
# Honduras Schools' Booklet 2019

# Contents

# 1. Study areas and research objectives

This is a field-based module run from the Operation Wallacea Research Facility located within the Cusuco National Park, Honduras. Honduran forests represent part of the Meso-American Forest Corridor hotspot, a region characterised by exceptional species richness as identified by Conservation International. Honduras is the most mountainous country in Central America with 65-80% of land composed of rugged mountains from 300-2850masl, with more cloud forest sites than any other country in Central America (nearly 40). Cusuco is but one of these cloud forest reserves. Cloud forests are associated with high biodiversity and endemism, demonstrated by the fact that 86% of the cloud forest sites are found within the 'Global 200 Priority Forest Ecoregions' identified by the World Wide Fund for Nature (WWF).

Honduras is Central America's second largest country, and boasts not only a mountainous landscape with dense montane and cloud forest, but also many Caribbean Islands which are surrounded by the second largest barrier reef in the world. Despite this, the biodiversity of Honduras has been less studied than other countries in Central America such as Costa Rica, Panama and Belize. Honduras is approximately 43,278 square miles (112,092 $km^2$) and is home to more than 6,000 species of vascular plants, of which 630 are orchids; around 250 known reptile and amphibian species, more than 700 bird species, and 110 mammal species, of which roughly half are bats. The 2 million acre Rio Plátano Biosphere Reserve in the Honduran Mosquitia (eastern Honduras) was recognized as Central America's first Biosphere Reserve in 1980 by the United Nations Educational and Scientific Organization (UNESCO), and in 1982 UNESCO Rio Plátano was also named as a World Heritage Site.

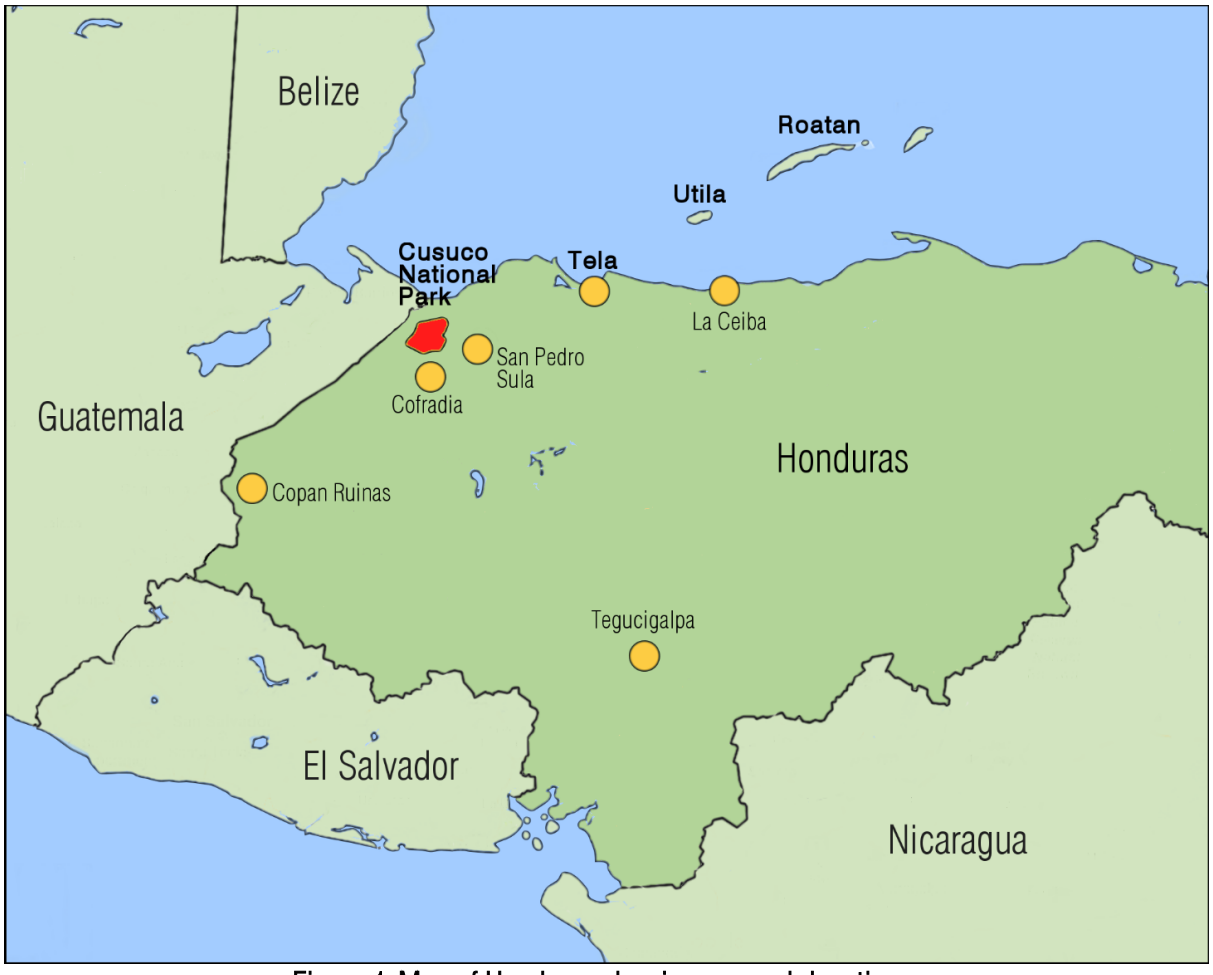


Figure 1-Map of Honduras showing research locations.

