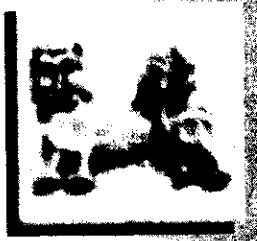
2. General Approach to Biodiversity Conservation. Objects and Goal of the Strategy



2.1. Concept of Sustainable Development and Biodiversity Conservation Strategy

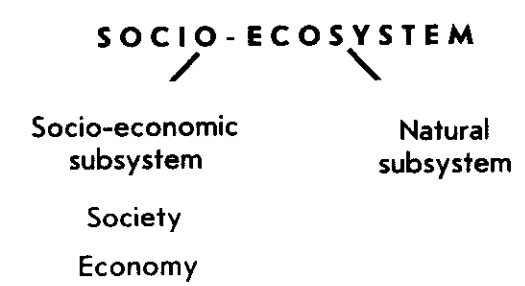
● The Strategy of biodiversity conservation should be considered as an element of the general trend of the country towards sustainable development. The Concept of transition of the Russian Federation to sustainable development was approved by the Presidential Decree No 440 of April 1, 1996. The following theses of this Decree are important for the elaboration of the National Strategy of biodiversity conservation:

- integration of society, economy and nature;
- importance of stable and maximally predictable development of the country excluding destruction and degradation of the environment.

Conservation of biodiversity can be achieved at a higher than ecosystemic level, namely at the socio-ecosystemic level which comprises socio-economic and environmental constutuents. The socio-ecosystem remains stable provided the normal development and harmonic interaction of all its components is ensured. Violation of this condition leads to the general crisis and degradation of the society and nature.

The present-day ecological crisis arises from a neglect of natural laws governing the development of ecosystems and the socio-ecosystem itself by man pursuing what he considers to be his vital interests without regard for the damage he inflicts on the environment. It should be recalled that nature often responds to human impact with a delay. Over-exploitation of natural resources may have important repercussions on the quality of human life after many years, when degradation of the environment becomes irreversible.

Social and economic developments at the expense of suppression and decimation of natural systems have led to the current economic crisis. The only way to overcome it is to recognize that the normal development of natural systems is a necessary prerequisite for the sustainable existence of the socio-ecosystem, hence of man himself.



● Biosystems perform functions vital for mankind of which the following are most important:

Environment-forming function consists of the maintenance of biospheric processes and creation of favourable living conditions for man, such as clean air and water, suitable climate, and fertile soils. This function is crucial for human existence. Life on Earth is a result of long evolution and uninterrupted work of nature during billions of years. The biosphere acts as a regulator and maintains characteristics of the environment within a narrow range which happens to be beneficial for man.

Productive function consists of biological production. Man obtains foods and raw materials for various sectors of economy both from nature (practicing forestry, fishing, hunting, etc.) and from artificial biosystems using a variety of biotechnologies including agriculture. Many mineral deposits, such as oil, gas, and coal, are actually remnants of past life forms that thrived at eralier geologic periods.

Informational function consists of the storage of information on the structure and function of biological and ecological systems (including genetic information) accumulated in the course of a long evolution of biosphere. Today, man uses only a small fraction of this information in research and education and for the development of biotechnologies. In the future, this function will acquire an increasingly greater importance.

Spiritual and aesthetic function consists of the enormous influence of living nature on the cultural development of mankind, formation of aesthetic and ethical views, and creation of comfortable environment.

● Sustainable existence of biosystems and efficient performance of the above functions is feasible due to biodiversity. Decreased biodiversity and the loss of key components of natural ecosystems lead to their dysfunction, instability, and eventual degradation.

● The objectives of the Strategy and basic principles of biodiversity conservation should be established with due regard for specific features of biological systems, their structure, function, and evolution. The socio-economic system determines possible mechanisms for the realization of the Strategy.

2.2. Objects of the Strategy

The object of the strategy is initially designated as "biodiversity". This notion needs to be expounded.

