



DARWIN
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Darwin

KS3

Module 4: Sustainability and Extinction



Lesson plan

Vulnerable species and habitats

Darwin examined the interconnectedness of the Galapagos Islands' wildlife. The arrival of humans brought great changes and threats that caused many of the organisms Darwin marvelled at to become endangered or extinct.

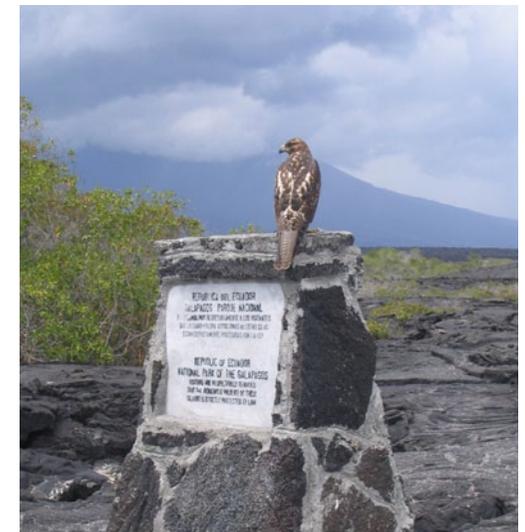
As a young man, fresh from University, Darwin visited the Galapagos Islands in 1835. He found that each island had its own unique set of animals and plants. The animals and plants that had arrived there from the mainland found themselves in an isolated habitat with few competitors or predators. Their populations grew as a result.

Students are introduced to the effects of human activity on vulnerable habitats. They examine the interconnectedness of the Galapagos wildlife, the impact of humans, and explore how isolated populations are vulnerable to becoming endangered or extinct.

Quotation

'I will conclude my description of the natural history of these islands, by giving an account of the extreme tameness of the birds ... This disposition is common to all of the terrestrial species; namely, to the mocking-thrushes, the finches, wrens, tyrant-flycatchers, the dove, and carrion-buzzard. All of them often approached sufficiently near to be killed with a switch, and sometimes, as I myself tried, with a cap or hat. A gun is here almost superfluous; for with the muzzle I pushed a hawk off the branch of a tree. One day, whilst lying down, a mocking-thrush alighted on the edge of a pitcher, made of the shell of a tortoise, which I held in my hand, and began very quietly to sip the water; it allowed me to lift it from the ground whilst seated on the vessel: I often tried, and very nearly succeeded, in catching these birds by the legs.'

Charles Darwin, *Voyage of the Beagle*, 1860



Above: Marine iguana.
Below: Galapagos hawk.

Lesson outcomes

- Examining the concepts of succession, interdependence and endemism.
- Exploring how new habitats are colonised.
- Identifying how human activity can affect communities of organisms and how these activities can have multiple and interconnected effects because organisms in an ecosystem are interdependent.
- Describing how organisms in an ecosystem are interdependent.
- Describing how the terrestrial Galapagos ecosystem has been affected by isolation and subsequent human colonisation.
- Explaining why isolated communities of organisms are particularly vulnerable to becoming endangered or extinct.



Giant Galapagos tortoise,
Santa Cruz Island.

Curriculum links

- To recognise that modern science has its roots in many different societies and cultures, and draws on a variety of valid approaches to scientific practice.
- To use scientific ideas and models to explain phenomena and developing them creatively to generate and test theories.
- To analyse critically and evaluate evidence from observations and experiments.
- To obtain, record and analyse data from a wide range of primary and secondary sources, including ICT sources, and use their findings to provide evidence for scientific explanations.
- To evaluate scientific evidence and working methods.
- To use appropriate methods, including ICT, to communicate scientific information and contribute to presentations and discussions about scientific issues.



Bartholomew Island Lizard.

Key words

Food chain, food web, environmental change, sustainability, interdependence, endangered, extinction, endemism, habitat, producer, consumer, herbivore, carnivore, predator, prey.

Resources

A1 sheet of paper or flipchart paper, coloured pens or pencils, hand lenses, Darwin notebooks, pencil, digital cameras, ICT facilities for research.

