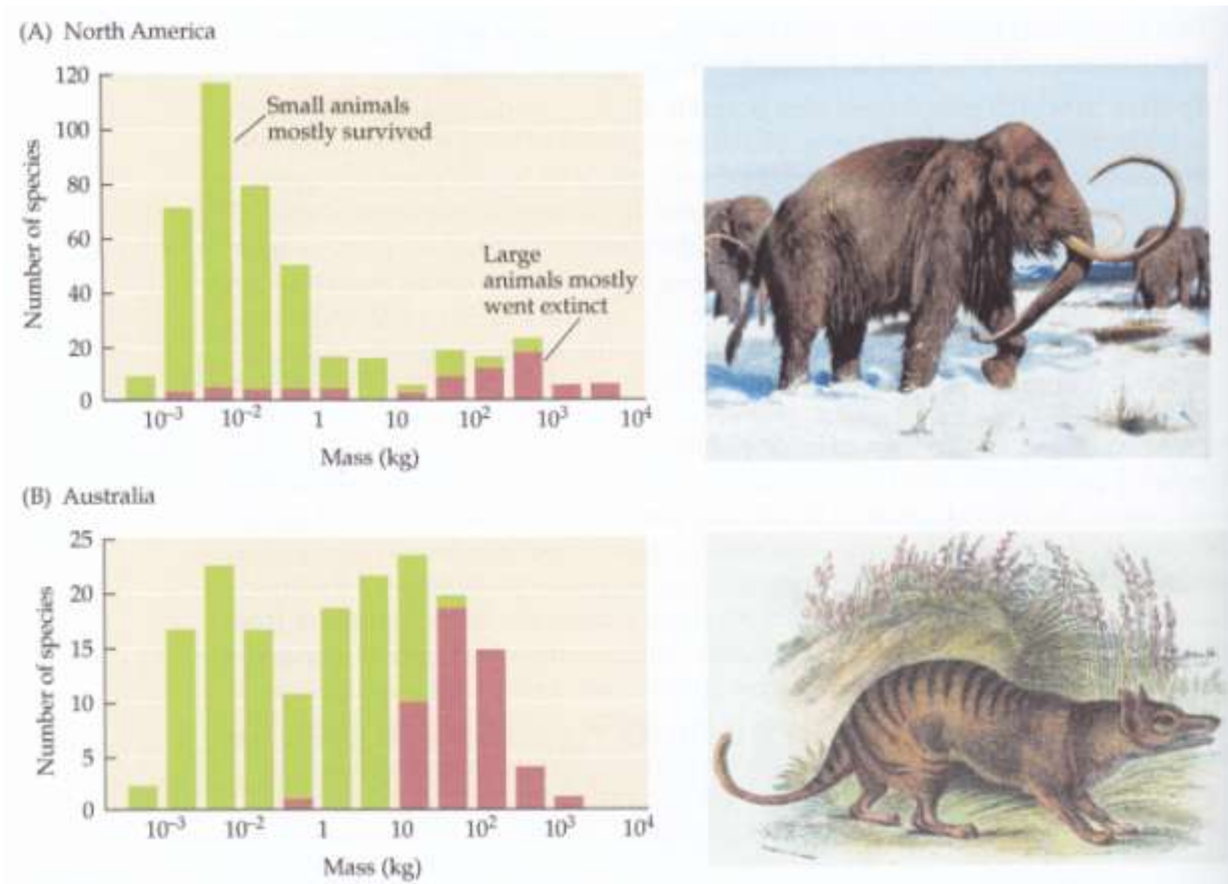
Cretaceous (dinosaurs)

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

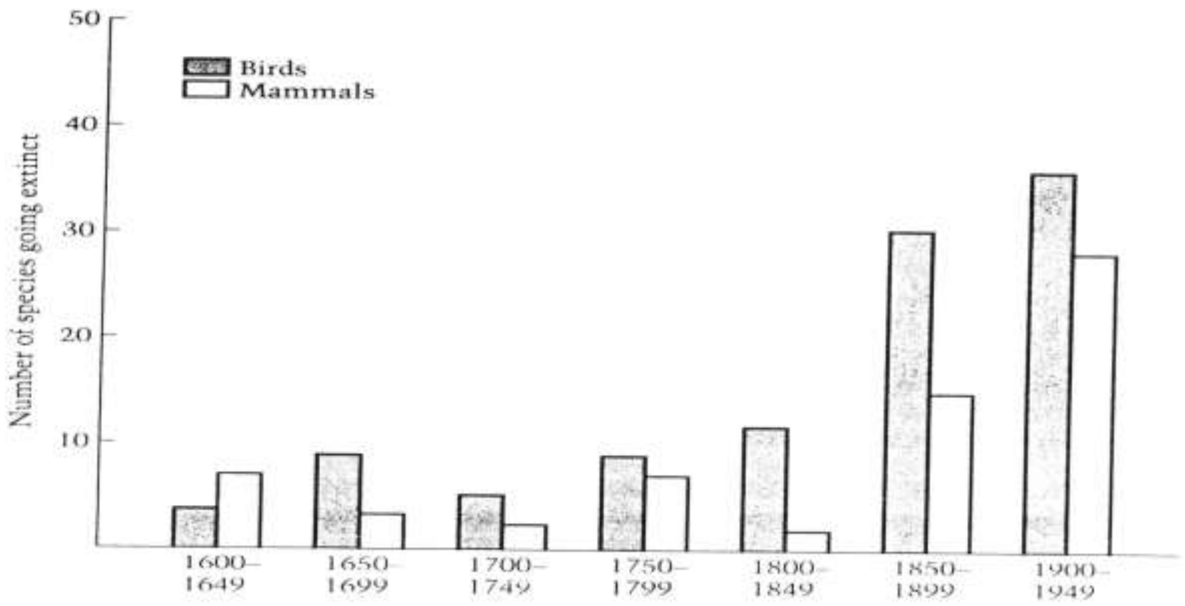


Human-Caused Extinctions

- 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[a]	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[a]	Hawaiian Islands
Cyanopsitta spixii	Spix's macaw	2000 (last record)	Brazil
Gallirallus owstoni	Guam rail	1987[a]	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[a]	Chad
Plants			
Argyroxiphium virescens	Silversword	1996	Hawaiian Islands
Commidendrum rotundifolium	Bastard gumwood	1986[a]	St. Helena Island
Nesiota elliptica	St. Helena olive	2003	St. Helena Island

Source: IUCN 2013 (www.iucnredlist.org).
[a]Species still exists in captivity.





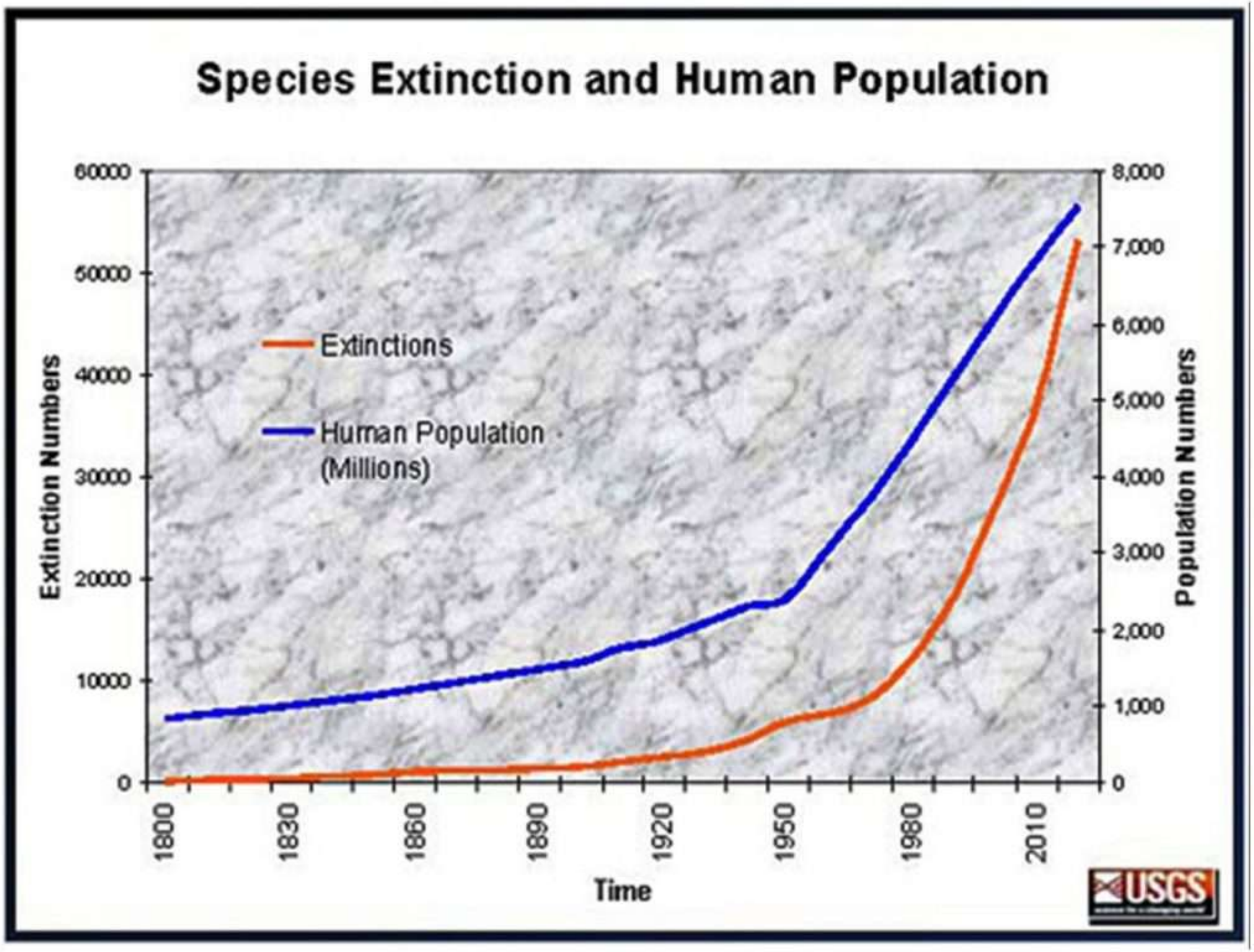







species/subspecies of amphibians, birds, mammals, and plants that have been





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

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

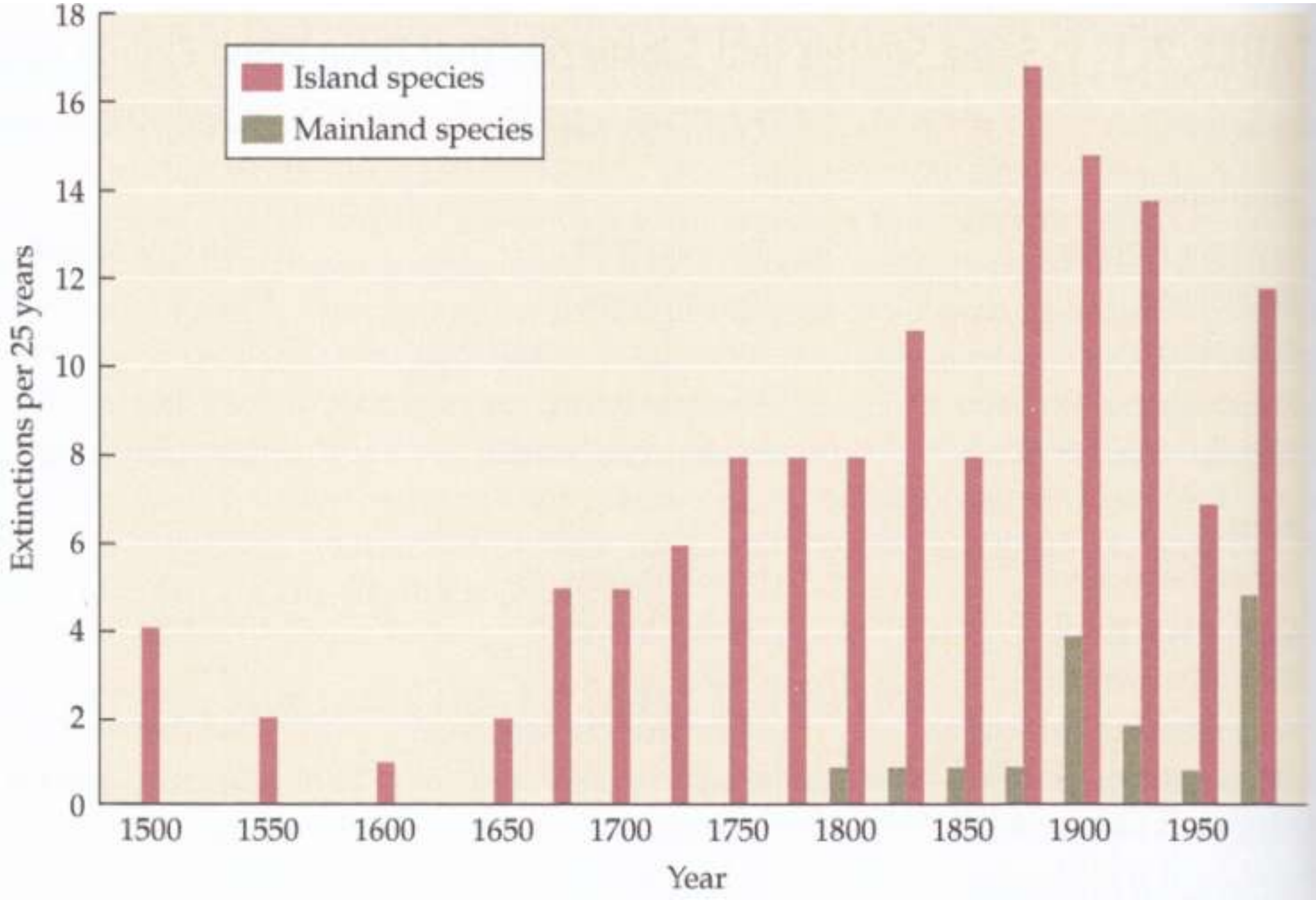


TABLE 7.3 Number of Native Plant Species and Those Species That Are Endemic for Various Islands and Island Groups

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 the islands

Comodo dragon

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

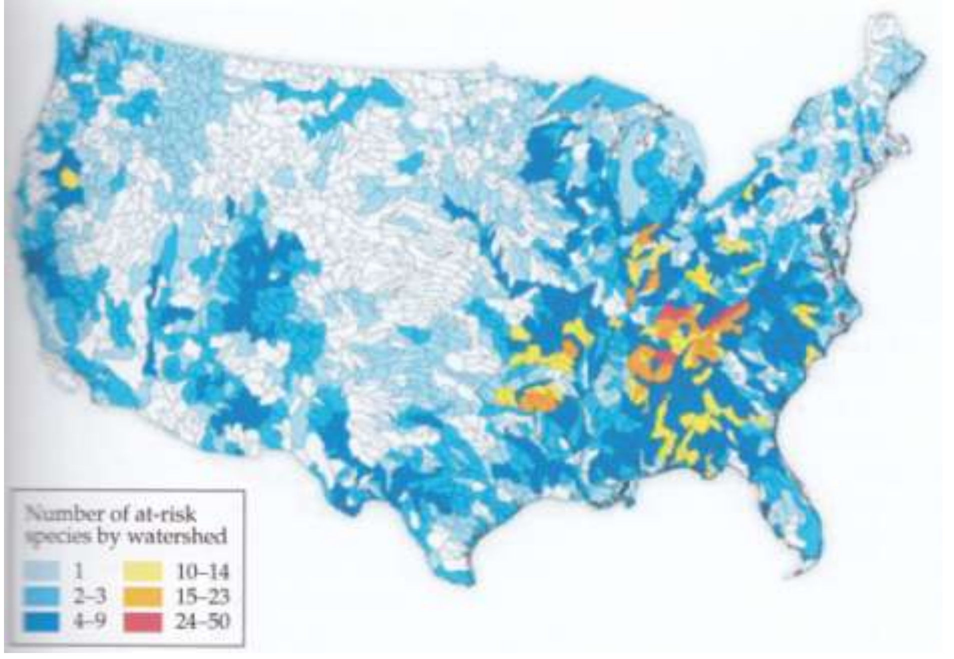
Endemic species in Oceanic region: 80% of them extinct or threathend by extinction

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

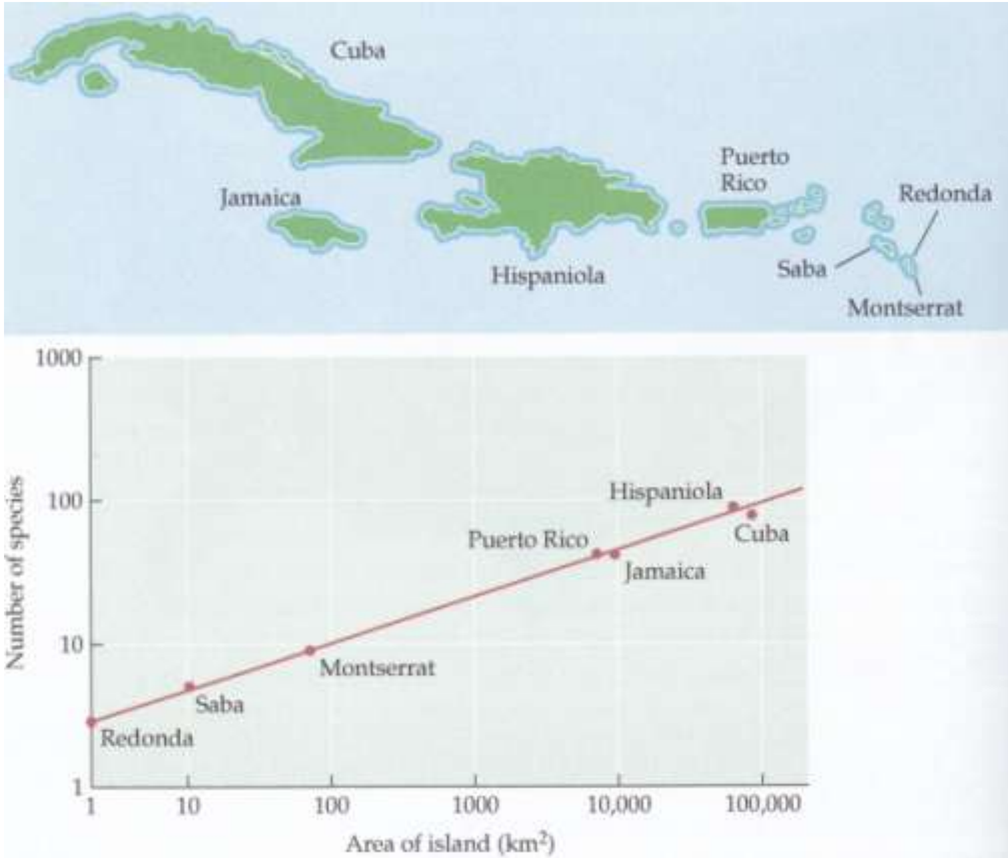
Extinction rates in Aquatic Environment

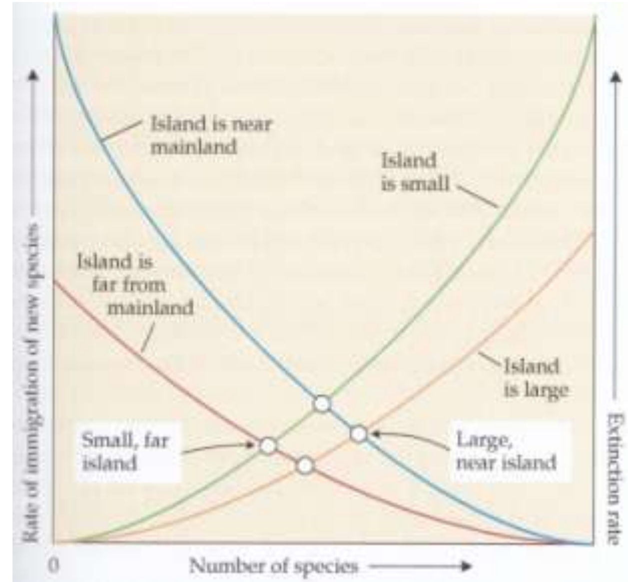


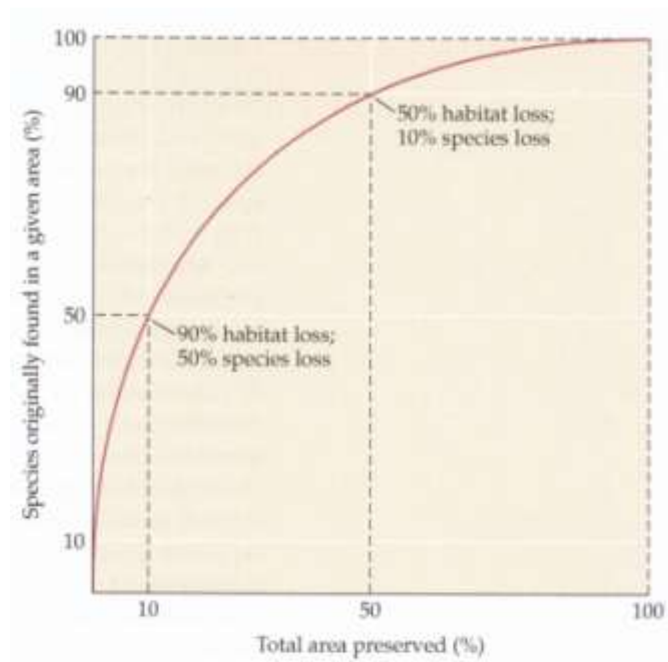
Number of fish and mussel species threatened with extinction in US.

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

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 cut 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 vulnerable

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	Geographic distribution: 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

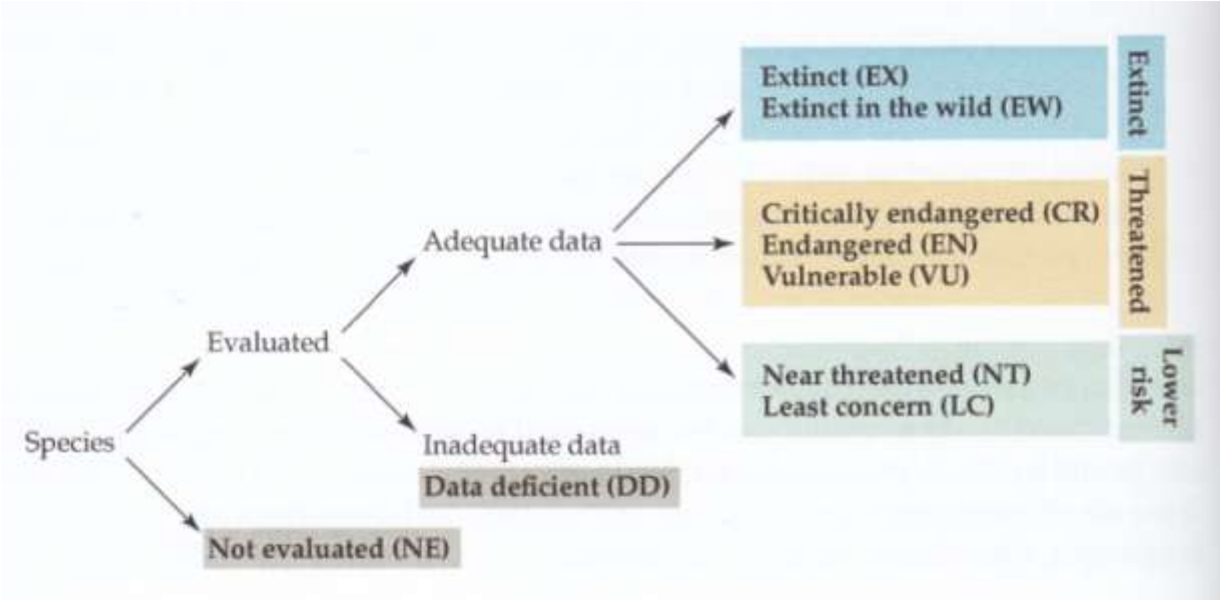
Region	Area (km^2)	Total number of species	Number of endemic species	Percent endemic species
Europe	10,000,000	10,500	±3500	33
Australia	7,628,300	15,000	14,074	94
Texas	751,000	4694	379	8
California	411,000	5647	1517	27
Germany	349,270	2600	6	<1
North and South Carolina	217,000	3586	23	1
Cape Region 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 probability of extinction within 10 years, 3 generations
- Endangered, 20% or greater probability of extinction within 20 years, 5 generations
- Vulnerable, 10% or greater probability 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.

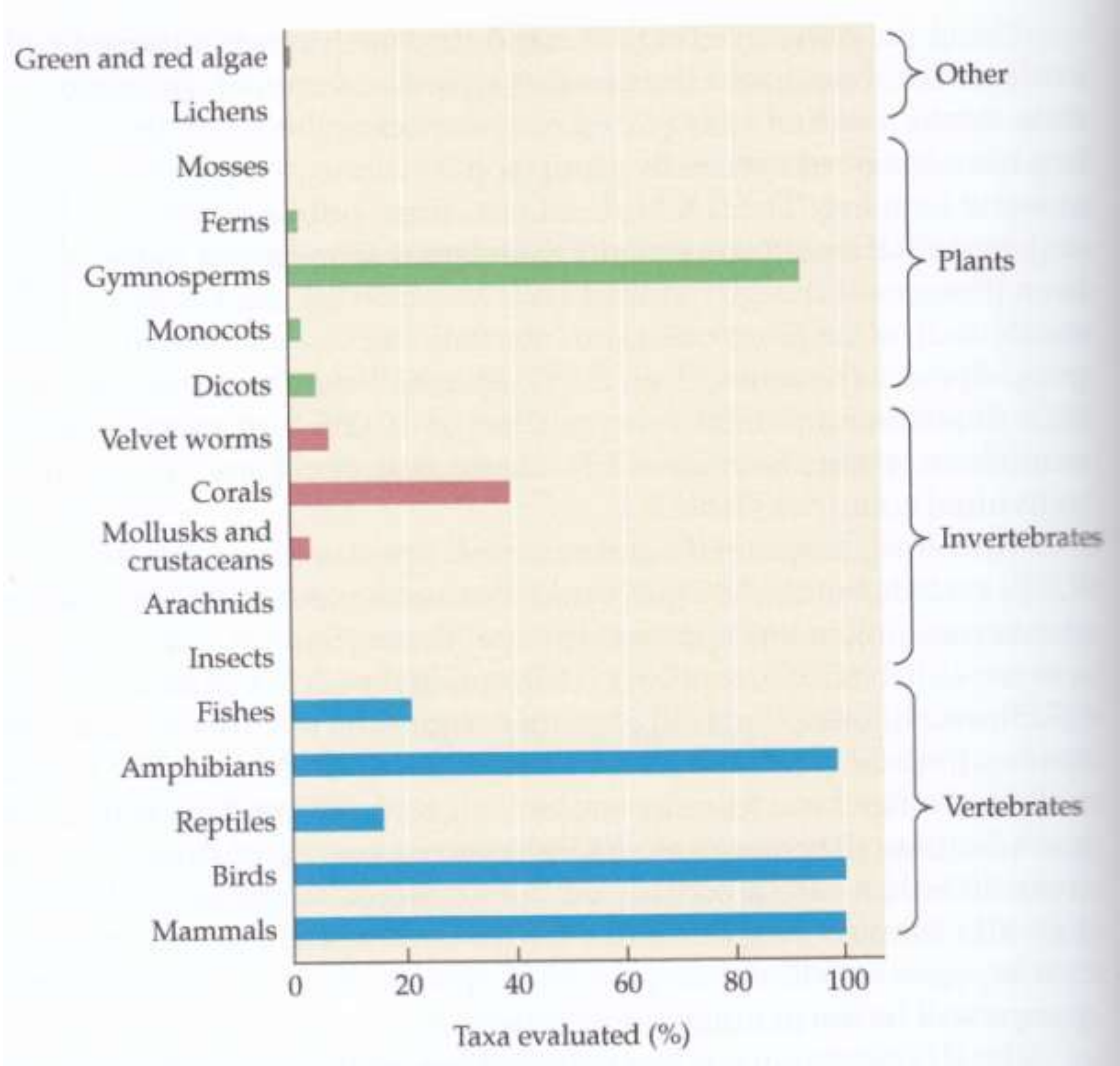
[b]Percentages are low for amphibians in Russia and for plants in all countries because most species have not yet been evaluated using the updated system of assigning categories. Once all species have been evaluated, these percentages will probably increase.

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

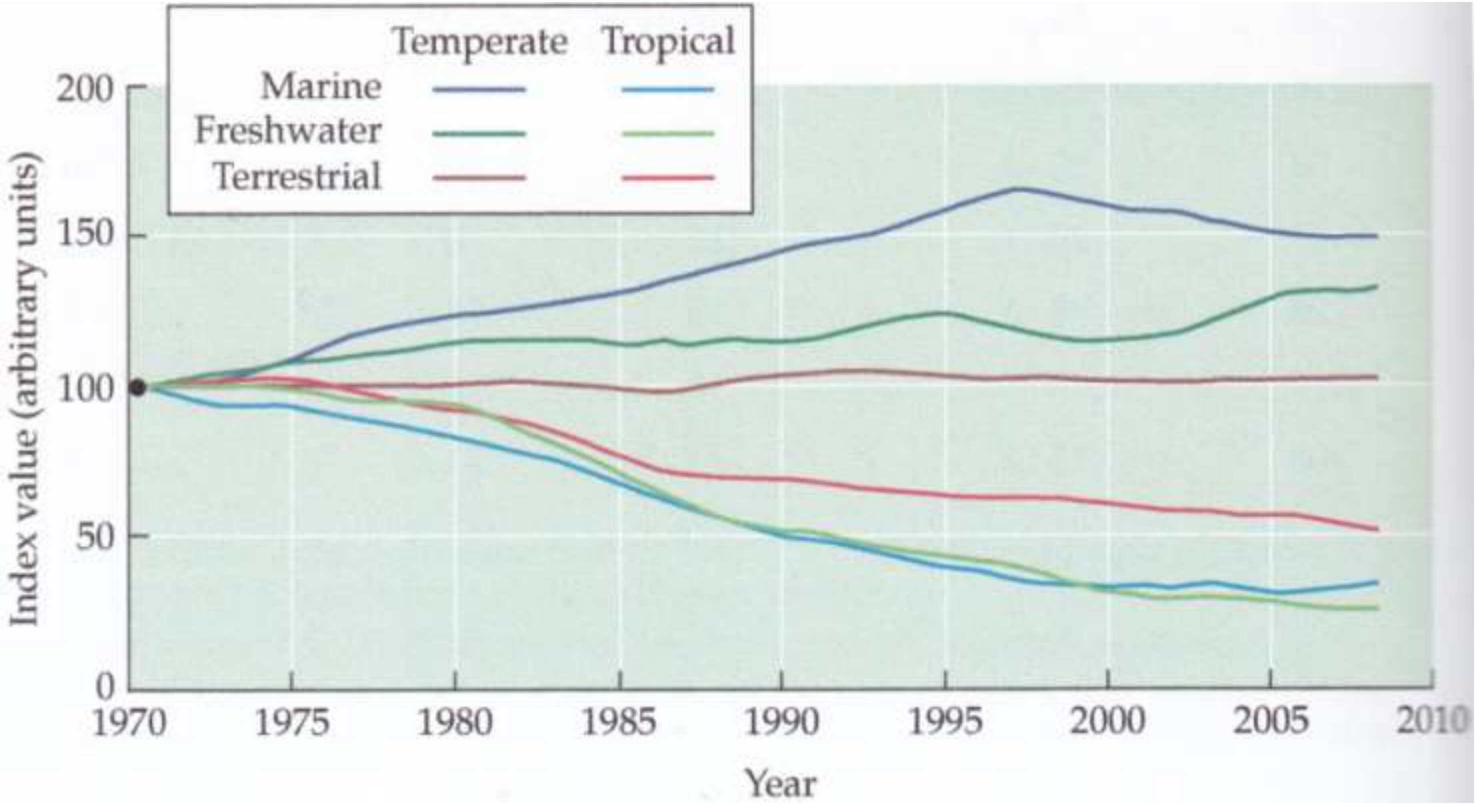
Reptiles		Amphibians[b]		Plants[b]	
Number of species	Percent threatened	Number of species	Percent threatened	Number of species	Percent threatened
432	1	159	19	9000	<1
39	15	46	2	9705	0
211	18	327	27	30,000	1.5
37	39	56	34	4700	<1
37	24	29	0[b]	11,400	<1
228	6	116	16	23,000	<1
7	14	8	0	1550	<1
300	12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

.