## Cusuco National Park

Cloud forests are associated with high biodiversity and endemism, demonstrated by the fact that 86% of the cloud forest sites are found within the 'Global 200 Priority Forest Ecoregions' identified by the World Wide Fund for Nature (WWF). Cusuco National Park holds a special importance and has been described as 'the jewel in the crown' of Honduras' national parks. It has also recently been described as one of the top one hundred parks in the world most important for global biodiversity conservation.
Cusuco National Park, and the adjacent protected "water production zone" (WPZ) is a 56,000ha (560 km2) protected area in the Merendon mountains of northwest Honduras (Fig. 2). Cusuco National Park and the adjacent water protection zone supply all of the water for San Pedro Sula. It is important to assess the water protection zone to compare it to Cusuco National Park. The region ranges from just above sea level in the west to 2425m in the centre. Cusuco comprises a 7,690ha (76.9 km2) core zone surrounded by a 15,750ha (157.5 km2) buffer zone. Both Cusuco and the WPZ encompass several major habitat types: including semi-arid pine forest; moist pine forest; moist broadleaf forest and at elevations above 2000m, dwarf forest which is known locally as bosque enaño.

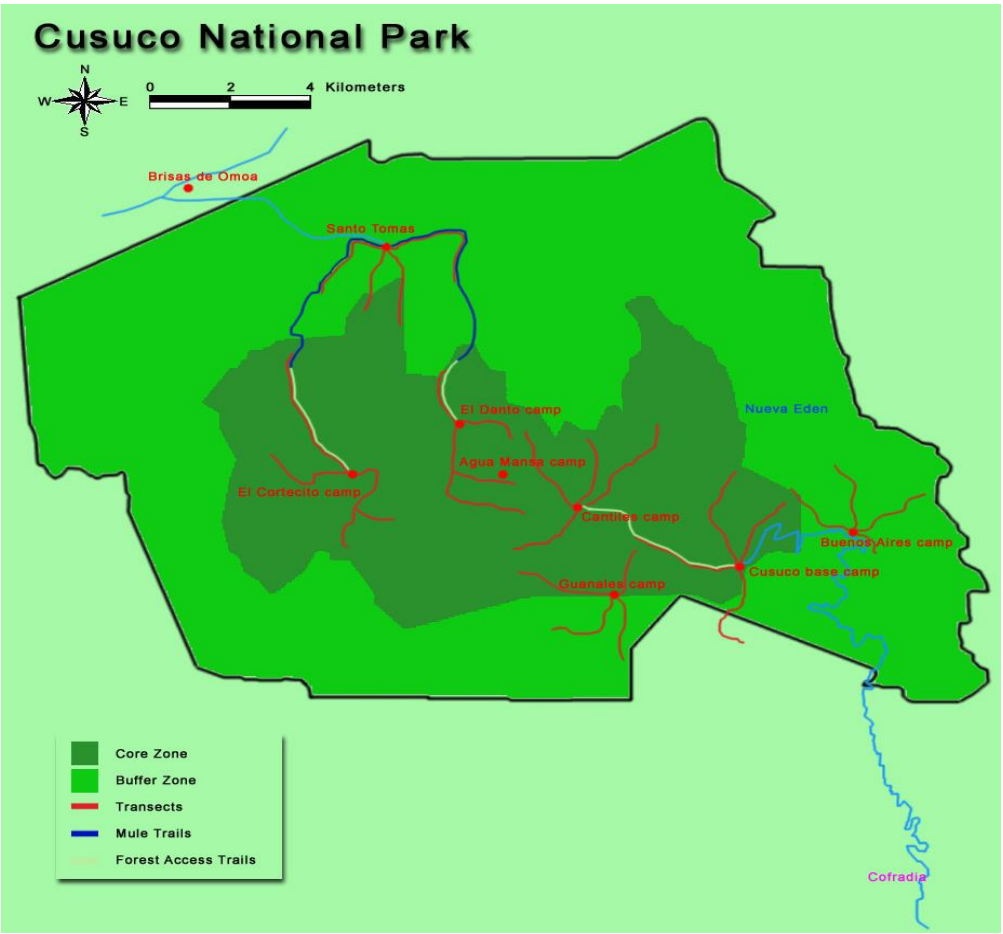


Figure 2-Study sites within Cusuco National Park.

The area provides an opportunity to study biodiversity, biogeography, community ecology, factors that impact diversity, environmental management, and issues relating to non-sustainable resource extraction. Although the core zone of the park has historically been relatively undisturbed, recent illegal logging in the core zone has become a problem. The buffer zone is also increasingly threatened by human activities, especially coffee production, land clearance and logging. These threats make it even more critical that Operation Wallacea continues to work in the area.