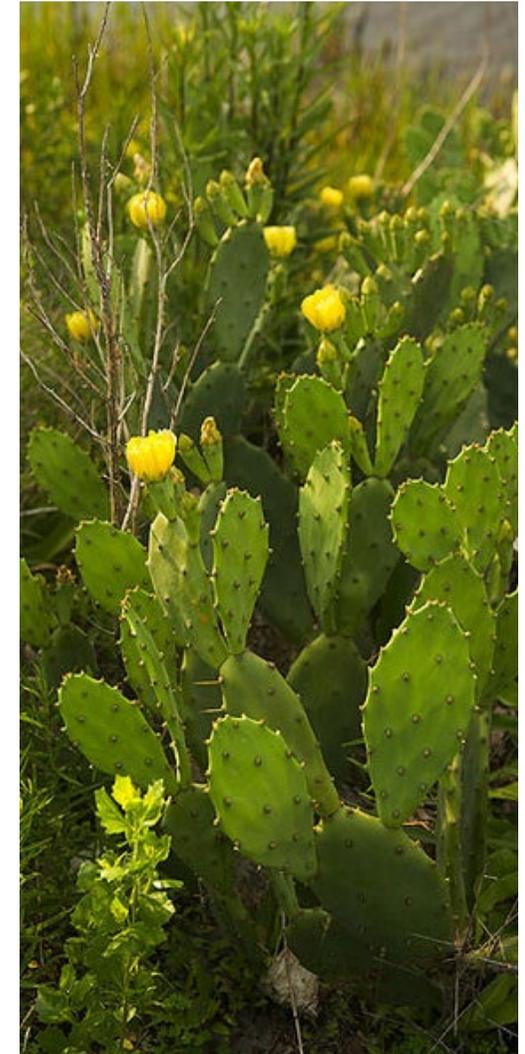
Lesson sequence

Pre-visit lesson

Starter activity

Introducing students to the unusual distribution of organisms that Darwin observed. There are few native mammals and predators, and some herbivores, such as the adult giant tortoise, do not have a native predator.

How did the animals and plants that live on the Galapagos Islands get there? Students work in small groups, using an A1 sheet of paper to draw an island in the sea. PowerPoint slides 2 and 3 can be shown as guides. Students consider how different types of organisms from the PowerPoint slides may have travelled 600 miles over the sea to the Galapagos. This task can be extended to consider which organisms had to come first. In what order would they need to arrive? Students can annotate their island by drawing the organisms and noting which must have arrived first to establish an ecosystem.



Prickly pear cactus

Pre-visit lesson

Main activity

Students are introduced through the presentation to:

1. Darwin's visit to the Galapagos and the animals and plants that he saw there.
2. the impact of human activity during and since Darwin's time.

Activity 1

Working in small groups, students are given a list printed from slide 14 of some of the human activities that can affect the Galapagos wildlife. Their task is to see the connections between activities. For instance, if the human population increases, more new buildings are needed which could lead to habitat destruction. An increase in the number of tourists arriving by air could lead to global warming and sea level rises, but is more likely to bring in more invasive or foreign species.

Students draw arrows to connect activities. Alternatively, students can use the slide on the interactive whiteboard (IWB) and individual students use an IWB pen to connect activities. A kinaesthetic way of performing the task would be for groups of students to represent a human activity and make connections to other groups with string or wool, making a 3D mind map.



Above: Galapagos penguin,
Fernandina Island.

Below: Red-breasted frigate bird,
North Seymour Island.

Pre-visit lesson

Activity 2

Individually or in groups this activity can be differentiated by ability. Students use the Galapagos animal/plant fact files (slides 20 -23) to create either:

- a simple food chain, or
- a longer food chain or simple food web, or
- a complex food web.

An example is given in the Resource materials page 17 and PowerPoint slide 17.

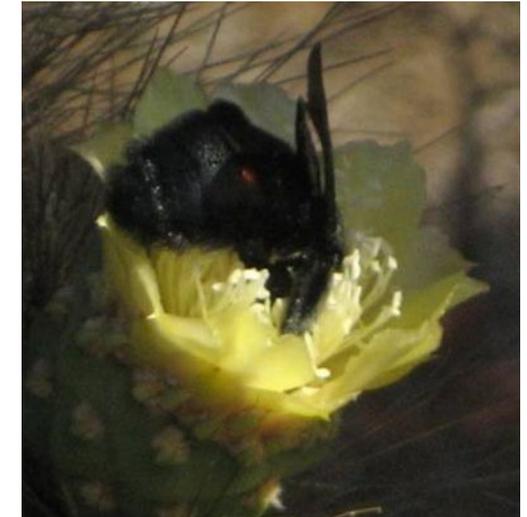
The task can be extended by:

- reference to the human activities discussed in activity 1.
- using the information on the invasive species factfile cards (slide 19).

