National University of Life and Environmental Sciences of Ukraine

Department of Agrosphere Ecology and Environmental Control

GUIDELINES

to conduct practicals in the discipline:

”Biodiversity and its conservation”

Kyiv-2022

UDC 502/504:378(03)

Vagaliuk L.

Guidelines to conduct practicals in the discipline “Biodiversity” for the "Bachelor" students in the specialty 101 «Ecology» / Compiler: associate professor L. Vagaliuk, Kyiv: NULES Publishing House of Ukraine, 2022. - 91 p.

Recommended to publish for educational purpuses by the educational committee at the faculty of Plant Protection, Biotechnology and Ecology
(Protocol №11, 16.06.22)

Reviewers:

N. Lesovoy - Doctor in Agricultural Sciences, professor of department of Ecobiotechnology and Biodiversity (National University of Life and Environmental Sciences of Ukraine)

V. Strokal - Ph.D. in Pedagogical Sciences, of the Department of Agrosphere Ecology and Environmental Control (National University of Life and Environmental Sciences of Ukraine)

L. Klymenko - Senior lecturer, Department of English Philology (National University of Life and Environmental Sciences of Ukraine

Methodical recommendations are developed for the implementation of laboratory-practical works on the discipline " *Biodiversity and its conservation*" by associate professors of the Department of Agrosphere Ecology and Environmental Control, Ph.D. in Agricultural Sciences, Liudmyla Vagaliuk.

CONTENTS

Module 1. Basic of biodiversity

Practical work 1. Biological diversity as an objective factor for assessing the state of the environment and the stability of ecosystems 4

Practical work 2. Biodiversity of Ukraine and principles of its protection 9

Practical work 3. The main causes of biodiversity loss 16

Practical work 4. Footprint and its assessment 18

Practical work 5. Rare and endangered species of flora and fauna of Ukraine 26

Practical work 6. Calculation of biodiversity indices. Determination of indices of species richness and species diversity of plants 31

Practical work 7. Determination of the quantitative ratio and level of dominance of individual species in the biocenosis 35

Practical work 8. Population and species levels of biodiversity organization 39

Module 2. Characteristics and assessment of threats to biodiversity

Practical work 9. Basic provisions of environmental legislation in the field of preservation of biotic and landscape diversity 31

Practical work 10. Study of the structure of the state cadaster of flora of Ukraine 36

Practical work 11. The state and prospects of development of the conservation business of Ukraine 41

Practical work 12. Analysis of the features of the development of the protected network of Ukraine

Practical work 13. Criteria for the formation of an eco-network of Ukraine 43

Practical work 14. 56

Reference

Module 1. Basic of biodiversity

Practical work 1.

Biological diversity as an objective factor for assessing the state of the environment and the stability of ecosystems

Purpose: to deepen knowledge about biological diversity, to investigate the importance of biodiversity as a factor in the assessment of natural resources and ecosystem stability.

Progress

1. Analyze the reference material "Biological diversity - an objective factor for assessing the state of the environment and the stability of ecosystems"
2. Complete the task
3. Give answers to questions.

Additional material

In everyday life, we are already used to such terms as "ecology", "environment", "natural environment", "environment" and know that in one way or another they are related to the protection of nature, its national wealth and man himself as integral part of nature. Recently, a new term appeared - "biological diversity" or "biodiversity", which is closely related to the above and today is becoming more and more common in our everyday life.

The term "biological diversity" as a legal category appeared as a result of the adoption at the UN Conference on Environment and Development of the Convention "On Biodiversity" (the Convention was opened for signature by the Parties on June 5, 1992 and entered into force on December 29, 1993.) In 1995 Ukraine ratified the Convention on Biological Diversity, taking on a number of obligations, including the obligation to develop a national strategy for biodiversity conservation.

The Convention defines biodiversity as the ability to exist in a multiplicity of different species of living nature: all species, and not only those that, from the point of view of the States parties to the Convention, have actual or potential benefit to humanity. It is the latter that fall under the definition of the concept of

"bioresources", which is much narrower than the concept of "biodiversity", since "bioresources" include genetic resources, organisms or their parts, populations or any other biotic components of ecosystems, as an actual or potential benefit or value to humanity, expressed in money.

Biodiversity has great ecological, genetic, social, scientific, cultural, recreational and aesthetic value; it is necessary for the evolution and preservation of ecosystems and the biosphere as a whole. An important task today is its preservation.

Biological diversity is the variety of living organisms from all sources, including terrestrial and aquatic ecosystems and ecological complexes of which they are components. This concept covers diversity within a species, between species and diversity of ecosystems.

Biological diversity can be divided into three categories:

- genetic diversity;
- variety of species;
- diversity of ecosystems.

Genetic diversity is the diversity within a species.

Species diversity is diversity within one region.

Diversity of ecosystems - diversity of habitats, biotic communities and ecological processes in the biosphere.

All three levels of biological diversity constitute a single system. A decrease in the genetic diversity of a species, which occurs, for example, due to the division of a once single area into parts (fragmentation of habitats), can cause the death of a species, and therefore, the biological diversity of a given region will decrease. Biological diversity is directly related to the stability of ecosystems and the biosphere as a whole and, at the same time, undergoes various changes, including those caused by human activity. The reduction of biological diversity leads to the destruction of existing ecological relationships and the degradation of natural communities to their inability to sustain themselves and, ultimately, to their destruction.

According to biologists, there are from 5 to 30 million species, and according to the most weighted estimates - about 10 million. Only 1.4 million species have been systematized. The greatest species diversity is observed among microorganisms, insects and shallow inhabitants of the ocean. Areas characterized by the greatest species diversity are the humid tropical forests of Southeast Asia, Central and West Africa, and Latin America. Ukraine has a rich biota, which includes more than 25,000 species of plants and 45,000 species of animals.

Problems of loss of biological diversity.

Today, no one doubts the fact that the problem of wildlife conservation is related to the problem of biodiversity.

National actions in the field of biodiversity conservation are based on the provisions of the Constitution of Ukraine, adopted in 1996, and are carried out in accordance with legislative acts in the field of the environment, the requirements of international conventions to which Ukraine is a party, as well as the Pan-European Strategy for the Conservation of Biological and Landscape Diversity.

Thus, the Convention on Biodiversity is considered by the world community as the most important legal means of solving one of the global environmental problems and, at the same time, to a large extent as a criterion for assessing the level of development and civilization of states. Therefore, the active participation of Ukraine in international cooperation in this area and the clear fulfillment of the requirements of the Convention are of particular importance for our state.

The main objectives of the Convention "On Biological Diversity" are the preservation of biodiversity, the tireless use of its components and the joint receipt on a fair and equal basis of the benefits associated with the use of genetic resources through the appropriate transfer of relevant technologies, taking into account all rights to such resources and technologies, as well as through adequate funding.

The content of the Convention indicates the intention of the Parties to unite efforts to preserve living nature as the property of all mankind through contractual arrangements.

The Red Book of Ukraine is the main state document, which contains generalized information about the current state of endangered animal and plant species, as well as measures for their conservation and scientifically based reproduction. Species of animals and plants listed in the Red Book of Ukraine are subject to special protection throughout the territory of Ukraine. Depending on the state and degree of threat to populations of animal or plant species, they are divided into the following categories: disappeared, endangered, vulnerable, rare, uncertain, insufficiently known, restored.

Biodiversity ensures the ecosystem and biosphere functions of living organisms and forms the environment of human life. Unfortunately, today we are losing this wealth during construction, land plowing, land reclamation, construction of water reservoirs, creation of transport infrastructure networks and other economic activities. Only in the last 350 years, about 60 species of animals and almost 100 species of birds have disappeared from the surface of our planet, a third of them - in the last 50 years. Currently, about 600 species of animals are on the verge of extinction.

Control over the extraction of resources is of great importance for the preservation of the flora and fauna of our country. Yes, many species of fish, mammals, and birds are disappearing due to overfishing, hunting, and poaching. As for plants, species with medicinal or decorative properties, which are harvested by harvesting organizations and the local population, suffer. Analysis of the dynamics of changes shows a general tendency to increase the loss of plant and animal species under the influence of anthropogenic pressure on the environment.

In order to create prerequisites for the preservation of biodiversity in Ukraine, it became necessary to provide the appropriate regulatory and legal basis and to develop a program for monitoring the biodiversity of Ukraine, aimed at ensuring the solution of the following tasks:

- ✓ control over the state of biodiversity in Ukraine;

- ✓ restoration of man-made landscapes and disturbed natural ecosystems; creation of conditions for reproduction of populations of endangered species and reintroduction of rare and endangered species;
- ✓ preventing the appearance of alien species dangerous for local flora and fauna;
- ✓ implementation of a number of measures aimed at balanced use of biological resources;
- ✓ implementation of measures to ensure compliance with standards for emissions of polluting substances into the natural environment;
- ✓ improvement of the conservation case in Ukraine;
- ✓ organization of environmental protection activities with the participation of the local public.

Task:

- ✓ Show the importance of the regulatory and legal basis for the preservation of biodiversity;
- ✓ Identify the problems of loss of biological diversity.
- ✓ Get acquainted with the creation of prerequisites for the preservation of biodiversity in Ukraine.

Answer the questions:

1. What do we understand by the term "biodiversity"?
    - only rare and vulnerable species of plants and animals;
    - all flora and fauna;
    - only the diversity of ecosystems;
    - diversity of life at all levels, from molecular genetic diversity to the biosphere.
2. What are the categories of biological diversity?
3. What basic measures must be introduced to preserve biodiversity?
    - make the most complete use of available natural biological resources for the benefit of people;

- available natural biological resources must be fully protected from human influence;
- the current way of using natural biological resources should be continued;
- balanced protection and rational use of natural biological resources.

4. Write the names of several "red book" species (no more than 10).

- _____
_____
- _____
_____
- _____
_____

5. What are the main threats to biodiversity?

What ways do you consider to be the most effective for preserving biodiversity? (underline up to three main answers)

- create new nature reserves; to combine protected objects into an eco-network;
- supplement the Red Book and the Green Book of Ukraine, protect rare species;
- prohibit hunting, and transfer the lands of hunting farms to the conservation fund of Ukraine;
- reduce environmental pollution;
- to develop biological and environmental education;
- to develop and start implementing a state program to provide for all of the above;
- other

Practical work 2.

Biodiversity of Ukraine and principles of its protection

Purpose: To get acquainted with the current state of biological diversity in Ukraine.
Materials and equipment: ecological and environmental protection maps of Ukraine and regions; Red Book of Ukraine, Green Book of Ukraine; herbariums and collection materials of rare species of biota.

Progress:

1. Familiarize yourself with the Additional material
2. To analyze the current state of biota of Ukraine.
3. Complete the task.

Additional material

Biota of Ukraine

The geographical position of Ukraine and its natural conditions contributed to the formation of a rich flora and fauna, which consists of more than 70,000 species. According to approximate data, a third of species, especially among insects and fungi, have not yet been described. However, the significant intensity and volume of anthropogenic impact significantly affected Ukraine's biodiversity.

In Ukraine, there are more than 25,000 species of plants, mushrooms, slimes and lichens, including 5,100 species of vascular plants, and, including the most important of the cultural ones, including exotics, which are grown on the open ground of botanical gardens, more than 75,000 species. About 250 species of vascular plants are recognized as medicinal by the state, although almost 1,100 species contain biologically active substances, and their preparations are used in world practice for the manufacture of medicinal preparations.

Floristically, the richest regions of Ukraine are the Crimean Mountains and the Carpathian mountain systems (2,220 and 2,012 species, respectively). A larger number of endemic species (from 240 to 300) grows in Crimea.

More than 29% of the territory of Ukraine is occupied by natural, secondary and semi-natural vegetation, in particular: forest - 14.3%, meadows - 9.7%; swamps

- 2%, steppes and salt marshes - 3%. Almost a quarter of the flora species of Ukraine are concentrated in forests (15.5% - in broad-leaved forests) and about 20% - in steppes. Vitamin (more than 200 species), essential oil (300 species), tanning and dyeing plants (100 species each) are widely represented. There are more than 100 species of woody plants.

The animal world of Ukraine includes more than 45,000 species, of which more than 44,000 species are invertebrates (more than 35,000 species of insects). Vertebrate animals are represented by fish and roundmouths (about 200 species), amphibians (17 species), reptiles (21 species), birds (about 400 species), mammals (108 species), 12 species of vertebrates are endemic. Up to 80% of the flora of the Ukrainian Polissia and Steppe are protected in nature reserves, and the vegetation of the Ukrainian Carpathians and mountainous Crimea is almost completely protected. To a lesser extent, the protection of species of animal diversity is covered.

Nature protection strategy

The idea of nature protection was first expressed by Jean-Jacques Rousseau, but it received general recognition after the First International Congress on Nature Conservation, held in Switzerland in 1913. In 1980, the World Strategy for the Protection of Nature and Natural Resources was announced. In 1982, the plenary session of the UN adopted the World Charter of Nature, which became a document of global importance. Nowadays, nature conservation is understood as a system of scientific knowledge and practical approaches to the rational use of natural resources, protection of the natural environment from anthropogenic degradation, and preservation of species of flora and fauna from destruction. The protection of all natural systems and objects became especially relevant in the 80s and 90s of the last century. The nature protection strategy includes:

a) preservation of biological diversity in natural biomes;

b) growing plants and breeding animals in botanical gardens and zoos;

c) reintroduction of plants and animals in the places of their previous existence;

d) long-term storage of genetic information in the form of cryobanks - deep-frozen germ and somatic cells.

The rapid anthropogenic change of the natural environment made it necessary to preserve its "standards", which were not yet exposed to such influences. A new approach in nature conservation is the creation of so-called "habitats of species". This is a rational method, since in many cases species die out not as a result of direct destruction by humans, but as a result of the destruction of their habitats. Protected areas should be large enough. Their dismemberment, the so-called insularization, leads to the loss of habitats needed by living organisms. In small reserves, the natural environment is rapidly deteriorating, there are few ecotopes, animal migration is not possible. The development of the theory of protection led to the conclusions that it is not possible to protect habitats or individual species of living organisms from pollution of a global nature at the local level. Reserves and other protected areas are just as sensitive to the effects of acid rain, soil and groundwater pollution as those that are not.

Protection of the gene pool. Red Book of Ukraine

One of the most important tasks of nature protection is the preservation of biological diversity. Biodiversity protection begins with the preservation of the gene pool of the planet's living organisms. Such preservation should apply to all living beings on the planet. The number of their species, by the way, has not yet been precisely established and ranges from 5 to 80 million, which is due to different interpretations by specialists of the number of types of viruses and bacteria. 45,000 species of animals live on the territory of Ukraine, including 17 species of amphibians, 20 species of reptiles, about 400 species of birds, and 200 species of fish. The flora of higher plants includes 4,997 species. According to V. Tikhomirov (1009), in the protection of the general biological diversity, the leading role is played by the preservation of plant cover, which carries out the primary synthesis of organic substances and is food for animals. Without the preservation of plants and vegetation, it is impossible to preserve the animal world.

