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BioSustainED

PRACTICAL TEACHING GUIDE:

METHODOLOGICAL GUIDELINES FOR BIODIVERSITY TEACHING AT SCHOOL

(designed for grades 10-12 in Latvia and Lithuania)

BioSustainED: Teacher Capacity Building in Biodiversity

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FOREWORD

Modern education programme is becoming increasingly complex and versatile. New curriculum, especially in life sciences includes a lot of laboratory and practical work in the field. Contemporary education is guided in the direction of practical real-life examples.

Learning becomes more focused on analysing information rather than memorizing it. The new curriculum is full of descriptions – "compares and explains, gets data, makes plans for research, and observes nature". However, teachers generally have an extremely small amount of practical material and skills for the new curriculum. Lack of teachers experience in working in nature and in the practical field can reduce the level of knowledge acquired by students. Thus, teachers need guidelines providing them with a clear understanding and specific steps to carry out practical lessons and extracurricular activities.

This guide provides teachers active in different school subjects with materials for conducting practical exercises for biodiversity exploration and understanding in classes and in nature. This guide is designed for teaching in general secondary education in Latvia or in gymnasium in Lithuania (grades 10-12).

Nowadays, the world is fast-paced, full of unsustainable human choices. This vicious circle leads to an even more rapid consumption of natural resources. Among various natural resources conservation measures, environmental education is now more important than ever, since *what children learn today will shape tomorrow's world* (The UNESCO climate change initiative, 2010).

Artificial intelligence plays an essential role in daily life. Different trainings on integration of this technology to the teaching process are available. This guide offers teaching materials not requiring the use of high-tech technologies in teaching biodiversity and tasks were elaborated without the support of the artificial intelligence. However, authors of this guide addressed ChatGPT to suggest a quote for this guide:

"Teachers nurture minds just as biodiversity nurtures life – both remind us that every species, every question, and every curiosity have a purpose in the grand design of our world."

(ChatGPT)

The project team is grateful to all teachers, experts, policy makers and everyone who contributed to the development of this guide – by providing feedbacks, participating in project events, engaging in lively discussions and interesting talks.

INTRODUCTION

Biodiversity refers to the richness and variety of the living world, as well as its ability to adapt to environmental changes and ensure the survival of species. Therefore, it is considered an invaluable natural heritage to be protected for future generations. Biodiversity is integral to Earth's equilibrium, providing the ecological foundation for the planet's stability, resilience, and sustainability. Overall, biodiversity is fundamental to the functioning of ecosystems and the sustainability of life on Earth. **Protecting and conserving biodiversity is essential for maintaining Earth's equilibrium and ensuring the well-being of present and future generations.**

Biodiversity is intricately connected with **biology**, the **study of living organisms and their interactions with each other and their environment.** For secondary school topics such as evolutionary biology, genetics and molecular biology, conservation biology are especially important.

Biodiversity relates to **geography**, the study of Earth's landscapes, environments, and spatial relationships. Biodiversity and geography subjects intersect and it is **biogeography** (**studies the distribution of species and ecosystems across space and time**), ecosystem geography (explores the geographic patterns of different ecosystem types, their biodiversity, and the ecological processes that govern their functioning), protected areas and conservation planning, climate change.

Biodiversity and **mathematics** might seem unrelated at first glance, but mathematics **plays a crucial role in understanding and analysing biodiversity patterns, processes, and conservation strategies.** Such theme as probability and statistics is a base of species distribution modelling, population dynamics.

Biodiversity relates to secondary school **chemistry** through various interdisciplinary approaches, **highlighting the connections between chemical processes and the living world such as chemical ecology, biochemical pathways** (involved in metabolism, photosynthesis, and respiration in living organisms), biogeochemical cycles, green chemistry and sustainability.

Biodiversity offers a rich and engaging topic for **school science projects**, providing opportunities for students to explore the natural world, conduct experiments, and develop critical thinking skills. Students can conduct **field surveys to document the biodiversity of local ecosystems**, such as parks, forests, or school grounds. Students can **investigate how different factors, such as habitat type, vegetation structure, and human disturbance, influence biodiversity**. Students can **study species interactions within ecosystems, such as predator-prey relationships, competition for resources, and mutualistic interactions.** They can design **experiments to explore the effects of these interactions on biodiversity and ecosystem dynamics.** Students can research threats to biodiversity, such as habitat loss, pollution, invasive species, and climate change, and propose conservation strategies to mitigate these threats. They can develop **action plans for promoting biodiversity conservation in their local community or school.** Students can participate in citizen science projects that involve collecting data on biodiversity for scientific research. They can **contribute to online databases and monitoring** programs by submitting observations of plants, animals, and other organisms in their area. Students can **create biodiversity gardens or green spaces on school grounds to attract native wildlife** and promote biodiversity. Students can learn basic data analysis techniques, such as **calculating species richness, diversity indices, and evenness measures,** to analyse biodiversity data collected during field surveys or experiments. School science projects focused on biodiversity provide hands-on learning experiences that engage students in scientific inquiry, foster environmental awareness, and encourage stewardship of the natural world. These projects can be tailored to different grade levels and educational objectives, providing opportunities for students to develop a deeper understanding of biodiversity and its importance for ecosystem health and sustainability.

THEORETICAL PART

OVERVIEW ABOUT BIODIVERSITY TOPIC

Definition and Scope

Biodiversity

Biodiversity is the variety of all living things and their interactions.

Biodiversity = biological diversity

The importance of biodiversity is multifaceted and extends across ecological, economic, social, and cultural dimensions. First, biodiversity ensures the resilience and stability of ecosystems. Different species play various roles in maintaining the balance of natural processes such as nutrient cycling, water purification, and pollination. A diverse ecosystem can better withstand environmental changes.

Biodiversity contributes to ecosystem services such as:

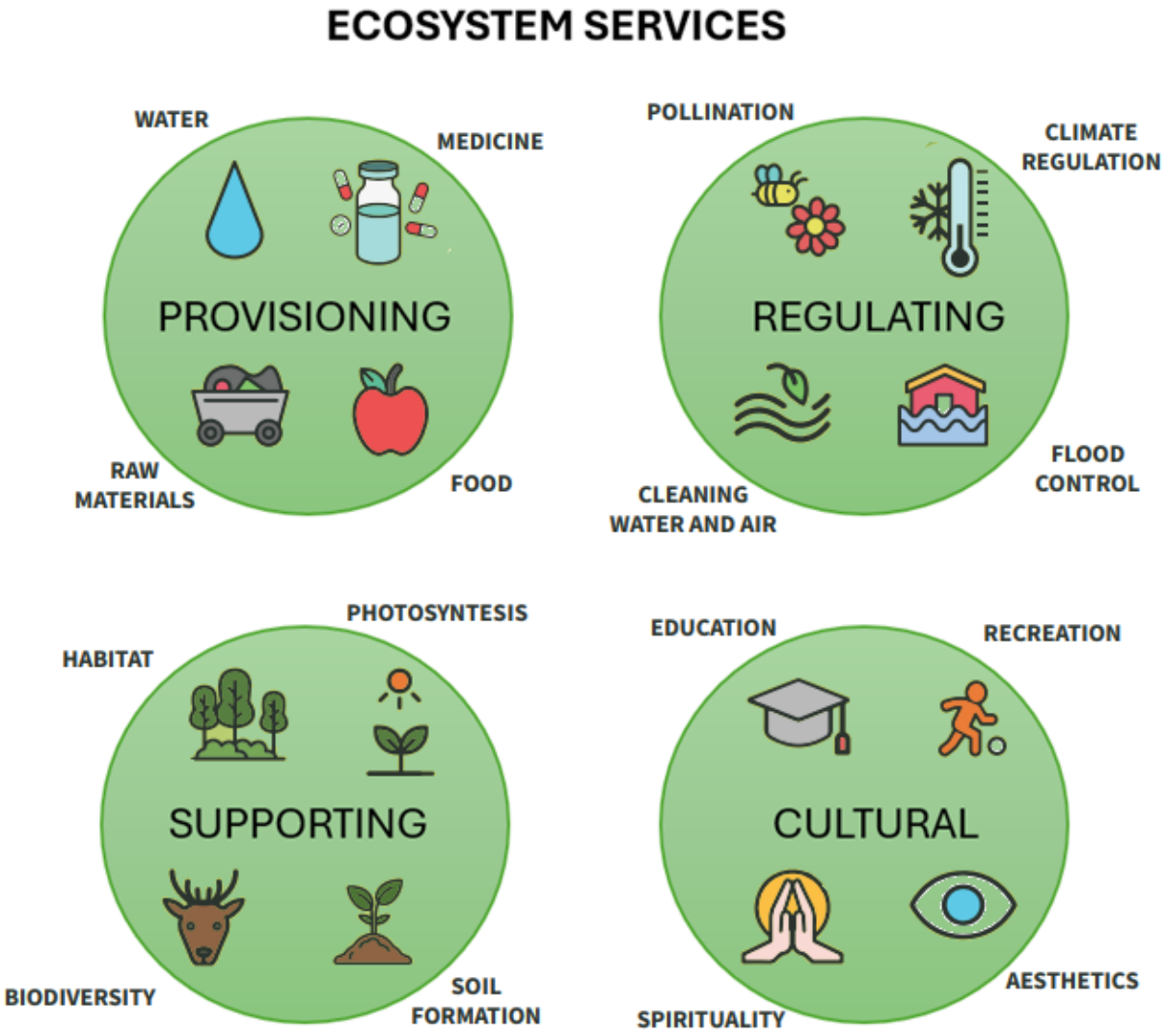
- **Provisioning services (the products obtained from ecosystems)**
  - ✓ Food: Crops, fruits, vegetables, fish, and livestock.
  - ✓ Water: Freshwater for drinking, irrigation, and industrial use.
  - ✓ Raw Materials: Timber, fibre, and fuelwood.
  - ✓ Genetic Resources: Genes for crop improvement and medicine.
  - ✓ Medicinal Resources: Plants and animals used for traditional and modern medicine.

- **Regulating services (the benefits obtained from the regulation of ecosystem processes)**
  - ✓ Climate Regulation: Forests and oceans absorb carbon dioxide, helping to regulate the global climate.
  - ✓ Water Purification: Wetlands and forests filter pollutants from water.
  - ✓ Pollination: Bees and other insects pollinate crops and wild plants.
  - ✓ Disease control: Natural ecosystems can control the spread of diseases through predators and biodiversity.
  - ✓ Erosion control: Plant roots stabilize soil and prevent erosion. Cultural services (non-material benefits that people obtain from ecosystems)

- **Cultural: Natural areas for tourism, hiking, and outdoor sports**
  - ✓ Aesthetic: Landscapes that provide inspiration and beauty.
  - ✓ Educational: Ecosystems serve as living laboratories for scientific research and education.

  Spiritual and Religious: Natural sites and species hold cultural, spiritual, or religious significance.

- **Supporting services (necessary to produce all other ecosystem services)**
  - ✓ Nutrient Cycling: Decomposition of organic matter and recycling of nutrients in the soil.
  - ✓ Soil Formation: Formation of soil through processes such as weathering and organic matter accumulation.
  - ✓ Primary Production, biodiversity and habitat: Photosynthesis and plant growth, which form the basis of food webs.



Biodiversity contributes to ecosystem services. Credit: BioSustainED

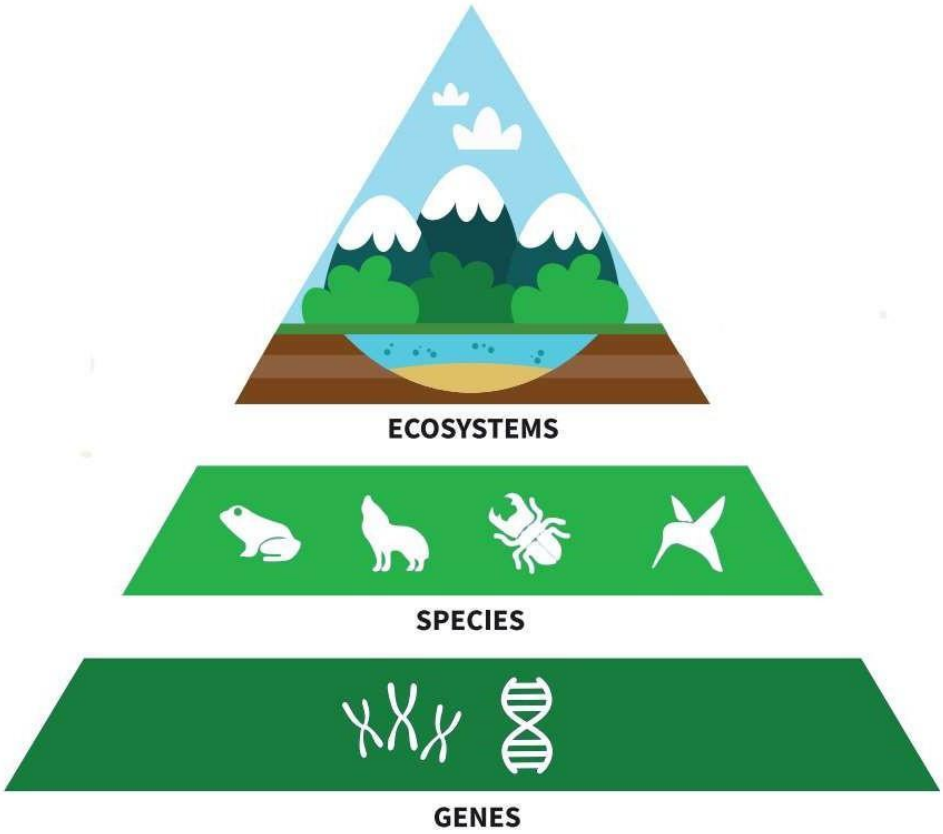
Why ecosystem services are important?

These services are vital for keeping a habitable planet and mitigating the impacts of climate change. Biodiversity is a vast reservoir of genetic material that can be harnessed for crop improvement, disease resistance, and other applications in agriculture and medicine. Loss of biodiversity means a loss of potential future benefits. From an economic point of view **biodiversity provides numerous ecosystem services that are essential for human well-being, including food, medicine, and materials for industry.**

For example, many pharmaceuticals are derived from plants, and diverse agricultural systems are more resistant to pests and diseases. Biological diversity enriches our lives by providing opportunities for recreation, tourism, and aesthetic enjoyment. Natural landscapes, diverse wildlife, and ecosystems attract millions of visitors each year, contributing to local economies and human well-being.

Biodiversity types

Biodiversity can be considered at three main levels: genetic diversity, species diversity, and ecosystem diversity.



Levels of biodiversity. Credit: BioSustainED

Elements of biodiversity:

Ecosystem Diversity	Genetic diversity	Species Diversity
Biomes	Populations	Domains or Kingdoms
Bioregions	Chromosomes	Phyla
Landscapes	Individuals	Families
Ecosystems	Genes	Genera
Habitats	Nucleotides	Species
Niches Populations		Subspecies
		Populations
		Individuals

Genetic diversity

Genetic diversity includes not only the individual genetic variation within a population, but also the genetic variation between populations that is often associated with adaptations to local conditions. If one population becomes extinct, then a species may have lost some of the genetic diversity that makes microevolution possible. This erosion of genetic diversity in turn reduces the adaptive prospects of the species. The loss of genetic diversity throughout the biosphere also affects human welfare. If we lose wild populations of plants closely related to agricultural species, we lose genetic resources that could be used to improve crop qualities, such as disease resistance, through plant breeding. For example, plant breeders responded to devastating outbreaks of the grassy stunt virus in rice (*Oryza sativa*) by screening 7,000 populations of this species and its dose relatives for resistance to the virus. One population of a single relative, Indian rice (*Oryza nivara*), showed resistance to the virus, and scientists succeeded in breeding the resistant trait into commercial rice varieties. Today, the original disease-resistant population has apparently become extinct in the wild.

Species diversity

Public awareness about the **biodiversity crisis primarily focuses on species diversity**, which refers to the variety of species within an ecosystem or across the biosphere. As species face extinction, the overall species diversity diminishes. Threatened species are those expected to become endangered in the foreseeable future. Species extinction can occur locally, such as when a species disappears from one river system while persisting in an adjacent one. Global extinction of a species indicates its disappearance from all ecosystems it inhabited, resulting in a permanent loss to biodiversity.

Statistics shedding light on the issue of species loss: 12% of the nearly 10,000 known bird species and a minimum of 20% of the nearly 5,000 known mammal species are under threat (https://iucn.org/). 20% of the recognized species of freshwater fishes globally have either gone extinct or are currently facing serious threats. 32% of all known amphibian species are either on the brink of extinction or classified as endangered (Stuart at al. 2004).