● Living nature has a hierarchical structure, and its conservation calls for a specific approach at each level of organization. The current state of science and society allows hierarchical levels from organism to biosphere to be considered for the practical purpose of biodiversity conservation. Two interrelated and overlapping but independent hierarchies should be distinguished:

– population/species hierarchy includes systems consisting of individuals of the same species: organisms, subpopulations, populations, intraspecific forms, subspecies, species and species complexes; genetic links between individual elements of the system represent a system-forming character of this hierarchy;

– hierarchy of ecological systems includes communities of organisms, biocenoses, and ecosystems of different spatial and temporal scale; ecological relations between the elements of the systems make up a system-forming trait of this hierarchy.

Solution of practical problems of biodiversity conservation should be based on the following conceptual approaches:

– *population-species approach* based on the belief that each species is a minimal genetically closed system possessed of a unique gene pool; this approach analyses genetically related systems of the population-species hierarchy;

– *ecosystem approach* based on the concept that all biological systems are inseparably connected with their environment and with one another, and that naturally free-living organisms exist only as members of ecological communities and ecosystems; this approach analyses ecological systems at different levels.

● With these approaches, the following objects of the Strategy whose diversity needs protection are distinguished: organism, population, species, community of organisms, ecosystem, territorial complex of ecosystems, biosphere.

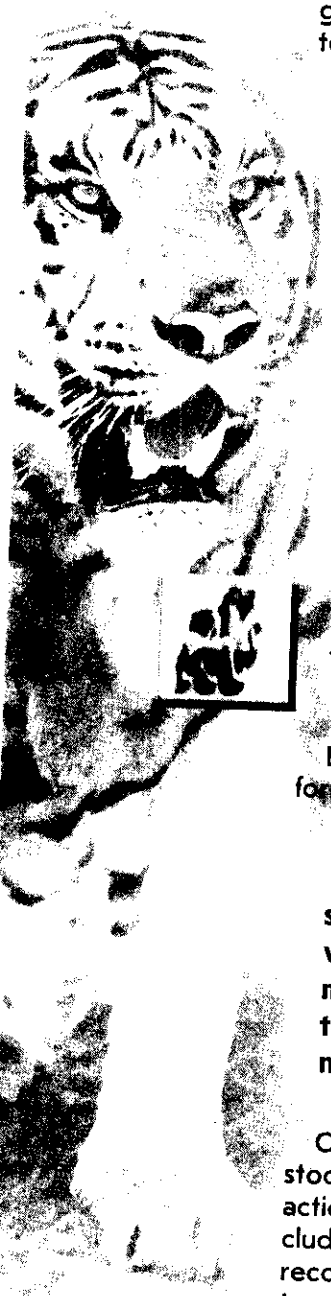
Objects of the Strategy and their internal diversity

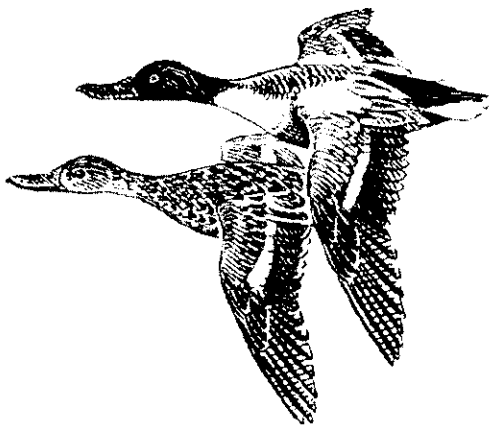
Approaches	*Objects*	*Internal diversity of objects*
Population-species	Organism	Diversity of genes, cells, tissues and organs*
	Population	Intrapopulation diversity of organisms including genetic diversity Population structural diversity
	Species	Diversity of populations, intraspecific forms and subspecies
	Community of organisms	Diversity of species
Ecosystem	Ecosystem	Diversity of species, communities and biotopes**
	Territorial complex of ecosystems	Ecosystem diversity
	Biosphere	Global species diversity Global ecosystem diversity

*Internal diversity of the organism is not considered in this Strategy within the framework of practical problems of biodiversity conservation.
**Conservation of abiotic environment is a necessary condition for the sustainable development of biodiversity.

• Most important in the context of the Strategy on biodiversity conservation is the diversity of systems at each hierarchical level conducive to the complexity and stability of systems at the next higher level. Conservation of internal biodiversity of biological systems is a necessary precondition for the conservation of these systems.

