



Ecuador Schools' Booklet 2017

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1. Structure of the Ecuador Expedition

This expedition combines working on a biodiversity research project with the Kichwa Indians in the Amazon with a week visiting the Galapagos Islands completing a course on Galapagos Island ecology.

The first week of the expedition will be spent in the remote Sani Reserve forest camp which is accessed by long boat along the Napo river and the groups based at this camp will be helping a team of specialists with surveying different taxa. The second week of the expedition is spent in the highlands of Santa Cruz Island in the Galapagos Islands.

2. Sani Reserve (Ecuadorian Amazon) Research Objectives and Study Area

The fieldwork takes place in the Amazon lowland forest of Ecuador around a jungle camp at the Sani Reserve on the Napo River, just north of Yasuni National Park. These forests are recognized as the most biodiverse terrestrial ecosystems in the Western hemisphere

Much of the Amazonian forests of Ecuador are under threat from oil extraction. In the Amazon, oil extraction has traditionally been followed with deforestation of the areas of extraction and has often been of little benefit to the native people on whose land the oil extraction is occurring. The Kichwa Amerindians have managed to protect their forests against proposed oil extraction. In essence, the Kichwa Indians are foregoing income from the oil industry in order to protect the forest, and that income needs to be replaced by an income of the same level or greater in order to ensure the long term protection of the forests. Sani Eco Lodge, an Ecuadorian ecotourism operator, has been working with the Quechua community to develop ecotourism income that provide sustainable jobs and income from leaving their forests intact. They have constructed a high end ecotourism lodge in the centre of the 40,000 hectares that encompass the Sani Reserve, and a separate field research camp that is being used by the Opwall survey teams, and as a camping experience for the high end ecotourist visitors. This income is helping, but visitor numbers need to be increased in order to provide sufficient long term funds to prevent the forests being logged. Part of the problem seems to be that there are only a small range of activities available for guests at the Lodge and there is not a great deal of expertise on site about the biodiversity of the various taxa encountered. The purpose of the 2017 research objectives is to complete a series of surveys that will provide the information and training needed to help increase Lodge visits to this outstanding reserve. The following outputs are scheduled for completion by the end of the 2017 season:

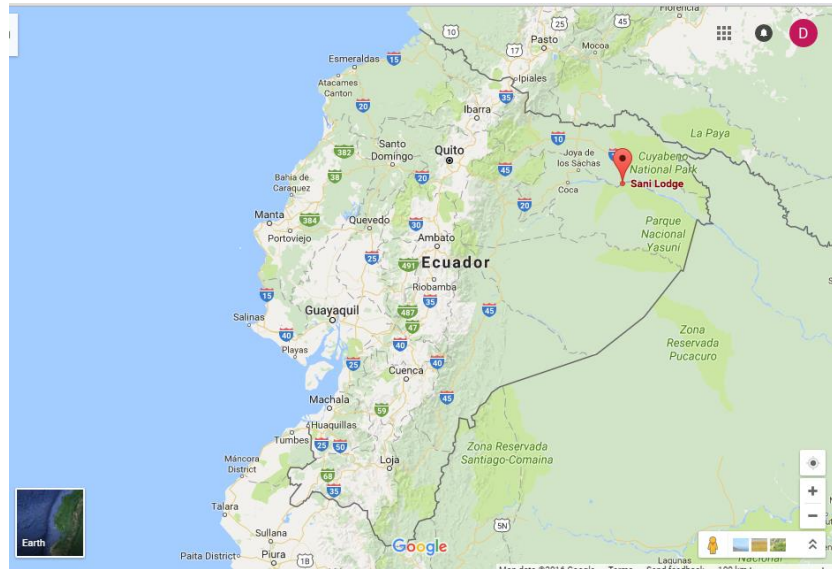
- To produce an illustrated guide of the distribution, habitat preferences and relative abundance of the bird community in the Sani reserve.
- To produce a guide of the fish of the Sani Reserve.
- To produce a detailed map of the vegetation types/habitats in the Sani reserve.
- To produce an illustrated guide of the distribution, habitat preferences and relative abundance of the reptile and amphibian communities in the Sani Reserve
- To identify the best sites for primate behavior or ecology studies and to identify the large mammal usage of the reserve.
- To identify an extended Sani Community interaction day trip that could be run exclusively by Sani Lodge.