Operation Wallacea have conducted surveys in Cusuco since 2004 documenting the biodiversity of the park, and monitoring populations to enable effective conservation management. By surveying the WPZ this dataset is further strengthened by reporting biodiversity at greater altitudinal and geographical ranges. A key objective of this research is to leverage funding for the long-term conservation management of Cusuco. Cusuco and the WPZ contain high diversity of habitats and high beta diversity in many taxonomic groups due to the large elevation gradients in the region. The park is a remarkable example of an increasingly threatened habitat and supports populations of many cloud forest specialist species including several which are endemic to Cusuco. These habitats are home to 270 known bird species, 93 Cusuco reptiles and amphibians, 35 bat species and charismatic large mammals such as the mantled howler monkey and Baird's tapir.

The Cusuco research programme has two main objectives – to complete the themed forest ecology research programme and to collect data on the carbon, biodiversity and community benefits of the forest which are then being used as part of a submission under the Reduction in Emissions from Deforestation and forest Degradation (REDD+ scheme) for funding the protection of the Cusuco forests.

The second week will be run from one of the two marine research sites run by Operation Wallacea located in the Bay Islands – either the island of Utila or Roatan. The main research objective at these sites is to complete annual monitoring of the coral and reef fish communities so the effectiveness of the management strategies between the islands can be assessed.

## Utila

Utila is part of the Honduran Bay Islands, and is also a popular dive tourism destination by budget travellers and backpackers. Having once been part of British Honduras, the language spoken on Utila is English, and the culture of the island is different from the Spanish speaking mainland. There is a small town on the southeast of the island, which is home to a small local population as well as the bulk of the tourism industry. Operation Wallacea are based in the Coral View Beach Resort and Research Centre around half an hour walk from the town, on the edge of a large mangrove lagoon. There is currently very limited protection for the coral reefs around Utila, despite the importance of these systems to the dive tourism industry and the economic benefits this brings to the local economy. As a result, there has been a significant impact from overfishing and other factors such as pollution from Utila town. Operation Wallacea conducts two main activities on Utila: (1) to collect data on ecosystem health which can be used to inform local government and management organisations on how best to protect their reefs and manage their marine resources, and (2) as a site of novel scientific research to increase our understanding of how coral reefs function and the impact that various threats have on them. Specifically, the main objectives of research on Utila are:

- Yearly monitoring of the status of the reefs around Utila, to determine the health of the reef system and the level of impact from human activities.
- Conducting high quality research with the aim of producing suitable studies for peer review and establish the Marine Research Station as an internationally recognised centre for quality marine research.
- To explore potential management strategies to mitigate the devastating ecological effects of the Caribbean lionfish invasion.
- To study the interactions between key groups of benthic organisms, particularly coral, seaweed and sponge, which is critical in determining the overall health of the coral reef and the associated fishery it can support.

- To determine the population dynamics of the ecologically important sea urchin population, and assess levels of recovery after the recent Caribbean-wide disease-led mass mortality.
- To gain a deeper understanding of behaviours exhibited at cleaning stations and the role that they play in maintaining healthy coral reefs in the Caribbean.

### Roatan

Roatan is the largest of the Bay Islands, which form a chain off the northern coast of Honduras. With a human population of approximately 50,000, fishing has historically been an important source of income to the island. However, recent decades have seen a large increase in tourism, and this sector now forms the island's most important income stream. The language spoken on Roatan is English, having once been part of British Honduras, and consequently the culture is noticeably different from the Spanish-speaking mainland. There are several small towns and villages dotted around the island, and the tourism facilities are spread across the island. Operation Wallacea partner with Ecodivers, which is located in an area called West End. Roatan has been progressive in terms of Honduran marine conservation, with the Roatan Marine Park actively working to protect the reefs for some time. The focus of Operation Wallacea on Roatan is to collect baseline data on ecosystem function and health. Roatan provides a great example of the benefits that can be provided by the establishment of a well policed Marine Protected Area (MPA), and the data we collect throughout the summer will hopefully be instrumental in helping the formation of other equally successful MPAs throughout the Caribbean. Specifically, the main objectives of research on Roatan are:

- To quantify the percentage cover of key benthic groups to provide a proxy of coral reef health, including ecosystem architects, the scleractinian corals.
- To assess the populations of ecologically important sea urchins on coral reefs around West End, as a representative site of a post-mortality population.
- To conduct surveys for the invasive lionfish, and conduct dissections of captured individuals to collect data on their morphology and dietary habits.
- To assess how diversity and reef health are maintained in a system dominated by fish-grazing in the absence of healthy sea urchin populations.

## 2. Week 1 Itinerary for Schools in Cusuco

The students on site will complete six days of training and research. These are divided into half day sessions totalling: three days of biodiversity lectures and associated survey practical sessions, half a day jungle skills training and two and half days of forest measurements and biodiversity monitoring. Students will arrive in the forest on Wednesday by mid-morning and will attend introductory lectures on health and safety, camp orientation and the schedule for the week for each group. Each of the students will spend a series of nights at one of the Main Camps (Base Camp in the core zone of the Park with accommodation in tents, or Buenos Aires a buffer zone mountain village on the East of the Park with accommodation in local houses) and three days in one of the field camps in the core zone of the Park where accommodation is a mix of hammocks and tents.

