

## IB ESS YEAR 1 - Unit 3 Biodiversity

<b>Teacher(s)</b>	IB ESS PLC	<b>Subject Group and Course</b>	Group 4 - ESS		
<b>Course Part and Topic</b>	Topic 3 Biodiversity & Conservation 3.1 Biodiversity and Evolution 3.2 Human Impact on Biodiversity 3.3 Conservation and Regeneration	<b>L or HL / Year 1 or 2</b>	SL Year 1	<b>Dates</b>	Jan - March (1st week) (8 weeks)
<b>Unit Description and Texts</b>		<b>DP Assessment(s) for Unit</b>			
<ul style="list-style-type: none"> <li>Intro and Origins of Biodiversity</li> <li>Biodiversity Threats and Conservation</li> <li>Oxford Textbook Topic 3</li> </ul>		<ul style="list-style-type: none"> <li>Formative/Summative assessment quizzes and activities/reports to check for understanding - Based in IB exam questions and format</li> </ul>			

### ***INQUIRY: Establishing the purpose of the unit***

<p><b>Transfer Goals</b></p> <p><i>List here one to three big, overarching, long-term goals for this unit. Transfer goals are the major goals that ask students to “transfer” or apply their knowledge, skills, and concepts at the end of the unit under new/different circumstances, and on their own without scaffolding from the teacher.</i></p>
<p><b>Statement of Inquiry</b></p> <p>The preservation of biodiversity is influenced by ecological, ethical, political, and economic considerations.</p> <p><b>Phenomenon:</b> Despite protection efforts, the orangutan remains critically endangered due to palm oil expansion.</p> <p><b>3 Unifying Concepts:</b></p> <ul style="list-style-type: none"> <li>Perspectives: allow students to develop deeper understandings of worldviews and individual perspectives on environmental issues.</li> <li>Systems: allows students to apply holistic analysis and understand the mechanics and purpose of human-constructed systems and the function of natural ones.</li> </ul>

- Sustainability: resource management issues are pivotal to sustainability (central to ESS Course)

**Cross-cutting Concepts (CCCs):**

- Patterns
- Stability and Change
- Cause and Effect
- Systems and System Models

**Science and Engineering Practices (SEPs)**

- Asking Questions and Defining Problems
- Analyzing and Interpreting Data
- Constructing Explanations
- Obtaining, Evaluating, and Communicating Information
- Engage in Argument from Evidence

Biodiversity is essential for ecosystem stability, human well-being, and sustainable development. Studying this topic helps students:

- ✓ Understand the components of biodiversity and why different ecosystems support different species.
- ✓ Analyze the threats to biodiversity, including habitat loss, climate change, invasive species, pollution, and overexploitation.
- ✓ Evaluate conservation strategies, from protected areas to international treaties.
- ✓ Examine ethical and economic perspectives on biodiversity protection.
- ✓ Explore real-world conservation efforts and their effectiveness.

This topic provides students with scientific knowledge and policy insights, equipping them to advocate for conservation and sustainability.

**Core Ideas:****3.1 Biodiversity and Evolution**

- Biodiversity exists at the genetic, species, and habitat levels.
- Evolution occurs through natural selection acting on variation.
- Speciation results from isolation and adaptation.
- Mass Extinctions have historically reduced biodiversity.

**3.2 Threats to Biodiversity**

- Biodiversity is threatened by habitat loss, invasive species, pollution, overexploitation, and climate change.
- IUCN Red List Assesses species' extinction risk using criteria like population size and decline.
- Human activities influence ecosystem services and species survival.
- Indigenous and local knowledge contribute to understanding and protecting biodiversity.

### **3.3 Conservation and Regeneration**

- Conservation methods include in situ (protected areas) and ex situ (zoos, seed banks) strategies.
- Biosphere reserves aim to balance conservation and sustainable use.
- Wildlife corridors help species movement and reduce habitat fragmentation.
- Conservation success can be measured ecologically, socially, and economically.