The local Sani community are going to identify one young person for each of the 6 projects who will work alongside the experts brought in to complete the tasks and to be able to provide some expert guidance to

visitors to the Lodge after the Opwall season. In addition, the Opwall partners in Ecuador, TropicEco have contracted a professional photographer to be on site for a full year to photograph as much of the wildlife encountered as possible in order to publish an illustrated book about the biodiversity of the Sani Reserve. The data collected by the team of specialists on site during the Opwall season will contribute significantly to this book.

Study Area

The site at Sani is situated on the river Napo, north of the Yasuni National Park (See Map 1 below).



Map 1. Location in Ecuador of the lowland field site at Sani, Orellana Province, Ecuadorian Amazon.

3. Week 1 Itinerary

On the Tuesday start date of the expedition the group will travel by bus from Quito over the Andes to Coca (approx. 7 hours) and long boat (3 hours) to the Sani reserve, followed by a 1 hour canoe ride into the forest camp site. The group will arrive in the afternoon which is when the expedition starts. After settling in they will attend lectures on health and safety, introduction to the reserve and the week's schedule.

Learning outcomes from health and safety briefings

- Awareness of dangerous plants and animals - from the briefings and demonstrations in the field
- Awareness of disease and health issues working in a tropical rainforest
- Safe working practices in remote locations (trekking protocols, crossing rivers, appropriate clothing, sun, safe water and dehydration), communications.

There are 6 different fieldwork teams and the students will be divided into up to 4 groups of a maximum of 6 - 7 students each which will rotate between these teams spending a day with each (see table 1). Each evening there will be a lecture in the Amazonian wildlife and conservation course. On the evening before joining each team the leader will meet with their group and describe the following day's activities

and surveys to be completed so the teams are prepared. Table 1 (below) gives an indicative timetable for week 1.

Table 1. Example timetable for week 1. Note there may be changes to this schedule.

Day	Group 1 activity	Group 2 activity	Group 3 activity	Group 4 activity
Tuesday	Meet in Quito and bus to forest via Coca and long boat canoe transfer to Sani			
Tuesday evening	Expedition starts. Welcome to Sani camp and intro talks on health & safety and objectives of the research programme			
Wednesday	Bird surveys using point counts and transect surveys	Fish surveys using electrofishing and throw nets	Primate and large mammal distribution surveys from DISTANCE, patch occupancy and camera trap surveys. In addition, helping with the vegetation community structure surveys	Reptile and amphibian surveys from standard search areas, use of cover boards and pitlines and spotlight sampling at night
Wednesday Lecture	Lecture 1 Amazonian wildlife and conservation course - Tropical rainforests structure and function Lecture 2: Plant life in the Neotropics			
Thursday	Reptile and amphibian surveys from standard search areas, use of cover boards and pitlines and spotlight sampling at night	Bird surveys using point counts and transect surveys	Fish surveys using electrofishing and throw nets	Primate and large mammal distribution surveys from DISTANCE, patch occupancy and camera trap surveys. In addition, helping with the vegetation community structure surveys
Thursday Lecture	Lecture 3: Fish in the Amazon Lecture 4: Reptiles and Amphibians of the Neotropics			
Friday	Primate and large mammal distribution surveys from DISTANCE, patch occupancy and camera trap surveys. In addition, helping with the vegetation community structure surveys	Reptile and amphibian surveys from standard search areas, use of cover boards and pitlines and spotlight sampling at night	Bird surveys using point counts and transect surveys	Fish surveys using electrofishing and throw nets

Friday Lecture	Lecture 5: Evolution, classification and birds of the Neotropics			
Saturday	Fish surveys using electrofishing and throw nets	Primate and large mammal distribution surveys from DISTANCE, patch occupancy and camera trap surveys. In addition, helping with the vegetation community structure surveys	Reptile and amphibian surveys from standard search areas, use of cover boards and pitlines and spotlight sampling at night	Bird surveys using point counts and transect surveys
Saturday Lecture	Lecture 6: Neotropical mammals			
Sunday	Visit to Sani Isla Community village			
Sunday Lecture	Lecture 7: Conservation challenges in the Amazon			
Monday	Long boat and bus transfer to Quito and overnight in Quito			

4. Amazonian Biodiversity Monitoring

Bird Surveys

The lowland Amazon is hyper-diverse for birds (500+ species), and the list of birds seen in the Sani reserve is extensive. However, there is no centrally maintained list or readily accessible information available to guests. The purpose of this survey is to produce a guide to the birds of the reserve and where they are most likely to be found as well as to establish a central data recording system so that expert birders visiting the Lodge as guests can input their observations onto a standard Excel sheet which can then be imported automatically onto eBird (<http://ebird.org/content/ebird/>) so that the data sets are continually updated.

