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BIODIVERSITY CONSERVATION

BY

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Biodiversity consists of abundance of living entities on Earth, genes carried by these, and complexity of ecosystems they form. Biodiversity conservation studies species and habitats endangered by human activities, priority having *key species* whose extinction leads to extinction of many species in the area. Conservation efforts will be focused on rescue of species threatened with extinction, proper administration of actual protected areas and establishment of new protected areas.

Introduction

Biodiversity represents the variety and variability of living organisms in ecological complexes in which they occur. There are: ecological diversity, referring to species number in a given area; genetic diversity and cultural (human populations).

Biodiversity conservation is a synthetic discipline (taxonomy, ecology, biogeography, environmental geography, genetics and population biology) aiming at natural world protection and management [3]. Ecological economy studies biodiversity's economical value. It is a crisis discipline at the same time, founded as scientific domain because none of the traditional disciplines was not enough comprehensive to decipher and at the same time reduce dangers addressed to biodiversity.

Study object

Biodiversity conservation studies species and habitats endangered by human activities but also efficiency of active protection measures, priority having *key species*, whose extinction (or significance decrease) leads to extinction of many species in the area (extinctions „in cascade"). On the other hand, reintroduction of key species does not compulsory lead to reinstallation of initial conditions.

There is a complex of factors that threaten species and habitats so studies have a social, economic, politic, and ethic character. Because of the risk that argument of immediate benefits related to economical development to lead to nature and traditional culture destruction, conservationists' actions are not only scientific but also politic and educational, by collaboration with governmental and local decision factors and with local communities.

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Traditional societies considered environmental hazards (fires, floods, earthquakes) as results of action against Gods' wish. Religions: Tao, Shinto, Hindu and Buddhist value and protect natural areas for their capacity to produce intense spiritual experiences. European colonists educated in Bible (Genesis) spirit as well as adepts of other monotheist religions savagely exploited the nature, considering uncultivated areas as haunted by bad spirits. Colonies administrators (e.g. Mauritius, Tobago, India) made connection between clearing and erosion, respectively drought/drying and famine.

World Wildlife Fund (1989) defined biodiversity as „abundance of living entities on Earth, genes carried by these, complexity of ecosystems they form". Biodiversity is characterized on 3 levels:

- specific/biological diversity (bacteria, protozoa, fungi, plants and animals);
- genetic diversity (genetic variation of species, populations, and individuals;
- ecosystem diversity.

Biological diversity is the result of two processes: speciation and extinction. Global biodiversity increased in geological time. Local biodiversity may increase by immigration and decrease by emigration. Biodiversity (species richness) is assessed at local (Tab. 1), regional and global scale. How many species exist? Circa 1.8 millions species were scientifically described among which: 56% insects, 14% plants, 3% vertebrates; 15% of all live in the ocean.

Table 1. Biological diversity hosted by forest ecosystems in Romania (source ICAS, 2002)

Taxonomic units	Number of species pointed out		
	in Romania	in forest ecosystems	in virgin and quasi virgin forests
superior plants	3567	1251	*x*
trees	58	58	27-51
shrubs	118	118	31-84
forest grasses	1075	1075	*x*
mammals	102	43	36
birds	387	over 250	over 156
reptiles	30	15	13
batrachians	20	16	15
freshwater fish	91	21	13

Extinctions

Extinction = death of a group of organisms due to a rapid environmental change (disequilibrium in habitat, new species introduction, excessive hunting, food species extinction). Five "mass" extinctions occurred in geological time. Actual extinction rate

(the 6th "mass extinction") is 100-1000 times higher than in the past and is exclusively anthropogenic.

Extinction causes are:

- natural: climate and habitat modification, predation/competition from behalf of invasive/exotic species, diseases due to micro parasites (viruses, bacteria, fungi, protozoa) or macro parasites (helminths, arthropods);
- anthropogenic: habitat destruction, fragmentation, and degradation, pollution, climate global change, overexploitation (excessive hunting/harvesting), that lead to „phantom" habitats (e.g. "empty forests" in western Europe), predators/competitors introduced by man;
- synergic: acid rain, clearing, poaching.

Extinction types are:

- global when the species is not found on the globe anymore;
- local when the species does not appear in wildness in the old area;
- in wildness when the species is met only in captivity;
- ecologic when few individuals still exist but the species lost the role in community.

Mass extinctions are catastrophic events that killed more than 60% of total species existent on Earth. 95% of world total species are extinct, 90% by natural causes (climate changes, asteroids).

