Teaching Guide

Topic 3: Biodiversity and conservation

Topic map

Sub-topic number and name	Learning outcome	Number of lessons (suggested) 1 hour per lesson	Relevant material
3.01 An introduction to biodiversity	Biodiversity can be identified in species, genetic or habitat diversity.	3	Pages 118–122 Figure 3.01 Self-assessment questions 3.01.01 Case study 3.01.01 End-of-topic question 1
3.02 Origins of biodiversity	The environment challenges species and drives evolution of diversity.	3	Pages 123–134 Figure 3.04 Self-assessment questions 3.02.02 Case studies 3.02.01, 3.02.02 End-of-topic question 3
3.03 Threats to biodiversity	Conservation status can be useful in assessing global biodiversity.	4	Pages 135–146 Figure 3.12; Table 3.03 Self-assessment questions 3.03.01–3.03.03 Case studies 3.03.01–3.03.03 End-of-topic question 3
3.04 Conservation of biodiversity	EVSs and the impact of losing biodiversity drive conservation efforts.	3	Pages 147–159 Figure 3.13 Self-assessment questions 3.04.01, 3.04.02 Case studies 3.04.01, 3.04.02 End-of-topic question 2

Sub-topic 3.01: An introduction to biodiversity

Overview

Students should have an understanding of biodiversity, but here is it is refined to include three key aspects: species, habitat and genetic diversity. The importance of quantifying biodiversity is key to conservation efforts.

Suggested activities

Possible starters

Recall the calculation of diversity index from Topic 2. The biodiversity portal on the Natural History Museum website (www.nhm.ac.uk/our-science/our-work/biodiversity.html) is a good resource to promote interest and discussion.

Main lesson content

- A key activity in the first lesson on this topic is to introduce the three measures of biodiversity and outline their individual and collective values. Habitat diversity can be studied by examining the niches present in an ecosystem, either practically or by considering a rainforest system with much diversity. www.tes.co.uk/teaching-resource/rainforest-layers-6131618 has some resources for this.
- Species richness and abundance were introduced in Topic 2 and should be familiar. Genetic diversity is a new concept which students may be unfamiliar with. Gene pool could be covered in relation to inbreeding of zoo animals, and the idea extended to the natural world.
- Quantification allows for comparison and objective judgements about systems, but students should realise that interpretation can be complex with some natural unpolluted sites having low diversity.
- www.nhm.ac.uk/nature-online/biodiversity/research-and-videos/index.html has video material on measuring diversity in different ecosystems.

Common misunderstandings and misconceptions

There may be confusion between different diversity indexes shown in reference material and used in different situations. Students should be told to use the one for their course and take care when using other data.

Supporting struggling students

As the information covered here is revisited in the following sub-topics, weaker students should be able to consolidate their knowledge and clarify any misunderstandings as they proceed.

Challenging high achievers

This resource provides extension material on the concept of the niche (and other related topics), which could be useful:
www.tes.co.uk/teaching-resource/a2-biology-stretch-and-challenge-pack-6110752

Homework suggestion

www.amnh.org/explore/curriculum-collections/biodiversity-counts/plant-ecology/how-to-calculate-a-biodiversity-index has additional resources on diversity indexes and could be useful for practice.

Cross-references with other sub-topics

2.05 Investigating ecosystems, 7.02 Climate change – causes and impacts.

Sub-topic 3.02: Origins of biodiversity

Overview

This sub-topic covers the evolution of new species and how biodiversity arises from evolutionary change. Students should also understand the importance of plate tectonics and mass extinctions in this process.

Suggested activities

Possible starters

www.newscientist.com/topic/evolution has some interesting starters to introduce the idea of evolution. The idea of change in populations over time can be introduced using antibiotic resistance in bacteria, which is familiar to most.

Main lesson content

- There are many hands-on interactive materials to demonstrate evolution in action:
    - http://evolution.berkeley.edu/evolibrary/teach/index.php
    - www.pbs.org/wgbh/evolution/educators
    - www.nuffieldfoundation.org/science-society/activities-evolution
    - www.arkive.org/education/teaching-resources-14-16 has good resources that cover biodiversity and evolution, Darwin's finches and the peppered moth.
- The websites above provide activities for pupils and ideas for teachers. The key point in this course is that evolution leads to biodiversity because the environment challenges species and those that are well adapted survive and/or change.
- Isolation is a key idea in speciation, and this can be covered in relation to plate tectonics and the formation of geographical barriers between populations. Over long periods of time, physical barriers may be enhanced by climatic barriers which arise as a result of climatic change and, in turn, lead to lack of food or a change in resources.
- Over geological time, movements of landmasses have created many barriers. Examination of the role of plate tectonics can be demonstrated with maps, simulations and visualisations, which in turn can be related to species such as flightless birds and marsupials.
  http://geology.com/teacher/plate-tectonics.shtml and
  www.geolsoc.org.uk/Plate-Tectonics are good resources here.
- Mass extinctions are probably not familiar to most students, and most find this an interesting topic to research. The current mass extinction caused by human activity is a salutatory lesson to most.