Survey work will be done from point counts in the forested areas and from transect surveys along the water course areas. Birds will be identified from both sightings and calls. A call library will be available on site of all the likely species to be encountered. In addition mist netting will be used to sample some of the understorey species. Measurements of all birds captured (e.g. bill length, body length, tail length, tarsus length, weight etc.) as well as details of any signs of moulting or breeding from the presence of a brood patch.

Large mammals and primates

This team will be retrieving the images from a network of cameras set up around the camping region of the Sani reserve. This involves trekking considerable distances, so during these treks this team will also be completing standard searches for terrestrial, arboreal mammals and game birds to complement the camera trap footage. Information registered on a census includes: day, site, species, number of

individuals, and perpendicular distance from the individual to the transect line, habitat, time, distance travelled and weather conditions.

Back in the camp the images from the camera traps will be analysed. Initial camera trap footage from the 2016 expedition has proven the presence of several large cat species, giant river otters, short-eared dogs, giant armadillos and several game bird species amongst others.

When primate groups are encountered the survey teams will stop the transects and will attempt to follow them for as long as possible. The purpose of this is to get the groups semi-habituated to the presence of people, and to identify potential sites and research questions for follow on year round PhD studies into primate behavior.

Habitat and Vegetation Community Surveys

These surveys will be linked to the large mammal and primate surveys and will involve collecting plant material for identification of key species. In addition, quadrat surveys will be completed where necessary to characterize the physical structure of the forest. Satellite data will have been analyzed to produce areas with different spectral properties before the expedition starts, and emphasis will be placed on characterizing the vegetation communities within these different areas. The final output will be a GIS map of the reserve with an illustrated description of each of the main vegetation communities and their constituent species.

Herpetofauna Survey

The techniques for these surveys involve active searching at a fixed width of 5m on either side of the transect line in the late morning when reptiles and amphibians are most active. Visual encounter surveys (VES) during the day will be carried out using a probe to disturb leaf litter and vegetation. To identify anurans during night transects instead of probing through leaf litter, torches will be used to catch the reflection of light from the eyes of anurans. Upon detection and capture of an individual each specimen will be handled carefully and morphological measurements taken. The distance along the transect and perpendicular distance from the transect for each specimen will be recorded. The total search times for each survey will be recorded so that herpetofauna abundance and diversity can be compared across transects based on constant survey effort. For all observed animals the GPS position are recorded. The differences in terms of species present will then be analysed based on the same methodology being used in the evening. In addition, pitlines and cover boards will be used to provide extra sampling effort. The output from this survey will be a digital guide to reptiles and amphibians found in the reserve with an assessment of the likelihood of encountering each species.

Fish Survey

This team will be completing surveys of the fish communities using both electrofishing from a boat and also the use of throw nets in shallower water. All fish captured will be measured (fork length), identified to species level and photographed before release back into the river. Since this team will be out on the river in motorised long boats they will also record any other river based species (e.g. cormorants, herons, kingfishers, river otters, turtles, etc.). The output from this survey will be a digital guide to the fish species in the reserve with an assessment of their relative abundance.

5. Amazonian wildlife and conservation lectures

Lecture 1: Tropical rainforests: biogeographical and ecological perspectives. Plant species and use.

- How do you define a rainforest and how are they distributed globally
- The history of South American rainforests and cloud forests
- Species richness and diversity of rainforests – biodiversity hotspots
- Why there are so many species in tropical rainforests
- Natural dynamics and nutrient cycling in rainforests
- The structure of the rainforest – trees, lianas, herbs & epiphytes
- Characteristics of rainforest trees – angiosperms, gymnosperms, diversity and competition.
- Mosses and Liverworts
- Defining ecosystem services and the role of plant life
- Forests and carbon – introducing REDD+

Lecture 2: Plant Life in the Neotropics

- Rainforest strata
- Vegetation adaptations
- Ecosystem services
- Plant usage by local communities
- Carbon storage
- REDD+ and carbon schemes

Lecture 3: Fish of the Amazon

- Fish sampling techniques for the Amazon
- Predators including piraña, payara and pacu
- Arapaima
- Electric eels, catfish and adaptations to waters with low visibility
- Candiru

Lecture 4: Evolution, classification and birds of the Neotropics

- Principles and history of taxonomy, evolution and classification
- Predators – Owls, vultures, kites, eagles, hawks and falcons
- Large forest birds – Chahalacas, tinamous, guans
- Parrots, Hummingbirds, Trogons and Quetzals, Motmots, Toucans and Barbets
- Woodpeckers and woodcreepers, Antbirds
- Lekking species – cock-of-the-rock, manikins.
- Survey techniques for birds including soundscapes

Lecture 5: Amphibians and reptiles of the Neotropics - Describing and identifying herpetofauna examples of Amazonian species.