The list of species of plants and animals in need of protection is given in the Red Book. The first Red Book was created in 1966 at the initiative of the International Union for the Protection of Nature and Natural Resources. Red books

exist in many countries. The Red Book of Ukraine (II edition, 1994, 1966) lists 429 species of vascular plants, 28 species of mosses, 30 species of mushrooms, 27 species of lichens, 17 species of algae, and 382 species of animals.

Green Book of Ukraine

The decrease in biodiversity on the planet is associated with the degradation of binomials and, above all, plant groups - phytocenoses. Degradation of natural systems is a general phenomenon, so coenoses need protection no less than individual species. And such protection is more relevant, since species cannot exist outside of coenoses. Work on the protection of plant communities went through three stages. At the first stage, the features of rare coenoses were studied. At the second stage, their passive protection began: the creation of nature reserves or national parks. And only at the third stage - active protection - was the task of preserving the phytocenofund of the planet as a set of phytocenotic taxa. Ukrainian botanists were the first in the world to emphasize the need to protect plant groups and developed a methodological basis for their registration in the form of a Green Book.

The first list of rare plant communities of the Carpathians that need protection, as well as typical coenoses of various ranks. Among them: forest groups - 51, steppe - 26, meadow - 16, water - 16, swamp - 12 and shrub - 5. Protection of rare coenoses can be carried out only as part of the corresponding ecosystems and areas of the biosphere.

Protection of ecosystems

Protection of ecosystems together with all their living components should be carried out in the so-called protected areas. According to J. Rowley, as of 1992, approximately 5% of the world's land area was under protection. In the 21st century this figure is planned to be doubled.

There is no clear classification of protected natural objects in the world. The division into categories of protected natural objects and territories was developed in the Law of Ukraine "On the Nature Reserve Fund of Ukraine" (1992). These objects

are divided into natural and biosphere reserves, national natural parks, sanctuaries, protected tracts, natural monuments, etc.

A nature reserve is an area set aside for the protection in its natural state of typical or unique natural complexes with all their components. The status of a nature reserve implies a complete ban on economic activity on its territory. More than 2,000 nature reserves operate in the world.

A biosphere reserve is a territory of international importance, intended for the preservation of areas of the biosphere in their natural state, background monitoring and study of the natural environment. Economic activity is not allowed in biosphere reserves. As of 1990, there were about 300 biosphere reserves in 76 countries of the world. Their area ranges from 300 hectares to 2 million hectares.

National natural parks are created with nature conservation, recreational, cultural, educational and research purposes for the protection and study of natural complexes of special importance in places that have natural, health, cultural and aesthetic value. Economic activities are also prohibited in such parks.

A national park is always a large area on which landscapes or their sections are protected along with all natural components. In natural national parks, nature protection is combined with the organization of people's recreation and their ecological education. Systems of special roads and trails are being built here. Until the beginning of the XX century. in six countries of the world there were 19 national parks with a total area of 4.6 million hectares.

Regional landscape parks are created for conservation and recreation purposes in places with a unique or typical landscape. During the organization of parks, economic activity within their borders does not stop. The task of these objects is to preserve the landscape as a complex of ecosystems. Currently, there are about 300 landscape parks in the world.

Reserve - a natural territory or water area intended for the preservation of a separate natural complex or even a separate component of it. Economic activities that do not harm the protected object are allowed in nature reserves. Reserves serve to protect and restore the population of certain species of plants or animals.

Depending on the object of protection, reserves are divided into landscape, geological, hydrological, botanical, zoological, paleontological.

Natural monuments are individual unique natural areas that have a special significance. Natural monuments can be objects of living or non-living nature: individual bodies of water, rocks, caves.

Protected tracts of trees, etc. - areas of forest, swamp, meadows, steppe and other vegetation that have scientific or aesthetic value and are protected to preserve their natural state.

Botanical gardens are organized for the cultivation, acclimatization and study of plants in specially created conditions.

In dendrological parks, tree and shrub vegetation is protected and studied in specially created conditions for the purpose of its scientific and aesthetic use.

A zoological park is a place where rare, foreign and local species of fauna are kept for the purpose of protecting their gene pool and organizing scientific and educational activities.

Parks - monuments of garden and park art are areas that have natural, aesthetic or historical value. In Ukraine, examples of monuments of garden and park art are "Sophiivka" in the city of Uman, "Olexandria" in the city of Bila Tserkva.

Currently, there are about 20,000 different protected natural areas on the planet, including 1,200 large protected areas.

Tasks:

1. To carry out an analysis of regulatory and organizational support for the protection of biological diversity.

2. Analyze the current state of biota of Ukraine and fill in Table 1.

Taxa	Quantity of species	Listed in the Red Book	Categories					
			I	II	III	IV	V	VI
Biota								
Flora								
Vascular plants								
Mosses								
Lichens								

Algae								
Mushrooms and Slimes								
Fauna								
Chords								
Mammals								
Birds								
Reptiles								
Amphibia								
Pisces								
Invertebrates								
Echinoderms								
Tentacles								
Clams								
Arthropods (no insects)								
Insects								
Ringworms								
Scrapers								
Round worms								
Nemertiny								
Flat worms								
Rib fins								
Intestinal								
Sponges								
The simplest								

3. Analyze the current state of the selected area and draw graphs of the biota composition of your region.

Practical work 3.

The main causes of biodiversity loss

Purpose: to develop the ability to analyze and critically evaluate global and regional problems regarding the causes of biodiversity loss; to improve the ability to discuss and argue one's opinion on a given problem.

Basic concepts and terms: natural resources, fragmentation, range, introduction, biodiversity, ecosystems, demographic explosion

Progress:

1. Get acquainted with the Additional material on the main causes of loss and reduction of biodiversity.
2. Complete the task.

Additional material

Biodiversity is rapidly declining due to factors such as: changes in land use, climate change, invasive species, overexploitation and environmental pollution. Such natural or, more often, man-made factors, called catalysts, mostly interact and reinforce each other.

While changes in biodiversity structure are more clearly associated with direct catalysts such as habitat loss, they are also associated with indirect catalysts that underlie many changes in ecosystems. The main indirect catalysts are changes in the structure of human communities, delocalization of economic activity, aggressive mechanization, cultural globalization, which leads to the emergence of cultural surrogates detached from a certain territorial context.

Various direct catalysts have been critically important in various ecosystems over the past 50 years. For example, in terrestrial ecosystems, the main catalyst was a change in vegetation cover, such as the conversion of forests to agricultural farms. Similarly, in marine systems, oil pollution and overfishing have been major drivers of biodiversity loss.

For the most part, the main factors that directly lead to the loss of biodiversity are: habitat changes, such as forest fragmentation; the invasion of invasive species

that take root and spread beyond their normal range of existence; excessive exploitation of natural resources; pollution, in particular, excessive use of chemical fertilizers, which leads to excessive amounts of toxic products of their decomposition in the soil and water.

Recent climate change has already had significant impacts on biodiversity and ecosystems in some regions. As climate change becomes more severe, adverse impacts on ecosystem stability are expected to outweigh economic gains, particularly from increased growing seasons, in most regions of the world. Climate change is expected to increase the risk of species extinction, floods, droughts, and disease outbreaks. Many negative factors affect biodiversity more strongly today than in the past, especially considering their cumulative effect. Through vulnerability to one threat, species often become susceptible to others; multiple threats can have unexpectedly dramatic consequences for biodiversity. Catalysts for extinction vary from local to global scales, and from immediate to long-term effects. For example, species extinction due to habitat loss can be rapid for some species but take hundreds of years for others.

Task:

1. After studying the provided additional material, prepare a report in the form of presentations on topics.
2. Make conclusions and provide recommendations on reducing the loss of biodiversity.

Topics for the report:

1. Losses of biological diversity under the influence of the increase in the world population.
2. Reduction of biological diversity due to the growth of "predatory" consumption of natural resources (flora, fauna, ecosystems). Consider how indigenous peoples of poor countries are victims of the unfair distribution of natural resources by rich countries and how this affects the biodiversity of these countries?
3. Destruction of habitats of species, habitat fragmentation and other causes of loss of biological diversity?

4. Impact of international trade on biological diversity?

5. State policy in the field of use of natural resources.

6. Introduction as one of the causes of biodiversity loss. Consider whether introduced species that have been transferred can lead to qualitative changes in ecosystems?

Practical work 4.

Footprint and its assessment

Purpose: to learn to determine the ecological footprint of a person on the planet; to improve the ability to critically assess the situation on planet Earth and to make predictions for the future on the given problem.

Equipment and materials: reference material, comparative table "Ecological footprint and biological capacity of some countries of the world".

Progress:

1. Process reference material
2. Analyze the comparative table "Ecological footprint and biological capacity of some countries of the world"
3. Solve calculation tasks.

Additional material

The ecological footprint is an assessment of the consumption of natural resources by the Earth's population. How carefully is natural capital used today? For this, it is necessary to measure how much we have and how much we spend. One of these indicators of sustainable development is the ecological footprint, or footprint (from the English foot - foot, print - imprint) - a "trace" that leaves an impact on the surrounding natural environment of an individual person, country, humanity in general. The ecological footprint takes into account the extent to which the economy of a particular region corresponds to the capacity of natural ecosystems.

When calculating this indicator, the biologically productive area of land or sea is taken into account, which is necessary for the production of renewable resources for consumption by the population of the given territory (water area), as well as for the assimilation of the received waste. The area is measured in global hectares - conventional units of area with average world productivity.

Thus, the ecological footprint takes into account (the consumption of natural resources and the pollution resulting from this consumption, regardless of which continent, at which point of the planet these processes take place. This feature of the

footprint makes it a universal indicator of sustainable development, which can be used to compare different countries and regions. The ecological footprint takes into account various types of anthropogenic load (growing plants for human nutrition, livestock fattening; breeding animals for the production of milk, meat, wool, leather; cutting down forests to obtain construction wood, fishing for fish and seafood; construction and placement of infrastructure objects (housing, transport highways, industrial enterprises, etc.).

If we add up all the indicators and divide by the number of the planet's population, we will get the natural capacity of the biosphere, which is expressed in hectares per capita. For different regions, characterized by different environmental conditions and living standards, the biological capacity per person and the ecological footprint of one inhabitant are different.

Reducing the ecological footprint.

The trend of economic growth, which is associated with an increase in the production and consumption of goods and services, according to (even optimistic) UN forecasts, will lead to the fact that in 2050 we will need twice as much natural resources as the Earth can produce. This level of excess will lead to the risk of losing the stability of natural ecosystems due to a sharp reduction in biological diversity.

An alternative scenario should prevent the biosphere from exceeding its capacity by increasing bioproductivity. It is quite obvious that this will require significant costs from society. Long-term investments will be needed in many areas, including education, technology, conservation, family planning, and environmental certification. From 2 to 10% of the global gross product must be directed to these goals.

The main goals of the ecological footprint reduction program are as follows:

1. Population growth must slow down. The three main factors that influence the choice of families to have fewer children are women's access to education, income level, and health care.

2. Reduction of consumption of goods and services per capita. People living at or below the poverty level may need to increase consumption, but wealthier people

can reduce consumption while maintaining a reasonably high quality of life (for example, reducing fossil fuel consumption by cars can be offset by making cities more walkable).

3. The volume of resources used in the production of goods and services must be significantly reduced - due to the increase in energy efficiency in production and in everyday life, the transition to cars that consume less fuel, due to the reduction of the distance of transportation of goods (preference to be given to local manufacturers), increase recycling and reuse of waste.

4. Increasing the area of bioproductive areas, improving poor lands. For this, terracing and irrigation can be used. However, firstly, it should be borne in mind that the economic efficiency may decrease, and secondly, it is necessary to prevent negative environmental effects, such as soil salinization and desertification.

5. Increasing bioproductivity of ecosystems. The volume of biota production from one hectare depends on the type of ecosystem and on the management method. For this purpose can serve: protection of soils from erosion; protection of wetlands, aqueducts to ensure supplies of fresh water; sustainable forest use and fishing; prevention of climate change (droughts, hurricanes, floods, etc.); refusal to use pesticides.

What are the benefits of ecological footprint calculations?

Positive aspects:

- to make it possible to monitor the needs of states and regions in natural resources and to compare these needs with the currently available opportunities;
- to give answers to more specific questions about the spatial distribution of these needs and opportunities, as well as about acceptable volumes of goods and services that provide support or improvement of the quality of life for the population of the region;
- to provide an opportunity to speak a common language when conducting negotiations on issues of sustainable development of society with governments of different levels of power, with the public.

In addition, ecological footprint calculations allow governments to:

✓ to increase the competitiveness of the regions by monitoring the ecological deficit, because after some time this deficit may become the cause of social and economic problems;

✓ to obtain an early warning tool to ensure long-term security, which will inform about global trends and warn about resource shortages;

✓ to monitor the cumulative effect of various environmental impact factors (eg. climate change, fish stocks, loss of arable land, deforestation, urbanization) that are usually assessed separately.

Undoubtedly, taking as a basis, when calculating the ecological footprint, the resource approach is not a single and comprehensive approach to determining the value of nature. At the same time, the *ecological footprint* is a system of complex scientifically based accounting, within which the use of natural resources by people and the ability of nature to recover are compared.

Calculation tasks:

Task 1.

When determining the ecological footprint, various types of anthropogenic load are taken into account, in particular:

- cultivation of plants for human nutrition, livestock fattening, production of fiber, oil, rubber and the like - 1.3 billion hectares of arable land;
- animal breeding for the production of meat, milk, wool, skin and fur requires pastures - 4.6 billion hectares;
- felling of forests to obtain construction wood, cellulose, firewood - 3.3 billion hectares;
- extraction of fish and seafood - 3.2 billion ha of water area;
- construction, placement of infrastructure facilities (housing, transport, highways, industrial enterprises, reservoirs) - 0.2 billion hectares;
- combustion of extracted fuel leads to emissions of carbon dioxide into the atmosphere (35% of emissions are absorbed by the ocean; to absorb the other 65%, the necessary area of forests and wetlands must be taken into account.

Execute: taking into account all the indicated indicators, determine the natural capacity of the biosphere.

Task 2.

Calculations show that the average resident of Ukraine needs 3.2 hectares to provide him with natural resources. At the same time, the bioproductive area of our country per Ukrainian is 1.7.

