

Biodiversity and the Galapagos

The Galapagos Islands have a high level of biodiversity and are the only places in the world where you can find penguins and albatross living in the same areas as coral reefs! *Table 1* gives some idea of the range of species found on and around the Galapagos and it is clear that many are endemic, unique, to the Islands. The Islands are very isolated and when they were formed life had to migrate from mainland South America. This great distance over open water meant that very few mammals made it to the islands. Those that did were small, such as rice rats, and would probably have come in on rafts of floating vegetation. There are no large land predators and so animals such as tortoises were able to evolve into giant species. The wildlife of the Islands is dominated by birds, especially marine species as the distance over the sea would have had less effect. This evolution in isolation has led the Galapagos to be called the World’s Natural Evolution Laboratory.

Table 1 Number of species found in the Galapagos Islands.

ORGANISM	NO. OF SPECIES	NO. OF ENDEMIC SPECIES
REPTILES	22	19
e.g. Iguanas	3	3
Lava Lizards	7	7
FISH	307	50
MAMMALS Plus whales	5	5
INSECTS	1600	
PLANTS	800	250
e.g. Scalesia – Daisy Tree		
BIRDS	58	28

Charles Darwin stayed on the Islands for 5 weeks in 1835 and made observations that eventually led to him developing his Theory of Evolution. He noticed that the finches on the various islands had slightly different adaptations to the local environment although it was obvious that they once came from the same original population. The offspring of a finch might have had a slightly different shaped bill that gave it an advantage over the other finches on the island. It survived better and passed on its genes to the next generation which also survived better. Eventually the new adaptations would mean that the finch was so different from the original population that it could no longer interbreed and was effectively a new species. There are now 13 different species of finches on the Islands. This was the idea of evolution by natural selection or the survival of the fittest, proposed by Charles Darwin.

The Galapagos Islands have the world’s only flightless seabird other than the penguin. The Flightless Cormorant lost its ability to fly as it had no land predators on the Islands and did not need flight for escape.

The Galapagos are also the home of Marine Iguanas, the only sea-going lizard in the world. They live on land but graze on a variety of seaweed either found on exposed rocks or by diving into the sea to graze under water.

The Galapagos Islands are regarded as an important Biodiversity Hotspot because of the numbers of species that are found there and nowhere else. They need to be protected as once they have disappeared from the Islands they are gone for ever.

BIODIVERSITY – This is the variety of life, often measured by the number of different species found within an area.

BIODIVERSITY HOTSPOTS – These are areas of the world that display a particularly high species richness such as the Great Barrier Reef or the Amazonian Rainforest.

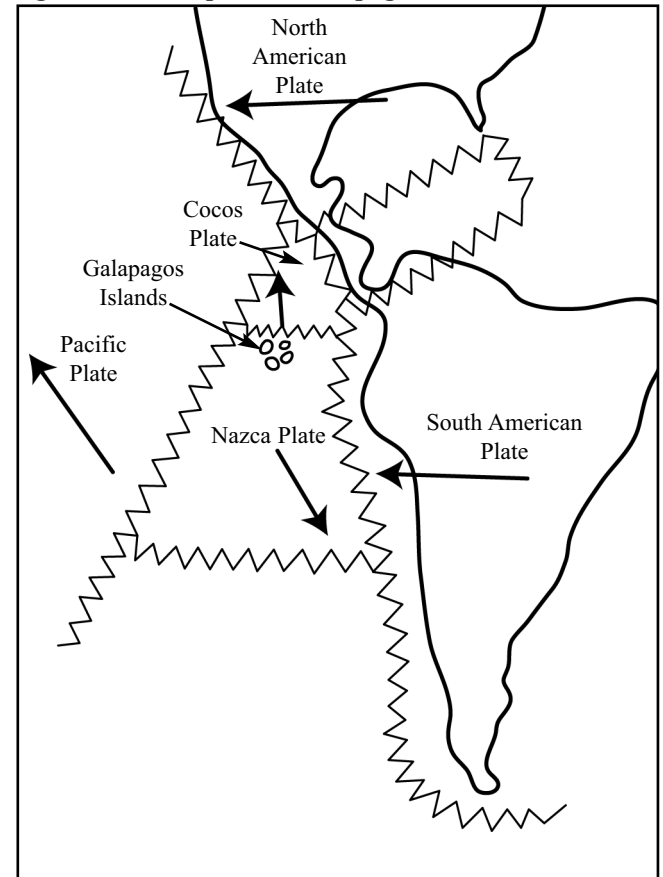
ENDEMICISM – A species is said to be endemic if it occurs in one area or location and nowhere else.