***ACTION: teaching and learning through inquiry***

Content / Skills / Concepts - Essential Understandings	Learning Process
	<i>Check the boxes for any pedagogical approaches used during the unit. Aim for a variety of approaches to help facilitate learning.</i>

<p><u>Students will know the following content:</u></p> <p><b>3.1 Biodiversity and Evolution</b></p> <p><b>Guiding questions</b></p> <ul style="list-style-type: none"> <li>• How can diversity be explained and quantified, and why is this important?</li> <li>• How does the unsustainable use of natural resources impact biodiversity?</li> </ul> <p><b>3.1.1</b> Biodiversity is the total diversity of living systems, and it exists at several levels. The biodiversity levels are habitat diversity, species diversity, and genetic diversity. (Taxonomy - organizing and classifying organisms hierarchically)</p> <p><b>3.1.2</b> The components of diversity contribute to the resilience of ecological systems. Each component of biodiversity contributes to the resilience of living systems.</p> <p><b>3.1.3</b> Biodiversity arises from evolutionary processes. Evolution is cumulative change in the heritable characteristics of a population or species.</p> <p><b>3.1.4</b> Natural selection is the mechanism driving evolutionary change. Natural selection operates continuously and can take place over billions of years, resulting in the biodiversity of life on Earth.</p> <p><b>3.1.5</b> Evolution by natural selection involves variation, overproduction, competition for limited resources, and differences in adaptation that affect rates of survival and reproduction. Natural selection occurs because genetic diversity gives rise to variation within a population. Individuals with variations that provide an advantage in a given environment are more likely to survive and reproduce than others. Variation is heritable; therefore, individuals with advantageous genes can pass them on to their offspring. As a result, the frequency of advantageous genes will increase over many generations.</p> <p><b>3.1.6</b> Speciation is the generation of new species through evolution. Speciation takes place when a population of a species becomes isolated and adapts in different ways to its environment. Over time, they become unable to interbreed with other populations of the original species, and thus they evolve into a new species.</p> <p><b>3.1.7</b> Species diversity in communities is a product of richness and evenness. Richness is the number of species in a community; evenness is how similar the population sizes of each species are. Consider the significance of these two variables for biodiversity.</p>	<p>supporting learning:</p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Lecture</li> <li><input type="checkbox"/> Socratic seminar</li> <li><input checked="" type="checkbox"/> Small group/pair work</li> <li><input checked="" type="checkbox"/> PowerPoint lecture/notes</li> <li><input checked="" type="checkbox"/> Individual presentations</li> <li><input checked="" type="checkbox"/> Group presentations</li> <li><input checked="" type="checkbox"/> Student lecture/leading</li> <li><input checked="" type="checkbox"/> Interdisciplinary learning</li> </ul> <p>Details:</p> <p><i>Students will learn through a combination of presentations, team/small group work, activities surrounding threats to and conservation of biodiversity, and a two-day outdoor activity, completing a plant biodiversity index (ACFOR scale)</i></p> <p>Other(s): Use of social media - Instagram/Twitter for increased awareness - creation of a children's book, game, etc, to inform the younger generation of issues surrounding biodiversity</p>
--	---

**3.1.8** Simpson's reciprocal index is used to provide a quantitative measure of species diversity, allowing different ecosystems to be compared and for change in a specific ecosystem over time to be monitored.

Consider appropriate sampling procedures for comparing diversity in areas containing the same type of organism in the same ecosystem.

Calculate diversity (D) if provided with data and the formula, in which N is the total number of individuals in the population and n is the number of individuals of a single species. The value of D will be higher where there is greater richness (number of species) and evenness (similar abundance), with 1 being the lowest possible value.

$$D = \frac{N(N - 1)}{\sum n(n - 1)}$$

**3.1.9** Knowledge of global and regional biodiversity is needed for the development of effective management strategies to conserve biodiversity. Include how knowledge of biodiversity is gathered in the local region.