In groups, students could discuss how the human activities would affect their food chain or web. Which organisms could be affected? How and why? The invasive species fact card can be used to focus on the effect on native species of competition and predation.

Plenary

In groups, students consider why isolated communities of organisms are more vulnerable to becoming endangered or extinct. Students generate and record questions in their Darwin notebook about the topics explored in this lesson. They will take the notebook with them on their visit and put their questions to an expert.



Carpenter Bee.

Extension activities

The Galapagos Islands board game

Students create their own board game based on the information they have about the Galapagos ecosystem.

Students use:

- the list of human activities
- the Galapagos animal and plant factfile cards
- the Invasive species factfile cards to create a game based on Monopoly™ using a board proforma.

Each student selects a Galapagos animal from the factfile cards and is given a starting population of 10,000. The object of the game is not to become extinct. A time frame can be applied such as a maximum number of circuits of the board, or the game can be timed.

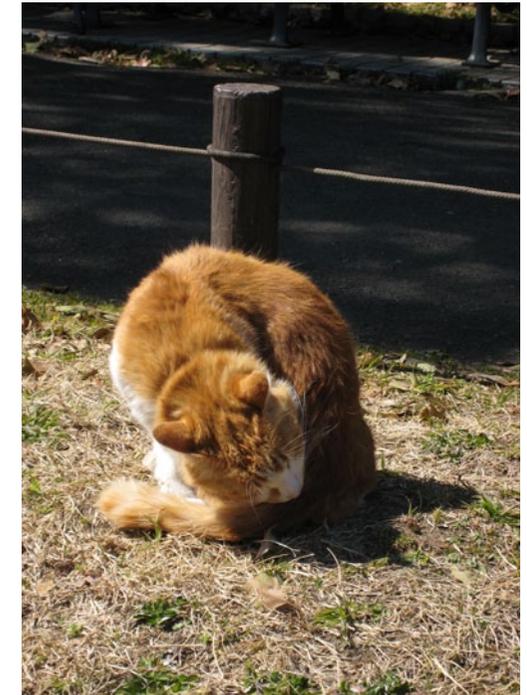
Students throw a dice to move around the board. Their throw may land them on a square describing a human activity or an invasive species. Each human activity or invasive species comes with a loss of population (for example, your habitat has been cleared for farming, lose 500 animals). Some activities have a higher impact than others. Students decide how great a species loss it will be by evaluating the potential impact of the activity or invader.

The board proforma (see Resource materials page 18 and slide 18) can be drawn on a larger scale and:

- annotated with the human activities, or
- alternatively labelled with a request to select cards containing descriptions of human activities or invasive species.

Coloured beads can be given to denote number of animals in a population, for example, red bead denotes 1000 individuals, blue bead denotes 500, yellow bead denotes 100.

This is an open-ended activity and once students understand the basic premise, they can decide the rules. It allows them to create a rule-based game with outcomes by evaluating and interpreting the information they have been given about the Galapagos ecosystem.



An invader: cats are introduced species.

Visit

Visit a local nature reserve or conservation centre

A Wildlife Trust site, RSPB centre, or a Wetland Centre can be visited at any time of year. A risk assessment will be needed and a preliminary visit is advisable. Because the visit is to enable students to collect information on an endangered British species, it will be essential to link with an expert at the site.

Students will need to take their Darwin notebooks and ask the questions arising in the pre-visit lesson. The aim is for them to collect data that indicates the characteristics of an endangered or vulnerable organism, its behaviour, habitat and the reason(s) it is endangered. Understanding the conservation work being done to protect a specific organism at the site is important.

Also useful will be a digital camera to capture images of habitat, conservation work and, potentially, endangered species.



Red Squirrel

Post-visit lesson

Main activity

During the visit, students collected information on an endangered British species.

They work in small groups to choose one of the organisms they have researched on their visit and plan a campaign to promote a conservation programme for that organism. Each group needs to describe the organism and where it lives, explain why it is endangered, explain persuasively why it should be protected, describe their proposed conservation programme, and explain why their conservation programme is likely to be effective.