Geology of the Galapagos Islands

The Islands are a result of submarine volcanic activity and are relatively young. 4 million years ago there was only open ocean where they now are.

They were formed as the Nazca Plate on which they are located moved south and east over an area where plumes of hot mantle material reach the surface (see Fig. 4).

Fig. 4 Pattern of plates – Galapagos.



Volcanoes occur which may be large enough to form islands. As the plate continues to move, the island moves away from the rising magma and a new volcano/island is formed over the hot spot. This results in the oldest islands within the archipelago being those furthest to the south east (see Fig. 5).

Fig. 5 The formation of the Galapagos Archipelago.

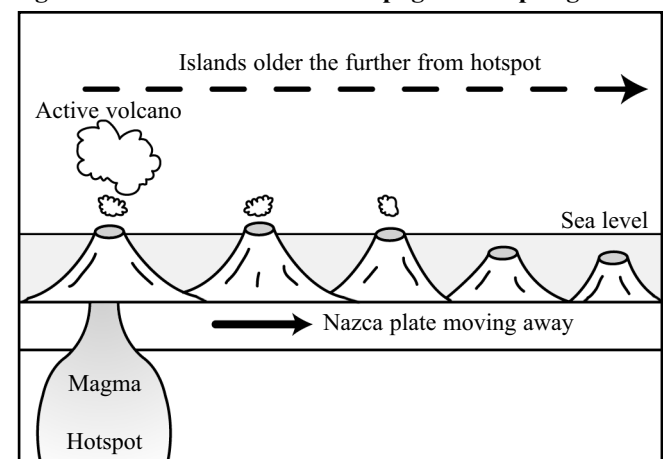
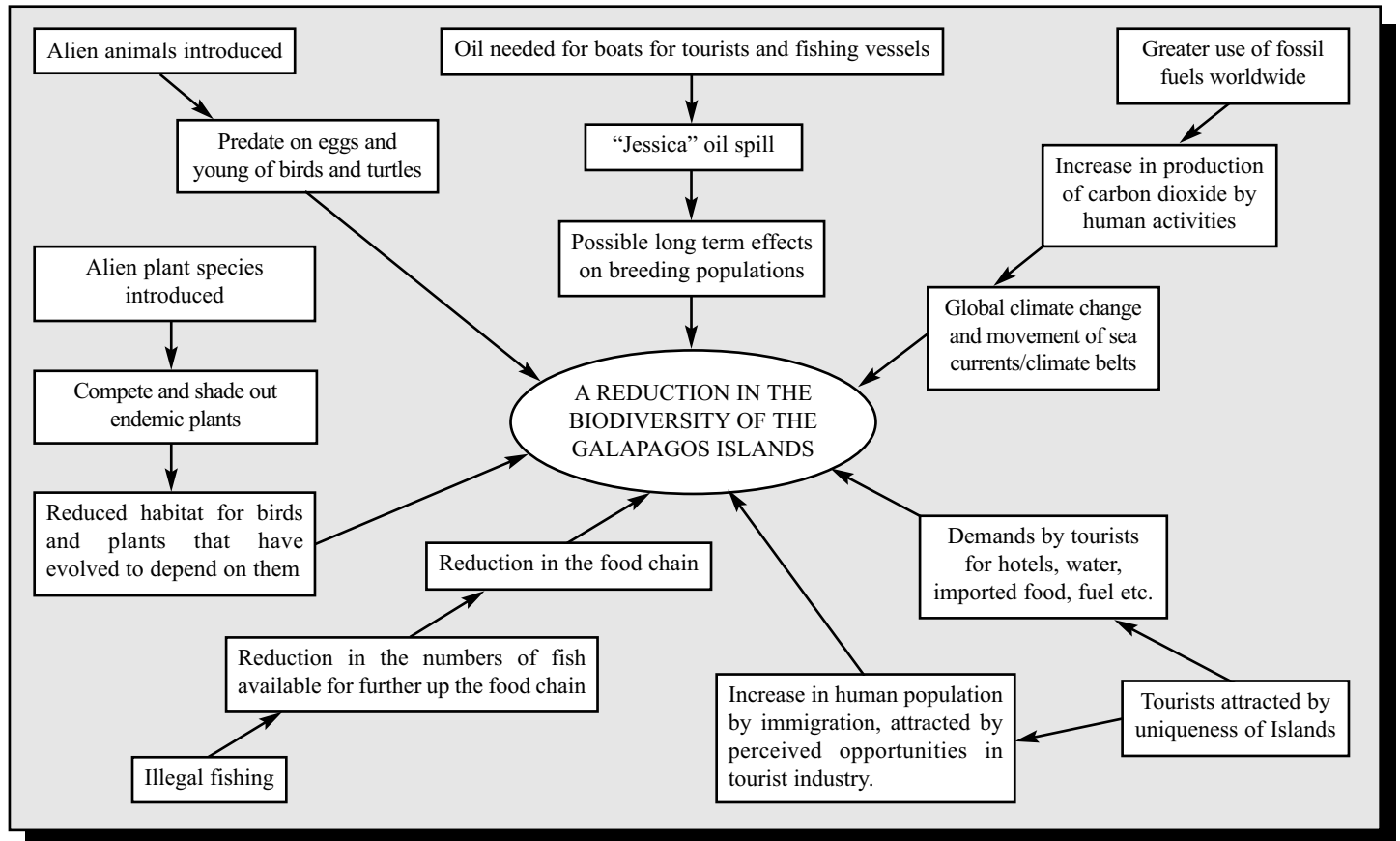