Execute: to determine the ecological deficit (or reserve).

Task 3.

The average world population's need for natural resources is 2.23 hectares per person. Currently, the bioproductive area of land and sea on our planet is 1.78 hectares per person.

Execute: answer the question:

1. Does the existing biologically productive area of land and sea satisfy the needs of humanity at this time?
2. What would it be like if all the people of the planet lived like in the United Arab Emirates?

Task 4.

The ratio of two factors - the level of use and the number of the population determines the global trend of ecological deficit.

Today, the ecological deficit is typical for both developed countries (3.12 ha) and underdeveloped countries (0.09 ha).

Execute: what caused the environmental deficit in these countries? What is the difference?

Task 5.

According to calculations, the average inhabitant of Bulgaria needs about 4.4 hectares in order to ensure his own need for natural resources. At the same time, the bioproductive area of the country is 6.9 hectares, that is, the available ecological reserve is 2.5 hectares (6.9 - 4.4 = 2.5 hectares). At the same time, with this level of consumption of natural resources by the Japanese, there is an ecological deficit of the territory (3.7 hectares).

Ecological footprint and biological capacity of some countries of the world

Region	Population, million people	Ecologist. trace, on/people	Biological capacity, on/people	Ecologist. deficit (-) or stock (+), ha/person	Environmental changes. Follow (1975-2003 pp.), %
The whole world	6 301,5	2,23	1,78	-0,45	14
Developed countries	955,6	6,4	3,3	-3,12	40
Developing countries	3011,7	1,9	2,1	+0,18	14
Weakly Developing countries	2303,1	0,8	0,7	-0,09	8
Africa	846,8	1,1	1,3	+0,24	-2
Egypt	71,9	1,4	0,5	-0,9	49
Libya	5,6	3,4	1,0	-2,4	13
Somalia	9,9	0,4	0,7	+0,3	-38
Middle East and Central Asia	346,8	2,2	1,0	-1,2	-19
Azerbaijan	8,4	1,7	1,2	0,5	-62
Armenia	3,1	1,1	0,6	-0,5	-76
Afghanistan	23,9	0,1	0,3	+0,2	-45
Georgia	5,1	0,8	1,2	+0,5	-83
Kazakhstan	15,4	4,0	4,1	+0,1	-14
Kirghizia	5,1	1,3	1,4	+0,1	-73
United Arab Emirates	3,0	11,9	0,8	-11,0	205
Tajikistan	6,2	0,6	0,5	-0,1	-86
Turkmenistan	4,9	3,5	3,6	+0,1	-24
Uzbekistan	26,1	1,8	0,8	-1,1	-60
Asia-Pacific region	3489,4	1,3	0,7	-0,6	38
Australia	19,7	6,6	12,4	+5,9	-7
India	1065,5	0,8	0,4	-0,4	16
China	13117	1,6	0,8	-0,9	82
Taiwan	62,8	1,4	1,0	-0,4	60
Japan	127,7	4,4	0,7	-3,6	30
Latin America and the Caribbean	535,2	2,0	5,0;	+3,4	21
Brazil	178,5	2,1	9,9	+7,8	30
Costa Rica	44,2	1,3	1,5	+2,3	13
Cuba	11,3	1,5	0,9	-0,7	-2
North America	325,6	9,4	5,7	-3,7	35
Canada	31,5	7,6	14,5	6,9	11
USA	294,0	9,6	4,7	-4,8	38
Europe (EU)	454,4	4,8	2,2	-2,6	31
Germany	82,5	4,5	1,7	-2,8	6
Finland	5,2	7,6	12,0	4,4	57
Sweden	8,9	6,1	9,6	-0,6	16

Estonia	1,3	6,5	5,7	0,7	41
Europe (without EU)	272,2	3,8	4,6	0,8	-11
Albania	3,2	1,4	0,9	0,5	0
Belarus	9,9	3,3	3,2	-0,1	-28
Moldova	4,3	1,3	0,8	-0,5	-72
Ukraine	48,5	3,2	1,7	-1,5	-30
Switzerland	7,2	5,1	1,5	-3,6	39

Exercises:

(identifying resources for your needs using the ecological footprint)

If you want to know your ecological footprint, answer the questions of the test. In order to calculate the ecological footprint, it is necessary to select the statement corresponding to your lifestyle and add/subtract the number of points indicated on the right. By summing up the points, you will get the size of the ecological footprint.

1.Housing.

1.1. The area of your home allows you to keep a cat, and a dog of normal size would be cramped +7

1.2. Large, spacious apartment +12

1.3. Cottage for two families +23

Divide the points obtained for the first question by the number of people who live in your apartment or in your house.

2. Use of energy.

2.1. Oil, natural gas or coal +45 is used to heat your home

2.2. Energy from water, sun or wind +2 is used to heat your home

2.3. Most of us get our electricity from fossil fuels, so give yourself +75

2.4 The heating of your house is arranged in such a way that you can adjust it depending on the weather -10

2.5. At home you are warmly dressed, and at night you hide under two blankets -5

2.6. When leaving the room, you always turn off the light in it -10

2.7. You always turn off your household appliances without leaving them in standby mode -10

3. Transport.

3.1. Commute to work by public transport +25

3.2. You walk or cycle to work +3

3.3. You drive a regular passenger car +45

3.4. You use a large and powerful car with +75 all-wheel drive

3.5. Last vacation you flew on the +85 plane

3.6. On vacation, you traveled by train, and the journey took up to 12 hours +10

3.7. You went on vacation by train, and the journey took more than 12 hours +20

4. Nutrition.

4.1. In the grocery store or at the market, you buy mainly fresh products (bread, fruits, vegetables, fish, meat) of local production, from which you prepare lunch yourself +2

4.2. You prefer already processed products, semi-finished products, fresh-frozen ready-made meals that only need to be heated, as well as canned goods, and you do not look at where they are made +14

4.3. Basically, you buy ready-made or almost ready-to-eat products, but try to have them made closer to home +5

4.4. You eat meat 2-3 times a week +50

4.5. You eat meat three times a day +85

4.6. You prefer vegetarian food +30

5. Use of water and paper.

5.1. You take a bath every day +14

5.2. You take a bath once or twice a week +2

5.3. Instead of a bath, you take a shower every day +4

5.4. Every now and then you water your yard or wash your car with a +4 hose

5.5. If you want to read a book, you always buy it +2

5.6. Sometimes you take books from the library or borrow from friends -1

5.7. After reading the newspaper, you throw it away +10

5.8 Someone else reads the purchased newspapers after you +5

6. Household waste.

6.1. We all create a lot of waste and garbage, so give yourself +100

6.2. In the last month, you handed in bottles -15 at least once

6.3. Throwing away garbage, you put waste paper in a separate container -17

6.4. You hand in empty cans from drinks and canned food -10

6.5. You throw away plastic packages -8 in a separate container

6.6. You try to buy mainly not packaged, but weighted goods; you use the packaging received in the store in the household -15

6.7. You make compost from household waste to fertilize your plot -5

If you live in a city with a population of half a million or more, multiply your total by 2.

Let's summarize:

Divide the result by 100 and you will find out how many hectares of the earth's surface are needed to satisfy all your needs, and how many planets would be needed if all people lived the same way as you!

For one planet to be enough for all of us, no more than 1.8 hectares of productive land should be available per person.

By comparison, the average US resident uses 12.2 hectares (5.3 planets!), the average European uses 5.7 hectares (2.8 planets), and the average Mozambican uses only 0.7 hectares (0.4 planets).

Practical work 5.

Rare and endangered species of flora and fauna of Ukraine

Purpose: to get acquainted with rare and endangered species of flora and fauna of Ukraine, as well as with the structure of the Red and Green Books.

Progress:

1. Carefully read the reference material on the conservation status of flora and fauna species.

2. To analyze the species of plants, animals and fungi that are listed in the Red Book according to the selected area.

3. Complete the task.

Additional material

The problem of environmental protection and preservation of biodiversity has become particularly relevant in our time, in the era of scientific and technological progress, which has given humanity powerful levers of influence on nature. Taking into account the sad mistakes of the past, now there is no doubt in anyone's mind that the disappearance of each successive biological species is a real catastrophe and may be the result of irreparable losses in the future. Protection and restoration of rare and endangered species of plants and animals in developed countries is considered one of the most important tasks of state importance.

In 1948, the International Union for the Protection of Nature and Natural Resources (IUCN) was established. In its organizational structure, a special commission is provided for assessing the state and determining the danger that hangs over wildlife, primarily vertebrates and vascular plants. One of the tasks of the IUCN is to involve the maximum number of countries, their governments, scientific forces and public organizations in solving complex and multifaceted environmental problems.

As a result of many years of hard work, in 1963, the register of rare and endangered species of wild animals and plants "Red Data Vook", i.e. "Red Book of Facts" appeared for the first time. Later, its name was simplified to "Red Book".

The need to protect plants and animals is reflected in many documents of international cooperation.

The Resolution of the Verkhovna Rada of Ukraine dated October 29, 1992 approved the Regulation on the Red Book of Ukraine, which is the main state document on the protection of animal and plant life. It contains generalized information about the current state of animal and plant species of Ukraine that are under threat of extinction, and measures for their preservation and science-based reproduction.

The conservation status of a species is an indicator of the likelihood that this species will continue to exist in the future. When assigning the categories of protection status, many factors are taken into account: not only the number of existing representatives of the species, but also trends in population change (decreasing or increasing), the degree of reproduction success, the normal number of a given species in the ecosystems where it lives, known danger factors and/ or factors contributing to the survival of the species, etc.

The IUCN Red List is the most comprehensive reference system on the conservation status of species on Earth. In it, taking into account both the above-mentioned general factors and individual features characteristic of each species, the species are divided into 9 categories:

- Extinct (EX)
- Extinct in the Wild (EW)
- Critically Endangered (CR)
- Endangered (EN)
- Vulnerable (VU)
- Near Threatened (NT)
- In a state of least concern (Least Concern, LC)
- Information is insufficient (Data Deficient, DD)
- Not evaluated (NE)

The list of extinct species includes those that disappeared after 1500.

Conservation status categories NatureServe:

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) classification is another system of classification of species whose existence is threatened, designed to prevent international trade of species in a form that may threaten their existence.

Within the framework of the European Union, in order to comply with the norms of CITES, such a section of legislation as the EU Wildlife Trade Regulations has been developed with its own database, which is a form of classification of species based on vulnerability. In addition, there are the EU Habitats Directive and the EU Birds Directive.

Within Canada, the USA and Latin America, a system of classification of the conservation status of species called "NatureServe conservation status" has been developed. This system now has a slightly different classification system from the IUCN Red List, but the further it goes, the more it is identified with the one adopted by the IUCN.

Tasks:

Task 1. Look at the pictures and familiarize yourself with a short list of plant, animal and mushroom species that are listed in the Red Book of Ukraine. Complete table 1.

A short list of plant, animal and mushroom species listed in the Red Book of Ukraine.

Fig. 1. Plants of the Red Book of Ukraine:

1.*Cypripedium calceolus* L. - vulnerable species;

2. *Crocus heuffelianus* Herb. - unrated species;

3. *Galanthus nivalis* L. - unrated species;

4. *Allium ursinum* L.- unassessed species;

5. *Lilium martagon* L. - unassessed species;

6. *Aster alpinus* L. - rare species;

7. *Lunaria (lunar) reviving Lunaria* L. - unappreciated species;

8. *Pulsatilla pratensis* (L.) Mill. - unrated species;

9. *Taxus baccata* L. - vulnerable species

Fig. 2. Animals of the Red Book of Ukraine:

1. *Lucanus cervus* Linnaeus - rare species;

2. *Papilio machaon* Linnaeus - vulnerable species;

3. *Acipenser ruthenus* Linnaeus - endangered species;

4. *Salamandra salamandra* Shaw - vulnerable species;

5. *Coronella austriaca* Laurenti - vulnerable species;

6. *Ciconia nigra* Linnaeus - rare species;

7. *Bubo bubo* Duméril - rare species;

8. *Erinaceus auritus* Gmelin - endangered species;

9. *Lutra lutra* Linnaeus - unrated species;

10. *Bison bonasus* Linnaeus - extinct in nature.

Fig. 3. Mushrooms of the Red Book of Ukraine:

1. *Tuber aestivum* Vittad - endangered species;

2. *Morchella steppicola* Zerova - rare species;

3. *Boletus aereus* Bull. - vulnerable species;

4. *Clathrus ruber* P.Micheli ex Pers.- rare species;

5. *Laricifomes officinalis* (Batsch) Kotlaba & Pouzar - extinct species.

Table 1.

	Name	Degree of vulnerability	Place of growth (for plants)	Living conditions (for animals)
1				
2				
3				
4				
5				
6				
7				

8				
9				
10				

Task 2. According to the selected area (optional), name the species of plants, animals and fungi that are listed in the Red Book, provide a photo and fill in Table 2.

Table 2

	Name	Degree of vulnerability	Place of growth (for plants)	Living conditions (for animals)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Practical work 6.

Calculation of biodiversity indices. Determination of indices of species richness and species diversity of plants

Purpose: to get acquainted with biodiversity indices, learn to determine the indices of species richness and species diversity of plants

Progress:

1. Read the theoretical material
2. Complete the task
3. Make conclusions

Theoretical material

The term "biodiversity" is often considered synonymous with "species diversity", in particular "species richness", which is the number of species in a particular habitat or biotope. The linear size of a habitat can vary widely and depends on the spatial homogeneity of environmental factors and the degree of mosaicism of biosphere components: for birds, for example, it may be a vast patch of forest, and for zoobenthos - a fragment of the bottom surface.

Species diversity is characterized by two criteria: species richness and evenness of species distribution.

Numerous formulas based on various modifications of these indicators are called indices in ecology and are used to quantify biodiversity.

Menkhinik index (*species diversity, or richness*), which is a characteristic of the number of species per unit of total number (abundance), which can be taken as the total number or biomass. This index makes it possible to estimate how many species account for the total number of individuals.

$$M = A / \sqrt{N},$$

where *A* is the number of species, *N* is the total abundance of all species in the community.

Simpson's index (*of dominance, or concentration and equivalence, or equiprobability*): reflects the "concentration" of dominance, as its value is greater the stronger the dominance of one or more species. The value of the diversity index

depends not only on the species richness, but also on the evenness of the proportions of different species in terms of their abundance.

$$C = \sum (n / N) 2 ,$$

where *n* is the abundance of one species

The **Jaccard's index** (*species or faunal similarity*), which can be calculated both between communities as a whole (Jag) and between dominant species complexes (Jdom), determines the ratio of total species to the number of species in the combined list:

$$J = c / (a + b – c),$$

where *a* and *b* are the number of species in the compared communities, *c* is the number of common species.