• Objects of the Strategy are both natural biodiversity (species, biocenoses, and ecosystems) and the diversity of domesticated and cultivated species of animals and plants, genetically engineered organisms, and man-made ecosystems (agroecosystems, ecosystems of urban areas, artificial water reservoirs and forest stands, parks, gardens, etc.)





2.3. Goal of the Strategy

Based on the Conception of sustainable development, the overall goal of the Strategy is formulated as follows:

Conservation of diversity of natural biosystems at the level ensuring their sustainable existence and sustainable use, as well as conservation of the diversity of domesticated and cultivated forms of living organisms and man-made ecologically balanced natural-cultural complexes at the level ensuring the development of efficient economy and formation of optimal environment for human life.

Conservation of biodiversity is understood as a complex of active measures and actions to meet the goal of the Strategy including direct measures for conservation, recovery and sustainable use of biodiversity and application of socio-economic mechanisms through which it is influenced by selected groups of the population and economic sectors.

The goal of the Strategy determines major lines of work for the foreseeable future. The desired characteristics of biodiversity to be maintained within a given period are detailed in the Action Plan. They need to be adjusted in light of events affecting biodiversity, changes of socio-economic situation, and progress in the realization of the Strategy.

3. Biological Principles of Biodiversity Conservation

Biological systems of different hierarchical levels differ in terms of structure, function, and development. Therefore, principles of conservation flowing from a set of initial scientific premises, its major objectives and methods need to be identified for each hierarchical level.

3.1. Organismic Principle

Object: organism.

Initial scientific premise: organisms are minimal self-contained life units capable of existing in the environment and carriers of hereditary information determining basic traits and properties of the species.

Main objectives

– Conservation of organisms and conditions for their reproduction.
– Conservation of genotypes.

Methods of ex situ conservation

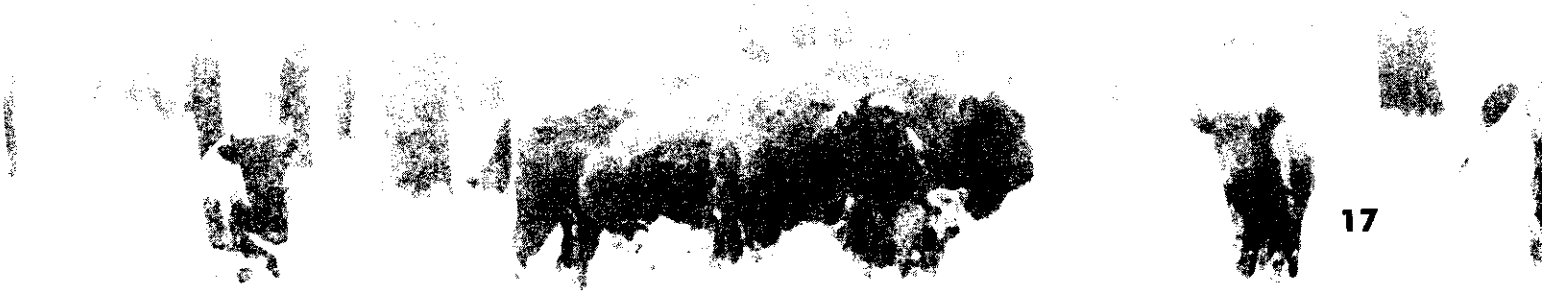
● *Keeping and breeding of organisms in nurseries, zoos, botanical gardens, and gene stock farms* need methods to ensure their natural and assisted reproduction.

● *Storage of genetic material*: gametes, zygotes, somatic cells, and embryos, in cryogenic gene, cell, and tissue banks, as well as in seed banks.

● *Cultivation of species*. Cultivation of species declining from overuse may alleviate or remove the pressure from their natural populations.

The organismic principle allows to preserve only a part of genetic diversity of natural populations. As a rule, only selected organisms (their genetic material) or small groups of organisms are conserved in gene banks, various nurseries, and botanical gardens. Genetic diversity of even thriving populations originating from the organisms preserved in captivity or cryobanks arises exclusively from progenitor genes (excepting new mutations). A long-term breeding of small groups of organisms in captivity tends to interfere with gene exchange inherent in their natural populations and compromise genetic diversity. Cultivation is equally inefficient as a tool to conserve the gene pool of species and their natural populations because it is fraught with significant changes of their properties and genetic structure.

