Opwall Schools' Booklet
Bay Islands 2022

Contents

1. Study Areas and Research Objectives

The Bay Islands region is made up of eight large islands and 53 smaller islets found at the southern extent of the Mesoamerican Barrier Reef (MAR) in the Western Caribbean. The MAR is the second largest barrier reef in the world and stretches 1000 km along the coast of Central America from the northern tip of the Yucatan Peninsula, through the coastal waters of Belize and Guatemala, and down to the Bay Islands, which lie 15-60 km off the coast of mainland Honduras.

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

Utila

Utila is part of the Honduran Bay Islands and is 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.
- 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 Parks 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 the ecosystem architects 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. Bay Islands Expedition Activities

The students will complete six days of training and research in marine science in either Utila or Roatan, followed by a further six days in the remaining site with a day allocated for travelling between sites.

During the first week, students have the option of completing their PADI Open Water dive qualification (see section 2.1). If students are already dive trained or opting to snorkel they will immediately begin the Caribbean Reef Ecology course (see section 2.3). A third alternative is to complete the theory and confined water practicals before coming out and then completing 4 open water dives on-site to achieve the PADI Open Water qualification, moving on to the reef ecology course for the remainder of the week. This is known as an Open Water Referral Course (see section 2.2).

During the second week, newly certified divers will progress on to the Caribbean Reef Ecology course (see section 2.3). Those students who have completed this course in their first week will complete a week of survey techniques and data collection (see section 2.4).

3. 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. An example schedule has been outlined in Table 1.

4. 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 2.3.

Table 1: 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.

Time	Thursday	Friday	Saturday	Sunday	Monday
0700	**Theory:** Knowledge Development 1	**Theory:** Knowledge Development 3	**Theory:** Knowledge Development 5	**Lecture 7:** Mangroves and Seagrass **Activity:** Lionfish	**Talks Preparation**
1000	**Theory:** Knowledge Development 2	**Dive:** Confined Water 1+2 **Activity:** 15 Minute Float	**Dive:** Open Water 1	**Dive:** Confined Water 4	**Dive:** Open Water 3
1200	**Activity:** Equipment Set-Up	**Theory:** Knowledge Development 4	**Theory:** Final Exam	**Lecture 8:** Future of Reefs **Activity:** Microplastics	**Talks Session**
1500	**Activity:** 200m Swim Test	**Dive:** Confined Water 3	**Dive:** Open Water 2	**Dive:** Confined Water 5 Activity: Skin Diver	**Dive:** Open Water 4
Evening Activity	Science Talk	Documentary	Trivia Night	Science Talk	Free Night

5. Caribbean Reef Ecology

Table 1 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, to be presented at some point throughout the two-week expedition.

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

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.

Time	Thursday	Friday	Saturday	Sunday	Monday
0700	**Lecture 1:** The Blue Planet **Activity:** Talks Briefing	**Lecture 3:** Coral Reef Conservation **Activity:** Quadrats	**Lecture 5:** Diversity II **Activity:** Video Analysis	**Lecture 7:** Mangroves and Seagrass **Activity:** Lionfish	**Talks Preparation**
1000	**Dive:** Check Dive **Snorkel:** Skin Diver	**Dive:** Coral ID **Snorkel:** Coral ID	**Dive:** Urchin Collection **Snorkel:** Urchin Collection	**Dive:** Seagrass Survey **Snorkel:** Seagrass Survey	**Dive:** Reef Assessment **Snorkel:** Reef Assessment
1200	**Lecture 2:** Introduction to Coral Reefs **Activity:** Reef Complexity	**Lecture 4:** Diversity I **Activity:** Beach Clean	**Lecture 6:** Diversity III **Activity:** Urchin Practical	**Lecture 8:** Future of Coral Reefs **Activity:** Microplastics	**Talks Session**
1500	**Dive:** Coral Watch **Snorkel:** Coral Watch	**Dive:** Invert ID **Snorkel:** Invert ID	**Dive:** Fish ID **Snorkel:** Fish ID	**Dive:** Fish UVC **Snorkel:** Fish UVC	**Dive:** Fun Dive **Snorkel:** Fun Snorkel
Evening Activity	Science Talk	Documentary	Trivia Night	Science Talk	Free Night

6. Survey Techniques and Data Collection

Those students who complete the Caribbean Reef Ecology course in their first week will spend their second week assisting our scientists with data collection across a variety of research projects, via either diving or snorkelling. This may include, but is not limited to:

- Underwater Visual Census (UVC): this standardised survey technique gives students the opportunity to use the ID skills gained from the Caribbean Coral Reef Ecology course to assess the abundance and diversity of fish populations in the study system.
- Line intercept video surveys: students will use videographic techniques to film benthic transects in-water. Videos will then be uploaded and analysed back on land to quantify the relative abundances of key benthic components, including hard and soft corals, macroalgae and sponges.
- Macro-invertebrate belt transects: students swim in a zig-zag pattern 1m either side of a 50m long transect to create a survey area of 100m2. All macro-invertebrates encountered within this area are recorded, including abundances of the keystone herbivore *Diadema antillarum* (the long-spined sea urchin).
- 3D modelling: using single GoPro cameras, students will film 2x2m benthic quadrats. The video can then be uploaded and manipulated to create a 3D model of the underlying reef architecture from which key measures of habitat structure are calculated. These data can be used in conjunction with those collected on the biodiversity surveys to identify the drivers of abundance and diversity in the study system.
- Lionfish dissection: fortunately, lionfish are relatively rare around the Bay Islands as culling programmes implemented by the well-established dive industry have kept their numbers low. However, students may have the opportunity to work with lionfish scientists to dissect individuals and gather key data pertaining to their stomach contents, sex and level of maturity. All these data are important for assessing the efficacy of grass-roots culling initiatives throughout the Caribbean.
- Urchin biometrics: *D. antillarum* will be removed from the reef and brought back to site where key biometric information, such as weight, test (body) diameter, mouth diameter, and length of longest spine, will be recorded. These biometrics will support the in-water abundance data and provide key information about the underlying health of the urchin populations.

Throughout both weeks, students will meet regularly with Operation Wallacea scientists who will give talks about the specifics of their research projects. Alongside the educational courses and surveys, students will be expected to complete an independent research project over the course of their two-week expedition and will present their findings to the group at the end of their second week.

7. 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.

Table 4: 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	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 5: Highlighted in Black are topics that you might experience at your research site. Key: IB ESS = Env Systems and Societies; APES = Advanced Placement Env. Science (v. 20/11/14)

Topic	Environmental Science APES and ESS	IB ESS	APES	UK Geography A Levels AQA, Edexcel, eduqas and OCR
Evolution, Classification and DNA	Evolution; Speciation; Species; Endemism; Gene pool; Allopatric; Sympatric; Isolation; Variation; Adaptive radiation Adaptation; Wallace; Darwin	◆		There has been a complete revision of UK Geography A levels. Although our expeditions are possibly not going to be as relevant to Geographers as they are to Biologists there are a significant number of topics covered by the various examination boards in which matching occurs with reference to: • human impact on ecosystems • ecosystems in general • biodiversity • sustainability • fair trade • work of NGOs • deforestation • GIS • carbon trading • climate change • case studies linked to biomes such as rainforests. All exam boards expect experience of field investigation techniques, statistical use and data manipulation which are very relevant to their experiences whilst on location at their expedition site. Almost all boards now require an independent investigation by students which fits really well with the present IRPs although the topic chosen must relate to their exam syllabus so topics such as the REDD scheme are possible choices. Their IRPs are between 3,000 and 4,000 words and should take up 4 days minimum to achieve. AQA have defined primary data as "Primary data is defined as unmanipulated data, either collected in the field or a raw dataset" which will work well with past data sets and the research data they help to collect when on their expedition. Specific detailed exam board matching is available on request.
	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			

8. Reading and Research Questions

IRPs or Individual Research Projects

In the last few years an increasing number of students joining our research programmes take this opportunity to undertake IRPs. These research projects take many different forms, but what they all have in common is the need to pose and answer a research question. Examples of these include Extended Project Qualification (EPQ), Extended Essay (EE) for IB, as well as many different projects specific to various education systems worldwide.

We can support a selection of different topics for either essay-based research projects or data-led research projects that are tailored towards what the students will experience on site. It is a fantastic opportunity for a student to witness first-hand many of the aspects of their research question and, in many cases, they will have access to samples of past datasets for their project. Students may also have the opportunity to talk with the actual scientists involved which will give them a convincing 'slant' to the way in which they answer their research question.

For success with IRPs, careful planning is needed by the student and a lot of the work will be done prior to their expedition. They will need close guidance from their school supervisor, and the scientists in the field need to be briefed so that support can be provided where they can. If you or your students are interested in undertaking a research project with us, you should contact schoolresearchprojects@opwall.com.

For more information visit the Opwall website - https://www.opwall.com/schools/educational-benefits/independent-research-project/.