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:

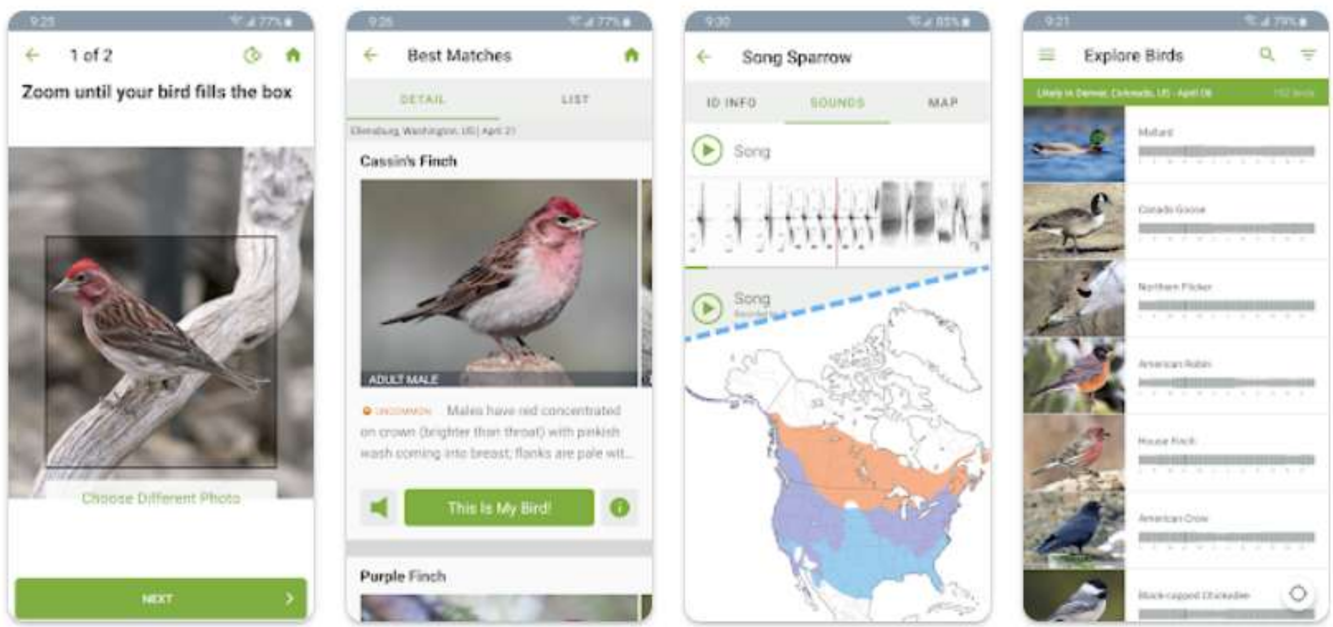
http://zeus.nye.hu/~szept/kurzusok.htm

Impovement of these schemes by smartphone applications

MERLIN ID

helps to identify birds you see and hear. Merlin is unlike any other bird app—it's powered by eBird, the world's largest database of bird sightings, sounds, and photos.

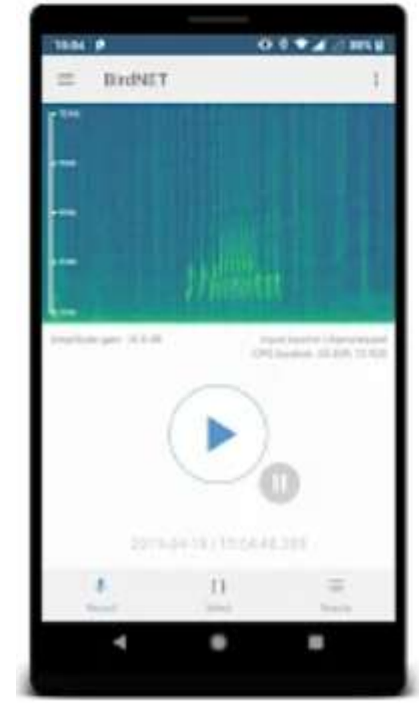
Android, IOS



Impovement of these schemes by smartphone applications

BIRDNET

The BirdNET uses artificial intelligence and neural networks to train computers to identify more than 3,000 of the most common species worldwide.

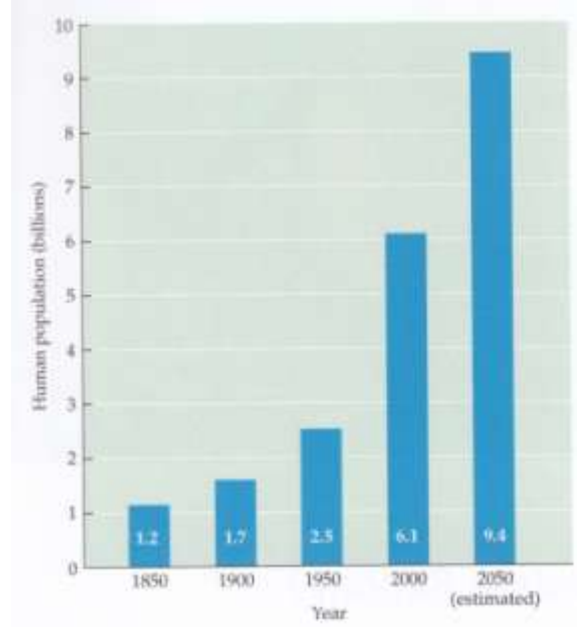


Android, IOS

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

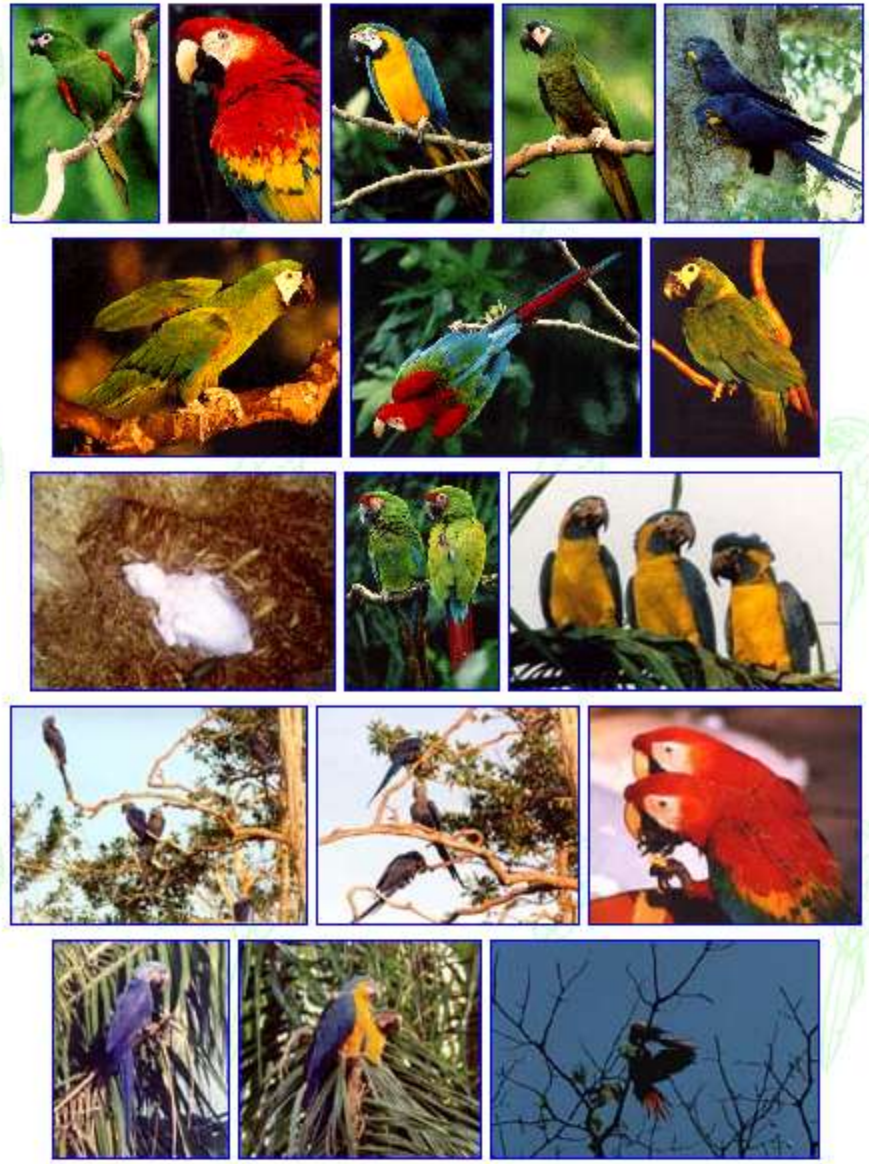
Conservation Biology

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

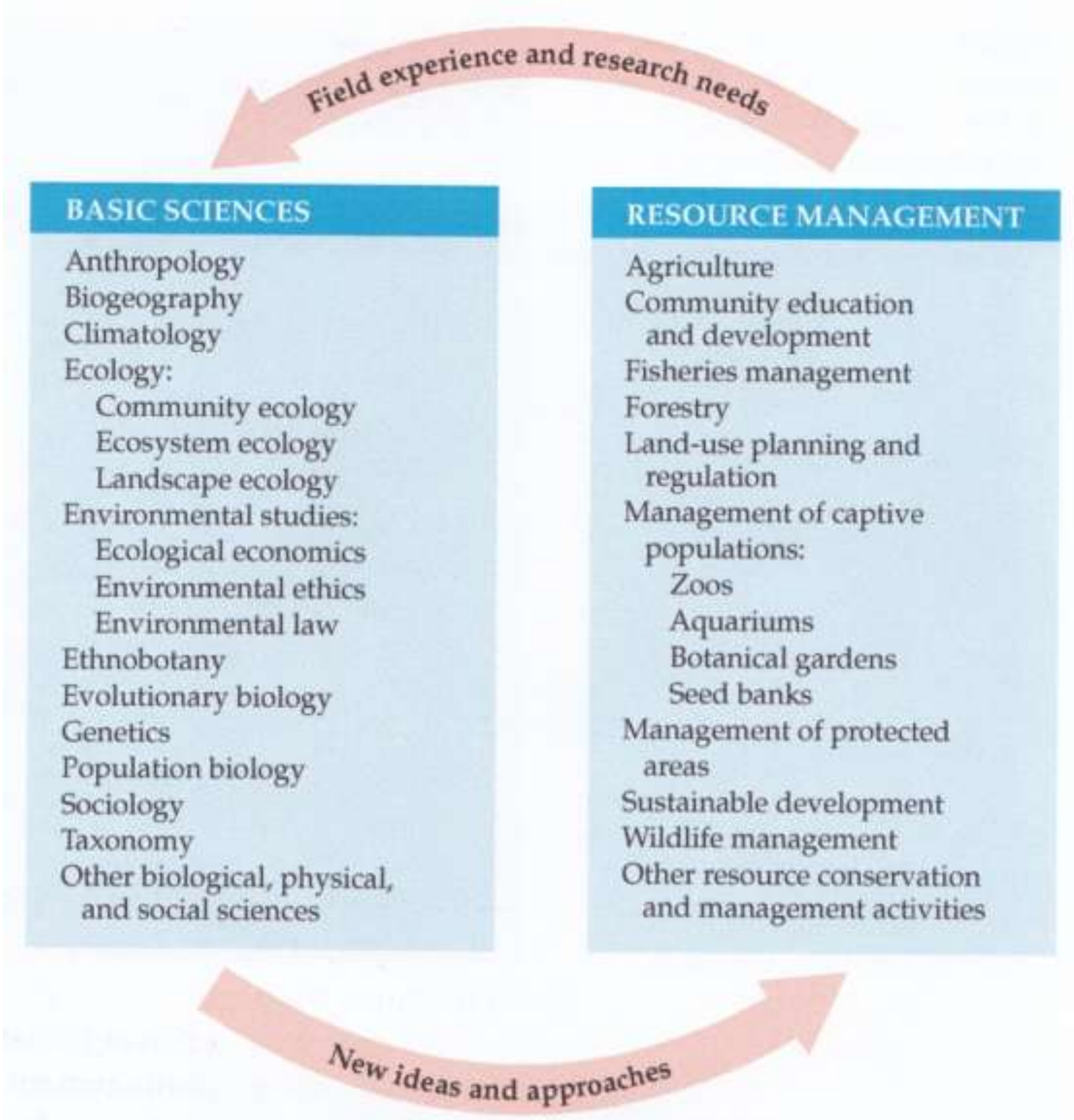
Case study

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

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



Conservation biology represents a synthesis of many basic and applies science

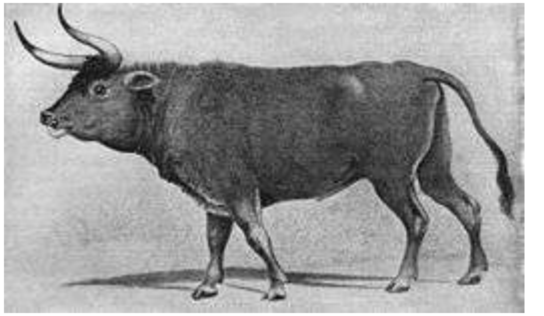


Origins of Conservation Biology

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

European Origins

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

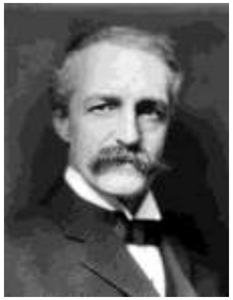


Origins of Conservation Biology

American origins

XIX century

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



XX. Century

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

Conservation Biology

Looking answers for:

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

Tasks:

- Discovering problems
- Preserving natural values
- Restoration

What is Biodiversity

What is Biological Diversity?