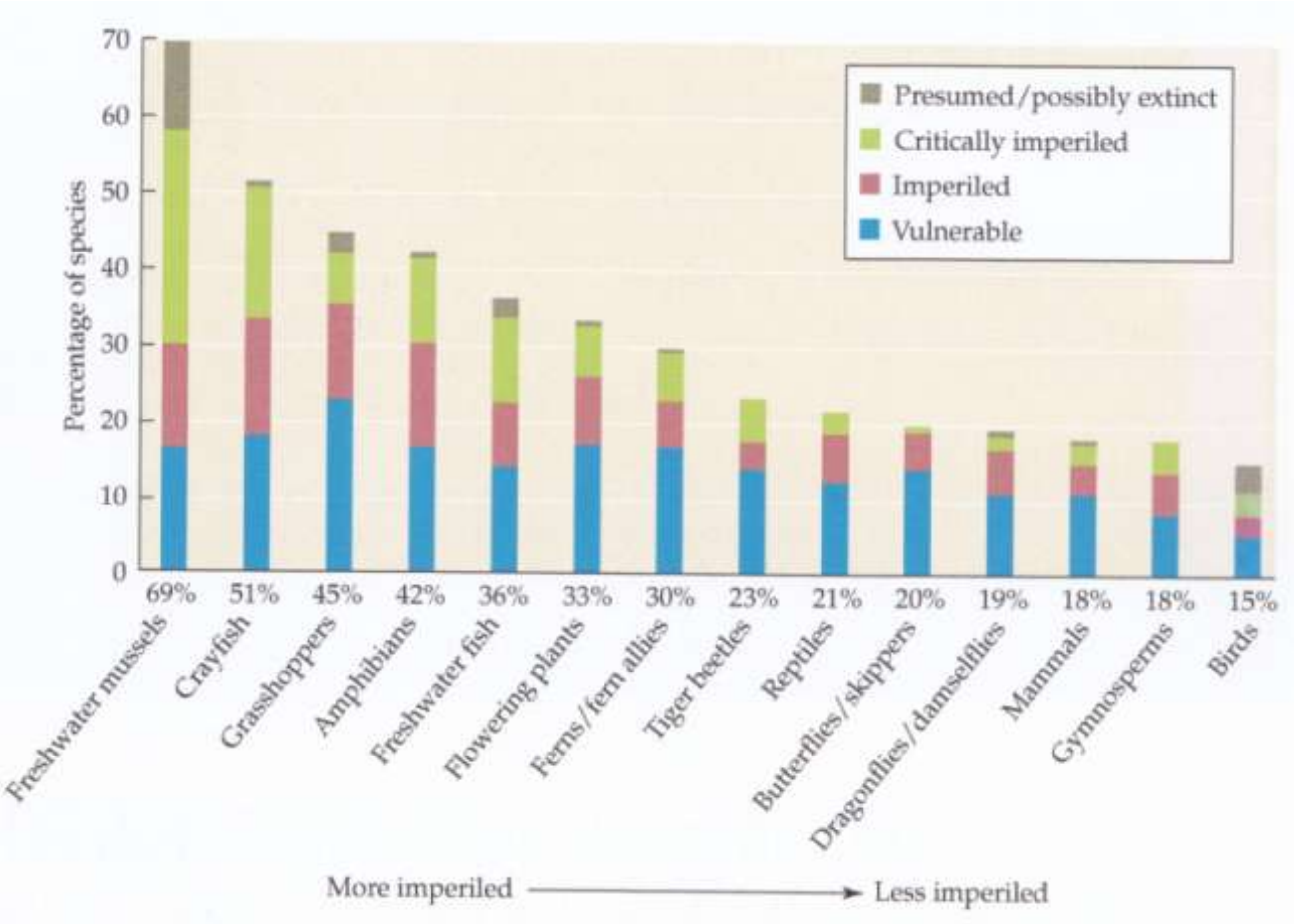
The percentage of species evaluated for IUCN Red List categories



Living Planet Index, follows population size of 2688 vertebrate species



Vulnerable species groups in US



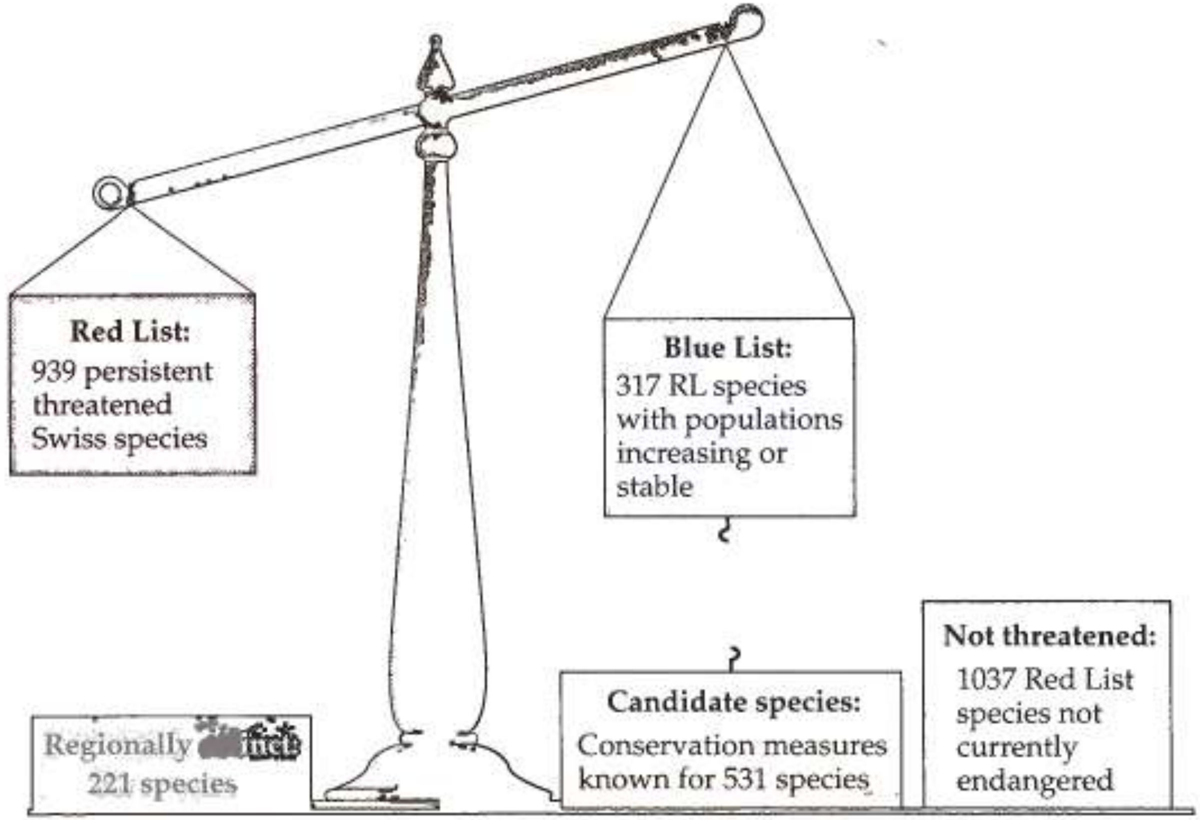
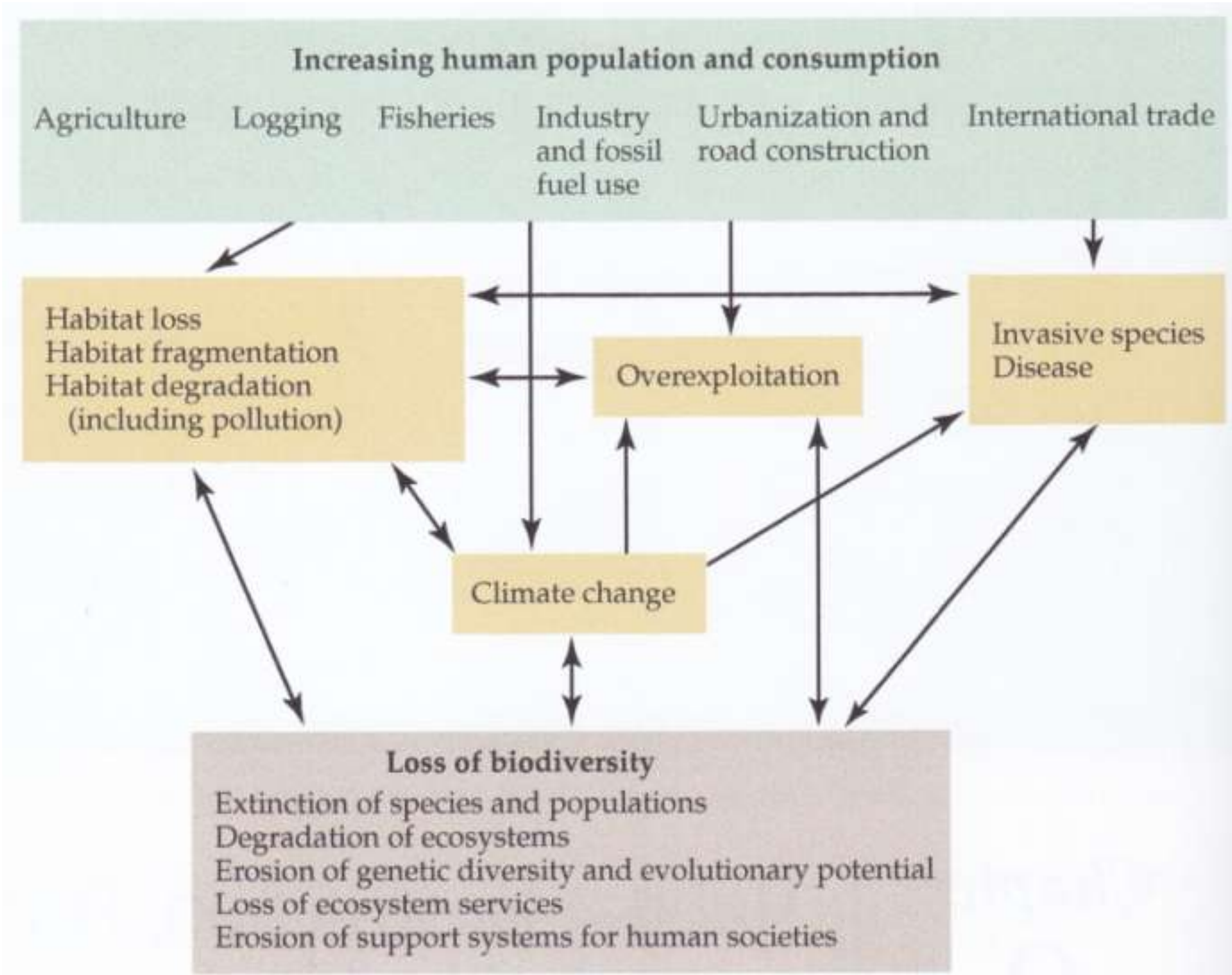


FIGURE 8.7 An innovative approach is being developed in three Swiss cantons to evaluate the current status of the species of plants and animals that are currently on the Red List of threatened and extinct species. Of these, 317 species have been identified as stable or increasing in abundance, thanks to conservation and protection measures; these species form a Blue List of recovering species that have been removed from the Red List. Protection and conservation techniques are locally successful or known for 531 species; these species are "candidate" species for the Blue List. There are 939 "persistent" Red List species that are still declining in size and for which recovery efforts are not yet known. There are 1037 species on the Red List not currently listed as threatened, but in some cases abundances are declining, data are inadequate, or species are not responding to current conservation measures. The goal is to shift the balance as the Blue List lengthens. (After Gigon et al. 2000.)

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.

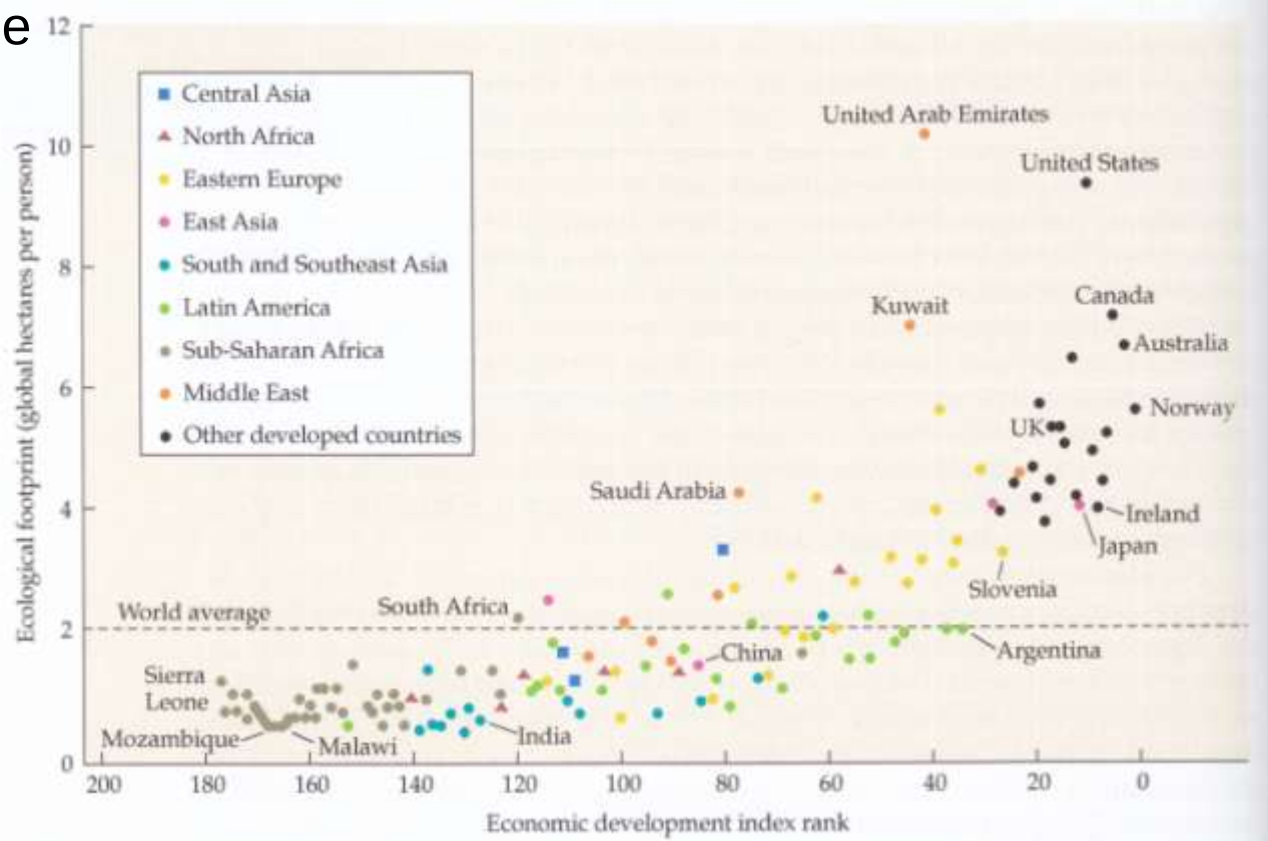
Sources: MEA 2005; Kulkarni et al. 2008.

Consumption

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

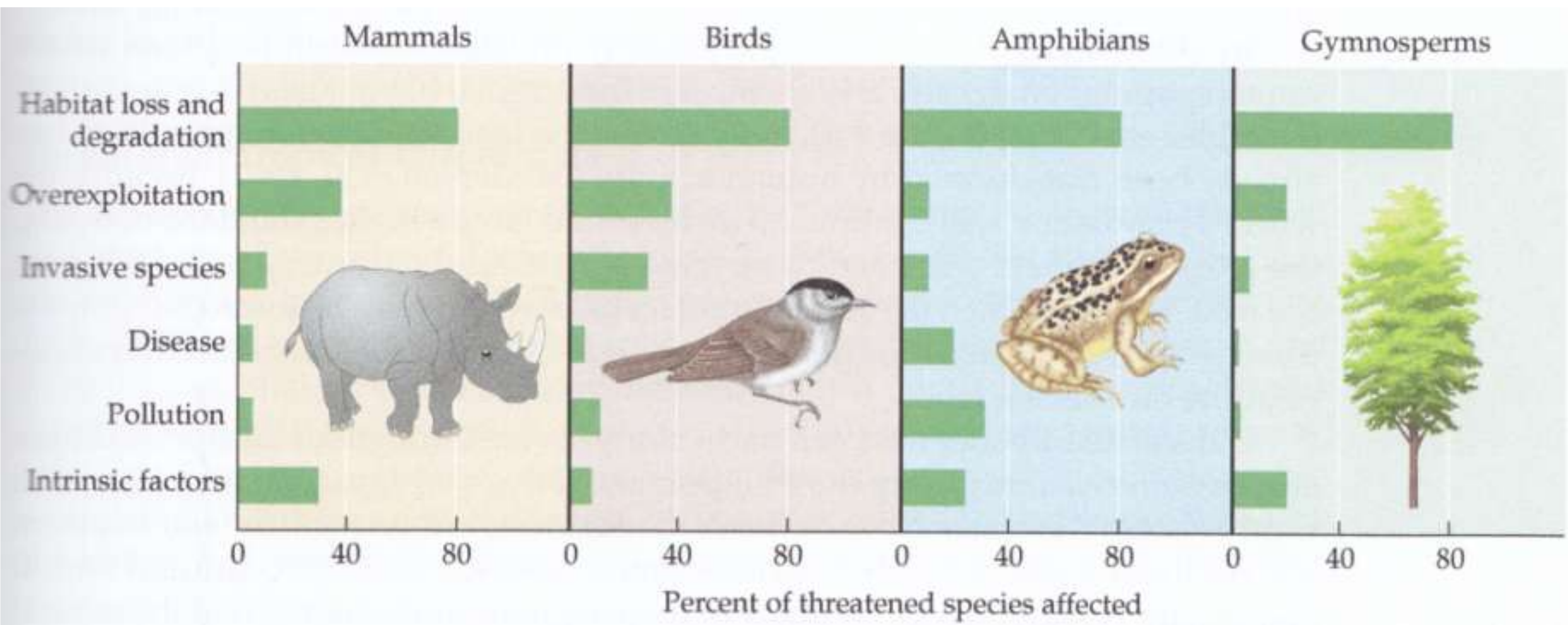
US, only 5% of world's human population, uses roughly 25% of world's natural resources

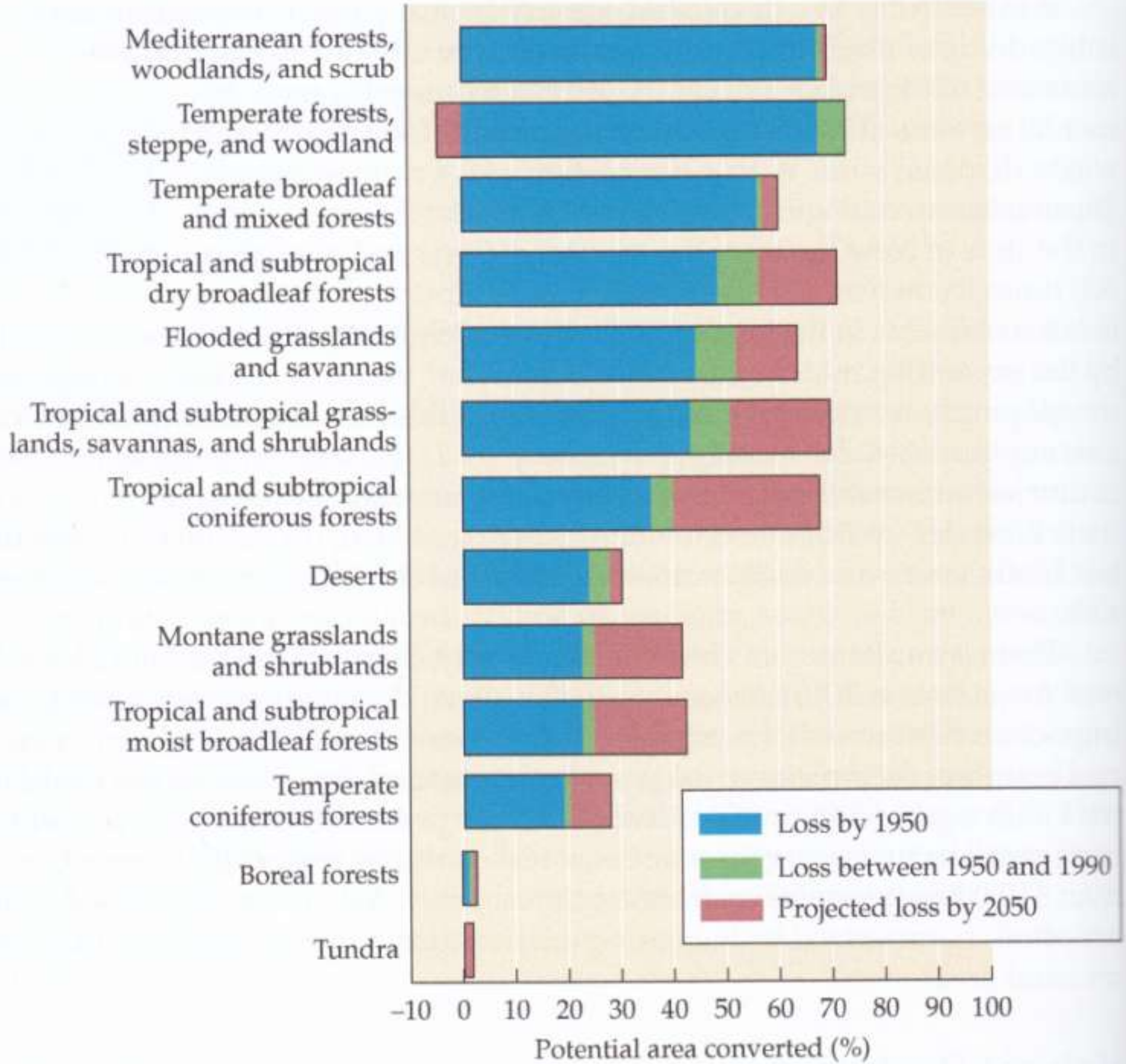
Annually, one US citizen use 25 times more energy, 79 times more paper than an Indian one



Habitat destruction

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



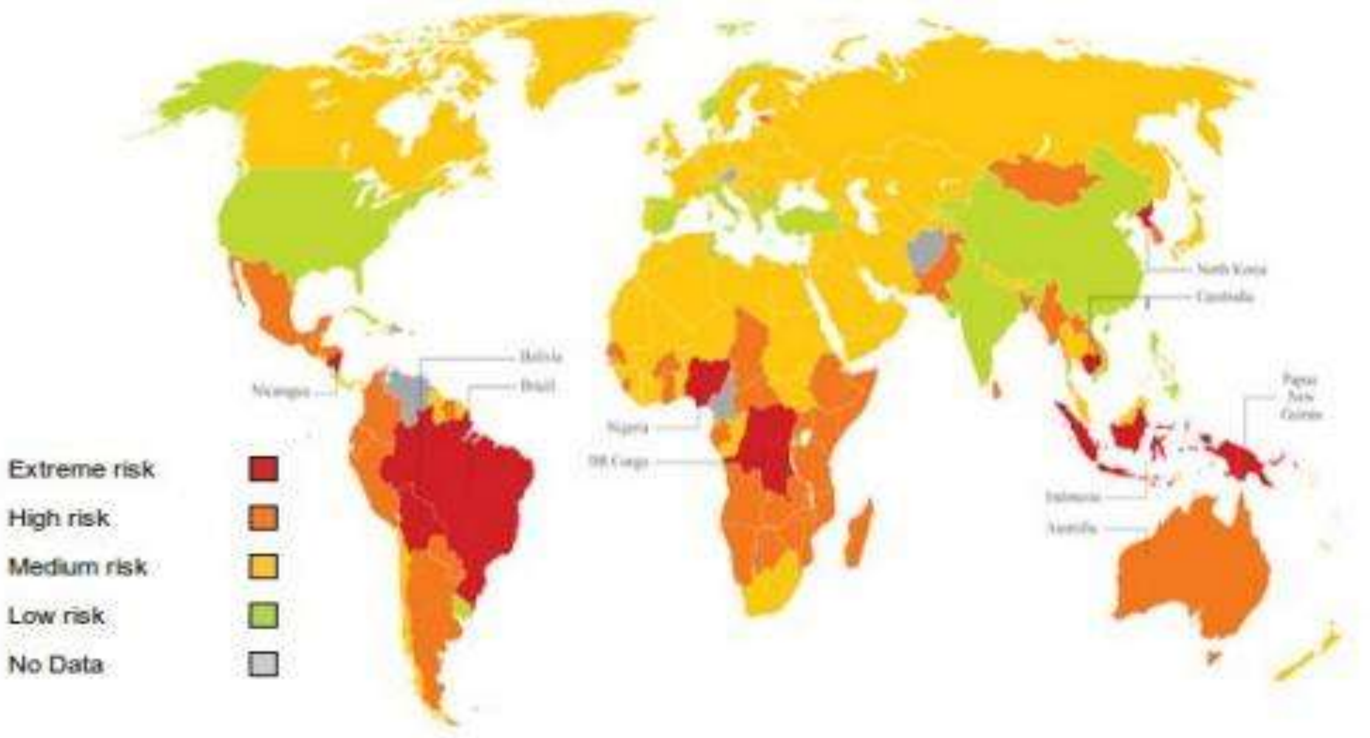


Mediterranean forests, woodlands, and scrub
Temperate forests, steppe, and woodland
Temperate broadleaf and mixed forests
Tropical and subtropical dry broadleaf forests
Flooded grasslands and savannas
Tropical and subtropical grasslands, savannas, and shrublands
Tropical and subtropical coniferous forests
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 unmodified 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.

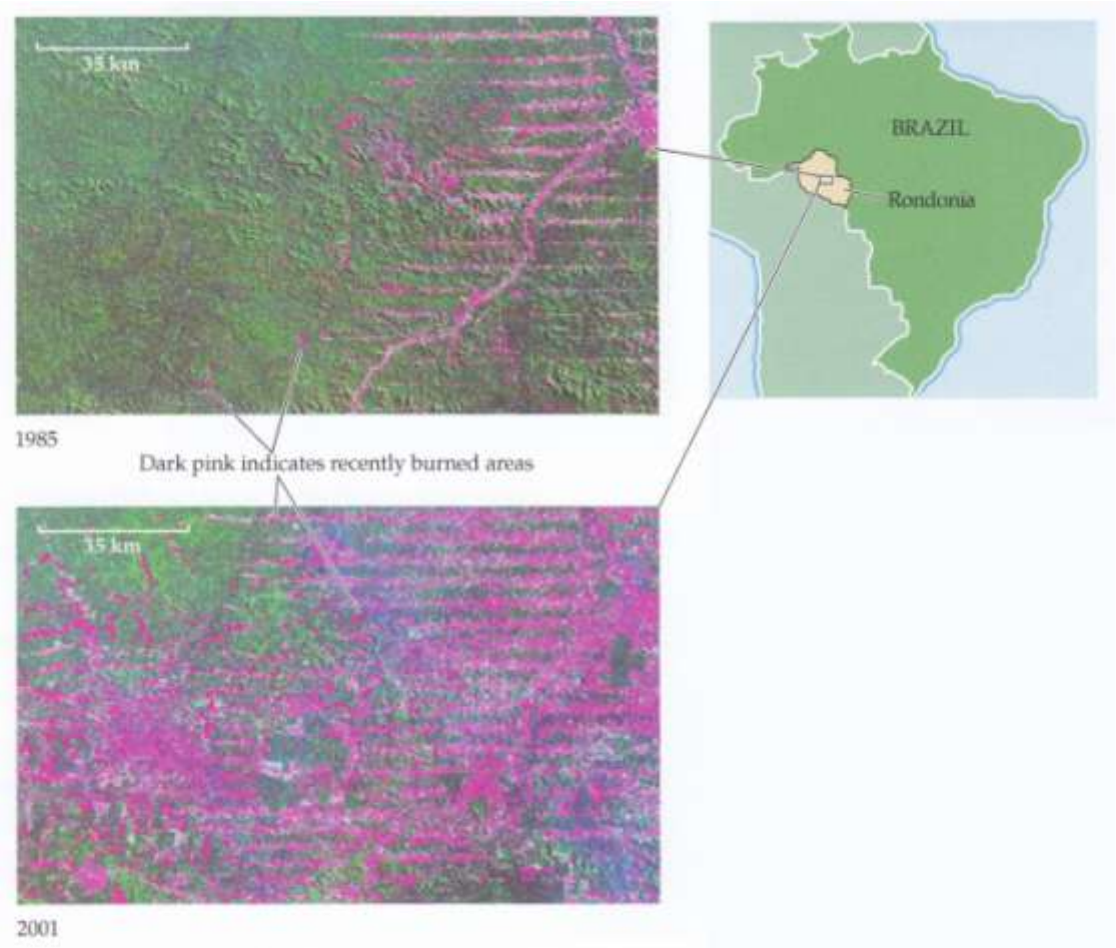
[f]FAOSTAT.