This is likely to involve citizen science and the work of voluntary and government-funded agencies. The training of indigenous people and others, such as parabiologists, is also used to gather information for use in conservation management.

#### **Possible engagement opportunities**

- Investigate the origin and increase in abundance of tuskless elephants in regions undergoing civil conflict.
- Investigate the impact of inequality on knowledge of biodiversity.
- Citizen science and voluntary agencies offer opportunities for students to participate in gathering knowledge of local and regional biodiversity.
- Create a podcast exploring the epoch of the Anthropocene.

### **3.2 Threats to Biodiversity**

#### **Guiding question**

- What causes biodiversity loss, and how are ecological and societal systems impacted?

**3.2.1** Biological diversity is being adversely affected by both direct and indirect influences. Direct threats include overharvesting, poaching, and the illegal pet trade. Indirect threats include habitat loss, climate change, pollution, and invasive alien species.

#### **Formative assessment(s):**

- Quizzes (2)
- In class activities - Simpson's Diversity Index, Solving the Extinction Crisis Debate, Mapping Biodiversity Hotspots, and Ecocentric and Technocentric Conservation Debate
- Biodiversity Case Studies
- Research assignments - Biodiversity and Conservation Research Project

**3.2.2** Most ecosystems are subject to multiple human impacts.

These impacts are increasing, and their effects are amplified when combined. For example, when the impact of climate change has reduced resilience, other threats, such as invasive alien species, have more impact than if they were acting alone.

**3.2.3** Invasive alien species can reduce local biodiversity by competing for limited resources, predation, and the introduction of diseases or parasites.

Consider how alien species can arrive in an ecosystem and the factors that can result in their exponential increase. Use a local example of an alien species that has become invasive and the management strategy that has been used to reduce its impact.

**3.2.4** The global conservation status of species is assessed by the International Union for Conservation of Nature (IUCN) and is published as the IUCN Red List. Status is based on the number of individuals, rate of increase or decrease of the population, breeding potential, geographic range, and known threats.

Precise criteria and data are used to assign status to a species, and a sequence of conservation status ranks has been defined from least concern (LC) to extinct (EX).

**3.2.5** Assigning a global conservation status publicizes the vulnerability of species and allows governments, non-governmental agencies, and individual citizens to select appropriate conservation priorities and management strategies.

Include differences between the perspectives of governments, agencies, and individuals in conservation.

**3.2.6** Investigate three different named species: a species that has become extinct due to human activity; a species that is critically endangered; and a species whose conservation status has been improved by intervention.

For the three different named species, consider the factors that contributed to their decline and the impacts of their decline, disappearance, or extinction on ecosystems and societies. Consider the conservation strategies that were employed, whether successful or not.

**3.2.7** The tragedy of the commons describes possible outcomes of the shared unrestricted use of a resource, with implications for sustainability and the impacts on biodiversity.

The tragedy of the commons is a concept relating to the overexploitation of shared natural resources through human activity and the tension between individual self-interest and shared benefits of sustainable development. Include two examples where a resource is overharvested (for example, fish stocks on the Grand Banks) or where an environment is

contaminated (for example, plastic pollution in ocean gyres).

**Possible engagement opportunities**

- Assess the tensions between exploitation, sustainable development, and conservation in a local ecosystem or protected area.
- Raise awareness of indigenous land rights.
- Raise awareness of endangered species and volunteer in a local NGO for wildlife rehabilitation.

**3.3 Conservation and Regeneration**

**Guiding questions**

- How can different strategies for conserving and regenerating natural systems be compared?
- How do worldviews affect the choices made in protecting natural systems?

**3.3.1** Arguments for species and habitat preservation can be based on aesthetic, ecological, economic, ethical, and social justifications.

Economic arguments for preservation often involve valuation of ecotourism, of the genetic resource, and commercial considerations of the natural capital. Ecological reasons may be related to the ecosystem services. Ethical arguments are very diverse and can include reference to the intrinsic or instrumental value of the species. Social arguments might highlight the importance of goods and services for the well-being of humans.