An example timetable for the groups is set out below. Note that when there are large numbers, the schools will be divided into two groups (table 1) who will each spend 3 nights in a Main Camp and 3 nights in a field camp. Group 1 will spend the first 3 nights at the Main Camp followed by 3 nights in a fly camp whilst group 2 will start off in the fly camp and finish in the Main Camp. When there are smaller groups ($<25$) then they will follow either the group 1 or group 2 itinerary below.

The normal schedule will be a dawn start for the teams doing the biodiversity practicals (a little later if the Canopy Access training is being done that morning). These teams will then normally be back late morning and in the main camps there will be a lecture before and after lunch. The afternoon practical will start at approximately 2pm with teams getting back for dinner, which is followed by a lecture and an evening practical.

| Day | Group 1 Main Camp/Fly Camp | Group 2 Fly Camp/Main Camp |
|---|---|---|
| Wednesday morning | Transfer to Main Camp | Transfer to Main Camp |
| Wednesday afternoon | Health and safety briefings<br>Light trapping or bat surveys | Trek to field camp |
| Wednesday evening | Lecture 1 Biodiversity and Rainforest structure | Health and safety briefings and introduction to field camp |
| Thursday morning | Bird mist netting, herpetofauna surveys/canopy access training<br>Lecture 2 Adaptation and co-evolution | Invertebrate pitlines, bird point counts or herpetofauna surveys |
| Thursday afternoon | Lecture 3 Amphibians and reptiles<br>Training in forest structure measurements | Forest structure surveys |
| Thursday evening | Light trapping or bat surveys | Jungle training briefing<br>Amphibian and reptile walk |
| Friday morning | Bird mist netting, herpetofauna surveys or canopy access training<br>Lecture 4 Cloud forest birds | Bird point counts or herpetofauna surveys |
| Friday afternoon | Lecture 5 Cloud forest mammals<br>Jungle training/canopy access training | Forest structure survey |
| Friday evening | Light trapping or bat surveys | Jungle training briefing<br>Amphibian and reptile walk |
| Saturday morning | Jungle training/canopy access training | Forest structure survey |
| Saturday afternoon | Trek to fly camp | Trek back to Main Camp |
| Saturday evening | Introduction to field camp | Lecture 1 Rainforest structure and biodiversity |
| Sunday morning | Invertebrate pitlines, bird point counts or herpetofauna surveys | Bird mist netting, herpetofauna surveys/canopy access training<br>Lecture 2 Adaptation and co-evolution |
| Sunday afternoon | Forest structure surveys | Lecture 3 Amphibians and reptiles<br>Training in forest structure measurements |
| Sunday evening | Jungle training briefing<br>Amphibian and reptile walk | Light trapping or bat surveys |
| Monday morning | Bird point counts or herpetofauna surveys | Bird mist netting, herpetofauna surveys or canopy access training<br>Lecture 4 Cloud forest birds |

| | | |
|---|---|---|
| Monday afternoon | Forest structure survey | Lecture 5 Cloud forest mammals<br>Jungle training/canopy access training |
| Monday evening | Jungle training briefing<br>Amphibian and reptile walk | Light trapping or bat surveys |
| Tuesday morning | Forest structure survey | Jungle training/canopy access training |
| Tuesday afternoon | Trek back to Main Camp | Forest structure survey |
| Tuesday evening | Lecture 6 Conservation Synthesis<br>Social evening | Lecture 6 Conservation Synthesis<br>Social evening |
| Wednesday morning | Travel to marine site | Travel to marine site |

Table 1. Example timetable for week 1. Note there may be changes to this schedule depending on size of groups, fitness of students, weather conditions, operational problems or timing of the canopy access training.

## 3. Jungle Skills

There will be briefings on introduction to the forest camps, how to identify risks throughout the Cusuco sites and to ameliorate these risks and health and disease issues. Each group will have to learn how to live in tents and hammocks and be shown how to select a safe camp site, make fires, dig latrines, field cooking, water sterilisation etc. During their walks into and out of the camp they will have constant reinforcement of the health and safety messages and, whenever possible, identifications of common trees, birds and reptiles encountered.

Learning outcomes:

- 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 -from the medical briefings and additional information given by the accompanying medic
- Safe working practices in remote locations- this is to do with trekking procedures, river crossings, taking water, hat, sunblock, organising communication etc and is partly from the lectures and partly field experience
- Establishing a temporary fly field camp -from experience gained in the field camp and is aiming at ensuring they know how to sling a hammock and be able to stay in the forest overnight

## 4. Example Forest Measurements*

Assessment of habitat type and level of habitat degradation provides the backbone to biodiversity monitoring programmes and assessment of ecosystem health. Assessment of a range of habitat variables and monitoring of habitat changes over time can be used to interpret variation in space and time of faunal diversity and abundance. Modelling of habitat quality and animal distribution patterns can then be used to predict changes to the ecosystem caused by a range of management plans as a means of choosing the most effective method of land management for a given area. In addition, these data are being used to calculate the carbon standing stock in the forest as a key component of the REDD+ application being submitted for the Park.

