Opwall Schools' Booklet
Fiji 2017

Contents

1. Study area and research objectives

This expedition is split between two main field sites on the Fijian Island of Vanua Levu in the South Pacific. The first week is spent at a forest camp within the lowland tropical forests of the Island. The second week is spent at the Natewa Bay Marine Research Centre within Natewa National Park.

Figure 1. Map of Fiji showing main locations student with stay or transit through

Fiji is comprised of a group of mountainous islands in the South Pacific, 1,300 miles (2,000km) northeast of New Zealand. The islands of Fiji were formed approximately 150 million years ago through volcanic activity. In fact, most of mountains in Fiji are dormant or extinct volcanoes. Fiji's climate is warm and tropical year-round, even in the islands' "winter" months. The average temperature in Fiji is 25°C (77°F), but it can climb to above 30°C (86°F) in summer (December and January) and sink to 18°C (64°F) in winter (July and August). Heavy rains (up to 304 cm or 120 inches annually) fall on the windward (south-eastern) side, covering these sections of the islands with dense tropical forest.

Only 106 of the 332 islands and 522 islets, which make up the Fijian archipelago, are permanently inhabited. The two largest islands are Viti Levu and Vanua Levu and between them they make up 87% of Fiji's landmass. The Operation Wallacea research site is based on the island of Vanau Levu which is the second largest island in the archipelago and covers just over 30% of the country's land area. Despite its size, this island is home to only 15% of the Fijian population.

The tropical forests of Fiji contain some of the richest communities of flora and fauna of all the oceanic islands of the Pacific. Moreover, their unusual biogeographical history, complex topography and relative isolation has led a large number of the species found in Fiji to be endemic. Over half of all Fiji's vascular plants are endemic, many of which are confined to a single island or single site, including some of the world's most primitive plant species. Twenty-five birds occur only in Fiji and most of the reptiles,

amphibians, bats, and invertebrates are unique to the islands. Because many of the species found in Fiji are restricted to only one or a few islands, they are vulnerable to human disturbance.

3,300 to 4,000 years ago the islands of Fiji's were first colonised by Polynesians and Melanesians. The current population of Fiji stands at approximately 880,000 and is rapidly growing. A rapidly growing population is often a key driver of deforestation. The FAO Global Forest Resource Assessment (2010) estimates Fiji's forest cover to be 56% of the total land area (1,014,0800 ha). Alarmingly, since the 1960's about 15% of the forests in Fiji have been completely cleared. 87.9% of the land is Fiji is communally owned as "iTaukei land" through traditional Fijian landowning units called Mataqali (pronounced matangali). As such, the state have limited control over land use or have the ability to designate protected areas or reserves. In Fiji, approximately only 68 km2 of moist forest is currently protected in reserves. This reserve system protects less than 1% of remaining forests and there is a strong need for reserves on islands to protect regional endemics.

In 2013 the Nambu Conservation Trust decided to create the first Fiji National Park on their mataqali land. This was an important step since >95% of the best remaining forest on Fiji is mataqali land. The neighbouring mataqali also agreed to put their land into the newly formed Natewa National Park so that the park area now encompasses 2000 ha of rainforest. There has been considerable interest from surrounding mataqali in extending this national park to include traversing and sustainable use rules onto other further high conservation value forests in the Natewa tribal district, which would result in a national park that covers a significant part of the quality conservation land on the Natewa peninsula. However in order to demonstrate to the remaining mataqali that the creation of a national park can lead to income for those communities, it is proposed to start in 2017 with the day tourist visits and biodiversity research in just the 2000 ha of the declared National Park. Once that is established the income generation and research activity will be spread to the remaining areas of the proposed expanded Park.

One of the best ways of generating income from protecting forests is to use funding sources such as REDD+ where a forest is packaged according to the carbon value, biodiversity and societal benefits and regular payments are made from a REDD+ fund to maintain the forests in their present condition. The REDD+ funds are provided by wealthy nations to the forestry departments of developing countries to ensure the forests are maintained and the carbon saved from not logging the funded forests is then counted towards the donor nations national carbon budgets. The objective is to complete the data collection to submit a REDD+ application for the forests of the Natewa District. In 2017 the REDD+ data collection protocols will be developed in the current borders of the Natewa National Park and initial data collected on this area. However, in future years the concept is to spread the survey work to the remaining forests indicated on the map below as REDD+ application forests.