To ensure that each student contributes, group members each have a specific task, for example, designing a campaign poster, creating a slogan, doing internet-based research, deciding on the detail of the conservation programme. In addition, each group member must contribute in some way to their campaign presentation.

Plenary

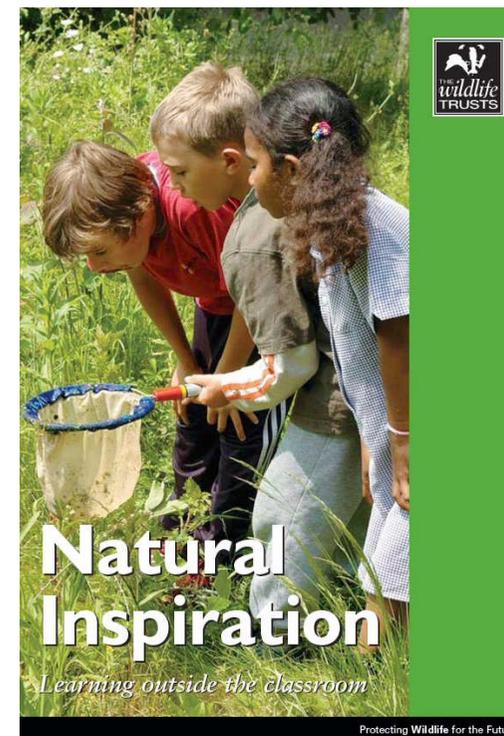
Students vote on which organism they think should be protected.

Assessment of progression

AF1 and **AF5** The food chain and web activities allow assessment of student understanding of feeding relationships.

AF1 and **AF5** The Galapagos board game challenges more able students and assesses their ability to understand and apply information on human activity and species loss.

AF1, **AF3** and **AF5** The post-visit plenary allows teachers to assess the degree to which students understand the issues relevant to species living in isolated and fragmented habitats.



Wildlife Trust campaign brochure.

Notes for teachers

Pre-visit lesson

These lessons would follow teaching about how we classify animals and plants. Students should be aware of the basic groups of animals including vertebrate and invertebrate examples. The animal and plant factfile card can be used to revisit these ideas and revise previous learning.

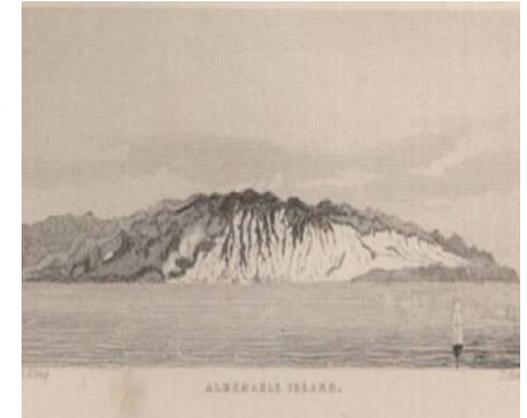
'I never dreamed that islands, about fifty or sixty miles apart, and most of them in sight of each other, formed of precisely the same rocks, placed under a similar climate, rising to a nearly equal height, would have been differently tenanted.'

Charles Darwin, Beagle Field notebook, 1835.

The focus builds on this quotation as it explores ecological relationships, extinction and the concept of sustainability. The Galapagos archipelago is the context, providing examples of habitats that have been affected significantly by human activity. However students are also encouraged to consider habitats in the UK, and locally if possible, to investigate the impact of human activity on wildlife nearer to home.

600 miles off the coast of South America, the Galapagos islands belong to Ecuador. They are volcanic, appearing out of the sea after an under-sea volcanic eruption. Darwin wrote:

'Some of the craters surmounting the larger islands are of immense size, and they rise to a height of between three and four thousand feet...there must be in the whole archipelago at least two thousand craters.'



P.G. King's drawing of Albemarle Island.

Pre-visit lesson

Darwin went on to describe the climate:

'Considering that these islands are placed directly under the equator, the climate is far from being excessively hot; this seems chiefly caused by the singularly low temperature of the surrounding water, brought here by the great southern Polar current. Excepting during one short season very little rain falls, and even then it is irregular; but the clouds generally hang low. Hence, whilst the lower parts of the islands are very sterile, the upper parts, at a height of a thousand feet and upwards, possess a damp climate and a tolerably luxuriant vegetation. This is especially the case on the windward sides of the islands, which first receive and condense the moisture from the atmosphere.'