– Conception

– **Measurable entity**

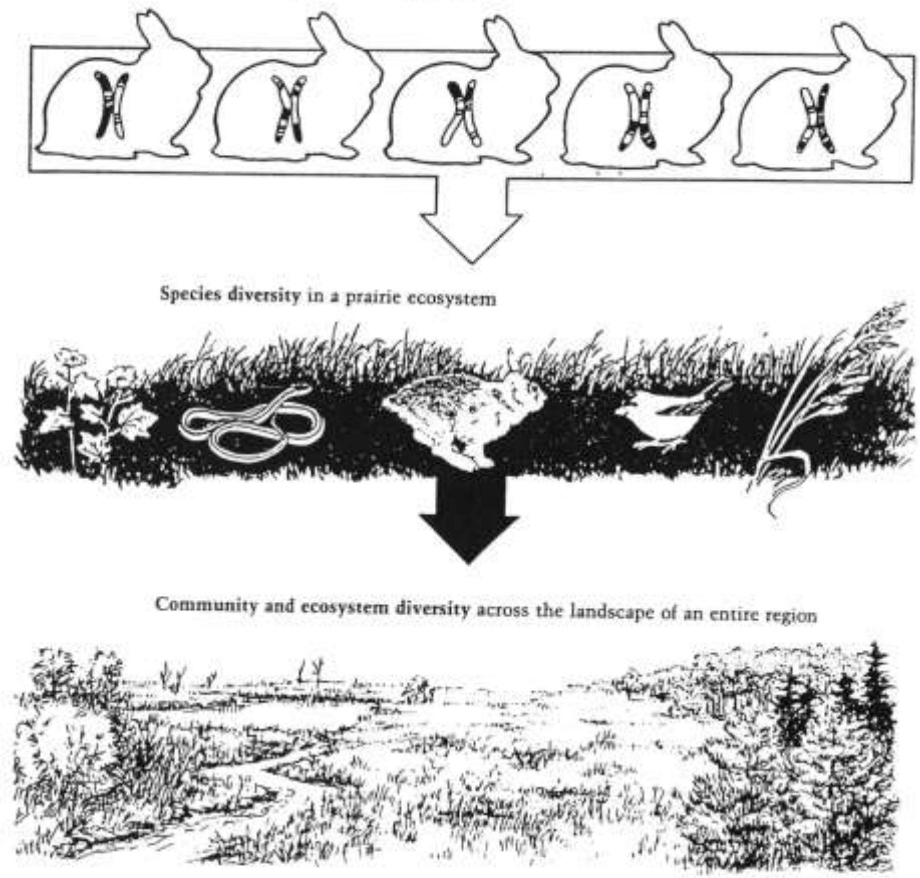
– Scientific field

Level of Biological Diversity

- Genetic diversity

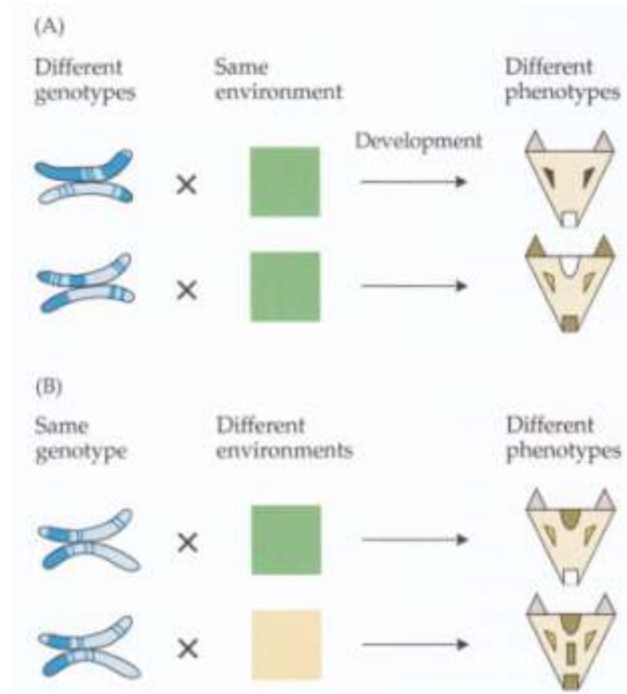
- Taxonomic diversity

- Community diversity

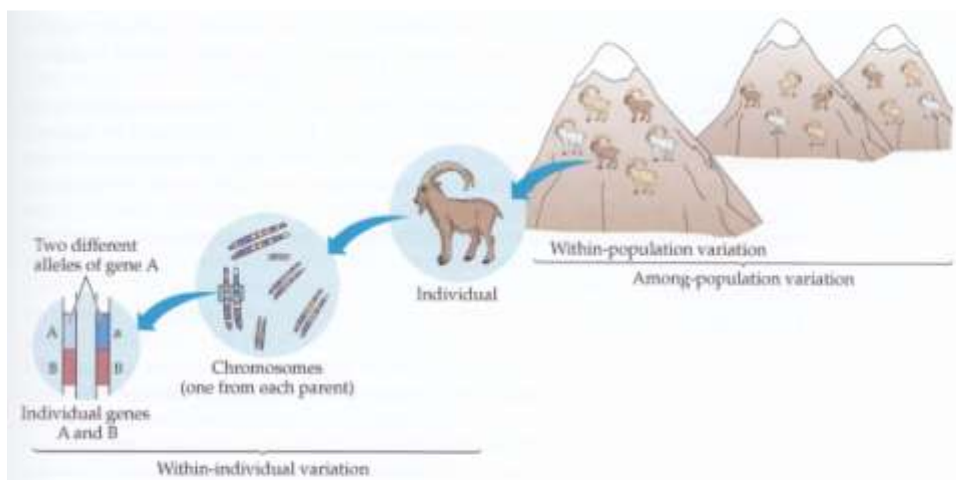


2.1 Biological diversity includes genetic diversity (the genetic variation found within each species), species diversity (the range of species in a given ecosystem), and community/ecosystem diversity (the variety of habitat types and ecosystem processes extending over a given region. (From Temple 1991;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

Genetic diversity



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



Genetic diversity

Measurement

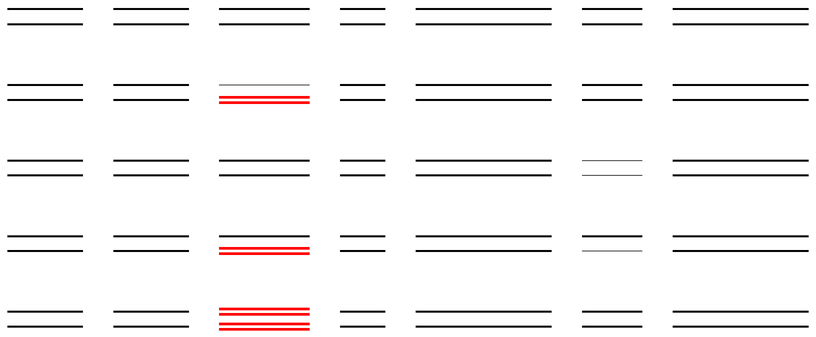
- Phenotypical diversity – isoensims
- Sequence of DNA

Polymorphism (P)

- Ratio of genes in the population with polymorphic allele

Heterozygousness (H)

The ratio of genes per individual that are polymorphic



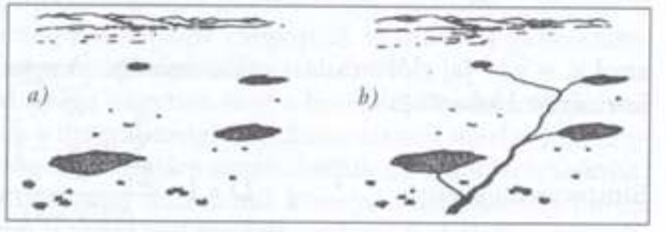
Genetic diversity

Species genetic diversity(H_t)

$H_t = H_s + D_{st}$

H_s: Diversity within population

D_{st}: Diversity between populations



Polymorphism and heterozygousness has positive correlation

Diversity of taxonomic groups

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

Number of species

Diversity index

Shannon-Wiener

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

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

Evenness

E= H/Hmax, H/lnS

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

A

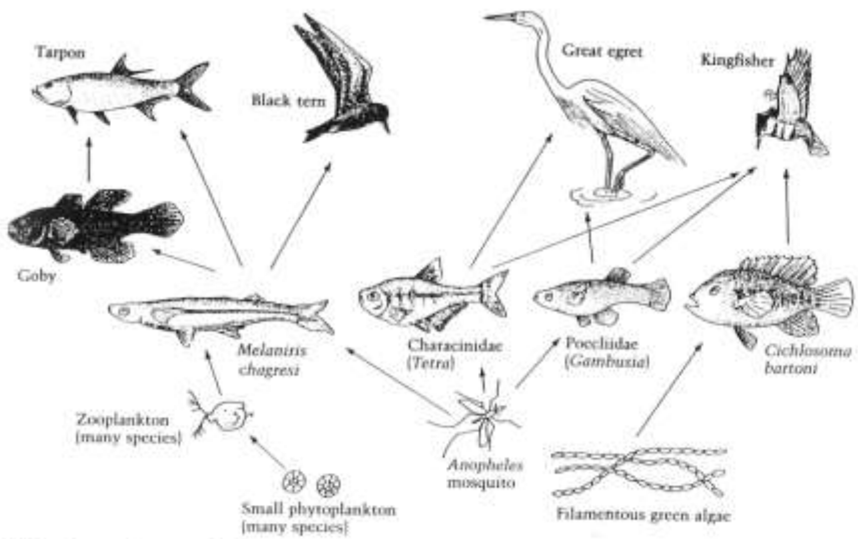
Species	Ni	pi (frequency)	ln pi	pi * ln pi	1/S	ln (1/S)	(1/S) * ln (1/S)
Great tit	13	0.406	-0.901	-0.366	0.143	-1.946	-0.278
Blue tit	8	0.250	-1.386	-0.347	0.143	-1.946	-0.278
Blackbird	4	0.125	-2.079	-0.260	0.143	-1.946	-0.278
Nuthatch	3	0.094	-2.367	-0.222	0.143	-1.946	-0.278
Great spotted woodpecker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

B

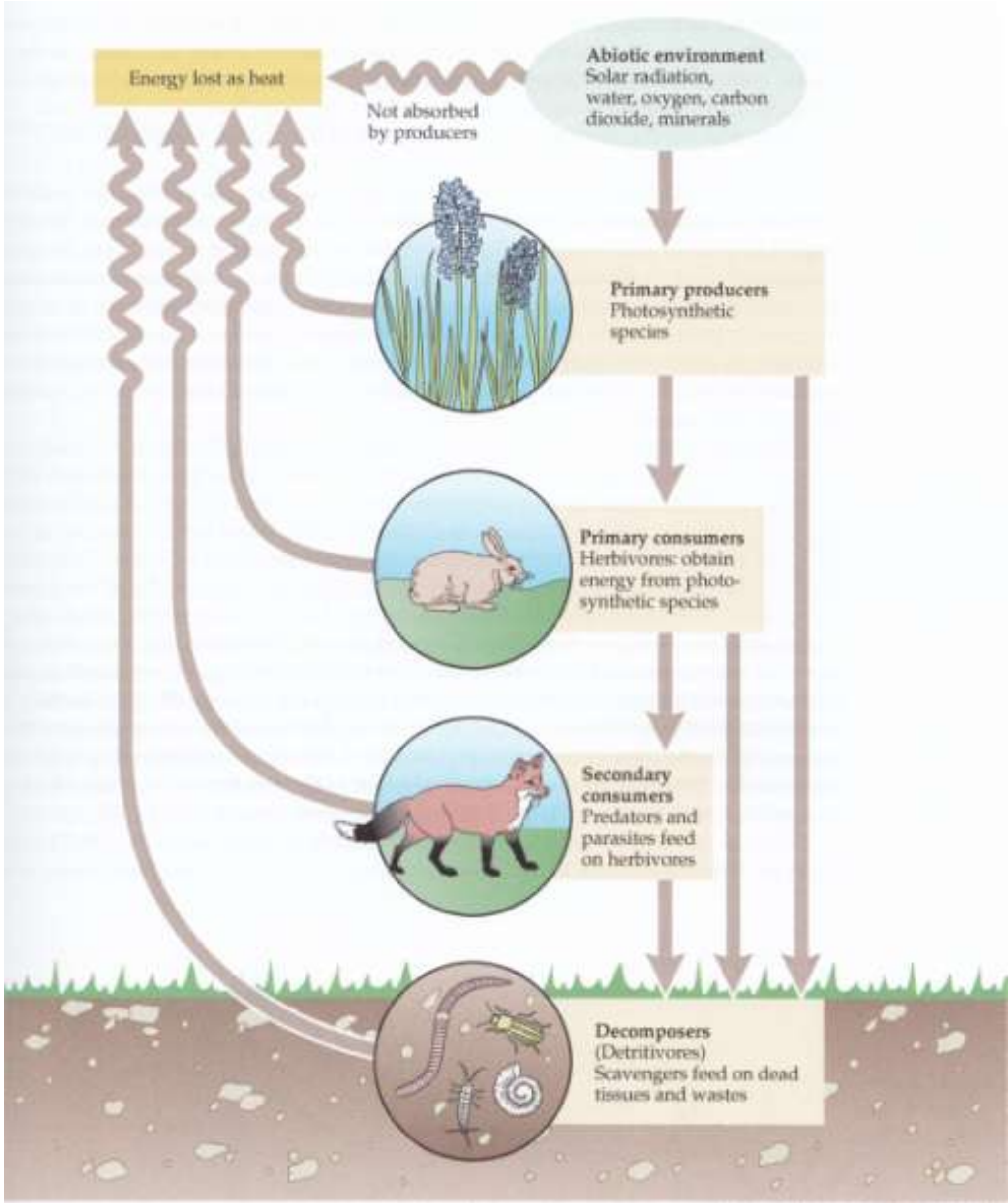
Species	Ni	pi (frequency)	ln pi	pi * ln pi	1/S	ln (1/S)	(1/S) * ln (1/S)
Great tit	20	0.625	-0.470	-0.294	0.143	-1.946	-0.278
Blue tit	5	0.156	-1.856	-0.290	0.143	-1.946	-0.278
Blackbird	3	0.094	-2.367	-0.222	0.143	-1.946	-0.278
Nuthatch	1	0.031	-3.466	-0.108	0.143	-1.946	-0.278
Great spotted woodpecker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