Fig. 6 Threats to the biodiversity of the Galapagos Islands.



Environmental Issues in the Galapagos Islands

The threats to the ecosystems of the Galapagos Islands are summarised in Fig. 6 (above).

1. Alien Species

Along with the arrival of humans to the Islands came introduced species of plants and animals. Many, having no natural predators or controls, exhibit rapid growth in numbers, threatening to dominate local ecosystems.

Table 2 Species introduced to the Galapagos Islands.

SPECIES	IMPACT
Norwegian Rat	Eats bird eggs and young. Recent arrival – 1983. Reducing bird numbers.
Donkeys	Destroy cactus species as they break them open to get at soft pulp
Feral Pigs	Eat bird and turtle eggs and impact on population numbers.
Cats	Huge impact on bird life as Galapagos birds have not developed fear of animal predators.
Wild Dogs	Found on several islands. Wiped out colony of 500 land iguanas on Santa Cruz.
Goats	Severe browsing. Have caused some local extinctions. On Pinta Island population of goats grew from 3 to 20,000 in 12 years. Probably part of reason for demise of the Pinta Giant Tortoise as compete for grazing. Only “Lonesome George”, a single male, left of his species.

2. Population Pressures

Until the late 1990s there was no limit to immigration from mainland Ecuador and the Islands experienced 8-10% growth per annum. Migrants come to work in the growing tourist industry but there is not enough work for them to support their families so they turn to activities such as illegal fishing or poaching of animals including the Giant Tortoise. As the population grows there is increased pressure on natural resources such as water, stone, agricultural land and fuelwood whose increased use impacts on the natural ecosystems.

3. Tourism

Tourism began in a small way soon after the opening of the Darwin Research Station. However, numbers have increased quite dramatically from 1,000 p.a. in the mid 1960s to 70,000 plus in the late 1990s. 50% of the tourists are from mainland Ecuador. In the mid 80s a second airport with connections to the mainland was opened, in San Cristobal, largely to disperse yet support increased tourist numbers. There is continued pressure for luxury hotels. The result is evidence of increasing erosion of footpaths in key areas, such as the Bantolemé veiw point, and an increase in the amount of litter and waste that has to be cleared. Tourism has acted as a magnet to migrants from the mainland as they move to the Islands in order to find work. Tourism is also largely responsible for the importation of fuel oils such as those carried by the “Jessica” which ran aground in 2001.

Overcrowding at visitor sites is also believed to be having a detrimental effect on animals such as the sea lions and may be affecting their breeding patterns. Each successive draft management plan for the islands has increased the guideline for the overall carrying capacity.

4. Illegal Fishing

This is a growing problem with both local small-scale fishermen (over 800) and large commercial enterprises illegally fishing within the waters of the Galapagos Marine Reserve. Commercial boats have a huge impact on dolphin deaths in the region - dolphins are usually caught as a by catch in the tuna fishery. In June 2002 a Colombian vessel was stopped from fishing illegally and 50 dead dolphins were found within its nets. The nets used can be as much as 40 kilometres long. At present the fines are very small. In the case mentioned above the Captain was only fined 4 cents! Since 1997 there has been a commercial fishing ban within the marine reserve but it is very difficult to patrol such a large area of ocean. Smaller scale fishermen are being tempted by non-traditional marine resources such as sea cucumbers and spiny lobsters. There is a lucrative market in Asia for such products. As more fish are being taken out of the ecosystem, there will be a knock on effect throughout the food chain and eventually the unique creatures of the Galapagos may die out.