[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

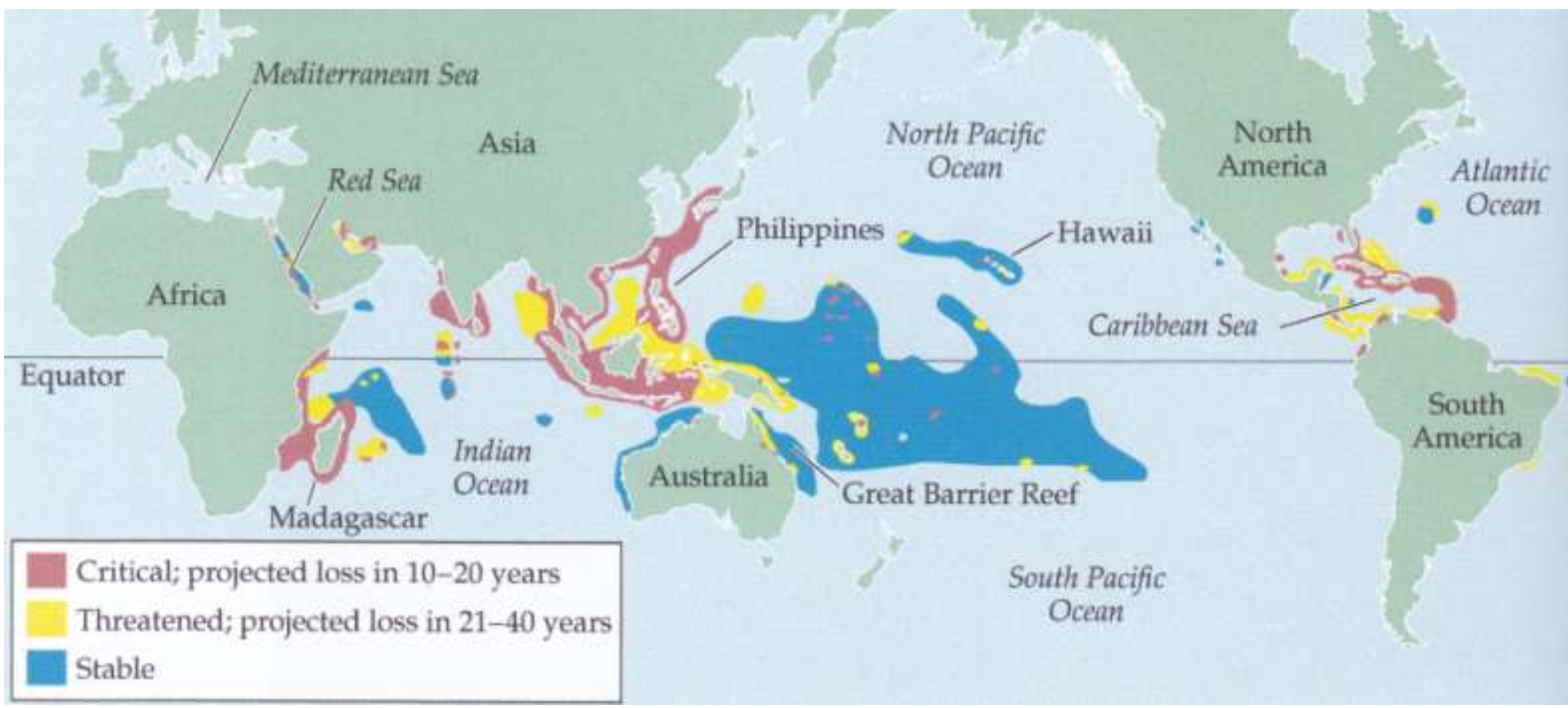
degradation by overfishing, pollution,

invasive species

Other threatened habitats

Coral reefs

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

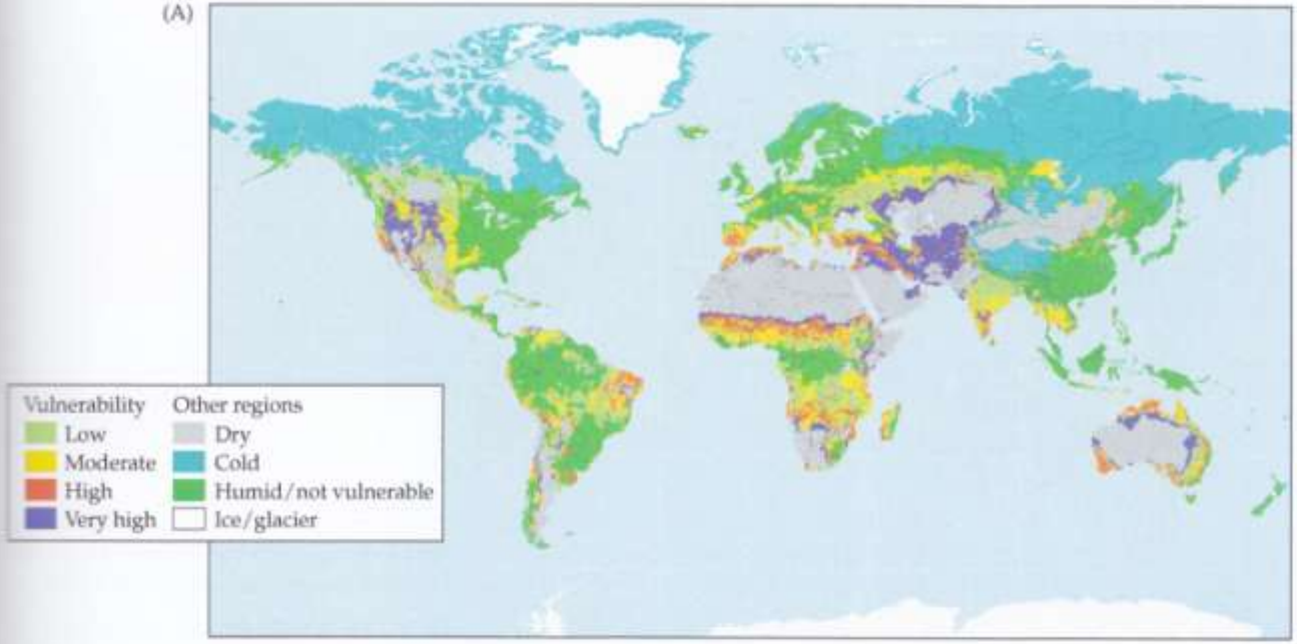


Desertification

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

9 million km^2 converted to man-made desert

(A)

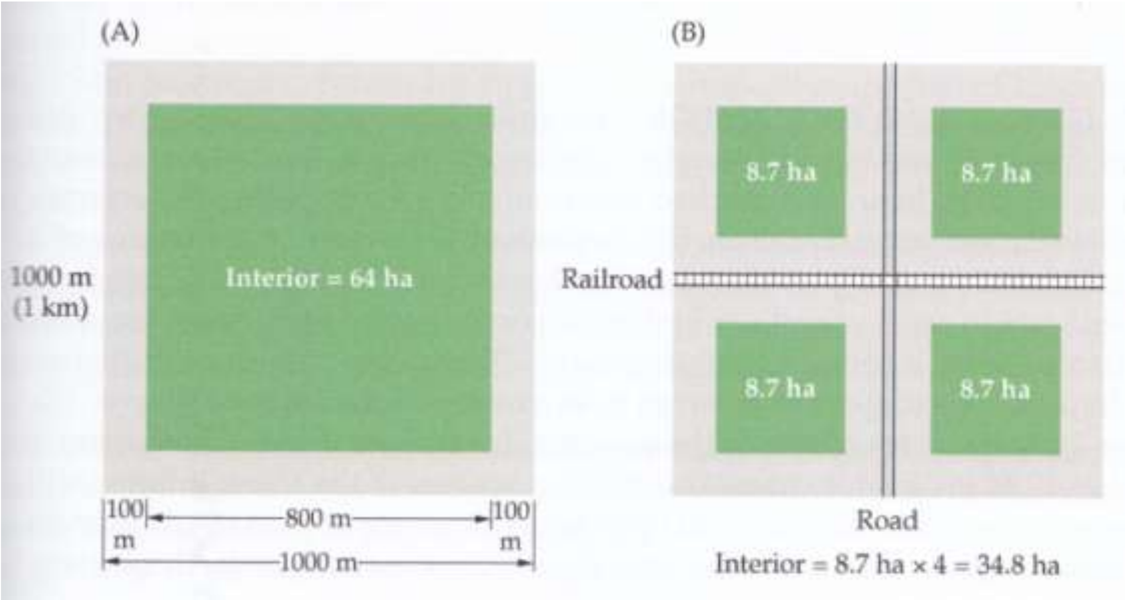


(B)

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

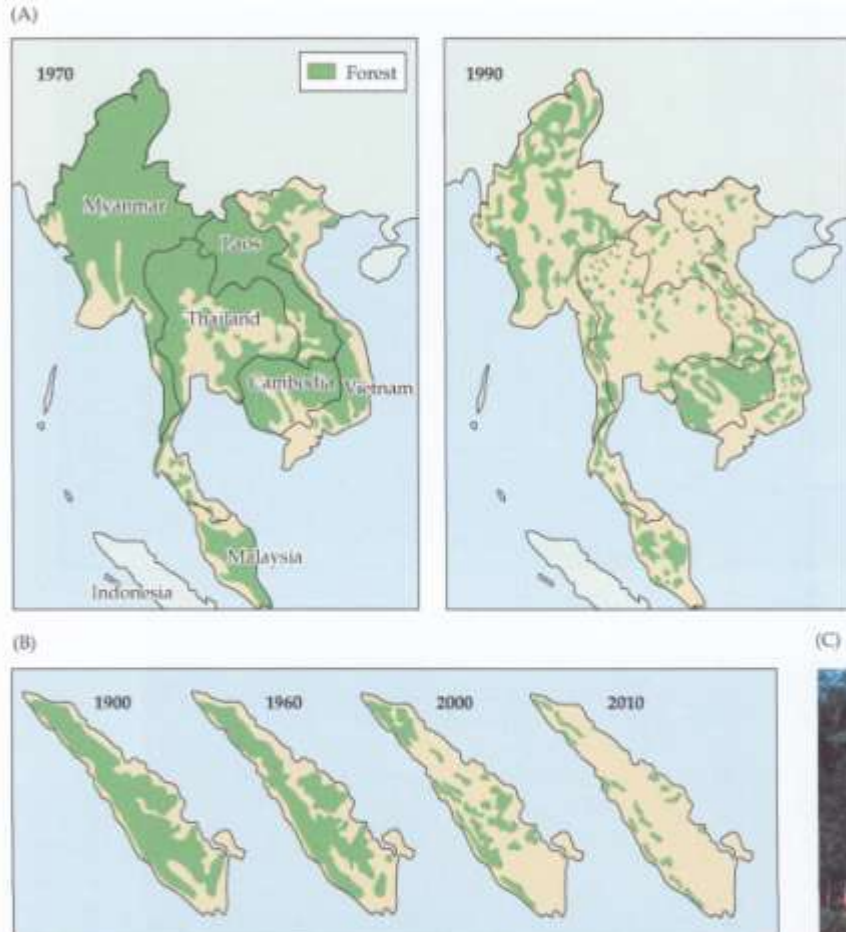
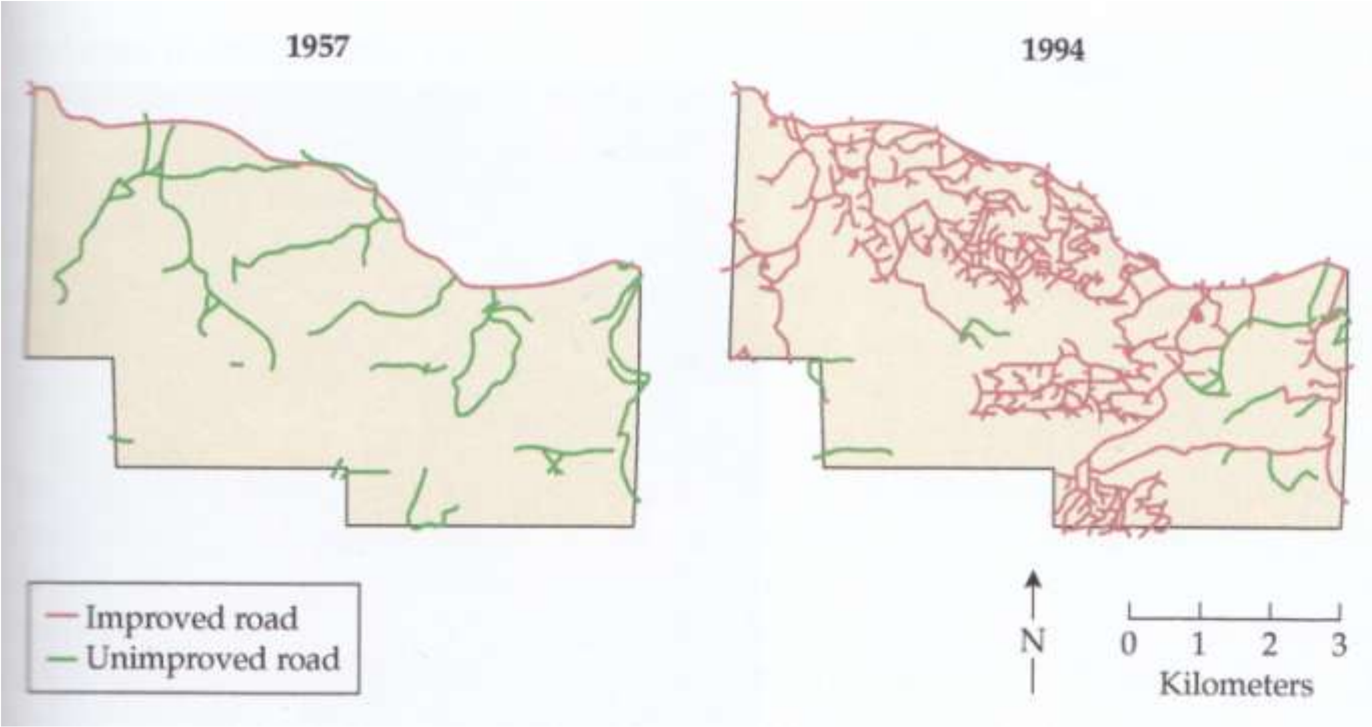


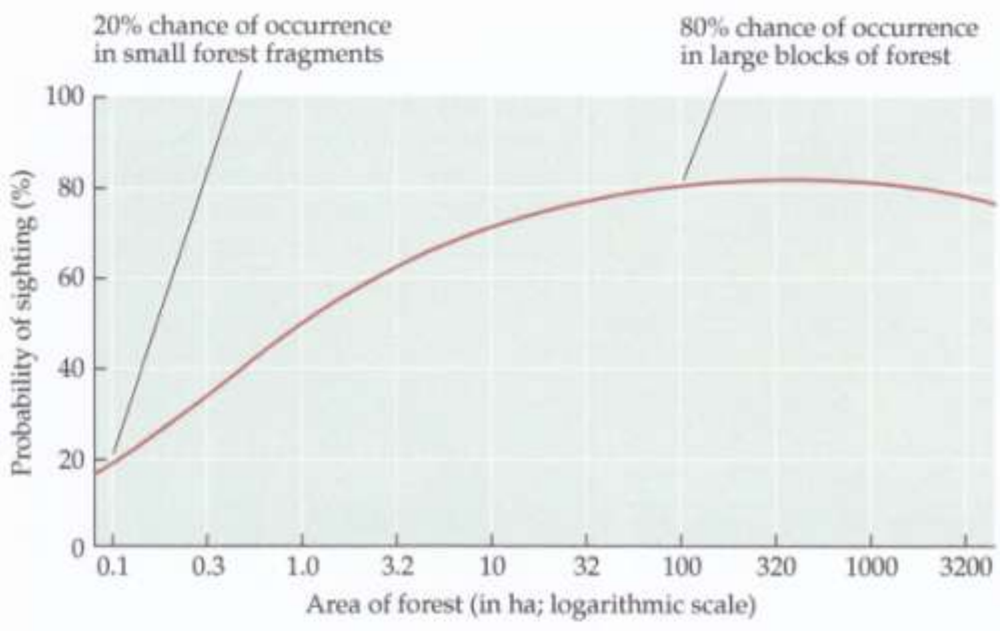
Figure 9.11 The forests of tropical Asia have experienced massive deforestation and fragmentation in recent decades. (A) Two forest maps of Southeast Asia from 1970 and 1990. (B) Sumatra, a large island of Indonesia, has experienced intense habitat destruction over the past 100 years. (C) A wide path (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

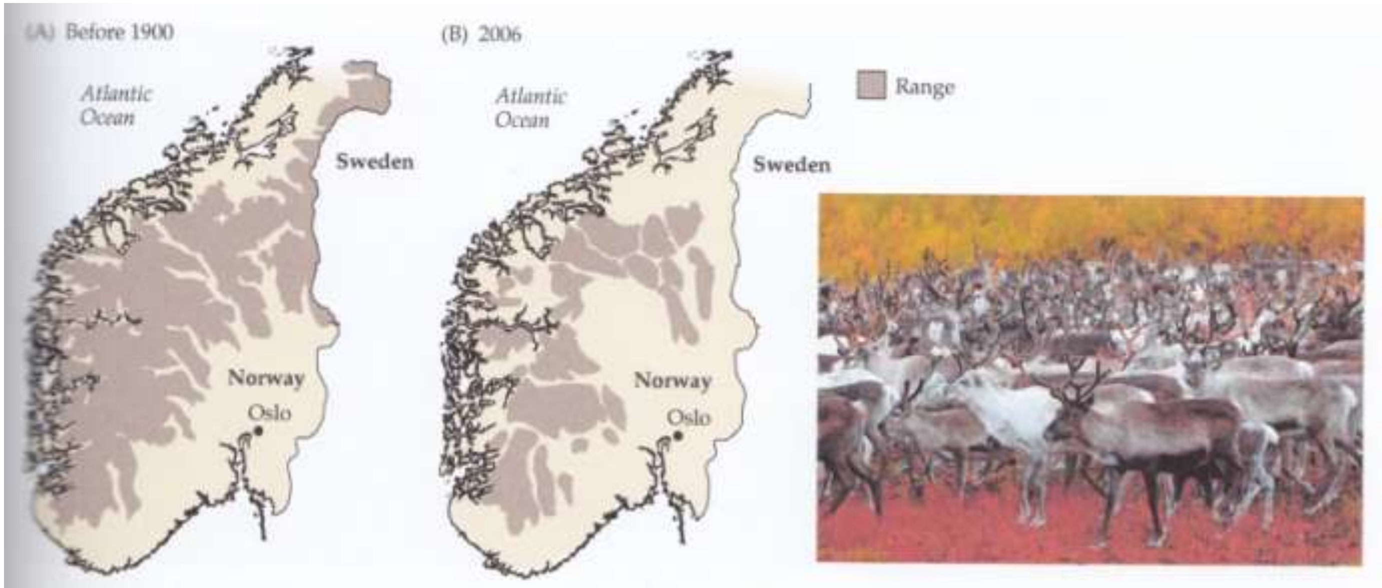


Habitat fragmentation

Population effects:

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

Wild reindeer population in Southern Norway

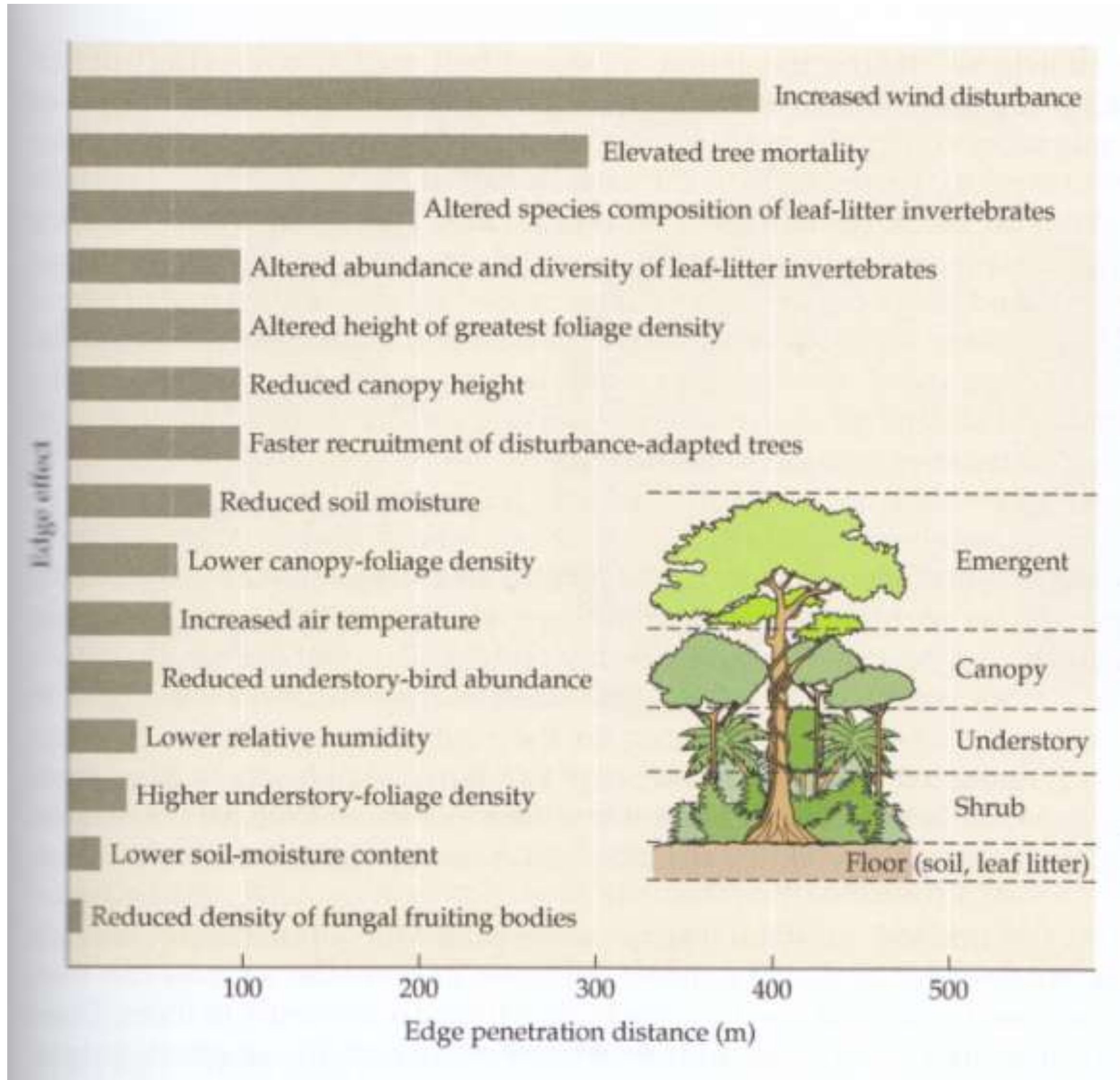


Habitat fragmentation

Edge effects:

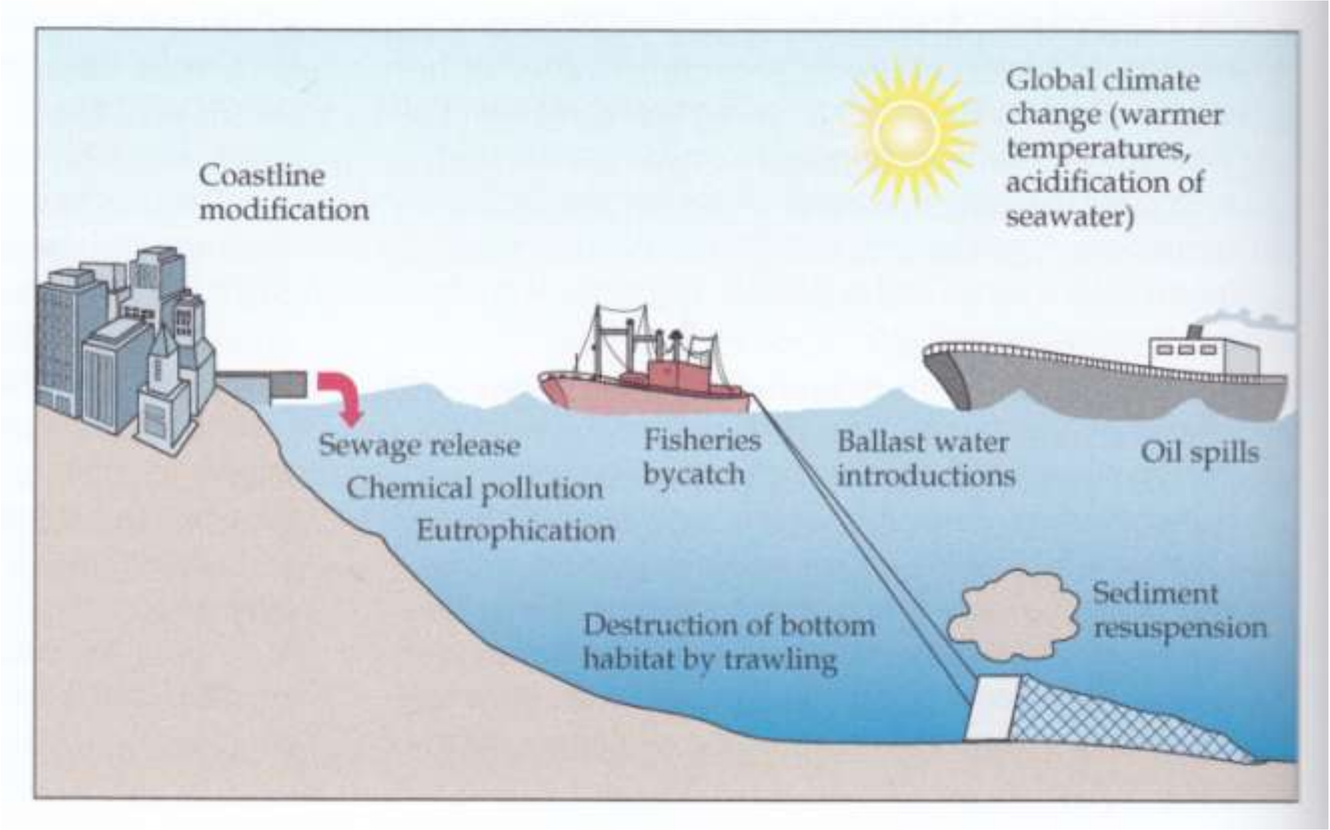
- Microclimate changes
- Increased incidence of fire
- Interspecies interaction
- Potential for disease

Edge effects in the Amazon rain forest



Habitat degradation and Pollution

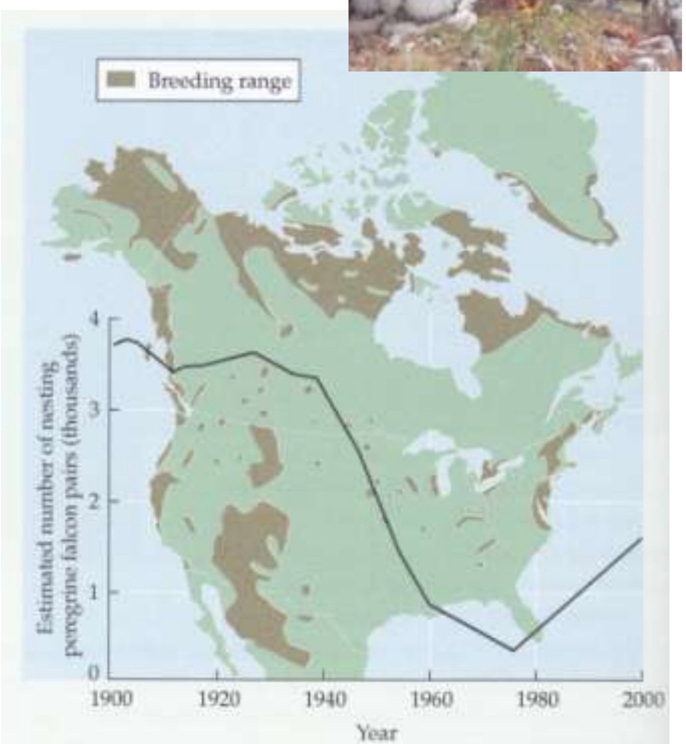
- Overgrazing and trampling grasslands by too many cattles
- Fishing trawlers across ocean floors