Purpose of the Red Data Book:

Identification of endangered species	The primary purpose of the Red Book is to identify species that are at risk of extinction within a particular region. This includes both plants and animals, as well as fungi and other organisms.
Conservation planning	The Red Book provides essential information for conservation planning and management. It helps governments, conservation organizations, and scientists prioritize species for protection and allocate resources effectively.
Public awareness	The publication of the Red Book raises public awareness about the importance of biodiversity conservation and the threats facing endangered species. It serves as a tool for education and advocacy.

The "The Red Data Book" is a commonly used term to refer to a list of endangered and threatened species. Each country typically maintains its own Red Book or equivalent publication, which catalogues species at risk of extinction within that specific region. The Red Book serves as a crucial tool for conservation efforts, helping to identify species in need of protection and prioritize conservation actions.

Overview table of Latvian protected animal species in the Latvian Red Book:
http://latvijas.daba.lv/aizsardziba/augi_dzivnieki/dz_tabula.shtml

The Lithuanian Red Book:
https://am.lrv.lt/uploads/am/documents/files/Raudonoji%20knyga/Raudonoji_knyga_2021_WEB.pdf

Ecosystem diversity

The diversity of ecosystems of the biosphere represents another facet of biological diversity. Ecosystems are intricate networks of interactions among different species populations, where the local disappearance of even a single species can detrimentally impact the overall species richness of the community. For example, in the Pacific Islands, flying foxes, a type of bat, play crucial roles as pollinators and seed dispersers. Unfortunately, they face escalating threats from hunters who sell them as luxury food items.

Conservationists are deeply concerned about the potential repercussions of flying fox extinction on the indigenous flora of the Samoan islands. Already in 2001 more than 79% of the island's trees rely on flying foxes for either pollination or seed dispersal. This interdependence underscores the vulnerability of ecosystems to the loss of key species (Brooke, 2001).

Human activities have significantly altered many ecosystems, with some facing rapid degradation. For instance, European colonization led to the drainage and conversion of over 50% of wetlands in the contiguous United States into agricultural lands. In the southwestern states of California, Arizona, and New Mexico, native riparian communities have suffered extensive damage due to factors like overgrazing, flood control measures, water diversions, declining water tables, and the encroachment of non-native plant species. Such alterations underscore the urgent need for comprehensive conservation efforts to safeguard the integrity and resilience of Earth's diverse ecosystems.

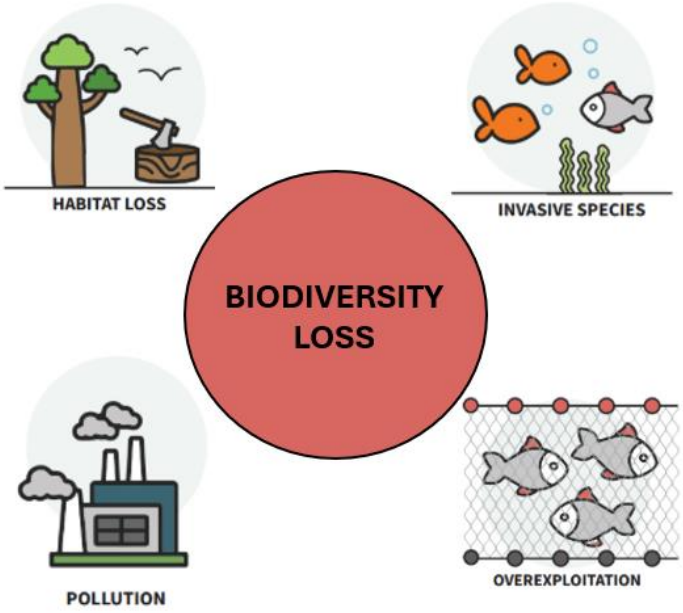
Ecosystem stability	
Endurance	**Flexibility**
How long can the ecosystem withstand the impact?	How quickly can the ecosystem restore balance?

Threats of human activities on biodiversity loss

Many different human activities threaten biodiversity on local, regional, and global scales.

The threats posed by human activities are of three major types:

- habitat loss;
- introduced species;
- overexploitation of soil and resources;
- pollution.



Threats of human activities on biodiversity loss. Credit: *BioSustainED*

Habitat loss

Human modification of habitats is the most significant threat to biodiversity across the globe. Habitat destruction has been caused by agriculture, urbanization, logging, mining, and pollution. Climate change is already transforming habitats today and is expected to have an even more substantial impact. When species cannot find alternative habitats or are unable to relocate, habitat loss can lead to extinction. According to the International Union for Conservation of Nature, habitat destruction is responsible for the extinction, endangerment, vulnerability, or rarity of 73% of species over the last few centuries. Habitat loss and fragmentation can occur over vast areas.

What are worldwide examples of the terrestrial habitat loss?

Nearly 98% of the tropical dry forests in Central America and Mexico have been cleared. In the state of Veracruz, Mexico, the clearing of tropical rainforests primarily for cattle ranching has resulted in the loss of about 91% of the original forest, leaving behind a fragmented landscape of small forest patches. Other natural habitats have also been fragmented by human activities. Almost invariably, habitat fragmentation results in species loss, as the smaller populations in fragmented habitats have a higher likelihood of local extinction.

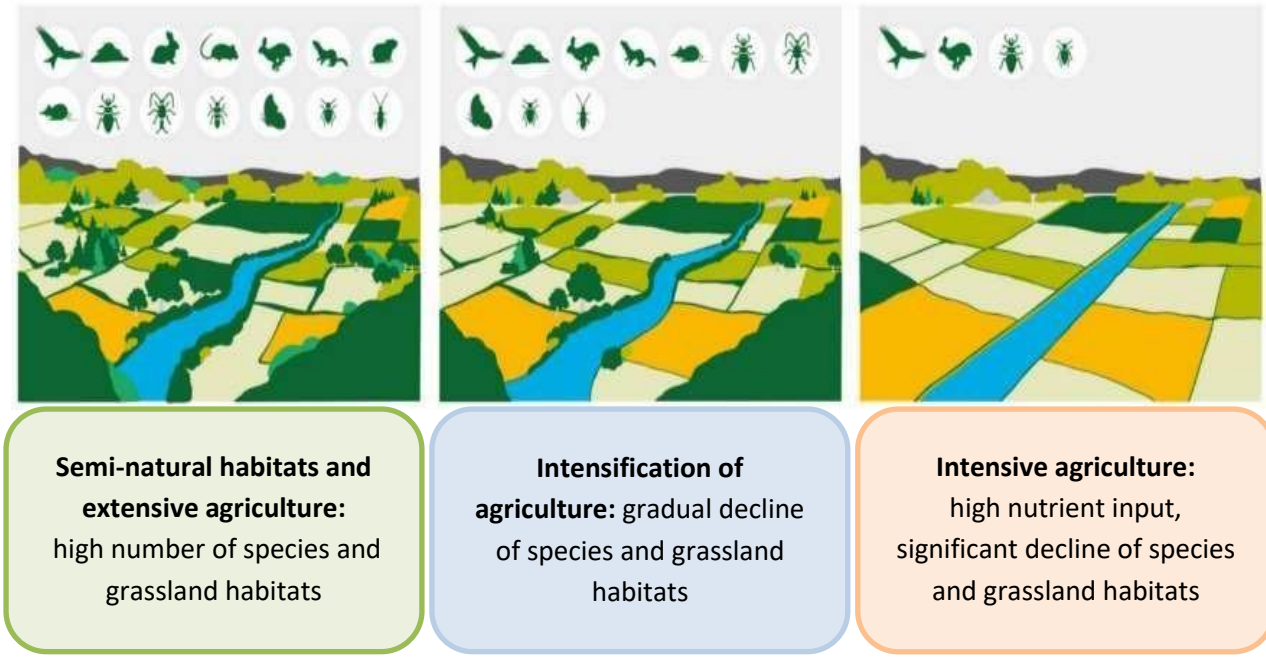
What are worldwide examples of the aquatic habitat loss?

Habitat loss also poses a significant threat to aquatic biodiversity, particularly along continental coasts and around coral reefs. Approximately 93% of coral reefs, which are among Earth's most species-rich aquatic ecosystems, have been damaged by human actions. At the current rate of destruction, 40-50% of coral reefs, which are home to one-third of marine fish species, could vanish in the next 30 to 40 years.

Which activities are often leading to the freshwater habitat loss?

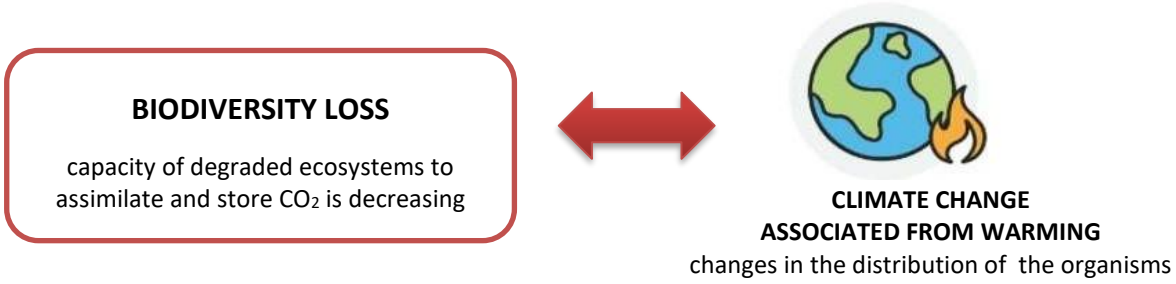
Freshwater habitats are often lost as a result of the dams, reservoirs, channel modification, and flow regulation, which is affecting most of the world's rivers.

How is intensification of the land use influencing farmland biodiversity?



Decline in farmland biodiversity due to intensification of land use. Source: ECA, based on Landesanstalt für Umweltschutz Baden-Württemberg, Landschaft natürlich (1992)

Biodiversity loss and climate change are interconnected and amplify each other.



Interconnection between biodiversity loss and climate change. Credit: BioSustainED

Habitat loss in the Baltic States has affected various species of animals and plants, leading to declines in populations and, in some cases, endangerment or extinction.

Animals and plants affected by habitat loss in the Baltic region:

ANIMALS	
Species	**Reason of the habitat loss**
European bison (*Bison bonasus*)	Habitat loss due to deforestation, agriculture, and urbanization has greatly reduced the range of the European bison in the Baltic States. Fragmentation of forests and conversion of grasslands into farmland have diminished suitable habitats for this iconic species.
Eurasian Lynx (*Lynx lynx*)	Fragmentation and degradation of forests, coupled with road construction and human settlement expansion, have fragmented lynx habitats in the Baltic States. Loss of prey species due to habitat alteration further exacerbates the challenges faced by lynx populations.
Common crane (*Grus grus*)	Wetland drainage and conversion for agriculture have diminished suitable breeding and foraging habitats for the common crane in the Baltic States. Loss of wetlands reduces nesting sites and disrupts migration routes, impacting crane populations.
European otter (*Lutra lutra*)	Loss and degradation of riparian habitats, pollution, and habitat fragmentation have adversely affected European otter populations in the Baltic States. Reduction of suitable freshwater habitats impacts their ability to find food and establish territories.
PLANTS	
Species	**Reason of the habitat loss**
Narrow-leaved marsh orchid (*Dactylorhiza traunsteineri*)	Drainage and conversion of wetlands for agriculture have led to the loss of suitable habitats for the narrow-leaved marsh orchid in the Baltic States. Wetland degradation and habitat fragmentation threaten the survival of this plant species.
Black alder (*Alnus glutinosa*)	Wetland drainage, river channelization, and deforestation have resulted in habitat loss and degradation for the black alder in the Baltic region. Loss of riparian habitats affect the survival of this important tree species.
Baltic Sea meadows (*Zostera marina* and *Ruppia maritima*)	Coastal development, pollution, and eutrophication have led to the decline of Baltic Sea meadows, which provide critical habitats for many marine species. Loss of seagrass beds affects biodiversity and ecosystem health in the Baltic Sea.
Heath spotted orchid (*Dactylorhiza maculata*)	Habitat loss and degradation due to agricultural intensification and land-use changes have affected populations of the heath spotted orchid in the Baltic States. Loss of grasslands and meadows reduces suitable habitats for this plant species.

Introduced species

Introduced species, also known as non-native, invasive or exotic species, are those that humans moved, either deliberately or unintentionally, from their native regions to new geographic areas. The speed of human travel by ship and airplane has greatly increased the rate at which species are relocated. Without the predators, parasites, and diseases that keep their populations in check in their original habitats, these transplanted species can spread rapidly in new areas. Some introduced species that set up themselves in new environments can disrupt the local ecosystem, often by preying on native species or outcompeting them for resources. The issue of introduced species is a global one, responsible for about 40% of extinctions recorded since 1750. Additionally, managing and mitigating the damage caused by these species costs billions of euros each year.

Examples of characteristics of invasive species	Distribution path	Impact of invasive species
• species characteristic differs from local • reproducing rapidly • spreading fast • dangerous for local species and habitats	• intended and unintended human activities (e.g., travel, transportation, decorative planting, breeding) • natural processes (e.g., wind, water, migration, climate change)	• possible transmission of the diseases that threatens local plants and animals • influencing native species and threaten the ecosystem • can have negative impact on human health • cause of economic losses natural processes (e.g., wind, water, migration, climate change)

In order to promote people's understanding of dangerous invasive species there developed different informative materials and websites. For example, the threats invasive species pose to Latvian nature, and to report on observations in nature in available www.invazivs.lv

The Baltic region has experienced the introduction of various non-native species, both intentionally and unintentionally, which have had significant ecological impacts on native ecosystems.

Examples of the introduced animals and plants in the Baltic region:

ANIMALS	
Species	**Description**
American mink (*Neovison vison*):	Originally introduced for fur farming, American minks have set up feral populations in the Baltic region after escaping or being released into the wild. They prey on native wildlife, including birds, fish, and amphibians, posing a threat to local biodiversity.
Raccoon dog (*Nyctereutes procyonoides*)	Raccoon dogs, native to East Asia, were introduced for fur farming in Europe, including the Baltic region. Escaped individuals have formed established populations, particularly in forested and wetland habitats. They compete with native species for food and habitat resources.
Gray squirrel (*Sciurus carolinensis*)	Introduced from North America, Gray squirrels have become established in urban and suburban areas of the Baltic region. They outcompete native red squirrels for food and habitat, contributing to the decline of red squirrel populations.
Canada goose (*Branta canadensis*)	Canada geese were introduced to Europe for ornamental and hunting purposes. They have set up feral populations in the Baltic region, often congregating in large numbers in parks, golf courses, and agricultural fields. Their grazing habits can damage vegetation and alter ecosystems.

PLANTS	
Species	**Description**
Japanese knotweed (*Fallopia japonica*)	Japanese knotweed is an aggressive invasive plant species that has spread rapidly in the Baltic region. It forms dense thickets along riverbanks, roadsides, and disturbed habitats, displacing native vegetation and causing erosion.
Giant hogweed (*Heracleum mantegazzianum*)	Giant hogweed, native to the Caucasus region, has become invasive in the Baltic States. It produces toxins that can cause severe skin reactions in humans. Giant hogweed invades riverbanks, wetlands, and other natural areas, outcompeting native plants.
Himalayan balsam (*Impatiens glandulifera*)	Himalayan balsam is a highly invasive plant species that has spread along riverbanks and riparian areas in the Baltic region. It forms dense stands, displacing native vegetation and reducing biodiversity. Its explosive seed dispersal mechanism aids its spread.
Canada goldenrod (*Solidago canadensis*)	Canada goldenrod is a North American plant species that has become invasive in the Baltic region. It colonizes disturbed habitats, roadsides, and meadows, displacing native flora and reducing habitat quality for native wildlife.

Overexploitation

The concept of overexploitation is about unsustainable harvesting of wild organisms by humans, surpassing the ability of those species to recover their populations. Species inhabiting confined habitats, such as small islands, are especially susceptible to overexploitation.

Vulnerable to overexploitation are large species with slow reproductive rates, including elephants, whales, and rhinoceroses, in Baltic States - bison. The decline of African elephants, the planet's largest extant terrestrial animals, exemplifies the repercussions of overhunting. Primarily due to the ivory trade, elephant populations have dwindled across of Africa over the past half-century. Despite an international ban on new ivory sales, poaching stays rampant, especially in central and eastern Africa. South Africa stands as an exception, where robust protection measures have stabilized or even increased elephant populations.