**3.3.2** Species-based conservation tends to involve ex situ strategies, and habitat-based conservation tends to involve in situ strategies.

Ex situ measures include botanic gardens, zoos, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and seed banks; in situ measures include the use of national parks, reserves, and sanctuaries. Consider two examples of ex-situ measures and two examples of in situ measures.

**3.3.3** Sometimes a mixed conservation approach is adopted, where both habitat and particular species are considered.

The mixed approach usually invokes flagship and/or keystone species to justify the need to conserve intact habitats and landscapes. Consider an example of a mixed approach where the emphasis of in situ measures is on a particular species, for example, the Chengdu Research Base of Giant Panda Breeding.

**3.3.4** The Convention on Biological Diversity (CBD) is a UN treaty addressing both

species-based and habitat-based conservation.

The objective of the CBD is to develop national strategies for the conservation and sustainable use of biological diversity. It further aims to identify protected marine areas outside of national jurisdictions. It also includes the Nagoya Protocol, which promotes the fair and equitable sharing of genetic resources.

**3.3.5** Habitat conservation strategies protect species by conservation of their natural environment. This may require protection of wild areas or active management. Include one example of a habitat where active management has been required and one example of the establishment of an ecosanctuary using pest-exclusion fencing. Surrounding land use for the conservation area and distance from urban centres are important factors for consideration in conservation area design.

**3.3.6** Effective conservation of biodiversity in nature reserves and national parks depends on an understanding of the biology of target species and on the effect of the size and shape of conservation areas.

Include edge effects and the importance of wildlife corridors for connectivity. Consider an example of a UNESCO biosphere reserve with high biodiversity and species of international conservation importance, including the designation of an appropriate area for conservation, potential human impacts, and management strategies. Include the concept of a pristine core, surrounded by buffer zones and outer transition zones that are sustainably managed.

**3.3.7** Natural processes in ecosystems can be regenerated by rewilding. Consider rewilding methods, for example, reintroduction of apex predators and other keystone species, re-establishment of connectivity of habitats over large areas, cessation of agriculture and resource harvesting, and minimization of human influences, including through ecological management. Consider one example, such as Hinewai Reserve in New Zealand, any other appropriate rewilding project, or a local example.

**3.3.8** Conservation and regeneration measures can be used to reverse the decline in biodiversity to ensure a safe operating space for humanity within the biodiversity planetary boundary.

Measures can be taken to conserve and regenerate biodiversity at individual, collective, national, and international levels.

**3.3.9** Environmental perspectives and value systems can impact the choice of conservation strategies selected by a society.

The success of conservation and regeneration measures depends on incorporating a

<p>diversity of approaches, including community support, adequate funding, education and awareness, appropriate legislation, and scientific research. Consider also issues of environmental justice. More ecocentric perspectives may approach conservation for the intrinsic value of biodiversity and so focus on low-intervention in situ strategies; more anthropocentric/technocentric perspectives may be driven by the economic, societal value of biodiversity and thus embrace more scientific interventions involving zoos, gene banks, and ecotourism.</p> <p><b>Possible engagement opportunities</b></p> <ul style="list-style-type: none"> <li>• Investigate the role of an NGO in a conservation project.</li> <li>• Visit a rewilding project or protected area and raise awareness about the project.</li> <li>• Volunteer in a local conservation project, for example, the removal of an invasive species or putting up bird boxes.</li> </ul> <p><b><u>Students will develop the following skills:</u></b></p> <p><b>Application of skills:</b></p> <ul style="list-style-type: none"> <li>• Investigate the impact of human activity on biodiversity in an ecosystem by studying changes in species diversity along a transect laid perpendicular to a site of human interference or by randomly sampling within transects before and after the human activity.</li> <li>• Collect data to work out Simpson’s reciprocal index for diversity.</li> </ul>	
<p><b>International Mindedness:</b></p> <p>Conservation needs to work at the local grassroots level to create meaningful change in the communities that live alongside conservation areas. International organizations are important for enforcing the Convention on International Trade in Endangered Species (CITES) agreement, assessing the global status of species’ numbers, and influencing governments.</p> <p>The ESS course emphasizes the importance of making local to global connections to develop an understanding of sustainability issues. This has remained strong in environmental education and is also reflected in the history of the environmental movement, with its initial focus on the local leading to a realization of the significance of the global context.</p> <p>The study of local ecosystems and environments through fieldwork is strongly recommended. Local knowledge is valuable for student studies, also in urban areas and</p>	<p><b>Summative assessments:</b> ACFOR outdoor Summative assessment over each subtopic and over Topic 3 all</p> <p><b>Differentiation:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Affirm identity - build self-esteem</li> <li><input checked="" type="checkbox"/> Value prior knowledge</li> <li><input checked="" type="checkbox"/> Scaffold learning</li> <li><input checked="" type="checkbox"/> Extend learning</li> </ul> <p>Details:</p>