Charles Darwin, *Voyage of the Beagle* Ch 17, 1860.

Cactus is common on the drier Galapagos Islands.

Darwin spent just 5 weeks of a 5-year voyage around the world visiting the Galapagos Islands. There are 15 main islands in the archipelago. Darwin visited 4 of them. He spent his time collecting specimens of animals and plants and recording his observations of the natural history of the islands in his notebook. It was to be a momentous trip because it shaped his theory of evolution by natural selection. However the importance of his observations did not occur to him at the time and it was only looking back that he realised what his observations could mean.

The Galapagos Islands are volcanic and, in geological terms, quite young, the oldest being about 5 million years old. What Darwin observed when he arrived was that each island had a unique set of species, different from the mainland and from other islands in the group. Scientists since have puzzled over how the native animals and plants arrived at such an isolated home. Terrestrial animals may have come by sea but in Darwin's time some scientists believed that there was a land bridge joining the islands to the mainland. This theory has not been proven.



Above: P.G. King's drawing of Charles Island.

Below: Marine iguana.

Pre-visit lesson

Isolation has influenced the ecology of these islands. There are few land mammals and comparatively few predators. Some of the primary consumers (herbivores), such as the giant tortoise, do not have native predators. Also, unusually, an invertebrate, the Galapagos centipede, is quite high up the food chain (see Resource material: A Galapagos island food web). Darwin himself also noted how tame the animals were and how they did not see humans as a threat.

He goes on to say that not only did tortoises differ in size on different islands but those on ‘...Hood Island, as having their shells in front thick and turned up like a Spanish saddle, whilst the tortoises from James Island are rounder, blacker, and have a better taste when cooked.’ Their size, up to 250 kilograms, made them an ideal target for replenishing meat stocks during long sea voyages of the 19th century. Their numbers were thus reduced over the centuries.

The Galapagos hawk is one of the top predators and feeds on lizards, flightless birds, snakes, rodents, tortoise and sea turtle hatchlings and small marine iguanas. It has no natural predators, is unafraid of humans and visits settlements to take food scraps.

The organisms that have populated the islands are pioneer species and, having arrived at a new home, had little or no competition or predation so that their populations had increased. The successful settlers were the ones able, through natural selection, to adapt to this new home which explains why they differ from mainland species. The islands are also isolated from each other because of sea currents. Each contains its own unique set of species. Isolation and the development of unique ecosystem and species is called endemism. Each island has some endemic species - species that are found only on that particular island and nowhere else. Check understanding of the following: what is meant by habitat, invasive species, where do species come from, how did they get there?



Above: Giant Galapagos tortoise

Below: Tourists being guided by local children.

Pre-visit lesson

Endemic species have restricted or fragmented habitats and are therefore vulnerable to new competition, predation or habitat change. They lack resilience and invasive species, particularly if they are adaptable generalists, can out-compete or predate the endemic species, quickly devastating a population. Endemics are also vulnerable to human activity that causes habitat change. Humans first settled the islands in the 1500s and the following factors have led to many of the organisms Darwin described becoming endangered or extinct:

- over fishing
- unregulated hunting
- clearing land for agriculture leading to habitat destruction
- clearing land for building leading to habitat destruction
- the human population doubling since the 1970s
- tourism: a tourist destination with 6 flights a day and cruise liners visit daily
- an increase in traffic, including air and sea traffic all adding to air pollution
- invasive species, such as dogs, cats, goats and pigs, but also invertebrates, including plants pests and microorganisms, introducing new diseases.

Potentially, global warming is a tremendous threat to these island ecosystems.

Examples of degradation of habitat: High tides, particularly when they coincide with Pacific ocean tsunami, can devastate island coastal areas. Those with mangrove swamps (slide 11) are protected to some extent. Removal of mangrove to improve access for tourists to coastal areas may create problems of coastal erosion.



Above: Wild pigs are invaders.

Below: Feral goats are invaders too.