Many populations of commercially important marine fishes, once thought to be inexhaustible, have been dramatically reduced by overfishing. Rising human population and protein demand, alongside advancements in fishing technologies like long-line fishing and modern trawlers, have pushed these species to levels that cannot sustain further exploitation. Overexploitation has significantly affected various species in the Baltic States, particularly within marine ecosystems (e.g., Atlantic salmon, European eel).

The North Atlantic bluefin tuna is an excellent overexploitation example. Until the past few decades, this big tuna was considered a little commercial value fish and used for cheap cat food. The surge in demand for bluefin tuna in Japanese markets, led to a rapid decline in populations. In just a decade, the western North Atlantic bluefin population plummeted to less than 20% of its 1980 size. A more recent example is the collapse of the northern cod fishery off Newfoundland in the 1990s, underscoring how formerly abundant species can be overharvested to the point of depletion.

Overexploitation of species in the Baltic region has occurred due to human activities:

- hunting;
- fishing;
- habitat destruction.

This has led to declines in populations and, in some cases, endangerment or extinction.

Examples of animal and plant species affected by overexploitation in the Baltic region:

ANIMALS	
Species	**Description**
European bison (*Bison bonasus*)	Once widespread across Europe, including the Baltic region, European bison populations declined drastically due to overhunting and habitat loss. By the late 19th century, they were nearly extinct in the wild. Conservation efforts have led to their recovery, but they stay vulnerable to overexploitation.
Atlantic salmon (*Salmo salar*)	Overfishing and habitat degradation have significantly reduced Atlantic salmon populations in Baltic rivers. Dams, pollution, and habitat fragmentation disrupt their migratory routes and spawning grounds, contributing to population declines.
European eel (*Anguilla anguilla*)	Overfishing, habitat loss, and barriers to migration have led to a severe decline in European eel populations in the Baltic Sea. The construction of dams and weirs prevents eels from reaching their freshwater spawning grounds, affecting their reproductive success.
PLANTS	
Species	**Description**
Common juniper (*Juniperus communis*)	Overexploitation of common juniper for its wood, berries, and medicinal properties has led to declines in populations in the Baltic region. Unsustainable harvesting practices and habitat degradation threaten the survival of this important plant species.
Northern white waterlily (*Nymphaea candida*)	Habitat loss, pollution, and overcollection for ornamental purposes have reduced populations of the northern white waterlily in the Baltic region. Wetland drainage and shoreline development further endanger this plant species.
European yew (*Taxus baccata*)	Overharvesting of European yew for its valuable wood and taxol, a compound used in cancer treatment, has depleted populations in the Baltic region. Habitat destruction and illegal logging worsen the threats facing this slow-growing tree species.

Pollution

Pollution has significant and often detrimental effects on biodiversity, changing ecosystems, species, and the interactions between them. Pollution can degrade natural habitats, making them unsuitable for many species. Main pollution types are air, water, soil and noise pollutions.

What can cause pollutants?

Many pollutants are directly toxic to living organisms, leading to mortality, because high concentrations of pollutants can cause death in sensitive species or different health issues. **Pollutants can cause diseases, reproductive problems, developmental abnormalities in wildlife.**

Pollution types. Credit: BioSustainED

Pollution type	Explanation	Worldwide examples
Air Pollution	Acid rain, caused by air pollution, can damage forests and aquatic ecosystems.	Acid rain has severely changed the Black Forest, Germany causing tree damage and decline in forest health, which affects the entire ecosystem's biodiversity. Rapid industrialization in China and India has led to severe air pollution in many regions, with particulate matter and nitrogen oxides affecting local wildlife and reducing biodiversity in affected areas.
Water Pollution	Contaminants such as heavy metals, pesticides, and nutrient run-off can poisonaquatic habitats, affecting both plants and animals. Eutrophication from nutrient runoff leading to dead zones in water bodies where aquatic life cannot survive.	The Ganges River, India is heavily polluted with industrial waste, sewage, and religious offerings. This pollution affects human health and the river's biodiversity. Aquatic species, including the endangered Ganges River dolphin, face severe threats from the degraded water quality. Efforts are ongoing to clean up the river, but pollution is still a significant challenge. Water pollution poses a significant threat to the Great Barrier Reef, one of the world's most diverse and vital marine ecosystems.
Soil Pollution	Contaminants in the soil can harm plants, reduce soil fertility, and disrupt microbial communities. Bird populations decline due to pesticides like DDT thinning eggshells.	The explosion and later fire at the Chernobyl nuclear power plant released large quantities of radioactive materials into the environment. Contaminants like cesium-137 and strontium-90 polluted the soil, making it highly radioactive and unsuitable for agriculture. The contamination has led to long-term health problems for local populations, including increased cancer rates, and has made large areas of land uninhabitable and agriculturally unproductive.
Noise pollution	An often-overlooked environmental issue has significant negative impacts on biodiversity. It disrupts the natural behaviour, communication, and survival of various species.	Noise pollution on biodiversity is the effect on marine mammals, particularly whales. Noise pollution in the oceans, primarily from shipping, industrial activities, and military sonar, has profound and often devastating effects on these animals. Noise from offshore construction, such as pile driving, can disrupt the spawning behaviour of fish like Atlantic cod (*Gadus morhua*). North American elk (*Cervus canadensis*) show increased vigilance and reduced feeding time in areas with heavy traffic noise. Frogs, such as the Puerto Rican coqui (*Eleutherodactylus coqui*), rely on vocalizations for mating. Noise pollution from urbanization can interfere with these calls.

Does pollution have an influence on balance of the ecosystems?

Pollutants such as heavy metals and persistent organic pollutants can accumulate in organisms over time and magnify up the food chain, leading to toxicity in top predators. Predators at the top of the food chain, including birds of prey and large fish, often suffer the most severe effects. **Pollutants cause disruption of food webs.** Changes in population sizes and health of different species can disrupt the balance of entire ecosystems. **Pollution can reduce genetic diversity within populations by causing selective pressures that favour only those individuals that can tolerate pollutants.** This reduction in genetic diversity can make populations more vulnerable to diseases and other environmental changes. Polluted environments can be more susceptible to invasion by non-native species, which can outcompete and displace native species, further reducing biodiversity.

What are the main pollutants in the Baltic States?

Pollution in the Baltic States is a significant environmental issue, affecting air, water, and soil quality. The primary sources of air pollution in the Baltic States include industrial emissions, transportation, residential heating, and agriculture. Key pollutants include particulate matter (PM10 and PM2.5), nitrogen oxides (NOx), sulphur dioxide (SO2), and volatile organic compounds (VOCs). Latvia and Lithuania face challenges with urban air pollution from vehicle emissions and residential heating, particularly in winter.

Nature conservation

Conservation biology integrates ecology, physiology, molecular biology, genetics, and evolutionary biology to conserve biological diversity at all levels. Efforts to sustain ecosystem processes and stem the loss of biodiversity also connect the life sciences with the social sciences, economics, and humanities.

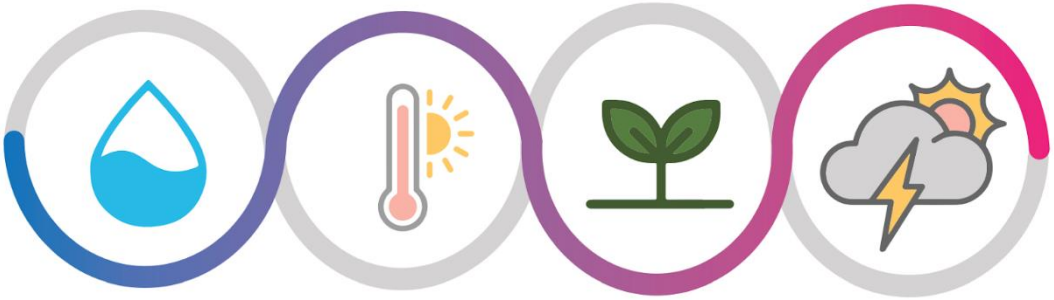
Historically, preservation efforts concentrated on protecting individual species. However, contemporary efforts now often aim to maintain the biodiversity of whole communities, ecosystems, and landscapes. This broader perspective needs comprehending and applying the principles of community, ecosystem, and landscape ecology, along with the principles of human population dynamics and economics. The goals of landscape ecology, which encompasses ecosystem management, include understanding the historical, current, and future patterns of landscape use and integrating biodiversity conservation into land-use planning.

Environmental protection refers to the preservation and conservation of natural resources and the prevention of environmental degradation. It involves efforts to: (i) mitigate pollution, (ii) conserve biodiversity, (iii) promote sustainable development, (iv) combat climate change.

Environmental protection is crucial for keeping healthy ecosystems, ensuring the well-being of both present and future generations, and fostering a harmonious relationship between humans and the environment.

Nature conservation includes several means:

- legislation;
- regulations;
- public awareness campaigns;
- technological advancements;
- international cooperation.



Environmental protection. Credit: BioSustainED

The biodiversity of a given landscape is in large part a function of the structure of the landscape. Understanding landscape structure is critically important in conservation because many species use more than one kind of ecosystem, and many live on the borders between ecosystems.

Fragmentation and edges

The boundaries (edges) between ecosystems are the transition zone between a lake and the surrounding forest or between agricultural land and suburban housing areas and are key features of landscapes. Each edge has distinct physical conditions that differ from those on either side. For instance, the soil surface at the edge between a forest patch and a burned area gets more sunlight and tends to be hotter and drier than within the forest interior but cooler and wetter than the burned area soil.

The effects of fragmentation on community structure have been studied since 1979 in the Biological Dynamics of Forest Fragments Project in the Amazon River basin. This area consists of isolated forest fragments separated from continuous tropical rainforest by distances ranging from 80 to 1,000 meters. Researchers worldwide have documented the physical and biological impacts of this fragmentation on various taxa, from bryophytes and beetles to birds. Their findings consistently show that species adapted to forest interiors suffer the most in the smallest fragments, showing that landscapes dominated by small fragments will support fewer species, primarily due to the loss of interior-adapted species.

In fragmented habitats, the presence of a movement corridor—narrow strips or series of small habitat patches connecting otherwise isolated areas—can be crucial for preserving biodiversity. Streamside habitats often act as corridors, and in some countries, government policies protect these riparian zones from alteration. In regions with significant human activity, artificial corridors are sometimes created. For example, bridges (eco ducts) or tunnels can help decrease the number of animals killed while trying to cross highways.

Movement corridors can also ease dispersal and decrease inbreeding in shrinking populations. These corridors have been proven to enhance the exchange of individuals among various organisms, including butterflies, voles, and aquatic plants. They are particularly vital for species that migrate between different habitats on a seasonal basis.

Forest aerial wildlife crossing forming a safe natural corridor bridge (Eco duct) for animals to migrate between conservancy areas. Image created using AI tools in Canva.

Establishing protected areas

Conservation biologists are using their knowledge of community, ecosystem, and landscape dynamics to create protected areas aimed at reducing biodiversity loss. Currently, governments have chosen about 7% of the world's land as various types of reserves.

Deciding where to set up and how to design these nature reserves presents numerous challenges e.g.:

- Should the reserve be managed to minimize threats like fire and predation to endangered species?

or

- Should it be left as natural as possible, allowing natural processes such as lightning- ignited fires to occur?

This is just one of the many debates among stakeholders concerned with the well-being of national parks and other protected areas. When deciding which areas should be prioritized for conservation**, biologists often concentrate on regions that are hot spots of biological diversity.**

Specially protected nature territories in Latvia (https://www.daba.gov.lv/lv/par-ipasi- aizsargajamam-dabas-teritorijam) and Lithuania (https://vstt.lrv.lt/lt/) are geographical areas, that are under special state-level protection to safeguard and maintain biodiversity of nature:

- rare and typical ecosystems;
- habitats for rare species;
- landscapes, that are peculiar, beautiful and characteristic for country;
- geological and geomorphological formations;
- territories significant for recreational and educational purposes.

TYPE OF PROTECTED AREA	EXPLANATION	NUMBER IN LATVIA	NUMBER IN LITHUANIA
Strict nature reserves	areas chosen for the preservation of their natural condition and biodiversity, with minimal human interference. These reserves are set up to protect ecosystems, species, and genetic diversity, ensuring that natural processes can occur without significant human impact. Typically, strict nature reserves have stringent regulations prohibiting activities such as logging, hunting, and even tourism, except for scientific research and monitoring that does not disturb the environment. The primary goal is to maintain the area's ecological integrity and provide undisturbed habitats for wildlife.	4	6
National parks	protected areas set up by governments to conserve natural environments and their wildlife while providing opportunities for public enjoyment and education. These parks are managed to preserve their scenic beauty, biodiversity, and cultural heritage, often allowing for recreational activities like hiking, camping, and wildlife observation.	4	5
Biosphere reserve	are broad territory in which landscapes and ecosystems of international significance are found. The goal of setting up biosphere reserves is to ensure the preservation of natural diversity and to promote sustainable social and economic development of the territory.	1	1
Nature parks	protected areas chosen to conserve the natural environment and its resources while allowing for public enjoyment and education. These parks aim to preserve natural landscapes, ecosystems, and wildlife, often offering recreational opportunities such as hiking, birdwatching, and picnicking. Management practices in nature parks focus on supporting ecological integrity and promoting sustainable use, ensuring that human activities do not harm the environment. Nature parks often serve as important sites for conservation, recreation, and environmental education, helping to foster an appreciation for the natural world.	42	30
Nature monuments	protected areas appointed to preserve specific natural features of exceptional value, such as unique geological formations, ancient trees, rare plant or animal species, and other notable natural phenomena. These areas are typically smaller than other types of protected areas. Access and activities are often strictly regulated to minimize human impact and keep pristine condition.	355	1088
Nature reserves	protected areas set up to conserve the natural environment, including its biodiversity, ecosystems, and landscapes. The primary aim of nature reserves is to protect and keep ecological integrity by allowing natural processes to occur with minimal human intervention. These areas often provide habitat for threatened or endangered species and serve as important sites for scientific research, environmental monitoring, and education. Management practices in nature reserves typically focus on preserving native species and habitats, controlling invasive species, and supporting or restoring natural conditions. Public access to nature reserves may be restricted or carefully managed to minimize human impact.	261	402

Philosophy of Nature Reserves

Nature reserves are like biodiversity islands surrounded by habitats that have been degraded by human activities. These protected "islands" are not isolated from their environments. Human disturbance and fragmentation become increasingly common in landscape features, the dynamics of disturbances, populations, edges, and corridors are all crucial for designing and managing protected areas.

An important conservation question is whether to set up fewer large reserves or more numerous small reserves. As conservation biologists learn more about the requirements for keeping minimum viable populations for endangered species, they realize that most national parks and other reserves are far too small. For example, the area needed for the long-term survival of the Yellowstone grizzly bear population is more than ten times the combined area of Yellowstone and Grand Teton National Parks. Therefore, areas of private and public land surrounding reserves will likely need to contribute to biodiversity conservation. In cases where reserve land is surrounded by commercially viable property, the use of land for agriculture or forestry must be integrated into conservation strategies.

Zoned Reserves

A zoned reserve is a large region that has areas relatively untouched by humans, surrounded by areas that have been modified by human activity for economic purposes. The primary challenge of this approach is to create a social and economic environment in the surrounding lands that supports the long-term sustainability of the protected core. These surrounding areas continue to be used to support human populations, but they are regulated to prevent extensive alterations that could affect the protected area. Consequently, the surrounding habitats act as buffer zones, preventing further encroachment into the undisturbed areas.

Baltic Green Belt (https://www.europeangreenbelt.org/european-green-belt/baltic) is inspired by the European Green Belt initiative. The Baltic Green Belt extends across the Baltic Sea shoreline, encompassing a diverse array of marine habitats and diverse coastline featuring expansive dune fields, lengthy beaches, dramatic cliffs, and secluded lagoons—a unique landscape within the broader European Green Belt. This coastline facing significant pressure from development and exploitation. Preserving the invaluable natural and historical treasures of this coveted landscape presents a challenge for the Green Belt initiative.

The Baltic Green Belt extends across the Baltic Sea shoreline. Source: europeangreenbelt.org

Natura 2000 is a European network of protected areas chosen for the conservation of biodiversity and the protection of habitats and species of European importance. It is the largest coordinated network of protected areas in the world, both on land and at sea. The sites within Natura 2000 are chosen under the Birds and the Habitats Directives (https://natura2000.eea.europa.eu/).