<p>school grounds (outdoor observatory).</p> <p>Students will be given opportunities to access and gain knowledge may come from indigenous cultures. International mindedness can include developing an understanding of communities with different worldviews, both within the school and in neighbouring communities.</p> <p>International organizations such as the World Wildlife Fund (WWF), Greenpeace, Friends of the Earth International (FoEI) and Earth First! undertake global programmes in terms of conservation of biodiversity.</p>	<ul style="list-style-type: none"> <li>● <i>SWD/504 – Accommodations Provided</i></li> <li>● <i>ELL – Reading &amp; Vocabulary Support</i></li> <li>● <i>Intervention Support</i></li> <li>● <i>Extensions – Enrichment Tasks and Project</i></li> </ul>
<p><b>Approaches to Learning (ATL)</b></p> <p><i>Check the boxes for any explicit approaches to learning connections made during the unit. For more information on ATL, please see <a href="#">the guide</a>.</i></p>	
<ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Thinking <ul style="list-style-type: none"> <li>● Evaluating claims of attaining sustainability and the identification of barriers to attaining sustainability</li> <li>● Critically examining and evaluating the evidence and theory supporting competing narratives on environmental/sustainability issues</li> <li>● Evaluating and defending ethical positions on environmental/sustainability issues</li> </ul> </li> <li><input checked="" type="checkbox"/> Social <ul style="list-style-type: none"> <li>● Assigning and accepting specific roles during group activities</li> <li>● Generating agreed solutions with respect to the interests of all stakeholders</li> </ul> </li> <li><input checked="" type="checkbox"/> Communication <ul style="list-style-type: none"> <li>● Practicing active listening skills and appreciating that understanding different perspectives can allow for better communication</li> </ul> </li> <li><input checked="" type="checkbox"/> Self-management <ul style="list-style-type: none"> <li>● Breaking down major tasks into a sequence of stages</li> <li>● Logically organizing and ordering a variety of information sources</li> </ul> </li> <li><input checked="" type="checkbox"/> Research <ul style="list-style-type: none"> <li>● Locating and evaluating secondary information sources for accuracy, bias, credibility and relevance</li> <li>● Explicitly discussing the importance of academic integrity and full acknowledgement of the ideas of others</li> <li>● Seeking out interconnections between academic disciplines and real-world experience</li> </ul> </li> </ul> <p>Details: This topic provides students with a vast amount of information that can be studied in many ways. The ATLs used for this subtopic will vary depending on the individual students and groups approach to showing their understanding of the material.</p>	