- Evolution of Neotropical herpetofauna – biogeography and history
- Ecuadorian herpetofauna – ecology and conservation status
- Mimicry and adaptation
- Threats and conservation (habitat loss, chytrid fungus)
- Herpetofauna survey techniques

Lecture 6: Neotropical forest mammals

- Neotropical mammals – biogeography and history
- Ecuadorian mammals – ecology and conservation status
- Bat diversity, ecology and survey methods
- Primate conservation
- Large mammal survey techniques (distance sampling, patch occupancy sampling and camera trapping)

Lecture 7: Conservation challenges in the Amazon: Threats from environmental change and resource pressures

- Threats to wildlife in Ecuador
- The drivers of land use change and climate change in Ecuador
- Conservation in a biodiversity hotspot – protected areas
- Poverty and conservation – Community conservation: the example of Sani Ecolodge
- Ecuador's response to Climate change and Conservation, REDD+.
- Natural Forest Standard as a way of packaging forests

Workshop/ Discussion: Round up of the weeks activities and the contributions the students have made to the research. What they can do when they get home.

6. Learning Outcomes from Week 1

The students should achieve the following learning outcomes from the fieldwork, practicals, lectures and discussions/activities:

- Be able to define a rainforest
- Be able to describe the key fauna found in South American lowland forests
- Be able to describe natural forest dynamics and nutrient cycling
- Describe how biodiversity hotspots are defined
- Be able to identify at least 20 Amazonian forest birds
- Be able to identify at least 10 Amazonian forest herpetofauna
- Identify the major threats and conservation efforts of Amazonian forest mammals
- Describe fish, herpetofauna, bird and mammal survey techniques

7. Galapagos week

The Galapagos Islands are one of the most visited ecotourist sites in the world, and the funding created from this activity has enabled long term research and conservation of the wildlife on the islands. However, many visitors to the islands gain only a cursory knowledge of their ecology, main habitats and key species. The second week is designed to give the students an in depth understanding of these issues and why the speciation that is apparent between the islands was such an important stepping stone in the development of Darwin's ideas.

The groups will be based in the Pajaro Brujo Reserve in the highlands of Santa Cruz island. This reserve was originally established by the Nature Conservancy in the US to protect the declining numbers of the Galapagos race of the Vermilion Flycatcher. The reserve is now managed by FUNDAR – Galapagos, a non-profit organisation which aims to use the centre for education and research. The students will be joined in this week by a couple of Galapagos based students who will also be completing the same

course as the Opwall students. The reserve covers 84 ha and has lots of Giant Tortoises everywhere, as well as trails that give access to highland vegetation and the *Scalesia* forests, with specialist birds such as the Woodpecker Finch. Accommodation is in safari style tents on platforms with mattresses inside or in bunk beds in the research centre (groups can choose).

8. Galapagos Island practicals and itinerary

On the Tuesday morning the group will take an early morning flight from Quito to Baltra Island in the Galapagos (approx 2 hrs). Baltra Island is a small island just north of Santa Cruz Island and from there you will transfer by bus (5 mins), short ferry (5 mins) and bus (45 mins) to the Pajaro Brujo Reserve. During this week the students will be split into a 4 groups each with a maximum of 6 completing the following practicals:

Diving

One day of the course is dedicated to gaining a diving experience. For those with no previous diving experience they will be completing a Discover Scuba dive. This requires watching an initial training video followed by kitting up and going out in the boat to a sheltered and shallow underwater area where the students practice some skills. During this skill training session the students will be in water in groups of 2 with a Dive Instructor. Once these skills have been practiced there will be a break in the boat on the surface for a packed lunch. Afterwards the students will dive in groups of two with a Dive Instructor to a maximum depth of 12m. Since not all students will be able to dive at the same time, those not completing skills or doing their Discover Scuba dive will be snorkeling with a Dive Instructor will be teaching the identification of some of the fish species encountered.

For the qualified divers their first dive will be a check dive with a Dive Instructor to each group of 4 students. After satisfactory completion of the check dive and lunch on the boat, the second dive will be concentrating on learning some of the fish species encountered.