Pre-visit lesson

Conservation efforts

PowerPoint slide 4: The ability of the marine iguana to swim is an evolutionary trait that developed after the iguanas arrived on the islands. When they first arrived they were land based. They learned the ability to swim over a long period of time. Between noon and late afternoon, the hottest part of the day, large iguanas enter the water to find food. The waters around the Galapagos are very cold so, as they feed, the iguanas lose heat and must return to the rocks to heat up again in the sun. Small iguanas lose heat even more quickly so they must forage by scraping algae from rocks at low tides. They also graze on seaweeds in shallow water. Iguanas that do go into the sea ingest salt that they excrete by sneezing. In the evening iguanas retreat into crevices or beneath boulders for the night. In March 1998 the Galapagos Marine Reserve was designated.

PowerPoint slide 5: On one of the islands, Santa Fe, Galapagos National Park Service culled feral goats in the 1970s so that natural vegetation could recover. Since then the island has remained free of exotic species that threaten land iguana. However because Santa Fe is just one small island, land iguanas continue to be vulnerable to biological threats and this species is monitored closely. Due to their small feeding areas, land iguanas are easily affected by changes to climate in the area. Another threat is predation by Galapagos hawks.

PowerPoint slide 16: Although the Galapagos Islands are a designated National Park and World Heritage Site, the problems associated with population increase and a growing tourist trade remain. The protection of flora and fauna may need to be addressed if its unique range of species are to survive. Here a breeding programme has been initiated to repopulate islands where few of the unique tortoise population survive.



Above: Marine iguana in mating colours.

Below: Giant tortoise breeding programme.

Visit

A risk assessment will be necessary before the visits. The timing of this activity will depend on when there will be most to see, and best therefore between May and October. Each student's task is to research endangered species nearer to home and appreciate how human activity has caused some species to become endangered in the UK.

Post-visit lesson

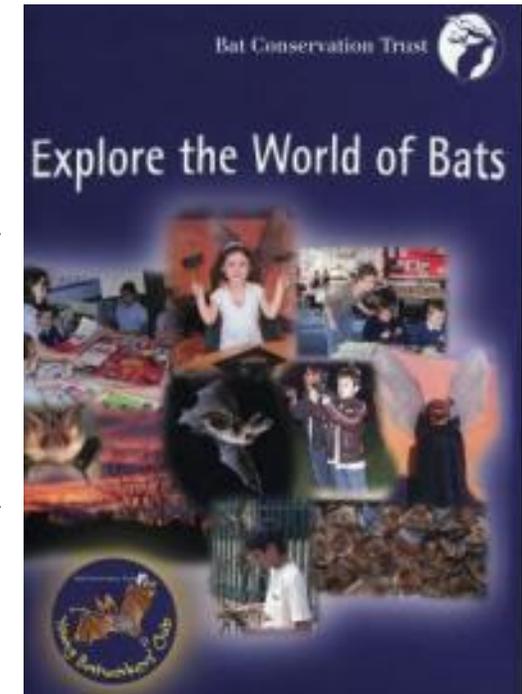
Students working in small groups choose one of the organisms they have researched on their visit and plan a campaign to promote a conservation programme for that organism.

Plenary

Students vote on which organism they think should be protected.

Assessment of progression

Peer assessment is possible as students question each group about its campaign. Students should progress not only in their understanding of sustainability and extinction but also in the understanding of Darwin Inspired Learning (KS3 Introduction)



Above: Bat Conservation Trust campaign brochure.

**Website links, videos,
interactives, references**

Endemic animals of the Galapagos

Marine iguanas: <http://www.arkive.org/galapagos-marine-iguana/amblyrhynchus-cristatus/video-00.html>

Land iguanas: <http://www.arkive.org/galapagos-land-iguana/conolophus-subcristatus/video-08.html>

Giant tortoise: <http://www.arkive.org/galapagos-giant-tortoise/geochelone-spp/video-ho00.html>