The organismic principle may be considered as the leading one only when all other opportunities for safeguarding natural populations of a species have been exhausted.



3.2. Populational Principle

Object: population.

Initial scientific premise: populations are a form of species existence, elementary units of evolution possessed of a unique gene stock.

Population number is of crucial importance for sustainable existence. A population decline enhances the probability of stochastic extinction and compromises intra-population genetic diversity.

Genetic diversity, spatial, socio-ethological, age and sex structures of the population determine its stability, adaptability, and ability to survive in the changing environmental. Conservation of genetic diversity of domesticated species, cultivated breeds and varieties is an important prerequisite for their effective economic exploitation and availability for further selection.

However, neither the number and nor the genetic diversity of a population is of itself sufficient to evaluate its condition because certain human impacts on natural systems lead to a significant deterioration of the health of organisms, even if population numbers and genetic diversity remain unchanged for a time or even increase. Health status of organisms is an important indicator of the population well-being determining the possibility of their long-term sustainable conservation.

Conservation of natural environment typical for a population is another indispensable prerequisite for its effective long-term conservation.

Main objectives

- Conservation or restoration of population number and range at a level sufficient for sustainable existence and exploitation.
- Assurance of population well-being.
- Conservation of intra-population genetic diversity and genetic uniqueness of the population.
- Maintenance of population structural diversity (spatial, ethological, social, sex, and age diversity).

Methods of ex situ conservation

● *Conservation of populations of wild and domestic plants and animals in nurseries, zoos, botanical gardens, and gene stock farms*; implementation of optimal schemes for an exchange of organisms between nurseries as a tool to maintain genetic diversity in particular groups of organisms and a population as a whole.

Methods of in situ conservation

● *Conservation of populations of rare and endangered species listed in the Red Data Book of Russian Federation; monitoring and management* of populations of other unexploited species*. Attention should be given not only to the maintenance of population numbers, but also to the conservation of population structure.

* Here and hereinafter, monitoring and management are understood as a wide range of measures and techniques for population, species, and ecosystem control including prevention of their illegal exploitation, rating of their legal use for various purposes (recreational, scientific, cultural, etc.), ecological expertise of economic projects likely to affect biodiversity.

● *Population control of commercial species*. When planning exploitation, the necessity of maintianing population stability, genetic and structural integrity should be taken into account. This objective is reached not only through the catch-size control but also by the evaluation of structural characteristics of a harvested fraction of the population (sex, age, size, and other variables). Conservation of population structure and genetic diversity must be a major concern in any sustainable use scenario.

● *Conservation and restoration of the environment, habitat reconstruction*. This approach is imperative in regions with intense economic activities. Decreased diversity and habitat area are a major cause of extinction of natural populations. It is often necessary and sufficient to reconstitute the environment and restore the lost habitats naturally occupied by a population at risk to ensure its maintenance and conservation.

● *Conservation on specially protected natural territories* is one of the most efficient methods for the conservation of rare or endangered populations including populations of species listed in the Red Data Book of Russian Federation. In may cases, a specially protected natural territory needs to be established for the conservation of a given population.

● *Assisted or artificial reproduction* is an effective tool for the maintenance of natural populations whose natural rehabilitative mechanisms have been undermined by overexploitation or disturbance (certain commercial, rare, and endangered species). However, partial and especially total dependence on artificial breeding is fraught with a disturbance of the population genetic structure and impoverishment of its gene pool. No effort should be spared to recover the population's potentai for natural reproduction.