The **MSA index** (*generalized species diversity index)* is calculated as the product of typological units of the agro-landscape, taking into account the relevant indicators of impact on the state of biodiversity. This index "takes into account" long-term factors of influence and does not "react" to short-term factors that can lead to a crisis state of biodiversity, such as the use of plant protection products, excessive plowing, etc. The index reflects the ratio of the current species diversity of the territory and the potential species diversity of the ecosystem integrity within the same territory. Accordingly, the index can have a value from 0% in a completely degraded ecosystem to 100% in an integral one. According to the developers, this index can also be interpreted as an indicator of the naturalness of the territory.

The average impact on biodiversity (**MSAi**) is obtained as the product of MSA values for each of the impact factors: land use change (**MSALUC),** fragmentation (**MSAI**), infrastructure (**MSAF**), climate change (**MSAN**), atmospheric nitrogen deposition (**MSACC**).

Shannon-Weaver index (*general or informational diversity*), which gives an idea of both aspects of diversity at once: the number of species and the uniformity of their quantitative representation, and therefore can be complexity, organization, stability). It can be calculated both by individual species and by superspecies taxa or other elements of diversity. Unlike many other indicators, it assesses the diversity

of random samples, so it is most often used in the study of the structure of natural communities. In addition, this indicator combines species richness and evenness into a single value and quantifies (in bits) the equivalence of registration of different species in the community.

$$H = -\sum P_i \cdot ln\ P_i \text{ where}$$

P_i is the probability of contribution of each species to the community.

$P_i=n/N$, n is the number of points that each species receives according to the percentage of projected cover or abundance (density) in a given community.

N is the total amount of points received by all species of a given community by this indicator ($H = \sum N$).

Projection coverage is the area of projections of aboveground parts of plants of the same species on the soil surface excluding gaps between leaves and branches.

Instead of scoring the abundance of species in the community on the scale of O. Drude:

1 point - plants are closed in separate parts;

2 points - plants are very abundant;

3 points - plants are abundant;

4 points - plants are quite abundant;

5 points - plants are sparse;

6 points - plants are solitary;

7 points - one plant in the detection area.

Tasks:

1. Four plots measuring 1m x 1m are fenced off in the case of studying a meadow system and 10m x 10m in the case of a forest system.

2. Determine the projected cover of the studied community or use the abundance score of species in the community according to the O. Drude scale (n).

3. Find the probability of contribution of each species in the community (P) and determine the species diversity using Shannon's formula.

4. Enter the results of calculations in Table 1.

Table 1

Scoring of species by projected cover and probability of contribution of each species to the community

Species name	Projective cover score (Drude scale) (n).	Probability of contribution of each species P_i
1	2	3

Table 2

Calculation of species diversity of plant communities

Species diversity index (according to Shannon)	Plant community №1 _____ (name)	Plant community №2 _____ (name)

Compare the indicators of species diversity of different plant communities (Table 2) and **make a conclusion**.

Practical work 7.

Determination of the quantitative ratio and level of dominance of individual species in the biocenosis

Purpose: to learn how to determine the quantitative ratio and level of species dominance using the Simpson, Berger-Parker, Margalef and Pielu indices.

Progress:

1. Familiarize yourself with the additional material
2. Complete the task
3. Make conclusions

Additional part

Simpson's index of dominance provides a quantitative characteristic of the relationship between the number of different species.

$$C = \sum(n_i /N)^2,$$

where n_i is the number of individuals of each species, and N is the total number of individuals of all analyzed species.

The Berger-Parker dominance index takes into account only the share of the dominant species:

$$D_{BP} = n_{max}/X$$

where n_{max} is the number of the species that occurs most often.

Both indicators take on a smaller numerical value, the more aligned the dominance structure, i.e., the closer the abundance estimates are for all species. At the same time, Simpson's index gives more weight to common types, since when squaring small ratios (n_i/N) very small values are obtained.

Species diversity, or a measure of species heterogeneity of a group, is determined by Shannon's formula or Simpson's formula.

Both indicators take the maximum value when the number of all species in the group is equal. At the same time, Shannon's diversity index goes to $H_{Sh} \rightarrow ln\ s$, and Simpson's diversity index goes to $H_S \rightarrow (s-l)/s$, where s is the total number of species.

The Margalef index is used to numerically assess the species richness of groups:

$$DMg = \frac{S - 1}{\ln N}$$

The more species, the higher the value of this index. An increase in the number of individuals with an unchanged number of species leads to a decrease in the value of the index.

The evenness of species distribution, which also reflects the degree of group diversity, is determined by the Piel evenness index:

$$E = Hsh / ln\ s,$$

where H_{Sh} is the value of the Shannon diversity index for this grouping. Pielu's evenness index takes values from 0 to 1. For real groups, this indicator rarely exceeds 0.80.

Practical task.

During the analysis of the plant community of the oak-hornbeam forest, the presence of 10 tree species was noted, the number of individuals of which is presented in the table below. It is necessary to evaluate the indices of dominance, diversity and species richness of this group.

Table 1

Results of observations

Type	Hornbeam	Oak	Maple	Ash tree	Aspen	Hazel	Poplar	Birch	Linden	Cherry tree
	1	2	3	4	5	6	7	8	9	10
The number of units per hectare	100	75	60	55	40	35	15	10	5	5

Task

1. Analyze the structure of this plant group.
2. Calculate the Simpson (C) and Berger-Parker (DVR) dominance indices.

3. Construct and analyze a graph of the Whittaker dominance-diversity curve. To do this, plot the value of the share of the total abundance of each species in the total abundance on a semi-logarithmic scale along the OX axis:

$$p_i = (n_i / N) \cdot 100\%$$

The type I curve corresponds to a situation when all members of the group are strongly dependent on some resource, and there is a random, but non-intersecting, distribution of ecological niches of species along the gradient of this resource ("broken rod" model).

A type II curve is characteristic of communities consisting of a small number of species that are in fierce competition for limited resources, often in harsh environmental conditions.

Type III curve is characteristic of groups with high species saturation, in conditions where the "success" of one or another species is determined by a large number of independent and homogeneous factors.

Thus, the higher the curve and the more flattened it is, the greater the overall diversity for a given number of species.

4. Determine what type the resulting curve belongs to. What does its structure indicate?

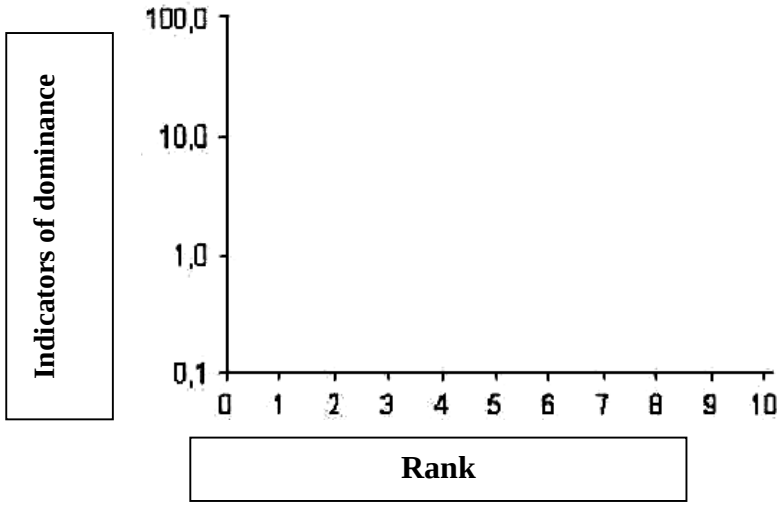

Fig. 1. Graph of the Whittaker curve

5. Calculate the indices of species diversity according to Shannon (Hsh) and Simpson (Hs).

6. Estimate the species richness of woody plants of the forest using the Margalef index (Dm).

7. Estimate the uniformity of species distribution according to Piel (E).

8. **Make conclusions.**

Options for completing tasks

Task 1.

Calculate the index of species richness (Margalef index), if it is known that the number of individuals in the sample is 259. The sample is represented by 23 species.

Task 2.

It is known that the conditional sample taken in the forest complex is 781 individuals of birds, which are represented by five species: great tit - 257 individuals, black thrush 152 individuals, jay - 209 individuals, bunting - 84 individuals, warbler - 79 individuals . Find Shannon Index, Berger-Parker Dominance Index. Make conclusions about the state of bird fauna of the forest complex.

Task 3.

Determine the number of species in the sample, if it is known that the Margalef species richness index is 5.538, and the number of individuals in the sample is 387.

Task 4.

Find the Margalef index for a sample in which 17 species of mammals are represented by 795 individuals.

Task 5.

Conditional sampling of birds was made in the breeding area. It consists of 419 individuals, represented by 7 species that are not rare in this area, including:

pigeons - 79, starlings - 59, swallows - 37, sparrows - 118, crows - 65, magpies - 34 , swifts - 27. Calculate the index of species diversity and Shannon's variance.

Task 6.

Calculate the species richness of the White Lake ecosystem, if it is known that it includes 25 species of living organisms, and the total number of individuals is 579.

Task 7.

Using Simpson's index of species diversity, calculate species diversity of a deciduous forest, if its biocenosis includes: oak - 73, birch - 50, hawthorn - 12, squirrel - 26, hare 43 individuals.

Task 8.

Calculate the index of species diversity of the nature reserve, if its biogeocenosis includes the following species listed in the Red Book: Caucasian groundhog - 113, forest cat - 87, deer beetle - 98, berry yew - 75, peach-leaved bells - 101, Kolkhido boxwood - 9. Which index should be used to solve this problem? Calculate the Pielu evenness index (E) of the ecosystem of the nature reserve.

Practical work 8.

Population and species levels of biodiversity organization

Purpose: To get acquainted with the population-species level of biodiversity, to learn to calculate the individual links between the ecological pyramid, to master the rules of the ecological organization of the pyramid, to learn to determine the position of living organisms in trophic chains.

Progress:

1. Read the theoretical material
2. Consider several examples of solving problems in ecology.
3. Solve independently according to the options of the problem.
4. Make a conclusion.

Theoretical material.

In nature, any biological species usually consists of a large number of populations. Nowadays, under the influence of anthropogenic factors, the populations of wild species of plants and animals have deteriorated and become fragmented. At the same time, the ranges of population species adapted to human economic activity are expanding. A reduction in the number of individuals increases the probability of a random population measurement and is accompanied by a reduction in intra-population genetic diversity. The size of the population depends on the birth rate - the ability of individuals of the population to reproduce and mortality - the rate of decrease in the number of the population.

From the point of view of preservation of biodiversity, the most important indicator is the minimum number of the population, such a number for which the level of genetic heterogeneity will be maintained in the population, thanks to which it does not degenerate. Consistently reducing the population to a minimum number, man destroys them without even killing the last representative.

Favorable climatic conditions, a sufficient amount of food, weakening of predation lead to an increase in fertility and birth rate, and an increase in population. There are also a number of factors that limit the size of the population

The sequence of living organisms, which can be imagined as consisting of links - species of plants, animals, fungi and bacteria, connected to each other by the relationship "food - consumer", is called a trophic chain. In addition, the simplest food chain has several trophic levels. The first trophic level is formed by green plants (producers); the second is occupied by animals that live on plants (consumers of the first order); the third - predators that give herbivorous animals (consumers of the second order), and the fourth - predators whose victims remain smaller predators (consumers of the third order). Reductants are microorganisms (bacteria and fungi) that destroy the remains of dead creatures.

The rule of the ecological pyramid is a regularity according to which the amount of vegetable matter, which is the basis of the food chain, is approximately 10 times greater than the mass of herbivorous animals, and each subsequent food level also has a mass 10 times smaller than the previous one.

Examples of problem solving.

When making a food chain, it is necessary to correctly arrange all the links and show with arrows from which level the energy is obtained.

Example 1. The following live in a meadow community: caterpillars, larks, alfalfa, sculpins. Make a food chain.

Answer: alfalfa — caterpillars — larks — shuliks.

Example 2. Based on the rule of the ecological pyramid, determine how much plankton is needed to grow one individual kalan (sea otter) weighing 30 kg in the sea, if the trophic chain has the form: phytoplankton, non-predatory fish, predatory fish, kalan.

It is known from the ecological pyramid rule that each subsequent trophic level has a mass 10 times smaller than the previous one. Knowing this, you can easily solve the problem.

Solution. Let's make a trophic chain, starting from producers: phytoplankton — non-predatory fish — predatory fish — kalan.

Knowing that the mass of the eel is 30 kg, and the mass of consumers of the second level that it consumes should be 10 times greater, let's calculate the mass of

predatory fish that it feeds on: 30 X 10 = 300 (kg); accordingly, the mass of non-predatory fish: 300 X 10 = = 3000 (kg); and the mass of phytoplankton that non-predatory fish feed on: 3,000 X 10 = 30,000 (kg). So, we get the answer: in order for one eel weighing 30 kg to grow in the sea, 30,000 kg of phytoplankton is needed.

Problems for independent solving

Option 1.

1. Match the organism with the trophic level of the ecological pyramid on which it is located, and write in the table of the given form: plants, eagle, frog, microscopic fungi, beetle.

Producer	
Consumer 1 order	
Consumer of the 2nd order	
Consumer3 order	
Reductant	

2. Determine the mass of the components of the power chain, if it is known that the mass of the consumer of the 3rd order is 8 kg.

Power chain components	Total mass
Phytoplankton	
Small crustaceans	
Pisces	
Otter	8kg

3. Using the rule of the ecological pyramid, determine the area (in m2) of the corresponding biogeocenosis on which a wolf weighing 55 kg can feed (food chain: herbaceous plants — ungulates — wolf). The biomass of forest vegetation is 2,000

g/m2. Take into account that the mass fraction of water in the body is 70% of the total mass.

4. Determine the area of the sea water area required to feed a common dolphin weighing 60 kg (30% of dry matter) in the food chain: phytoplankton — fish — dolphin. Productivity of phytoplankton is 500 g/m2.

5. The biomass of dry hay from 1 m2 of field is 300 grams. Based on the ecological pyramid rule, determine how many hectares of field are needed to feed one schoolchild weighing 50 kg (70% of the mass is water), according to the food chain: grass-cow-human.

Option 2

1. Match the organism with the trophic level of the ecological pyramid on which it is located, and write in the table: cyclops, phytoplankton, zander, crucian carp, crayfish.

Producer	
Consumer 1 order	
Consumer of the 2nd order	
Consumer3 order	
Reductant	

2. Determine how many seagulls can feed the supply chain, if it is known that the total mass of the producer is 8,000 kg, and the mass of one seagull is 0.2 kg.