Endemic plants of the Galapagos

<http://www.arkive.org/lava-cactus/brachycereus-nesioticus/#text=All>

Organisation that champion endangered UK species

<http://www.wildlifetrusts.org/>

<http://www.rspb.org.uk/>

http://www.bats.org.uk/pages/resources_for_teachers_youth_leaders.html

<http://www.butterfly-conservation.org/>

<http://www.wwt.org.uk/>

<http://www.whaledolphintrust.co.uk/>

<http://www.mammal.org.uk/>

<http://www.britishhedgehogs.org.uk/>

Conservation of habitats

<http://www2.btcv.org.uk/>

<http://www.nbn.org.uk/>

Endangered species

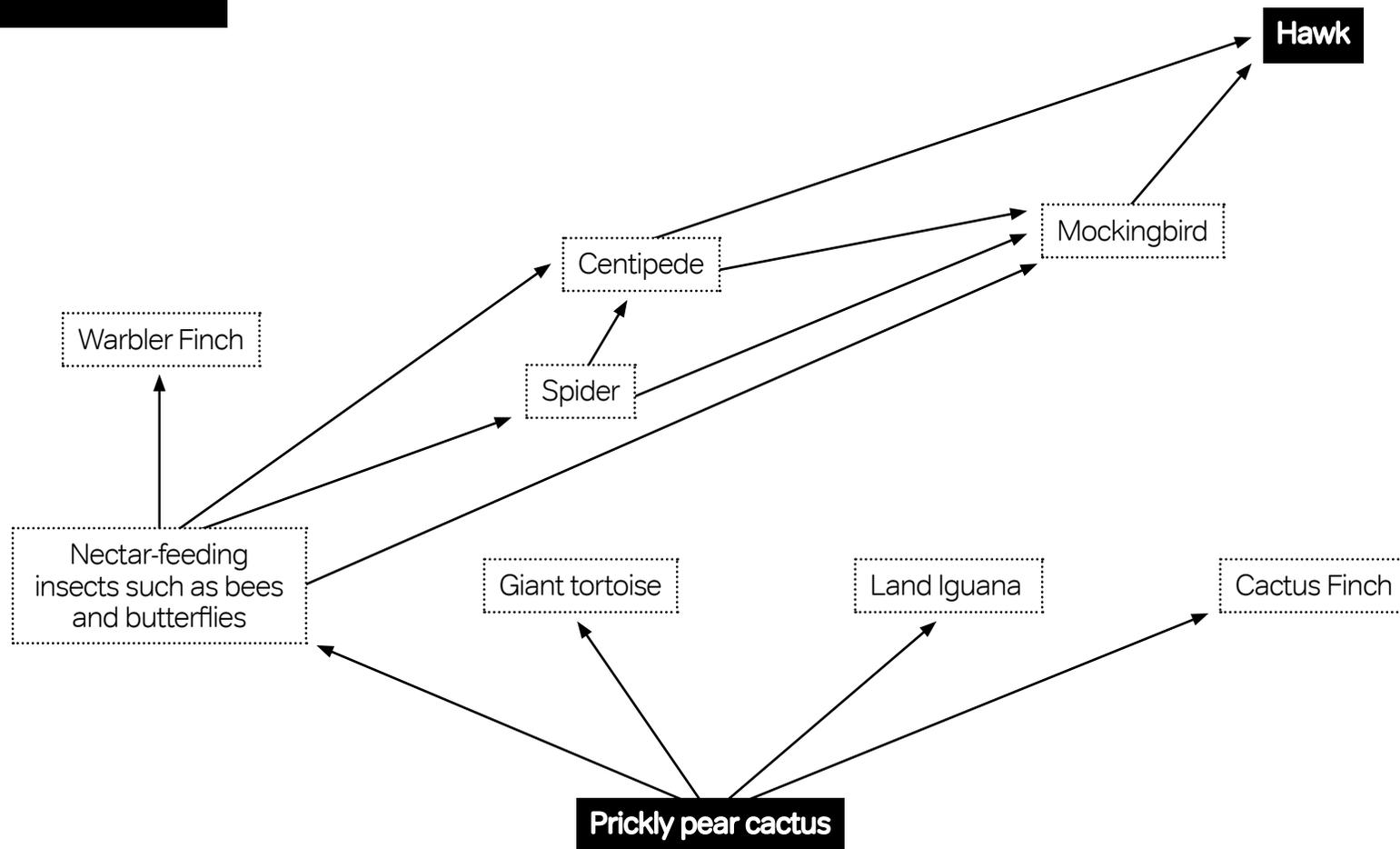
<http://www.ypte.org.uk/>

<http://www.independent.co.uk/environment/the-10-most-endangered-species-in-britain-414113.html>

http://en.wikipedia.org/wiki/List_of_endangered_species_in_the_British_Isles

Resource materials

A Galapagos island food web



Resource materials

The Galapagos Islands board game

<p>You join a captive breeding programme: population rise 500</p>					<p>Your habitat becomes protected: population rise 2000</p>
<p>You join a conservation programme: population rise 1000</p>					<p>You don't breed this year: miss a turn</p>

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