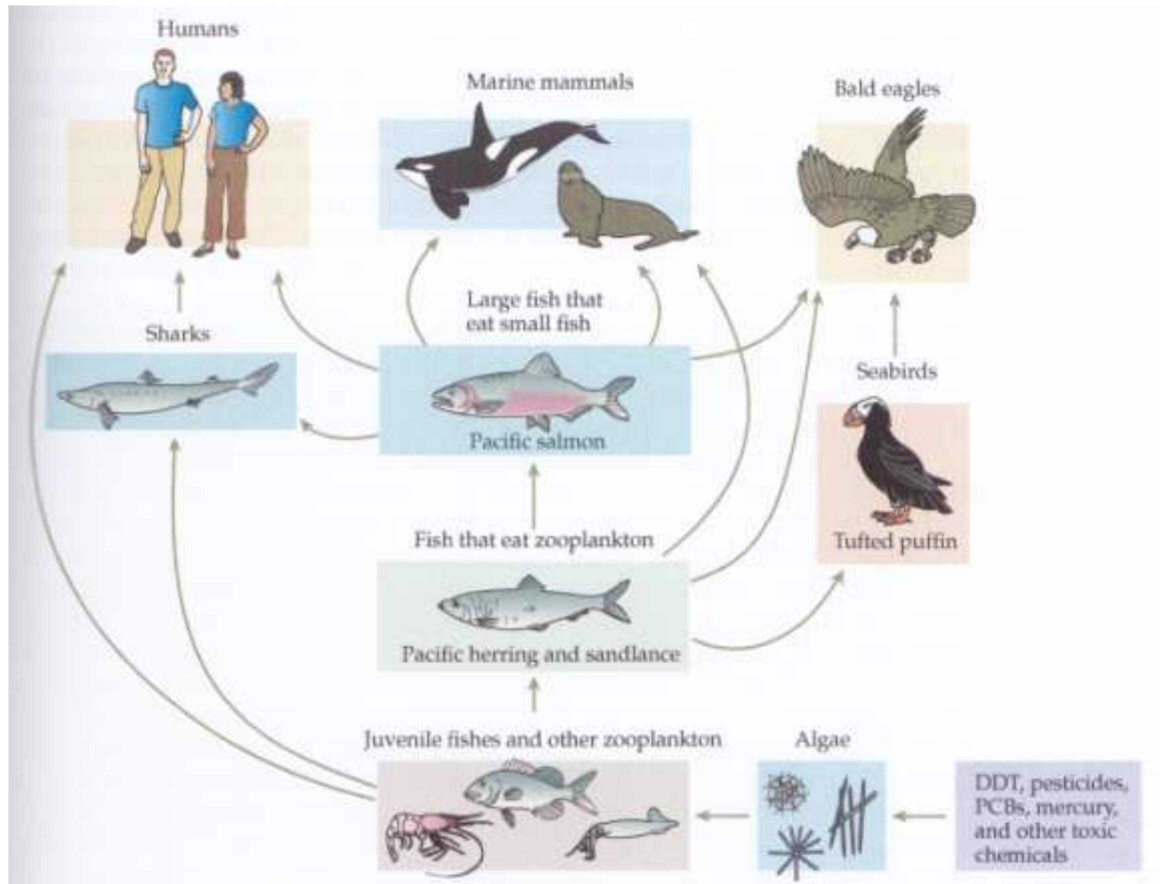


Habitat degradation and Pollution

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

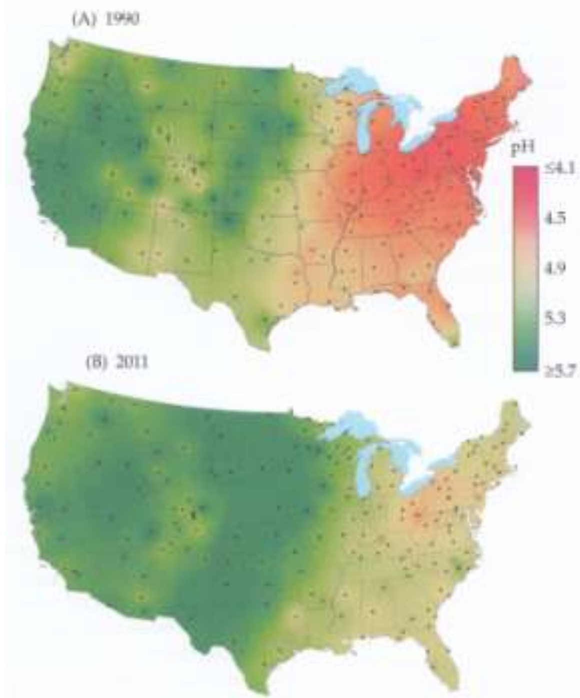
Acid rain

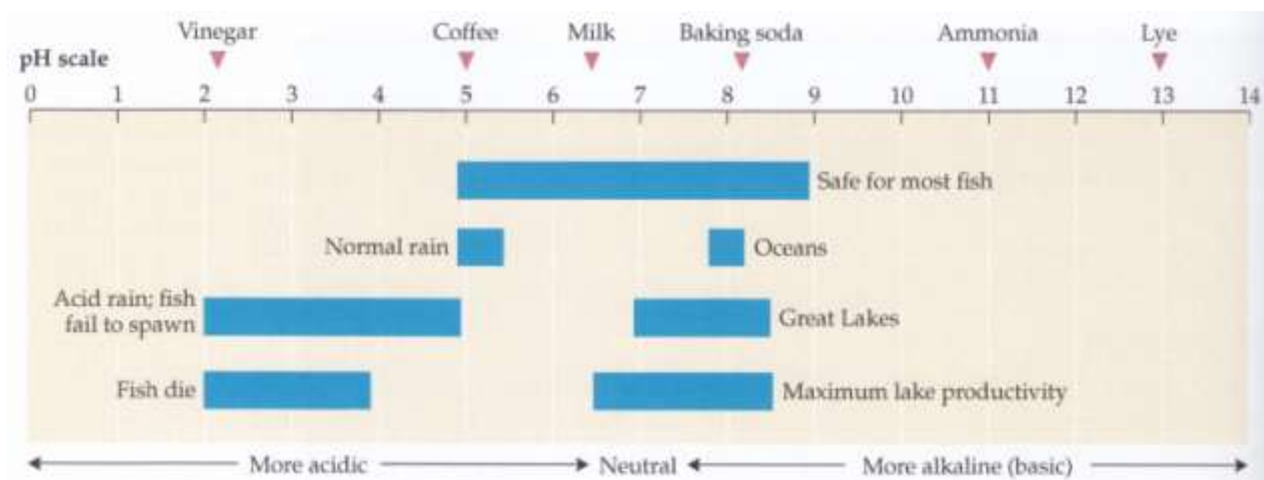
Ozone production

Nitrogen deposition

Toxic metals

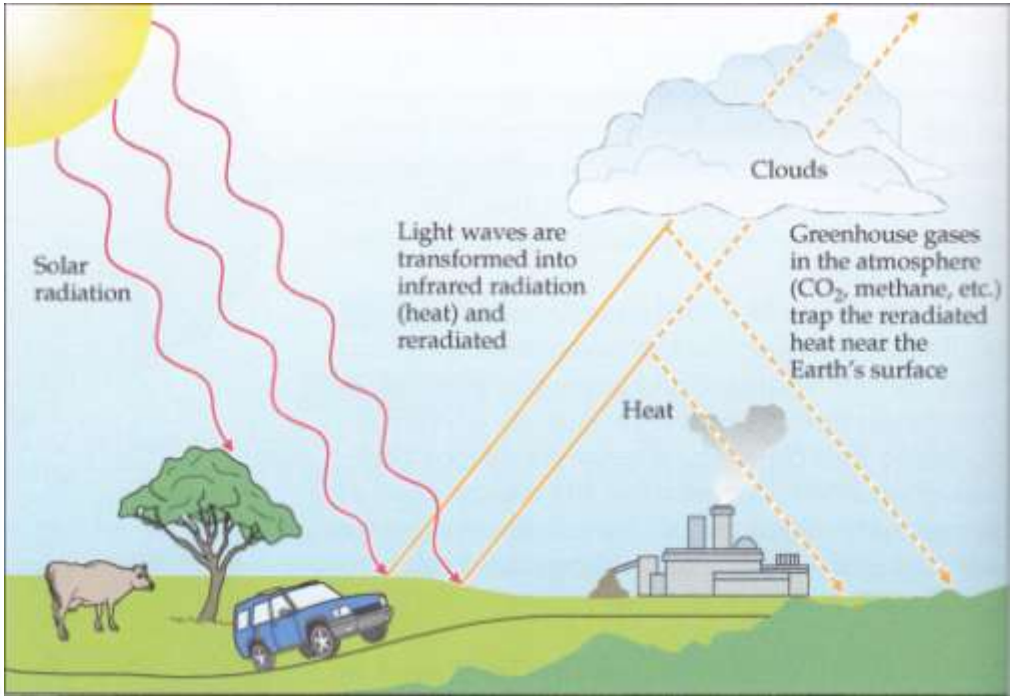
leaded gasoline

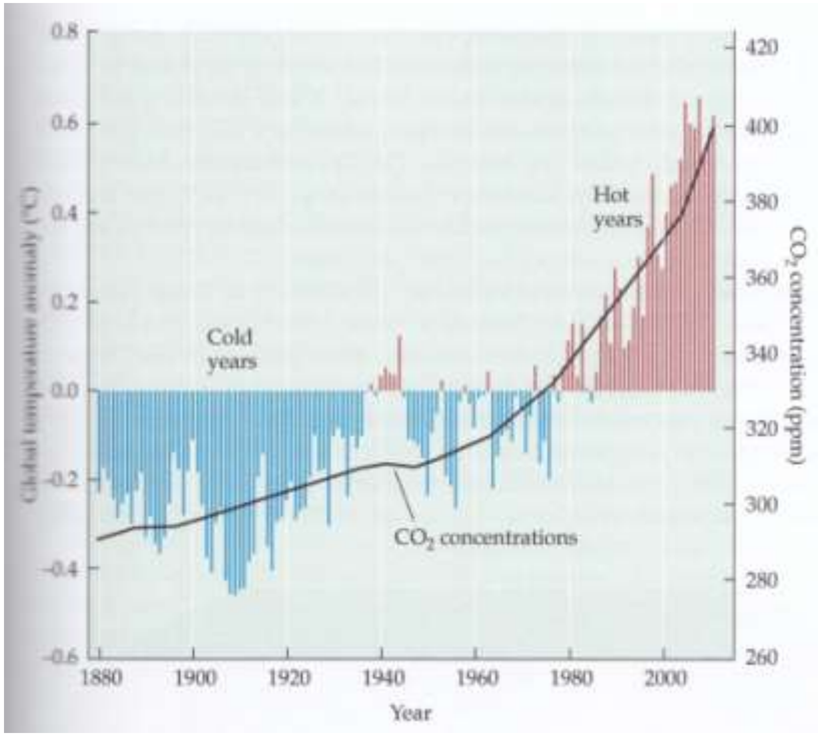


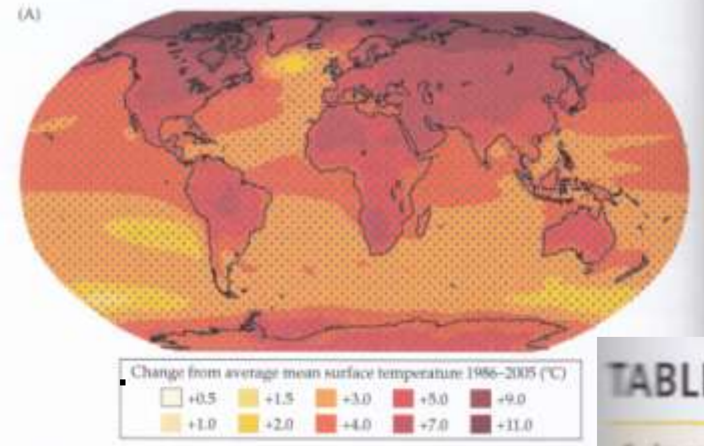


Global Climate Change

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.

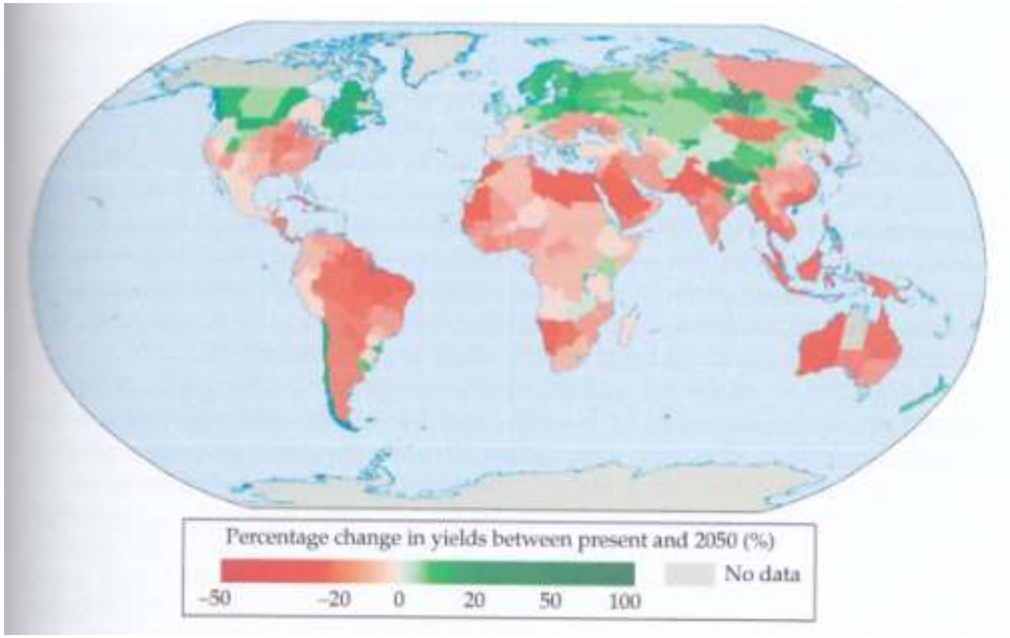
Global Climate Change

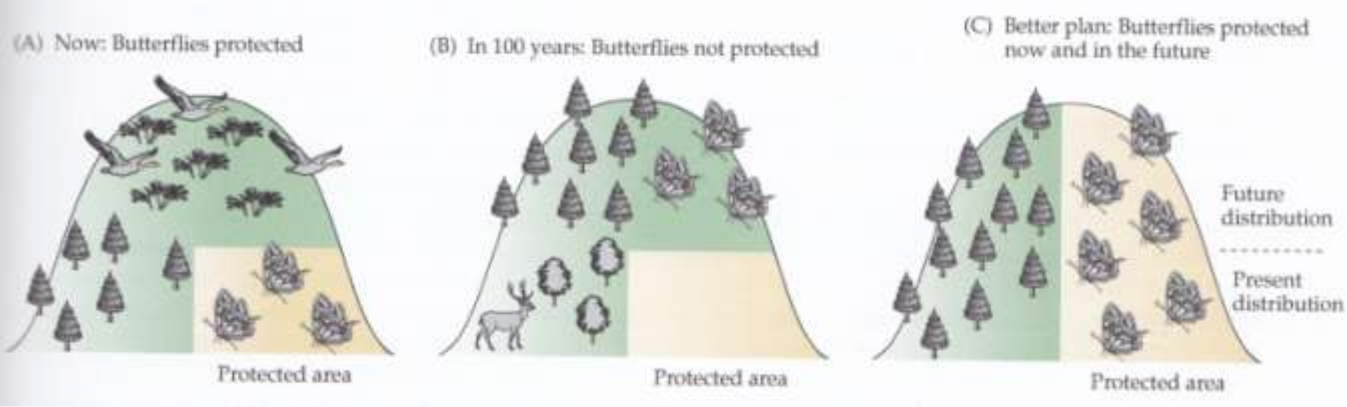
Rising see levels and warmer waters

- 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





Overexploitation, Invasive Species and Disease

Overexploitation, Invasive Species and Disease

Overexploitation by humans threatens 25% of endangered vertebrate species in US. This figure is 75% in China – results of extensive use of wildlife for food and traditional medicine

People have always hunted and harvested of wild animals and plants and methods were not effective in most case it was sustainable

Nowadays the harvesting methods are more effective and cover much larger areas

Exploitation in the preindustrial society

For meat has led to the decline and extinction of local species of birds, mammals and reptiles

e.g. ceremonial cloaks worn by the Hawaiian kings made from feathers of the mamo birds (for single cloak used feathers of 70 000 birds) which extinct

Traditional society sometimes imposed restrictions to prevent exploitation

- hunting, harvesting in in certain areas were banned
- prohibition harvesting female, juvenile, undersized animals
- certain seasons were closed for harvesting
- certain efficient methods of harvesting were not allowed

Exploit communal resources on a long-term, sustainable basis (e.g. Pacific Islands)

Exploitation in the modern world

Restriction on using common property resources are often less effective today – resources are exploited opportunistically

Common-property resources often become an open access resources without regulation

In rural areas, the traditional controls of natural product weakened

Areas with human migration, civil unrest or war, control may no longer exist (e.g. Somalia, Cambodia, former Yugoslavia, Congo, Afghanistan, Iraq, Syria)

Population of large primates, ungulates and other mammals may be reduced by 80% or more by hunting.

Bushmeat crisis

Decline in animal populations caused by the intensive hunting

- Eating primate bushmeat increases the possibilities transmission of new disease to human population (e.g. Ebola)
- In coastal Africa, the export of fish to supply European markets is creating even greater demand for bushmeat to supply local protein needs

Solutions:

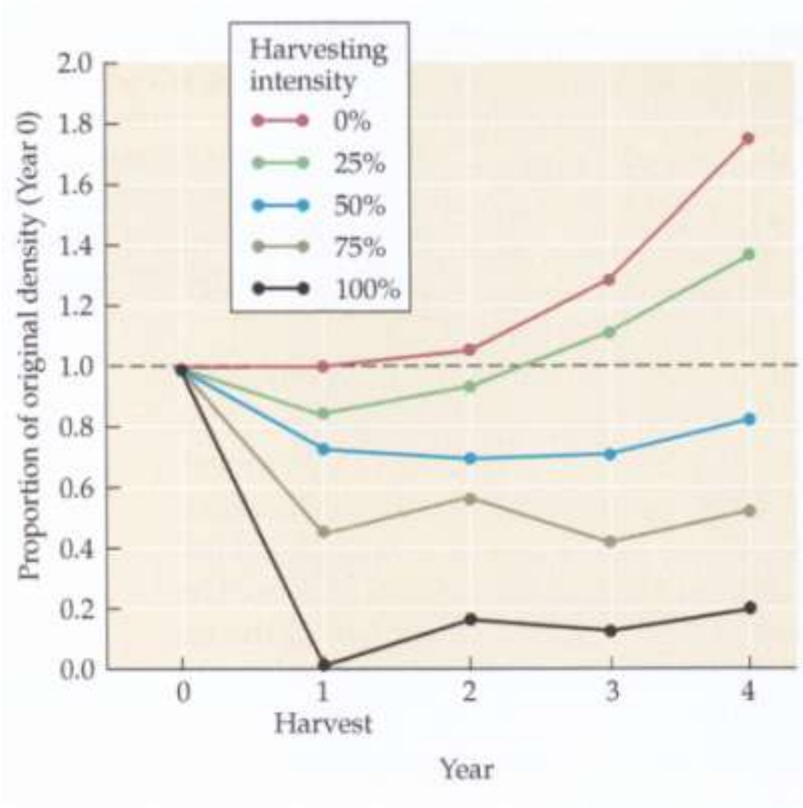
Restriction of sale and transport of bushmeat

Protection of species

Alternative protein sources

Overharvesting plants

e.g. American ginseng



Species can often recover when they are protected from overexploitation

International wildlife trade

The legal and illegal trade in wildlife is responsible for decline of many species – 10 billion$/year

Major exporters are primarly in the developing world, often in the tropics

The most major importers are in the developed countries and East Asia (Canada, China, European Union, Japan, Singapore, Taiwan, US)

CITES treaty against trade of protected species

e.g.

-Indonesia export 100 million Frogs to Europe for luxory meals (frog legs)

-Sea horses, 54 tons/year consumed in China as medicine (19 million ind.)

TABLE 10.1 | Major Targeted Groups of the Worldwide Trade in Wildlife

Group	Number traded each year[a]	Comments
Primates	70,000	Mostly used for biomedical research; also for pets, zoos, circuses, and private collections.
Birds	250,000	Zoos and pets. Mostly perching birds, but also legal and illegal trade of about 80,000 parrots.
Reptiles	1,000,000	Zoos and pets. Also 10–15 million raw skins. Reptiles are used in some 50 million manufactured products. Mainly come from the wild, but increasingly from farms.
Ornamental fish	350,000	Most saltwater tropical fish come from wild reefs and may be caught by illegal methods that damage other wildlife and the surrounding coral reef.
Reef corals	1000–2000 tons	Reefs are being destructively mined to provide aquarium decor and coral jewelry.
Orchids	50 million	Approximately 10% of the international trade comes from the wild, sometimes deliberately mislabeled to avoid regulation.
Cacti	10 million	Approximately 15% of traded cacti come from the wild, with smuggling a major problem.

Sources: Karesh 2005; WRI 2005; Nijman et al. 2011; www.cites.org.

[a]With the exception of reef corals, refers to number of individuals.

Whale hunting in the past and its consequences

Commercial whaling reach enourmos threat, 2 million whales were killed for their blubber oil and for meat

Most of these species were close to the extinction

Since 1986 global moratorium on all commercial killing of whales

Worldwide Populations of Whale Species Harvested by Humans

Species	Numbers prior to whaling[a]	Present numbers	Primary diet items	Status
Baleen whales				
Blue	350,000	10–25,000	Plankton	Endangered
Bowhead	59,000	22,000	Plankton	Least concern
Fin	725,000	60,000	Plankton, fish	Endangered
Gray (Pacific stock)	23,000	15–22,000	Crustaceans	Least concern
Humpback	150,000	60,000	Plankton, fish	Least concern
Minke	140,000	1,000,000	Plankton, fish	Least concern
North Atlantic right	At least 5700	300–350	Plankton	Endangered
Sei	250,000	54,000	Plankton, fish	Endangered
Southern right	100,000	7500	Plankton	Least concern
Toothed whales				
Beluga	Unknown	200,000	Fish, crustaceans, squid	Near threatened
Narwhal	Unknown	80,000	Fish, crustaceans, squid	Near threatened
Sperm	1,100,000	360,000	Fish, squid	Vulnerable

Sources: American Cetacean Society (www.acsonline.org); IUCN Red List.

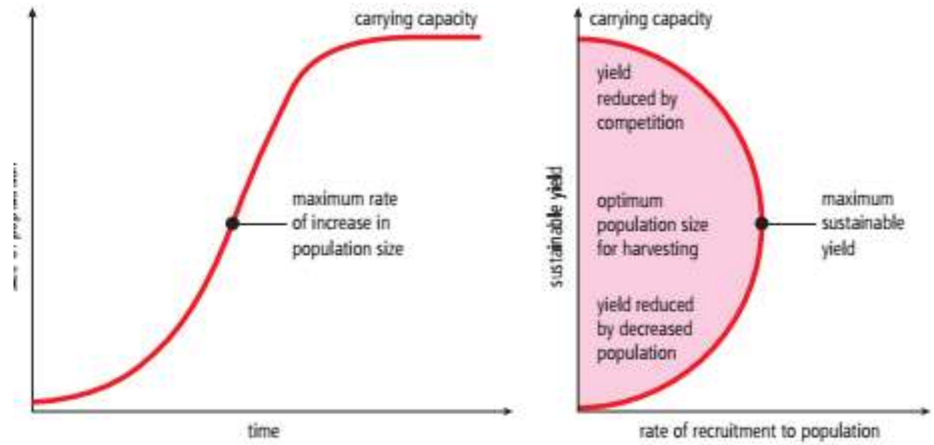
[a]Preexploitation population numbers are highly speculative; recent evidence suggests the populations might have been even greater (Roman and Palumbi 2003; Alter et al. 2007).

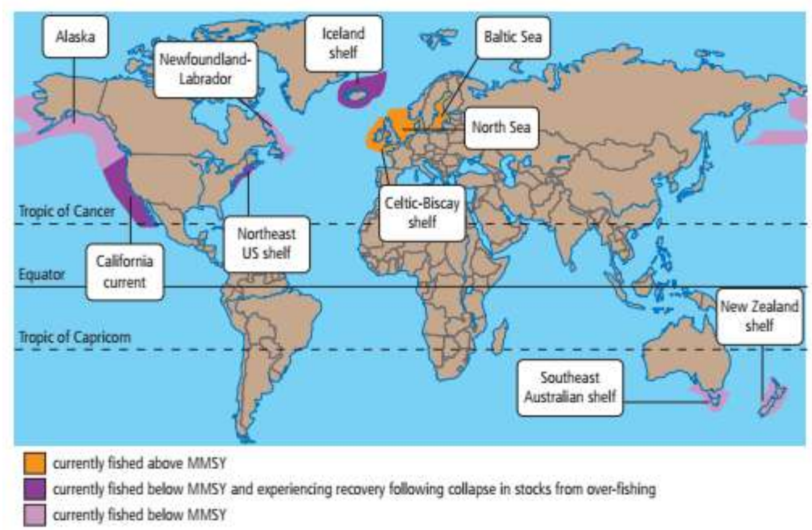
Commercial harvesting

Often claim that they can avoid overharvesting by applying scientific managent

Maximum sustainable yield

However, in many real-world situations may lack the key biological information that is need to make accurate calculation





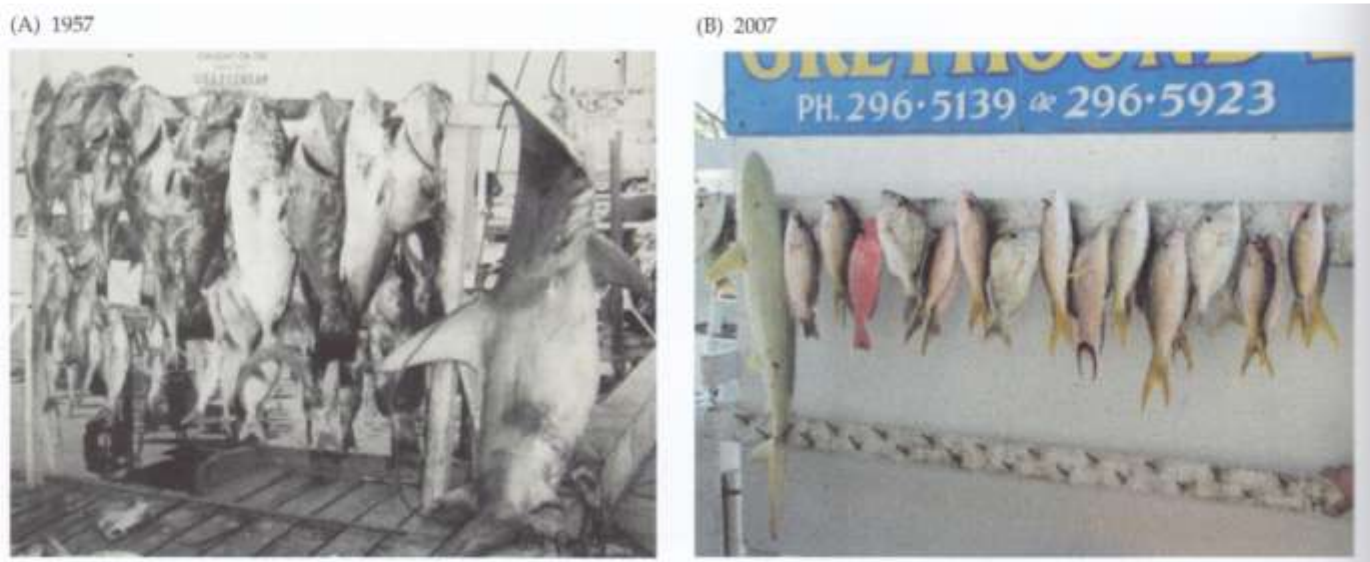
Problems with yield management- The Fishing industry

80% of world's major fish stocks have been classified as overfished

It is difficult to coordinate international agreement and to monitor yield limits when species migrate across national boundaries, waters

Illegal harvesting hard to estimate

Example: Canadian fishing of cod – cod stock dropped to 1% of their original numbers by 1992 -> eliminating 35 000 jobs



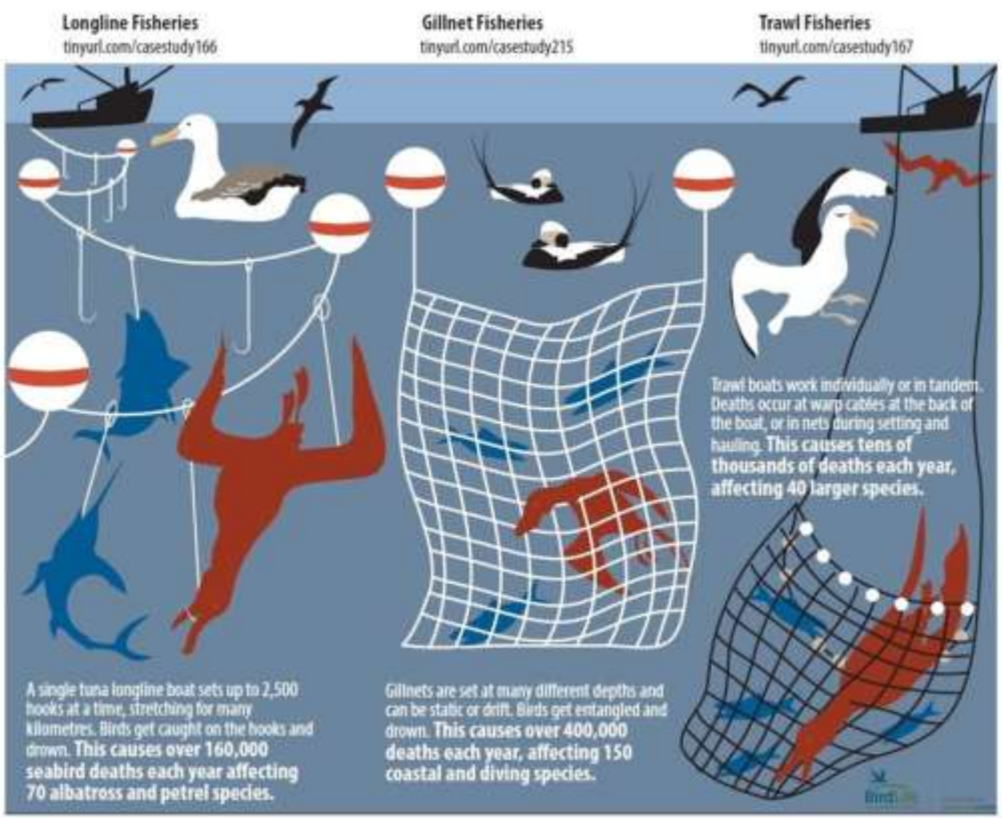
Indirect effects of commercial fishing

Many marine vertebrates are caught incidentally as bycatch

- 25%-75% of the harvest is dumped back into the sea to die

-All of the world's 22 albatross species are threatened with extinction, largely as a result of bycatch

-Huge number of sea turtles and dolphins killed



Invasive species

Invasive species which spread and increase in abundance rapidly, sometimes at the expense of native species

-may displace native species by competition or by predation

In US, invasive species threat 42% of the endangered plant and animal species

Sources:

Colonisation

Agriculture, horticulture, aquaculture

Accidental transport

Biological control

Invasive species

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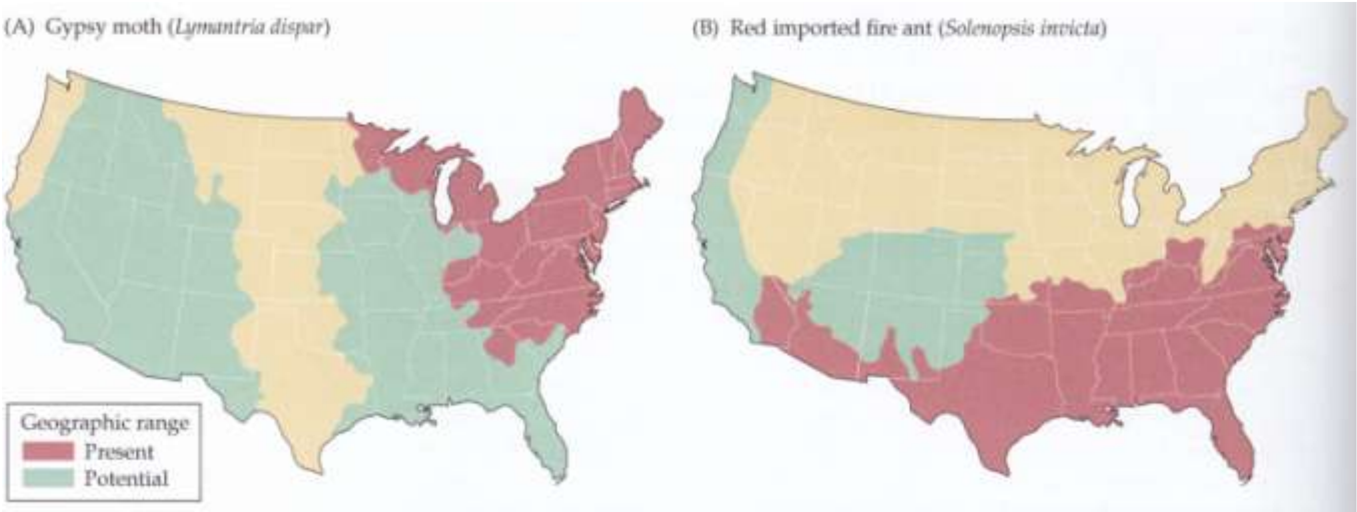
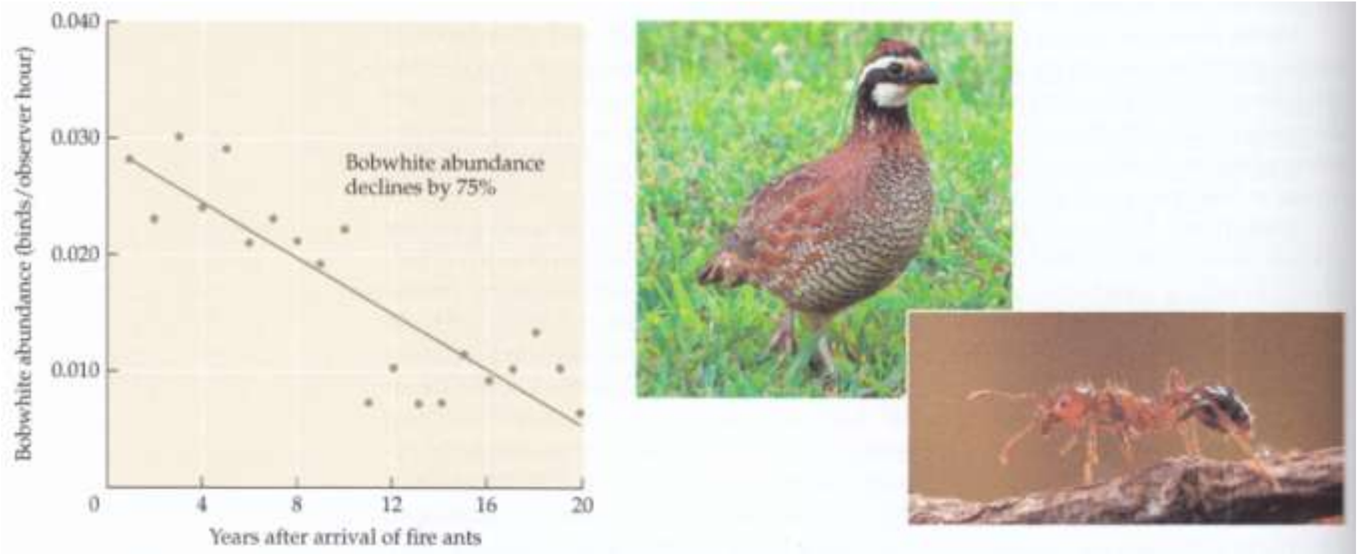




Invasive species on islands

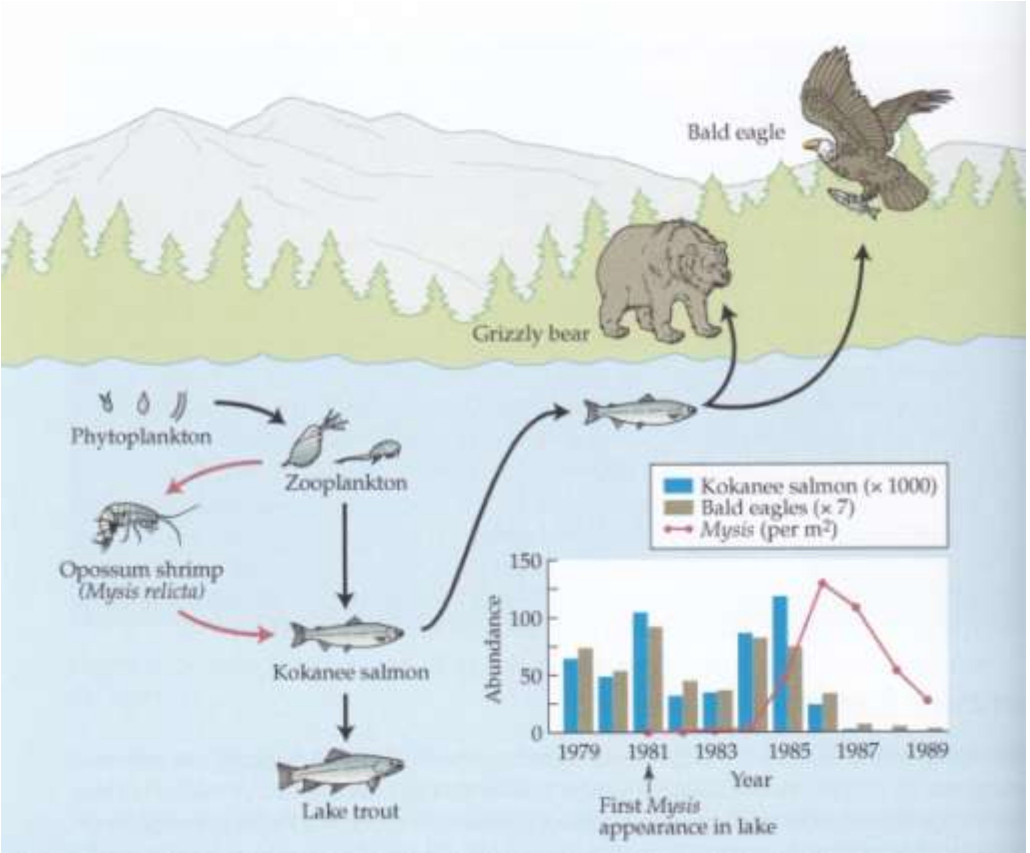
The introduction of just one exotic species to an island may cause the local extinticion of numerous native species

Example: Brown tree snake
– in Guamhas driven 10 of 13 forest bird species extinct since middle of XX. century

Invasive species in aquatic habitats

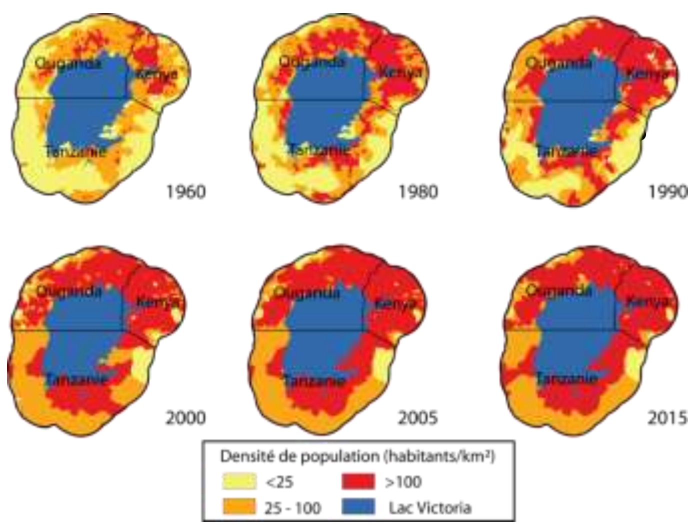
Freshwater ecosystem are similar to oceanic island in that they are isolated habitats surrounded by inhospitable and uninhabitable terrain

Example: introduction of opossum shrimp in a Flathead Lake (US)



Lake Victoria – Nile perch

- 400 native fish species
- Nile perch introduction from 1954-1960
- In 1978, 2% of catches were Nile perch, in 1986 it was 80%
- Massive disappearance, extinction, of native fish species (~200 species)
- Increased frequency of water blooms – anaerobic conditions now at 25 m depth, previously oxygen-rich up to 60 m depth; appearance of water hyacinth
- Species forced into shallow waters, decline of cichlid fish species, organic pollution (population growth), more frequent water blooms



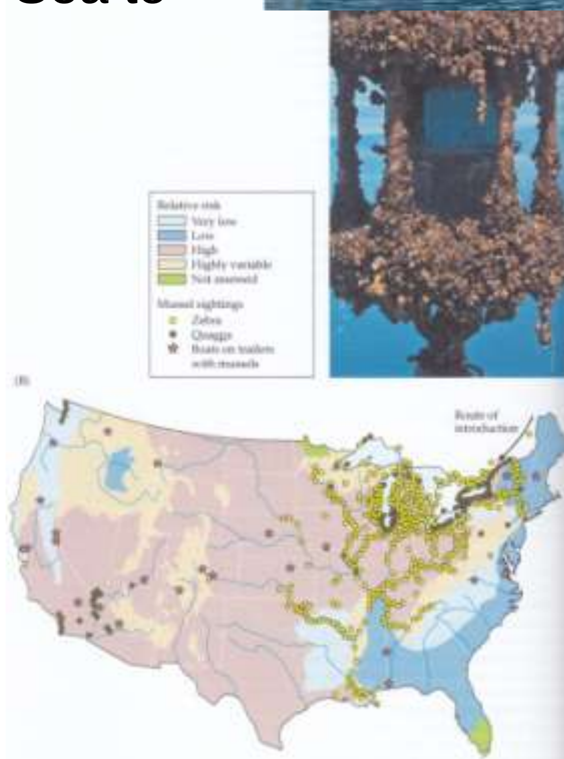
In essence, the introduction of Nile perch, coupled with human-induced pollution, has caused dramatic ecological changes, leading to the collapse of native fish populations, increased water pollution, and shifts in the lake's overall ecosystem.