Power chain components	Total mass
Plants	8 000
Insects	
Small birds	
Sichi	

3. Using the rule of the ecological pyramid, determine by how much the weight of a young fox increased during a week of mousing, if during this week it ate 200 voles and mice (the weight of one rodent is approximately 10 g). Take into account that the mass fraction of water in the body is 70% of the total mass.

4. Determine the area of the water area of the river, which is required to feed pikeperch weighing 1 kg (30% of dry matter) in the food chain: phytoplankton — herbivorous fish — pikeperch. The productivity of phytoplankton is 700 g/m2.

5. Plankton biomass is 500 g/m2 of sea area. Using the rule of the ecological pyramid, determine what area of the sea can feed one polar bear weighing 500 kg (70% is water) according to the food chain: plankton-fish-seal-polar bear.

Module 2. Characteristics and assessment of threats to biodiversity

Practical work 9.

Basic provisions of environmental legislation in the field of preservation of biotic and landscape diversity

Purpose: Study the conventions and agreements ratified by the Supreme Council of Ukraine; consider the main issues of basic international conventions, agreements and other legal mechanisms regarding the preservation of biotic and landscape diversity.

Progress:

1. Familiarize yourself with the additional material
2. Complete the task
3. Answer the questions

Additional material

It is quite obvious that nature knows no state borders. Living organisms, carrying out seasonal migrations, cross them without hindrance. Therefore, cooperation on an international scale is necessary for the preservation of migratory species, especially rare and endangered ones. There is another acute problem - illegal international trade in objects of living nature.

The main international legal acts in this field are international agreements and treaties. Multilateral agreements - conventions - are put into effect (ratified) by the legislative bodies of the member states (in Ukraine - the Verkhovna Rada). The main conventions related to the preservation of biodiversity are:

• Convention on Biological Diversity (Rio de Janeiro, 1992);

• Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973);

• Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 1979);

• Convention on the Protection of Wild Flora and Fauna and Natural Habitats in Europe (Bern, 1979);

• Convention on Wetlands of International Importance as Waterfowl Habitat (Ramsar, 1971).

Species of living organisms listed in the Washington Convention traditionally have the highest international protection status. Back in 1953, the International Union for Conservation of Nature (IUCN) introduced the so-called International Red Book, where at first only the rarest species of mammals and birds were listed. Then the IUCN repeatedly revised this book, compiling new Red Lists, which included representatives of other taxa of living organisms.

The European Red List, which includes rare and endangered species of living organisms of European countries, is also an important environmental protection document.

Legal regulation of biodiversity at the current stage

Terminologically, the concept of "biological diversity" or "biodiversity conservation" is found in national legislation only when setting out the principles of legal regulation of this or that law (point "d" of Article 3 and Article 61 of the Law "On Environmental Protection", Article 9 of the Law "On animal world", the relevant article of the Law "On Plant Life" and some others).

Regulation of relations regarding the preservation of biodiversity at the national level is largely carried out indirectly: first of all, through the regulation of protection of the territories of stay or growth of biological resources. It is about the nature reserve fund and other categories of natural territories of special protection (Laws of Ukraine "On environmental protection", "On the nature reserve fund of Ukraine", etc.).

Secondly, it is natural resource legislation (land, forest, water, mining, faunal, floristic, etc.), in particular, the Codes: Land, Water, Forest and "On the Subsoil", the Law of Ukraine "On the Animal World", etc.

Thirdly, legislation on the protection of species of biological resources, primarily rare and endangered ones (legislation on the Red Book, Green Book, etc.). A number of national and regional programs have been developed and implemented, including the Prospective Program for the Development of Protected Affairs in

Ukraine, the National Program for the Formation of the National Ecological Network of Ukraine for 2000-2-15 (approved by the Law of Ukraine dated September 21, 2000).

Tasks:

Task 1. Fill in table 1 using the Additional material "Conventions and Agreements".

Table 1

List of basic international conventions on conservation of biotic and landscape diversity

Name, place and year of initiation of the convention, agreement	**Legal document regarding the participation of Ukraine**	**The purpose of the convention, agreement**
Convention on Biological Diversity (CBD @ Rio de Janeiro, Brazil, 1992)	Law of Ukraine on Ratification of the Convention of November 29, 1994.	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CGHS @ Washington, USA, 1973)	The Law of Ukraine on Accession to the Convention of May 14, 1999	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CGHS @ Washington, USA, 1973)	The Law of Ukraine on Accession to the Convention of May 14, 1999	
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention®, Bonn, Germany, 1979)	Law of Ukraine on Accession to the Convention of March 19, 1999	
UN Convention to Combat Desertification in Countries Suffering from Severe Drought and/or Desertification, Especially in Africa (Paris, France, 1994)	Law of Ukraine on Accession to the Convention dated July 4, 2002	

Task 2. Fill in table 2 using the Additional material "Conventions and agreements".

Table 2

List of pan-European basic international conventions and agreements on the preservation of biological and landscape diversity

Name, place and year of initiation of the convention, agreement	**Legal document regarding the participation of Ukraine**	**The purpose of the convention, agreement**
Convention on the Protection of Wild Flora and Fauna and Natural Habitats in Europe (Bern Convention, Bern, Switzerland, 1979)	Law of Ukraine on Accession to the Convention of October 29, 1996	
Agreement on the Conservation of Afro-Eurasian Migratory Wetland Birds (AEWA operates within the framework of the Bonn Convention of The Hague, the Netherlands, 1995)	Law of Ukraine on Accession to the Convention dated July 4, 2002	
Agreement on the conservation of bats in Europe (EUROBATS operates within the framework of the Bonn Convention, London, Great Britain, 1991)	The Law of Ukraine on Accession to the Convention of May 14, 1999	
Pan-European strategy for the preservation of biological and landscape diversity (Sofia, Bulgaria, 1995)	Signed by the Minister of Environmental Protection of Ukraine in 1995, ratification of the convention is not required because, on the basis Existing international agreements are part of the pan-European strategy	

Task 3. Fill in table 3 using the Additional material "Conventions and Agreements".

Table 3

List of regional basic conventions, agreements, directives regarding the conservation of biotic and landscape diversity

Name, place and year of initiation of the convention, agreement	**The purpose of the convention, agreement**
Convention on the Protection of the Black Sea from Pollution (Bucharest Convention, 1992)	
Framework Convention on the Protection and Sustainable Development of the Carpathians (Kyiv, Ukraine, 2003)	
Agreement on the conservation of cetaceans of the Black Sea, the Mediterranean Sea and the adjacent waters of the Atlantic Ocean (effective within the framework of the Bonn Convention of	
European Union Directive 79/409/EEC on the protection of wild birds (EU Wild Birds Directive)	
European Union Directive 92/43/EEC on the protection of habitats and wild fauna and flora (EU Habitats Directive)	

Answer the question:

1. What are the goals of the Convention on Biological Diversity (1992)?
2. What are the main tasks of the Bern (1979) Convention?
3. What is the purpose of the Agreement that was adopted in Monaco in 1996?
4. What is the purpose of the European Union Directive 92/43/EEC?

Practical work 10.

Study of the structure of the state cadaster of flora of Ukraine

Purpose: to investigate the concept of cadaster, to get acquainted with the structure of the state vegetation cadaster of Ukraine.

Progress

1. Familiarize yourself with the additional material
2. Complete the task
3. Make conclusion

Additional material

Cadaster of the plant world, floristic cadaster - a systematic compilation of information about the flora of a certain territory.

The state cadaster of the plant world contains information and documents on the distribution of plant world objects between owners and users of land plots, quantitative and qualitative characteristics of the national economic and scientific value of plant resources, the division of natural plant groups into categories, economic evaluation of technical, fodder, medicinal, food and other properties of natural plant resources, other data on plant natural resources, necessary to ensure their tireless use, reproduction and effective protection (Table 1).

The flora is understood as a historically composed collection of plant species, distributed in a certain area (flora of Europe) or in an area with certain conditions ("bog flora") at the present time or in past geological epochs.

The flora of Ukraine is characterized by a significant diversity of species composition. On the territory of Ukraine, there are up to 16,000 species of plants, including more than 4,000 species of higher wild plants. Among the angiosperms, the plants of the compositae (700 species) and legume (about 300 species) families are the most common in our country.

Vegetation is a set of plant groups (phytocenoses) of the planet as a whole or its individual regions and localities.

Distinguish natural and anthropogenic vegetation, as well as modern vegetation and vegetation of past geographical periods. The main types of vegetation in Ukraine are forest, steppe, meadow and swamp.

Table1

The structure of the state cadaster of flora of Ukraine

Flora	**Vegetation**	**Vegetation resource**
Vascular	Forest	Medicinal
Moss-like	Shrubby	Nutritive
Lichens	Steppe	Spicy and aromatic
Algae	Meadowy	Technical cultures
Fungus	Swampy	Fodder crops
	Aquatic	
	Halophytic	
	Aridna	
	Synanthropic	

Forest vegetation. The total area of forests in Ukraine is about 10 million hectares, which is approximately 14% of its territory. The largest forests are in the Ukrainian Carpathians (40.5%) and the Crimean Mountains (32%).

The forests are dominated by young and medieval trees, such species as pine, spruce, beech, and oak are common. They occupy about 90% of the forested area. In addition, there are groves of hornbeam, linden, maple, birch, poplar, alder, etc. Pine (pine) forests occupy large areas in Polissia, as well as in the valleys of the Forest-Steppe and Steppe rivers. They grow on sod-podzolic sandy soils, poor in humus and nutrients. Oak and pine forests are common on the best soils.

Until that time, steppe vegetation in its natural form was preserved only on the slopes of the ravines, in the foothills of the Crimea, on the sand spits of the Azov-Black Sea coast, and islands. Areas of virgin steppes are protected in nature reserves. In the typical steppe zone in the north there was a wide variety of herbaceous and sedge vegetation on ordinary chernozems (hoof, sedge, sedge, spring heather, steppe

milkweed, sage, astragalus), in the south - sedge and sedge on southern chernozems and dark chestnut soils (typchak, Ukrainian heifer, kelleria, from various herbs - thistle, tansy), along the Azov-Black Sea coast - sagebrush-cereal vegetation on chestnut saline soils.

Depending on the location, meadows are divided into *floodplain, dryland, lowland, and mountain meadows*. On floodplain meadows, thickets of vines, fescue grasses, brooms, calendulas, as well as clover, yarrow, sorrel, yarrow, etc. are common. In the dry meadows, broom, sweet cornflower, cornflower, dandelion, and cornflower grow. Lowland meadows are limited to lowlands in watersheds, terraces, and valleys, so they are watered for a long time. Their grass cover is dominated by red fescue, meadow timothy, common sedge, meadow and white clover. Meadows are used as haymakers. Mountain meadows are widespread in the Ukrainian ***Carpathians.*** In the herbage of mountain meadows, fescue, whites, clover, and rush are common. In the subalpine belt, meadows of whitebeard, timothy, evergreen sedge, and fescue were formed.

Marsh vegetation develops in depressions with excessive moisture. Swamps occupy about 2% of the territory of Ukraine. They were most widespread in Polissia. Swamps have significant reserves of peat. According to their location, floodplain, lowland, valley, floodplain, and old river marshes are distinguished. Lowland swamps are the most common. Their vegetation is dominated by grass and grass-moss groups. Common sedge, reed, rush, reed, horsetail, sedge, etc. Of the trees - black alder, less - pine, birch, willow, willow and birch shrubs.

Aquatic plants are plants that grow in water. Among them, we distinguish: hydrophytes - plants that are submerged in water only with the lower part (reed, rush, rush), hydatophytes - plants that are completely or mostly submerged in water (water lily, watercress, elodea).

Halophytes are salt-tolerant plants. Especially interesting are halophytes, which are characterized by significant resistance to high concentrations of salts (sarzan, kermek, solonets, soleros).

Arid vegetation develops in conditions where plants experience a lack of moisture during vegetation (phytocenoses of deserts, xerophytic sparse forests). They have developed various ways of adapting to the lack of moisture: a short growing season, morphological and anatomical adaptations (reduction of leaves, their pubescence), physiological adaptations (increasing the osmotic pressure of cell juice, etc.).

Synanthropic vegetation is vegetation that benefits from anthropogenic changes in the environment and, therefore, spreads near anthropogenic landscapes, that is, near human habitation, fields, pastures, roads, settlements. These include cultivated and weed plants.

Medicinal plants - plants, the organs or parts of which are raw materials for obtaining means used in folk, medical or veterinary practice with a therapeutic or preventive purpose.

Today, about 500,000 species of plants are known, but only a small part (about 10%) of them are widely used in medicine (St. John's wort, chamomile, calendula, rosehip, sea buckthorn, licorice, plantain, mint, sage, yarrow, etc.)

Spicy-aromatic plants are plants that contain aromatic or pungent-tasting substances (essential oils, glycosides, tannins, etc.).

These include cloves, black pepper, vanilla, ginger, parsley, garlic, dill, etc.

Industrial crops are agricultural plants used mainly as raw materials for various industries (food, textile, soap, paint, pharmaceutical, etc.): sunflower, flax, castor, rapeseed, soybean, rose, oak, hops.

Tasks:

1. Based on the initial data in Tables 2-4, give examples and describe the flora, vegetation and plant resources of your chosen area.

Table 2

Flora of the region

Flora	Representatives	Characteristics of one species
Vascular		
Moss-like		
Lichens		
Algae		
Fungal		

Table 3

Vegetation of the region

Vegetation	Representatives	Characteristics of species
Forest		
Shrubby		
Steppe		
Meadowy		
Swampy		
Aquatic		
Halophytic		
Aridna		
Synanthropic		

Table 4

Plant resources of the region

Plant resources	**Representatives**	**Characteristics of resources**
Medicinal		
Nutritive		
Spicy and aromatic		
Technical cultures		
Fodder crops		

- ✓ **Make conclusions**

_____

_____

_____

_____

Practical work 11.

The state and prospects of development of the conservation business of Ukraine

Purpose: to characterize the current state and structure of the protected network of the region, to get acquainted with the position of international and national biodiversity conservation programs.