For those who have completed the referral elements of the PADI Open Water dive training course (i.e. the theory and confined water skills), there will be two dives with a maximum of 8 students and 2 Dive Instructors in the water with them at any time. Both of these dives will concentrate on learning the skills needed to complete the full Open Water course and these dives can be counted towards the 4 needed to complete the course. Alternatively, these 2 dives can be used to obtain the PADI Scuba Diver certification, which can then be upgraded to the full PADI Open Water scuba certification at a later date.

The dive location used for these dives and snorkel practicals has huge shoals of fish, sealions, turtles, sharks and marine iguanas.

Guided Visits to the Transitional and Humid Zones

These two half-day practicals will be based in the Pajaro Brujo reserve and consist of guided walks with an experienced naturalist explaining about the vegetation changes across the reserve and the birds and other animals encountered. Two of the four main vegetation types on the island (Transitional and Humid Zones) are found in the Pajaro Brujo reserve or adjacent to it. The two walks with the naturalist will concentrate on the two separate vegetation communities. The transitional zone is found above 200 feet elevation and is where the cacti and trees become taller and closer together. In these communities you can find Small and Medium Ground Finches, Vegetarian Finch, Cactus Finch, Small tree Finch, Galapagos Mockingbird, Yellow Warbler and Galapagos Dove as well as Large Ground Finch, Large billed

Flycatcher, Warbler Finch, Woodpecker Finch and hopefully also the Galapagos Vermilion Flycatcher. The second walk will concentrate on the humid zone where the *Scalesia* forest (tree related to sunflowers) and also the evergreen shrub Miconia are the dominant vegetation types. This habitat has many similar birds but there are also wetland areas with Galapagos Rail, White-cheeked Pintail and Paint-billed Crake present here. In addition there are many Santa Cruz tortoises. At the end of these two practicals the students should be able to identify many of the birds.

Guided Visit to the Coastal Arid and Mangrove Zones

This full day practical with a professional local naturalist guide is in the Tortuga Bay National Park. The first part of the visit is through the arid coastal zone and here the guide will be showing the students the typical *Opuntia* cacti, spiny bushes and small trees including Manzanillo tree (poison apple tree). The birds of this zone will also be taught although these are similar to those found in the transitional zone. Then there is a walk along a 1km long beach and a chance to snorkel next to the mangroves. This is an excellent site for marine iguanas and the guide will explain about their ecology and the students will complete some scan and focal sample behavioural observations on the marine iguanas. The final session explains about the mangroves and some of associated species such as the bright red Sally Lightfoot crabs and Lava Herons. Some of the seabirds such as the Blue-footed Boobies, Brown Noddys and Frigatebirds can be seen and their different ecological niches described.

Geology Guided Visit

This is a days trekking from the reserve to the nearby El Chato reserve with a specialist guide who will explain about the geology of the islands and the formation of the lava tubes that the students will be able to see.

Marine Species Training

In addition to the session learning fish species as part of the diving day, there will be a separate one day trip to the Itabaca Channel at the north of the island. The students will first need to kayak with professional guides and a safety boat, along the edge of the mangroves and will then be able to snorkel where they have a good chance of encountering rays and white tipped sharks as well as many other fish species.

So over the 6 days on site the students will have 3 sessions of snorkeling including one session where they are either diving if qualified or completing two dives towards their Open Water or Scuba Diver certification or doing Discover Scuba if not qualified or completing a referral course, visits to all four ecological zones on the island, be able to identify many of the Galapagos birds and fish species as well as learning about Galapagos island ecology and the iconic species (tortoises, sealions, marine iguanas, Darwins finches) and the geology of the islands.

The expedition finishes on the Monday morning at the end of the second week. The group will be taken back to the Baltra airport and fly out to Guayaquil to connect with International flights.

An example timetable is given below. The details of the exact order that groups will complete the various activities will vary according the total numbers on site that week and how many are already dive trained or have completed referrals.

Table 2. Example timetable for week 2. Note there may be changes to this schedule.