See http://evolution.berkeley.edu/evolibrary/news/120901_afterextinction and http://smithsonianscience.si.edu/2014/12/mass-extinction-life-brink

Common misunderstandings and misconceptions

Students often confuse the idea that individuals vary but populations change. Individuals survive and reproduce leading to changes in the population's characteristics.

Supporting struggling students

The common misunderstanding can be addressed with familiar or well-documented examples such as bacteria and peppered moths, which have short life spans.

Challenging high achievers

The 'theory of knowledge' aspect relating to the difference between a dogma and a scientific theory is interesting for high achievers.

Homework suggestion

Further reading: Wilson, E.O. (1992) *The Diversity of Life*, Cambridge, Massachusetts, USA: The Belknap Press of Harvard University Press.

Cross-references with other sub-topics

2.04 Biomes, zonation and succession, 7.02 Climate change – causes and impacts.

Sub-topic 3.03 Threats to biodiversity

Overview

Most students of this course are likely to be familiar with the problems that species face today and the threat that human activities pose to them. This is likely to be a topic that will actively engage and challenge students.

Suggested activities

Possible starters

The plight of orang-utans in Borneo as their habitat is taken over by palm oil plantations is a simple but direct demonstration of the threats to an iconic species and others that share its habitat (wwf.panda.org/what_we_do/endangered_species/great_apes/orangutans). Students could investigate how many products in their homes contain palm oil.

Main lesson content

- Estimates of numbers of species on Earth are an interesting area for investigation. Useful resources can be found at: www.scientificamerican.com/article/are-we-any-closer-to-knowing-how-many-species-there-are-on-earth and www.arkive.org/education.
  Students could draw pie or bar charts to practise their mathematical skills.

- The conservation status of different species is available on the International Union for Conservation of Nature (IUCN) website (www.iucnredlist.org). Students must study three threatened species from an ecological, socio-political and economic viewpoint. They may use the examples in the textbook or select others from the IUCN website. Ecological roles and the consequence of species loss should be included.
- Human activities leading to species extinction are exploitation of habitat (e.g. orang-utans), invasive species, pollution and overharvesting. This is a good topic for independent research, and students can take a category each and present their findings and examples to the class.
- A plenary can evaluate the impact of humans on tropical biomes and include reference to the biomes' location in less economically developed countries (LEDCs) and conflicts between development and conservation. Data is available at: http://rainforests.mongabay.com and www.teachervision.com/rain-forest-ecology/teacher-resources/6659.html as well as on many other reference websites and in books.

Common misunderstandings and misconceptions

Misunderstandings and misconceptions are not usually a problem in this topic. The concepts are straightforward, and exemplars are the key issue here.

Supporting struggling students

Students do not usually have a problem with this descriptive and popular topic, but weaker students could be supported with relevant newspaper or internet articles about the impact of humans on the environment.

Challenging high achievers

High achievers might find the political context of conservation and problems of international agreement an interesting area to study.

Homework suggestion

Prepare presentations on endangered species with information from the Red List.

Cross-references with other sub-topics

1.04 Sustainability, 8.02 Resource use in society.

Sub-topic 3.04: Conservation of biodiversity

Overview

Conservation is a topic which students will have read and seen information about, but here they must consider which species to conserve and why, and the various approaches to conservation strategy.

Suggested activities

Possible starters

Students should identify species that have been preserved for different reasons: aesthetic, ecological, economic and ethical. Show video clips of rainforest, coral reefs, etc.

Main lesson content

- www.arkive.org/education/teaching-resources-14-16 has a useful teaching pack which asks students to design a conservation programme and learn about the economic benefits and services ecosystems provide.
- WWF, Greenpeace and Friends of the Earth all have good websites that describe their global conservation strategies. It is interesting to compare non-governmental organisations (NGOs) with government programmes, and their relative successes. The work of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) should be included.
- Students should be aware of the differences between in situ and ex situ breeding programmes and the advantages and weaknesses of each. They should consider how conservation of a charismatic species (e.g. panda) and a keystone species has helped in the conservation of other species. The Smithsonian has resources:
    - http://nationalzoo.si.edu/education/conservationcentral/teacher/resources
    - www.educationscotland.gov.uk/pandas/conservation/index.asp

  Information on keystone species and other links are available at: http://education.nationalgeographic.co.uk/education/encyclopedia/keystone-species/?ar_a=1

  Design of conservation areas could be considered locally. Students may be able to visit a local park and look at the size, shape and variety of habitats it contains.

Common misunderstandings and misconceptions

It is important to challenge the view that everything can be put right by breeding endangered species in zoos and releasing them into the wild. Students must understand that the situation is far more complex.

Supporting struggling students

Students are unlikely to struggle with the concepts here; most find the topic fascinating. Any who really struggle could be provided with specific examples of famous species that have been conserved either locally or in the wider world.

Challenging high achievers

Invite high achievers to put forward the case for conservation of an unattractive small invertebrate that is important to an ecosystem.

Homework suggestion

Research on websites that are used for ecotourism is an interesting way to compare motivation for conservation work. Travel agents and websites have a wealth of information about what is available in different parts of the world. Students can evaluate the costs and benefits involved.

Cross-references with other sub-topics

1.01 Environmental value systems, 8.02 Resource use in society.