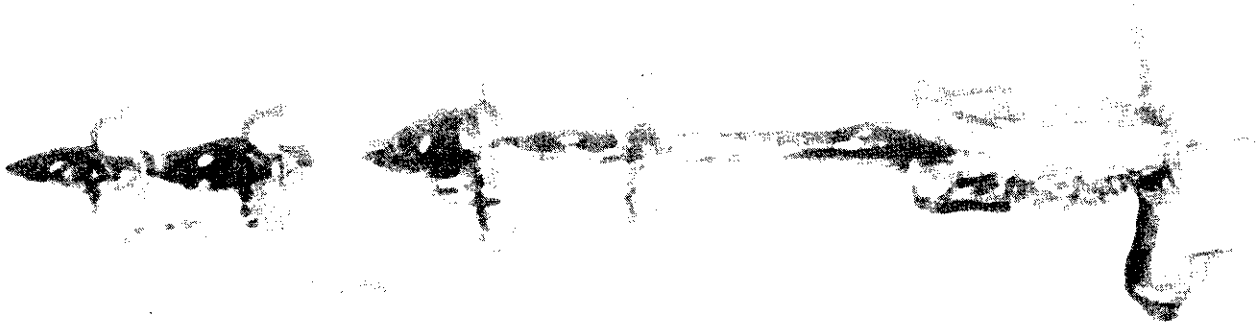
● *Measures for the prevention of damages to the population spacial structure* caused by engineering works (pipelines, highways and other roads, power lines, canals, dams, etc.); establishment of corridors for animals; the use of devices excluding animal mortality on man-made constructions.

● *Technological and organizational measures for the prevention of animal mortality* during agricultural, felling, ameliorative, and other works; assistance to animals in emergency situations (technogenic and natural disasters, weather anomalies, etc.)

● *Elimination of factors threatening the health of organisms,* such as chemical and radioactive pollution of the environment, injurious harvesting techniques, depletion of food resources, deterioration of hydrological conditions, and other environmental changes. The cause of the worsening health of the organisms should be identified and eliminated to ensure the long-term conservation of the population.

● *In situ conservation of populations of domestic animals and cultivated plants* implies their keeping in initial conditions under which a given race, breed, or variety originated and developed. Maintenance of typical agroecosystems, habitats, and breeding conditions is a necessary prerequisite for the in situ conservation of the diversity of forms and races. Territories where a traditional economy is practiced may be used as an instrument of in situ conservation if they are protected from import and introduction of alien breeds and varieties. In situ conservation techniques allow to combine protection and sustainable use of local genetic resources of plants and animals, maintenance of traditional economies and nature management, and sometimes conservation of natural ecosystems (e.g. grazing aboriginal livestock in steppe reservations).

● *Prevention of hybridization between protected wild organisms and genetically engineered ones* is crucial for the conservation of natural populations, domestic animals, and cultivated plants.



3.3 Species Principle

Object: species.

Initial scientific premise: species is a minimal genetically closed system carrying a unique gene pool; as a rule, species exists as a system of interrelated local populations, intraspecific forms and subspecies.

Conservation of the population structure of a species is a necessary precondition for its stable existence and sustainable exploitation. Local populations, intraspecific forms, and subspecies are carriers of unique adaptations to specific environmental conditions. In order to maintain the spatial and genetic structure of a species, it is necessary to ensure an extent of isolation of its populations and forms that takes place in nature. Both an exceedingly strict isolation and a break of the isolating barrier as well as artificial mixing are detrimental for populations and forms.

Main objectives

- Conservation of species numbers and range.
- Maintenance of spatial and genetic population structure.
- Conservation of the diversity of populations and intraspecific forms (seasonal races, ecological forms, subspecies, etc.)

Methods of in situ conservation

● *Conservation of rare and threatened species listed in the Red Data Book of the Russian Federation*, monitoring and management of other non-exploited species. Attention should be given not only to the maintenance of numbers and range, but also to the conservation of population structure.

● *Population control of commercial species*. When planning exploitation, not only the maintenance of species number at a constant level should be considered but also that of genetic and structural integrity of its populations. Inter-regional and international co-ordination of harvesting strategies over the entire range of the species is mandatory.

● *Conservation and restoration of the environment, habitat reconstruction*. This approach is imperative in regions with intense economic activities. Habitat rehabilitation may be necessary if certain important biotopes of the species, e.g. breeding or wintering sites, have been lost or when an extinct population of the species needs to be reconstructed.

● *Conservation on specially protected natural territories* is one of the most efficient methods for the conservation of rare or endangered species occupying small areas. This equally refers to a number of species listed in the Red Data Book of Russian Federation.