Students will work in a group to complete surveys of 20m x 20m habitat plots. The first task for the team at each site will be to mark out the 20m X 20m square around using the marked corners. Once the 20m X

20m square has been positioned the tapes will need to be tied off and bisecting tapes positioned so that four 10m X 10m quadrants are positioned within the 20m X 20m square. During this process care should be taken to minimise damage to the site. The teams are then divided into three groups: growth rates and dead wood estimation, canopy openness and spatial heterogeneity of the site and regeneration rates.

The growth rates team will complete dbh (diameter at breast height) measurements on all trees with dbh values >30cm. If the tree is tagged the tag number will be noted and if no tag is present, then a new tag will be fixed. This team will then record the length and circumference of any fallen trees or branches (>20cm circumference) as an indication of turnover within the forest. Note only the part of the fallen tree or branch within the 20m x 20m site should be measured and the total volume of dead wood should be recorded on the data sheet.

The canopy openness and spatial heterogeneity team will estimate the openness of the canopy by taking a reading with a canopy scope facing the largest opening in the canopy from the centre of each of the four quadrants and one from the centre of the overall 20m X 20m square. If any of these points is closer than 1m to a tree trunk, then the observation point should be moved slightly so that it is at least 1m from the nearest tree trunk. The perspex square needs to be held 20cm from the eye and has a number of dots engraved on the square. The observer counts the number of dots that coincide with gaps in the canopy.

20m tapes will have been used to bisect the 20m X 20m site in order to produce the four quadrants. The canopy openness and spatial heterogeneity team will use a 3m pole marked in 0.5m segments and record the number of vegetation touches on the pole in each 0.5m segment up to a maximum of 10 touches, every 1m along these bisecting tapes. If one of the positions coincides with a tree assume each of the 0.5m segments include vegetation.

The regeneration rate team will position a 2m X 2m square randomly within each of the four 10m x 10m quadrant and the number of woody saplings <1.5m counted.

* Note that our methods are continually being reviewed and so slight changes may be necessary between years in order to get the most relevant data. We do our best to inform before the expedition if any changes are made to the protocols.

# 5. Biodiversity Monitoring

The following are the practicals with on-site briefings that will be completed by each group:

## Mist net sampling

This practical session will also include a lecture on Neotropical birds. Students will work alongside ornithologists to survey birds using mist nets. Students will assist with the identification and marking of birds, and assist with collecting additional data such as samples for DNA analysis, weight, sex and morphometric measures of the wings and head. Students will be reminded of the advantages and limitations of surveying birds using mist netting and will study the list of species caught to look for biases in data collection. The session will be conducted early in the morning when birds are most active.

## Scan search sampling of herpetofauna

The students will practice transect sampling by walking along a transect line in the forest and searching for reptiles and amphibians on either side of the transect line. Many of the transect lines connect with a stream. While at the stream they will use systematic scan searching of amphibians. All animals caught along the transect line or in the stream will be identified. Skin swabs of amphibians will also be collected as part of the ongoing monitoring of the chytrid fungus. There will also be an accompanying lecture to reinforce the skills that are learnt in the field.

## Light trapping of invertebrates

A light trap will be set to monitor nocturnal invertebrates such as moths and jewel scarab beetles. Students will assist the scientists to set-up traps and will be reminded of the advantages and limitations of this sampling method. The light trap will then be left for a period of time, in which a short briefing will be given to support the learning outcomes. Students will return to the light trap to identify the various species caught. Lepidopterans are covered in the invertebrate lecture.

## Bat mist netting

This practical will involve working with the bat scientist in the evening to set and empty mist nets. The captured bats will be identified and the main identification features explained.

## Pitfall surveys for dung beetles

Pitfall traps baited with dung have been established around each of the core zone camps. These traps need checking and emptying daily and the captured specimens sorted into the main morphotypes.

## Bird point counts

At each of the sample points along the transects early morning bird point counts are completed. This involves standing in an outward facing circle with an experienced ornithologist in the centre. All birds seen

or heard over the next 10-minute period are noted down together with the timing of the record and estimated distance from the count point.

### Spotlight surveys for amphibians and reptiles

This practical will involve spotlight surveys of river after dark with a herpetologist to assess frog communities and opportunistically sighted reptiles. Species encountered will be identified and the main identification features explained.

## 6. Biodiversity lectures

### Lecture 1: Biodiversity, Hotspots and Monitoring

An introduction to Biodiversity and Cusuco National Park. Students will learn about the meaning of biodiversity and how this applies to Cusuco. They will also look at the structure and importance of rainforests and the long-term collection of monitoring data to identify trends and patterns in populations.