E.g. aurochs (*Bos primigenius*) became extinct in Europe in 1627 (Tab. 2), bird dodo (*Raphus cucullatus*) from Mauritius in 1680. 23 species were lost in Australia (40 species in the world) in the last 200 years. At present one species becomes extinct per year. Extinction normal rate is several species per year. 2-10 species are annually lost due to other causes than natural (volcanic eruptions, floods, violent climate changes at local level).

Rates of extinction were estimated as:

- 1 million species between 1975-2000 (Fig. 1);
- 1-11% of the species become extinct each decade (10 years);
- 50% of the total Earth species in the 21st century.

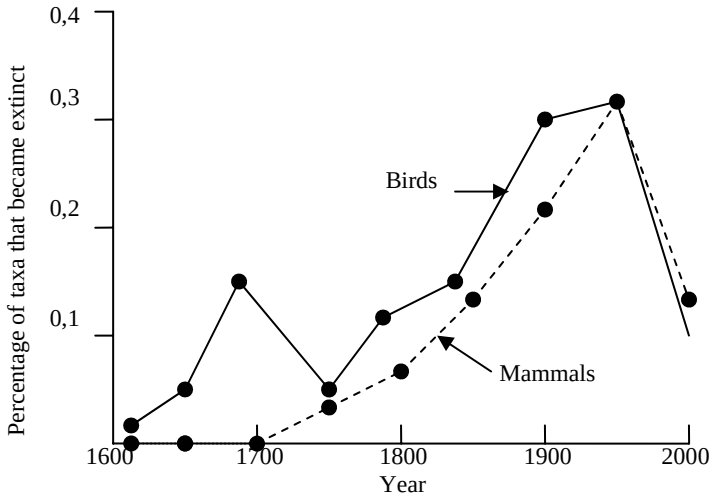

Fig. 1. Extinction rates for mammals and birds (Smith et al., 1993)

Table 2. Species of mammals and birds extinct in Romanian fauna (Drugescu, 1994 and Zoocinegetical Encyclopedia, 1996)

Species	Extinction period	Observations
aurochs (*Bos taurus primigenius*)	centuries XV-XVI	
forest horse (*Equus cabalus silvaticus*)	after 1700	
steppe marmot (*Marmota bobac*)	1800	
Saiga antelope (*Saiga tatarica*)	1800	
elk (*Alces alces*)	1813-1850	reappeared after 1960
ure ox (*Bison bonasus bonasus*)	1762	reintroduced in some reserves
alpine partridge (*Lagopus mutus*)	1884	
alpine marmot (*Arctomys marmota*)	1890-1900	reintroduced in some mountains
rock partridge *Alectoris graeca saxatilis*)	1920	
beaver (*Castor fiber*)	1824	reintroduced in 1998

Species	Extinction period	Observations
lammergeyer (*Gypaetus barbatus aureus*)	1934	
black/brown bald vulture (*Aegypius monachus*)	1960	
grey bald vulture (*Gyps fulvus fulvus*)	1960	
small vulture (*Neophron percnopterus*)	1980	

IUCN established (1996) 10 categories of population conservation:
- extinct
- vanished in wildness
- in imminent danger
- in peril
- vulnerable
- dependent on conservation
- nearly threatened
- insufficiently known
- with incomplete data
- unevaluated.

Categories 2, 3 and 4 are considered threatened with extinction [9].

Protection by population conservation

The 4th Wild Areas World Congress occurred in 1987. Many national parks were created in order to protect *charismatic mega fauna* (lions, tigers, bears) – national symbols, elements of tourist interest.

Conservation efforts will be focused on:
- rescue of species threatened with extinction;
- proper administration of actual protected areas;
- establishment of new protected areas.

It is difficult to legally protect a species if there are not certainties on it (see interspecific hybrids). Taxonomists described 10-30% of the world while many species became extinguished before described. More specialized taxonomists should be formed.

A conservation plan requires:
- existence of a large number of individuals of the species in decline;
- possibility of protected areas establishment for habitat protection.

Population minimum size means the smallest population presumed to have good chances to survive in a predictable future. It was estimated (Schaffer, 1981) as 10,000 individuals for invertebrates and 500-5,000 individuals for vertebrates respectively [3]. Small populations are especially threatened due to 3 types of causes:
- genetic (loss of genetic variability, sterility, genetic drift).

Migrations between small populations, even at a low frequency, attenuate genetic drift, minimizing the loss of genetic variability. Endogamy leads to fertility decrease and endogamy crisis. These effects raised serious problems to populations maintained in captivity (zoological gardens, growth centres).
- demographic (fluctuations, birth/mortality rate variation).
Population effective size, meaning the individuals capable of reproduction, must be considered as well. Demographic variation is called demographic stochasticity.
- environmental (predators, competition, diseases, food resources, natural catastrophes such as: fires, floods, drought). Accidental variation of environmental factors (physical, chemical, biological) is called environmental stochasticity.