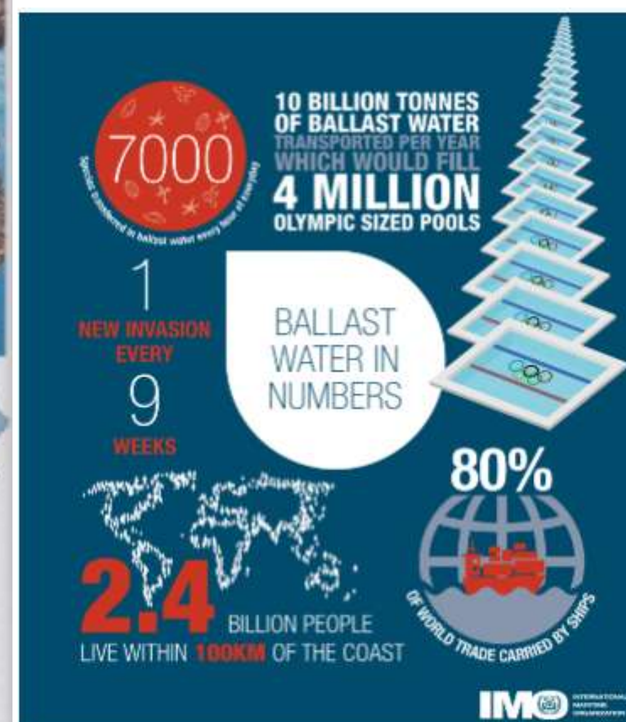
Invasive species in marine and estuarine ecosystems

Shipping is the major cause, transport of ballast water, followed by aquaculture

Example:

Zebra mussel from Caspian Sea to US





Control of invasive species

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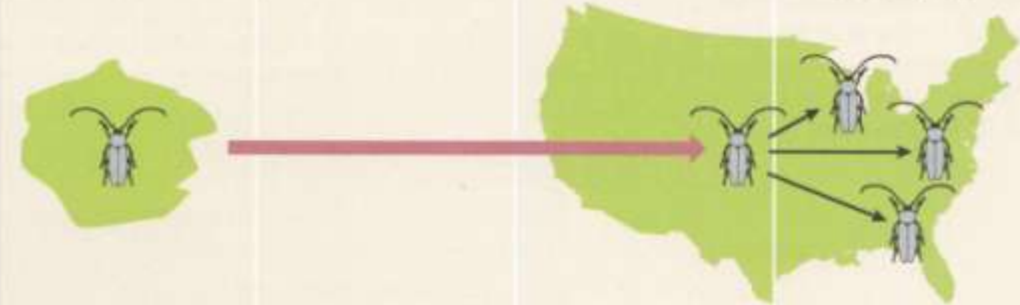


	Source	Transit	New infestation	Spread, increase, and impacts
1. Prevention	Set international policies that optimally balance trade with minimizing high-risk pathways and species transfers	Minimize high-risk pathways and species transfers	Undertake preventative habitat management for systems risk	Minimize high-risk pathways and species transfers
2. Detection and early intervention	Detect, identify, and eradicate populations of high-risk species			
3. Long-term management			Implement large-scale and long-term control programs targeting individual high-risk species and systems at risk of invasion by these species Manage multiple invasive species to minimize overall impacts on ecosystem management goals	

Disease

The increased transmission of disease as a result of human activity is a major threat to many endangered species.

Decline of numerous frog populations from montane habitats across the world is apparently due in part of the introduced exotic fungal (chytrid fungus) disease

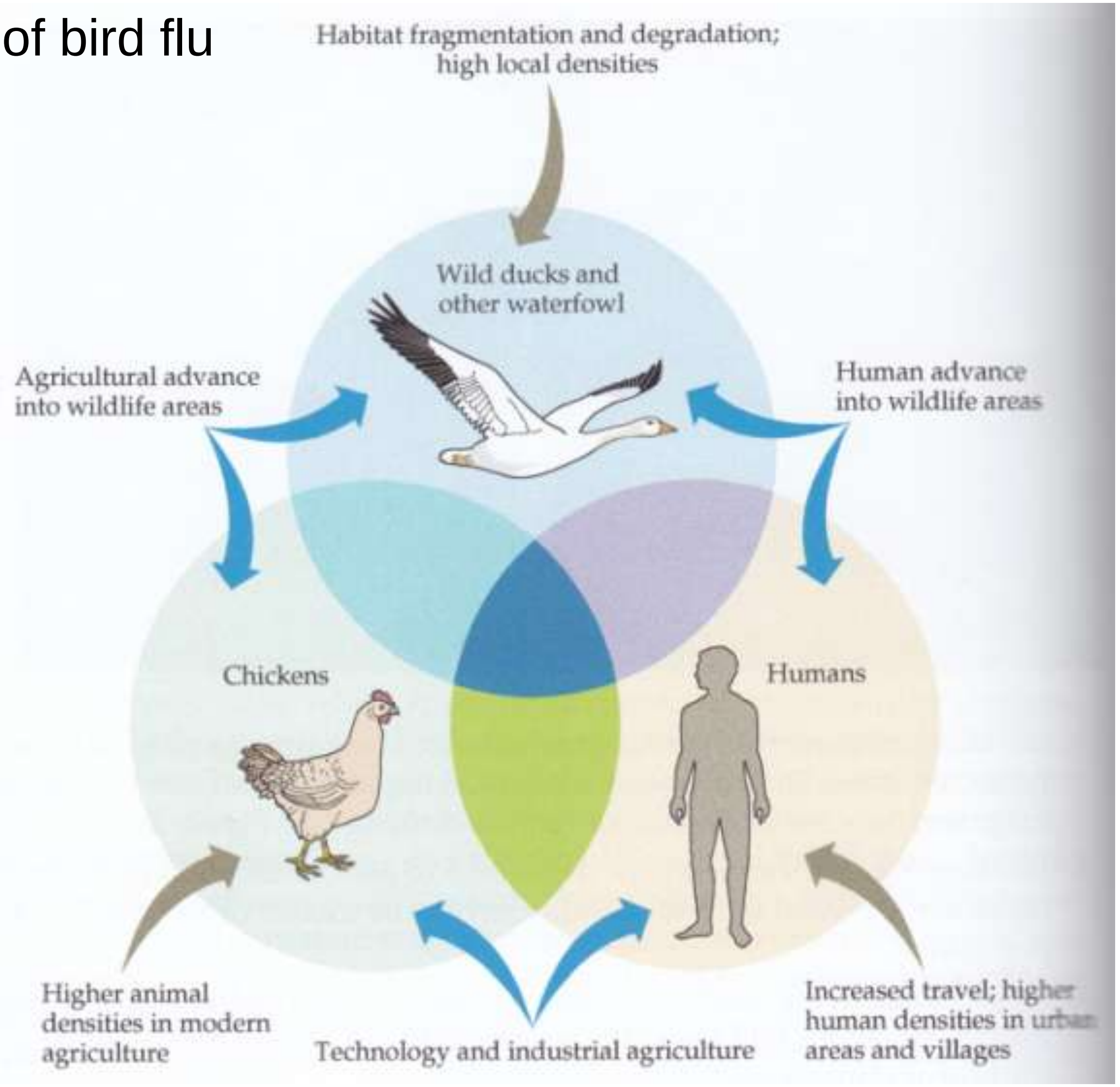
White nose syndrome by a fungus – killing millions of bats in eastern US, in some caves 90% died – fungus carried from European caves

Zoos, aquarium – several species are close to each other, high chance for transmission – e.g. fatal herpes virus from African elephant to Asian elephant

From domestic animals – 25% of lion killed in the Serengeti NP by canine distemper

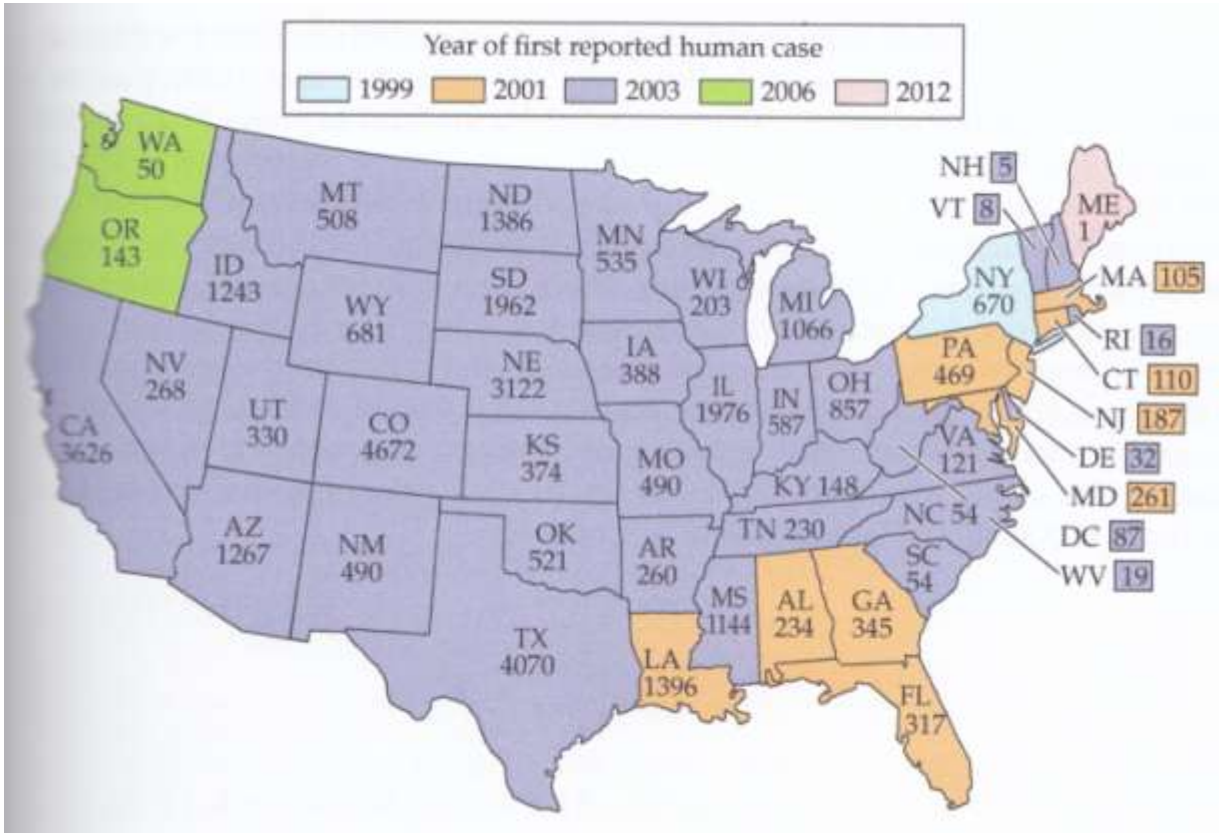
Disease

Infection and transmission of bird flu



Disease

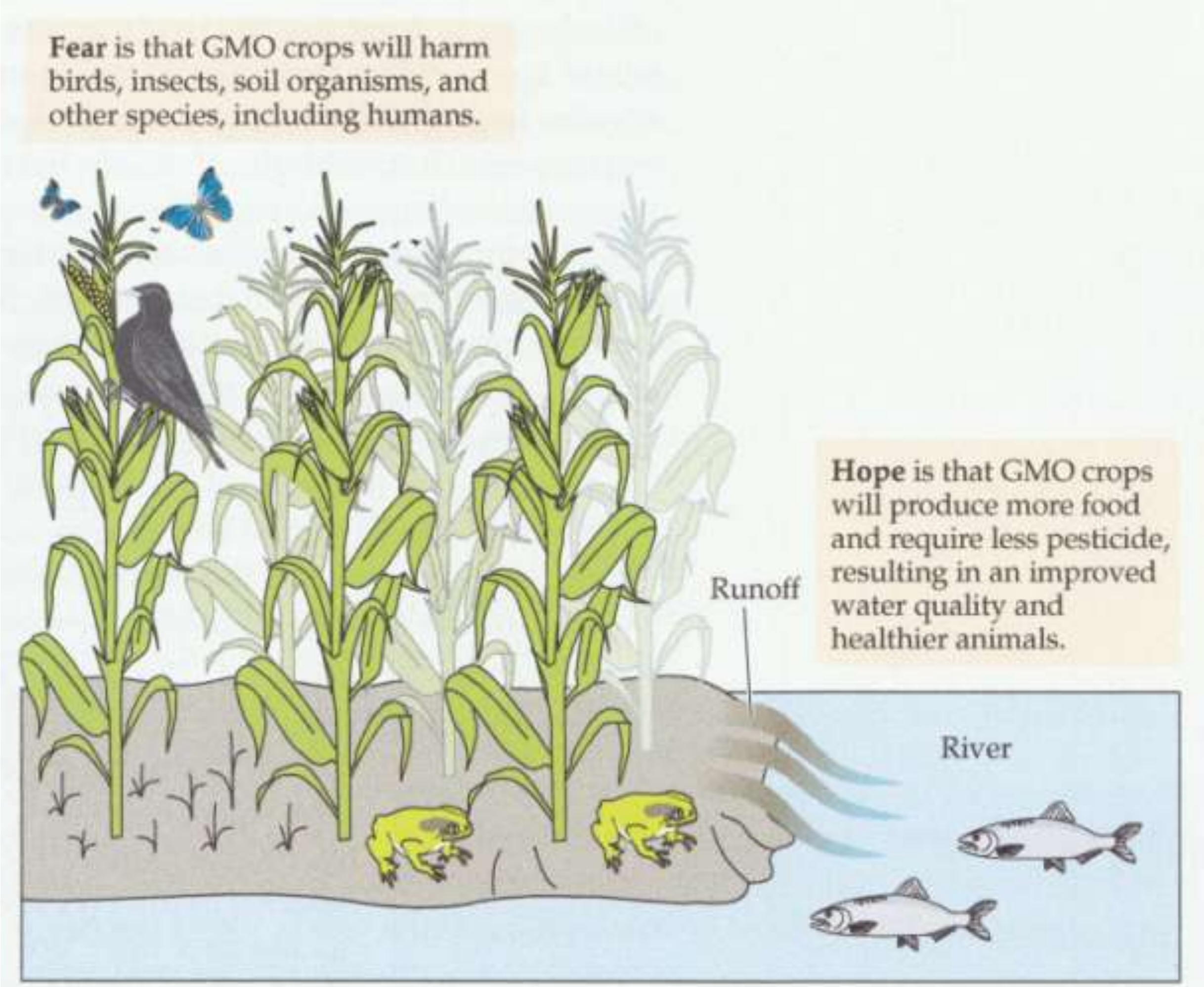
West Nile virus



Genetically modified organism (GMOs)

Potential threats to biodiversity:

- Modified crop species will hybridize with related species -> invasion by new aggresive weeds, virulent diseases
- GMOs contain bacterial gene produce insect toxin could harm noncrop species (insects, birds and soil organisms) in large areas



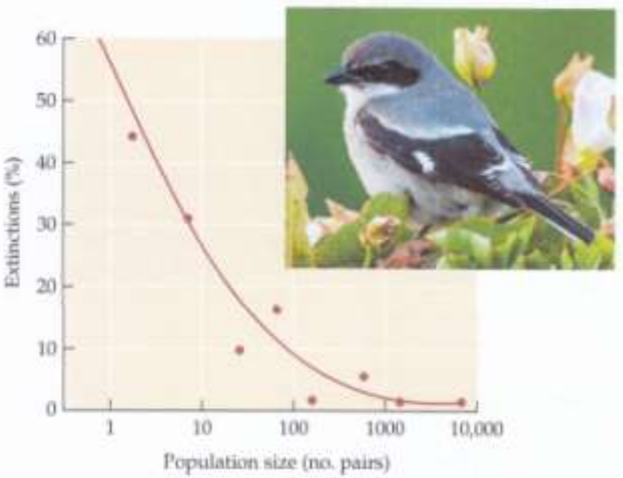
GMO crops have the potential to produce more abundant, cheaper food while requiring less pesticide. However, there is a concern that these crops will hybridize with wild species to create new weeds and diseases, that the crops will harm wild animals that eat them, and that eating food from GMO crops might harm people.

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



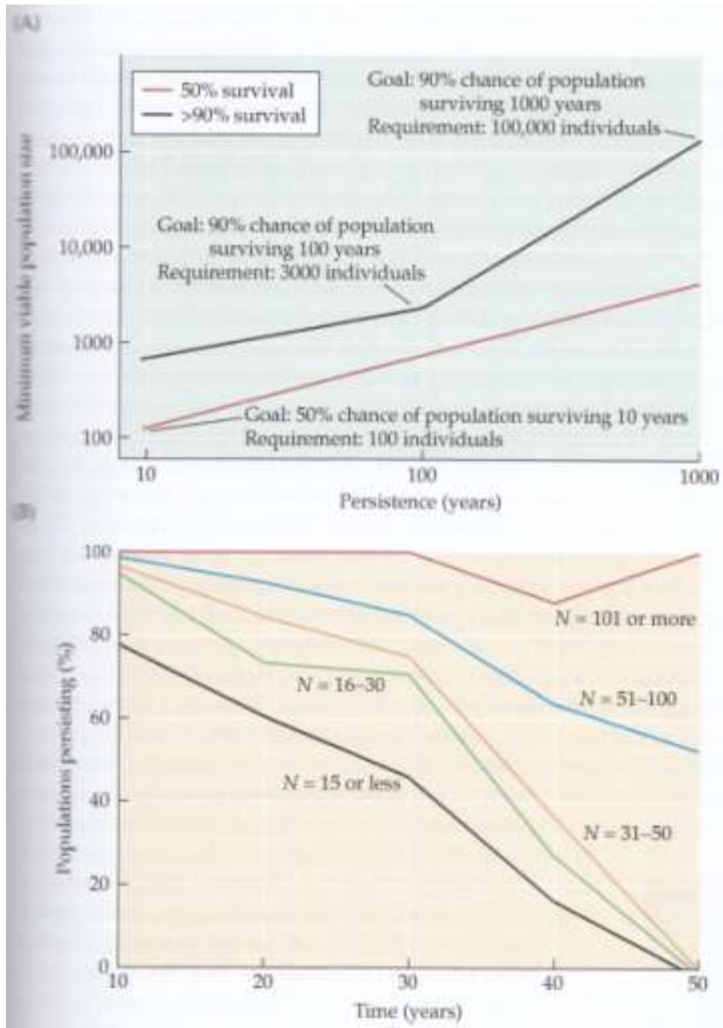
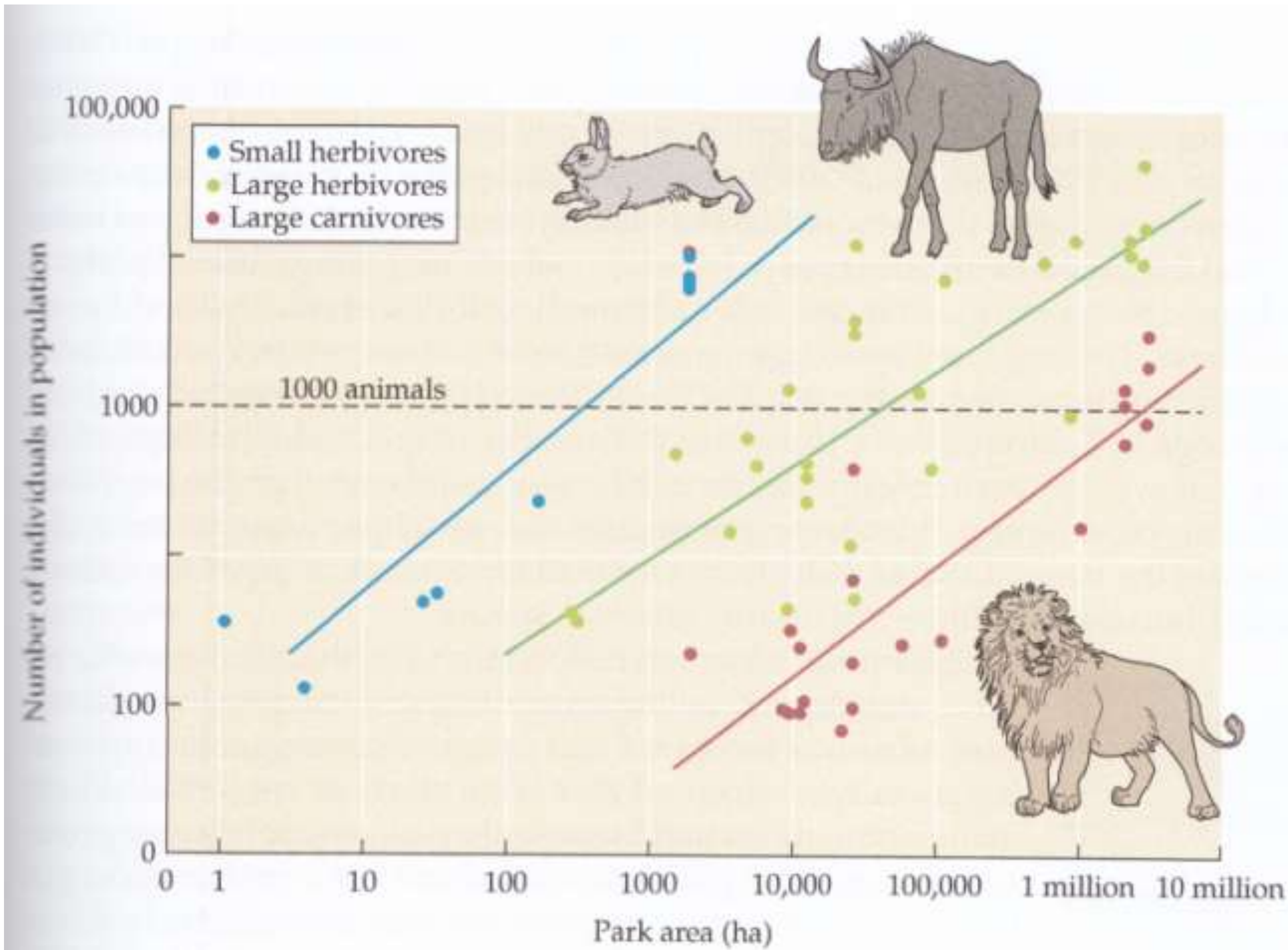


Figure 11.1 (A) If the goal is persistence for a greater number of years, then a larger minimum viable population (MVP) size is needed. A greater MVP is needed to ensure a higher probability of persistence, as illustrated in this case by a 50% probability of survival and a greater than 90% probability 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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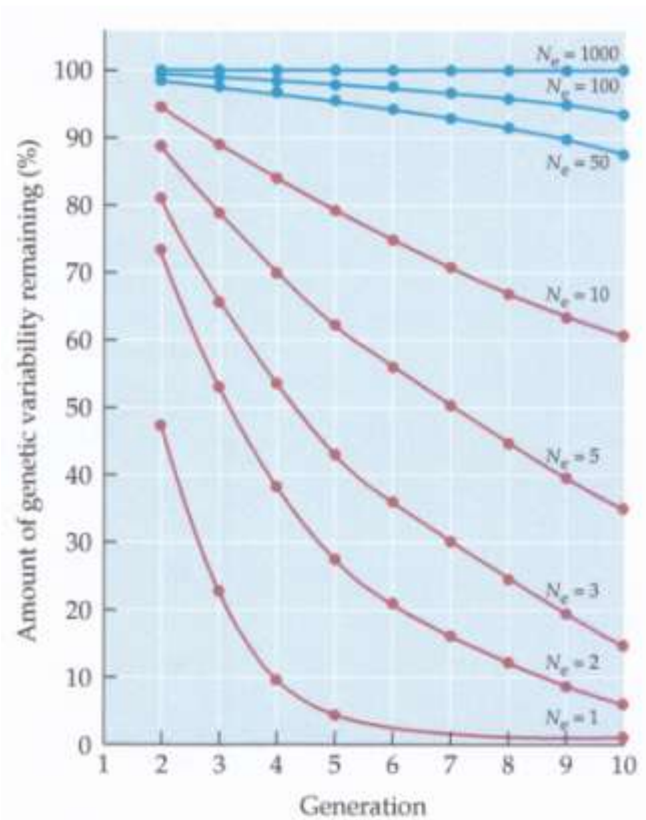