5. Climate Change

As there is increasing evidence of global climate change due to a rise in carbon dioxide emissions from human use of fossil fuels, there seems to be a corresponding increase in the number of El Niño events. These alter the currents around the Islands and the availability of nutrients to the food chain and have a disastrous knock-on effect on wildlife.

6. Oil Spills

In January, 2001, the cargo ship “Jessica” ran aground off the island of San Cristobal whilst carrying a load of 240,000 gallons of fuel oil. There was a great deal of support, both volunteer help and financial aid, when this event was made public as people are aware of the uniqueness of the Galapagos Islands and its World Heritage status.

Action taken after the Jessica incident:

- Dispersants were applied on the sea near the ship.
- 50,000 gallons were offloaded from the stricken ship.
- Some oil was contained and removed with absorbent materials.
- Animal rescue centres were set up to cope with oiled birds and animals.

One year later there is evidence of widespread contamination but of minimal amounts. 79 sea lions were affected but no deaths recorded. In the areas where the oil reached some colonies, the mortality of iguanas has increased, in some cases by an estimated 62% although the reasons are not yet clear. It may be that the oil pollution affected their food source. The spill highlighted the modern pressures on these islands.

Conserving Biodiversity

The Islands have a range of levels of protection (see Fig. 7). The National Park and the Marine Reserve are under the control of the government of Ecuador but because of the global importance of the Galapagos they are also designated as a World Heritage Site and as a World Biosphere Reserve which gives them international protection.

● Tourism

All visitors to the Islands have to pay an entrance fee of \$100, part of which goes towards the costs of maintaining the Charles Darwin Research Centre and part towards training of local people as guides. The key issue is that most of it goes to the Ecuadorian National Government.

Within the National Park there are strict rules:

- Do not feed or handle animals
- Do not litter.
- Do not remove any natural object whether living or dead.
- Do not bring pets.
- Do not buy objects made of sea lion teeth, black coral, tortoise or turtle shell or other artifacts made from plants or animals.
- Stay on the marked trails.

There is also a very clear zoning strategy (see Fig. 7) which was developed in the 1970s. In 1998 a number of management options were put forward (see options below Fig. 7) to manage the increasing flow of visitors which brought such important economic benefits to the islands. To reduce the numbers visiting fragile areas, no new permits will be given for more boats to take tourist around the Islands until 2005. With an increasing number of trained guides it is hoped that visitors will leave the Islands with a much better idea of their global importance.

● Population

The Islands need to reduce their resident population in order that fewer demands are made of the fragile ecosystems within the Islands. The aim is to reduce it by 2% by 2004 and to maintain it at a steady but not increasing level. Migration to the Islands from the mainland has been made more difficult by imposing quotas and insisting that people have a job lined up before arriving.

Fig. 7 The Zoning Strategy.

There are 5 zones of permitted use in the Galapagos:

Zones	Permitted Use
Intensive Use	There are about 25 of these zones where a maximum of 90 people (four to five groups of 20 visitors with guide) are authorised to disembark daily.
Extensive Use	There are about 16 of these less interesting sites, where around 12 people are allowed to disembark daily and no larger groups allowed.
Primitive Use	These may have introduced species on them, but they are still of interest to some people. A special permit is required to visit them.
Primitive Scientific	These are only visited for scientific research, with no casual visitors.
Special Use	These are next to colonised areas and can be exploited by the residents for wood, sand and volcanic rock, although use is strictly controlled.

The plan was updated in 1998 to reflect the increased pressures.

Master Plan Zoning Map

Options for the management of tourists in 1998:

- Encourage maximum usage of the colonised zones and the special use zones adjacent to them, for migrants’ children who wish to stay and establish businesses in the Galapagos. At the same time control the flow of new migrants from Ecuador.
- Raise the level of visitors in the intensive use zones to a maximum of 120 people (6 groups of 20) and allow 2 two hour disembarkations a day.
- Create some more extensive use sites (up to 25) all for small boat tourism (12 people at a time).
- Develop primitive use zones for adventure company tours in islands with 4-wheel drive road access.
- Open up 2 further scientific research zones for keen ecotourists to view the work of the scientists and field stations and the Charles Darwin Centre.
- Develop a number of boat cruise itineraries for groups who do not land and merely view the wildlife from small boats and small cruise ships.