The research objectives for the first year of the forest project are:

- To establish a series of permanent vegetation plots using a stratified random design to reflect the different vegetation communities within the Park
- To gather data on the carbon levels and forest structure from these plots
- To sample arthropod fauna of the Park using a variety of techniques and to complete identifications using genetic bar coding
- To provide baseline data on the population levels of the endemic birds within the Park
- To collect data on the herpetofauna and bat communities within the Park

- To establish the carbon, biodiversity and societal impact survey protocols that will produce data for the REDD+ scheme within the Park and which can be extended to the remaining forested areas in future years

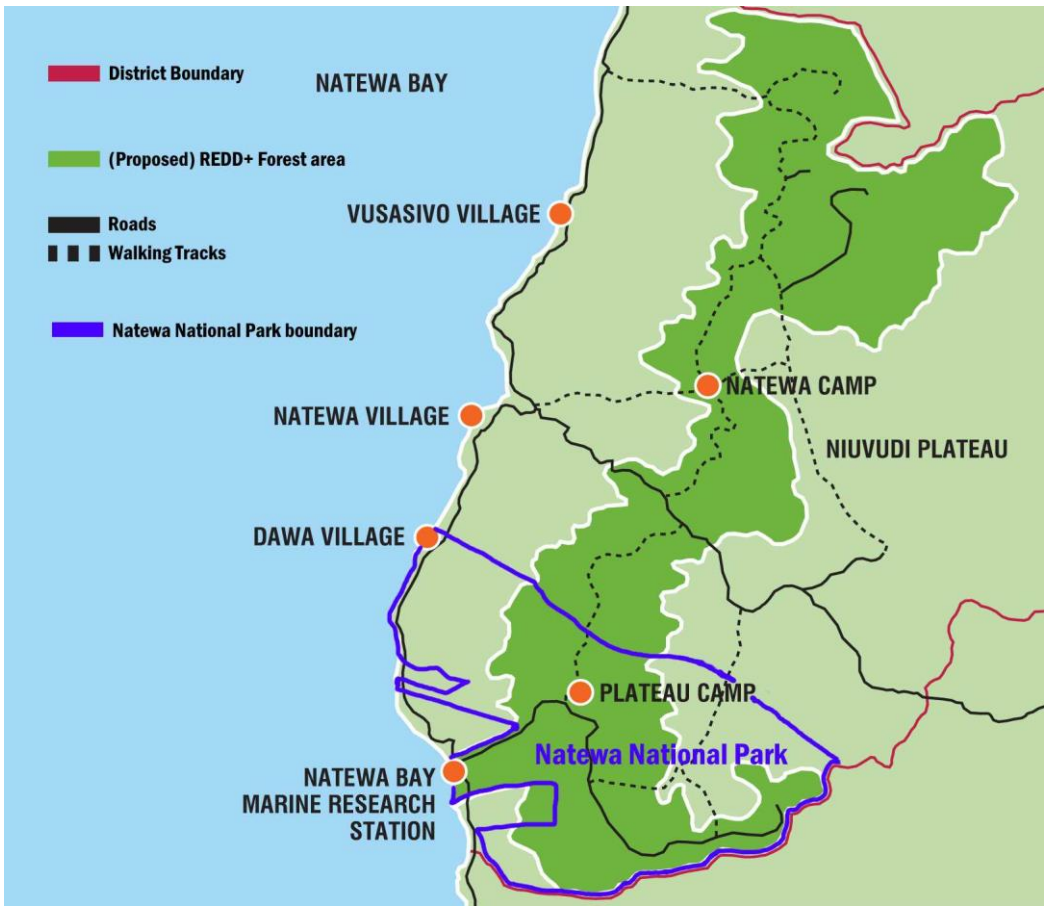

Figure 2. Research locations in Fiji – week 1 will be spent at the Plateau camp and one week will be spent at the Natewa Bay marine research station

The Peninsula is geologically and biologically an 'almost island' that is 60km long and averages over 10km wide. At its eastern end it is 10km from Taveuni Island, and at its western end (where it is connected by a narrow neck of land to Vanua Levu) the peninsula is only half a kilometre wide. The Natewa Peninsula is the wildest remaining area in Fiji with forests still containing some of the largest native trees and with the highest floristic and faunal diversity in the Fijian islands. It is also home to a number of the Fijian endemic species including the Silktail Flycatcher which is found only on the peninsula and in one small island offshore.

The Fijian Archipelago hosts a highly diverse and extensive marine environment encompassing an array of different marine habitats including; barrier and fringing coral reefs, mangroves, deep pelagic areas, and eelgrass beds. These habitats are considered to be internationally important sites for marine biodiversity and support numerous fish species, turtles and nesting seabirds. It is argued that the coral reefs of this region have some of the most species rich assemblages in the world. The waters of the Fiji contain 3.12% of the World's coral reefs including Cakaulevu, the Great Sea Reef, which is the third largest coral reef in the world. Marine life includes over 390 known species of coral and 1,200 varieties of fish of which 7 are endemic. Currently 25% of Fiji's waters have some form of protection or marine management plan.