Progress:

1. Familiarize yourself with the additional material
2. Complete the task
3. Make conclusions

Short Additional part

The term "Biodiversity" does not have a standard definition. The most common is "the variability of life at all levels of biological organization," but it is a bit too general for concrete interpretation. According to another definition, biodiversity is a measure of relative diversity among the set of organisms that make up an ecosystem. "Diversity" in this case refers to both differences within species and between species, as well as comparative differences between ecosystems. Biological diversity is the basis for the sustainable existence of ecosystems. In 1992, under the auspices of the United Nations, an international convention on the conservation of biological diversity on earth was adopted in Rio de Janeiro, and in 1998, a law of Ukraine on the preservation of biological diversity in the country was adopted. In 1995, in the city of Sofia, Ukraine signed the All-European Strategy for the Preservation of Biological and Landscape Diversity. Based on this concept, the National Program for the Conservation of Biological Diversity until 2015, as well as the Program for the Development of the Ecological Network in Ukraine, was developed. A number of issues of protection of natural habitats of plants and animals are regulated by the Land (1992), Forest (1994) and Water (1995) codes and the Subsoil Code (1994).

Task:

1. Write down the main provisions of the UN Convention on Biological Diversity:

2. Familiarize yourself with clause 3.5 of the Law of Ukraine "On the nationwide program for the formation of the national ecological network of Ukraine for 2000-2015" (Reports of the Supreme Council of 2000, No. 47, Article 405. write down the main purpose of this clause.

3. Analyze the state of the protected network in Ukraine at the current stage and determine its compliance with European indicators.

4. Name the protected areas of your region. Using the map of the nature reserve fund of Ukraine (region), indicate in table 1 the location and area of nature conservation areas. Name the representatives of the flora (fauna) protected in these protected areas. Enter the data in the table.

Table 1

Name of nature conservation areas	Type	Location, area	Representatives of protected flora (fauna)

5. How, in your opinion, can you evaluate the implementation of provisions on the preservation of biodiversity in your region, in Ukraine?

6. **Make conclusions**

_____

_____

_____

_____

Practical work 12

Analysis of the features of the development of the protected network of Ukraine

Purpose: to form concepts about the development of the protected network, to clarify the role of international and national programs in the preservation of biodiversity.

Progress

1. Read the theoretical material.
2. Using the tables "Nature Reserves of Ukraine" and "Biosphere Reserves of Ukraine", determine the features of the development of the network of protected areas in our country from 1921 to 2009. Construct a histogram that will display the decade (on the XY axis) and the number of protected areas created (on the OW axis).
3. How can you explain the decrease in the rate of growth of the area of the natural reserve fund of Ukraine?
4. Make conclusion.

Additional material

A nature reserve fund is a section of land and water space, the natural complexes of which have a special nature conservation, scientific, aesthetic, recreational value.

During the years of independence, the area of the nature reserve fund of Ukraine has more than doubled. It includes more than 7,250 territories and objects with a total area of 3.3 million hectares, which is about 6% of the state's territory (in 1991, this figure was only 1.9%). But this is not enough: the area of protected lands per person in Europe is 2,200 m2, and in Ukraine - only 570 m2.

As of March 1, 2010, according to the Ministry of Nature, there were 19 natural and 4 biosphere reserves, 47 national nature parks, 2,853 sanctuaries, 3,203 natural monuments, 27 botanical gardens, 12 zoos, 54 arboretums, 542 parks- monuments of garden and park art, 55 regional landscape parks, 800 protected tracts.

Biosphere reserves of Ukraine are natural protected areas of international importance, in which all layers of the biosphere are protected and access to which is extremely limited.

Modern careful ecological and economic calculations and models show that the preservation of the gene pool of any region is possible only if no less than 10–15% of its area is occupied by protected territories of the rank of a reserve or reserve. In most European countries, the average percentage of conservation is 15%. The presence of a developed network of protected areas is a necessary (though not sufficient) condition for preserving biodiversity. Therefore, every state that has joined the Convention on Biological Diversity is obliged to maintain and develop a network of protected areas, primarily reserves.

Nature reserves of Ukraine

№	Name	Year of establishment	Area, ha	Region
1.	Nature reserve "Gorgany"	1996	5 344,2	Ivano-Frankivsk
2.	Dnipro-Orilsky nature reserve	1990	3 766,2	Dnipropetrovsk
3.	Drevlyany nature reserve	2009	30 872,84	Zhytomyr
4.	Nature Reserve "Yelanetsky Steppe"	1996	1 675,7	Mykolayivska
5.	Kazantila Nature Reserve	1998	450,1	Autonomous Republic of Crimea
6.	Kaniv nature reserve	1923	2 027	Cherkassy
7.	Karadaz nature reserve	1979	2 872	Autonomous Republic of Crimea
8.	Crimean nature reserve	1923	44 175	
9.	Luhansk Nature Reserve	1968	2 122	Luhansk
10.	Nature Reserve "Medobory"	1990	10 521	Ternopilsk
11.	Nature Reserve "Cape Martyan"	1973	240	Autonomous Republic of Crimea
12.	Nature Reserve "Mykhailivska virgin land"	2009	882,9	Sumy
13.	Opuk nature reserve	1998	1 592,3	Autonomous Republic of Crimea

14.	Nature Reserve "Rostochchia"	1984	2 084,5	Lviv
15.	Polisky nature reserve	1968	20 104	Zhytomyr
16.	Rivne Nature Reserve	1999	42 288,7	Rivne
17.	Cheremysky nature reserve	2001	2 975,7	Volynsk
18.	Ukrainian steppe nature reserve	1961	3 335,6	Donetsk, Zaporizhzhya, Sumy
19.	Yalta mountain and forest nature reserve	1973	14 523	Autonomous Republic of Crimea

Biosphere Reserves of Ukraine

№	**Name**	**Year of establishment**	**Area, ha**	**Region**
1.	Askania-Nova	1921	11 100	Khersonsk
2.	Danube Biosphere Reserve	1981	50 252,9	Odesa
3.	Carpathian Biosphere Reserve	1968	57 880	Zakarpattia
4.	Black Sea Biosphere Reserve	1927	89 129	Khersonska, Mykolaivska

Answer the questions:

1. Define the term biodiversity?
2. When was the Convention on the Protection of Biodiversity adopted and ratified by Ukraine?
3. Ecological network of Ukraine, what is it and why is it there?
4. What are nature conservation areas, list them?

Practical work 13.

Criteria for the formation of an eco-network of Ukraine

Purpose: to form a holistic view of the formation of an ecological network based on the objects of the PZF of Ukraine, to master the main criteria for the formation of an ecological network. Consider the main aspects of creating a national eco-network in Ukraine.

Progress:

1. Familiarize yourself with the additional material
2. Complete the task

Additional material

The formation of a pan-European eco-network is a qualitatively new stage in the development of environmental protection activities. Within its limits, each country forms its own national eco-network in order to preserve biotic and landscape diversity. The scheme of such a network was also developed in Ukraine and approved by the relevant law.

The International Union for Conservation of Nature - IUCN (IUCN) considers the main criteria for the selection of territories for the creation of nature reserves of various types:

- ✓ preserving the natural state of ecosystems and their spontaneous dynamics;
- ✓ conservation of habitats and habitats (including water resources);
- ✓ support of genetic diversity;
- ✓ preservation of traditional landscapes as aesthetic and cultural heritage;
- ✓ conservation of resources that are renewable in natural systems;
- ✓ the possibility of conducting scientific research;
- ✓ the possibility of developing protection measures for each type of reserve.

Floristic and faunal criteria

Floristic (faunistic) criteria are features of the composition (set) of taxa (primarily species) of plants and animals of a certain territory. In addition to

qualitative (flora as a list of species) and quantitative (flora as the number of species) characteristics of species diversity, flora can be characterized by the composition of its geographical, biomorphological, ecological elements, that is, groups of species (typological elements of flora) that have certain common features. The same applies to fauna. Floristic and faunal criteria are among the most important for the analysis of the territory and the planning of elements of the ecosystem.

The selection of territories for the purpose of creating key territories must be carried out taking into account the hierarchy of biogeographical zoning. It is desirable to create at least one representative key territory of the corresponding rank in each division of biogeographic zoning of different rank (except for unique ones that can be located on the same territory).

Geobotanical (syndynamic) criteria

Geobotanical criteria are closely related to the floristic criteria for selecting territories for inclusion in the eco-network lists. Flora and vegetation are inextricably integrated in one vegetation cover, and each elemental (specific) flora corresponds to its succession system of vegetation, a regularly organized system of series of natural changes in vegetation cover (succession series) An additional criterion for including territories in the lists of the eco-network can be the principle of "protection of the weak link" - in order to fully preserve successional series, their most vulnerable stages, the areas of which are the rarest and least resistant, should be protected.

Landscape criteria

In accordance with Article 15 of the Law of Ukraine "On the Ecological Network of Ukraine", the design of the eco-network is carried out by developing regional schemes for the formation of the eco-network of the Autonomous Republic of Crimea and regions, as well as local schemes for the formation of the eco-network of districts, settlements and other territories of Ukraine. In this regard, the first stage of eco-network planning is the analysis and assessment of the specifics of the territory of the administrative region in a number of positions.

Practically every administrative division from the point of view of the natural structure is an artificial unit to one degree or another. Administrative subdivisions, as a rule, do not have natural boundaries, therefore neither floristic nor syndynamic criteria, despite their naturalness and absolute necessity, are not sufficient. They must be supplemented with another group of criteria - landscape criteria. It is the landscape criteria that are decisive for the comprehensive analysis of the natural conditions of artificial administrative units, they take into account both the aggregate of physical and geographical information and data on the anthropogenic transformation of the area.

The analysis of the spatial structure of the landscape includes the study of the ratio of natural and anthropogenic elements in its various sections (sections), as well as the presence of anthropogenic ecotones. It is convenient to use maps M: 1:100000–1:200000 to assess the structure of the landscape. In this range of scales, the following 5 types of landscape structure can be distinguished:

A – natural elements of the landscape cover the entire territory of the allocation being analyzed;

B – natural elements cover the allocation territory, however, there are anthropogenic ecotopes along communications, reclamation channels, etc.;

B – there are both natural and anthropogenic elements of the landscape on the territory of the allocation;

D - anthropogenic landscapes prevail within the allocation, including natural ecosystems;

E - there are only anthropogenic landscapes within the allocation.

Criteria for selecting structural elements of the eco-network

The next stage of the selection of territories for inclusion in the eco-network lists is the structuring of the territories selected according to the criteria discussed above. That is, giving them the status of a certain structural element of the ecosystem. The structural elements of the regional eco-network are determined by objectively determined natural factors, spatial parameters of ecosystems and other

types of territorial formations, in accordance with the principles of territorial structuring of the All-European Eco-Network and the Law of Ukraine "On the Ecological Network of Ukraine" (Table 1). Structural elements, key, connecting (eco-corridors), buffer and restoration territories, in their continuous unity, create an eco-network that functionally unites biodiversity centers into a single national and continental system.

Criteria for choosing key areas of the eco-network

Key areas are areas of preservation of genetic, species, ecosystem and landscape diversity, as well as habitats of organisms, that is, areas of important biological and ecological importance, well integrated in the landscape. They are characterized by a great diversity of biota species, landscape forms and habitats and play an extremely important role in the preservation of endemic, relict and rare species and groups. Their area may be different depending on the territory on which natural diversity has been preserved, the distribution of rare species or functional connections with other natural territories, as well as on the territorial level, but at least 500 hectares.

Table1.

Constituent structural elements of the ecosystem

Name structural element of the ecosystem	**Territorial level (territorial scale of influence)**	**Signs**
The main base area	• biosphere • continental • national • regional • local	Nodal element of the eco-network. The territory of preservation of genetic, species, ecosystem and landscape diversity, habitats of organisms
Connecting territory (eco-corridor)	• biosphere • continental • national • regional • local	Connecting element. A spatial structure with an elongated configuration that connects natural cores and provides support for the processes of reproduction, gene pool

		exchange, migration, maintenance of ecological balance, etc.
Buffer area	• biosphere • continental • national • regional • local (according to the status of the key territory)	Protective element. The territory that surrounds (partially or completely) a key core or ecocorridor and provides their protection from external influences.
Restoration area	It is determined depending on what functions the territory will perform after renaturalization	A promising element. Designed to restore the integrity of functional connections in a key or connecting area. This can be an area with completely or partially degraded natural elements, on which priority measures should be taken to restore the original natural state. In the future, it should become part of other elements of the eco-network.

According to their importance, key territories can be divided into three groups:

- ✓ territories marked by diversity or uniqueness of biota;
- ✓ territories with well-preserved natural landscapes of continental, national or regional value;
- ✓ territories that represent human-transformed landscapes that have significant historical and cultural value.

Table 2

Criteria for selecting key areas

Index	Criteria	Signs of criterion compliance
BE – Bioecological criteria		
BE-n	Nature	Ecosystems and biota of the territory are in a natural or almost natural (slightly disturbed) state

BE-ds	Species diversity	The territory is characterized by a high level of richness and diversity of flora and fauna (above the average level for the region as a whole)
BE-dc	Cenotic diversity	The territory is characterized by a high level (above the average for the region) of richness and diversity of plant communities
BE-s	Uniqueness and rarity of biota	The territory is characterized by a high concentration of endemic, relict and rare species and plant communities
BE-r	Representativeness	The biota of the territory is representative of the corresponding biogeographical region.
L – Landscape criteria		
L-n	Nature	The landscapes of the territory have preserved their appearance in a natural state or close to it
L-u	Uniqueness	There are unique natural landscapes on the territory
L-d	Landscape diversity	A significant number of different and contrasting types of landscapes or natural territorial complexes occur on the territory.
L-r	Representativeness	The landscape structure of the territory is typical for this region
L-c	Cultural importance	The landscapes of the territory have been transformed by man and have significant historical and cultural value
T – Territorial criteria		
T-a	Sufficient area	The area of the territory is sufficient to identify its bio-ecological, functional, landscape, historical and cultural significance on a regional scale
T-c	Territorial integrity	Within the key territory, valuable sites are represented by a continuous massif, or in such a massif there are small windows of anthropogenically altered sites and are spatially connected in a local eco-network.

Thus, the key territories are the territories of the greatest concentration of biodiversity with a high degree of naturalness, rarity, etc., they have a particularly high nature conservation, ecological, scientific and aesthetic value. First of all, the composition of the key territories includes the territories and objects of the nature

reserve fund of high ranks (natural and biosphere nature reserves, national natural parks, as well as large area reserves and protected tracts, regional landscape parks); land plots on which plant communities grow, entered in the Green Book of Ukraine; territories that are places of residence or growth of animal and plant species listed in the Red Book of Ukraine.

Criteria for choosing connecting territories (eco-corridors) of the eco-network

Eco-corridors are spatial structures with an elongated configuration that connect natural cores and include existing biodiversity of varying degrees of naturalness and its habitat. Their main function is to ensure maintenance of reproduction processes, exchange of gene pool, migration of species, spread of species to adjacent territories, survival of adverse conditions, hiding, maintenance of ecological balance. The functional designation of ecocorridors as paths of migration, colonization and gene exchange due to unfavorable conditions is carried out at different geographical distances - from local to global, and for small and sedentary species - from local to regional, which determines the territorial status of ecocorridors.