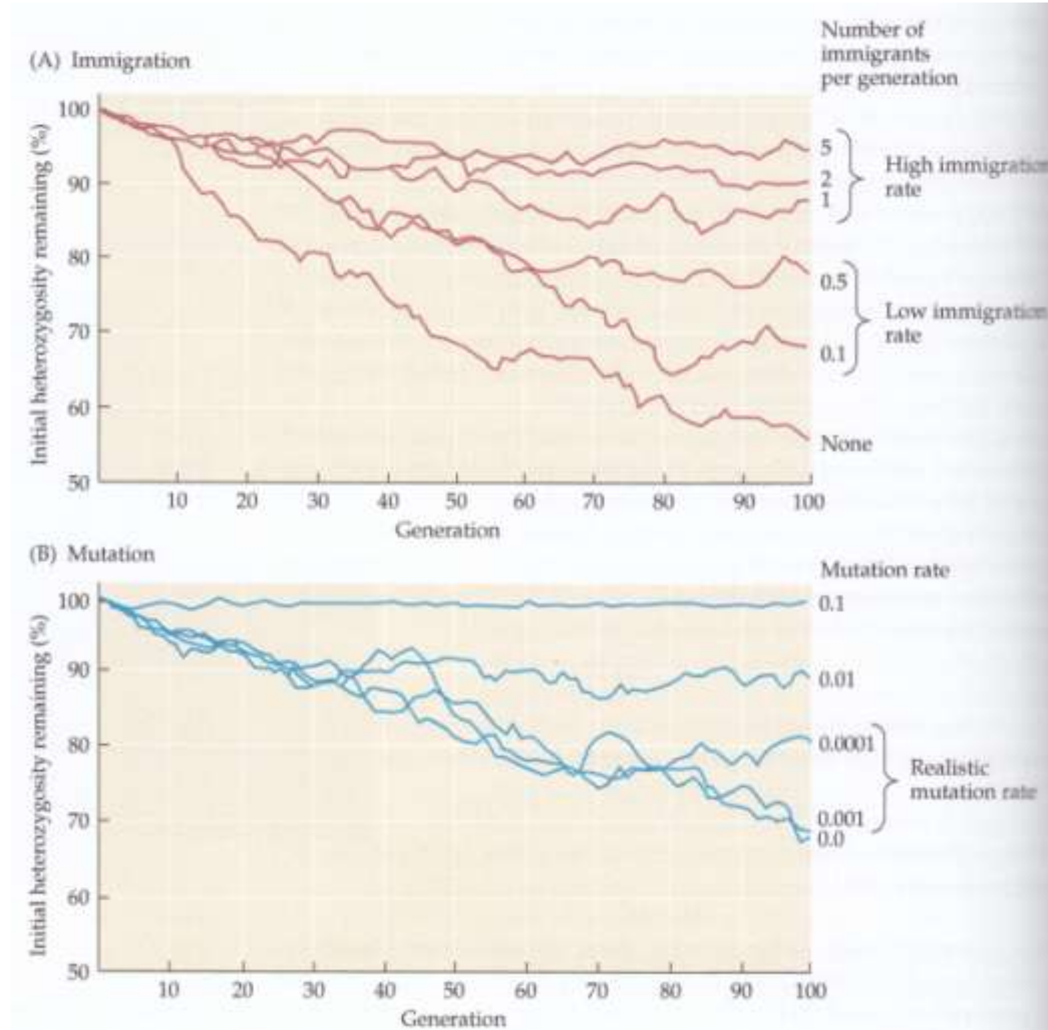

Loss of genetic variability

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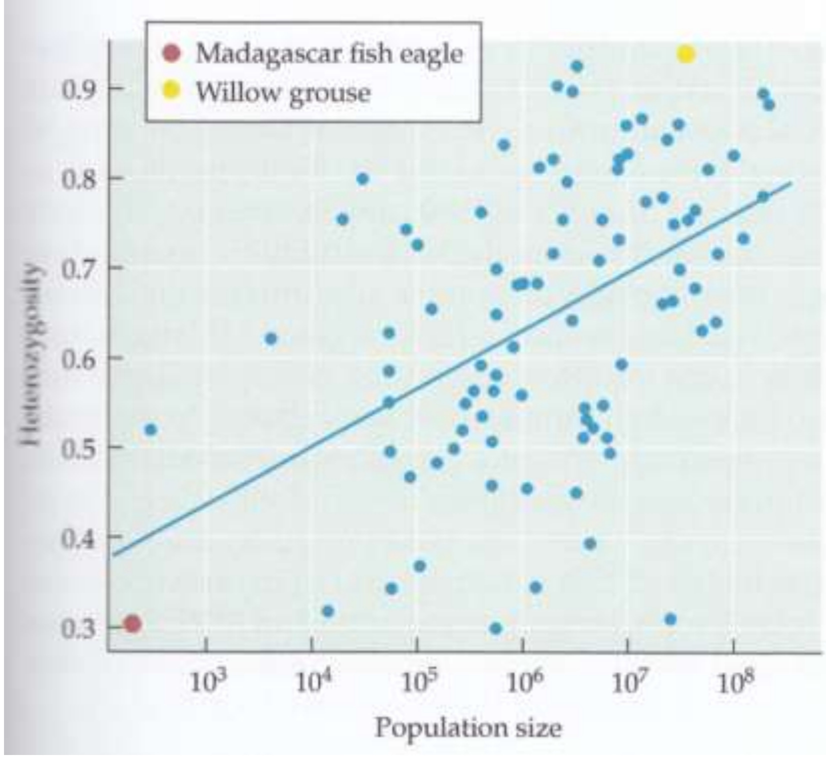
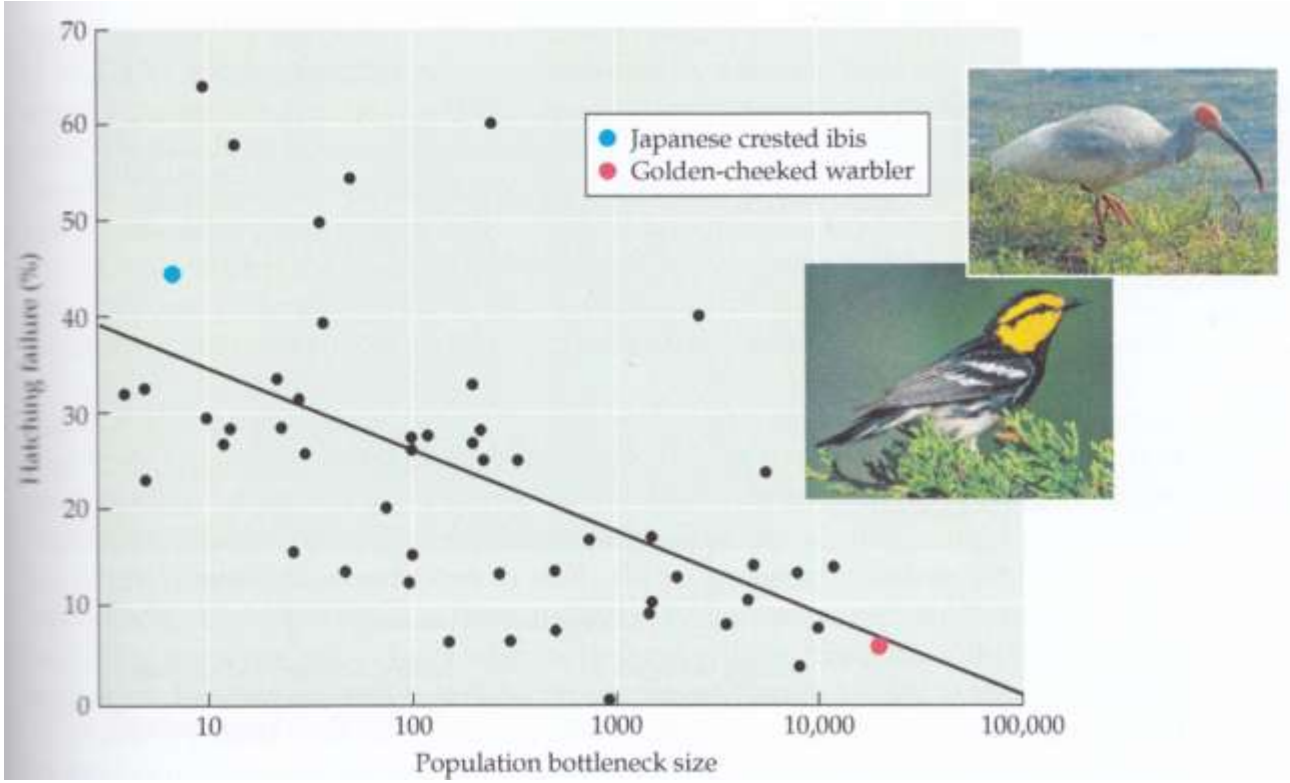


Consequences of reduced genetic variablity

Inbreeding depression

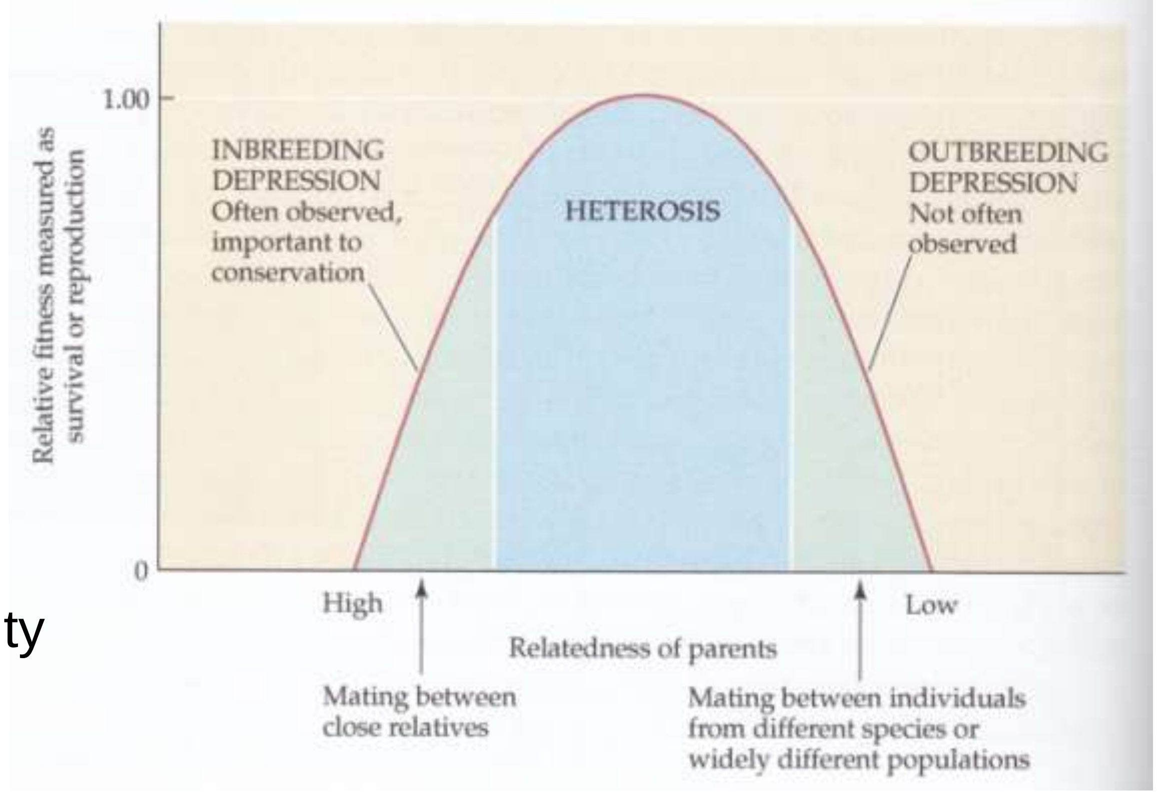
mating among close relatives



Consequences of reduced genetic variablity

Outbreeding depression

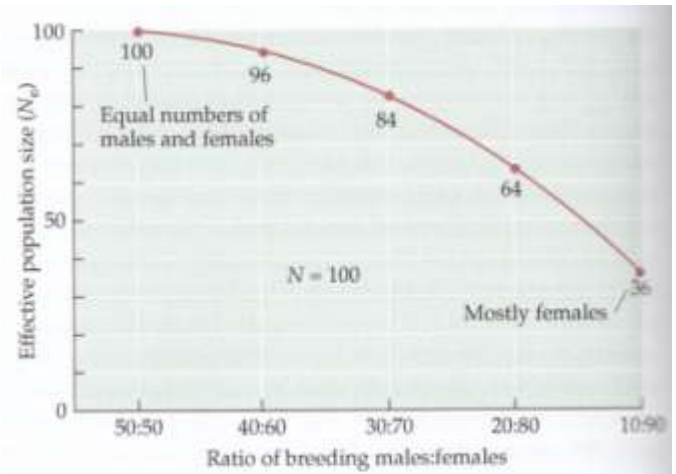
- mating with different populations or species



Loss of evolutionary flexibility

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



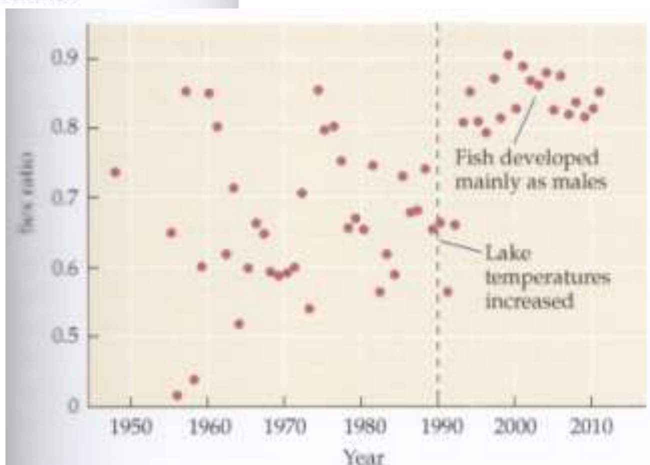
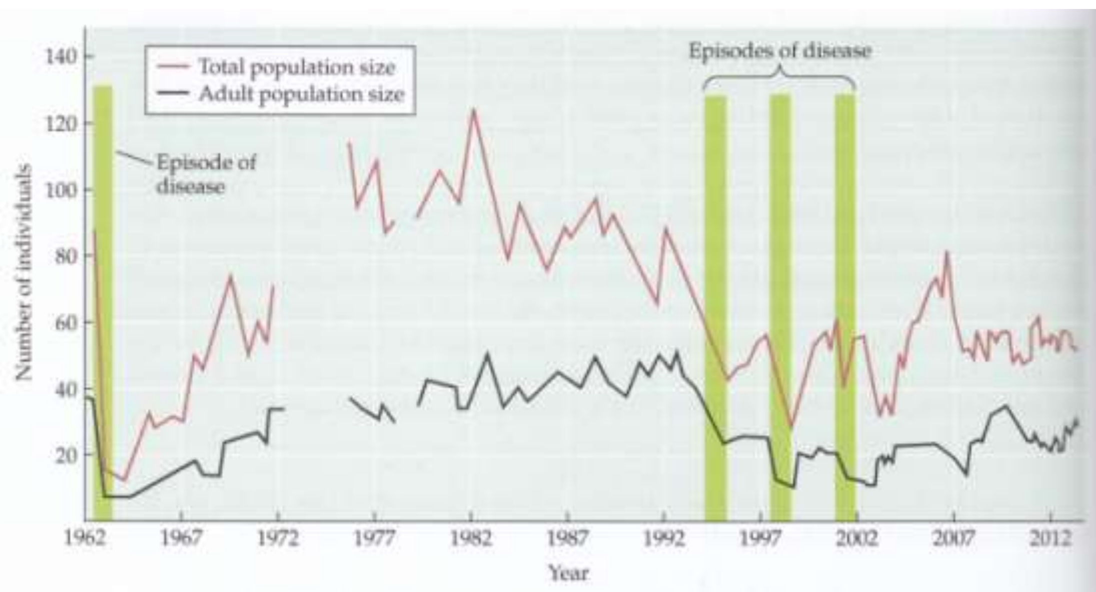


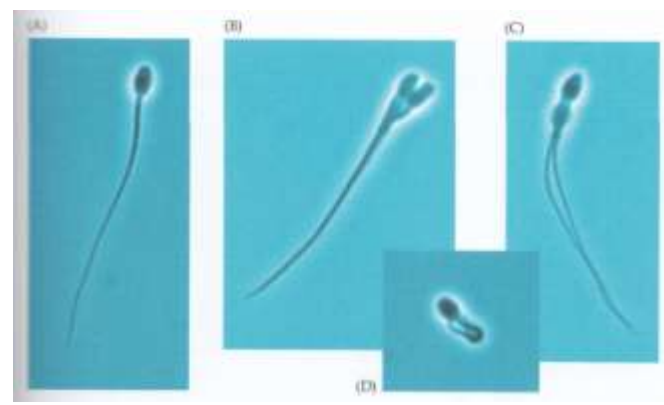
Figure 11.10 (A) The sex ratio of grayling, a fish in the salmon family, in Lake Thun, Switzerland, has shifted from being around 65% male (and highly variable) before 1990, to consistently 80%–90% male after 1990, when lake temperatures increased. The sex ratio is best explained by the temperature fish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

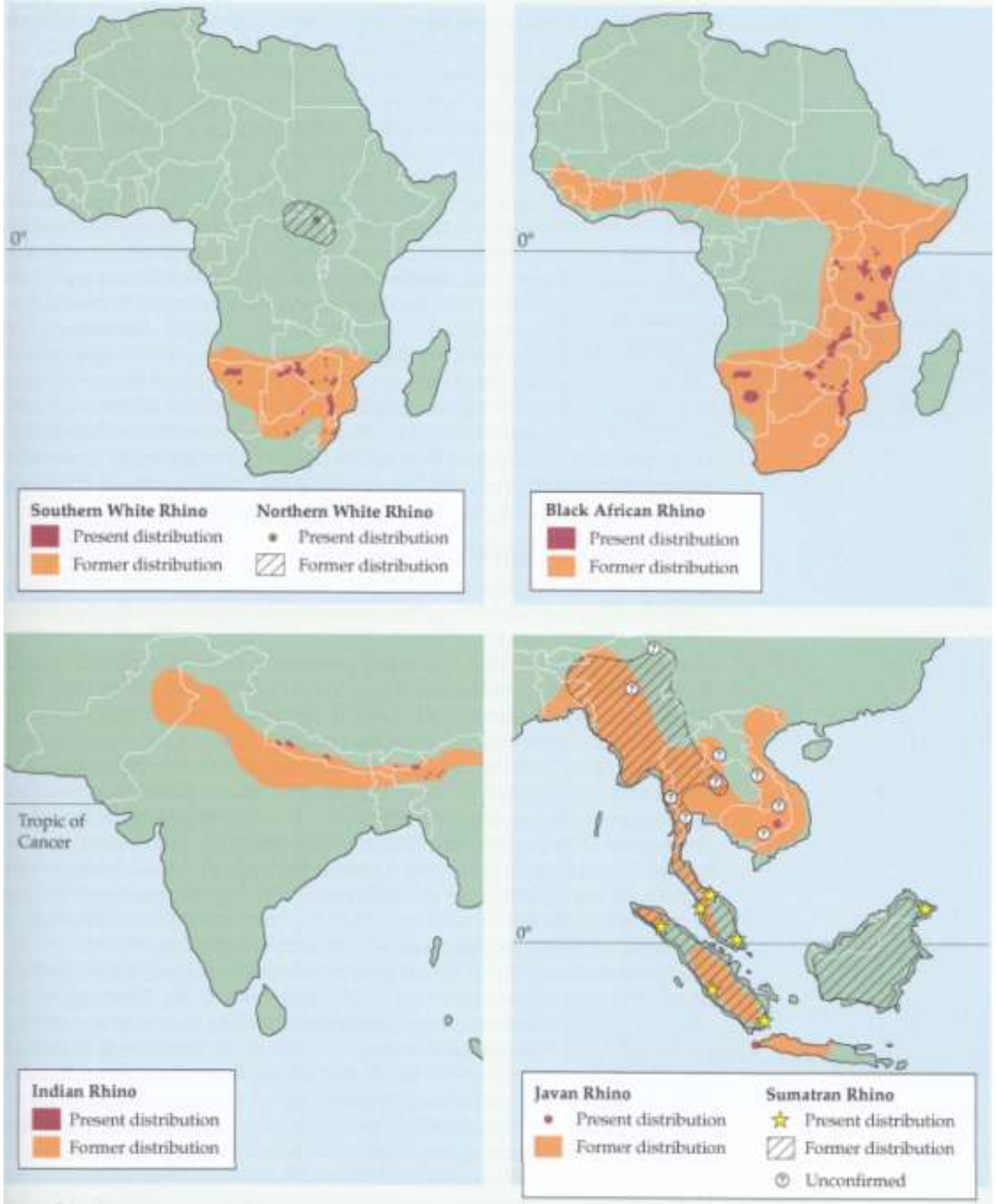
Population bottleneck

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





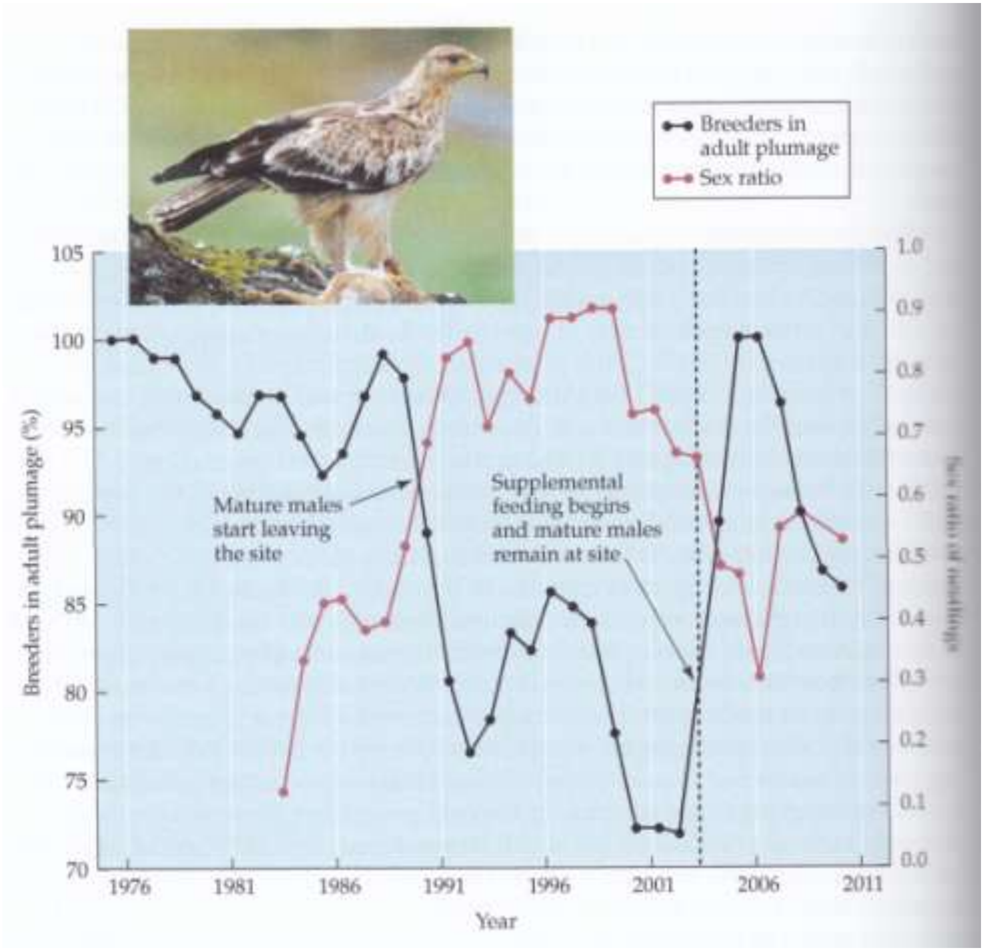


Each of the five rhinoceros species currently occupies only a tiny fraction of its former range, and their situations and levels of endangerment vary greatly. (After www.rhinos-irf.org)

Other factors affect the persistence of small population

Demographic stochasticity

- random fluctuations of birth and death rates



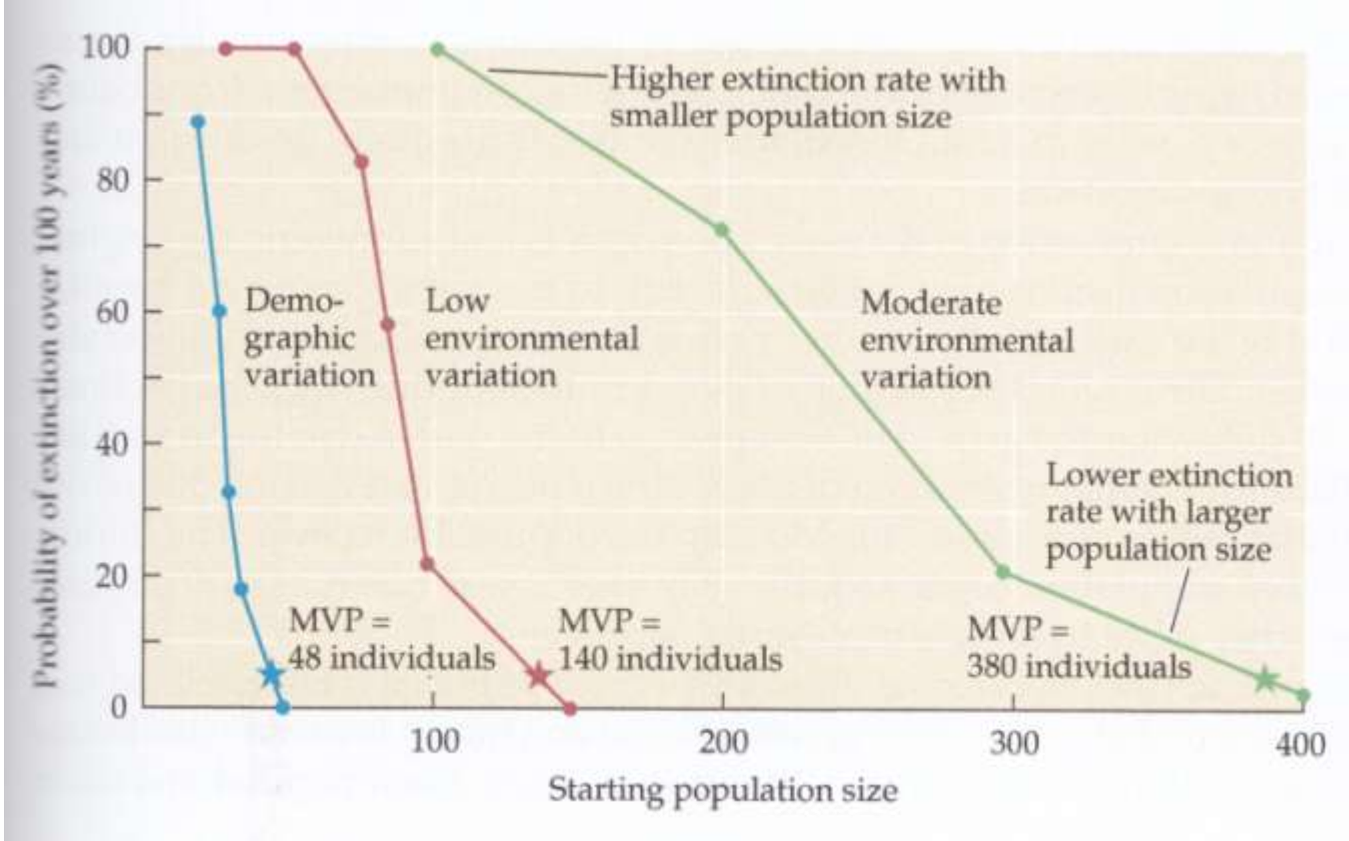
Population density and Allee effect

- 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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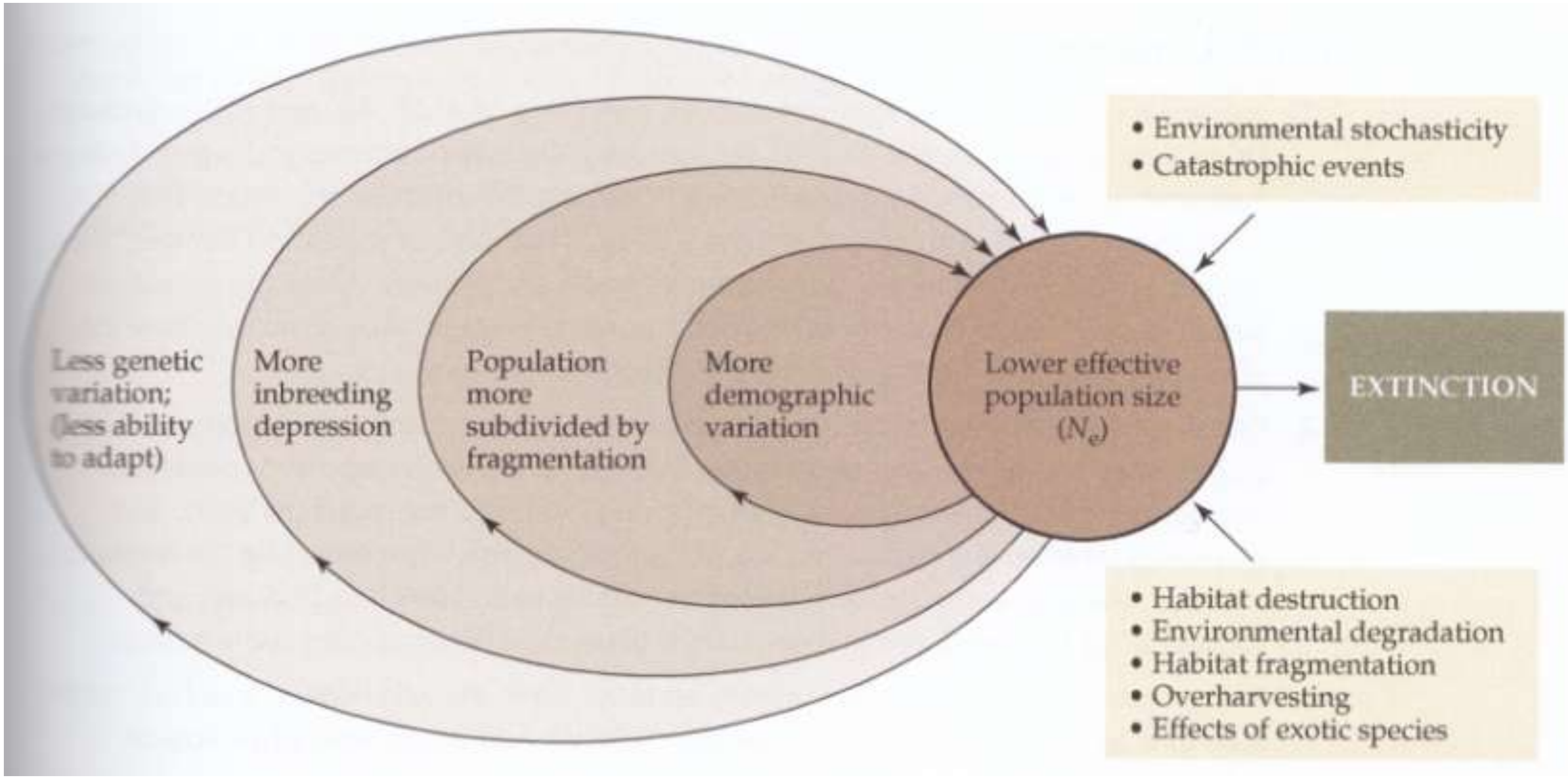

Small population paradigm (SPP) < - > Declining population paradigm (DPP)

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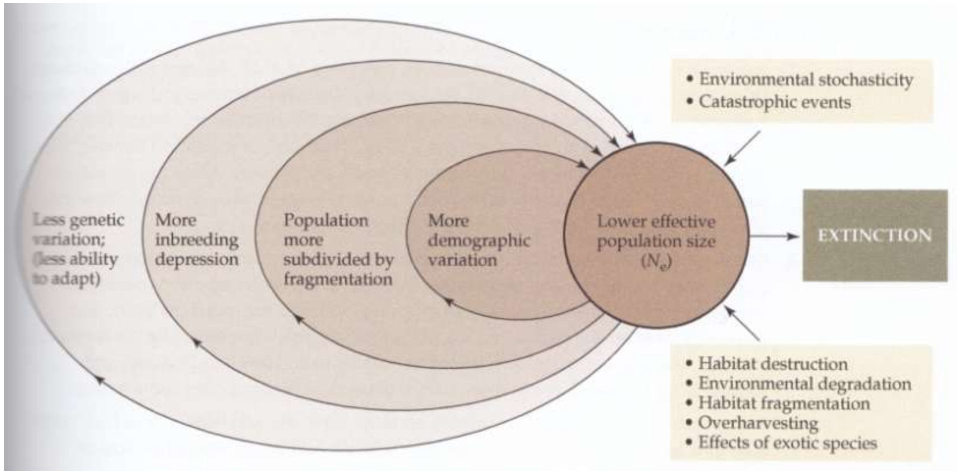


Conservation triage is closely related to the Small Population Paradigm (SPP) and the Declining Population Paradigm (DPP):

SPP (Small Populations): Triage may lead to prioritizing small populations that still have a chance of recovery rather than investing in populations already past the "point of no return.„

DPP (Declining Populations): Some argue that preventing species from reaching critically low numbers in the first place is a better use of resources than trying to rescue species that are already on the brink.

In practice, a balanced approach is often used, integrating elements of both paradigms while applying triage to make difficult decisions in resource-limited conservation efforts.

Applied population biology

Examining the factors affecting the abundance and distribution of rare and endangered species

Important informations:

- Environment
- Distribution
- Biotic interactions
- Morphology
- Physiology
- Demography
- Behaviour
- Genetics
- Interactions with humans

Gathering ecological information

- Published literature
- Unpublished literature
- Fieldwork

FIGURE 12.1 Satellite tracking of Magellanic penguins (*Spheniscus magellanicus*) off the coast of Argentina shows that penguins incubating eggs forage up to 600 km from their breeding colonies. When penguins are feeding chicks, foraging takes place mainly within a seasonal fishing exclusion zone that was established to protect spawning fish. Fieldwork provided this vital information about the penguins' foraging habits, which led to leaving the fishing zone closed until the chicks left their nests. (After Boersma et al. 2006.)

Three Primatologists Who Became Activists

Many researchers have started their careers by studying species and ecosystems in the field, and then have become involved in conservation activities.

"Trimates" Dian Fossey (left), Jane Goodall (center), and Biruté Galdikas began by studying animal behavior but eventually devoted themselves to conservation activism. (Photograph courtesy of The Leakey Foundation.)

Biodiversity monitoring

Makes repeated observations of the natural environment and the species, habitats, and ecosystems found in natural, semi-natural, and cultural landscapes, including wetlands, rivers, coastal waters, and the open seas.

Its aim is to understand patterns of status and change in the past and present to make predictions about future changes and – working with modelling and experimental investigations – to help suggest possible drivers, pressures, and remedies where these changes are undesirable.