Day	Group 1	Group 2	Group 3	Group 4
Tuesday	Arrive	Arrive	Arrive	Arrive
Tuesday afternoon	Intro lectures	Intro lectures	Intro lectures	Intro lectures
Wednesday morning	Discover Scuba/Snorkel (8)	Tortuga Bay and snorkel	Tortuga Bay and snorkel	Ecology practical 1
Wednesday afternoon	Discover Scuba/Snorkel (8)	Tortuga Bay and snorkel	Tortuga Bay and snorkel	Ecology practical 2
Thursday morning	Ecology practical 1	Discover Scuba/Snorkel (8)	El Chato Lava Tunnels	El Chato Lava Tunnels
Thursday afternoon	Ecology practical 2	Discover Scuba/Snorkel (8)	El Chato Lava Tunnels	El Chato Lava Tunnels
Friday morning	Tortuga Bay and snorkel	Ecology practical 1	Discover Scuba/Snorkel (8)	Tortuga Bay and snorkel
Friday afternoon	Tortuga Bay and snorkel	Ecology practical 2	Discover Scuba/Snorkel (8)	Tortuga Bay and snorkel
Saturday morning	Itacaba visit and snorkel	Itacaba visit and snorkel	Ecology practical 1	Discover Scuba/Snorkel (8)
Saturday afternoon	Itacaba visit and snorkel	Itacaba visit and snorkel	Ecology practical 2	Discover Scuba/Snorkel (8)
Sunday morning	El Chato Lava Tunnels	El Chato Lava Tunnels	Itacaba visit and snorkel	Itacaba visit and snorkel
Sunday afternoon	El Chato Lava Tunnels	El Chato Lava Tunnels	Itacaba visit and snorkel	Itacaba visit and snorkel
Monday morning	Fly home	Fly home	Fly home	Fly home

9. Galapagos Island Ecology Lectures

Each evening there will be a lecture covering the following topics over the course of the week

Lecture 1: An introduction to the Galapagos

- Discovery of the islands and population
- Formation of the islands
- Humboldt, Cromwell and warm water currents
- Effects of El Nino on the islands
- Darwin in the Galapagos
- Island speciation
- Predicting island species numbers from size and physical complexity of the island and distance from the mainland
- Threats to the islands

Lecture 2: Vegetation zones and how species arrived

- Main vegetation zones
- Colonisation from wind blown organisms
- Colonisation over the sea
- Colonisation by flight
- Arrival of invasive species

Lecture 3: Marine environments of the Galapagos

- Vertical stratification of the sea and linkage to biodiversity
- Coral reefs
- Marine mounts
- Hydrothermal vents

Lecture 4: Fish and invertebrates of the Galapagos

- Fish biology
- Herbivorous fish ecology – parrotfish, surgeonfish, damselfish
- Carnivorous fish ecology – grunts, butterflyfish, triggerfish, frogfish
- Classifying invertebrates
- Examples of Cnidaria
- Examples of Crustacea
- Examples of echinoderms

Lecture 5: Endemic species of the islands

- What is endemism?
- Galapagos Red List terrestrial species
- Examples of endemic birds – Darwin's finches, flightless cormorants and penguins, Lava gull, Galapagos Hawk
- Other important bird species – Blue footed Boobies, Greater Flamingo, Waved Albatross
- Reptiles – marine iguanas, giant tortoises, lava lizard, Galapagos racers

Lecture 6: Marine megafauna of the Galapagos

- Challenges of being large and benefits of an aquatic existence
- Why sharks can't live in the deep sea
- Electroreception
- Shark finning and impacts on shark populations
- Whale ecology
- Fur seals and sealions
- Turtles

Lecture 7: Adaptive radiation

- Adaptation and fitness
- Camouflage and aposematism
- Mimicry
- Darwin's finches
- Adaptive radiation in giant tortoises

Lecture 8: Conservation of the Galapagos

- Extinction rates
- Control of invasions
- Reintroductions
- El Niño
- Galapagos marine protected areas

10. Learning outcomes from week 2

The students should achieve the following learning outcomes from the fieldwork and activities at the Galapagos site:

- Be able to identify at least 10 endemic species to the Galapagos
- To understand how the Galapagos formed and how species invaded the islands
- To understand the threats to Galapagos Island species
- To be able to identify at least 5 marine invertebrate and 5 fish species
- To be able to conduct snorkel based surveys of marine wildlife
- To be able to describe some successful conservation interventions in the Galapagos

11. Links to biology, geography, and environmental science syllabuses

The following tables suggest how specifications for Biology, Geography, and Environmental studies might link with your expedition experience though lectures, practicals or in discussion topics; keywords are used for the matching topics. Topics that have been greyed-out are unlikely to be relevant at this expedition location.

Table 3: Biology.