● *Reacclimatization (reintroduction) of species, restoration of the lost populations.* Reacclimatization should be done taking into account requirements of the species for a specific environment (areas formerly inhabited by the species, reconstructed or specially selected new biotopes may be used for the purpose). Also, the species genetic structure and potential repercussions of its reacclimatization on natural ecosystems should be considered. Reacclimatization is especially valuable as a tool for safeguarding species listed in the Red Data Book whose numbers and range significantly decreased in the past but tend to recover at present.

3.4 Biocenotic Principle

Object: community of organisms.
Initial scientific premise: in nature, species live in close functional relation to other species; collectively, they give rise to a community of organisms.

Species diversity accounts for the complex structure of communities and their cenotic relationships. The disappearance of some species and a decrease in species diversity result in community degradation. Introduction of alien species either by man or through spontaneous dispersal may also lead to a change in the structure of natural communities. Their effective and long-lasting conservation is feasible only if their intrinsic species diversity is preserved with due regard for natural community dynamics.

Main objectives

- Conservation and restoration of communities.
- Conservation of species and functional diversity of communities.
- Maintenance of natural processes underlying formation of community structure and composition.

Methods of conservation

● *Control and regulation of anthropogenic pressure on communities*. This objective is achieved in a variety of ways including management of individual species, regulation of recreational pressure, etc. A reduction of human impact on biocenoses to the level at which communities still retain their ability for self-recovery may be sufficient for their lasting conservation.

● *Monitoring and management of community composition and structure*. Stability of natural communities is ensured by maintaining their intrinsic species composition including relative abundance of the constituent species and the structure of cenotic relationships, with due regard for their dynamics.

● *Monitoring and management of the species composition of organisms derived from natural ecosystems*. These objectives are achieved by maintaining species composition and biodiversity typical of natural ecosystems under different conditions of exploitation.

● *Reintroduction of species extinct from a biocenosis*. This method is efficient when the structure of a biocenosis has not undergone irreversible changes since the time of species extinction. Reintroduction enhances overall stability of the biocenosis. Conversely, reintroduction of a species into a grossly altered biocenosis may be detrimental for its stability.

● *Monitoring and management of spontaneous dispersal and acclimatization of alien species*. The main task is to prevent the introduction of invasive species which can significantly change the structure of natural communities. Removal of such species from a biocenosis and restoration of its original structure may be difficult or unfeasible. It is necessary to distinguish between the natural introduction and dispersal of non-invasive species and those induced by man. The former should be promoted.

● *Prevention of penetration of genetically engineered organisms into natural ecosystems*, control of their use in agrosystems and in forestry.

● *Restoration (reconstruction) of communities and biocenoses*. This method is used when damages to a biocenosis are so serious that its self-recovery is either impossible or time-consuming.

3.5. Ecosystem Principle

Object: ecosystem.

Initial scientific premise: a totality of functionally related organisms (biocenosis) and abiotic components of the environment where they coexist (biotope, ecotope) make up an integral system (ecosystem).

Effective lasting conservation of species and communities of organisms is possible only in their capacity as members of a natural ecosystem, together with their specific environment. The quality of abiotic components (water, air, ground) is considered today as most important indicator of environmental health.

The normal existence and development of ecosystems implies a regular succession of stages. Its dynamic character should be taken into consideration in the elaboration of the strategy of biodiversity management at the ecosystemic level. Ecosystem conservation can be ensured only through the conservation of the diversity of communities representing various stages of succession and the total stock of their species.

Main objectives

- Conservation and restoration of natural ecosystems, maintenance of their environment-forming functions.
- Maintenance of natural processes underlying the development of natural ecosystems.
- Conservation and restoration of ecologically balanced natural-cultural complexes.
- Conservation and restoration of the environment (abiotoc components of ecosystems).

Methods of conservation:

● *Monitoring and management of the use of land and water areas*. At this level, the attention should be paid first of all to the conservation and restoration of abiotic environment.

● *Establishment of specially protected natural territories with different protective regimes*. The protection of such territories may include special measures for the conservation of the environment, e.g. a ban on a specified physical or chemical impact, protection of unique abiotic features of the environment (waterfalls, springs, cliffs, etc.).

● *Reconstruction (restoration) of natural ecosysyetms* is required if an ecosystem and the related habitat have been destroyed. This method includes habitat reconstruction as an essential stage of the conserevation process.