NATURA 2000 network in Lithuania and Latvia. Source: Print screen from the map Zones of Natura 2000 (https://natura2000.eea.europa.eu/)

Restoration ecology

Restoration ecology is return of ecosystems that have been to a condition similar to their natural state. Sometimes recovery can take centuries, especially when humans have severely degraded the environment. In many tropical regions, soils quickly become infertile and are abandoned after being cleared for agriculture. Mining activities may persist for decades, but the land is often left in a degraded state afterward. Additionally, many ecosystems are inadvertently damaged by the dumping of toxic chemicals or accidents like oil spills. Environmental damage is partially reversible. Restoration ecologists try to identify and to control the processes that most limit the speed of ecosystem recovery. In extreme cases, the physical structure of a site may need to be restored before biological restoration. For example, if a stream was straightened to channel water quickly through a suburb, the meandering channel might be reconstructed to slow the water flow and reduce erosion of the stream bank. To restore an open pit mine, engineers might first grade the site with heavy equipment to create a gentle slope, spreading topsoil once the slope is in place.

The goal of restoration ecology is to enhance biodiversity, ecosystem resilience, and ecological functioning. It is relatively new discipline.

Wetland restoration. Source: shutterstock.com

Significant restoration ecology projects taking place worldwide:

Oostvaardersplasse, Netherlands	Originally a polder reclaimed from the sea, Oostvaardersplassen has been allowed to undergo natural ecological succession since the 1960s. It has evolved into a diverse wetland habitat supporting numerous bird species, mammals, and plants. The project showcases the potential for passive restoration and the importance of allowing natural processes to shape ecosystems.
The Aral Sea Restoration Project, Central Asia	Once one of the world's largest inland bodies of water, the Aral Sea has shrunk dramatically due to water diversion for irrigation. Efforts to restore the Aral Sea involve restoring water flow to the remaining northern part, implementing water management strategies, and planting vegetation to stabilize exposed seabed. Despite efforts to restore water flow to the remaining northern part of the Aral Sea, the overall shrinkage of the sea due to extensive water diversion for irrigation remains a significant challenge. The drastic reduction in water volume has led to severe ecological and socioeconomic consequences, including the loss of biodiversity, the collapse of fisheries, and adverse health effects on local communities.
Great Green Wall Initiative, Africa	The Great Green Wall is an ambitious pan-African initiative aimed at combating desertification and land degradation by creating a mosaic of restored landscapes across the Sahel region. The project involves planting trees, restoring degraded land, and promoting sustainable land management practices. While still ongoing, the initiative has gained international attention and support for its potential to address environmental challenges and improve resilience in the region. Since its start, the Great Green Wall has made significant progress, with millions of hectares of degraded land restored, millions of trees planted, and thousands of hectares of farmland rehabilitated. However, the initiative also faces challenges, including funding constraints, political instability, and competing land-use interests.
Yellowstone National Park, USA	After the reintroduction of gray wolves to Yellowstone in the 1990s, the park has seen remarkable ecological restoration. The presence of wolves has led to a trophic cascade, resulting in changes to vegetation patterns, stream dynamics, and the behaviour of other wildlife species. This example proves the importance of top predators in maintaining ecosystem balance and resilience.
Elwha River Restoration Project, USA	The removal of two dams on the Elwha River in Washington State is one of the most significant dam removal and river restoration projects in history. The removal of the dams has allowed migratory fish species such as salmon to return to their historic spawning grounds, leading to ecosystem recovery and increased biodiversity in the river and its watershed.
Loess Plateau Watershed Rehabilitation Project, China:	This project is one of the largest and most successful ecological restoration efforts in the world. Initiated in the late 1990s, it aimed to restore degraded ecosystems, combat soil erosion, and improve water quality and availability in the Loess Plateau region. The project involved implementing a range of soil and water conservation measures, including terracing, reforestation, and the construction of check dams. It has led to significant improvements in ecosystem health, increased vegetation cover, and enhanced livelihoods for local communities.

What are restoration ecology projects in Baltic States?

In the Baltic states notable restoration ecology projects relate to the restoration of natural grazing ecosystems by reintroducing large herbivores such as European bison, wild horses, and aurochs (a type of cattle) to selected areas within the region. The aim is to mimic the natural grazing patterns and disturbance regimes that shaped European landscapes for thousands of years before human intervention.

What are the key strategies of restoration ecology for biological restoration?

Once the physical reconstruction is complete or when it is not needed, the biological restoration is the next step. Two key strategies in restoration ecology for biological restoration:

- bioremediation (uses organisms to remove harmful substances)
- biological augmentation (uses organisms to add essential material to a degraded ecosystem)

Bioremediation

The use of organisms, usually prokaryotes, fungi, or plants, to detoxify polluted ecosystems is known as bioremediation.

Certain plants adapted to soils having heavy metals can accumulate high levels of potentially toxic metals such as zinc, nickel, lead, and cadmium in their tissues. Restoration ecologists can use these plants to revegetate sites polluted by mining and other human activities, after harvesting them to extract the metals from the ecosystem. **In the United Kingdom, researchers discovered a lichen species that thrives on soil contaminated with uranium dust leftover from mining activities. This lichen accumulates uranium in a dark pigment, offering potential applications as a biological monitor and remediator.**

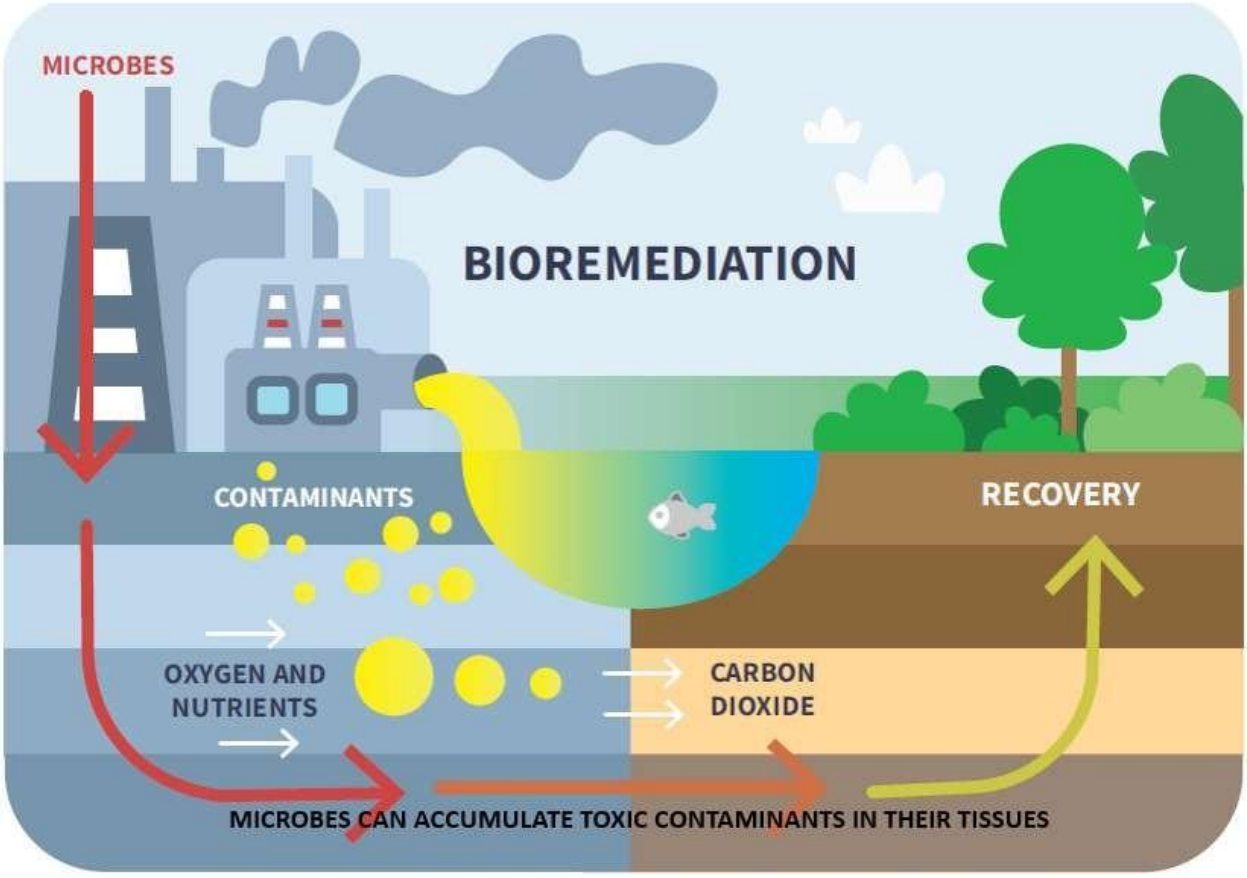
Ecologists are exploring the bioremediation capabilities of various prokaryotes for soils and water. Scientists have sequenced the genomes of at least seven prokaryotic species specifically for their bioremediation potential. Among these species, *Shewanella oneidensis*, a bacterium, shows particular promise. It can metabolize over ten elements in both aerobic and anaerobic conditions to produce energy. For instance, it converts soluble uranium, chromium, and nitrogen into insoluble forms, reducing the likelihood of leaching into streams or groundwater.

Researchers at Oak Ridge National Laboratory in Tennessee, led by Wei-Min Wu, stimulated the growth of Shewanella and other uranium-reducing bacteria by introducing ethanol to groundwater contaminated with uranium. Over five months, the concentration of soluble uranium decreased by 80%.

Genetic engineering involves the direct manipulation of an organism's genes using biotechnology. It entails changing or inserting specific genes to achieve desired traits or outcomes. In the future, genetic engineering may prove increasingly valuable as a tool for enhancing the effectiveness of prokaryotes and other organisms as bioremediators.

Is bioremediation developed in Baltic States?

Bioremediation in the Baltic States is a growing field that uses the region’s biodiversity to address environmental pollution. The use of native plants, microbes, and fungi offers sustainable solutions to mitigate pollution, especially in the context of the Baltic Sea’s unique ecological challenges. Continued research and international cooperation are vital for advancing bioremediation technologies and ensuring environmental protection in the Baltic region.



Various organisms helping to detoxify polluted ecosystems by accumulating toxic contaminants. Credit: BioSustainED

ORGANISATIONS LEADING NOTABLE PROJECTS AND RESEARCH IN LATVIA AND LITHUANIA ON BIOREMEDIATION	
Baltic Marine Environment Protection Commission (HELCOM)	HELCOM works on a variety of projects aimed at reducing marine pollution in the Baltic Sea, including efforts that use bioremediation techniques. This involves both in-situ and ex-situ approaches to manage and mitigate pollutants like oil spills and nutrient run-offs.
Latvian Institute of Aquatic Ecology	This institute is involved in monitoring and bioremediation of coastal pollution, utilizing native algae and microbial communities to reduce nutrient loading and improve water quality in the Baltic Sea.
Lithuanian Research Centre for Agriculture and Forestry	Research here focuses on the use of agricultural by-products and residues for bioremediation. This includes utilizing straw and other organic waste to enhance microbial activity and pollutant degradation in soils.

Biological Augmentation

Biological augmentation uses organisms to add essential materials to a degraded ecosystem, in contrast to bioremediation, which is aimed to remove harmful substances. To enhance ecosystem processes, it's essential to identify the factors, such as chemical nutrients. Promoting the growth of plants adapted to nutrient-poor soils often accelerates the successional changes necessary for the restoration of damaged sites. For example, in alpine ecosystems of the western United States, nitrogen-fixing herbs like lupines are often introduced to increase nitrogen levels in soils disturbed by mining and other activities. Once set up, these nitrogen-fixing plants improve the soil's nitrogen content, enabling other native species to thrive.

BIOLOGICAL AUGMENTATION PRACTICES IN THE BALTIC STATES		
Microbial augmentation	Indigenous microbes	Locally sourced microbial consortia are often employed to ensure compatibility with the native environment. These include bacteria like *Pseudomonas*, *Bacillus*, and *Acinetobacter*, known for their ability to degrade hydrocarbons and other organic pollutants.
	Engineered microbes	Research is also exploring genetically modified microorganisms that can enhance bioremediation efficiency, particularly for specific contaminants like chlorinated solvents and heavy metals.
Fungal augmentation	White-Rot fungi	Species like *Phanerochaete chrysosporium* are introduced to contaminated sites for their ability to degrade complex organic compounds such as lignin, polycyclic aromatic hydrocarbons (PAHs), and certain pesticides.
	Mycorrhizal fungi	These fungi form symbiotic relationships with plant roots, enhancing hytoremediation by improving plant health and pollutant uptake.
Phytoremediation enhancement	Plant Growth-Promoting Rhizobacteria (PGPR)	These bacteria are added to the rhizosphere to improve plant growth and pollutant uptake. They can produce plant hormones, enhance nutrient availability, and protect plants from pathogens
	Endophytic Bacteria	These bacteria live within plants and can enhance the plant's ability to tolerate and accumulate pollutants.

INTERNATIONAL POLICY DEVELOPMENT TOWARDS SUSTAINABILITY

The Green Deal and The Clean Industrial Deal

The European Green Deal and the Clean Industrial Deal are the flagship initiatives of the European Commission. They are parts of a comprehensive plan to make the European Union carbon-neutral by 2050 while promoting economic growth, innovation, and social cohesion. The Baltic States are actively engaged in those initiatives, especially on political level. These initiatives provide a real-world context for teachers to integrate these topics in different lessons.

How can European Green Deal be introduced at schools?

Climate Neutrality: ambitious goals have been set to reduce greenhouse gas emissions by 2050.

Possible activity: Students can explore this through discussions on climate change, personal carbon footprints, and local action projects.

Renewable Energy: the shift towards solar and wind energy is transforming how countries meet their energy needs.

Possible activity: Schools can arrange projects exploring how renewable energy works and its benefits.

Energy Efficiency and Green Buildings: the renovation of buildings to save energy is another focus area.

Possible activity: Students can examine how their school building could become greener or use this as a base for design projects.

Circular Economy: emphasizing eco-design, waste reduction and recycling.

Possible activity: to organize recycling campaigns and classroom challenges for reducing single-use plastics.

Biodiversity Protection: efforts made to preserve species and ecosystems.

Possible activity: to plan school excursions to nature reserves or research projects on local biodiversity.

From farm to Fork: fair, healthy and environmentally friendly food system (e.g. food production, consumption)

Possible activity: to organize round-table discussions about responsible food consumption and local farming.

Funding and Innovation: the European Union offers funding for sustainability projects.

Possible activity: to engage schools in community initiatives and to connect with other European schools through collaborative projects.

The United Nations Sustainable Development Goals

Seventeen Sustainable Development Goals (SDGs) adopted by members of the United Nations, including Latvia and Lithuania, aim ending poverty and hunger, achieving gender equality, improving the quality of education for all children, and taking action to protect the climate and environment (https://sdgs.un.org/goals#icons).

Most relevant SDGs for the biodiversity in Baltic States and possible activities at schools:

- **Life on Land (Goal 15):** Focused on protecting forests, wetlands, and habitats.
    - Teachers can lead projects on tree planting or habitat restoration.
- **Life Below Water (Goal 14):** The Baltic Sea faces challenges like pollution and overfishing.
    - Exploring these issues helps students understand marine conservation and responsible fishing practices.
- **Sustainable Cities and Communities (Goal 11):** Urban biodiversity and green spaces are increasingly important.
    - Students can take part in mapping green spaces or designing eco-friendly neighbourhoods.
- **Climate Action (Goal 13):** Understanding climate change and its effects on ecosystems is crucial.
    - Teachers can use climate simulations, documentaries, and hands-on experiments.
- **Clean Water and Sanitation (Goal 6):** Water quality and pollution are key issues.
    - Schools could engage in water-testing projects or campaigns to reduce water waste.
- **Responsible Consumption and Production (Goal 12):** Encouraging students to think about the lifecycle of products and sustainable choices helps foster responsible habits.
- **Partnerships for the Goals (Goal 17):** Cooperation between countries, schools, and communities makes these goals achievable. Schools can start international school partnerships or join European

sustainability networks.

TEACHING STRATEGIES FOR BIODIVERSITY AND ENVIRONMENTAL EDUCATION

IMPORTANT! **When we speak about biodiversity, we do speak about environmental education as well.**

- Environmental education teaches how to understand and protect the environment.
- The biodiversity topic focuses on the variety of life forms that make up the environment.

Teachers' role and interdisciplinary approach

What is the role of the teacher who teaches at a secondary school level?

The role of a secondary school teacher in teaching about biodiversity is to teach also about environmental education. The purpose is to inspire and equip students with the knowledge, skills, and attitudes needed to understand and address environmental challenges.