Natewa Bay, which at over 1000 km^2, is the largest bay in the South Pacific, bounds the northern part of the Natewa Peninsula. This bay has very low levels of fishing pressure and some superb reefs. Moreover, due to geological faults the centre of the bay is over 1,000m deep. Amazingly, no biological surveys have ever been completed on this bay. The Natewa National Park is keen to investigate the biodiversity of the bay and use the data collected to make a World Heritage site. The first step in this process is to establish a marine research centre and the students on this expedition in 2017 will be contributing to getting the marine research and training centre launched. In addition scientists at the centre will be completing an initial scoping exercise to determine the monitoring programme that will be run from 2018 onwards.

2. Week 1 itinerary for Schools at the Forest Camp

Groups arrive in Fiji on the Saturday before their expedition officially starts on the Sunday afternoon. Groups will arrive into Nadi and overnight at a hotel. The following day groups will then take an internal flight from Nadi to Labasa where they will be picked up by bus for a couple of hours to the pretty coastal town of Savusavu where they will have lunch. After lunch the bus will travel the remaining 2 hours to Vusa Ratu Village arriving in the late afternoon on the Sunday. To enable acclimatisation to the area and rest before trekking into the forest, groups will enjoy a home stay with the local community in a traditional Fijian village for the first two nights.

On the Monday at the start of the expedition all the newly arrived groups will spend the day in the Fijian village learning about local culture, customs, and agricultural practices. There will be lectures and practical demonstrations about the natural and cultural history of Fiji during this day. In addition there will be health and safety briefings and the students on site from the various schools will be divided into 4 smaller teams of 4-8 students. Students will stay in these small group when participating in biodiversity surveys (you see more animals if you enter the forest in small groups), but groups may join together again for lectures and meal times.

In the early morning of the second day the group will trek up the hills onto the forest plateau at around 800m above sea level and will be staying in a forest camp for the next 4 nights. An example weekly timetable is set out below (Table 1).

Different groups of students will join different biodiversity surveys each day to ensure that all students get the chance to work with each of the different teams. The normal schedule will be a dawn start for the groups working with birds or mammals, around 8am for those working with herpetofauna or habitat and around 10am for those setting butterfly traps. These teams will then be back at camp mid to late morning with a bit of rest time before lunch. Straight after lunch there will be a lecture followed by afternoon data collection (birds, butterflies, reptiles, amphibians, and habitat). The teams return to camp for dinner and after dinner some students (those who are not scheduled to start early the next day) will be scheduled to participate in nocturnal surveys for herpetofauna or arthropods. This schedule has been designed to avoid data collection in the heat of the day because physical activity at this time of day can be exhausting and because animal activity is extremely low at this time. These options will be interspersed with lectures, talks and practical sessions.

Table 1 – Indicative timetable for the first week. 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.

Day	Activities team A	Activities team B	Activities team C	Activities team D
Sunday afternoon	Welcome lecture Health and safety briefings			
Sunday evening	Lecture 1: Island biogeography and endemism Home stay in traditional Fijian village			
Monday	Talks and practical demonstrations of Fijian culture, customs and agriculture			
Monday evening	Lecture 2: Ecology of Fiji endemics Homestay in traditional Fijian village			
Tuesday morning	Early morning trek up to forest camp (2 -4 hrs) and camp orientation			
Tuesday afternoon	Forest structure and carbon surveys	Arthropod pitfall, flight intercept and pooter surveys	Herpetofauna trapping	Bird mist netting
Tuesday evening	Rest	Light trapping for arthropods	Spotlight surveys for amphibians	
Wednesday morning	Bird transect surveys	Forest structure and carbon surveys	Arthropod pitfall, flight intercept and pooter surveys	Herpetofauna trapping
Wednesday lunch	Lecture 3: Survey Techniques			
Wednesday afternoon	Bird mist netting	Forest structure and carbon surveys	Arthropod sample sorting	Herpetofauna trapping
Wednesday evening		Rest	Light trapping for arthropods	Spotlight surveys for amphibians
Thursday morning	Herpetofauna trapping	Bird transect surveys	Forest structure and carbon surveys	Arthropod pitfall, flight intercept and pooter surveys
Thursday lunch	Lecture 4: Threats to island species and recent extinctions			
Thursday afternoon	Herpetofauna trapping	Bird mist netting	Forest structure and carbon surveys	Arthropod sample sorting
Thursday evening	Spotlight surveys for amphibians		Rest	Light trapping for arthropods
Friday morning	Arthropod pitfall, flight intercept and pooter surveys	Herpetofauna trapping	Bird transect surveys	Forest structure and carbon surveys
Friday lunch	Lecture 5: Successful conservation initiatives on Pacific islands			
Friday afternoon	Arthropod sample sorting	Herpetofauna trapping	Bird mist netting	Forest structure and carbon surveys
Friday evening	Light trapping for arthropods	Spotlight surveys for amphibians		Rest
Saturday morning	Trek to marine site (2 hrs)			