Community ecosystem diversity

- Diversity of functional groups



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



Community ecosystem diversity

- Diversity of habitats
- Diversity of habitat patches

Biodiversity

The importance of species varies in the nature

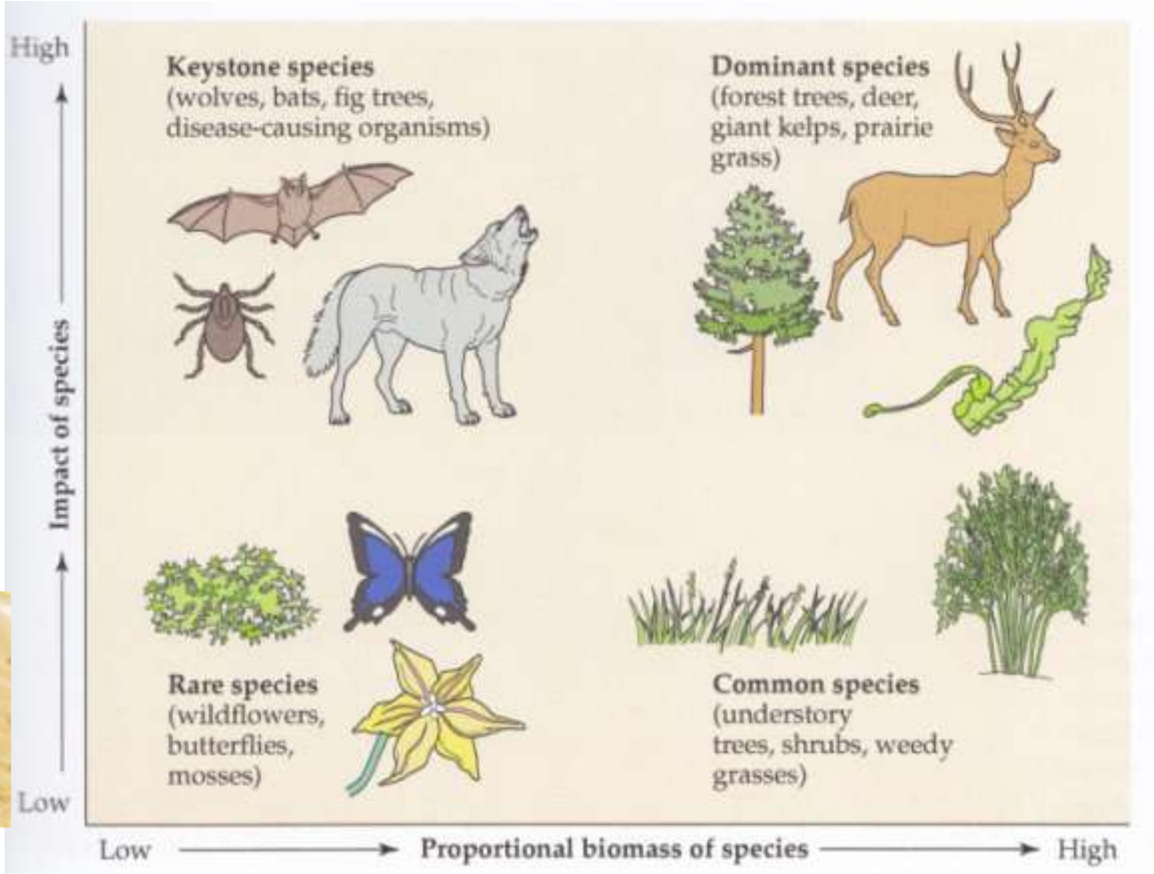
Naturalness – rarity - threateness

Keystone species

- Top predators– e.g. wolf

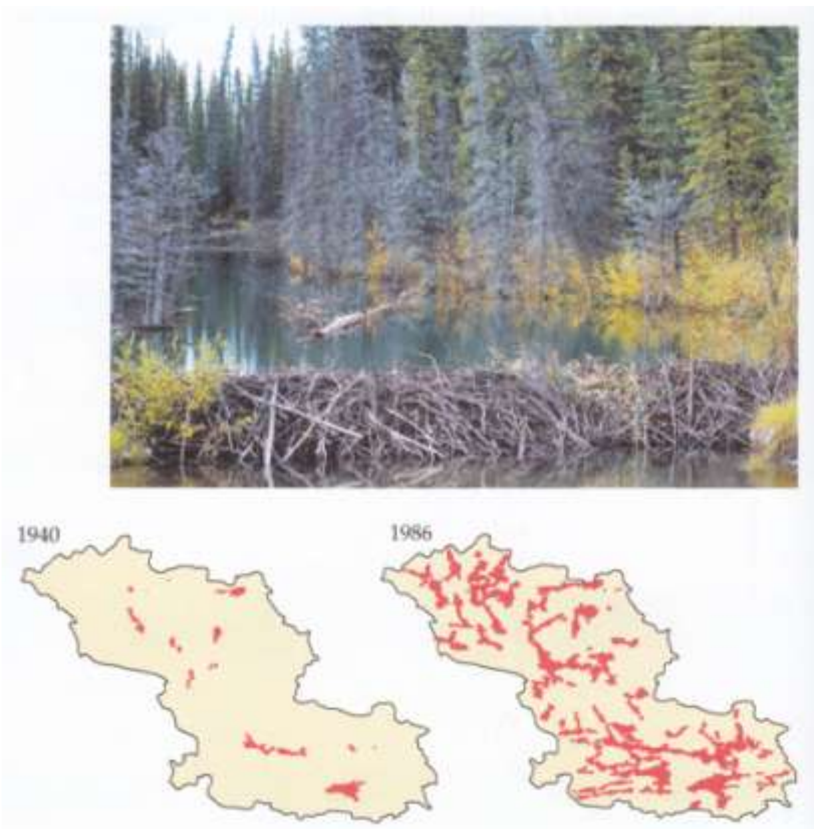
- Flying foxes

- Ecosystem engineers – beaver, elephant, dung beetles



Ecosystem engineers

- Beavers



Ecosystem engineers

- Elephant

Keystone Resources

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

Indicators

- Flagship species (Panda, Californian Condor)

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

- Umbrella species (e.g. Grizzly Bears)