Teachers are facilitators of a learning process that engages students by making real-world connections through exploration and questioning (inquiry-based learning). encouraging critical thinking and fostering a sense of curiosity about the natural world. Teachers create opportunities for students to explore local and global biodiversity issues, emphasizing the interconnectedness of ecosystems and the importance of conservation. By integrating real-world examples, hands-on activities, and collaborative projects, teachers can make learning engaging and relevant.

Here are main teaching strategies that could be used efficiently:

- **Inquiry-based learning**, **where students are encouraged to ask questions, investigate environmental issues, and explore solutions.** Students might examine the causes and effects of habitat loss in their region and develop conservation strategies. This method fosters critical thinking and scientific literacy, as supported by Pedaste et al. (2015). Similarly, experiential and outdoor learning allows students to engage directly with nature through activities such as biodiversity surveys or visits to local ecosystems. Rickinson et al. (2004) highlight that these experiences strengthen **emotional connections with the environment and enhance environmental awareness.**

- **Project-based learning** (PBL), **which involves students collaborating on long-term projects to address real-world environmental problems.** Students could design and implement a plan to increase biodiversity in their schoolyard by planting native species. Research shows that PBL helps students keep knowledge by applying it in meaningful contexts. Teachers can also adopt a place-based approach by focusing on local environmental issues to make learning more relevant. Gruenewald and Smith (2008) emphasize that connecting lessons to local ecosystems fosters a deeper understanding of biodiversity and its importance.

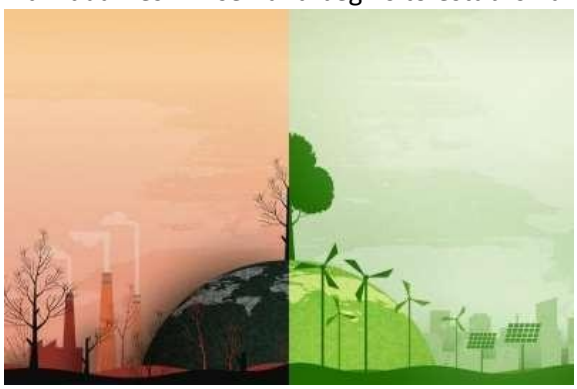
- **Infusion model –** integration of biodiversity concepts and environmental education themes into existing school subjects and curricula. **It allows students to see its relevance across different contexts and promote interdisciplinary learning.** The infusion model emphasizes the interconnectedness of biodiversity with social, economic, and cultural issues, encouraging students to think critically about its broader implications. For example, students might examine how deforestation affects indigenous communities, global climate change, and economic development. **The model helps students understand the complex interactions within ecosystems and how human activities influence biodiversity.** Also, the stressed importance of biodiversity in real-life contexts, makes learning more engaging and meaningful.

Importance of environmental education and main principles

Why do we need to integrate biodiversity and environmental education in the secondary school curriculum?

What are the main key principles for biodiversity teaching?

Human personality forms from a young age, gradually, a child individualizes himself and begins to establish an emotional and valuable connection with the environment, nature, and society. It is a personal development stage where knowledge is easy to grasp and produces effective results now and onward. **Environmental education fosters an environmentally- conscious attitude, it helps to reach certain skills and a liable way of living in days to come** (Lamanauskas, 2023). Hence, the main goal of environmental education is seen to maintain the Earth and its reserves for the future, while gaining skilfully.



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North American Association for Environmental Education introduce key principles on which environmental education should be based on: (NAAEE, 2021)

Human well-being	Human welfare is closely related to nature. Manmade creation directly affects the environment, nevertheless, people to this day struggle to recognize the consequences of their actions in relation to nature. Environmental education promotes uncovering connections between two elements and altogether.
Importance of where one lives	While learning in a close outdoor environment students explore their immediate surroundings and develop knowledge that is based on a bondage with nature. Students are in pursuit of gaining perspective from a local to a broader point of living.
Integration and infusion	Environmental education can be taught through various disciplines, and by doing so, promote extensive competences and creativity. Therefore, environmental education alone is most effective whilst educated in the context of other disciplines.
Justice, equity, diversity, and inclusion	This type of education clasps all the basic human rights principles. The goal is to give learning opportunities to people of all backgrounds and abilities.
Lifelong learning	Encouraged analytical and creative approach among other diverse abilities does not have an expiration date, it is valuable now and for the future.
Roots in the real world	The most efficient way is to learn through hands-on experience in the closest surroundings, analysing the actual problems and needs.
Sustainable future	In environmental learning, the past intertwines with the present to improve the future. Attention is drawn to personal, collective, and corporate decisions related to the well-being of nature.
Systems and systems thinking	Systems are the smaller parts of the whole and can be analysed as a separate entity or as an interplay of all. Systematic outlook helps students to understand the complexity of life, since the biological world itself is an intricate set of various organic processes.

There are many different aims of education policy that could reinforce learning motivation. Joy Palmer and Phili Neal study suggest the focus principles of environmental education:

- To raise awareness on the environmental situation.
- To provide an interdisciplinary outlook on the issue and gain various competence.
- To point the meaning and ways of individual and collective engagement into climate issues (Palmer & Neil, 2003).

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In any learning process, consistency plays a paramount role. Climate focused teaching is becoming a set part of learning, seeing that foundations and habit models form at early age and later progress. So, sustainability related subjects must be continually trained from a different disciplines point of view, providing an opportunity to associate environmental dilemmas to day-to-day learning. Among varied teaching aids, advanced technology is an attractive tool to provide a theoretical approach on nature-based topics. Nevertheless, the most sensible standpoint is to delve into hands-on tasks that would give an empirical learning taste (Lamanauskas, 2023). The experiential learning transforms biodiversity and environmental education into an engaging, hands-on process that fosters deeper understanding, emotional connection, and practical skills.

To sum up, integration of teaching about biodiversity and environmental education into the school curriculum is essential **for fostering a sustainable future and preparing students to address global environmental challenges. Teaching students about vital ecosystem services such as clean air, water, food, and climate regulation helps them understand the interconnectedness of ecosystems and human well-being, promoting a sense of responsibility to protect the planet.** Environmental education broadens this perspective by equipping students with the knowledge, skills, and attitudes needed to tackle pressing issues like climate change, habitat destruction, pollution, and resource depletion.

Experiential learning advantages

What are the advantages of hands-on tasks and learning from experience?

Experiential-based learning has a history, and it is seen as an ongoing development. This learning method allows to get knowledge from nature. Its modern basis reaches the XIX century, when Friedrich Fröbel first originated the term “kindergarten” – “children’s gardens”. He claimed that “children should learn through sensorial experiences and not through… the mere explanation of words.”[1] This raised an interest of teachers to switch from traditional training to experiential one. Nowadays experiential education is widely applied and covers a variety of learning spaces, adapted to various needs of people.

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[1]History of outdoor learning. Accessed: 2024. https://outdoorplaybook.ca/learn/education-research/history-of-outdoor-learning/

In hands-on study learning goes in cycles, knowledge is constantly updated by new insights, and it is driven by problem solving situations, including full engagement of a student. Here, field work outcome becomes a line that connects the student and nature, existing understandings are complemented by new ones. Experiential learning is perceived as *the* **process whereby knowledge is created through the transformation of experience** (Kolb & Kolb, 2005).

The basis of environmental education lies in acknowledging the surroundings as much as possible. Nature is an experiential realm; thus, the most rational learning outlook is to trespass the class doorstep to explore. To revise relatable but not essential themes of interest. To gain an outlook on reality, because learning involves actual person, surroundings and a concern. Hands- on learning helps students to develop their observatory, analytical skills. It creates an opportunity for communication and all-round knowledge, because students share inner insights and hear out their peers. Most importantly, youngsters reach awareness and responsibility on environmental topics, while collaborating, combining theory and practice (Palmer & Neil, 2003).

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Experiential learning is conceived as a versatile standpoint. Here, the theoretical approach led by first-hand teaching boosts the impulse to learn and stimulates vocational, cognitive, and individual competences. Moreover, empirical outlook offers a chance to master the process of act and aftermath that naturally unfolds (Piščalkienė & Lottrup Ingemann, 2018). **Learning through experience and outdoor activities is particularly well-suited for teaching about biodiversity as it allows students to engage directly with the natural world,** fostering a deeper understanding and appreciation for its complexity. Experiential learning transforms abstract concepts—such as ecosystems, species interdependence, and conservation—into tangible realities by immersing students in hands-on activities like observing wildlife, identifying plant species, or analysing habitats. These real-world encounters encourage curiosity, critical thinking, and the ability to make meaningful connections between classroom knowledge and the living environment. For example, exploring a local forest or wetland provides an authentic context to study biodiversity in action, such as the relationships between organisms and the roles they play in keeping ecosystem balance.

Tips on assessment and reflection

Reflection is a vital part of assessment in biodiversity education, helping students internalize their learning and recognize its relevance. Guided reflection questions, such as “What surprised you most about today’s activity?” or “How do human actions impact biodiversity, and what can we do differently?” encourage deeper insights. Reflection can also be documented through journals or portfolios, where students record their experiences, observations, and personal growth. Group discussions further enhance this process by allowing students to share diverse perspectives and learn collaboratively.

Self-assessment and peer assessment are equally important tools for evaluation. By reflecting on their own learning, students develop a better understanding of their strengths and areas for improvement. Peer reviews encourage constructive feedback and teamwork, fostering a supportive learning environment. Rubrics can be used to evaluate complex tasks, such as projects or fieldwork, with clear criteria like understanding of concepts, problem-solving ability, collaboration, and quality of reflection.

Another recommendation is **to check progress over time**, because it is **crucial for capturing the evolution of students' knowledge and attitudes toward biodiversity.** Pre- and post- assessments, such as surveys or reflective journals, can measure changes in understanding and awareness. Growth portfolios, where students track their learning journey and document shifts in their perspectives, are effective for illustrating long-term development. Incorporating technology, such as digital portfolios, interactive quizzes, and multimedia projects, can further enhance assessment by engaging students and offering innovative ways to demonstrate their knowledge.

Providing meaningful feedback is essential for effective assessment. Feedback should highlight strengths, offer specific suggestions for improvement, and encourage students to reflect on their progress. For example, praising a student’s creative approach to solving an environmental problem while suggesting added evidence to strengthen their argument helps foster growth and confidence. By combining diverse assessment methods, reflective practices, and actionable feedback, teachers can create a comprehensive system that not only evaluates learning but also inspires students to become informed and proactive stewards of the environment.

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PRACTICAL PART: TEACHING MATERIALS

STEM FIELDS

Laboratory work: presence of Anisakis parasite in the salted herring

Average time length	Subject Areas	Place	Season
~ 40 minutes preparation	Environmental Sciences Biology	Indoors	Year-round

Description

The nematode larvae of Anisakis cause anisakiasis. The causative agent of anisakiasis is Anisakis simplex and other species from the Anisakidae family. The source of the invasion is fish infested with Anisakis larvae, less commonly crabs and squids. The parasites are transmitted orally by consuming insufficiently cooked infected marine fish and squids. Infected fish and marine animals have been recorded in all regions of the World Ocean, especially in northern waters, where populations of definitive and intermediate hosts are larger. Humans contract anisakiasis from Anisakis and Pseudoterranova larvae: herring and cod worms. Humans are facultative hosts where the larvae do not further develop. Humans are considered a "biological dead-end."

Definitive hosts include seals, dolphins, and seagulls, with adult forms parasitizing the intestines of definitive hosts. The definitive host becomes infected by eating infected fish or squids. The larvae reach the intestines and develop into adults. Anisakiasis is more often registered in Japan (up to 1000 cases per year) because raw fish dishes are traditionally consumed. Sporadic cases are also reported in Western Europe. Freshwater fish, which do not meet marine waters or brackish river outflows at any life stage, do not carry Anisakis larvae. Clinical Manifestations: The incubation period varies from 1-12 hours (acute form) to 7-12 days. The disease is characterized by allergic reactions, formation of parasitic granulomas in the stomach and intestinal mucosa, causing pain, nausea, vomiting, and bloating. In some cases, fever, itching, and hives-like rashes appear. The chronic form involves the development of hyperemia and necrotic changes in the intestines. The disease can also be asymptomatic. Treatment is primarily surgical. If parasites are localized in the stomach, they can be removed endoscopically. Drug therapy is not yet possible.

Aim

The research activity aims to introduce students to the nature of parasitism, the Anisakis life cycle, and the importance of food safety, while also developing practical skills using simple sample analysis tools.

Preparation

- Prepare a theoretical introduction on the diversity of parasites, their life cycles, and their significance in human life.
- Prepare materials for the laboratory work.

Specific Materials

- Lightly salted herring (whole)
- Tray or another container
- Knife/scissors
- Gloves
- Glass jar
- Magnifying glass or microscope
- Light source
- Tweezers

Procedure:

Step 1

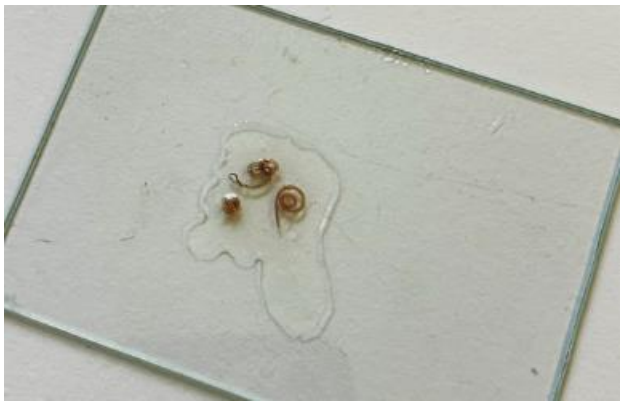
Allocate about 5 minutes for the introduction - prepare students for the work and explain the task. Prepare the work area and materials.

Step 2

Group work for about 15 minutes. Students will work in groups of 2-3. Cut open the belly of the herring and remove the internal organs by hand.

Step 3

Examine the internal organs. The larvae form transparent capsules and localize on the serous membranes of the internal organs, rarely in the musculature.



Anisakis larvae removed from lightly salted herring. Image by S. Kecko

Step 4

Each group briefly presents its results: Were parasites found? How many and what kind were seen? Discuss individual and general practices. Individual Prevention: Consume only thermally processed fish and squids. Prevent cross-contamination in the kitchen. General Prevention: Ensure strict sanitary and veterinary control over fish processing. Educate the public about sanitary and hygiene standards.

Reflection

- What are the consequences if a person consumes infected fish?
- Why is thermal processing important when preparing fish?
- How does this research help ensure food safety?
- Did the results of your observations match your expectations before the study?
- What did your group do best while conducting this research? Did you meet any difficulties? How did you overcome them? How did group collaboration help achieve the task's goal?

Recommendations

Demonstrate safe and proper fish dissection techniques to the class. Show how to carefully examine the fish body, focusing on the intestines and surrounding areas where Anisakis larvae are most likely found.

Show a video of fish examination for better understanding.

Literature/Links

- Zinčenko L., Kirjušina M., Krūmiņa A., 2015. Medicīniskā parazitoloģija. RSU
- https://www.youtube.com/watch?v=gHG88TEaqb0&t=348s

Laboratory work: yogurt preparation

Average time length	Subject Areas	Special Equipment	Place	Season
~ 40 minutes preparation, result after 6 hours	Environmental Sciences Biology	Yes	Indoors	All seasons

Description

The yogurt preparation process is closely linked to microorganism biodiversity, as lactic acid bacteria are the microorganisms responsible for transforming milk into yogurt. The diversity of bacteria and their ability to convert milk into lactic acid is a crucial part of the food production process. During this laboratory work, students will see how different bacterial cultures promote food processing and how they influence the taste and texture of food.

Aim

To explore the yogurt production process and understand how bacterial cultures are used in milk processing. Students will gain knowledge about the role of microorganisms in food production and their importance in biological diversity.

Preparation

- Prepare a theoretical introduction on bacterial diversity and its significance in human life.
- Prepare materials for the laboratory work.

Specific Materials

- 500 ml of milk (raw or pasteurized)
- 2-3 tablespoons of natural yogurt (with live cultures)
- Thermometer
- Small pot (for heating milk)
- Three containers (for yogurt production)
- Spoon or stirrer
- Cloth or cheesecloth
- Plastic or glass container with a lid
- Heat source (e.g., thermos, towels, or small electric heating device)

Procedure:

Step 1

Spend about 5 minutes introducing the students to the task. Prepare the workspace and materials. Explain to the students how microorganisms can be both beneficial and harmful to humans and how this relates to biodiversity.