The shape of the corridors can be different, both straight and winding. According to territorial integrity, continuous and island ecocorridors are distinguished. The first are a continuous strip with natural or semi-natural vegetation, the second are an elongated contour, within which there are natural areas between which the exchange of genetic information exists or is potentially possible. The main conditions for this are:

- ✓ the length of the ecocorridor is no more than the distance over which the majority of species that exist in the key territories connecting the ecocorridor migrate;
- ✓ the width of the ecocorridor allows populations to effectively use it as a migration and settlement channel;
- ✓ edaphic conditions of the ecocorridor are similar or close to edaphic conditions

- ✓ the conditions of those key territories that it connects;
- ✓ within the ecocorridor there are no migration barriers or other factors that could hinder the migration and dispersal of species.

In addition to the connecting value, the ecocorridor can have an independent value for the preservation of bio- and landscape diversity. This is especially important for areas or water areas of hydro-ecological corridors, which themselves have a high level of biodiversity. The components of the connecting territories of the eco-network include: territories and objects of the nature reserve fund (customers, natural monuments, protected tracts); water fund lands, wetlands, water protection zones; lands of the forest fund; other forested areas, incl. forest strips and other protective plantations that are not classified as forest fund lands; recreational lands with their natural resources; other natural territories and objects (areas of steppe vegetation, pastures, hayfields, stone outcrops, sands, salt flats, land plots within which there are natural objects of special natural value); land plots on which plant communities grow, entered in the Green Book of Ukraine; territories that are places of residence or growth of animal and plant species listed in the Red Book of Ukraine; partly agricultural land of extensive use - pastures, meadows, hayfields, etc.

Table 3

Criteria for choosing connecting territories of the eco-network

Index	Criterion	Signs of compliance with the criterion
Ec-n	Nature	The eco-corridor must have natural boundaries.
Ec-l	Effective length	The length of the ecocorridor should not exceed the distance over which the individuals of the populations for the preservation of which the econetwork was created migrate or settle, or there should be "islands" on the territory of the ecocorridor where species can temporarily stay for continued migration or settlement.
Ec-w	Effective width	The width of the ecocorridor should allow populations to settle or migrate along it with the necessary efficiency.

Ec-e	Ectopic	The territory of the ecocorridor should be continuous or have breaks, but the length of the breaks should not interfere with the migration of species.
Ec-t	Territorial communication	The territory of the ecocorridor should have fairly well-preserved vegetation and a high level of biodiversity.
Ec-d	Biodiversity	An eco-corridor may include areas where rare, endemic or relict species of plants and animals grow or exist, or rare areas of the eco-network.
Ec-s	Sozological	The territory of the ecocorridor should be continuous or have breaks, but the length of the breaks should not interfere with the migration of species.

Criteria for choosing buffer areas of the eco-network

Buffer territories are transitional strips between natural territories and territories of economic use. The main function of the buffer area is to protect the territorial elements of the ecosystem from negative anthropogenic influence. Therefore, they must have an area sufficient to protect key territories and eco-corridors from the effects of external negative factors and optimize certain forms of management in order to preserve existing and restore lost natural values. When designing specific local and regional eco-networks, the criteria for allocation of buffer territories are determined by the features of key and connecting territories, for the protection of which the first one is created. The width of the buffer areas is determined depending on the direction and degree of influence of surrounding agricultural lands or industrial facilities on the key and connecting territories of the eco-network, as well as the impact of the latter on agricultural lands.

Criteria for the selection of restoration areas of the eco-network

Restorative areas are created as part of the eco-network for the purpose of its further development and improvement of its functioning. These are territories where it is necessary and possible to restore the natural vegetation cover and carry out the repatriation of plant and animal species. This is a potential reserve, due to which it is possible to increase the area of key and connecting territories in the future.

Therefore, the main criteria for the selection of restoration areas are the preservation of habitats on them, even if the natural biodiversity is completely destroyed (drained peatlands, degraded meadow and steppe natural pastures, thinned forests, agrocenoses of intensive use) and the real possibility of carrying out renaturalization measures.

The following territories are included in the components of the eco-network restoration territories:

- ✓ long-plowed, low-yielding;
- ✓ salted for the second time due to excessive irrigation;
- ✓ pasture failures, areas of cattle drive and places of its permanent concentration;
- ✓ infested with quarantine weed species, including harmful to human health;
- ✓ quarries, rock dumps, etc.;
- ✓ arable land on slopes, which are set aside under soil protection strips, or permanent areas intended for the breeding of wild pollinating insects;
- ✓ embankment slopes and exclusion strips along highways, railways, oil and gas pipelines, power lines and other communications;
- ✓ areas of open soil on which erosion and landslide processes occur or may develop;
- ✓ places of permanent rest and other recreational areas;
- ✓ areas that are subject to long-term conservation due to radiation, chemical or other pollution that poses a threat to the health of people and animals;
- ✓ residential areas subject to reclamation - estates, abandoned farms, etc.

Formation of the eco-network of Ukraine

The new worldview initiated the formation of two strategic directions for the development of protected zoology in Ukraine, namely:

1) improvement of the categorical and functional structure of the PZT system and

2) the creation of a national eco-network as a component of the pan-European network. Therefore, the basis of the concept of building a network of PZT of Ukraine is the following scientific requirements:

1) objects of the PZT network must have a multifunctional purpose according to the main functions (protection, recreation, environmental education and education, balanced use of territories and their restoration);

2) the selection of territories should be carried out taking into account the typicality and uniqueness of ecosystems of natural and geographical zones;

3) it is advisable to place objects more or less evenly;

4) they should be considered in connection with long-term plans for economic development of natural resources;

5) depending on the specific conditions of the region and development tasks, the network will have different ranks, namely: national, regional and local. It follows from this that in the protected sozology of the near future, indisputable priority should be given to the creation of a dense network of NPPs and BZs, which are designed to embody models of sustainable development and rational nature management both for individual regions and for Ukraine as a whole.

The creation of a system of nature-protected territories (hereinafter PZT) must be carried out on a clear scientific basis.

I. Group of scientific approaches. It is designed to provide the PZT system with the necessary set of its elements that create conditions for the protection of biodiversity and stabilization of the ecological balance.

Rare. For scientific purposes, it is necessary to preserve rare ecosystems, phytocenoses and species, primarily relict, endemic or endangered. Based on this, first of all, forest components are reserved and bequeathed.

Categorical and functional. A single structure of mutually complementary categories and functions of PZT is being formed, and new ones are being developed if necessary. A system of palliatives and ways of introducing reserved natural areas is envisaged. The categorical structure should be dynamic depending on the priority goals of protection and changes in the functions of some of its elements.

Security regimes. All scientifically based types of regimes for the protection of forest ecosystems are introduced, and new ones are developed if necessary, especially in cases where several functions of the PZT are in conflict. The system of

protection regimes must be combined with the system of nature management and territorial planning and is formed together with the unified system of PZT.

Monitoring. In the formation of the PZT system, it plays an important role in the fulfillment of global, regional and local environmental tasks. The PZT system will be complete only when it has an extensive network of objects necessary for monitoring and controlling anthropogenic processes occurring at different ecological levels of the forest biome.

II. A group of scientific principles. This includes the principles according to which the state nature-reserved territories (hereinafter, protected areas) forming the system are selected. On its basis, the scientific problems of preserving the gene and cenofund, ensuring the existence of all forms and varieties of life will be solved.

Ecological and phytocenotic. Ensures the representativeness of biodiversity protection, namely: gene pool, cenofond and ecofund of a certain territory (network), primarily in extreme environmental conditions. This principle is fundamental in stabilizing the ecological balance.

Zonal and geographical. Provides landscape-geographical, latitudinal-meridional, and in mountainous regions – altitudinal-belt regularities of distribution of forest natural ecosystems in historical, geographical and other respects in the PZT system.

Evolutionary and genetic. Ensures the preservation of all links of the evolutionary processes of the biostroma. It is based on a population approach, where special attention is paid to evolutionarily progressive and ancient species and their forms. According to this principle, protection of forest price systems of a dynamic type, which have an important ecologically stabilizing value, is carried out.

III. A group of natural and social principles. It complements the PZT system with principles that are not the main thing in solving the problem of biodiversity conservation, but only represent a scheme of balanced development in nature use, which represents society's attitude to nature in the ideal.

Cultural and educational. It provides for the inclusion of all forest objects of general educational, scientific and informational, cognitive, and cultural importance

in the PZT. First of all, these are classical objects that contribute to the development of the population's ideas about the general laws of nature, its functioning, and its importance for society.

Aesthetic. Causes the inclusion of the most picturesque areas of nature in the PZT system, which contribute to the development of the emotional sphere of a person and his aesthetic ideas.

Recreational. It stipulates the inclusion of territories rich in recreational resources, that is, forest territories of general health, balneological, sanitary-hygienic, and sports-tourist significance. The area of these facilities should ensure year-round mass recreation of people without harming nature.

Resource and economic. It determines the preservation of forest territories that have applied national economic significance and are used by humans in the production sphere.

In terms of qualitative and quantitative content, scientific and ecological value, the regime of protection of PZT are unequal. Therefore, they can be united by similar characteristics into certain aggregates representing some nature protection category. A unified categorical structure of the PZT system has not yet been developed, since the PZF of Ukraine is not perfect in terms of the number and quality of categories. In addition to the artificially created ones, it includes only natural, generally recognized natural parks and natural parks and regional natural parks (hereafter RLP), sanctuaries and natural monuments, protected tracts. In foreign countries, there are a number of other categories that are represented in the IUCN classification. The main elements of the national eco-network of state importance are presented in Table 4.

Table 4

The main elements of the national eco-network of national significance

Element ecological network	Location according to physical and geographical conditions	The main territories and objects are components of the ecological network
Natural regions		

Carpathian	Carpathian mountain country Precarpathia and Opilia	Biosphere Reserves: Carpathian, Roztochan, Eastern Carpathians; Gorgan Nature Reserve; Natural national parks: Synevir, Karpatsky, Uzhansky, Skolivsky Beskydy, Hutsulshchyna Halytskyi National Natural Park
Crimean mountain	Carpathian mountain country	Nature reserves: Crimean, Yalta, Karadaz, Opuk; Natural national parks: Sevastopol, Chatyr-Dag.
Zahidnopolisky	Western Polissia	Western Polissia Biosphere Reserve; Nature reserves: Cheremskyi, Rivneskyi, Yuzhnopoliskyi.
Central	Dnipro Polissia	Polisky Biosphere Reserve; Nature reserves: Dniprovskyi, Desnyanskyi; Natural national parks:Mezynskyi, Korostyshivskyi, Ichnyanskyi, Holosiivskyi forest.
Polisky	Eastern Polissia	Natural national parks: Srednyoseimskyi, Desnyansko-Starogutskyi, Trostyanetsko-Vorskliansky
Eastern Polisky	Podilsk Heights	Medobora Nature Reserve; Natural national parks: Podilsky Tovtry, Kremenetsky Mountains, Central-Podilskyi, Savransky Forest, Dniester Canyon.
Podolsky	Middle Dnieper	Ukrainian forest-steppe Biosphere reserve; national natural parks: Cherkasy Bir, Kholodny Yar, Middle-Prydniprovsky, Trakhtemyrivsky, Preyaslav-Khmelnytskyi, Chornoliskyi; Kaniv nature reserve.

Middle Dnieper	Valley of the River Siverskyi Dinets	National nature parks: Svyati Gory, Siversko-Donetsk, Slobozhansky, Homolshansky.
Donetsk-Priazovsky	Donetsk ridge, Azov upland	Ukrainian Steppe Nature Reserve; National natural parks: Pryazovsky Meotida.
Tavriyskyi	The Dnieper-Molochan confluence	Biosphere reserves: Chornomorskyi, Askania Nova; National nature parks: Nizhnyodniprovsky, Azov-Syvasky.
Nizhny-Dniester	Below the valley of the Dniester river	Nizhny Dniester Natural National Park.
Lower Danube	Below the valley of the Danube river	Danube Biosphere Reserve.
Azov	Sea of Azov	Kazantypskyi, Opukskyi nature reserves; national natural parks: Azov-Syvasky, Meotida.
Of Black Sea	Northeast shelf	National natural parks: Big phyllophore field, Zernova, Small phyllophore field, Kinburska spit.
Natural corridors		
Polisky	Zone of mixed forests	Forests of the first and second groups, swamps.
Halytsko-Slobozhanskyi	Forest-steppe zone	Forests of the first and second groups, forest strips, meadows, pastures.
South Ukrainian	Steppe zone	Forest strips, pastures, hayfields.
Priberezhnomorskyi	Riverside	Inland sea waters, sea spits, shoals, beaches, islands.
Dnistrovskyi	Azov and Black seas	Floodplain meadows, shrubs, sloping land with little vegetation cover, forests, water bodies.

Buzky	The valley of the Dniester river	Floodplain meadows, shrubs, sloping land with little vegetation cover, forests, water bodies.
Dniprovsky	River valleys of the Western and	Floodplain meadows, shrubs, sloping land with little vegetation cover, forests, water bodies
Seversko-Donetsk	Southern Bug	Floodplain meadows, shrubs, sloping land with little vegetation cover, forests, water bodies

Task:

Task 1. Compose a crossword based on the Additional material (10 questions each horizon tally and vertically).

Task 2. Fill in table 5 based on the Additional material contained in the practical work.

Table 5.

A group of scientific approaches

Scientific approaches	Value

Task 3. Describe the group of scientific and socio-natural principles and fill in Table 6.

Table 6.

A group of scientific and socio-natural principles

№	Principles	Characteristic

Task 4. Describe the main elements of the national ecological network and indicate which ecological element of the ecological network they belong to. Fill in table 7.

Table 7.