02.11

Where is the World's Biodiversity found

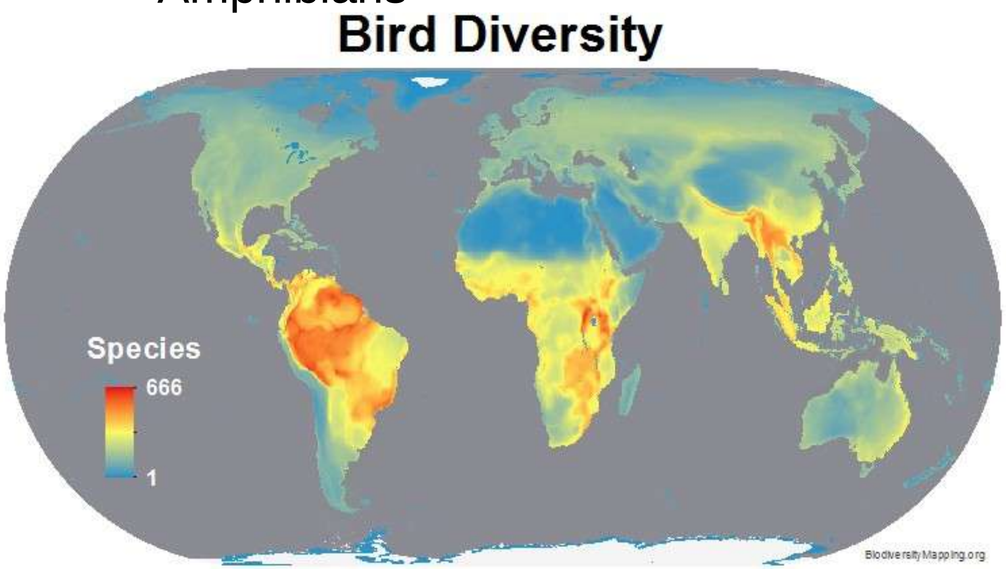
Biological diversity in the Earth

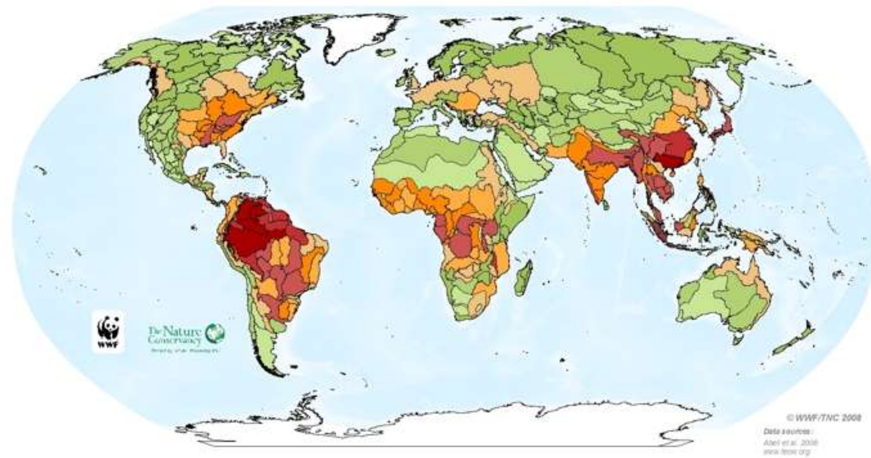
Bird

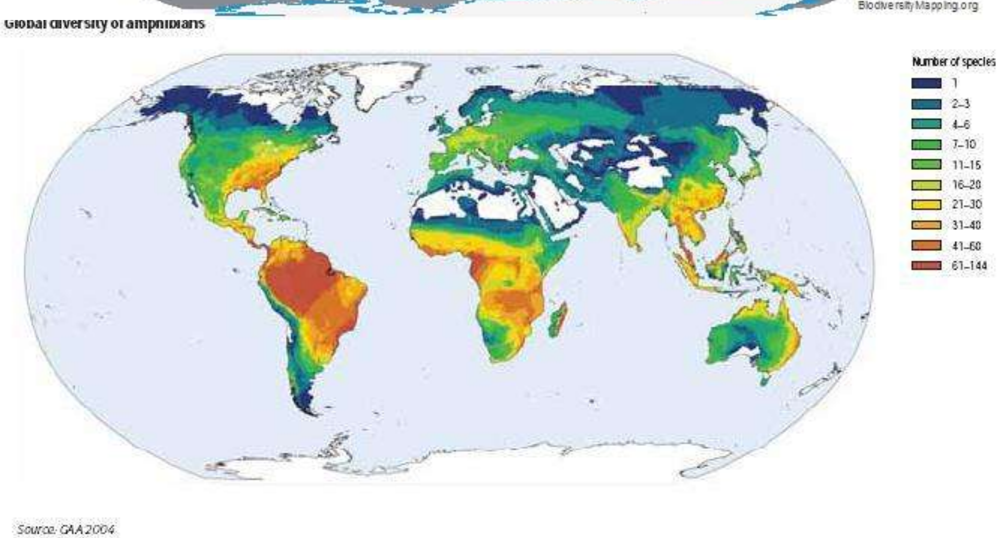
Fish

Amphibians

Vascular Plants







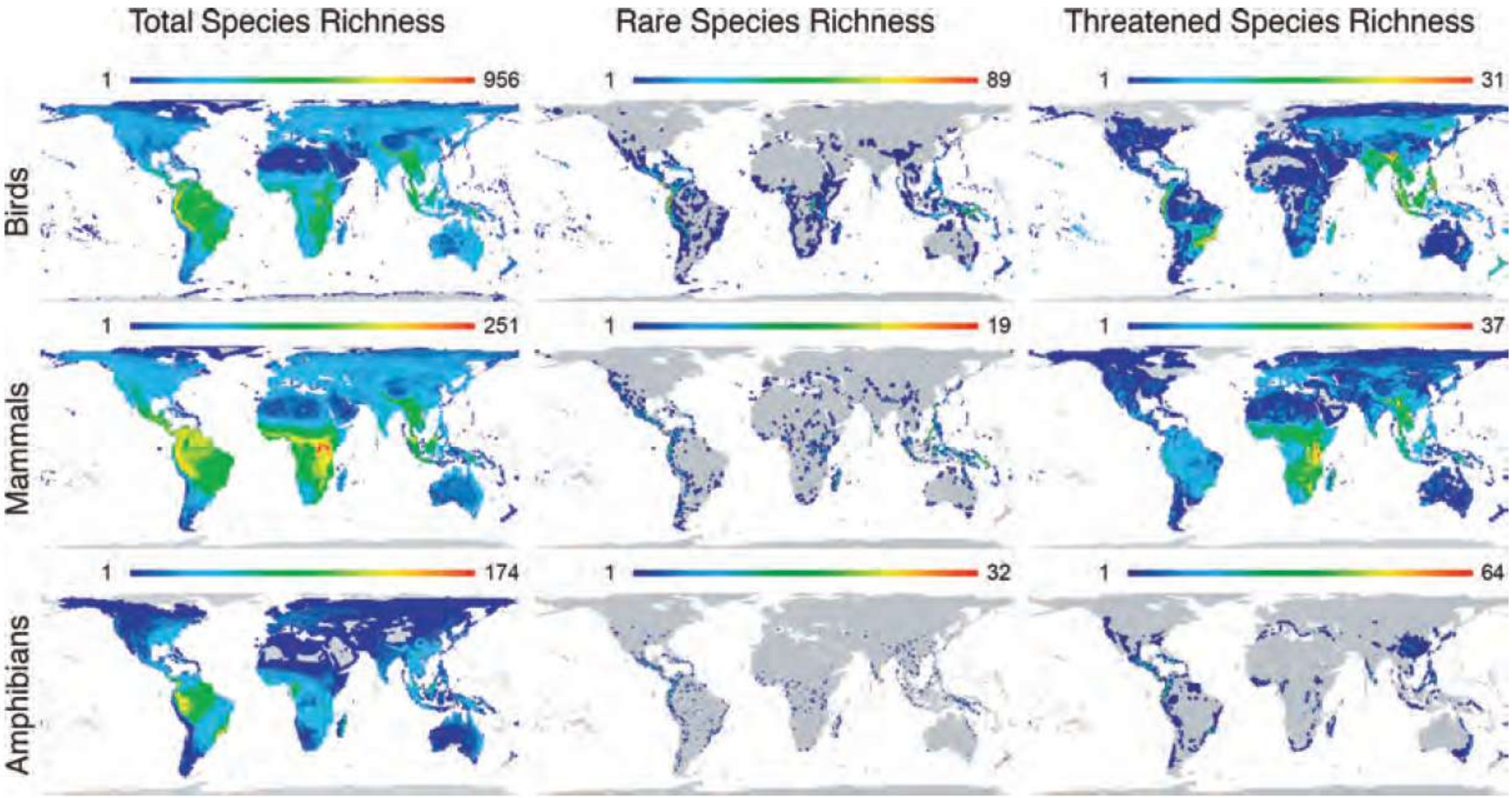
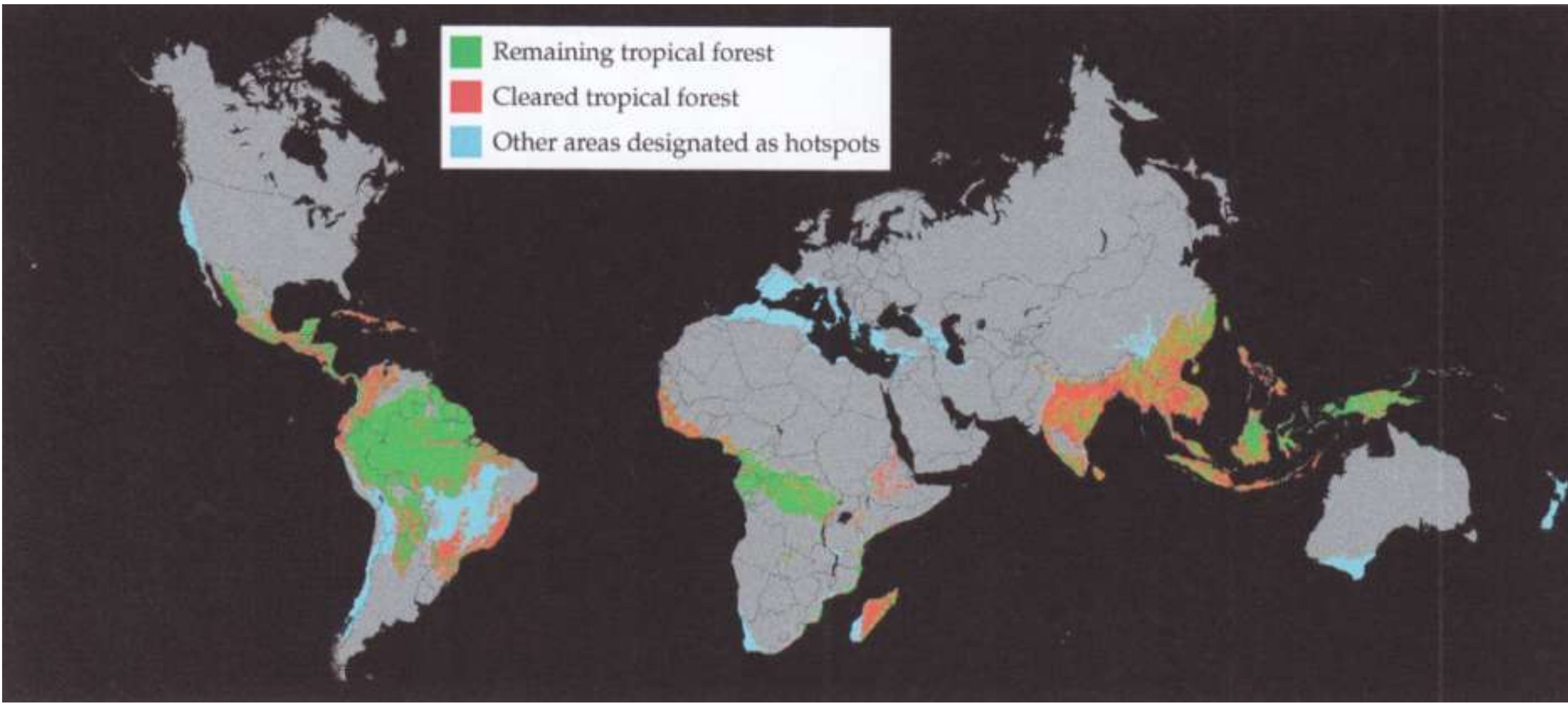


Figure 2.4 Global species richness patterns of birds, mammals, and amphibians, for total, rare (those in the lower quartile of range size for each group) and threatened (according to the IUCN criteria) species. Reprinted from Grenyer *et al.* (2006).

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

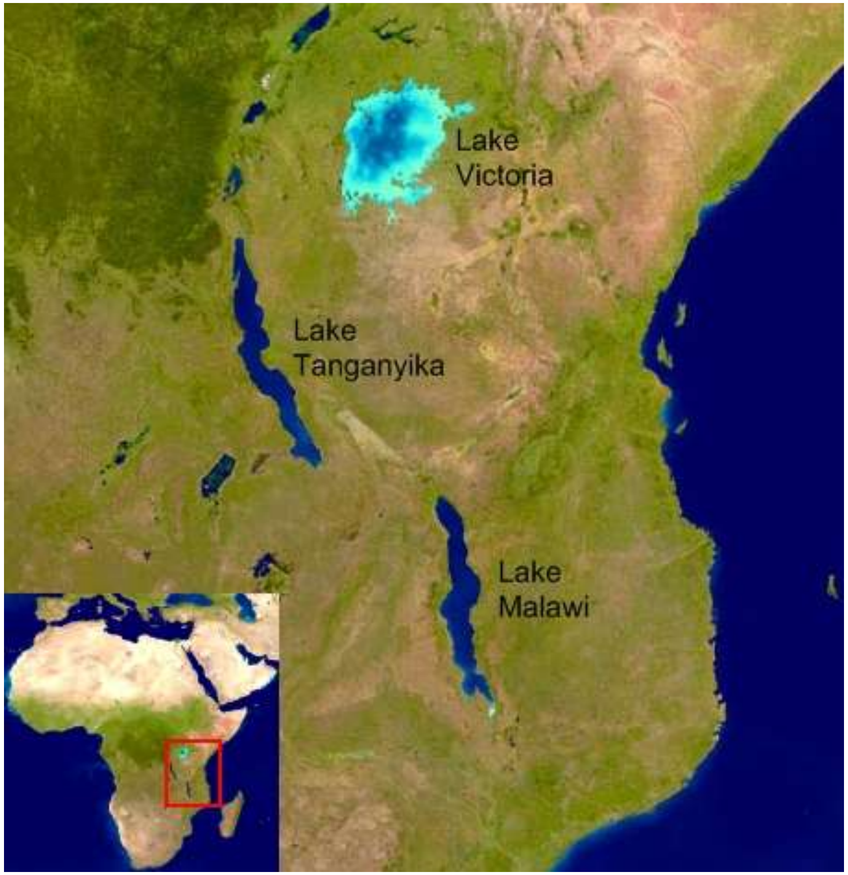
Biological diversity in the Earth

The most diverse areas:
- Coral reefs

Biological diversity in the Earth

The most diverse areas:

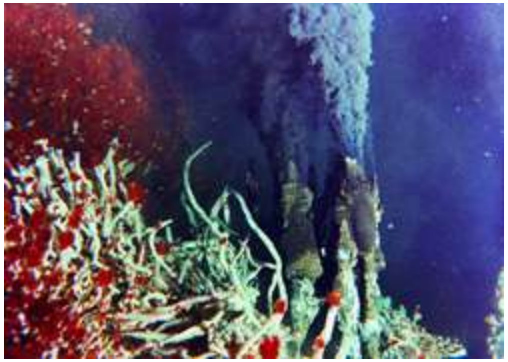
- Large tropical lakes, fast evolutionary radiation of fish and other species

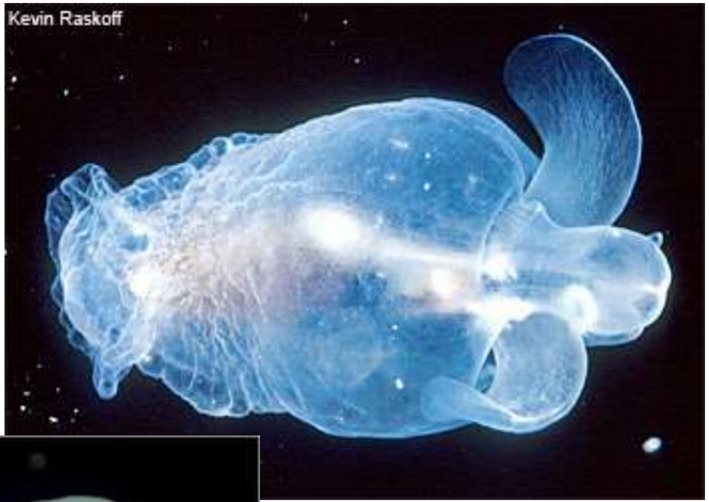


Biological diversity in the Earth

The most diverse areas:

- Deep seas, large and stable environment





Biological diversity in the Earth

The most diverse areas:

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

Biological diversity in the Earth

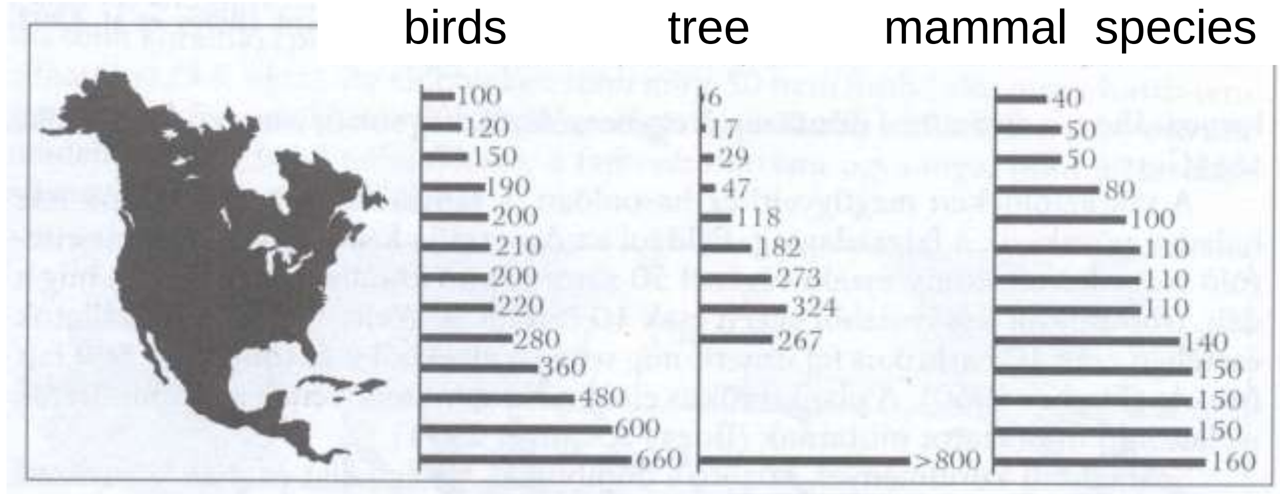
Information on the base of zoologist, botanist