Population minimum area means the habitat necessary to maintain population minimum size. An area of 10,000-100,000 ha was estimated for small mammals (Schonewald-Cox, 1983) while 980-2420 ha for *grizzly* bears (Noss and Cooperrider, 1994) [3].

A conservation plan takes into account:
- environment (in what habitats/on what surface the species exist);
- distribution;
- biotic interactions (food, competitor species, diseases, predators, parasites);
- physiology (use of food resources, vulnerability);
- demography (population size and stability);
- behaviour (reproductive, intraspecific communication, intraspecific competition/cooperation, survival);
- genetic (genetic determinism of morphological and physiological individual variability).

Effective protection of species rare/threatened depends on understanding their relations with the environment, and knowledge of species status (species natural history/ecology) as well. This is realized by species monitoring (inventories, investigation, demographic studies) as follows:
- repeated inventories show if a population is numerically stable, increasing or decreasing;
- investigation estimates species density in a certain community. By sampling, population size is estimated.
- demographic studies assess growth, reproduction, survival rates.

Monitoring permits knowledge of rare species status. Long term monitoring shows species/population response to environmental changes; allows distinguishing between normal fluctuation and tendencies on long term. Survey regards:
- phenomena occurred in ecosystem (temperature, precipitations, humidity, soil acidity, water quality, soil erosion, etc.);
- communities (plants species, type vegetal cover, biomass on each trophic level, etc.);
- populations (number of individuals within species).

Passive observation does not solve problems leading to extinction. Increasing populations' size and responsible reintroduction is necessary. Since 1988 within IUCN

framework exists a *Group of Experts for Species Introduction* (G.S.R.) with over 400 de reintroduction projects achieved in over 80 countries (Stanley Price and Falcon, 1996) [9].

LIFE Nature Programme is concerned with reintroduction in Europe of large carnivores, birds and reptiles [5], [6]. 3 types of Programmes for new populations of animals and plants constitution are used in practice:

- reintroduction in an area not occupied by species anymore, but initially occupied;

Wolfs were reintroduced since 1995 in Yellowstone National Park. In U.S.A. were also reintroduced: pilgrim eagle, Californian condor (*Gymnogyps californianus*), blacklegged polecat (*Mustella nigripes*), *grizzly* bear. In Romania, chamois (*Rupicapra rupicapra*) was reintroduced in Rodnei Mountains in 1964 [1], [2]. These programmes have a high educational value and require existence of growth centres or bringing population from another location. Population reintroduction is also called translocation or re-establishment or relocation.

- increase of population dimension when individuals sampled in another area or obtained in captivity are introduced in a population in order to enrich genetic fund;
- introductory, that involve plants and animals removal outside of historical area when initial area is so degraded that reintroduction of original populations is impossible. Special attention is paid to avoid degradation of new environment/ecosystem or to put in danger native populations. Individuals introduced must not spread within wild populations diseases contracted while in captivity. Marmot (*Marmotta marmotta*) was introduced in Retezat Mountains.

Attentive monitoring and „implosion" procedures are necessary in order to assure rapid elimination of the species introduced when problems for other species arise. Problems of ethics related to conservation methods might arise. For a successful reintroduction programme, transparency in public relation is essential (goal explication, programme requirements) to assure that local population help, involve or at least not oppose.

Techniques of soft release are recommended instead of hard release. Animal introduced in a new habitat will be „assisted" until capable to survive alone (temporarily in cages, to accustom to the new area. The ones abruptly released might disperse in opposite directions, far from the protected area, so the programme fails. A *training* of the animals bred in captivity is necessary: specie's behaviour is „taught" (attention paid to *imprinting* phenomenon possible!). E.g. for *headstarting*: turtle offspring obtained in captivity are protected while in vulnerable stages and than released in wildness. This is the proceeding in Romania for Hermann's tortoise in the National Park "Porțile de Fier" (since 2001). There is a growth centre at Eşelnița (Mehedinți) where tortoise eggs are incubated.

Successful reintroduction programmes also have a high educational value, e.g. the tamarind (*Leontopithecus rosalia*) reintroduced in Brasil, Arabian gazelle (*Oryx leucoryx*) reintroduced in Oman desert and turned into a national symbol [4]. Such programmes became a support element for protection policy, a source of jobs. Less

rentable hunting led to Swiss Alps repopulation with *Capra ibex* at the beginning of the 20th century. In order to constitute new plant populations special treatments such as arson, competitive vegetation removal with selective herbicide, earth digging or removal of the grazing animals are applied; e.g. for the Californian species belonging to family Boraginaceae - *Amsinckia grandiflora* [5].