The main elements of the national eco-network of national significance

The main territories and objects are components of the eco-network	An element of the ecosystem
Biosphere Reserves: Carpathian, Roztochan, Eastern Carpathians; Gorgan Nature Reserve; Natural national parks: Synevir, Karpatsky, Uzhansky, Skolivskyi Beskydy, Hutsulshchyna Halytskyi National Park	
Nature reserves: Crimean, Yalta, Karadaz, Opuk; Natural national parks: Sevastopol, Chatyr-Dag.	
Western Polissia biosphere reserve; Nature reserves: Cheremskyi, Rivneskyi, Yuzhnopoliskyi.	
Polisky Biosphere Reserve; Nature reserves: Dniprovskyi, Desnyanskyi; Natural national parks: Mezynskyi, Korostyshivskyi, Ichnyanskyi, Holosiivskyi forest.	
Natural national parks: Serednyoseimsky, Desnyansko-Starogutsky, Trostyanetsko-Vorskliansky;	
Medobora Nature Reserve; Natural national parks: Podilsky Tovtry, Kremenetsky Mountains, Central-Podilskyi, Savransky Forest, Dniester Canyon.	
Ukrainian forest-steppe biosphere reserve; national natural parks: Cherkasy Bir, Kholodny Yar, Middle-Prydniprovsky, Trakhtemyrivsky, Preyaslav-Khmelnytskyi, Chornoliskyi;	
National nature parks: Svyati Gory, Siversko-Donetsk, Slobozhansky, Homolshansky.	
Ukrainian Steppe Nature Reserve; National natural parks: Pryazovsky Meotida.	
Biosphere reserves: Chornomorskyi, Askania Nova; national natural parks: Nizhnyodniprovsky, Azov-Syvasky	

Nizhny Dniester Natural National Park.	
Danube Biosphere Reserve.	
Kazantypskyi, Opukskyi nature reserves; national natural parks: Azov-Syvasky, Meotida.	
National natural parks: Big phyllophore field, Zernova, Small phyllophore field, Kinburska spit.	

Make conclusions:

_____

_____

_____

_____

Practical work 14.

Determining the amount of damage caused by the illegal destruction of wild animals

Purpose: to determine the amount of damage caused as a result of illegal extraction or destruction of objects of the animal world, damage or destruction of their habitats and places of residence and reproduction.

Progress:

1. Familiarize yourself with the additional material.
2. Calculate the damage caused by the violation of the legislation on the nature reserve fund as a result of illegal extraction or destruction of objects of the animal world, damage or destruction of their dwellings and structures, places of stay and reproduction according to your option.
3. To characterize the species of destroyed animals listed in the Red Book of Ukraine according to the options.
4. To draw a conclusion about the damage caused to the environment and ways to minimize it.

Additional material

According to the "National Program for the Preservation of Biodiversity for 2005-2025", biodiversity is the national wealth of Ukraine, the preservation and tireless use of which is recognized as one of the priorities of the state policy in the field of nature management, ecological safety and environmental protection, an integral condition for improving its condition and ecologically balanced social and economic development.

This is facilitated by fees (fees) for damage or destruction of objects listed in the Red Book of Ukraine.

The calculation of the damage caused by the violation of the legislation on the nature reserve fund as a result of illegal extraction or destruction of objects of the animal world, damage or destruction of their dwellings and structures, places of stay and reproduction is carried out in accordance with Resolution of the CMU No. 541 dated 07.29.2013 "On approval of fees for calculation of the amount of damage

caused by a violation of the legislation on the nature reserve fund" (CMU Resolution No. 521 of 04/21/1998 "On approval of fees for calculating the amount of compensation for damage caused by a violation of the nature protection legislation within the territories and objects of the nature reserve fund of Ukraine » cancelled).

Damage is calculated according to the formula:

$$D = \sum n_{i=0} (Ad_i \cdot n) + \sum n_{i=0} (Ad_{i\,i} \cdot n_d \cdot C_d) + \sum n_{i=0} (Ad_{i\,i} \cdot n_e \cdot C_e) + \sum n_{i=0} (Ad_{i\,i} \cdot n_{ee} \cdot Cde),$$

(1)

where ***Ad*** - the amount of damage caused by illegal extraction or destruction of objects of the animal world listed in the Red Book of Ukraine, hryvnias/individual. (Table 2);

n - the number of individuals of illegally obtained or destroyed objects of the animal world, listed in the Red Book of Ukraine (Table 1);

nd- the number of damaged habitats of animals listed in the Red Book of Ukraine, pcs. (Table 1);

Cd - the coefficient that is taken into account in the case of damage to the habitat of animals listed in the Red Book of Ukraine (***Cd***=2);

ne - the number of illegally extracted or destroyed embryos of animals listed in the Red Book of Ukraine, pcs. (Table 1);

Ce - the coefficient that is taken into account when extracting or destroying embryos of animals listed in the Red Book of Ukraine (***Ce***=2);

Nee - the number of illegally extracted or destroyed eggs of birds, entered in the Red Book of Ukraine, pcs. (Table 1);

Cde - the coefficient that is taken into account when extracting or destroying the eggs of birds listed in the Red Book of Ukraine (***Cde*** =1).

Special cases of damage assessment:

1. The amount of damage caused by illegal harvesting or destruction of animals from the classes of insects and amphibians also extends to the larval stage of development.

2. The amount of damage established for systematic groups of animals applies to all species in these groups.

3. In the event that illegal actions on the territory of the nature reserve cause the destruction of an animal colony (including without the destruction or destruction of nests and other habitats), compensation for the damage is calculated as for the destruction of all nests (residents) in the colonial settlement.

4. For the destruction or illegal removal of animals that are in the zoological collections of zoos, zoos, oceanariums, other institutions and objects of the nature reserve fund, created for the purpose of organizing educational work and keeping animals in captivity or semi-free conditions, as well as for the cruel treatment of animals, which led to their death, the amount of damage is determined by three times the amount of costs for the purchase of animals of the corresponding species to renew the collections.

Table 1

Characteristics of illegally extracted or destroyed objects of the animal world, damaged or destroyed dwellings and structures, places of residence and reproduction

№	**The type of object is animal the world**	**Number,** ex.	**Notic**
1	2	3	4
1	elk little petrel terrapin	1 2 5	
2	Turkmen kulan great white heron toad	1 1 6	1 nest destroyed
3	noble deer whooper swan ladybug	2 8 15	Destroyed 1 embryo
4	fallow deer quail scarab	1 3 15	Destroyed 1 embryo
5	spotted deer little white heron newt	2 1 2	1 nest destroyed damage 3 holes
6	wild pig gray heron Scorpio	2 1 2	1 nest destroyed
7	moufflon flamingo turbot flounder	2 1 2	

8	roe	1	Destroyed 1
	swan-caller	8	embryo
	ant lion	5	1 nest destroyed
9	beaver	1	
	white stork	4	Destroyed 1
	burrowing wasp	10	
10	fox	3	3 nests destroyed
	a large hawk	2	
	peacock eye	5	
11	raccoon dog	2	
	red heron	1	1 nest destroyed
	common viper	5	
12	wolf	4	Destroyed 2
	white partridge	3	embryos
	pike	2	
13	American mink	2	Destroyed 2
	common pheasant	1	embryos
	singing cicada	5	
14	marmot	1	Destroyed 2 burrows
	long-tailed eagle	1	
	mackerel	3	
15	muskrat	2	
	harrier	2	1 nest destroyed
	caviar of amphibians	1 placing	
16	ordinary hedgehog	4	
	common cuckoo	1	
	crayfish	10	
17	squirrel	1	
	nuthatch	3	
	spinning wheel	4	
18	ordinary blind man	4	Destroyed 1
	kingfisher	8	embryo
	lobster	2	4 eggs destroyed
19	the rat is black	4	
	long-eared owl	3	
	shuttlecock	5	
20	water vole	14	Destroyed 3 burrows
	remez	2	1 nest destroyed
	mantis	5	

Table 2

Reference data for practical work

Objects of the animal world	**Unit**	**The amount of damage**
1	2	3
Animals:		
elk	for 1 person	40000
Turkmen kulan	for 1 person	20000
noble deer		16500
doe, spotted deer, wild boar		11000
mouflon, roe deer		8800
beaver, badger		2860
fox, raccoon dog		2605

wolf		1000
marmot, American mink		2710
muskrat, nutria free		1824
ordinary hedgehog, mole		260
squirrel		495
ordinary blind man		521
the rat is black		182
water vole		26
Birds:		
great white and little white heron	for 1 person	3645
gray and red heron	for 1 person	1730
white stork		2970
whooper swan, whooper swan		2657
a large hawk		4950
harrier		1250
long-tailed eagle		3000
flamingo		2657
white partridge		939
common pheasant		939
kingfisher		250
common cuckoo		396
long-eared owl		1484
remez		521
nuthatch		350
quail		469
little petrel		250
Reptiles:		
terrapin	for 1 person	350
common viper, spinner		730
Amphibia:		
newt	for 1 person	26
toad		47
caviar of amphibians	for 1 laying	26
Fish		
pike	for 1 copy	602
turbot flounder		1515
mackerel		752
Butterflies:		
peacock eye, mother-of-pearl,	for 1 person	16
singing cicada, praying mantis		21
Beetles:		
ground beetle (turun)	for 1 person	31
scarab, rhinoceros		26
Reticulata:		
ant lion	for 1 person	16
Hymenoptera:		
bees, burrowing wasps	for 1 person	10
Arachnids:		
scorpion, pseudoscorpion,	for 1 person	8
Shellfish:		

river crayfish, hermit crab	for 1 person	45
lobster		1560
Roundworms:		
spinning wheel	for 1 person	301
Intestinal:		
hydroids, jellyfish, coral polyps	for 1 person	2

Answer the questions:

1. According to which document is the calculation of damage caused by violation of the legislation on the nature reserve fund as a result of illegal extraction or destruction of objects of the animal world?
2. What coefficients must be taken into account when calculating the amount of damage caused by illegal extraction or destruction of objects of the animal world listed in the Red Book of Ukraine?
3. What indicators depend on the calculation of damage caused by violation of the legislation on the nature reserve fund as a result of illegal extraction or destruction of objects of the animal world, damage or destruction of their dwellings and structures, places of residence and reproduction?
4. Describe special cases of damage assessment.

Reference

1. Environmental assessment of land of agricultural enterprise in Ukraine / Vita Strokal, Liudmyla Vagaliuk // IX International Scientific Agriculture Symposium "Agrosym 2018" – P. 511-512.
2. Vagaliuk L.V. Biodiversity and trophic relationships of entomofauna of agrolandscapes of the Forest-Steppe of Ukraine / Vagaliuk L.V., Minyaylo V.M. Chaika // Scientific Bulletin of the National University of Life and Environmental Sciences of Ukraine. 2016. - Issue 234. - P. 78-89.
3. All-Ukrainian strategy for the conservation of biological and landscape diversity. - K., 1998. - 52 p.
4. Horbatenko A.A. Calculation of the MSA index on the territory of the SE NUBiP of Ukraine "Agronomic Experimental Station" using the experience of global modeling // Abstracts of the international scientific-practical conference of young scientists "Actual problems of life sciences and nature management" October 26-29, 2011, Kyiv, pp. 28-29.
5. Ermakov D.S. "Ecological footprint - an indicator of sustainable development" // Bulletin of Ecological Education in Academy of MNEPUM. - T.1., V. 67.- 2013.- P. 16-19.
6. Emelyanov, I. G. Assessment of biodiversity of ecosystems in the context of optimization of the network of protected areas // Conservation in Ukraine at the turn of the millennium (current state, problems and development strategy): Materials of the All-Ukrainian ... conf. (Kaniv, October 11-14, 1999). Kaniv, 1999. P. 119-127.
7. Reserves and national parks of Ukraine. - K.: Higher school, 1999. - 230 p.
8. Conservation of biodiversity of Ukraine: Second national report. - K.: ChemJest, 2003. - 112 p.
9. Vagaliuk L. The use of ecological network as a measure for biocenotic reclamation of agricultural landscapes of Ukraine //International scientific and practical conference "Challenges, threats and developments in biology, agriculture,

ecology, geography, geology and chemistry": conference proceedings, July 2-3, 2021. Lublin: "Baltija Publishing"

doi https //doi.org/10.30525/978-9934-26-111-4-11

10. Translated with www.DeepL.com/Translator (free version) Conservation and monitoring of biological and landscape diversity in Ukraine. - K.: NNC, 2000. - 244 p.

11. Kovalchuk A.A. The reserved case. - Uzhhorod: Lira, 2002. - 328 p.

12. Convention on Biodiversity. - Ministry of Environment, 2005.

13. Kuznetsova U.V. Reserve business: Study guide. - Symf.: TEI, 1999. -52 p.

14. Malysheva N.R., Oleshchenko V.I., Kuznetsova S.V., Karamushka V.I. Legal principles of implementation of the Convention on Biodiversity in Ukraine. K.: ChemJest, 2003. - 176 p.

15. Stoyko S.M. Ecological strategy of functioning of biosphere reserves in Ukraine and increasing the representativeness of their networks / S.M. Stoyko // Ukrainian Botanical Journal - 1999. - Vol. 56. - No. 1. - P. 89-95.

16. National action plans for the conservation of globally vulnerable birds. - K.: SoftArt, 2000. - 205 p.

17. The main aspects of the conservation and reproduction of biological diversity of Ukraine / L.V. Vagaliuk, N. Kysil \\ VII International Scientific and Practical Conference of Students, Postgraduates and Young Scientists "Ecology - the philosophy of human existence" April 21-23, 2021 - P. 64-66.

18. Patyka V.P., Solomakha V.A., Burda R.I. et al. Prospects for the use, conservation and reproduction of agrobiodiversity in Ukraine. - K.: ChemJest, 2003. - 256 p.

19. Action plans for the conservation of populations of flora and fauna species listed in the Red Data Book of Ukraine and international Red Lists within the institutions of the nature reserve fund. - Kh.: Ryder, 2006. - 160 p.

20. Nature Reserve Fund of Ukraine of national importance: Handbook. - K., 1999. - 240 p.

21. Strokal V.P. Ecological certification of economic entities by types of nature use: theoretical substantiation // Herald of KhNAU - 2013, № 2, pp. 247-256.

22. Subin O.V. Methodical instructions for laboratory work in the discipline "Fundamentals of biodiversity".-Kyiv: Publishing House of the Ukrainian Phytosociological Center.- 2014.- 95p.

23. Taxonomic structure of plant communities. [Electronic resource]. - Access mode: https://studfiles.net/preview/5461929/.

24. Chaika V.M., Vagaliuk L.V. Ecological principles of conservation of agrobiodiversity of insect dendrobionts of the Northern Forest-Steppe of Ukraine: Monograph / V.M. Chaika, L.V. Vagaliuk / edited by Doctor of Agricultural Sciences, Professor V.M. Chaika - Kyiv, CP "Komprint", 2018. 174 p.

25. Red Book of Ukraine. Plant world. - K.: Ukrainian Encyclopedia named after M.P. Bazhan, 1996. - 608 c.

26. Red Book of Ukraine. Animal world. - K.: Ukrainian Encyclopedia named after M.P. Bazhan, 1994. - 463 c.

27. Shelyag-Sosonko Y.R., Dubyna D.V., Makarenko L.P. et al. Conservation and sustainable use of biodiversity of Ukraine: state and prospects. K.: ChemJest, 2003. - 243 c.