Topic	Biology	AQA		C	CCE A		C.Int		Ed/Sal		OCR		SQA		WJE C		A P	IB
		S	2		S	2	S	2	S	2	S	2	H	A H	S	2		
Evolution, Classification and DNA	Evolution; Speciation; Species; Endemism; Gene pool; Allopatric; Sympatric; Isolation; Variation; Adaptive radiation Adaptation; Wallace; Darwin		♦	♦		♦		♦	♦		♦		♦	♦		♦	♦	♦
	Classification; Taxonomy; Binomial system; Dichotomous Keys	♦		♦	♦		♦	♦	♦	♦			♦	♦				♦
	PCR; Genome sequencing; Genetic fingerprinting; DNA profile		♦	♦	♦				♦		♦	♦				♦	♦	♦
Ecology and	Ecology; Habitat; Niche; Abiotic; Biotic		♦	♦	♦		♦		♦	♦	♦					♦	♦	♦
	Biome; Ecosystems; Rainforests; Deserts Coral reefs; Mangroves; Marine; Coasts Hot arid; Semi-arid; Woodland Bush; Tropics; Tropical		♦	♦		♦	♦					♦				♦	♦	♦
	Populations; Competition; Interspecific; Intraspecific; Predator Prey; density dependent; independent: Symbiosis		♦	♦		♦	♦					♦				♦	♦	♦

Ecosystems	Succession; Climax community		♦			♦				♦	♦	♦				♦		♦		
	Biodiversity	♦		♦	♦			♦	♦	♦	♦					♦		♦	♦	
	Practical work; Field techniques; Ecological sampling; Random sampling; Transects; Capture, mark, release and recapture; Biodiversity indexes; Data handling and presentation; Quadrats; Statistical testing; Measuring; GIS; Research tools		♦	♦		♦					♦	♦	♦	♦	♦			♦	♦	♦
	Written reports; Research project; Report; Case studies			♦						♦				♦	♦			♦	♦	♦
Agriculture, Human activities, Conservation and Sustainability	Sustainability	♦		♦					♦	♦		♦					♦			
	Agriculture; Agricultural impact; Agricultural exploitation; Cultivation crops; Food production; Sustainable agriculture; Sustainability; Forestry; Timber; Deforestation; Fisheries; Over fishing; Deforestation; Human management; Human effects; Human activities	♦				♦						♦	♦				♦	♦		
	Fair-Trade; Coffee; Rain Forest Alliance; Ecotourism; Tourism; Carbon trading; Greenhouse gas emission control (REDD)																	♦		
	Indicator species; Pollution; Climate change; Global warming Carbon footprint; Fossil fuels		♦	♦		♦					♦	♦		♦					♦	♦
	International conservation; Endangered species; Invasive species; Biological control; Pests; CITES; Ethical, Local; Global	♦	♦	♦		♦					♦	♦	♦					♦		♦
	National Parks; Wildlife reserves																			♦
	Environment; Environmental monitoring; Environmental impact; SSSI																			
Behaviour	Animal behaviour; Primate Social behaviour; Courtship; Territory; Co-operative hunting; Herbivores; Grazing	♦		♦	♦					♦			♦	♦	♦			♦	♦	♦

Table 4: Geography and Environmental Science.

Topic	Geography, APES and ESS	IB ESS	AP ES	AQA		CCEA		Edex		OCR		WJEC	
				S	2	S	2	S	2	S	2	S	2
				Levels: S=AS 2=A2									
Evolution, Classification	Evolution; Speciation; Species; Endemism; Gene pool; Allopatric; Sympatric; Isolation; Variation; Adaptive radiation Adaptation; Wallace; Darwin												