Among popular contra arguments:
- costs are too high: e.g. millions of $ for a few ugly birds!
- lack of necessity: e.g. why do we need wolves when other countries have plenty?
- inefficiency: increased mortality recorded in captivity (e.g. polecats)
- pseudoethics: e.g. let the last individuals of a species to extinguish without torture them in captivity (zoological gardens)!

Conservation strategies

- *in situ* (preservation *on-site*): most recommended on long term because species natural evolution only occurs in wildness.
- *ex situ* (preservation *off-site*): very expensive (maintenance of an African rhinoceros or elephant in a zoological garden costs 50 times more than in a national park) but recommended when a species extinct in wildness (due to increased anthropogenic pressure and too small population) has no chance to recover through *on-site* techniques, e.g. David's stag (milu) – *Elaphurus davidianus*, Franklin's tree (*Franklinia altamaha*).

Among facilities for *ex situ* techniques:
- for animals: zoological gardens, hunting funds, aquariums, centres or growth in captivity;
- for plants: botanical gardens, forest parks, seeds banks;
- *mixed* or for integrate conservation (*ex* and *in situ*) consists of monitoring and management of species rare and threatened within small protected areas.

Threatened species exhibition in zoological gardens has a proved educational effect.

Among the techniques used in zoological gardens:
- crossed nursing;
- artificial insemination;
- artificial incubation;
- embryos transfer (ovules of rare species are implanted after artificial fertilisation in "surrogate mothers" chosen from commune species);
- freezing of biological material (ovules, sperm, tissues, embryos) sampled from species threatened with extinction ("frozen zoological gardens"), aiming at future cloning (e.g. Tasmanian wolf). Some seeds are „recalcitrant/refractory": germinate immediately or die (e.g. tropical species) so freezing is not a solution in this case. On the other hand, tissue cultures or periodical cuts from mother plant might be proceeded.

Protected areas

By protecting 50% of the habitat surface, 90% of the species will survive. By protecting only 10% of the habitat surface, almost 50% of the species will be maintained.

There are different protection levels and regimes:

- *Natural reserves*

Cover a territory usually smaller than 1000 ha, mainly representing original ecosystems (of zoological, botanical, forest, palaeontological, limnological, speleological, marine or mixed interest) or not affected by human activities, or biocentres. A natural reserve part of the most important natural legacy of a state is a "national natural reserve" (Tab. 3) [8].

There are:

- integral natural reserves where any activity which modifies natural equilibriums is prohibited;
- partial reserves for certain species conservation (ure ox, chamois);
- special reserves for certain biological ensemble elements only.

Buffer zones where eventual activities harmful to natural resources will respect an adequate juridical regulation are established around natural reserves.

- *Landscape protected areas*

Usually cover a surface larger than 1000 ha with ecosystems fragmented but important for biodiversity and ecological stability conservation, with characteristic landscape features or specific forms of historical sites.

- *National parks*

Harmoniously combine nature protection with tourism development. Usually cover a surface larger than 1000 ha mainly consisting of ecosystems substantially unaffected by human activities or with landscape unique and natural structures. Represent national biocentres and the most important natural legacy where nature protection takes priority against other activities. It is the most complex form of nature protection and brings important incomes to national economies.

A national park consists of 3 distinct zones:

- zone of proper scientific reservation where only scientists' access is permitted;
- buffer zone accessible to tourism organized on certain itineraries;
- prepark zone with role in tourism systematization of the entire park.

Zoning of limits and areas inside a national park aims at 3 major goals:

- protection of biodiversity and vulnerable sites;
- public access to recreation and environmental education;
- sustainable development of local communities.

- *Protected sites*

Usually have a surface smaller than 1000 ha mainly representing biocorridors, interactive elements or biocentres of local or regional importance. May also be a zone with a stable animal and plant population, minerals and fossils, sites used in scientific, cultural or educational purposes, as well as parts of nature modified by man: mainly water reservoirs, brushes, parks, gardens and quarries.

- *Nature monuments*

Are punctual ecosystems, linear or small (associations or species of animals or plants threatened by extinction, secular trees, unique geological phenomena, fossil sites), generally smaller than 50 ha, with scientific, cultural, ecological, esthetical or landscape

significance, especially uncultivated: rocky formations, cliffs, canyons, dunes, sections of water courses, springs, lakes. A unique natural monument representing a part of the most important natural legacy of a state is a „national natural monument" (e.g. caves, abysses, natural cascades).