- What is biodiversity?
- What is a species?
- Measuring diversity and diversity gradients.
- Why measure biodiversity and why is it important?
- Endemism
- Other important things to know about – the IUCN Red lists and Biodiversity Hotspots
- Cusuco National Park
- Monitoring methods

Discussion/Activity: Discussion on the word 'biodiversity'. Short video on Biodiversity.
Key words: Biodiversity; Species; Ecosystems; Rainforest; National Parks; Endangered species

### Lecture 2: Herpetofauna and adaptation

This lecture looks briefly at the process of evolution and the unique situation for Honduras. It then considers two forms of adaptation as shown by mimicry in the forest, before going into detail about the different groups within amphibians and reptiles. The lecture finishes by looking at herpetofauna specific to the cloud forest and Cusuco before focussing on the case study of Chytrid fungus, which is responsible for severe declines and extinctions of amphibians worldwide and is a hot topic of science research at present.

- Evolution
- Evolution of herpetofauna in Central America
- Amphibians
- Reptiles
- Snakes and venoms
- Herpetofauna in cloud forests
- Amphibian decline and Chytrid

Discussion/Activity: Herp ID test
Key words: Evolution; Allopatric; Wallace; Darwin; Adaptation; rainforest

### Lecture 3: Invertebrates and adaptation

This lecture is split into two parts. Firstly, it introduces the importance of invertebrates (particularly insects) and introduces the concept of ecosystem services. It then goes over the main invertebrate groups studied in Cusuco and why they are ideal study systems and important indicators of ecosystem health. The second

part of the lecture looks at adaptation, demonstrated in the form of mimicry in the forest (Batesian and Mullerian). The lecture concludes by looking at some strong evolutionary studies using the same invertebrate groups that Cusuco researchers study with the help of students.

- Invertebrate diversity
- Lepidoptera, Hymenoptera & Coleoptera
- Adaptation
- Aposematism
- Mimicry – Batesian and Mullerian
- What makes a good indicator species
- Example studies on indicator species

Discussion/Activity: Butterfly or Moth quiz, adaptation activity where students discuss the different adaptation of cloud forest species

Key words: Adaptation, aposematism, camouflage, mimicry, Batesian, Mullerian, indicator species

### Lecture 4: Neotropical birds

In this lecture the main birds of Cusuco are discussed along with an idea on how to identify birds in the field. It examines different aspects of bird biology and ties this in with both natural selection and sexual selection, for example: morphological adaptations, feeding, courtship behaviours and reproduction. The lecture finishes with a discussion of survey methods used by scientists in the forest.

- Bird evolution and classification
- Bird anatomy and adaptation
- Courtship and mating systems
- Songs and calls
- Bird identification
- Birds as indicators of ecosystem health
- Bird surveys and monitoring

Discussion/Activity: How to survey birds and an optional Bird ID test

Key words: Classification; field techniques; indicator species; behaviour; courtship.

### Lecture 5: Neotropical Mammals

The main mammals of Cusuco are reviewed and linked to the concepts of evolution and adaptation which have been previously covered, followed by a summary of sampling techniques used in the forest.

- Mammal evolution
- Mammal diversity
- Mammals in Cusuco
- Baird's tapir and relevant studies
- Sampling techniques
- Conducting a small mammal survey

Discussion/Activity: Mammal ID test

Key words: Habitat; niche; Rainforest; Field techniques; Transects; mark and release; conservation; mammals.

### Lecture 6: Conservation, Operation Wallacea & Cusuco National Park

This lecture looks at conservation issues in Cusuco National Park and surrounding area, in addition to the importance of long-term biodiversity monitoring data and its application to carbon-trading schemes such as REDD, REDD+ and Natural Forest Standards.

- Conservation and the Opwall conservation model
- Opwall project in Cusuco National Park
- Pressure-state-response monitoring
- Cusuco monitoring data
- Carbon trading and REDD+

Discussion/Activity: Round-up of the weeks' activities and the contributions the students have made to the research.
Key words: Conservation; REDD; Carbon trading; GIS; Threats; Fair Trade

## 7. 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 and cloud forest
- Be able to describe the key fauna found in Central American cloud forests
- Give examples of cryptic, warning colourations, Batesian and Mullerian mimic species
- Be able to identify 5 species of herpetofauna in Cusuco
- Describe the Chytrid fungus and its impact on amphibian populations worldwide
- Describe how snakes are classified according to their teeth and venom
- Describe different bird survey techniques
- Be able to identify 10 species of cloud forest bird
- Describe survey techniques used to monitor mammal populations.
- Be able to identify 10 species of cloud forest mammal
- Be able to describe the UN REDD+ scheme

## 8. Week 2 Itinerary

The students will complete six days of training in marine science. If the group is going to Utila or Roatan they will be catching the mid-afternoon ferry from La Ceiba and arriving Wednesday evening. Accommodation on both Utila and Roatan is in shared rooms with air conditioning.

At either site the students have the option of completing their PADI Open Water dive qualification (see section 10). If they are already dive trained or don't want to dive then they can do the Caribbean Reef Ecology course on Utila or Roatan, with the practical's carried out either by diving or snorkelling (see section 9). A third alternative is to complete their theory and confined water practicals at home, leaving just 4 open water dives to complete the course and achieve the PADI Open Water qualification on site (see section 11). They will then move onto the reef ecology course for the remainder of the week. Students will be occupied in the evenings with a series of science talks, documentary viewings and discussions/activities relative to the ecology course, as well as being able to enjoy the beautiful settings of whichever of our marine sites they are visiting.