● *Support of traditional economic activities* is necessary for the maintenance of ecological equilibrium in natural-cultural complexes.

● *Construction of ecosystems* is in order when restoration of natural ecosystems is unfeasible, e.g. in agricultural, urban, and industrial areas, man-made water bodies, etc. Artificial ecosystems with a structure similar to that of natural ones are most stable and have the highest environmental-forming potential.

3.6. Territorial Principle

Object: complex of conjugate ecosystems occupying a single land or water area.
Initial scientific premise: territorial complex arises at a territory having a unique history and harbouring interrelated ecosystems.

Biodiversity conservation within territorial complexes of ecosystems requires to take into account the following data:
- distribution of biodiversity objects through the territory;
- total area of nature ecosystems;
- spatial structure of populations, species, ecosystems;
- minimal areas for sustainable existence of natural biocenoses and ecosystems;
- minimal areas for existence of particular individuals, families and populations of protected species, including the requirement of the conservation of various seasonal habitats.

Main objectives

- Conservation of territorial complexes of ecosystems.
- Conservation of the diversity of natural ecosystems and their spatial structure within the territorial complex.
- Conservation of the diversity of ecologically balanced natural-cultural complexes.

Methods of conservation:

● *Territorial planning with a view to objectives of biodiversity conservation*. Planning of socio-economic developments at administrative territories (e.g. the siting of engineering works such as construction of roadways and other linear structures, allotment of land, etc.) should take into consideration the needs of biodiversity conservation including protection of species and ecosystem diversity, integrity of territoral complexes of ecosystems, etc.

● *Planning of measures for the conservation and sustainable use of biodiversity in ecological regions or basins*. Any anticipated impact on biological systems should take into consideration their size and integrity; in other words, it should be planned by the basin or ecoregional principle and supplement administrative-territorial planning.

● *Measures for conservation and recovery of spatial structure of populations, species and ecosystems:*

– prevention of fragmentation of natural ecosystems by organization of ecological corridors (including the establishment of special regime of land use on the rights of way around engineer constructions and troads, as well as other non-reclamated lands;

– conservation of natural barriers between populations, species and ecosystems; their recovery if they are disturbed by men.

● *Creation and development of the network of specially protected natural and historico-cultural territories with different protective regime*. Compexes of ecosystems may be conserved within the bounds of large specially protected territories. Smaller territories having this status are designed to protect individual ecosystems or their constituent elements (e.g. nature sanctuaries and natural monuments). Natural ecosystems, ecologically balanced natural-cultural complexes, and their elements at specialy protected territories should be connected by ecological corridors established on specially alloted and managed lands such as right-of-ways and others used by a public utility or man-made construction. The network of specially protected natural territories must ensure protection of the diversity and integrity of territorial complexes of conjugate ecosystems.

3.7. Biospheric Principle

Object: the biosphere.
Initial scientific premise: species and ecosystem diversity supports biospheric processes and ensures functioning of biosphere as an integral system.

A global decline in species and ecosystem diversity affects spatial integrity of the biosphere and thus undermines the ability of the Earth's biosystems to perform their functions.

Main objectives

- Conservation of the global ecosystem (biosphere).
- Conservation of global species diversity.
- Conservation of global ecosystem diversity.

Methods of conservation

● *Elaboration and implementation of global, regional and national strategies for biodiversity conservation*. Convention on Biological Diversity gave impetus to the development of a global biodiversity conservation system. The Convention provides a framework for international co-ordination of principles and approaches to biodiversity conservation.

● *International agreements on biodiversity conservation and control of their implementation*. The basic objective of relevant international agreements is to ensure conservation of the systems most important for the normal functioning of the biosphere or to improve control over human activities most harmful for living nature.

● *Elaboration and implementation of international research and development programs on conservation of selected species and natural systems*. Such programs must be primarily targeted at the objects most important for the conservation of global biodiversity and may be implemeneted at a global or regional levels.

● *Participation in keeping the IUCN Red List* and other international lists of rare and threatened plants and animals aimed at identification of live organisms most vulerable globally or regionally.

● *Development of global network of specially protected territories* including biosphere reserves and other systems of specially protected natural and historico-cultural territories of international importance.