Step 2

Group work for approximately 35 minutes. Students will work in groups (4-5 people).

Step 3

Pour 500 ml of milk into a small pot and heat it to 80°C, stirring constantly to prevent boiling. Importance of heating the milk: It kills unwanted bacteria, preparing the environment for the bacteria needed for yogurt production. Students will measure the temperature with a thermometer to ensure the milk does not reach boiling point.

Step 4

Allow the milk to cool to 40-45°C, which is the ideal temperature for adding yogurt bacteria. Importance of temperature: Bacteria require a warm environment to activate and start converting lactose into lactic acid. Take 2-3 tablespoons of natural yogurt (with live bacteria) and add it to the warm milk. Stir gently to ensure the yogurt cultures are evenly distributed throughout the milk. The bacteria begin producing lactic acid, which causes the milk to thicken.

Step 5

Pour the resulting mixture into containers or jars with lids and place them in a warm environment. The yogurt mixture should be kept warm so that the bacteria can actively multiply and form yogurt. A thermos or warm water bath can be used for this purpose. The bacteria start converting the milk's lactose into lactic acid (fermentation process), making the yogurt thicker and more acidic.

Step 6

After 4-6 hours, students can assess the readiness of the yogurt. They can taste the yogurt and add fruits or honey to enhance its flavour.

Reflection

- How is yogurt production related to biological diversity?
- What is the role of microorganisms in nature and food production?
- How can the choice of bacterial cultures affect the taste and consistency of yogurt?
- Do the results of the observations match what you expected before the experiment?
- What was the best part of the experiment for your group? Were there any difficulties? How did you solve them? How did group collaboration help achieve the task's goal?

Recommendations

Ensure that students begin the process early enough to allow sufficient time for fermentation. If necessary, prepare samples in advance so that students can observe the fermentation results. If possible, offer students different bacterial cultures to create various types of yogurts and understand microorganism diversity.

Literature/Links

- https://www.youtube.com/watch?v=on31VixEGus

Laboratory work: biodiversity of aquatic ecosystems – identification and analysis of Zooplankton

Average time length	Subject Areas	Place	Season
~40 min (if water samples are pre-collected)	Environmental Science, Nature Conservation Biology	Indoor/Outdoor Activities	Indoors year-round, outdoors in late spring, summer, early autumn

Description

Zooplankton are small, floating animals inhabiting aquatic environments, playing a key role in the food chain. They consume phytoplankton (microalgae) and serve as a food source for fish larvae and other aquatic organisms. The composition of zooplankton in water samples can indicate water quality and help assess ecosystem health. Students will analyse a zooplankton sample, find various organism groups, and discuss their role in aquatic biodiversity.

Aim

The aim of this research activity is to introduce students to the roles and functions of zooplankton in aquatic ecosystems and their importance for maintaining biodiversity while developing students' practical and analytical skills using a microscope and classification tools.

Preparation

- Prepare a theoretical introduction on zooplankton diversity and its significance in human life.
- Prepare materials for laboratory work, including water samples. If there is time, water samples can be collected together with the students from the nearest body of water.

Specific Materials

- Water sample (from a pond, lake, sea, or other water source)
- Plankton net with mesh size 65 µm (if collecting water samples during the activity)
- Small glass or plastic jars for water samples
- Microscope (or magnifying lens)
- Petri dishes or slides
- Pipettes
- Pens and observation sheets
- Plankton identification guide or illustrations

Procedure:

Step 1

The teacher introduces the concept of zooplankton, its role in the food chain, and its connection to biodiversity. Displays images of zooplankton and discusses how to find them. Explains the goal: to analyse water samples and identify zooplankton species to understand aquatic biodiversity.

Step 2

Students work in groups (2–4 members). Each group carefully places their water sample into Petri dishes or onto prepared slides. Checks and adjusts microscope settings as necessary.

Step 3

Students use microscopes to study water samples. They identify and count zooplankton organisms, such as:

- Rotifers
- Crustaceans (e.g., Daphnia or copepods)
- Aquatic worms

Observations are compared with identification guides or illustrations. Results are recorded in a table, noting the count of each identified species.

Step 4

Each group briefly presents their findings: Which species were identified?
Does the observed zooplankton suggest high or low aquatic biodiversity?
Were any species dominant? Discusses how zooplankton diversity reflects water quality and the impact of pollution or climate change.

Reflection

- Why is zooplankton diversity important?
- How can the presence of zooplankton species indicate water quality?
- What methods could improve aquatic biodiversity?
- How does this study help understand human impacts on aquatic ecosystems?
- Did the observations match your initial expectations?
- What went well during the activity? Were there challenges, and how did you address them?
- How did teamwork contribute to achieving the objective?

Recommendations

If possible, show videos of zooplankton movement under a microscope to enhance understanding. If natural water samples are unavailable, prepare artificial samples with observable organisms. Assist students in identifying organism characteristics during microscope work.

Literature/Links

- https://www.eoas.ubc.ca/~swaterma/473-573/Handouts/IntroductoryZooplanktonFieldGuide_2014.pdf
- https://www.maine.gov/dmr/sites/maine.gov.dmr/files/docs/PhytoplanktonIdentificationGuide6-DMRGuideat10x.pdf
- https://du.lv/wpcontent/uploads/2023/12/Brakovska_Aija_Promocijas_darbs_12.2023.pdf
- https://www.youtube.com/watch?v=yRF1XTIW5J8&ab_channel=Omnicurious
- https://www.youtube.com/watch?v=daIwxTxXAh8&ab_channel=CliveBagshaw

Promoting positive thinking in society by breaking false stereotypes and forming positive attitudes towards natural objects that have a negative public perception

Average time length	Subject Areas	Place	Season
~ 3 hours	Environmental Sciences, Nature Conservation	Indoors/ outdoors	All seasons for working indoors, outdoors in late spring, early autumn and summer

Description

The aim of this lesson is to raise awareness of the forest as a biologically valuable place where a variety of organisms live. The objective of the lesson is to characterize the different structures of the forest that contribute to its biodiversity. Identify important protected species. To debunk socially ingrained myths about what the forest should look like and how to behave in different situations with wild animals. In addition, attention will focus on human activities in forests that have predictable negative consequences.

Aim

The aim is to raise awareness of forest biodiversity and its constituent structures, and to break down public misconceptions about the characteristics of forest species and the role of humans in their conservation.

Preparation

1. For the classroom lesson, prepare a presentation comparing a commercial forest and a biologically valuable forest. The presentation should include slides about important forest structures: logs, snags, ant hills, various tree-destroying fungi, openings in the forest canopy, and hollow trees. In addition, the presentation should include slides with facts about the inhabitants of the forest, which are perceived differently in society, as well as human activities that affect the forest ecosystem.

2. For the nature class, an itinerary should be prepared that allows for a natural comparison between economically and biologically valuable forests. In a biologically valuable forest, a route should be created that introduces students to important forest structures. It is also desirable to show the consequences of negative human activities in the forest, such as littering or taking green matter from homestead plots into the forest. For successful outdoor activities, children need appropriate clothing and safety knowledge. When going to the forest, children should be vaccinated against tick-borne encephalitis.

Specific materials

- Projector
- Computer
- Insect collection
- Fungi collection
- Clothes appropriate for the weather

Procedure

Step 1

Survey the children by asking them what they think a beautiful forest should be like. After receiving the answers, show a picture of a commercial forest and ask if it is a beautiful forest, then show a biologically valuable forest and repeat the question. The teacher talks about the differences between these forest types.

Step 2

Survey the children by asking them to answer the question of what they think a beautiful tree is. After receiving the answers, show a picture of an old hollow tree and ask if it is a beautiful tree. The teacher talks about the value of an old hollow tree.

Step 3

Ask which fungi the students can name. Based on the students' ideas, extend their knowledge of fungi in the forest by noting that fungi such as slime molds and other lesser-known fungi also play an important role in the forest.

Step 4

The teacher clarifies the students' attitudes towards insects in the forest. The teacher points out the important role of saproxylic insects in the forest ecosystem. Describes the general diversity of insects in the forest and points out protected species.

Step 5

The teacher shows larvae that look like May beetle larvae and asks what kind of larvae they are and whether they have been seen. After listening to the pupils, he points out that we often do not know what we see and, for example, to which insect species the larvae belong. He shows that these individuals belong to the stag beetle, which is a very rare and protected species.

Step 6

The teacher asks a question about snakes in Latvia/Lithuania and how many snakes can be found in our country. Tells about the legless lizard, which looks like a snake. Tells that snakes are not a threat, but useful animals. Also talks about behaviour when in contact with snakes.

Step 7

The teacher asks whether the students feed wild animals or take them home. After listening to their opinions, the teacher tells them when to feed the birds and what they can be fed with. He also talks

about hedgehogs as they are often fed and taken home. Tells what hedgehogs actually eat. Talks about baby animals that should not be taken home.

Step 8

Finally, the teacher talks about organisms that threaten the local fauna and are considered invasive. These include the red-eared turtle, amur sleeper, Asian ladybird, and invasive plants such as Canada goldenrod and others. In addition, they will talk about the importance of taking all litter out of the forest with you when you go into it to rest, and they will tell you about the hazards of litter bins in the forest and what they should be like so animals can't get to the litter.

Reflection

Possible reflection questions:

Has your perception of forests changed?
Have you ever done anything that you would not do after this lesson?
What other public misconceptions about wildlife would you like to check?

Tips

- To make the lesson more interesting, it is recommended to use collections of different biological objects.

- When planning an outdoor lesson, a map of protected habitats should be used, choosing the most suitable objects among high quality forest habitats and common commercial forests, preferably spruce or pine forests.

Literature/Links

- https://fsc.org/en/blog/sustainable-forestry
- https://www.daba.gov.lv/en/biologically-valuable-tree
- https://theconversation.com/fungi-the-missing-link-in-tree-planting-schemes-175008
- https://www.unsaccopulito.com/en/blog/news-1/waste-in-the-woods-the-environmental-impact-and-solutions-for-a-healthier-outdoors-1.htm
- https://www.daba.gov.lv/lv/invazivas-sugas

Lichens as bioindicators

Average time length	Subject Areas	Place	Season
~ 40 minutes	Environmental Sciences	Outdoor activity	Spring end, summer, early autumn

Description

Students will have the opportunity to explore lichens as unique organisms and understand their role in environmental quality assessment. Lichens are sensitive bioindicators that reflect air pollution, especially the presence of sulphur dioxide (SO_2) and other toxic substances.

Students will learn how to identify different lichen species, investigate their occurrence, and analyse collected data to make conclusions about air quality in the school vicinity.

Aim

To understand the biological role of lichens and their function as bioindicators by assessing the surrounding environment, particularly air pollution levels, through practical observations and analysis.

Preparation

- A theoretical introduction is needed: Lichens are symbiotic organisms consisting of fungi and algae or cyanobacteria. This partnership allows lichens to thrive in harsh conditions and adapt to different environmental settings. They grow on trees, rocks, soil, building walls, and other surfaces. Lichens obtain nutrients from the air and precipitation, making them sensitive to pollution, particularly sulphur dioxide, heavy metals, and other toxic substances. In areas with high pollution, lichens either do not grow or are present only as a few resilient species. In areas with clean air, lichens grow abundantly and are found in various forms.
- A simplified lichen identification chart should be prepared. A worksheet for students is also needed.

Worksheet Sample:

Observation Location: _____

Lichen Species (describe): _____

Lichen Density:

Low ☐

Medium ☐

High ☐

Lichen Condition:

Healthy ☐

Damaged ☐

Conclusions about the environment: _____

- Prepare a route and the area to be surveyed for the outdoor activity (school yard, nearby park, roadside). Appropriate clothing and knowledge of safety protocols for outdoor activities are required.

Specific Materials

- Magnifying glass
- Note paper or worksheets with pre-prepared questions
- Simplified lichen identification chart (with pictures or descriptions)
- Pencil
- Weather-appropriate clothing

Procedure:

Step 1

Spend about 10 minutes introducing lichens and explaining their role as bioindicators. Ask the students why lichens are bioindicators. Conduct a survey among the children, asking them how many lichens they think can be found in the city, along the roadside, near a factory, or in the forest.

Step 2

Outdoor work for approximately 20 minutes. Students will work in groups (3–4 people). Each group's task is to explore a specific area and document the presence of lichens. Record where lichens were found (e.g., on trees, rocks, building walls), what species they were (based on shape), and assess their density. The teacher will move between groups, helping identify lichen species and answering questions.

Step 3

Discussion on the way back to school and in class for about 10 minutes. Ask the students which lichens they can name. Together, conclude the air quality and pollution level near the school.

Reflection

- What differences did you observe in the distribution of lichens in different places?
- Was it easy to distinguish between lichen species? What helped you identify them?
- How might lichen diversity and condition relate to environmental quality?
- What can you conclude about the air quality near your school?
- Did the observation results match your expectations before the study?
- What did your group do best during this study? Were there any difficulties? How did you solve them? How did group collaboration help achieve the task's goal?
- What new things did you learn about lichens and their importance in nature?
- How could lichen studies be used in other environmental research projects?
- What would you recommend improving air quality in areas where lichens are scarce?

Recommendations

Review the lichen identification materials: Prepare simplified charts or pictures that will help students recognize lichens.

Choose a suitable study area: Ensure that the study location (school yard, park) is safe and provides a diverse environment for lichen exploration.

Literature

- https://www.daba.gov.lv/lv/media/6044/download
- https://environment.lv/assets/upload/Kerpju%20rokasgramata/Kerpju_rokasgr_izdrukam_vienpusejam.pdf

Research activity: organism diversity in nature

Average time length	Subject Areas	Place	Season
~ 40 minutes	Environmental Sciences, Nature Conservation	Outdoor activity	Spring end, summer, early autumn

Description

Biodiversity refers to the richness of living organisms found in various ecosystems, from forests and meadows to urban areas. Each organism is an essential component of an ecosystem, and preserving this diversity is vital for maintaining the natural balance. In this research activity, students will be introduced to a practical method for assessing biological diversity through observations in a sample plot. This activity will help students understand the variety of organisms that live even in seemingly small areas and how the environment is influenced by various factors such as human activity, lighting, and soil properties. During the activity, students will use simple tools to identify and record the organisms they observe and evaluate how the results reflect the biological diversity of the area under study. This will encourage students to develop a deeper connection with their surroundings and promote responsible environmental conservation.

Aim

To understand the diversity of organisms in a specific environment and develop skills in observation and data collection.

Preparation

- A theoretical introduction about biological diversity and the concept of sample plots is needed.
- The area for the outdoor activity should be prepared (schoolyard, nearby park, roadside). Select a sample plot (2x2 meters or 1x1 meter). Appropriate clothing for children and safety protocols are required for a successful outdoor activity.

Specific Materials

- Magnifying glass (if available)
- Note paper or worksheets with a pre-prepared table
- Measuring tape for defining the sample plot
- Pencil
- Weather-appropriate clothing

Procedure:

Step 1

Spend about 10 minutes preparing the students for the activity and introducing the task. Explain what biological diversity is (the variety of all living organisms and ecosystems in a particular area, which ensures the stability of the ecosystem). Describe what a sample plot is (a limited area used for observing and studying the composition and density of living organisms). Conduct a survey among the students, asking them how many different types of organisms they think they can find in the city, along the roadside, near a factory, in a forest, or by a lake.

Step 2

Outdoor work for approximately 20 minutes. Students will work in groups (3–4 people). Each group's task is to explore a specific area and document the presence of different organisms. Observe and record all the organisms seen (plants, insects, and other animals). It may only be possible to identify organisms at the group level (e.g., "grasses," "ants"). Use a worksheet to record the data (columns: Type of Organism, Count, Features). Record the data in the worksheet:

- Type of Organism (plant, insect, moss, etc.)
- Count (how many individuals observed)
- Features (e.g., colour, size, behaviour)

Step 3

Discussion on the way back to school and in class for about 10 minutes. Ask the students what types of organisms they can name. Each group will briefly share their results (total number of organisms, dominant types, interesting observations). Discuss how biodiversity depends on environmental conditions and why areas less impacted by humans are typically more diverse. The topic of invasive species may also be addressed.

Reflection

- Does the organism diversity differ between the various sample plots?
- Which factors (light, moisture, human impact) might affect diversity?
- Do the observation results match what you expected before the study?
- What worked best for your group during the research? Were there any difficulties? How did you solve them? How did group collaboration help achieve the goal of the task?

Recommendations

If possible, encourage students to use a magnifying glass or phone camera to observe small organisms. Choose a suitable study area: Ensure that the research location (schoolyard, park) is safe and provides a diverse environment for studying organisms.