Habitat conservation was born from respect and deep love for nature [7]. First form of intervention to protect species of plants and animals threatened with extinction consisted of national parks establishment. Alexandru Borza (1928), director of the Cluj Botanical Garden said about the goal of a national park: *refuge for nature: plants, animals, geological monuments and at the same time a wonderful school, naturalistic research, love for nature and true patriotism, as well as place for recreation and fun for people*.

National parks were aimed at nature and environment protection by:
- increased control upon field, landscape and living environment;
- biodiversity conservation;
- protection and administration of especially beautiful natural zones;
- development of "natural tourism" as an alternative to mass tourism.

Natural tourism offers an alternative to mass tourism developed on seasonal and commercial bases and spares population's deep-rooted sense of local and regional identity. Natural tourism increased at an annual rate of 10-30% while total tourism increased at a rate of 4% annually.

Protected area is a terrestrial and/or marine zone with natural and cultural resources, especially dedicated to biological diversity protection, managed by legal means.

The six administrative categories of protected areas, established by the International Union for Conservation of Nature (IUCN) are:
- Category I - scientific reserve: protected area mainly administrated for scientific research and conservation of native genetic fund;
- Category II - national park: protected area mainly administrated for ecosystem protection, and leisure;
- Category III - natural monument: area or natural objective mainly administrated for conservation of specific natural features;
- Category IV - natural reserve: protected area mainly administrated for conservation of characteristic life environments that may be of geological, palaeontological, speleological, floristic, forest or fauna interest;
- Category V - landscape reserve: contains relief forms or vegetal associations with a high aesthetic value. Conservation aims at maintaining natural beauty integrity.
- Category VI - protected area with resources managed, mainly administrated for adequate use of natural ecosystems.

Table 3. Total surface of natural areas protected in Romania (according to Law 5/2000)

Surface of Romania	23,839,100 ha
Surface of natural areas protected	1,234,608 ha
Percentage realised by natural areas protected	5.18%
Among which: Danube Delta occupies from country surface	2.43%

International legislation role

International agreements, conventions and treatises together with their annex protocols have a vital role for biodiversity conservation (Fig. 2) because:
- migratory species exist;
- trade with biological products is being carried out;
- biodiversity is a good of whole mankind [6].

Most significant and effective international conventions agreed were:
- Ramsar Convention regarding wetlands of international importance especially as waterfowls habitat (1991);
- Paris Convention regarding protection of world cultural and natural heritage (1990);
- Bern Convention regarding conservation of wildlife and natural habitats in Europe (1993);
- Washington Convention regarding international trade with endangered species of wild fauna and flora (CITES, 1994);
- Rio de Janeiro Convention regarding biological diversity (1994);
- United Nations Convention for control of desertification in countries severely affected by drought and/or desertification especially in Africa, adopted at Paris, June 17th, 1994.

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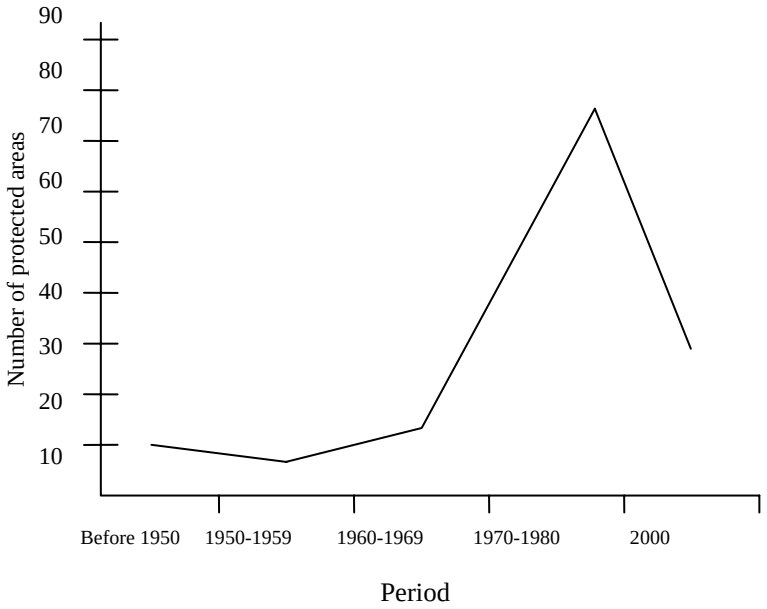

Fig. 2. Number of protected areas in Romania (1972 - Stockholm Convention)