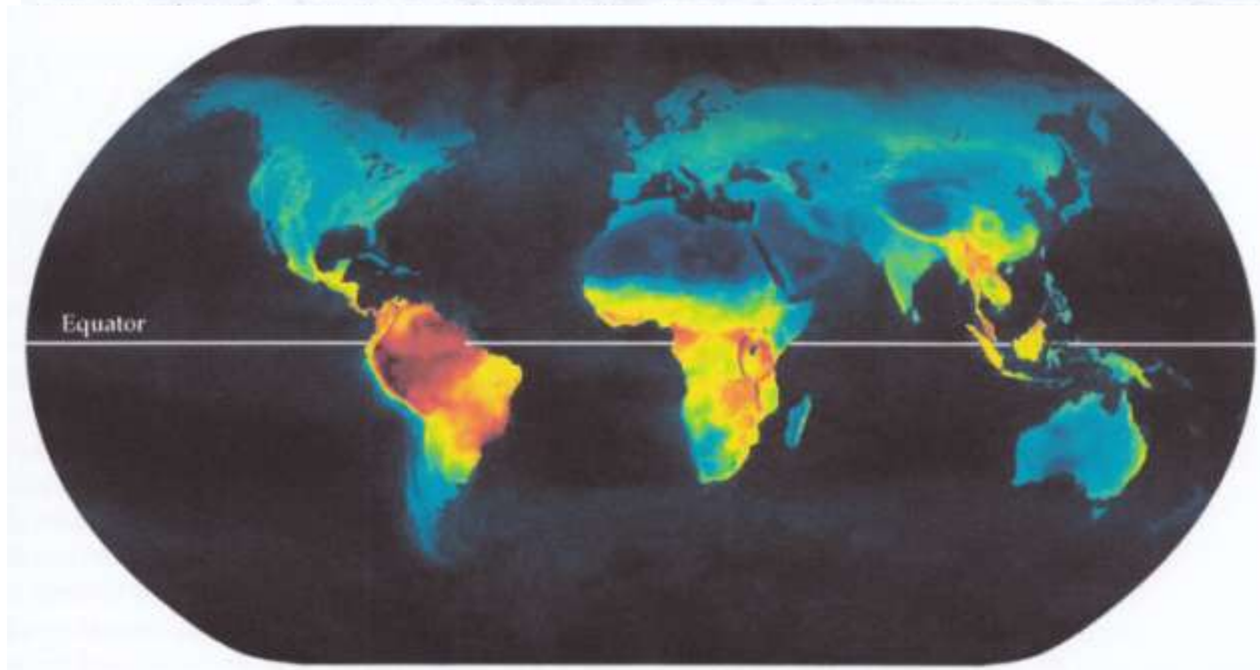
Still limited information

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

Biological diversity in the Earth

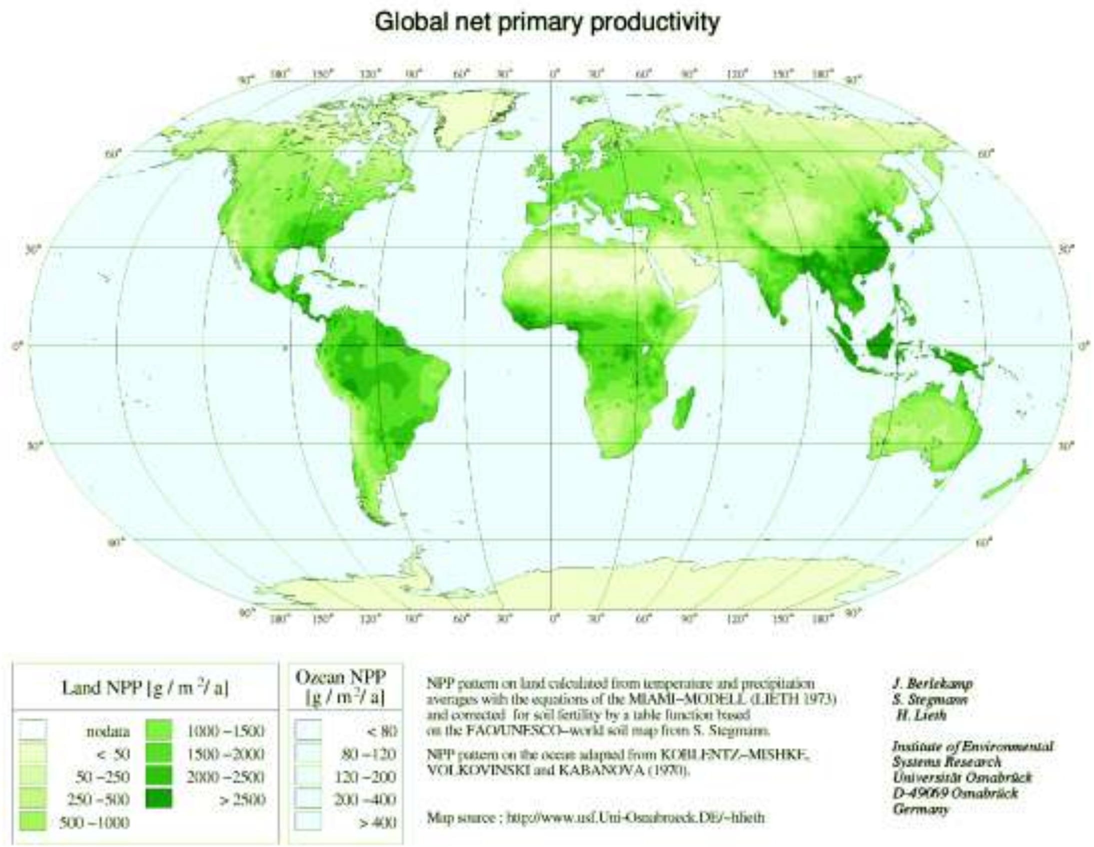
Species diversity increasing toward the equator





Why are there so many species in the tropics?

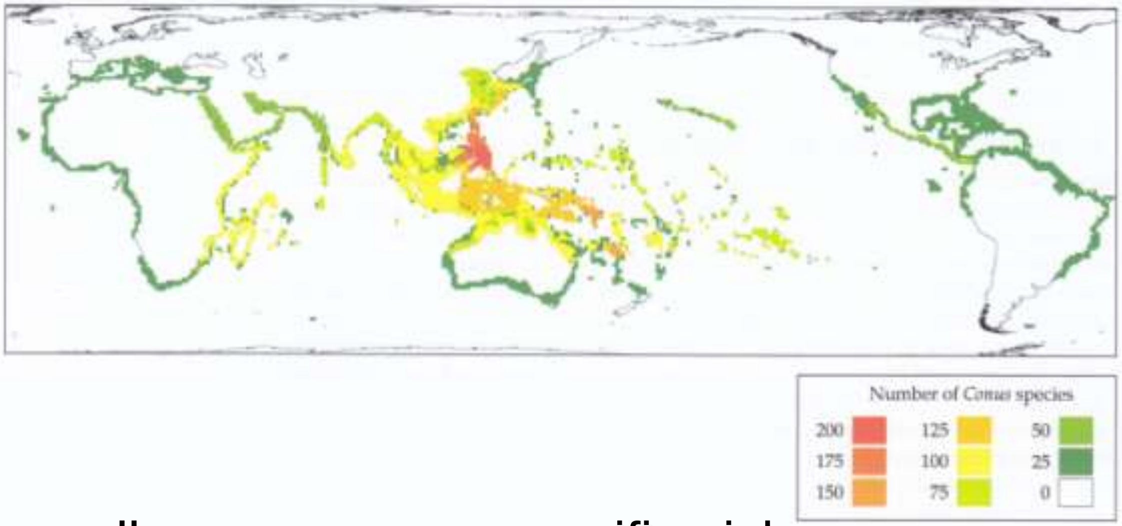
- High level of primary production



Why there is the largest biodiversity in the tropical areas?

- High level of primary production

- More time for speciation



- Rapoport-rule – species with smaller areas, more specific niche

- More stable climate than temperate regions – proper for speciation

- Largest effects of parasites and predators

- Low level of self fertilisation

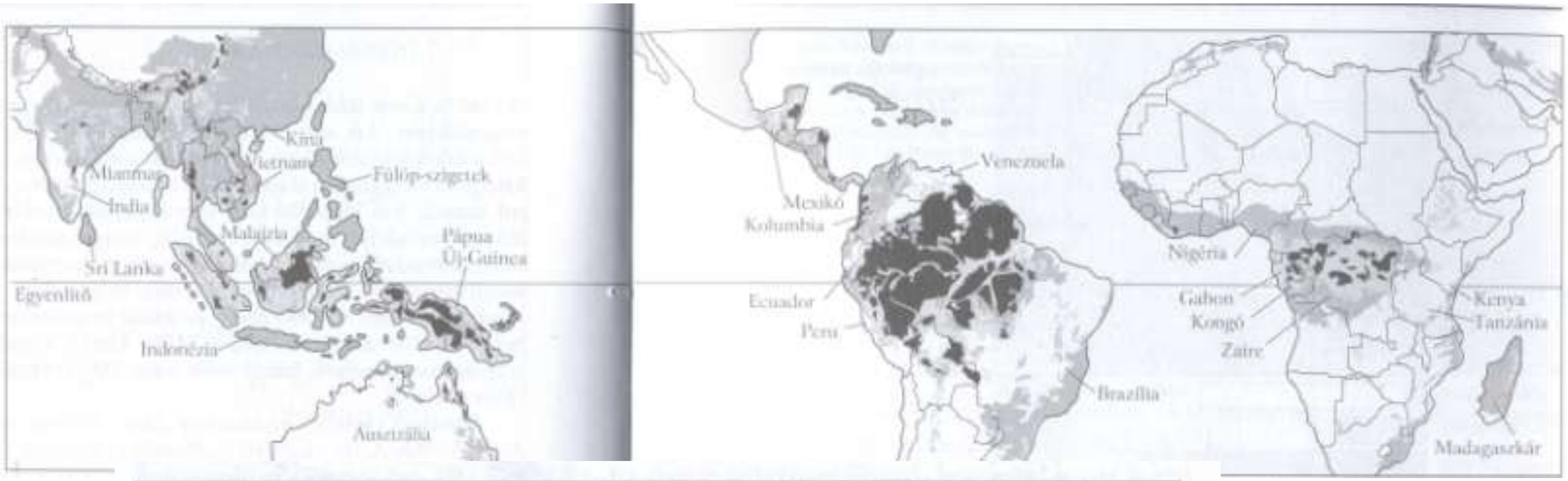
Tropical forests

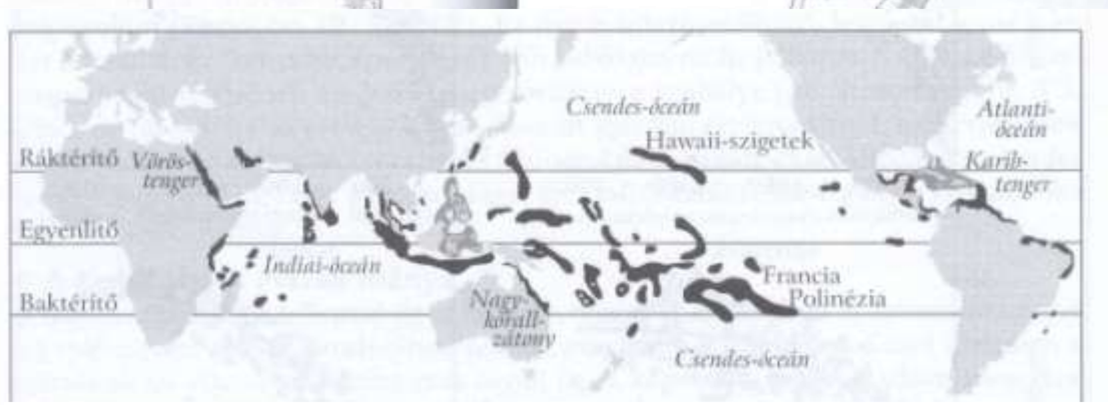
7%-of the Earth, 50% of known species. In the case of insects 90%, plants 66%, birds 30%. In tropical islands, 78% of non marine bird species

Coral reefs

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

Important regions with tropical forests

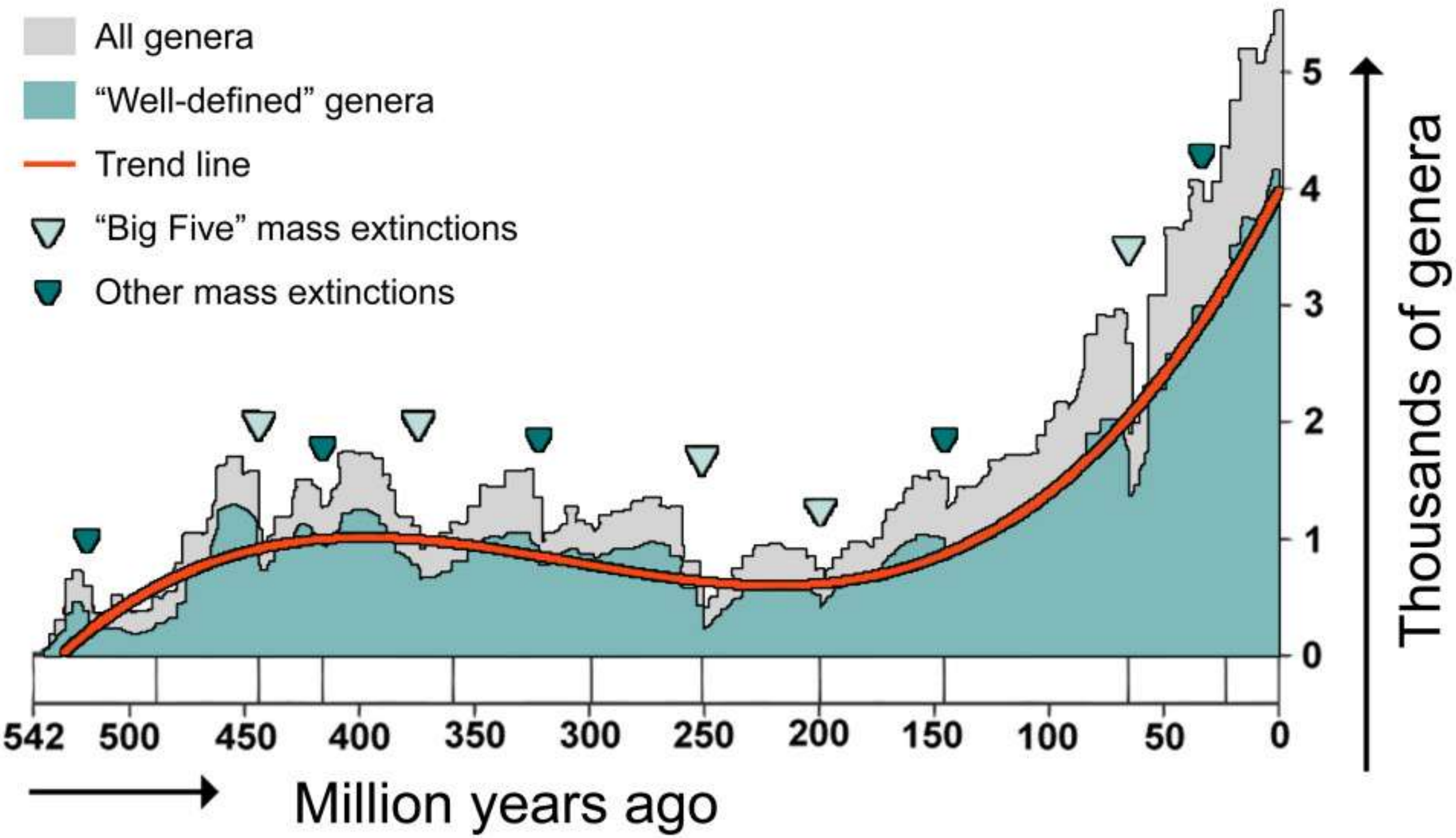




Distribution of coral reefs

How many species live in the Earth?