● **Fishing**

The National Park only has one patrol boat and has difficulty in patrolling such a large area of ocean (another boat has been provided by a wildlife charity). There are very strict limits around the Islands but these are constantly being breached. Long lines and purse seine nets are prohibited but commercial fishing fleets especially from Colombia and the Far East continue to break the rules and have a serious impact on the ecosystems of the Islands. Sniffer dogs are now used on the Islands to try and detect illegal exports of products such as shark fin. In comparison small-scale local fishing of traditional catches has a minimal impact on the marine ecosystems and can be allowed to continue. The long-term aim is to attract the fishermen to work within the tourist industry as guides to the Marine Reserve and use the waters surrounding the Islands in a more sustainable way. There has been a lot of conflict between local fishermen and the conservationists with threats to kidnap the giant tortoises and damage to the Charles Darwin Centre.

● **Goats, Dogs and Cats**

These are controlled by hunting although this is difficult in hilly terrain. The alternatives of trapping or poisoning are not suitable as they also harm native species. The Isabela Project aims to eradicate goats in the northern part of the island so that vegetation is available once again for the Giant tortoises which are under threat because of a reduction in their grazing habitat.

● **Iguanas and Tortoises**

The eggs of both are collected and incubated with the young being kept until they are of a size more able to withstand predators.

● **Plants**

There are several projects to eradicate invasive species but it is a costly process and has to be repeated on a regular basis. There is a call for a Plant Control Unit whose task will be focused on eradication programmes of alien plant species.

● **Charles Darwin Research Centre**

This was set up in the 1960s and it monitors and records populations and acts as adviser to the government and other bodies. It also has an important role in the education of visitors, local inhabitants and links with research bodies.

The Future

Worldwide there is an interest in the Galapagos Islands because of their unique flora and fauna and because of the lessons we can learn about adaptation and evolution. There is a growing realisation that these islands need detailed research and special care.

In the UK there is the Galapagos Conservation Trust which highlights the importance of the research being carried out on the Islands and also tries to help raise funds for their preservation.

Charles Darwin, whose name is associated with these islands because of his Theory of Evolution, was born and educated in Shrewsbury and now there are moves afoot to twin the town with the islands. The idea is for a virtual twinning, especially involving young people using the Internet, which will lead to a greater understanding of interactions within fragile environments and the impact of humans upon them. Without having to personally visit the Islands and impacting in any negative way, students will be able to learn and appreciate the global heritage of the Galapagos Islands of which they are partially inheritors.

Exam Questions

Using an example of a named and located ecosystem you have studied:

- (a) Outline the threats to it. (10 marks)
- (b) Explain how decision makers are dealing with those threats. (15 marks)

Answer Outline

- (a) THREATS:
- Illegal fishing
 - Increasing tourist numbers
 - Alien species
 - Increase in population
 - Oil spills
 - Climate change
- (b) DECISION MAKERS:
1. Government of Ecuador – National Park and Marine Reserve. Regulate use of the Park. Organise management of the Park and Reserve. Provide some finance to aid protection. Can monitor and regulate oil transport to the Islands. Controls the number of migrants from the mainland. Can impose the laws controlling commercial fishing around the Islands.
 2. UNESCO World Heritage Site - international Biosphere Reserve - international. Provide international expertise on ecosystem management. High level of protection for the rare species and habitat. Some funding as a result of the designations. Help with the control e.g. of the problem of commercial fishing.
 3. Charles Darwin Research Centre - monitoring, recording, experimenting, restoration of habitats. Research on the island gives great insight into the functioning of species and habitats. Attracts international interest and funding. Monitors and suggests controls for alien species. Makes informed comment on effect of tourist numbers on habitats and species.
 4. Local people - once educated about the uniqueness of the islands can make informed decisions about their activities.
 5. Other supporting charities such as the UK's Galapagos Conservation Trust which comes under the umbrella organisation Friends of the Galapagos. Aim to support work on the islands by raising fund but also to highlight the importance of these Islands to the world.

Further Research

- Burton, J. (editor). Atlas of Endangered Species. Quarto Publishing ISBN 1-84092-251-6.
- Leon, G. Henrichsen, D. & Markham, A. Atlas of the Environment. Arrow Books Ltd. ISBN 0 – 09984620-9.
- Issues Analysis – The future of Galapagos (available from Tourism Concern).

Useful Websites

- www.darwinfoundation.org - Darwin Foundation Site - lots of information about the species and their habitats.
- www.gct.org/galapagos Galapagos Conservation Trust - information on what is being done in the Galapagos Islands.

Acknowledgements

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