General objectives of surveying and monitoring

Survey defines the collection of spatial and/or temporal data about a species, a community or a habitat. The information provides a snapshot of presence, absence and, dependent on its design and sophistication, abundance and spatial distribution.

Monitoring is often loosely regarded as a programme of repeated surveys in which qualitative or quantitative observations are made, usually by means of a standardised procedure. However, by itself this is merely **surveillance** as there is no preconception of what the findings ought to be.

Monitoring can be more rigorously defined as 'intermittent (regular or irregular) surveillance undertaken to determine the extent of compliance with a predetermined standard or the degree of deviation from an expected norm'

Monitoring can

- establish whether standards are being met;
- detect change and trigger responses if any of the changes are undesirable;
- contribute to the diagnosis of the causes of change; and
- assess the success of actions taken to maintain standards or to reverse undesirable changes, and, where necessary, contribute to their improvement

Monitoring populations

Changes in population size and distribution can be determined by repeatedly surveying a population on a regular basis

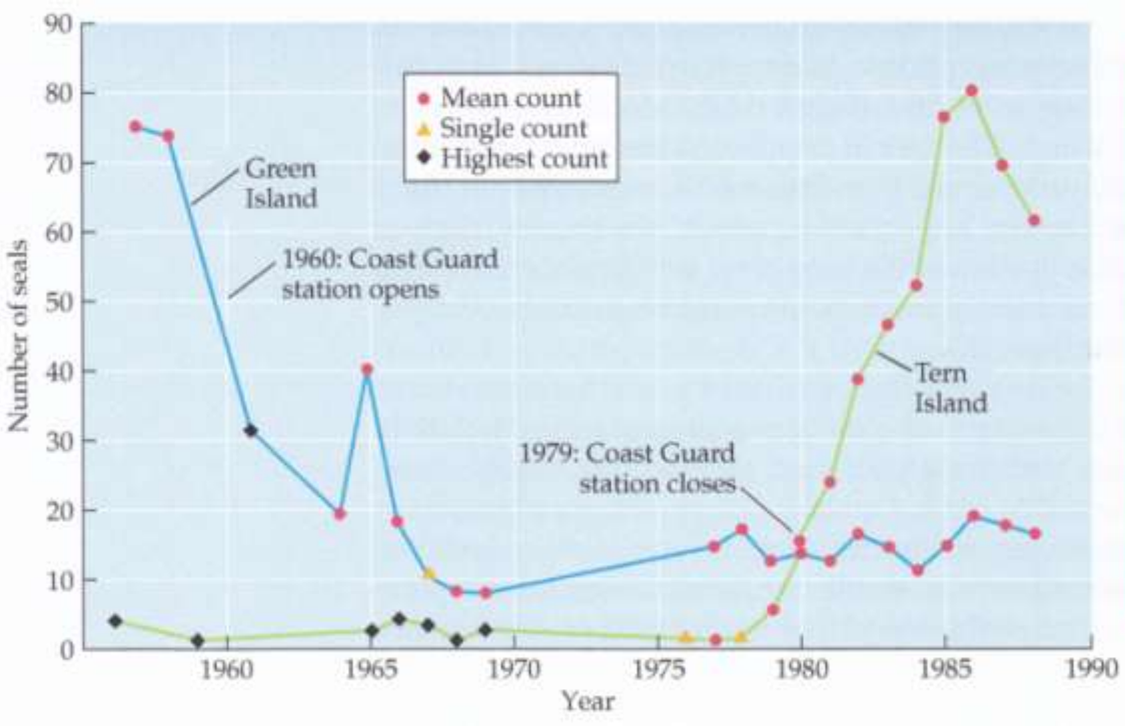
Most common types:

- Cenuses
- Survey
- Population demographic studies

Monitoring - census

A count of the number individuals present in a population

Hawaiian monk seal cenus



Monitoring - census

The most extensive censuses have been carried out in the British Isles by a large number of local amateur naturalists supervised by professional societies.

The most detailed mapping efforts have involved recording the presence or absence of plants, lichens, and birds in a mosaic of 10 km squares covering the British Isles.

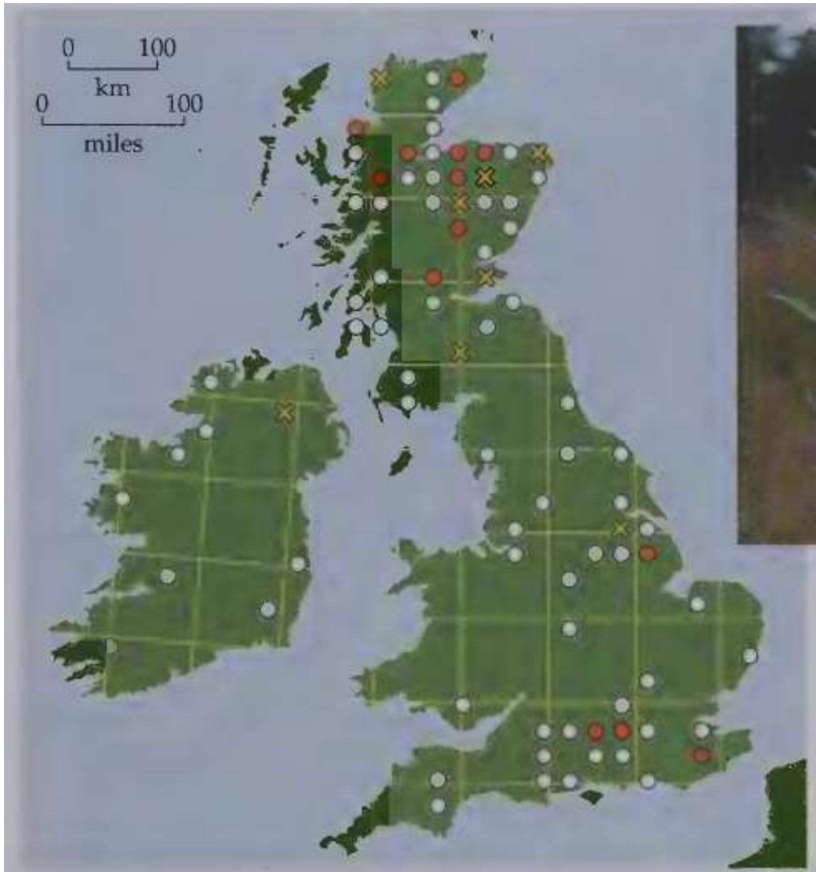


FIGURE 12.4 The British Isles Monitoring Scheme has documented the decline in the woodland cudweed (*Gnaphalium sylvaticum*), a perennial herb covered by silvery hairs. Large numbers of populations present from 1930 to 1960 were no longer present in the period from 1987 to 1988 (open circles), particularly in Ireland and England. Many populations in Scotland persisted during this interval (orange dots), and there were a few new populations (yellow crosses). (After Rich and Woodruff 1996; photograph © Bernd Haynold.)

Monitoring - survey

A survey of a population involves using a repeatable sampling method to estimate the number of individuals or the density of a species in a part of a community.

An area can be divided into sampling segments and the number of individuals in certain segments counted.

These counts can then be used to estimate the actual population size.

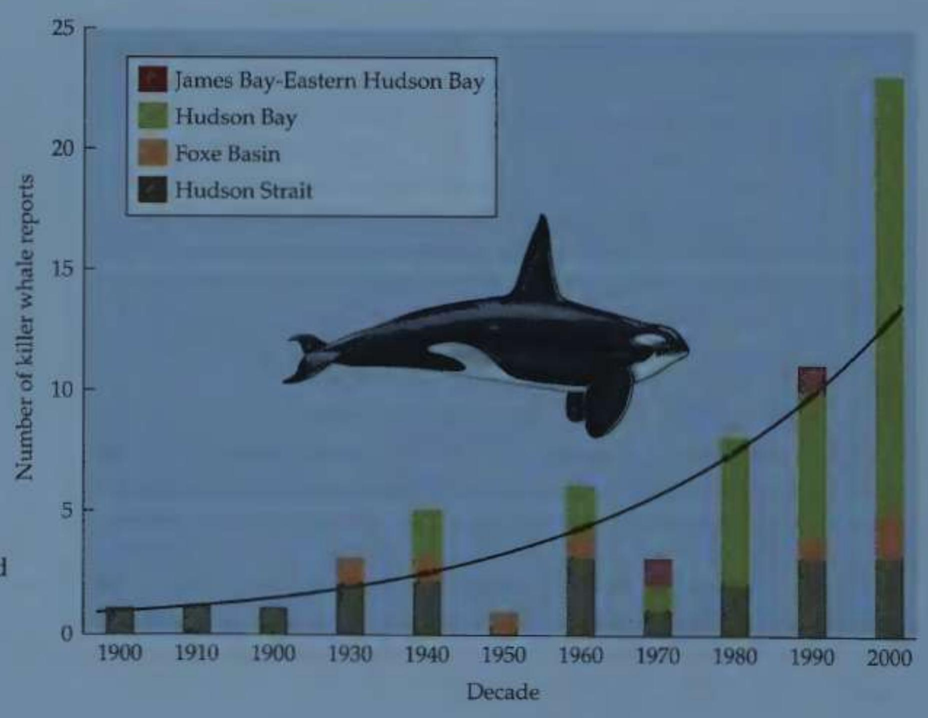
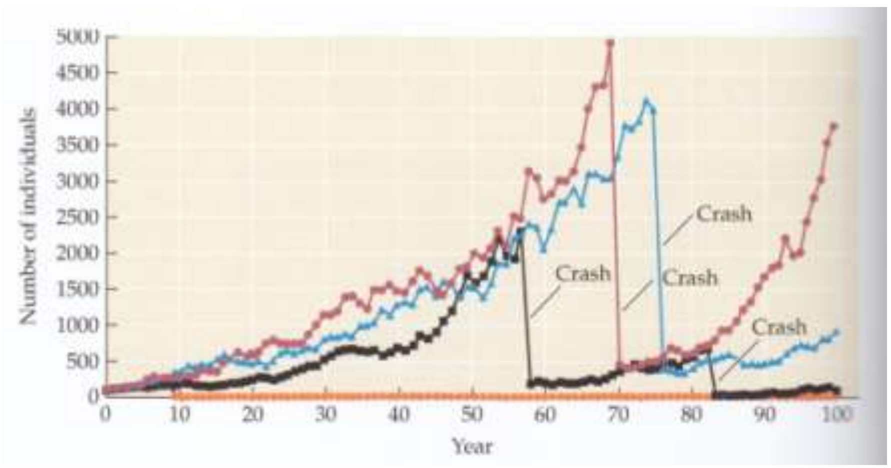


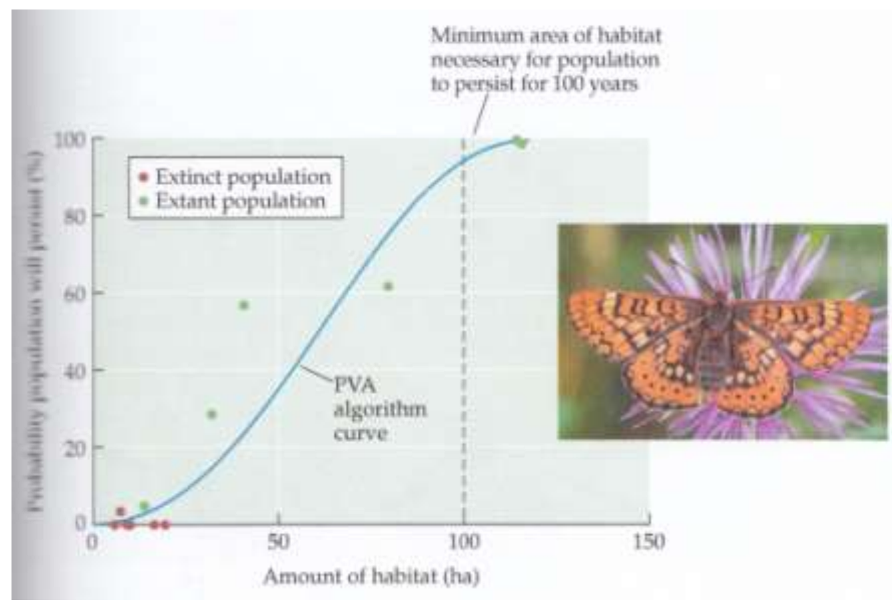
FIGURE 12.5 Number of killer whales sighted in the Hudson Bay region of eastern Canada has been increasing over the past 110 years, probably because of the reduction of winter sea ice. (From Higdon and Ferguson 2009).

Population Viability Analysis (PVA)

Estimation of the ability of a population to persist in the future

PVA uses mathematical and statistical methods to predict the probability that a population or species will go extinct or change in size within certain time period, and useful in modelling the effects of habitat degradation and management efforts

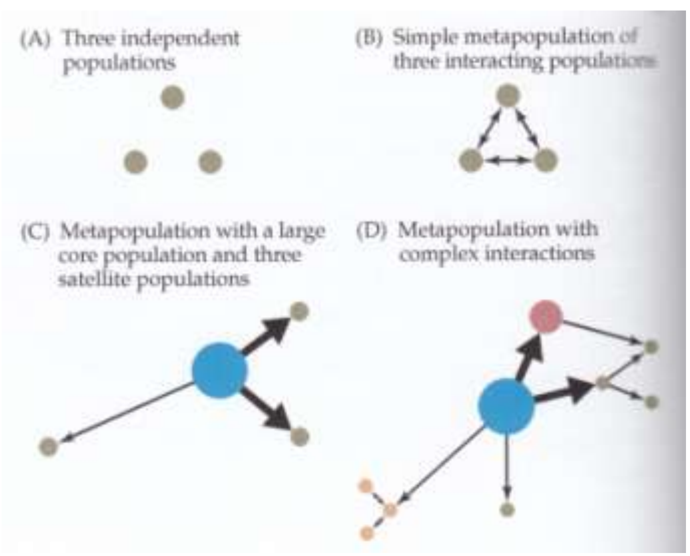


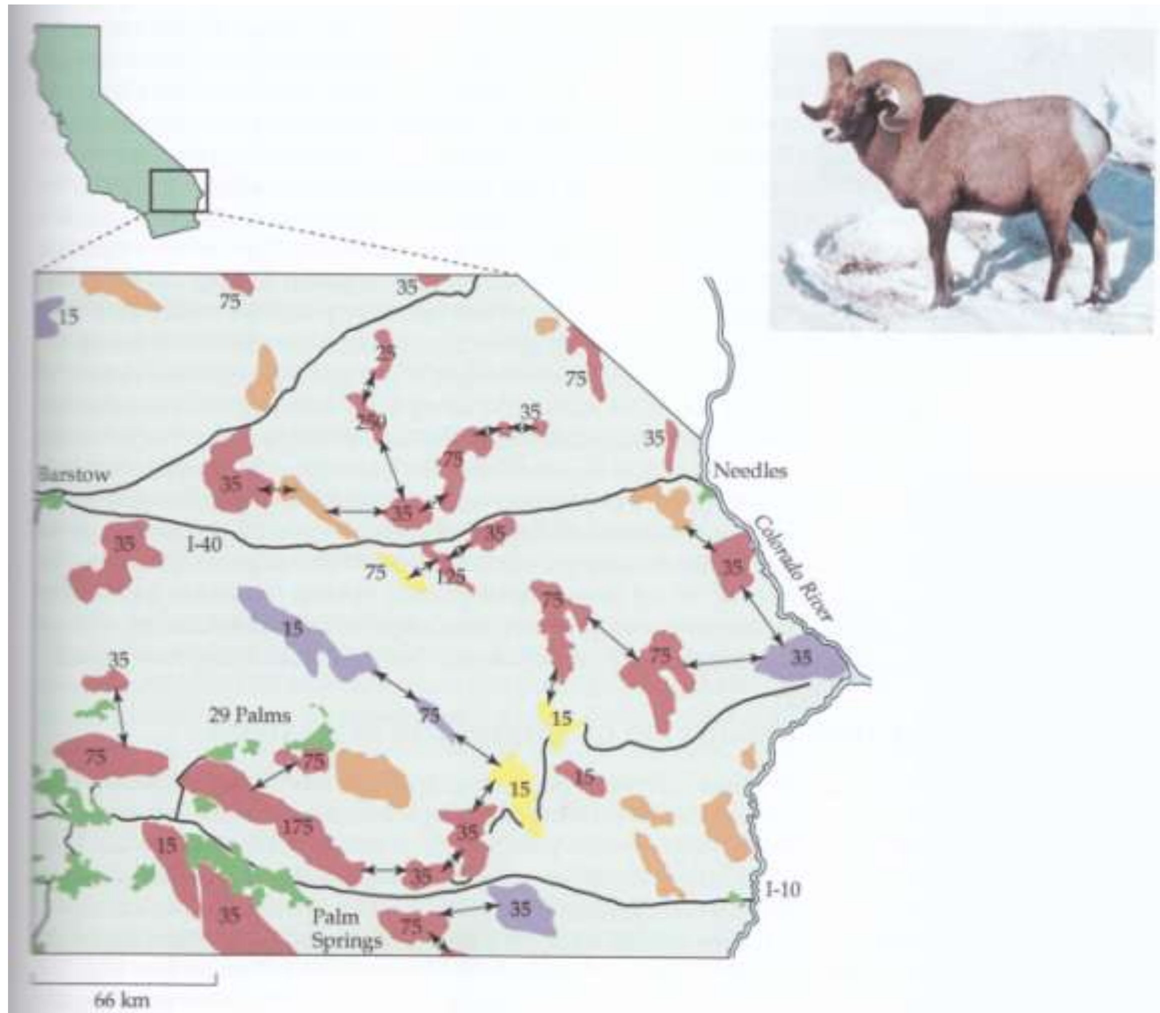


Metapopulations

Populations of a species are often connected by dispers a land can be considered as a metapopulation. In this system, the loss of one population can negatively affect other populations.

Important to identify the source (core) and sink (satelilite) populations





Long-Term Monitoring of Species and Ecosystems

		Years	Research scales	Physical events	Biological phenomena
	10^5	100 Millennia			Evolution of species
	10^4	10 Millennia	[illegible]oecology and limn[illegible]gy	Continental glaciation	Bog succession Forest community migration
	10^3	Millennium		Climate change	Species invasion Forest succession
	10^2	Century		Forest fires CO_2-induced climate warming	Cultural eutrophication Population cycles
	10^1	Decade			
LTER	10^0	Year		Sun spot cycle El Niño events Prairie fires Lake turnover Ocean upwelling	Prairie succession Annual plants Seasonal migration Plankton succession
	10^{-1}	Month			
	10^{-2}	Day		Storms	Algal blooms
			Most ecology	Daily light cycle Tides	Daily movements
	10^{-3}	Hour			

FIGURE 12.11 The Long-Term Ecological Research (LTER) program focuses on timescales ranging from years to centuries in order to understand changes in the structure, function, and processes of ecosystems that are not apparent from short-term observations. (From Magnuson 1990.)

Long-Term Monitoring of Species and Ecosystems

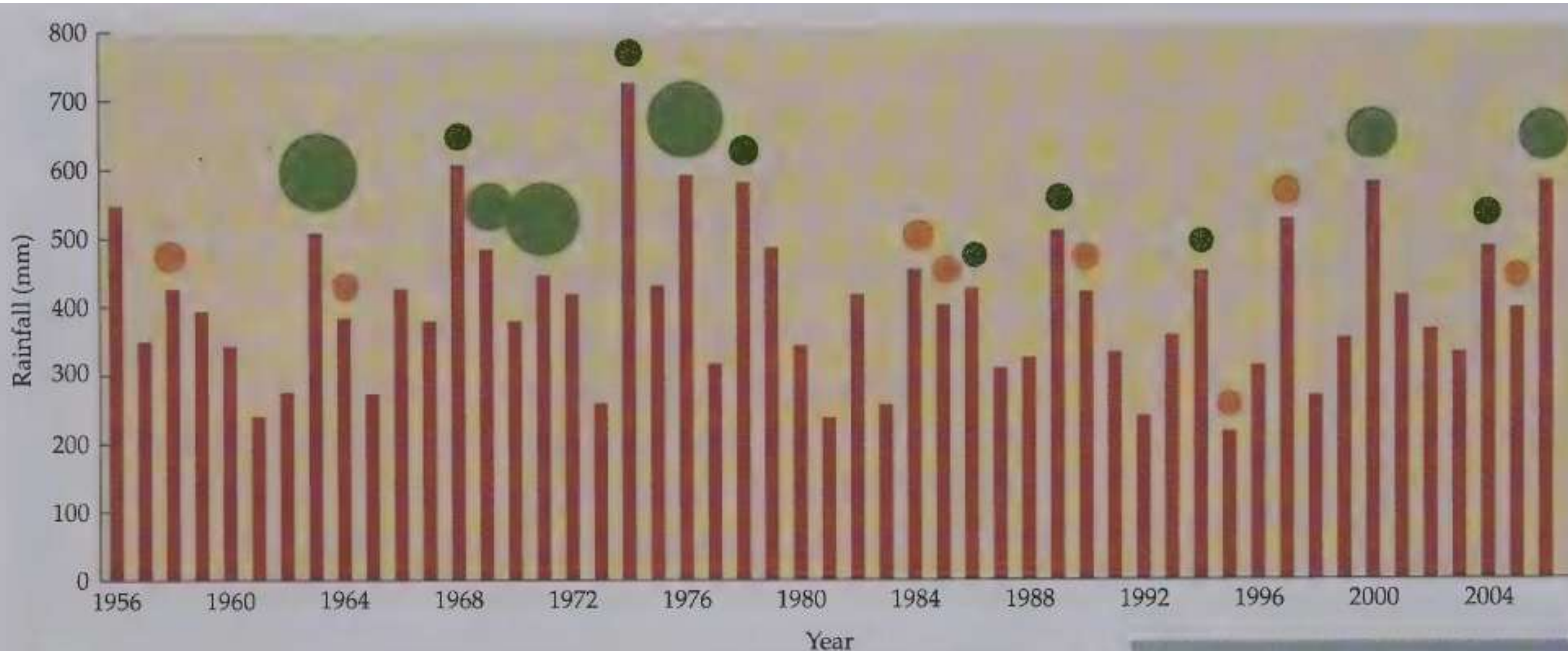


FIGURE 12.12 The bars show rainfall data from Etosha National Park for the years 1956 to 2006. The flamingo breeding events that occurred in those years are indicated by circles. Orange circles indicate failed breeding events: eggs were laid but no chicks hatched. The small, medium, and large green circles indicate, respectively, fewer than 100 chicks hatched, hundreds of chicks hatched, and thousands of chicks hatched. The last large hatching occurred in 1976. (After Simmons 1996 and personal communication; photograph © Kevin Schafer/DigitalVision/Photolibrary.com.)

Establishing New Populations

Establishing New Populations

Indentifying the factors that caused decline or extinct the species is critical

Reintroduction program – create a new population in its original environment

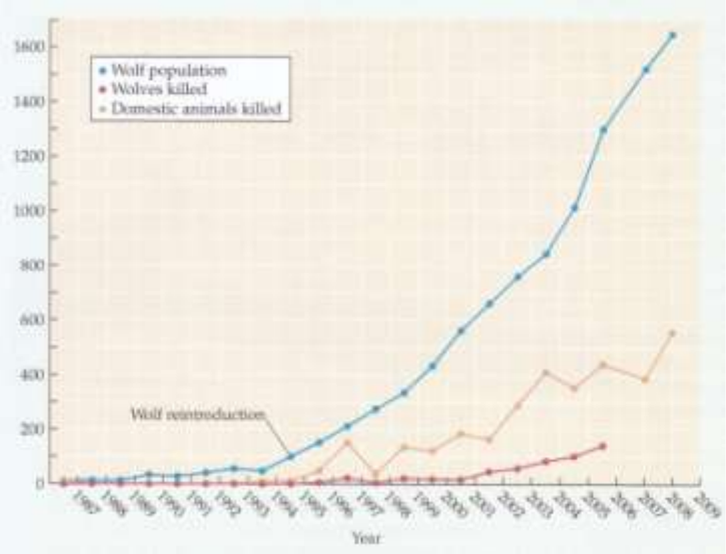
Gray wolfes into Yellowstone NP in 1995

https://www.youtube.com/watch?v=dGHSXTsf8yQ

Reinforcement program – releasing individuals into existing population to increase its size and gene pool

The release of greater praire chickens

Introduction program – moving captive-bred or wild-collected animals and plants to areas suitable for the species outside their historical range



Golden Lion Tamarin reintroduction

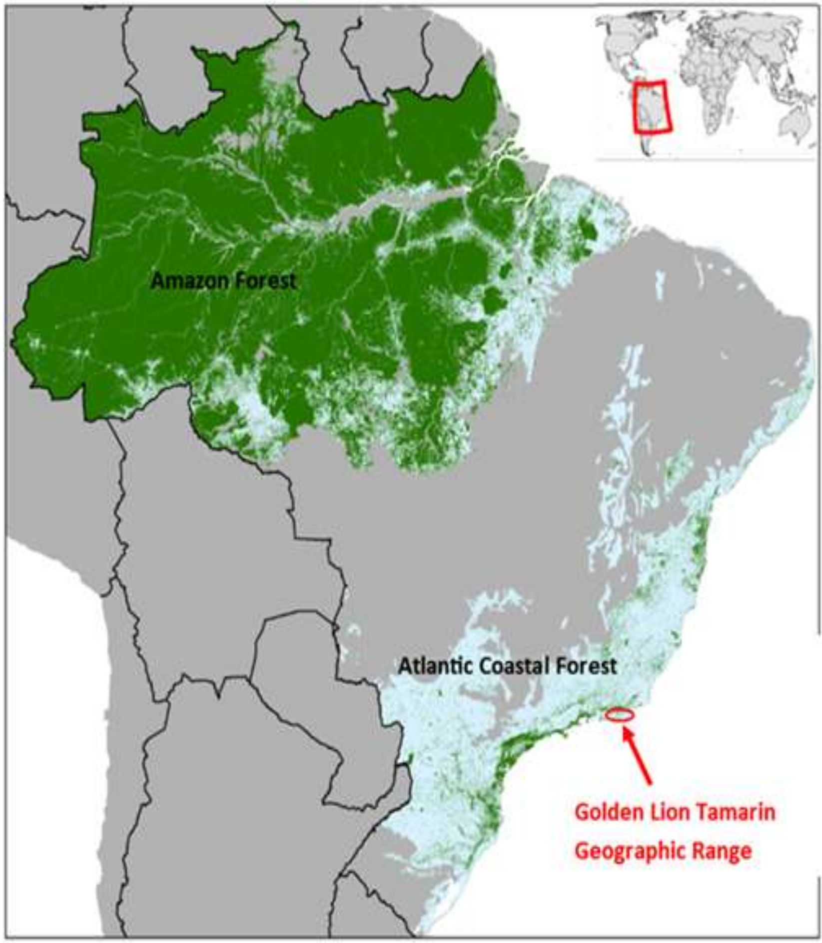
- They live in groups of up to 10 individuals
- Each group typically consists of only two to three adult individuals, with the rest being young animals
- Their territory covers about 60 hectares
- They spend the night in a tree hollow
- During most of the day, they move from one fruit-bearing tree to another
- They stay at a height of 5-10 meters above the ground
- They prefer areas with dense vegetation
- They consume insects, spiders, fruits, bird eggs, and tree sap
- Predators
  - Birds of prey, Jaguar, Jaguarundi, Ocelot Snakes

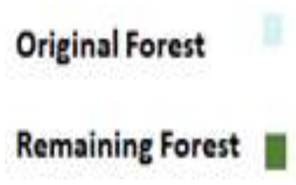
https://www.youtube.com/watch?v=EZ1oSOaurUs&t=2235s

- Natural habitat
  - Rainforests of the Atlantic coast of Brazil – Mata Atlântica
  - Lowland rainforests

The main cause of the drastic population decline

- Human activity
  - Habitat fragmentation and loss
  - Deforestation
  - Agricultural cultivation
  - Livestock farming
  - Urbanization, road construction
- Hunting
  - "Jungle meat”
- Misconceptions
  - Believed to be carriers of malaria and yellow fever
- Illegal exotic pet trade





<<< 2-7% !!!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© picture-alliance/Mary Evans Picture Library/N. Gordon

Early 1970s

- –Small, isolated wild populations << 500 individuals
- –Zoos: ~75 specimens

1972 – "Save the Lion Tamarin!" international Conference

- –Coordinated zoo breeding program
- –Planned breeding, standardized husbandry techniques

Golden Lion Tamarin Conservation Program(National Zoological Park and the Smithsonian Institute)

Regional conservation efforts

•Establishment of self-sustaining 'ex situ' populations in natural habitats

•Conservation awareness (information, education)

1974 – Creation of Poço das Antas Biological Reserve (50 km²)

Brazil's first wildlife conservation area!

1984 – Beginning of reintroduction efforts!

https://www.saveteliontamarin.org/

SAVE THE GOLDEN LION TAMARIN

CITES

Common name: Golden Lion Tamarin
Scientific name: *Leontopithecus rosalia*
Synonym: *Leontideus rosalia*
Distribution: Brazil
CITES listing: Appendix I (01/07/1975)

Captive breeding and animal behavior studies

→ Successful zoo breeding programs

Maintaining genetic diversity and reproductive success

→ Initiating reintroduction programs

Regular monitoring, census

First attempts at releasing back into the wild failed

–Development of reintroduction methods

–Pre**p**aration

-"Magic boxes" – micromanipulation, dexterity, patience

-Use of instructors

-Movement and climbing in natural vegetation

Zoos in natural forests

Gradual release / "gentle release”

Feeding and sheltering sites

Reducing poaching!

Problems during the conservation program

Captive-bred individuals, without proper learning, after release into the wild

- Feeding Issues
  - Lack of natural foraging skills made it difficult for them to find and properly consume food in the wild
- Avoiding Predators
  - Without the experience or instinct to avoid predators, released animals were vulnerable to being hunted
- Orientation Problems
  - Difficulty navigating the wild and locating essential resources such as food, water, and shelter.
- Importance of Preparation for Independent
  - Life Training with wild/mentor individuals and habituation to the wild were essential to preparing animals for survival in their natural environment
- Need for Local Community Engagement and Cooperation
  - The involvement and support of local populations were critical for the success of conservation efforts, including reducing poaching and ensuring safe habitats.