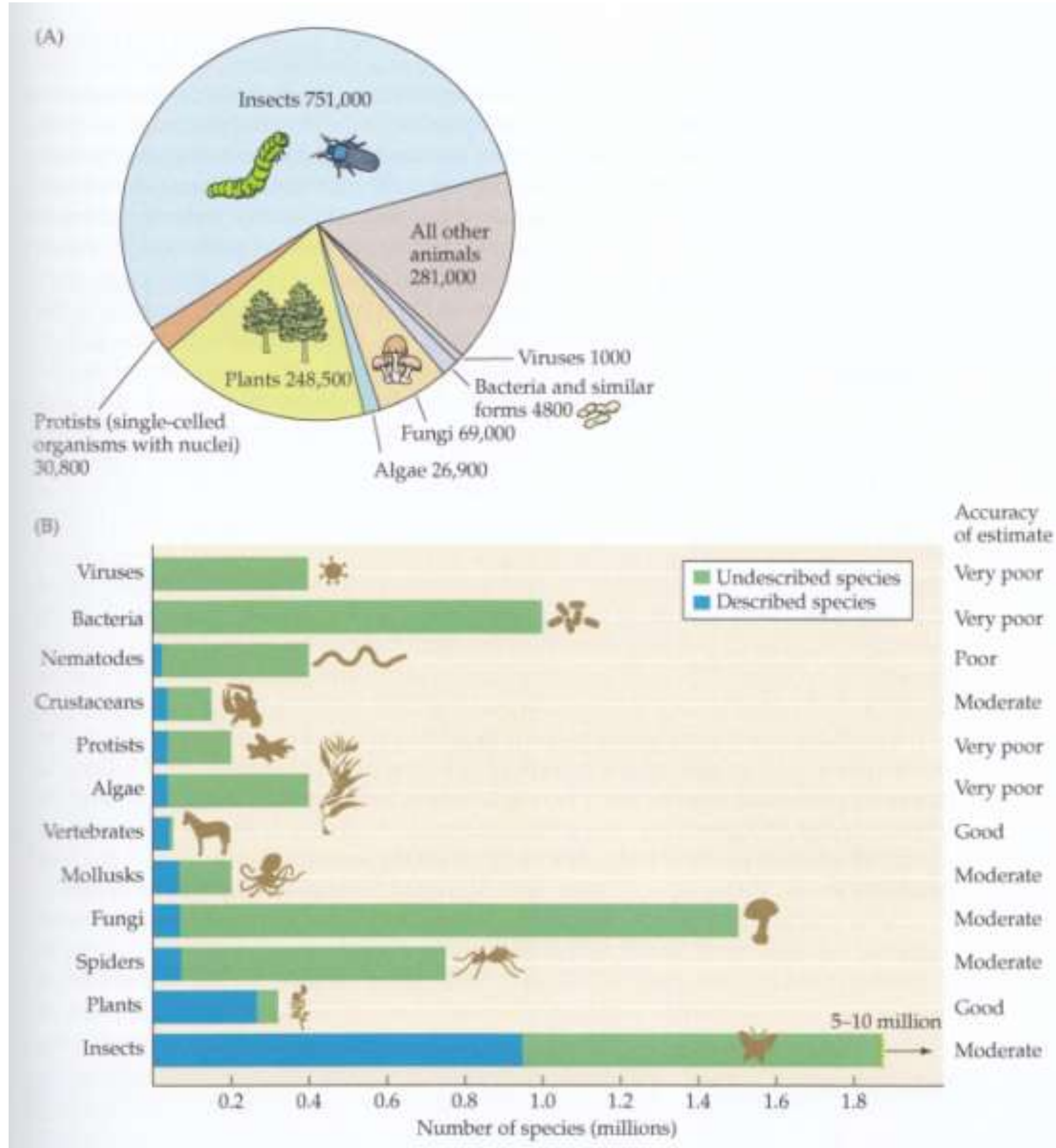
The most species lived until the spread of the human population



How many species live in the Earth?

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

The most species are not known for the science



How many species live in the Earth?

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

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

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

- We only can estimate the number of species:

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

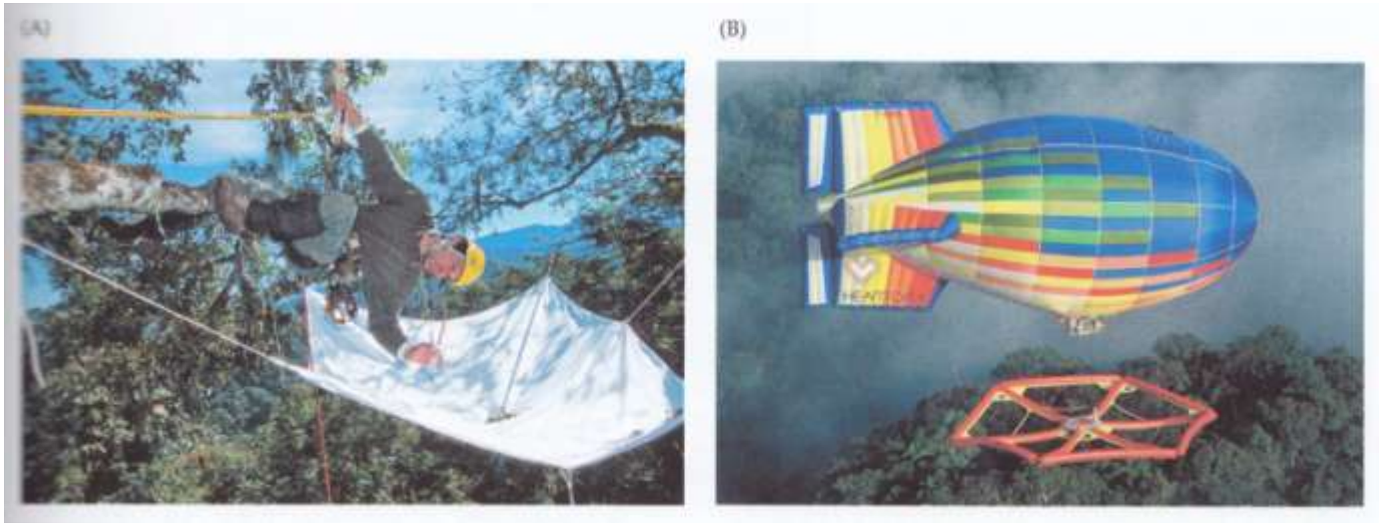
In Europe, there are 6 times more fungi species than plant species, in the case of 270 000 plant species of the Earth it could be 1.7 million fungi species

The number of virus, 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
- Soil investigation in deep level



Problem of knowing species

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

Valuing Biodiversity. Ecosystem functions and services

Valuing Biodiversity

How much does protection cost?

How much is biodiversity worth?

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

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

Ecological Economics

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

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

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

The Tragedy of the Commons

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

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

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

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

Every farmer benefits from adding another cow to the pasture.

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

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

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

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

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

The Tragedy of the Commons

Solution (?!)

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

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

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

Cost-Benefit Analysis

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

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

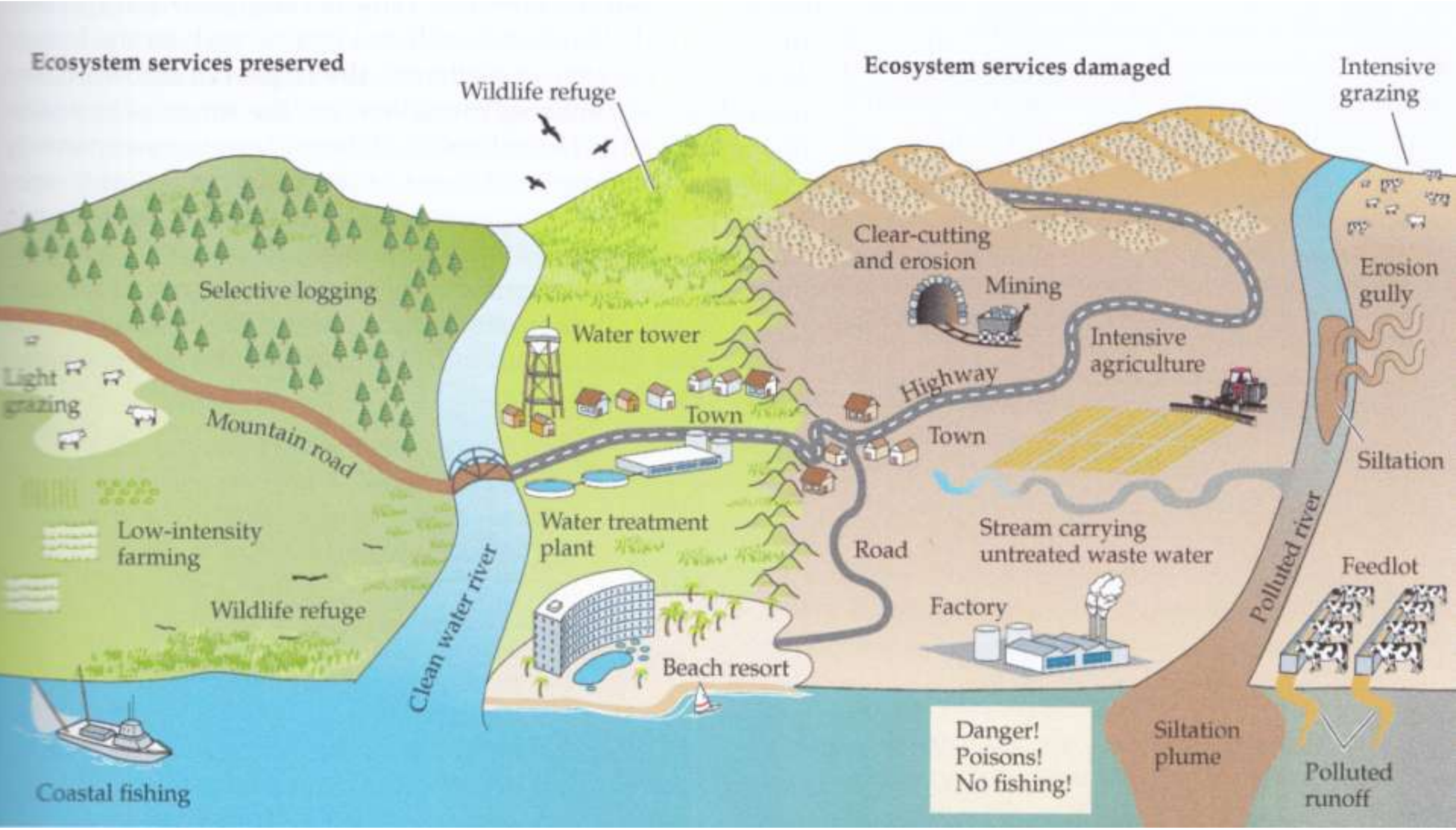
Source: Hodgson and Dixon 1988.