If an excursion to nature is possible, repeat the task outside the city (in a forest or meadow) and compare the results obtained.

Literature/Links

- https://dabasdati.lv/lv/cat/7/
- https://www.daba.gov.lv/lv/invazivas-sugas

The Stromantha story – a holistic approach to understanding life processes

Average time length	Subject Areas	Place	Season
~ 2 hours	Science (biology, chemistry, geography); environmental education, interdisciplinary links with arts, social sciences	Indoors	All seasons for indoor activities

Lesson description:

This lesson introduces students to a holistic approach to science, promoting an interdisciplinary understanding of life processes in plants. It uses the study of the stromantha as a house plant to combine aspects of biology, chemistry, geography, art and social studies, and integrates ICT and research skills into the learning activities.

Lesson objective:

To promote students' understanding of the relationship between life processes and the environment and sustainability by developing research, creative and collaborative skills.

Preparation and specific materials required:

1. Prepare the plants (or parts of plants, e.g. leaves) for the practical work.

2. Prepare the necessary tools (microscopes with digital camera, digital hand-held microscope USB 1600x, slides, coverslips, needles for preparation, tweezers, laboratory containers (petri plates, beakers, funnels, pestle and mortar), chemical reagents, 70% ethanol solution, filter paper, maps and geography materials).

3. Provide access to digital tools (e.g. Pixton digital application for comics).

Lesson plan:

1. Introduction: the holistic approach to science and learning about the story of the stromantha

Duration: 10 minutes

Activities:

- Brief introduction to the holistic approach to science education, emphasizing that the 'story' of a stromantha helps to connect the biological, chemical, geographical and creative aspects.

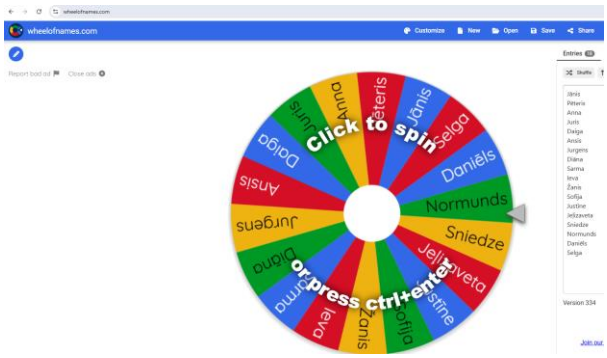
- To show stromantha plant or images, a short video extract for raising interest of students. Emphasis on the unique patterns and colours of the leaves.

For example:

- ✓ *Tips for propagating Stromanthe sanguinea (0,48 min.)* *https://youtube.com/shorts/qGlqwD4cThk?si=dmUoqCkZJRIt3bfG*
- ✓ *How to grow Stromanthe sanguinea Stromanthe triostar care for indoor* *https://www.youtube.com/watch?v=TD7Dy6jYkww (4,21 min.)*

- The teacher asks, **"What life processes can you imagine looking at this plant?"**

Students work in **5 different groups/stations**, which the teacher and students create using the digital application "Wheel of Fortune" www.wheelofnames.com



2. Biology activity "Journey into the microworld of a stromantha leaf"

Duration: 30 minutes
Objective: to prepare a micropreplicate of a stromatic leaf, to study the epidermal cells of the leaf and to understand how its structures help the plant to adapt.
Steps:
1. In a group, students select a stromanthal leaf.
2. Students' microscope the epidermal cells, study them, take photos at 40x, 100x, 400x magnification, take photos with a digital USB 1600 x microscope, prepare a biological drawing at 100x magnification and record the structures observed. The group creates 1 digital photo collage from the 4 microscope images and the biological drawing.
3. As a group, prepare the results for the presentation and discuss: "*How do the observed structures help the stromantha to adapt to different environmental conditions?*"

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3. Chemistry activity: 'Pigment laboratory'

Duration: 30 minutes
Objective: to isolate and analyse pigments from the leaves of a stromantha.
Steps:
1. Using available Internet and printed resources, students identify the role of pigments in plants (chlorophyll, carotenoids, anthocyanins).
2. In a group, students crush a leaf of the stromantha, add a 70% ethanol solution and use filter paper to isolate the pigments.
3. After evaluating the results, the group analyses the colours of the pigments and discusses how they help the plant in photosynthesis and protection against environmental conditions.
4. The group creates 1 digital photo collage of 5 images recording the progress and/or outcome of the work.

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4. Geography activity: "Stromanta's journey around the world"

Duration: 30 minutes
Aim: To find out the natural origin of the stromantha, its habitat characteristics and to understand its distribution outside the tropics.
Steps:
1. Students analyse digital world map, information sources and learn about the natural habitat of the stromantha, its characteristics.
2. Groups explore possible pathways of dispersal of the stromantha, analysing the role of climate and tropical forests in the plant's habitat.
3. The groups present their findings by creating a story-digital collage about the adaptation of the stromantha to grow in other regions.

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5. Art activity: "Artistic portrait of Stromantha"

Duration: 30 minutes
Aim: to develop creativity using the patterns and colours of the stromantha leaves as inspiration.
Steps:
1. Students learn examples of different artistic expressions and techniques to represent the leaf patterns of plants (graphic drawing, collage of coloured papers, watercolour, etc.).
2. Each pupil in the group, inspired by the art material studied, creates a digital artistic representation of a plant leaf pattern.
3. When the work is finished, an exhibition is organised in the classroom and pupils discuss how nature inspires the artists' work.

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6. Social studies activity: 'Tropical Forest Survival Plan'

Duration: 30 minutes
Aim: To understand the importance of sustainable development in protecting the natural habitat of the stromantha - the tropical forest.
Steps:
1. Students are given roles (e.g. biology researcher, entrepreneur, ecosystem defender).
2. The group prepares a short presentation on how to balance the use and protection of tropical forest resources.
3. A simulated class discussion is held to agree on a sustainable action plan.

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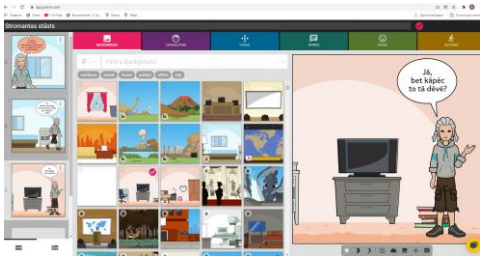
7. ICT Individual Activity: 'Stromantha's Story - a comic for a holistic understanding of life processes'

Duration: 20 minutes
Aim: Each student individually, using free digital tools and applications, creates a visual representation of the story of stromantha, based on the aspects explored during the group work, highlighting and integrating the research questions and results.
Steps:
Students register on Pixton (or another tool of their choice, e.g. www.canva.com, etc.) as "Student" and receive instructions for creating the comic. AI-generated comics can also be used, making appropriate references in the work.
2. Students individually create a comic strip about the story of a stromantha and life processes, adaptation.
3 The comics are sent digitally to the teacher, who compiles and presents them to the class. Students vote for the 3 most creative entries.



Conclusion: reflection and discussion

Duration: 10 minutes

Aim: to analyse what has been done and to get feedback. Reflection questions can be included at the end of the group work activities.

Questions for reflection:

Biology:

- What new things did you learn by studying stromantha leaves under a microscope?
- How do stromantha epidermal cell structures help a plant survive in different habitats?
- What principles of science/biology that we learned today are applicable to other plants or ecosystems?

Chemistry:

1. What pigments were found in the leaves of stromantha and why are they important?
2. How did chemical analysis help us understand how the stromantha adapt to their environment?
3. How would you use similar methods to study other plants?

Geography:

1. What did you learn about the natural habitat of the stromantha and its distribution around the world?
2. Why are the growing conditions of the stromantha so important in tropical regions?
3. How might climate change affect the distribution of stromantha and other tropical plants?

Art:

1. How did the colours and patterns of the tree leaves inspire your artwork?
2. Which technique or means of artistic expression did you use to reflect the beauty of nature?
3. What did this activity show you about the interconnection between nature and art?

Social Sciences:

1. How has your role (e.g. as a biological researcher, entrepreneur or ecosystem advocate) influenced the debate on tropical forest conservation?
2. What were the main challenges to reaching agreement on a sustainable action plan?
3. What did you learn about the importance of tropical forests for human well-being and the environment?

ICT and comics (individual reflection):

1. How did making a comic help to understand the life cycle and adaptation mechanisms of a stromantha?
2. Which part of the comic was the most interesting to create? Why?
3. How could you use the comic as a tool to talk about other science topics?

General questions for reflection:

1. How did the interdisciplinary integration of different subjects help you to better understand the role of stromantha in nature?
2. What was the most challenging part of this lesson? How did you overcome the difficulties?
3. How could this experience change your perspective on sustainability and natural processes?

Suggestions and tips for a successful lesson:

- Ensure that all materials and resources are available in advance, especially the stromantha plants and digital tools for making comics.
- Encourage active participation of students by allowing them to make their own discoveries and discussions.
- Allow enough time for each activity, especially the more challenging hands-on activities.
- Use a variety of teaching methods to engage students with different learning styles.
- Reflect on the progress of the lesson in order to adapt the activities to the next tasks.

Literature and resources

- A holistic approach to preserving our health – and our planet's. https://www.embl.org/news/events/one-health-science-society/
- Digitālā aplikācija augu noteikšanai „LeafSnap Plant Identification"
- For the Love of Nature! Introducing Biophilia in the K-12 Learning Environment. https://nacarchitecture.com/NACLab/biophilia.aspx
- Digitālā aplikācija "Laimes rats" www.wheelofnames.com
- How Biophilic Learning Environments Boost Student Achievement (2019) https://www.demcointeriors.com/blog/biophilic-learning-environments/#
- How to grow Stromanthe sanguinea Stromanthe triostar care for indoor https://www.youtube.com/watch?v=TD7Dy6jYkww
- Komiksu veidošanas datoraplikācija https://app.pixton.com/ vai ChatGPT
- Margeviča-Grinberga,I., Šūmane, I.(2020) Mūsdienīga mācību vide skolēnu aktīvai iesaistīšanai mācību procesā. Rīga: LU Akadēmiskais apgāds
- National STEM Forum Germany. Working together toward a national STEM strategy in Germany https://www.siemens-stiftung.org/en/projects/national-stem-forum-germany/
- 5 Layout Ideas for Your Hybrid Office Design. https://robinpowered.com/blog/10-coolest-biophilic-design-offices
- Oļehnoviča E, (2023) Sukulentu superbingo, Daugavpils Inovāciju centrs.
- Tips for propagating Stromanthe sanguinea (0,48 min.) https://youtube.com/shorts/gGlqwD4cThk?si=dmUoqCkZJRIt3bfG

Teaching materials elaborated by the project invited expert Dr. paed. Eridiana Olehnovica

Pi search

Average time length	Subject Areas	Place	Season
2 hours	Mathematics Natural science	Outdoors / indoors	All seasons

Description

This exercise is designed for students to link the connection between mathematics and real-world implications and to put mathematical knowledge to practice. Working with Pi encourages mathematical thinking and problem-solving skills, aiding in the development of analytical capabilities.

Aim

The aim of this task is to practice mathematics in a natural environment and to better understand how mathematical and calculable the world around us is. Students will learn how to calculate Pi number using everyday objects and experience interdisciplinary approach to learning.

Preparation

- Provide context: Pi is an irrational number (3.14159…), meaning it cannot be expressed as a simple fraction. It is essential in various areas of mathematics, particularly in geometry, trigonometry, and calculus.
- Explain that Pi appears in many scientific and engineering formulas, including those in physics (wave equations, circular motion), engineering (designing mechanical components), and even in fields like statistics.
- In advance prepare a results table on the board (see the table example below).

Specific materials

- Paper
- Pen
- Tape measure

Procedure

Step 1

Organize the students into pairs, ensuring everyone is matched up. Tell the pairs they need to look around the area and find something that is circular in shape. Give them examples such as:

- A fountain
- A wheel
- A flowerbed

Step 2

If there are no appropriate objects nearby, students can create their own circle by using a rope to represent the radius, with one student acting as the center point and another student outlining the circumference, possibly using chalk on a concrete surface or forming the shape in gravel.

Step 3

Students should examine the lengths of the diameter and circumference. It's essential that they take notes to avoid confusing the two mathematical terms as they move from one object to another. They can choose any measuring unit, but must apply the same unit for all objects, such as meters or steps.

Step 4

Afterwards, record the results on the table on the board:

	Circumference	Diameter	C / D
Wheel			
Pot			
Flowerbed			
Sandpit			
Aspen			
Mean Value of C / D			

Step 5

In the final column, students can calculate the ratio of the circumference to the diameter. If everyone measures accurately, the final value will be approximately the same, leading them to discover Pi! The average of all pairs' measurements is usually closer to the actual value than the individual measurements.

Reflection

What did you learn?

What did you like the best about the activity?

What other calculations could be done outdoors?

Tips

Pi is a Greek letter that is written π. You can celebrate International Pi Day on March 14 by having a round food feast: eat a pizza or a pie! Go on a search for circles and Pi or create fun ideas of your own.

Literature/Links

- *Learning in the Outdoor Classroom – a Swedish Anthology of Activities* (2015), p. 34-35, Vimmerby: Outdoor Teaching Förlag. ISBN 9789197960090.
- https://www.youtube.com/watch?v=6TPjRoWm8Ck&ab_channel=RTX
- https://www.youtube.com/watch?v=0kd6wX6cWWM&t=18s&ab_channel=MashupMath

A number game

Average time length	Subject Areas	Place	Season
30 minutes – 1 hour	Mathematics; Natural science	Outdoors / indoors	All seasons

Description

This is an enjoyable math game. In this activity, students will enhance their memorization and focus skills, as well as their ability to think strategically, while also improving their understanding of numbers.

Aim

The goal of the activity is to boost memory, utilize strategic thinking skills, and have fun, ideally outdoors.

Preparation

In advance prepare cards with various higher numbers (for example: 55, 108, 960, etc.)

Specific materials

- Cards with numbers
- Clothes pegs

Procedure

Step 1

Each student will have a number attached to the back of their collar using a clothes peg.

Step 2

The challenge is to discover what number they have by circulating and asking questions. Each student is allowed to ask one yes-or-no question of every other student.

Step 3

Once a student discovers the number on their collar, they can then display it on the front of their clothing while continuing to answer others' questions.

Example:

– Is my number higher that 16? – Yes.

– Is it between 25 and 30? – No.

– Can it be divided equally by 5? – Yes.

Reflection

Possible reflection questions:

Do you feel energized after this game?

How could you change the game?

What have I learnt?

Was it hard or easy to guess?

Tips

- This exercise can also be effectively applied to geometric shapes.
- This activity can be used to categorize groups into odd and even numbers, higher and lower numbers, or numbers that are divisible by 3 or 7.

Literature

- *Learning in the Outdoor Classroom – a Swedish Anthology of Activities* (2015), p. 23, Vimmerby: Outdoor Teaching Förlag. ISBN 9789197960090.

LITERATURE, ARTS, DRAMA

A Poem

Average time length	Subject Areas	Place	Season
45 min.	Environmental Education; Language; Art	Anywhere, preferably where trees could be found)	All seasons

Description

The exercise is dedicated to increasing the sense of connection to the place and what you can find there through creating stories and writing poetry. During the activity students will learn how to get inspiration from different things they see/feel in nature, while being in a natural environment and practicing their spoken and written language skills. This activity is more suitable for learning and practicing foreign language as well as to integrate a topic of importance environmental protection.

Aim

The aim of the lesson is to practice language skills while observing trees in the park or the forest area. During this lesson, pupils will learn how to be in presence and focus on their thoughts, emotions and imagination.

The main objectives could be summarized as follows:

- To practice vocabulary
- To create a poem about a thing/things they see/feel in nature
- To use descriptive language
- To practice teamwork and social skills

Preparation (if needed)

The teacher has to choose a place for the lesson in advance and should search for a ‘magic spot’ outside, where trees or other exceptional nature elements such as rocks, hills could be found.

Specific materials

- Preferably some mature trees
- A sheet of paper for each student
- A pen for each student
- First aid kit for the teacher when going outdoors

Procedure

Step 1 *(10 min approx.)*

Divide the group of students to smaller groups. For someone who is not familiar with the place or the vocabulary it is important to create relations to the surroundings thus a short introduction should be provided. While walking around talk about these nature elements by naming them and describing why these objects are special, because it is important in this activity that the starting point is something interesting and that you can estimate the age of something or admire some features in nature.