## 9. Coral Reef Ecology Course

Table 2 shows an example timetable of the activities that students undertaking the Caribbean Coral Reef Ecology Course will complete over the week. The practical element of the reef ecology course can be completed either by diving or snorkelling. If students are already qualified divers by the time they arrive on site, they will be required to complete a compulsory check dive with a PADI professional at the start of the

course. The Caribbean Coral Reef Ecology course covers a range of topics suitable to support A-Level, IB and AP biology and geography students over a range of different syllabuses. Lectures will be supported by a mixture of in-water and land-based practicals. In addition to the lectures, students will also be expected to complete a small group task throughout the course of the week. Students will be provided with an information pack at the start of the week, which will give them detailed information about an important topic in coral reef ecology/conservation. On the Monday afternoon at the end of their stay, they will present their findings to the group in as an imaginative way as possible!

### Lecture 1: The Blue Planet

- Quick fire facts to excite students about the marine world
- Who would win in a fight between a great white shark and a killer whale?
- Why is the sea blue and salty?
- Why are whales so important?
- Where did life originate?

**Land-based activity:** presentation briefing
**In-water activity:** check dive/snorkel

### Lecture 2: An Introduction to Coral Reefs

- Coral biology; growth, development, feeding and reproduction
- Importance of the symbiotic relationship between corals and photosynthetic microalgae
- What are coral reefs and where are they found?
- Introduction to the Caribbean

**Land-based activity**: assessing the complexity of a coral reef
**In-water activity:** coral ID dive

### Lecture 3: Conservation of Coral Reefs

- The value of coral reefs
- An introduction to macroalgae
- Competition between macroalgae and hard coral; phase-shifts
- Local threats to coral reefs that stimulate phase-shifts; i. Destructive fishing, ii. Coral mining, iii. Overfishing, iv. Water pollution, v. Coastal development, vi. Disease, vii. Lionfish invasion
- Potential management solutions

**Land-based activity:** quadrat building
**In-water activity:** assessing levels of coral bleaching using PADI's 'Coral Watch' guideline

### Lecture 4: The Diversity of Coral Reefs I

- An introduction to taxonomy
- Classifying a green alga
- Classifying a sea cucumber
- Classifying the stoplight parrotfish

**Land-based activity:** talk preparation
**In-water activity:** fish ID dive

### Lecture 5: The Diversity of Coral Reefs II

- Coral reef food webs
- Fish herbivory
- Invertebrate herbivory
- Filter feeding
- Predation

**Land-based activity:** video analysis
**In-water activity:** urchin collection

### Lecture 6: The Diversity of Coral Reefs III

- An introduction to behaviour
- Parasitism
- Commensalism
- Symbiosis
- Camouflage
- Fish sensory systems

**Land-based activity:** urchin practical
**In-water activity:** invertebrate ID dive

### Lecture 7: Mangroves and Seagrass

- Mangrove adaptations
- Seagrass adaptations
- Ecosystem services and functions
- Importance of habitat connectivity
- Threats to mangroves and seagrasses

**Land-based activity:** lionfish practical
**In-water activity:** seagrass practical

### Lecture 8: The Future of Coral Reefs

- Rising sea surface temperature
- Ocean acidification
- The structure of a reef in 2100
- Conservation management

**Land-based activity:** talk preparation
**In-water activity:** Rapid Reef Assessment

| Time | Thursday | | Friday | | Saturday | | Sunday | | Monday | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 | Group 2 | Group 1 | Group 2 | Group 1 | Group 2 | Group 1 | Group 2 | Group 1 | Group 2 |
| 0700 | **Lecture 1:** paperwork and talks briefing | **In-water activity:** checkout | **Lecture 3:** equipment building | **In-water activity:** fish point out | **Lecture 5:** SVS analysis | **In-water activity:** urchin collection | **Lecture 7:** lionfish dissection | **In-water activity:** Rapid Reef Assessment | **Talk preparation** | **In-water activity:** beach clean up |
| 1000 | **In-water activity:** checkout | **Lecture 1:** talks briefing | **In-water activity:** coral watch | **Lecture 3:** equipment building | **In-water activity:** urchin collection | **Lecture 5:** urchin measuring | **In-water activity:** seagrass | **Lecture 7:** lionfish dissection | **In-water activity:** beach clean up | **Talk preparation** |
| 1200 | **Lecture 2:** reef complexity practical | **In-water activity**: skin diver skills | **Lecture 4:** talk preparation | **In-water activity:** coral watch | **Lecture 6:** urchin measuring | **In-water activity:** invert point out | **Lecture 8:** talk preparation | **In-water activity:** seagrass | Talks session | **In-water activity:** fun snorkel/dive |
| 1500 | **In-water activity:** skin diver skills | **Lecture 2:** reef complexity practical | **In-water activity:** fish point out | **Lecture 4:** talk preparation | **In-water activity:** urchin return and invert point out | **Lecture 6:** SVS analysis | **In-water activity:** Rapid Reef Assessment | **Lecture 8:** talk preparation | **In-water activity:** fun snorkel/dive | Talks session |
| **Evening** | Opwall Science Talk | | Science Talk | | Pub Quiz | | Science Talk | | Free Night | |

Table 2. Indicative timetable for students completing the Caribbean Coral Reef Ecology Course. Note there may be changes to this itinerary depending on fitness of students, weather conditions or operational issues on site and the exact order of activities throughout the week may differ from the proposed timetable below. The timetable outlined above is an example of how a week on site may look – the exact details will vary.