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

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

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

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



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

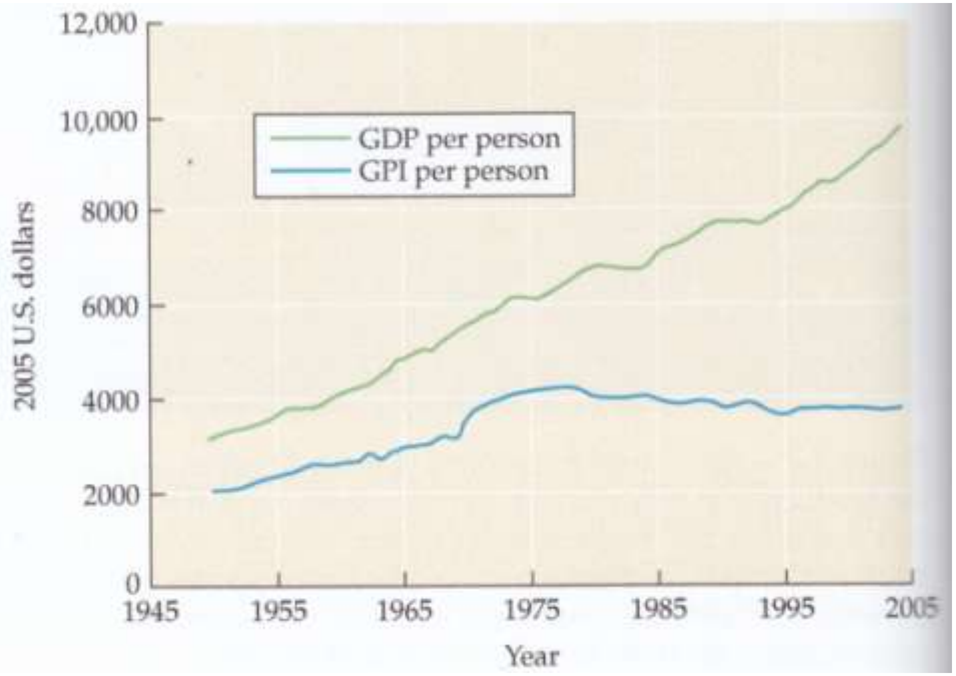
Exxon Valdez disaster, 1989: 42 million liters of oil spilled.Billions spent on cleanup – GDP increased, but the environmental damage is unknown.-
https://www.youtube.com/watch?v=CVm1pB3iJOw
https://www.youtube.com/watch?v=UsBYe68PH

Natural Resource and Wealth of Societes

ISEW – Index of Sustainable Economic Welfare

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

GPI – Genuie Progress Indicator



Natural Resource and Wealth of Societes

ISEW – Index of Sustainable Economic Welfare

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

GPI – Genuie Progress Indicator

Can everything be assigned a value?

How can the value of a beautiful landscape be measured?

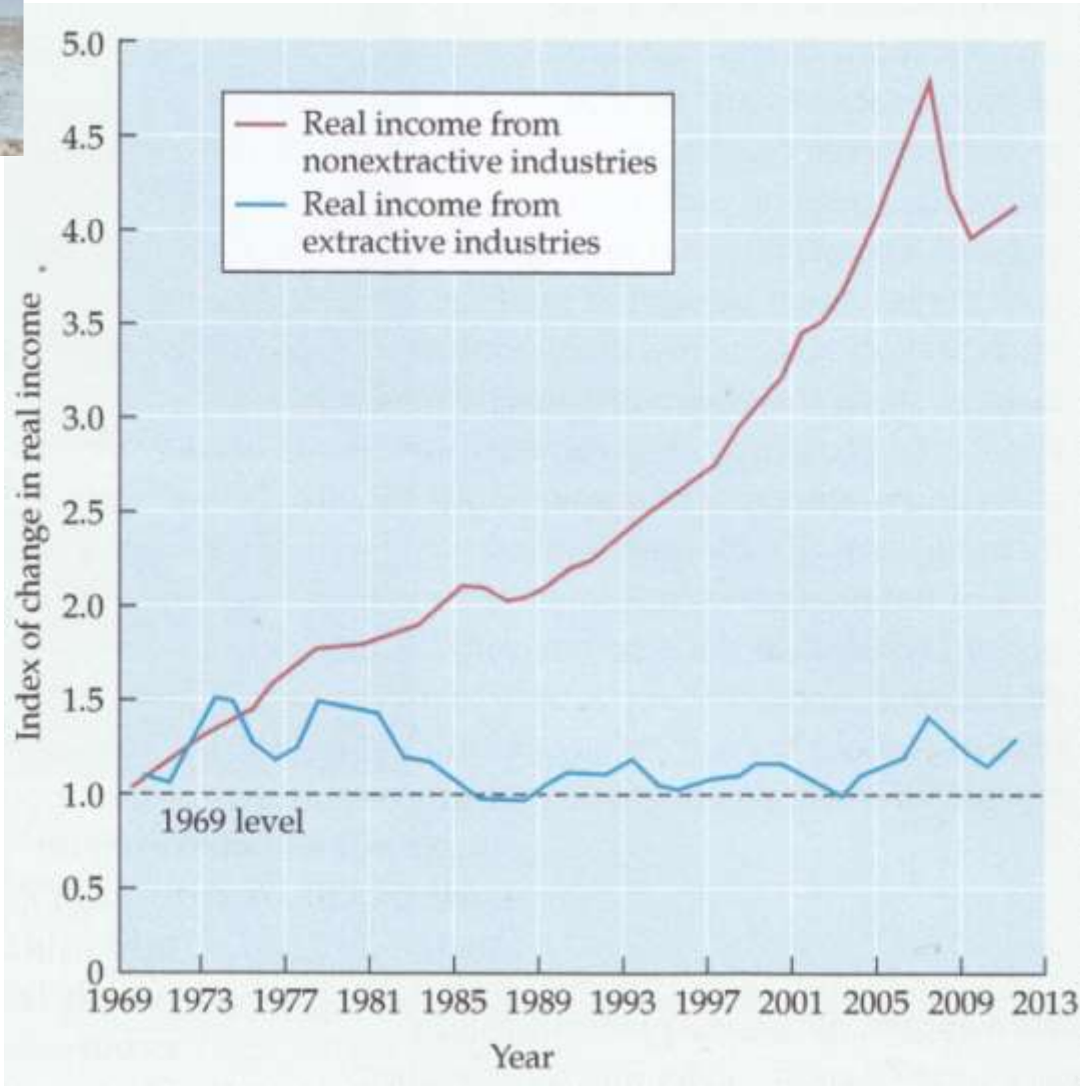
A breeding ground for corruption.

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

Economic values of Natural resources

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

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



How much is a species worth?

A new lily species on a 25-hectare area:

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

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

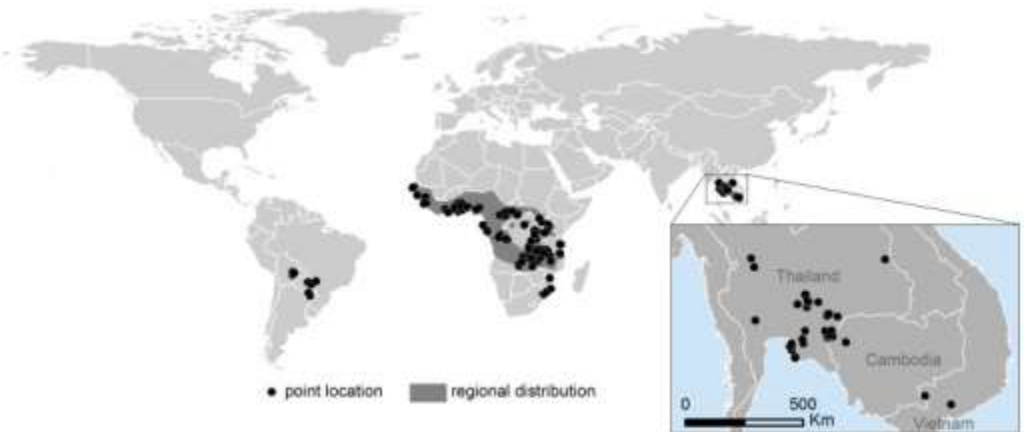
A local gardener would pay for exclusive rights to cultivate 10% of the seeds and sell them over five years. Producer value: $5,000/year -> $25,000/5 years.

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

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

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

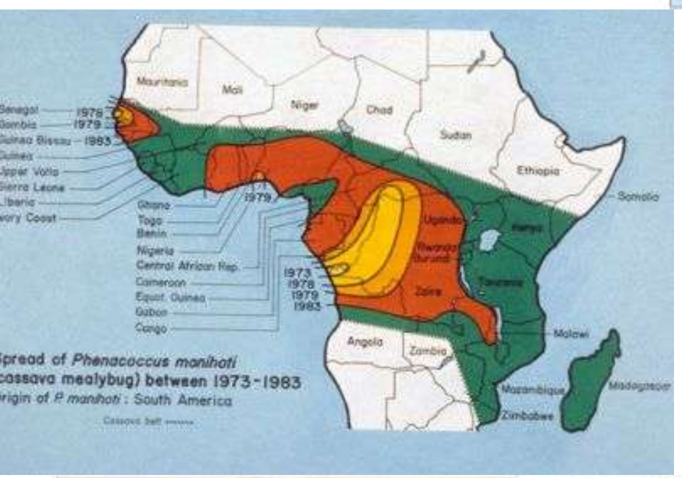
cassava beetle



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.

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

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

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

Breeding animals, 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)

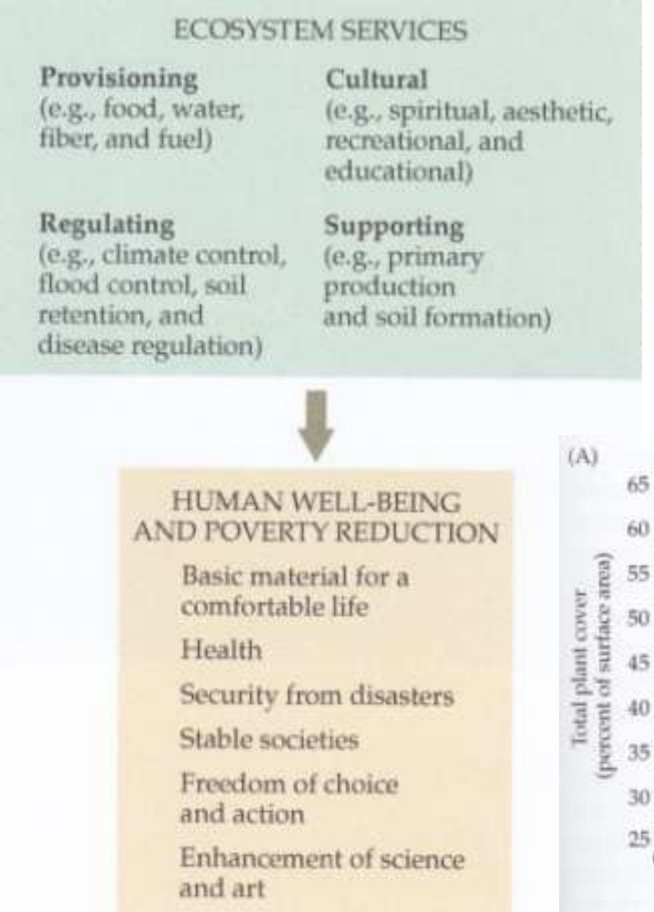
Indirect Use Values – Environmental Processes and Ecosystem Services

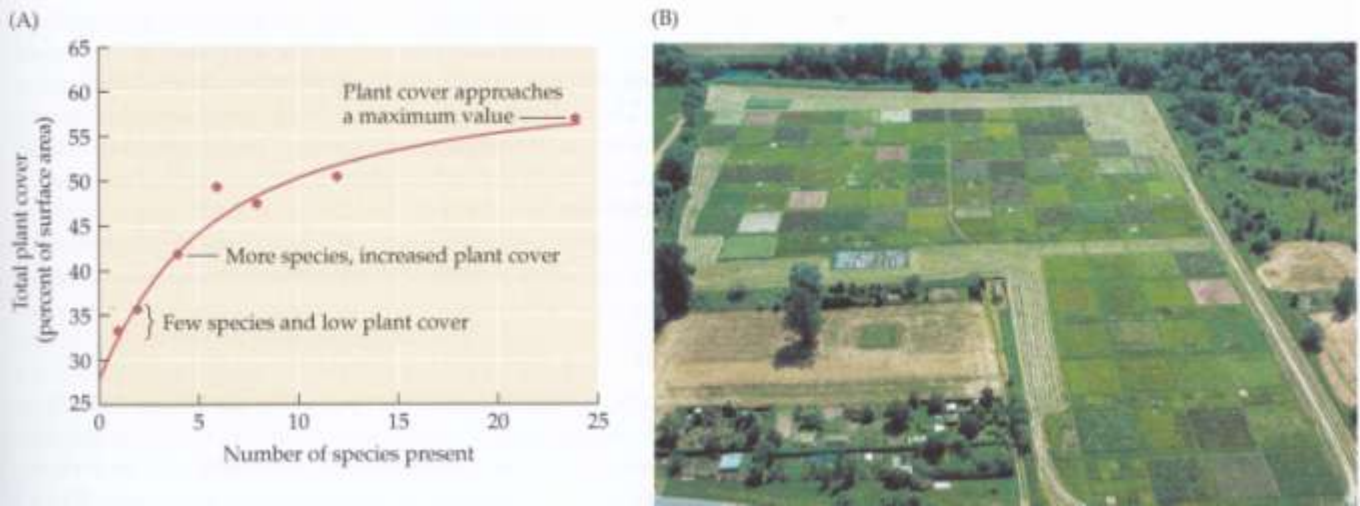
– Public goods – benefits without the need for harvesting