Step 2 *(10 min approx.)*

In groups of 4-6 students are asked to find their own "magical spot" in that area. They can choose where to sit and get inspiration from (under a tree, by a rock etc). Here the students can for example observe the trees and choose a mature tree to sit under. Individually they sit quietly, look up at the branches or gaze on the ground and record the words they think of by writing it down on the paper. These words could be nouns, adjectives or verbs, object descriptive words or all the words they can think of.

Step 3 *(15 min approx.)*

Finally, the assigned group work together and use the words to compose a poem about the tree. The words could be written on individual pieces of paper so they can be spread out and moved around. Groups will then be called to a circle where they can share the poems with the whole class.

If the teacher see that pupils are struggling to compose a poem during the group work, a structure or similar one as below can be provided:

I opened my eyes and saw…

I listened carefully and heard…

With my hands stretched out I felt…

I took a deep breath and smelt…

Down low I found…

Up high I discovered…

Reflection *(10 min approx.)*

What have I learnt?

How did I feel being in nature?

Why did you choose that element from nature? (rock, fallen tree etc)

Could you please tell us more about this element? Why it is so special?

Tips

- Learners explore the woodland and write down what they can see, hear, feel and smell.
- Starters are very useful! They can stimulate the students to activate all their senses, thus poems can be borrowed from well-known poets and authors.
- The same lesson plan could be adapted to different nature elements – bushes, flowers, various animals or even inanimate nature. It can also be adapted to different environments like the seaside, stream, garden etc.

Literature/Links

- Poems about trees in native or foreign languages.
- https://www.eilerasciai.lt/eilerasciai-apie-medzius/ (in Lithuanian).
- https://www.letonika.lv/literatura/Section.aspx?r=326&q=koka (in Latvian)
- Koivuntuohirunoja: tunnustuksellisia runoja metsistä ja puista (2005) (in Finnish)
- https://poets.org/text/poems-about-trees (in English)

Investigation

Average time length	Subject Areas	Place	Season
~ 2 hours	Literature; Art; Drama	Outdoors	Late spring, summer and autumn

Description

This exercise is designed to improve thinking skills, imagination and to boost literary creativity. During this activity students will pretend to be detectives and by using various strategies will solve the mysterious case.

Aim

The aim of the activity is to create an explanatory story according to different sensory signs provided.

Preparation

- To set up this activity, the teacher places ropes in different locations (one for each group) within a natural environment or on school grounds.
- The teacher shapes the rope into a figure that might have once been present, such as a dog, bird, person, or a mythical creature.
- The scene can be enhanced with an assortment of fabrics or items.

Specific materials

- 5-6 ropes, each 1 to 3 meters long
- Additionally, the area can be "spiced up" with materials like cinnamon, coffee, or an old shoe (or any other object).

Procedure

Step 1

Separate the class into groups of 3 to 5 students, who will act as detectives standing next to the ropes.

Step 2

They will have about 10 minutes to observe the area using all their senses and devise a plausible scenario explaining how the body (or object) ended up there. The clues for their story will come from what they see, hear, feel, smell, and taste.

Step 3

Each group will share their findings with one another at each rope location.

Step 4

The teacher will play the role of chief detective, seeking a brief overview of the situation.

Reflection

Can you think of an alternative scenario for your group's crime scene?

What kind of scene would you like to create? What would you use to live up the scene?

What have I learnt?

Tips

The placement of the ropes will influence how each group describes their scenario, so it is beneficial to select locations that are distinctly different from each other to create more diverse and interesting stories. For instance, a crime scene in the forest will lead to a scenario quite different from one near the school canteen!

Literature/Links

- *Learning in the Outdoor Classroom – a Swedish Anthology of Activities* (2015), p. 82-83, Vimmerby: Outdoor Teaching Förlag. ISBN 9789197960090.
- www.youtube.com/watch?v=CYhjqD8LXvk&ab_channel=Berks%2CBucks%26OxonWildlifeTrust

Upcycled material fashion show

Average time length	Subject Areas	Place	Season
~ 3 hours	Environmental Education; Art; Design and Technology, Drama	Indoors / outdoors	All seasons for indoor activity, outdoor in late spring and summer

Description

This exercise dedicated to raise awareness about sustainability in fashion, demonstrate the creative potential of waste materials, and promote environmentally friendly practices. During the activity students will learn how to upcycle their own clothes and display these creations to school, highlighting the artistry and innovation of sustainable fashion.

Aim

The aim of the activity is to raise awareness about recycling, waste reduction, and the benefits of choosing sustainable materials. Pupils will learn how to highlight their imagination by transforming recycled materials into innovative and stylish clothing and accessories.

Preparation

- Select a place for a crafting session and a choose a space for a runaway show. It could be indoors or outdoors.
- You may want to lay out the runway and chairs before starting the session.
- In advance before this session ask students to bring in their clean, dry outfits for upcycling.
- Set up some craft tables and lay the items out, so everyone can see the materials before using them. Set up some scissors, paper, pencils, sticky tape, paper clips, glue, etc.

Specific materials

- Clean recyclable clothes
- Scissors
- Pencils
- Scrap paper for sketching ideas
- PVA glue, glue gun
- Sewing kit
- Packing tape
- Staplers
- Other craft materials (for example, tissue paper, pipe cleaners, stickers, etc.)
- Coloured paper and markers for voting cards
- Device to play music
- Music playlist for the runaway show

Procedure

Step 1

Tell everyone that they are going to design and make an outfit or accessory out of clean, dry recycling clothes, and craft materials. Explain that at the end they are going to make a runway, and people can show off the item they have made, but only if they feel happy and comfortable to do so.

Step 2

Everyone should get a piece of paper and pencil. Then they need to design their outfit, looking at the materials available. Tell that students might add cool fabric shapes to a pair of jeans, add buttons to a bag, use fabric pens to decorate a t-shirt or pair of socks, or use fabric glue to add sequins or gemstones to a headband.

Step 3

When they are ready, students can start to make the outfit. They may need to use sticky tape, a needle and thread, glue, or safety pins to help hold bits together. One or few teachers could use a glue gun or sewing machine to help pupils to secure items together.

Step 4

Everyone should finish putting their outfit together and, if you have used glue or paints, leave it to dry. You may want to run this over two sessions to give everyone time to finish their item. Once finished, everyone should give their outfit or item a name to be announced on the runway.

Step 5

Put chairs either side of the lines for people to sit on. Make sure you have a fun music playlist for the show. You could invite parents and carers in to watch. Alternatively, you can split everyone into two groups and get them to take it in turns. The group not walking down the runway would be watching, before switching over.

Step 6

You may want to introduce each person, as well as their item name. People could walk down the runway in pairs if they are feeling a little nervous. People should walk to down the runway to the end. They may want to add a pose at the end and then walk back up the runway.

Step 7

Anyone watching could clap and cheer as people walk down. You could assign some people to be paparazzi, providing any photo permissions are in place. Make sure people are being supportive of one another the entire time.

Step 8

Once people have walked down the runway, switch groups and get them to walk the runway until everyone who is wanted to have shown off their item. At the end, students can either keep or recycle their outfits.

Reflection

What have I learnt?

How did I feel creating an outfit?

How did I feel being on runaway?

What other creative ideas popped up in your mind?

What did you like the best about the activity?

What would you like to do differently the next time?

Tips

- To make it harder, you could just use spare fabrics and allow people to practice sewing to put something together.
- If you need to make it easier and quicker, students could just use bin bags, clean recyclable newspapers to create a simple new outfit, rather than using craft materials and fabrics.

Literature/Links

- https://www.scouts.org.uk/activities/recycled-runway/
- https://eu.tallahassee.com/story/life/family/2019/05/28/students-recycle-sense-style-fashion-show/1249506001/
- https://www.youtube.com/watch?v=DlkVthMYwes

Rubbish art

Average time length	Subject Areas	Place	Season
3 hours	Literature; Art; Environmental Education	Outdoors	All seasons

Description

This exercise is dedicated to learning literature, art and environmental education while creatively working with rubbish found in nature.

Aim

The aim of the activity is to work in groups and create a rubbish art. During this exercise students will use their imagination by collecting trash and designing a piece of artwork.

Preparation

Think of a rubbish contained area for the activity, maybe it would be nice to pick trash around your school?

Specific materials

- Any rubbish students can gather in nature
- Gloves to collect the rubbish

Procedure

Step 1

Divide the class into groups of 2 to 4. Using disposed material that they find lying about, each group creates an artwork. They can also use objects from nature and should create their creation as much detailed as possible.

Step 2

The next step is for the groups to write about their art. What kind of materials does it contains of? How long will it take for them to decompose? What was your inspiration to design it? Mention other significant details about your creation.

Step 3

Now the groups must present their art to one another by showing the artwork and reading the description.

Reflection

How did you feel creating this kind of art?

What have I learnt about various materials?

What could be the use of trash art?

Tips

You can turn this activity into a long project and display it in a specially assigned place in school. You can even make a contest!

Literature/Links

- https://www.youtube.com/watch?v=OZLNb_fbGks&ab_channel=WoodlandsTV
- https://www.pinterest.com/tetonrecycling/trash-art/

The role-play educational game: The court “A schoolyard transformation: more green or practical?”

Average time length	Subject Areas	Place	Season
2,5-3 hours	Environmental Education; Natural science; Drama	Indoors	All seasons

Description

This is an interactive role-playing court game where participants take on the roles of key stakeholders involved in a debate over a school project. The game is set up in a courtroom-style setting, where players present their cases, cross-examine witnesses, and negotiate a resolution that balances environmental concerns with the practicalities of an already-approved plan.

Aim

The aim of this task is to engage participants in a critical thinking exercise, where they must argue their position using logic, evidence, and persuasive communication skills. The game encourages participants to consider both the environmental and practical aspects of a school project, work within existing constraints, and find creative solutions that balance sustainability with the needs of a community.

The situation:

The school is received funding from the municipality for the reconstruction of the school field. The reconstruction project has been prepared, the school administration and municipality approve the project, but the school council would like to change the project to a more nature friendly.

Current schoolyard situation:

The school surroundings are currently in poor condition. The tile covering is crumbling, the lawn is overgrown with various plants and bushes. Old trees cast shade and cover the yard with leaves in the autumn. The infrastructure is outdated, there are no rest areas.

The proposed plan:

After receiving funding from the municipality, it is planned to carry out the following improvements:

- Paving
- Concrete pavement laying
- Cutting bushes
- Cutting of old trees
- Formation of a short green lawn
- Planting of decorative trees
- Establishment of recreation and play areas

The problem:

A part of the school council (representatives of parents, students and teachers) does not support the project and would like to change the project to a more nature-friendly environment. They insist on redesigning of the school's outdoor environment by increasing biodiversity, creating more sustainable and eco-friendly space, where they could educate the school community on climate change impact and to have opportunity to organise an educational process outdoors. They propose more green solutions based on increased biodiversity such as to create small wildlife habitats, to leave old trees, to install solar panels etc. However, the project was already approved by the municipality and any changes are hard to achieve.

Preparation

1. List of Roles: Identify the key roles needed for the game. These might include:

- **The Council Representatives**: Parents, students, and teachers advocating for the eco-friendly redesign.
- **Municipality Representatives**: Defenders of the existing, approved plan.
- **Environmental Experts**: Specialists who can provide information on biodiversity, sustainability, and the environmental impacts of design choices.
- **School Administrators**: They may have a neutral stance and can provide insight on the logistical feasibility of the project.
- **Contractors/Planners**: These participants can speak to the technical feasibility and cost of the proposed changes.
- **Judge or Mediator**: A neutral party who oversees the game, ensuring the rules are followed and moderating discussions.
- **Witnesses:** individuals who provide testimony or evidence relevant to the case being tried. Their role is to help establish facts and clarify important aspects of the case.

2. Assign Roles: Distribute the roles to participants. Make sure they understand their character's position and interests within the debate.

3. Develop Game Materials

Case Files/Briefs: Provide each role with a case file that includes:

- A summary of the current project and the approved plan.
- The specific arguments for or against the proposed changes (e.g., benefits of eco-friendly design vs. practical constraints).
- Any relevant data or studies (e.g., on biodiversity, climate change, cost of solar panels, etc.).

Courtroom Structure: Set up the environment for the debate (a mock courtroom or conference room setup works well). Assign seating arrangements for the different roles, ensuring each side has space to present their arguments.

Evidence: Prepare any evidence participants might use to strengthen their arguments. This could be statistics, studies, or even visual aids like diagrams or models of the proposed redesign.

4. Prepare the Debate Structure

- **Opening Statements**: Each side (the council and the municipality) should be given a set amount of time (e.g., 5-10 minutes) to present their opening statement, outlining their main arguments and objectives.
- **Witnesses and Experts**: Plan to have specific "witnesses" or "experts" (e.g., environmental experts, contractors) who can testify about specific aspects of the project. These experts should be prepared with relevant information that supports one side's position.
- **Cross-Examination**: After the opening statements, there should be a cross-examination period where each side can question the other's witnesses or experts. This allows participants to challenge the opposing side's arguments and evidence.
- **Closing Arguments**: Each side will then summarize their position, restating their main points and responding to any challenges raised during the debate.

5. Set the Rules and Guidelines

- **Time Limits**: Set clear time limits for each part of the debate (e.g., 5 minutes for opening statements, 3 minutes for cross-examination). This keeps the game flowing and ensures that everyone has a chance to speak.
- **Respectful Debate**: Establish rules for respectful communication. Emphasize that participants should focus on the issue, not personal attacks.
- **Order of Speaking**: Ensure that each side has a clear order for when they speak and that the judge or mediator has control over the flow of the game.
- **Role-Playing Tips**: Encourage participants to get into character. Those representing the school council should focus on environmental values, while municipality representatives should emphasize practicality, budget constraints, and existing approvals.
- **Location**: Ensure the debate space is well-organized, with enough seating for all participants and any spectators.

Specific materials

- Make sure all case files, research materials, and any visual aids (e.g., charts, maps, or models) are printed (or drawn on the board) and ready for use.
- **Audience Handouts:** If you have spectators, providing handouts with a summary of the key points and the roles of the participants will help them follow the debate.
- **Feedback Forms:** If the game is part of an educational exercise, feedback forms can be distributed to the participants to gather insights on what they learned from the experience.
- **Optional Tech Materials:** Projector or Screen: If you want to display evidence or arguments to the group, a projector or screen can be helpful. This is especially useful for showing diagrams or research data.
- **Laptop/Tablet:** If participants want to reference digital materials or present research, laptops or tablets could be provided.

Procedure

Step 1

Opening statements: the prosecutor and advocate present their case, explaining why they believe the project is necessary or unnecessary and why the current project of school setup should be approved or improved with “green” solutions.

Step 2

Questioning and Witnesses: both sides can request the judges to summon witnesses (schoolteacher, pupils, director, biodiversity expert, etc.). Witnesses will provide their perspective on the project, either supporting or opposing it. The judges moderate this process, allowing each side to ask the witnesses questions.

Step 3

Cross examination: After the witnesses present their statements, both sides have the chance to question the opposing side’s arguments. The judges ensure that the questions and answers remain respectful.

Step 4

Closing Statements: Both groups summarize their key arguments and make a final plea to the judges.

Step 5

Judges’ Deliberation and Decision: The judges retire to deliberate, discussing the arguments and evidence presented by both sides. After deliberation, the judges announce their decision regarding whether the school board should support the project or improve it.

Reflection

What was your main argument, and how did you support it during the debate?

Did you face any challenges while defending your position? How did you overcome them?

What new insights did you gain about the complexities of balancing environmental sustainability with practical constraints (budget, municipal approval, space, etc.)?

Did your team encounter any disagreements or differing opinions? How were these issues resolved?

What was the most important lesson you learned from this debate?

What aspects of the debate would you improve or do differently next time?

Tips

- For this game you can use any other environmental concern.
- Role-Playing Mindset: Remember that you are representing a group or perspective that may not entirely align with your personal views. Stay in character, even if it means arguing for something you do not fully agree with. This helps you develop empathy and understanding for different perspectives.
- Ask Thoughtful Questions: During cross-examination, ask questions that will force the other side to explain their position in more detail or reveal any gaps in their arguments.
- Stay Calm Under Pressure: Cross-examinations and challenges from the opposing side can be intense. Keep your composure and respond thoughtfully, even if the opposing arguments are challenging. This shows you can think critically under pressure.
- Appeal to Emotion: Engage your audience’s emotions by discussing the positive impact your proposed changes would have on students, the environment, and the community.

TOGETHER TOWARDS TO THE SUSTAINABLE DEVELOPMENT