<b>Language and Learning</b> <i>Check the boxes for any explicit language and learning connections made during the unit. For more information on the IB's approach to language and learning, please see <a href="#">the guide</a>.</i>	<b>TOK Connections</b> <i>Check the boxes for any explicit TOK connections made during the unit</i>	<b>CAS Connections</b> <i>Check the boxes for any explicit CAS connections. If you check any of the boxes, provide a brief note in the "details" section explaining how students engaged in CAS for this unit.</i>
<ul style="list-style-type: none"> <li><input type="checkbox"/> Activating background knowledge</li> <li><input checked="" type="checkbox"/> Scaffolding for new learning</li> <li><input checked="" type="checkbox"/> Acquisition of new learning through practice</li> <li><input type="checkbox"/> Demonstrating proficiency</li> </ul> <p>Details:</p> <p><i>Students will acquire new vocabulary dealing with the origin, threats, and conservation of biodiversity</i></p>	<ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Personal and shared knowledge</li> <li><input checked="" type="checkbox"/> Ways of knowing</li> <li><input checked="" type="checkbox"/> Areas of knowledge</li> <li><input checked="" type="checkbox"/> The knowledge framework</li> </ul> <p>Details:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> <i>The term "biodiversity" has replaced the term "nature" in much literature on conservation issues—does this represent a paradigm shift?</i></li> <li><input type="checkbox"/> <i>Genetic diversity refers to the range of genetic material present in a population of a species.</i></li> <li><input type="checkbox"/> <i>Diversity index is not a measure in the true sense of the word, but merely a number (index), as it involves a subjective judgment on the combination of two measures: proportion and richness. Are there examples in other areas of knowledge of the subjective use of numbers?</i></li> <li><input type="checkbox"/> <i>The theory of evolution by natural selection tells us that change in populations is achieved through the process of natural selection—is there a difference between a convincing theory and a correct one?</i></li> <li><input type="checkbox"/> <i>There may be long-term consequences when biodiversity is lost—should people be held morally responsible for the long-term consequences of their actions?</i></li> <li><input type="checkbox"/> <i>There are various approaches to the conservation of biodiversity—how can we determine when we should be disposed to</i></li> </ul>	<ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Creativity</li> <li><input checked="" type="checkbox"/> Activity</li> <li><input type="checkbox"/> Service</li> </ul> <p>Details:</p> <p><i>Students may apply creativity in their group and individual projects- species profile and creation of a children's book, song, game, etc, that will teach the younger generation about the importance of biodiversity conservation</i></p> <p><i>Students will gain experience with outdoor surveying work through the ACFOR scale activity in the nature observatory.</i></p>

	<i>act on what we know?</i>	
<b>Resources</b> <i>List and attach (if applicable) any resources used in this unit</i>		
<ul style="list-style-type: none"> <li>● Oxford Environmental Systems and Societies ISBN 978-0-19-833256-5</li> <li>● Biozone Environmental Science Student Workbook ISBN 978-1-927173-55-8</li> <li>● Hodder Education Environmental Systems and Societies Study and Revision Guide ISBN 978-1-471-89973-7</li> <li>● IB ESS Schoology Group</li> </ul>		

***REFLECTION: considering the planning, process, and impact of the inquiry***

<b>What worked well</b>	<b>What didn't work well</b>	<b>Notes / Changes / Suggestions</b>
<i>List the portions of the unit (content, assessment, planning) that were successful</i>	<i>List the portions of the unit (content, assessment, planning) that were not as successful as hoped</i>	<i>List any notes, suggestions, or considerations for the future teaching of this unit</i>

<p>Conservation Island Activity to introduce the issues of land management (could extend/modify activity to add stakeholders or to give students different interests).</p> <p>IUCN species case study assignment and sharing. Provided students the opportunity to learn more about self-selected organisms and relate information to topic 3 and previous topics.</p> <p>Students appreciate topic review sheets.</p>	<p>Students still need more practice with command terms used in IB style assessment questions.</p> <p>Some students are still struggling with graph and chart reading for some types of figures. Students do well with maps or simple line and bar graphs, but struggle with more complex figures.</p>	<p>Increase outdoor collection of data. Consider moving this unit to early fall semester or late spring semester to provide more opportunities for field data collection.</p> <p>Include some crossover activities that highlight knowledge and skills used in other topics.</p> <p>Continue including time for IB command term practice and graph/chart/figure analysis.</p>
--	--	---