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





Indirect Use Values

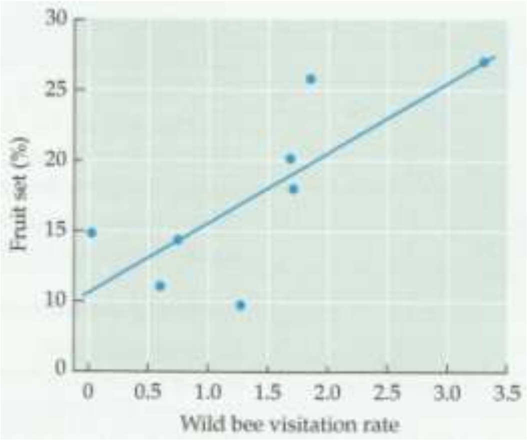
Productivity

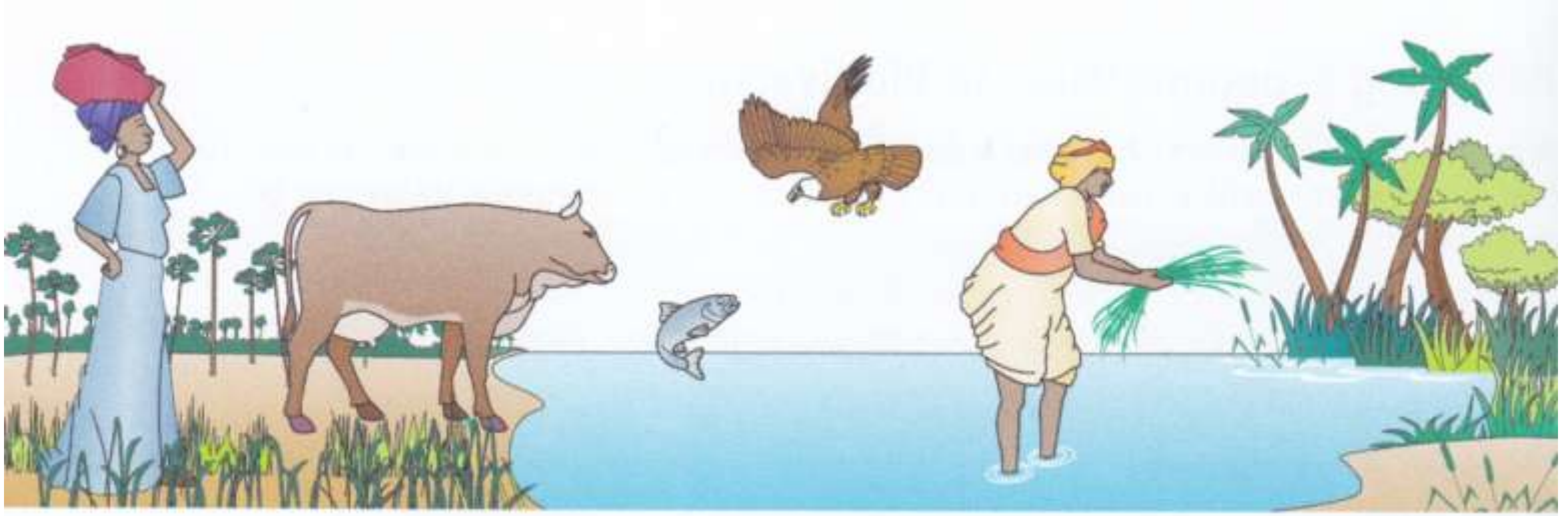
Water and soil protection

Climate

Waste management

Species relationships



- 

Total Economic Value of a Tropical Wetland Ecosystem

Use Values

Direct Use Values
- Fish and meat
- Fuelwood
- Timber and other building materials
- Medicinal plants
- Edible wild fruits and plants
- Animal fodder

Indirect Use Values
- Flood control
- Soil fertility
- Pollution control
- Drinking water
- Recreation and tourism (e.g., bird watching)
- Education
- Biological services (pest control, pollination)

Option Value
- Future products:
  - Medicines
  - Genetic resources
  - Biological insights
  - Food sources
  - Building supplies
  - Water supplies

Non-Use Value

Existence Value
- Protection of biodiversity
- Maintaining culture of local people
- Continuing ecological and evolutionary process

Indirect Use Values

Amenity value – recreational services for human

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

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

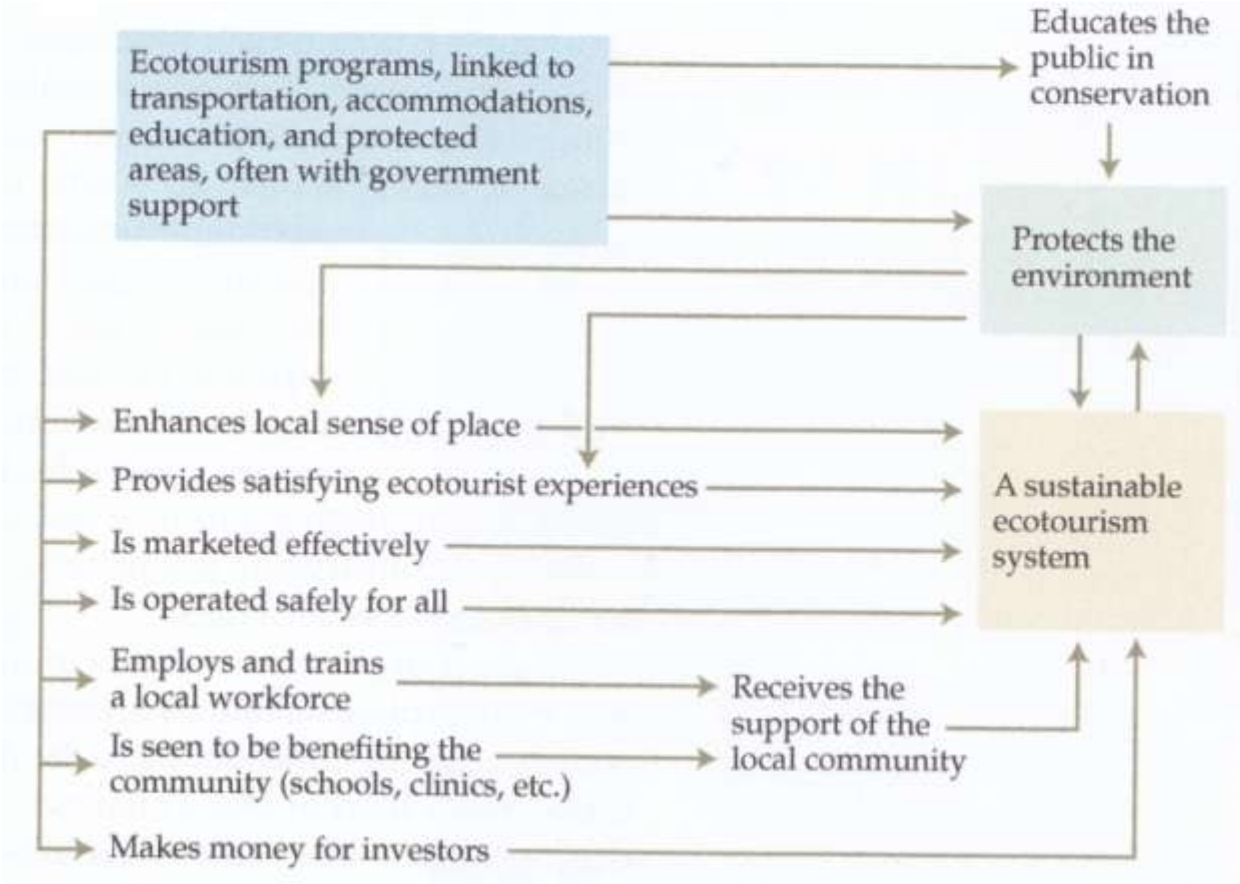
Consumptive uses	Low-consumptive uses	Nonconsumptive uses
Commercial hunting, sport hunting, and subsistence hunting	Zoos	Bird watching
Commercial fishing, sportfishing, and subsistence fishing	Animal parks	Whale watching
Fur trapping	Aquariums	Photography trips
Hunting for animal parts and pet trade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

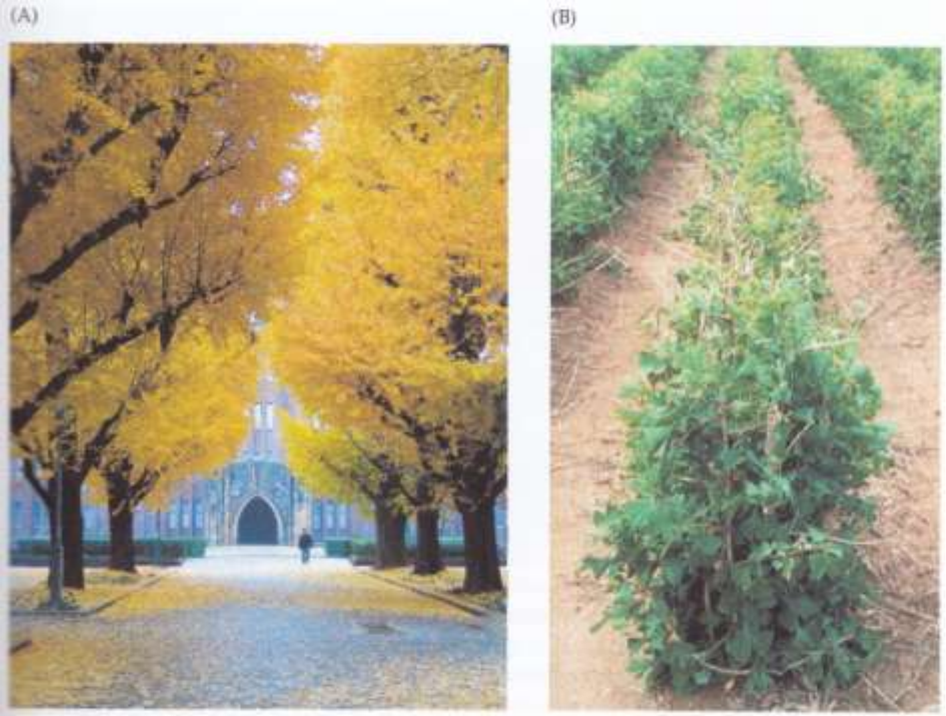
Indirect Use Values

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

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

Control of the influence of ecotourism is essential!

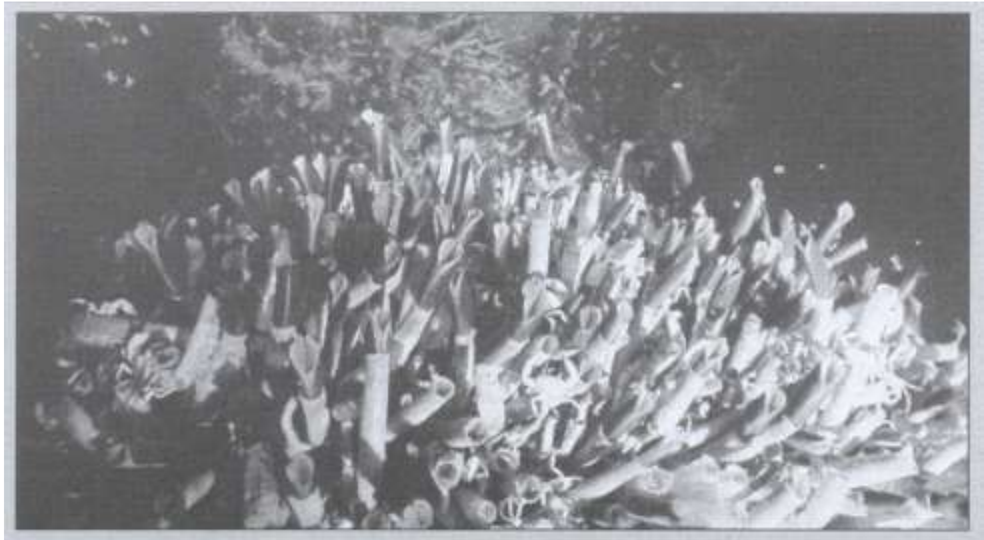




Potential Values

- Medicine, yew tree – cancer, ginkgo – circulation

The enzyme crucial for the PCR method, used in DNA based researches, was extracted from bacteria living in Yellowstone's hot springs.



Existence Values

How much people would pay to preserve it

USA: $2.3 billion annually to conservation organizations

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

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

4.12. ábra. A legtöbb ember számára egy másik faj egyedével való találkozás új tapasztalatot adó, felemelő élmény (Fotó: Scott Kraus, New England Aquarium)
A képen látható emberek egy halászhálóban fennakadt bálnát „üdvözölnek". A hálóhoz rögzített bója tette lehetővé, hogy kiszabadításáig a 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

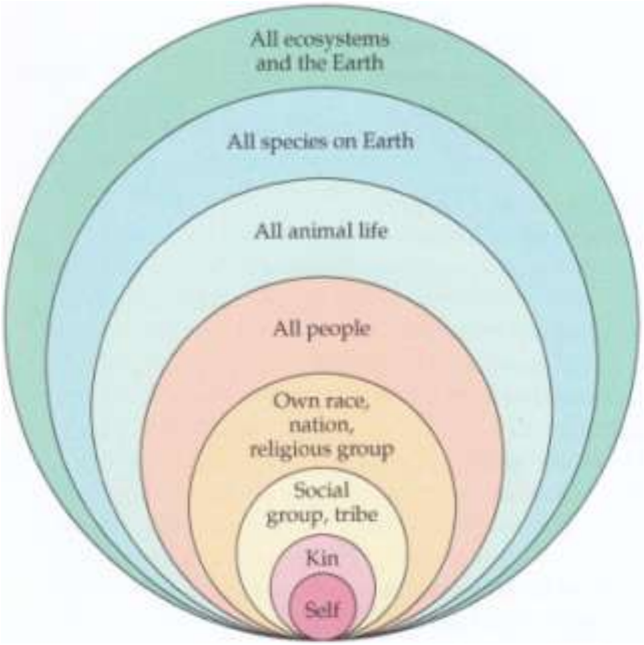
All species are interdependent

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