Genetics and DNA	Classification; Taxonomy; Binomial system; Dichotomous Keys	♦																		
	PCR; Genome sequencing; Genetic fingerprinting; DNA profile																			
Ecology and Ecosystems	Ecology; Habitat; Niche; Abiotic; Biotic	♦	♦									♦								
	Biome; Ecosystems; Rainforests; Deserts; Coral reefs; Mangroves; Marine; Coasts; Hot arid; Semi-arid; Woodland Bush; Tropics; Tropical	♦	♦	♦	♦			♦			♦	♦	♦	♦	♦	♦	♦	♦	♦	
	Populations; Competition; Interspecific; Intraspecific; Predator Prey; density dependent; independent: Symbiosis	♦	♦																	
	Succession; Climax community	♦																		
	Biodiversity	♦	♦			♦						♦								
	Practical work; Field techniques; Ecological sampling; Random sampling; Transects; Capture, mark, release and recapture; Biodiversity indexes; Data handling and presentation; Quadrats; Statistical testing; Measuring; GIS; Research tools	♦	♦			♦	♦			♦			♦	♦	♦					
	Written reports; Research project; Report; Case studies	♦	♦			♦		♦	♦				♦	♦						
Agriculture, Human activities, Conservation and Sustainability	Sustainability	♦	♦			♦		♦				♦	♦							
	Agriculture; Agricultural impact; Agricultural exploitation; Cultivation crops; Food production; Sustainable agriculture; Sustainability; Forestry; Timber; Deforestation; Fisheries; Over fishing; Deforestation; Human management; Human effects; Human activities	♦	♦			♦		♦												
	Fair-Trade; Coffee; Rain Forest Alliance; Ecotourism; Tourism; Carbon trading; Greenhouse gas emission control (REDD)							♦	♦			♦	♦						♦	
	Indicator species; Pollution; Climate change; Global warming Carbon footprint; Fossil fuels	♦	♦					♦	♦			♦								
	International conservation; Endangered species; Invasive species; Biological control; Pests; CITES; Ethical, Local; Global	♦				♦							♦							
	National Parks; Wildlife reserves											♦								
	Environment; Environmental monitoring; Environmental impact; SSSI																			
Behaviour	Animal behaviour; Primate Social behaviour; Courtship; Territory; Co-operative hunting; Herbivores; Grazing																			

12. Reading and research questions

Many students are now involved in producing Research 'Essays' or 'Projects' as part of their 2 year educational programme and many hope to carry this out whilst on an Opwall Expedition. If you are an IB school you will be involved in the EE or Extended Essay or if in the UK an EPQ or Extended Project Qualification. Those involved in CoPE will also have a similar project carrying out some research. There are many similar projects in most countries.

One of the key features of all of these 'Essays' or 'Projects' is that you have to choose your own research question but it is often difficult to find out exactly what is happening at each Opwall research site. To help in this, we have produced a 'Research' lookup database on the Opwall website – <http://opwall.com/epq-research-topic/> but you can also 'download' a more detailed version as an Excel Spreadsheet.

The database lets you find out what is happening at each site and there are links to pdf files and video clips. You can search the 'database' using a variety of filters such as research area and location.

Once you have decided on an area you need then to consult with your tutor and then at some stage (preferably months before you go) contact the Opwall country manager to see how appropriate your research question is for your expedition location.

The type of EPQ or EE will vary but it is less suitable for individual investigations where you collect your own primary data although in some cases you might be able to get hold of raw data and you will often have the opportunity to help collect some of the data yourself. You will certainly have the opportunity 'on-site' to meet up with the scientists involved which will allow you to get a deeper insight into your research question.

Many of you will also have seen the Wallace Resource Library (WRL) which contains many datasets based around the research being carried out and it has been prepared by the actual Opwall scientists involved. It is a very valuable source of ideas with comprehensive datasets to look at and study.

Demo version – <http://wallaceresourcelibrary.com>

Do also make use of the research library on the OpWall website - <http://www.opwall.com>

Books

Ghazoul, Jaboury and Douglas Sheil. *Tropical rain forest ecology, diversity and conservation*. Oxford: Oxford University Press, 2010.

Forsyth, Adrian and Ken Miyata. *Tropical nature: life and death in the rain forests of Central and South America*. Beaverton, OR: Touchstone Press, 1987.

Kricher, John. *The Neotropical companion*. Princeton, NJ: Princeton University Press, 1999.

Dawkins, Richard. *Galapagos: The Islands That Changed the World*. 2007

Barrett, Paul. *Law of the Jungle*. 2014

Guides for flora and fauna

Alwyn Gentry (1995) Field Guide to Woody Plants of Northwest South America: Colombia, Ecuador, Peru. University of Chicago Press

Diego Tirira (2007) Mamíferos del Ecuador [In Spanish]

Robert Ridgley and Paul Greefield (2001) The Birds of Ecuador. Cornell University Press.

George C McGavin (2010) Insects. DK Handbooks.

David L. Pearson and Les Beletsky (2013) Ecuador and the Galapagos Islands (Travellers' Wildlife Guide)

David Horwell (2011) Galapagos Wildlife (Bradt Travel Guides)

Pierre Constant (2007) Marine Life of the Galapagos: The Diver's Guide to Fish, Whales, Dolphins and Marine Invertebrates

Paul Humann (2007) Reef Fish Identification: Galapagos

Electronic media

Free Spanish lessons and material <http://www.bbc.co.uk/languages/spanish/>