# 10. PADI Open Water Diver Course

This course consists of three different elements of learning; dive theory (knowledge development), confined water dives and open water dives. Each component plays its own role in the students' development to meet the performance requirements and objectives they need to become a qualified diver.

Please be aware that as a part of the PADI Open Water Course, all students will be required to complete some basic stamina tests on site. Student divers will need to demonstrate that they can comfortably maintain themselves in water too deep in which to stand by completing a 10-minute swim/float without using any swimming aids. Students will also have students complete a 200m continuous surface swim or a 300m swim with mask, fins and snorkel.

| Day | Activity |
|---|---|
| Wednesday pm | Arrive Utila/Roatan |
| Thursday am | Dive documentation and dive theory |
| Thursday pm | Confined water |
| Thursday evening | Dive theory |
| Friday am | Dive theory |
| Friday pm | Confined water |
| Friday evening | Evening presentation |
| Saturday am | Caribbean Reef Ecology lecture |
| Saturday pm | Open Water 1 |
| Saturday evening | Caribbean Reef Ecology lecture |
| Sunday am | Open water 2 |
| Sunday pm | Open water 3 |
| Sunday evening | Dive theory exam |
| Monday am | Open water 4 & Dive certification |
| Monday pm | Caribbean Reef Ecology lecture |
| Monday evening | Social night |
| Tuesday am | Depart Utila/Roatan |

Table 4. Indicative timetable for students completing the PADI Open Water Course. Note there may be changes to this itinerary depending on progression through the course, fitness of students, weather conditions or operational issues on site.

# 11. PADI Open Water Referral Course

For those students who have completed both the dive theory and confined water sessions prior to expedition they can complete their PADI Open Water Referral Course on site. The students will first complete a check dive with their instructor to demonstrate that they still remember and can confidently perform the necessary skills to progress on to complete their open water dives.

Referral students will have completed all of their dive theory and confined water dives before coming out to the field. This means that they will have time on site to join the Caribbean Reef Ecology course and to get involved with the lectures and practicals that have been outlined in section 9.

# 12. Links to A-levels

The following two tables highlight how your Opwall expedition relates to the AS and A-level syllabuses across all exam boards. The red and blue blocks indicate that the keywords listed are covered on our expedition (through lectures, practical's or in discussion topics) and that these keywords are also within AS or A-level topics as shown.

| Topic | Biology | AQA | | C | CCEA | | C.Int | | Ed/Sal | | OCR | | SQA | | WJEC | | AP | IB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Levels: S=AS 2=A2 H =Highers | S | 2 | | S | 2 | S | 2 | S | 2 | S | 2 | H | AH | 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 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 | ◆ | | ◆ | ◆ | | | ◆ | | | | ◆ | ◆ | ◆ | | ◆ | ◆ | ◆ |

Table: Highlighted in Black are topics that you might experience at your research site. Key: C = Cambridge. Pre-U, C.int = Camb. Int. CCEA = N.Ireland; Ed/Sal = Edexcel Salters, S= SQA ; Edex = EdExcel ; IB = International Bacc; AP=Advanced Placement (v. 20/11/14).

| Topic | Geography, APES and ESS | IB ESS | APES | AQA | | CCEA | | Edex | | OCR | | WJEC | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Geography | | | | | | | | | |
| | Levels: S=AS 2=A2 | | | S | 2 | S | 2 | S | 2 | S | 2 | 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 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<br>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: Highlighted in Black are topics that you might experience at your research site. Key: C = Cambridge. Pre-U, C.int = Camb. Int. CCEA = N.Ireland; Ed/Sal = Edexcel Salters, S= SQA ; Edex = EdExcel IB ESS = Env Systems and Societies; APES = Advanced Placement Env. Science (v. 20/11/14).

# 13. Reading and Research Questions

Many students are now involved in producing Independent Research Projects (IRP) 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 task in which they carry 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.

This booklet also contains detailed information on the research projects you will be involved in and this may help you to locate your particular area of interest.

The type of IRP 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 this 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

## How does it work?

Once you have an idea send an email to schoolresearchprojects@opwall.com with your initial ideas and contact details so that one of the academic staff working with Opwall can contact you to discuss possible research questions. We can also send you further information to help you choose a suitable title for your research site. Once you have decided on a title you will then be asked to complete a registration form (supplied on request) which we can then forward to the appropriate country manager or scientist. This will then inform those at the research site about what you are hoping to achieve plus for us to give you as much assistance as we can. In some cases we will also be able to provide you with data sets from previous years which some students will find very useful.

**Deadlines:** Although each school will be operating their own schedule we would like registrations to be competed at least 3 months before their expedition begins although the earlier the better.