Translocation and epidemic

Some of the golden lion tamarins have been removed from small, isolated unsafe forests and placed into a larger, protected forest; specifically they were moved to União Biological Reserve and Poço das Antas reserve began in 1991

Despite the challenge of illness, the forty-two translocated golden lion tamarins' population grew to over 200

A 2016-2018 yellow fever epidemic in southeastern Brazil had a significant impact on the golden lion tamarin population, reducing it by 32% to approximately 2,516 individuals

Brazilian scientists created a customized yellow fever vaccine specifically for golden lion tamarins. By February 2023, the yellow fever outbreak had subsided, and the tamarin population had stabilized

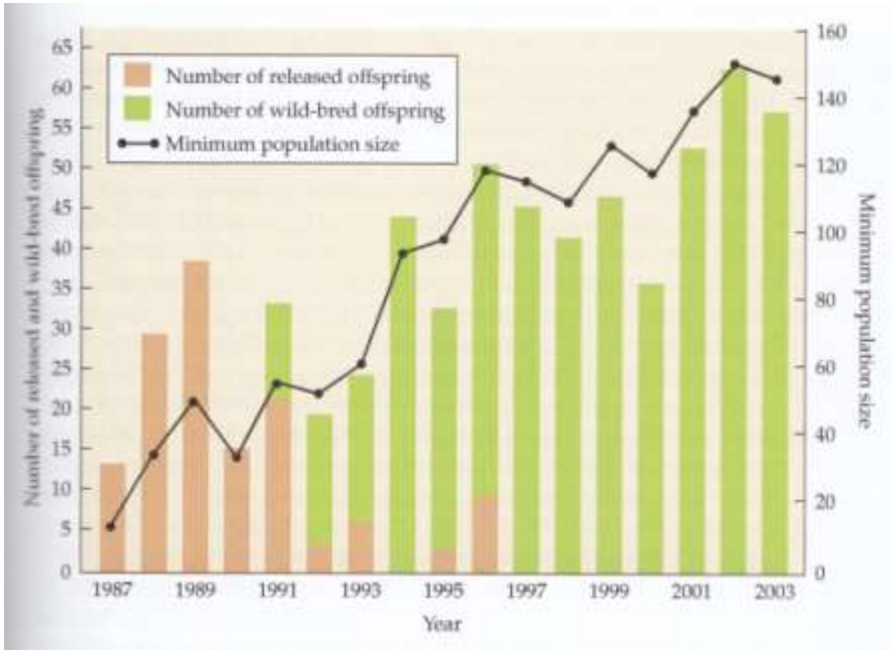
The number of wild golden lion tamarins is now up in the thousands in all reserves and ranches combined in Brazil. These numbers were once down in the 200s in 1991. By 2025, the number of golden lion tamarins that are protected is projected to be greater than 2000

Experience of 200 establishment programs

Mauritius kestrel reintroduction program

In 1974 the Mauritius kestrel was close to extinction, with only five or, possibly, six known birds of which two in captivity and a solitary breeding female

The numbers had increased to ~400 birds in 2019. This conservation achievement is regarded as one of the most successful and best documented bird restoration projects in the world



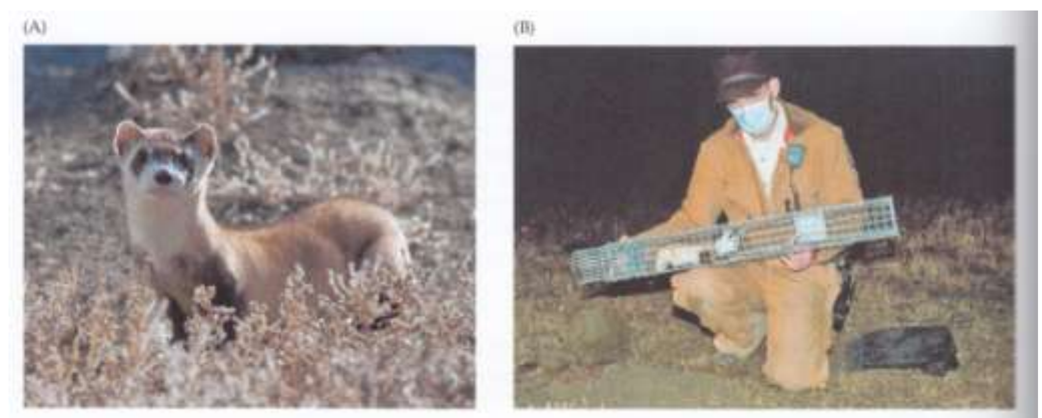
- -Success was greater for releases in excellent-quality habitat (84%) than in poor-quality habitat (38%)
- -Success was greater in the core of the historical range (78%) than at the periphery of and outside the historical range (48%)
- -Success was greater with wild-caught (75%) than captive-reared animals (38%)
- -Success was greater for herbivores (77%) than carnivores (48%)
- -For bird and mammal species the success increased when more than 100 individuals released
- -Success is lower for endangered species than projects for wildlife managed for hunting

New animal populations

Establishing new populations is often expensive and difficult because it requires a serious, long-term commitments.

Importance

- Well-run, well-designed program may be the best hope for preservation
- Include local people, community
- Considerable educational value
- Public attention, national pride, opportunities for employment
- No damage its new ecosystem
- Released individuals have not acquired any diseases
- Individuals carefully selected to guard against inbreeding depression
- Animals need to be familiar with site
- Learned behaviour of released animals



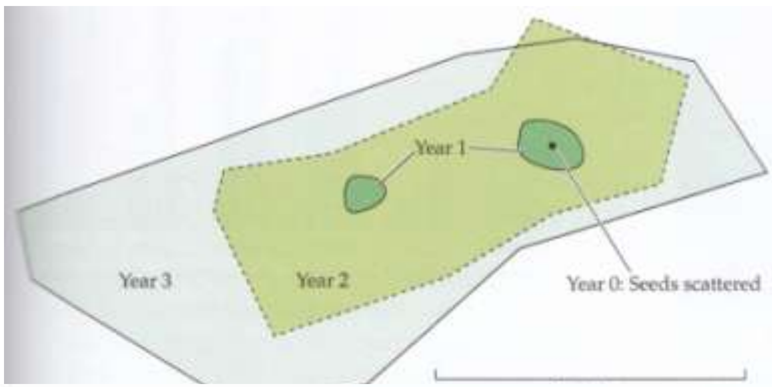
Learned behaviour of released animals

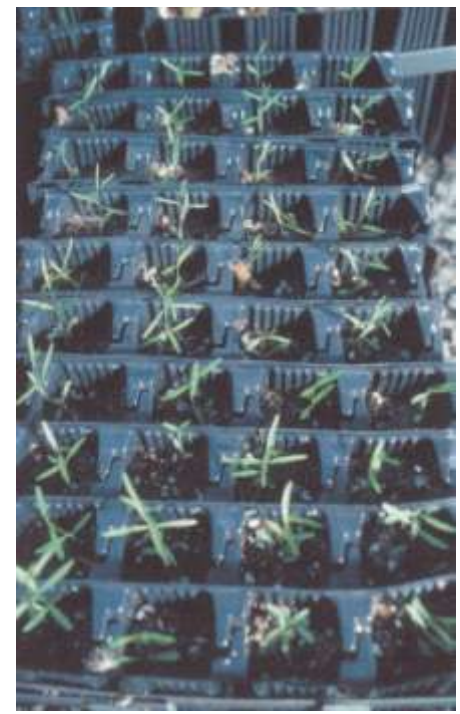
It is imperative that captive-bred mammals and birds learn predator avoidance, the ability to find food, and species-appropriate social behaviour

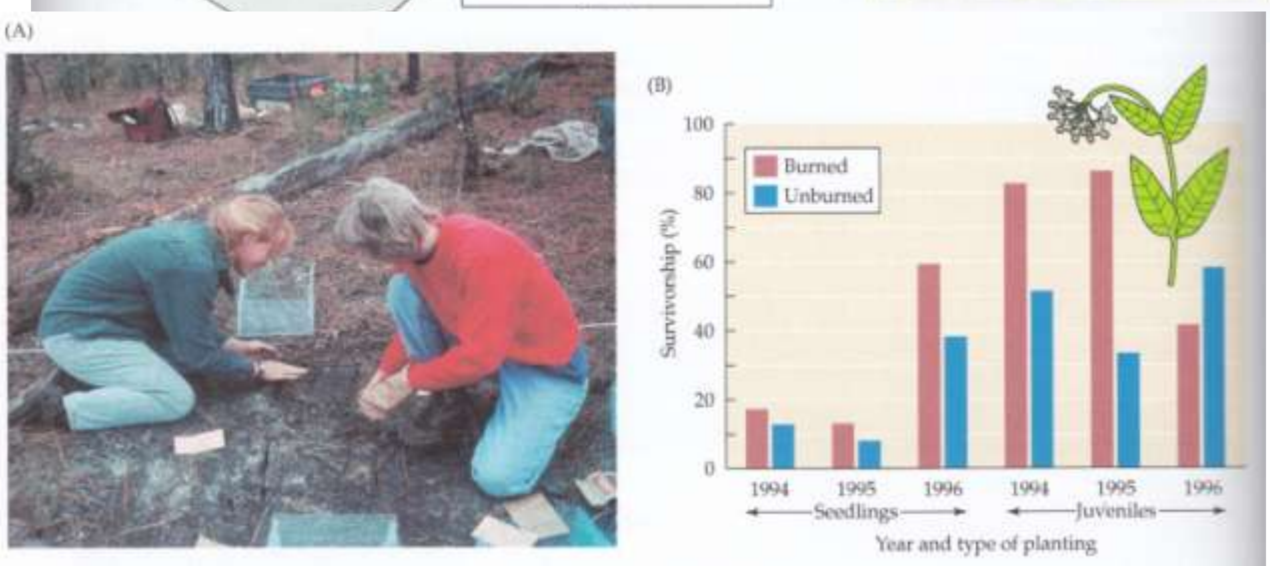
New plant populations

Plant populations typically fail to establish from introduced seeds at most sites

To increase the chance of success, often germinate seeds in controlled environment and grow young plants in protected condition – plants transplanted into the wild







Ex Situ Conservation

Conservation of population in the wild, known as **in situ**, or **on-site conservation**

Ex situ, or off-site conservation – Zoos, aquariums, sanctuaries, game farms, and private breeders, botanical gardens, arboretums, and seed banks

Integrated with efforts to protect existing populations and to establish new populations, ex situ conservation is an important conservation strategy to protect endangered species and educate the public

Complementary components of a Integrated conservation strategy

Ex situ conservation facilities

(A)

~ 2000 zoos and aquarium

Current goal, establish viable, long-term captive breeding populations of rare and endangered animals – traditionally focused on large vertebrates

Ecological themes and information about the threats to endangered species

Program to develop scientifically focused approaches to endangered species conservation

Educational programs to raise public attention to protect animals and their habitats

The potential educational and financial impact - 600 million visitors/year

Some species survived in the past in captive colonies (ex situ):

Przewalski' horse, Pére David's deer, takhi

(A)

Importance of Ex Situ conservation

-Can provide insight into basic biology of the species which would not be possible on wild animals – can suggest new strategies for in situ conservation

-The ease of access to individuals in captivity allows to develop and test relevant technologies that enhance the study of preservation

-Captive-bred individuals on display can serve as ambassadors for their species and its habitats and help to educate the public about the need to preserve it in the wild

-Revenues fund for conservation effort

Constraints:

Extremely expensive – e.g., 50 times more costly for elephants or black rhinos compared to in situ.

Population size

Adaptation to artificial environments

Learning skills

Genetic diversity

Continuity – lack of funding

Concentration – disaster risk

Surplus animals

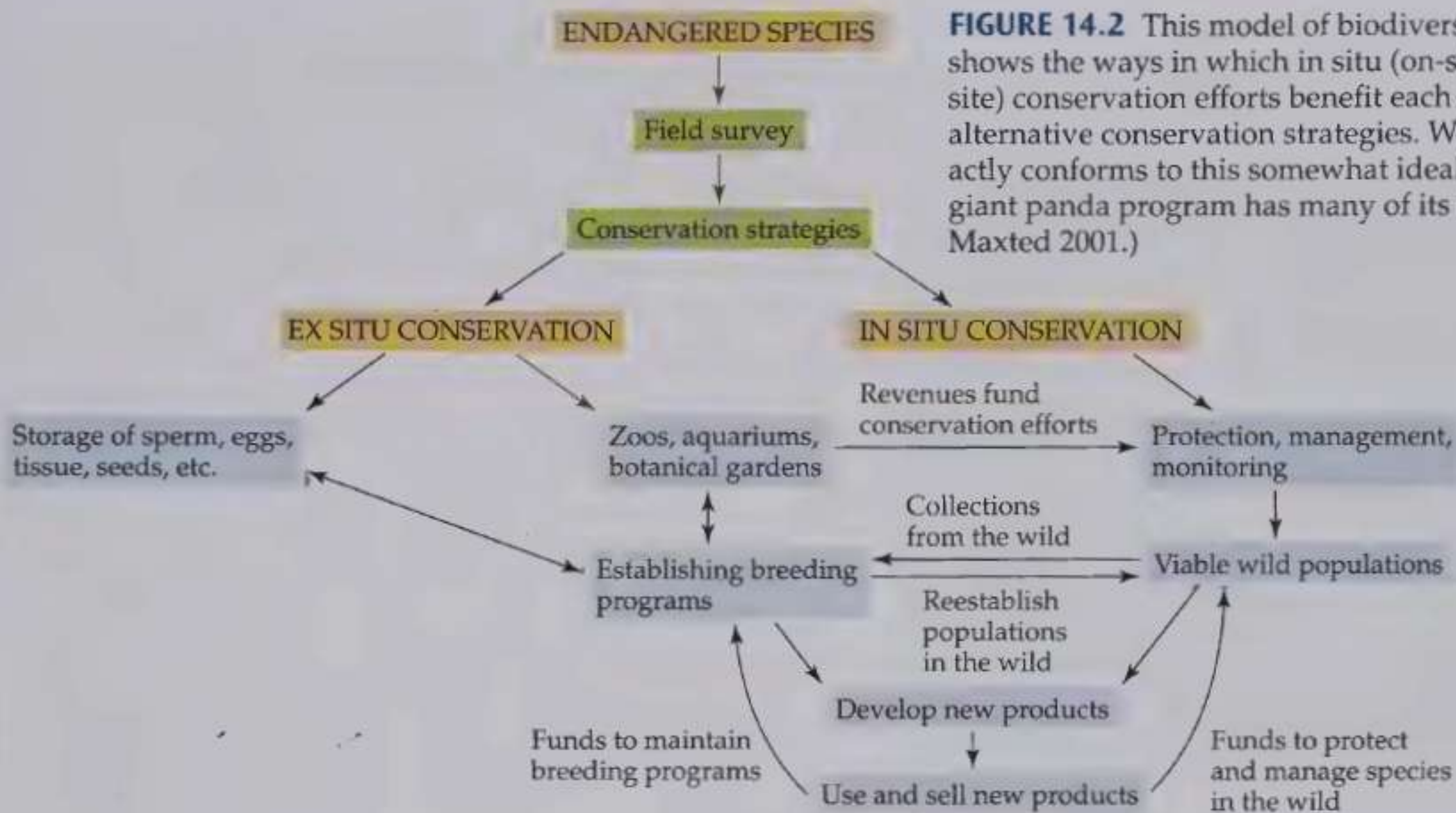


FIGURE 14.2 This model of biodiversity conservation shows the ways in which in situ (on-site) and ex situ (off-site) conservation efforts benefit each other and provide alternative conservation strategies. While no species exactly conforms to this somewhat idealized model, the giant panda program has many of its elements. (After Maxted 2001.)

Zoos

~2 million animals, 10 000 species, dominantly mammals, birds, reptiles and amphibians

TABLE 14.1 Number of Terrestrial Vertebrates Currently Maintained in Zoos

Location	Mammals	Birds	Reptiles	Amphibians	Total
Europe	101,921	125,846	30,799	57,413	315,979
North America	50,982	62,448	31,270	50,588	195,288
Latin America	3653	5105	2455	634	11,847
Asia	29,089	39,216	9338	887	78,530
Australasia	7674	10,312	3890	1875	23,751
Africa	4185	7939	2435	356	14,915
Worldwide totals					
All species	197,504	250,866	80,187	111,753	640,310
Number of taxa[a]	2238	3753	969	544	7486
Percent wild-born[c]	5%	9%	15%	5%	
Rare species[b]	59,030	37,748	22,474	3398	122,650
Number of taxa[a]	527	344	207	29	1107
Percent wild-born[c]	7%	9%	18%	7%	

Source: Data from ISIS, provided by Laurie Bingaman Lackey 2013.
[a]The number of taxa is not exactly equivalent to number of species, because many species have more than one subspecies listed.
[b]Rare species are those covered by CITES (the Convention on International Trade in Endangered Species).
[c]The percentage of individuals born in the wild is approximate (particularly for reptiles and amphibians), since the origin of the animals is often not reported.

Zoos

- Out of ~2 million individuals, 10,000 species are kept under ex situ conditions
- In many cases, the show cased species originate from wild specimens

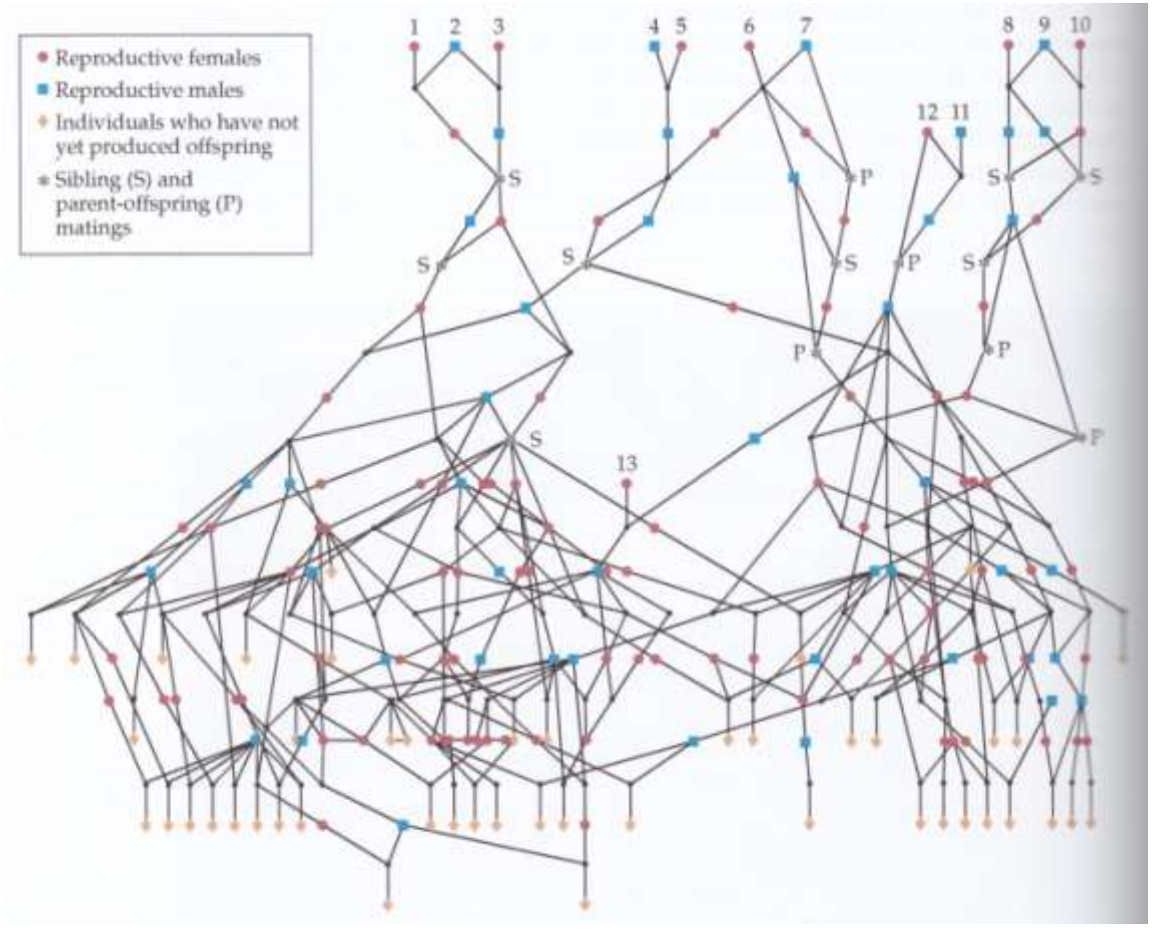
- In the USA, there are only 100 self-sustaining populations for rare mammal species
- Breeding programs with 100–150 individuals per species could preserve only 2,000 mammal species
- International Union for Conservation of Nature (IUCN) has a specialized group – advising on breeding programs for endangered species
  - Example: Nyíregyháza Zoo participates in over 50 species-saving programs:

    e.g. Successfully breeds species such as giraffes, pygmy marmosets, Bornean orangutans, Bali mynas, and Siberian tigers

The importance of conserving invertebrate species is increasingly coming to the forefront

ISIS

ISIS International Species Information System – combating inbreeding 825 institutions from 76 countries10,000 species, 2,000,000 individuals



Aquariums

Conservation of marine and fresh-water species a significant priority, with a special focus on fish and marine mammals

Botanical gardens and arboretums

1600 locations, 4 million specimens, 80 000 species, 30% of world's flora

200 million visitors per year

Specialization occurs

Largest in globally: UK Kew Gardens

In Hungary: Vácrátót

Knowledge acquisition, experts, public awareness

Temperate zone species are overrepresented

Seed Banks

- Seed banks represent an effective startegy for plant conservation because the seeds of many wild plants and crop plants can be stored for years in cold, dry conditions

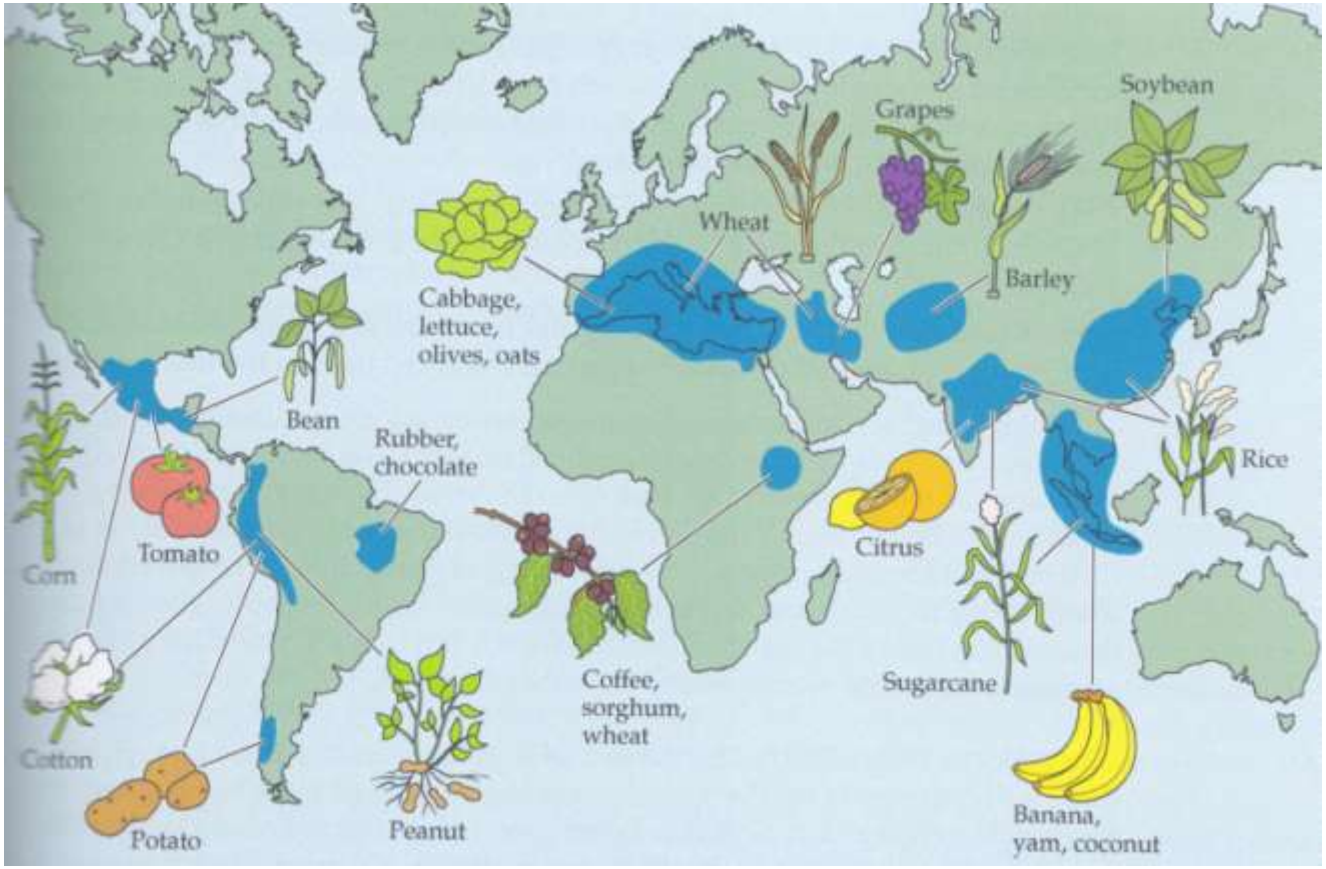
- Generally focused on ~100 plant species that make up over 90% of human food consumption

- At present, seeds of ~10% of the world's species are stored in seed banks

Figure 14.9 (A) The National Center for Genetic Resources Preservation in Fort Collins, Colorado, is an example of a modern seed bank facility. (B) At seed banks, seeds of many plant varieties are sorted, cataloged, and stored at freezing temperatures. (C) Seeds are also stored in liquid nitrogen at −196°C. (D) Seeds come in a wide variety of sizes and shapes. Each such seed represents a genetically unique dormant individual. (Photographs courtesy of the U.S. Department of Agriculture.)

Diversity hotspots of cultivated species

The need for fair trade between countries



Love alone cannot save the giant panda

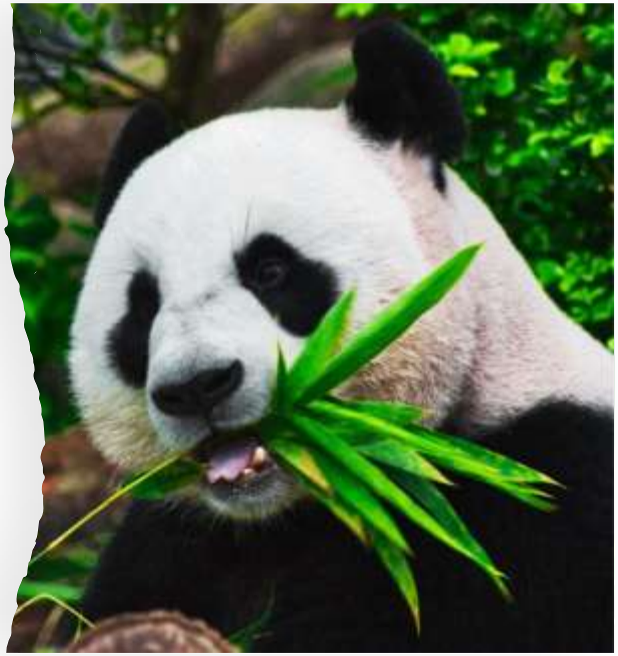
Giant Panda

The panda, with its distinctive black and white coat, is adored by the world and considered a national treasure in China.

Pandas live mainly in temperate forests high in the mountains of southwest China, where they subsist almost entirely on bamboo. They must eat around 12 to 38 kg of it every day, depending on what part of the bamboo they are eating.

Lack of anatomical adaptations characteristic of herbivores. No elongated digestive tract or symbiotic bacteria that assist in cellulose breakdown, improving digestion efficiency.

As a result, they must eat continuously to obtain the nutrients necessary for survival



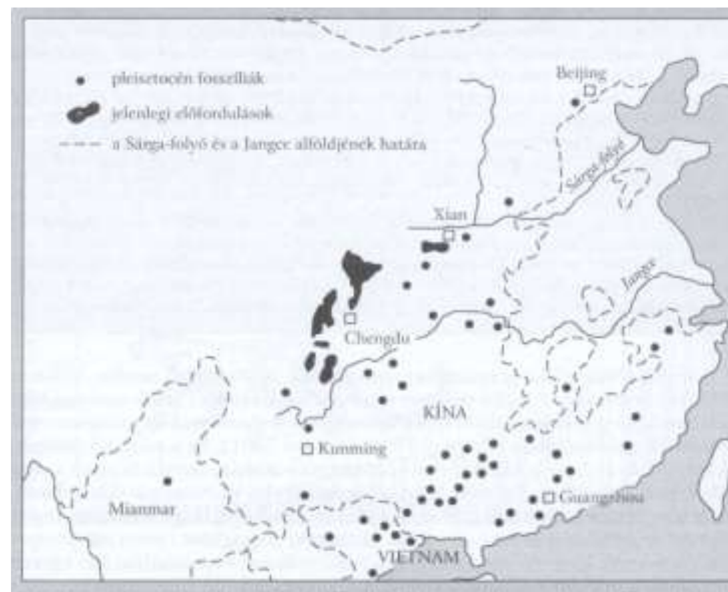
Threats

Habitat Loss and fragmentation

China's Yangtze Basin region holds the panda's primary habitat. Infrastructure development (such as dams, roads, and railways) is increasingly fragmenting and isolating panda populations, preventing pandas from finding new bamboo forests and potential mates.

Forest loss also reduces pandas' access to the bamboo they need to survive. The Chinese government has established more than 50 panda reserves, but only around 67% of the total wild panda population lives in reserves, with 54% of the total habitat area being protected.

Bamboo species reproduce in long-term cycles, from 15-100 years, a certain area will flower and die in a single season – pandas need to move to new area in that situations



Az óriás panda valaha elterjedt faj volt Kína keleti részén, Mianmarban és Vietnamban is; napjainkban elterjedése mindössze néhány területre korlátozódik Chengdu és Xian városok környékén

Large bamboo die-offs in the 1970s

In the 1970s, when several bamboo species died off simultaneously over large area, at least 138 pandas died of starvation, population declined by more than 23%

Chinese government tried to establish a self-sustaining captive population from saved individuals.

Breeding attempts were unsuccessful for long time

- Pandas are highly selective in choosing mates
- Pairs arranged by zoos were often incompatible and insufficient time was provided for bonding
- Artificial insemination was attempted, but success was minimal.

They rarely give birth to live offspring, and even when cubs are born alive, they often survive only a few days at most

By the 1980s, only 90 cubs had been born, of which only 37 survived beyond six months.

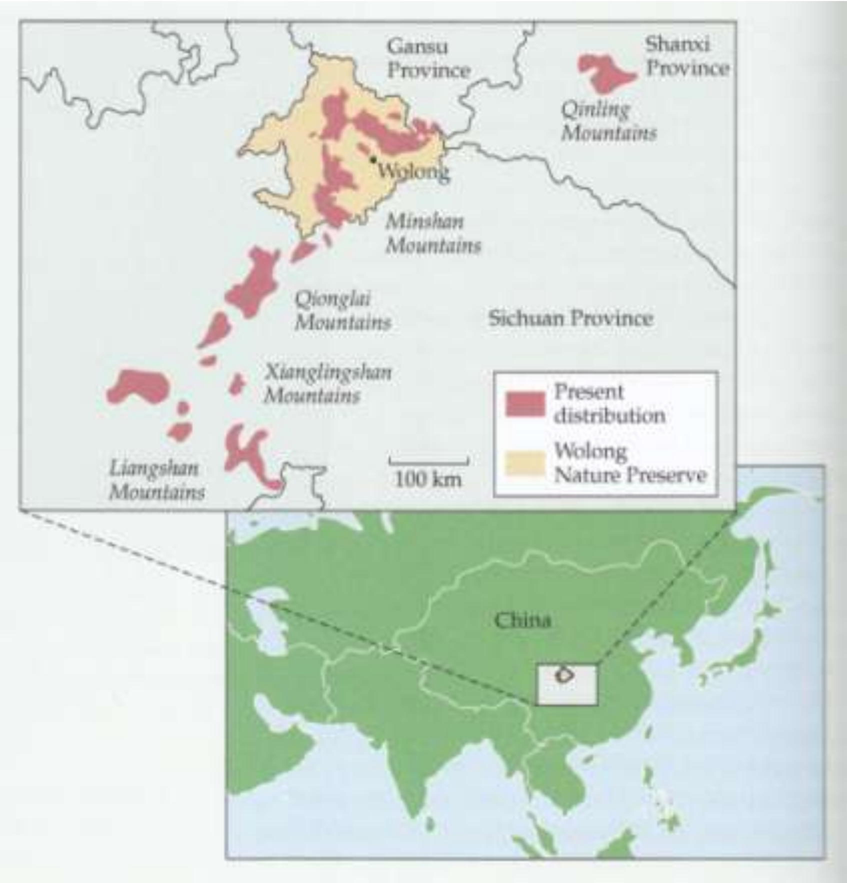
Conservation

Another major issue is the small population of wild pandas occupying 23 000 km^2 of habitat, which is only around 1 600 individuals, scattered over large areas

They live in 25 small populations, many with fewer than 20 individuals, leading to challenges such as breeding females being unable to find mates or suffering from inbreeding

There are now 40 reserves covering 45% of panda's habitat.

Poachers kill them for their fur, despite severe penalties (including the death penalty) being in place



The Chinese government has allocated resources to protect wild pandas, but even the reserves struggle to cope with the pressures of massive human population and economy growth

In July 2021, population in the wild exceeding 1,800