3. Forest Structure 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.

Habitat surveys will be conducted in each of 20m x 20m survey sites to investigate tree diversity and forest structure. On each transect the first plot will be located at 200m, the second at 600, the third at 1000m, the fourth at 1400m and the fifth at 1800m along the transect line. The number of saplings (trees with circumference $<$15cm and a minimum height of 2 metres) will be counted for each plot. For each tree in the plot with a circumference $>$15cm, the circumference at breast height (which will be converted to DBH), whether the tree is alive or dead, and the tree species, will be recorded on datasheets. Where species cannot be identified in the field, photographs of leaves, fruit (if available leaves and bark will be taken for later identification from textbooks. If identification is not possible from photographs, then samples may be taken from the tree at a later date for full examination. CBH will be measured using 50m tape measures. The number of fallen trees and cut stumps in the plot will also be recorded.

Forest structure measurements include understorey vegetation, canopy cover and leaf litter depth. To measure understorey vegetation, the plot will be bisected to produce the four quadrants. A 3m pole marked in 0.5m segments will be used to 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 then each of the 0.5m segments will be recorded and having vegetation touches. The openness of the canopy will be measured 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 has 25 dots engraved on the square. The observer should look upwards holding the square 20cm from the eye count the number of dots that coincide with gaps in the canopy to give a score out of 25. Leaf litter depth should also be recorded in each of the 4 quadrants and in the centre of the plot using a ruler to give 5 separate leaf litter measurements (mm) per plot.

4. Biodiversity Monitoring

Arthropod surveys

This team aims to increase the species lists for the island for target taxa. Much of the invertebrate fauna of Fiji is under studied and there are undoubtedly many new species awaiting discovery. Arthropods will be surveyed from sweep net searches, flight intercept traps and pitlines. A light trap will be set to monitor nocturnal invertebrates such as moths and night flying insects. 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. Typically, the team will spend half a day working out in the field and then half a day in the laboratory at the research camp sorting and identifying the specimens collected.

Herpetofauna surveys

Herpetofauna data will be collected using active searching along the forest transect lines between 9.30am-1pm (to monitor diurnal species) and between 7.30pm-11.30pm (to monitor nocturnal species). Searches will be conducted along the transect line and up to 2m either side of the transect line. The duration of the survey and total distance travelled will be recorded for each survey in order to calculate relative abundance of species that incorporates survey effort. For each animal observed the species will be identified, the GPS location and distance travelled along the transect will be recorded along with the time, weather conditions and habitat type. Wherever possible, the animal will be captured in order to mark for recapture (scale clipping of reptiles only) and to record additional information before releasing the animal in the same location as capture. For each animal captured the sex, age (adult or juvenile), weight (g), the length of the animal (SVL), length of the head, and length of tail (were relevant) and colouration (camouflage or aposematic) will be recorded. In addition the animal will be photographed in situ (back, head and side).

For cryptic species difficult to record via active scan search various capture methods will be used. Pitfall and funnel traps will be arranged at various sites. Pitfall and funnel traps will be arranged in a Y shape consisting of 3 buckets buried flush with the ground surface, a fence of mosquito netting to connect the buckets and a funnel trap at the end of each fence (3 funnel traps in total). The traps will be left in-situ each night and will be checked for captures each morning. For each capture, the sex, age (adult or juvenile), weight (g), the length of the animal (SVL), length of the head, and length of tail (were relevant) and colouration (camouflage or aposematic) will be recorded. In addition the animal will be photographed in situ (back, head and side).

One of the main factors affecting the abundance of herpetofauna, birds and other small mammals is the presence of mongoose. Mongoose are not thought to have penetrated into the upper reaches of the Park but in order to determine the extent of their presence, a network of traps will be set from sea level up to the plateau. In addition small mammal traps will be set to determine the presence or absence of other species.

Bird surveys

Bird data will be collected using point counts and mist netting. The point count surveys will be completed between 05:00am and 09:00am. If it is raining heavily or there are strong winds the survey should be cancelled. On all surveys the weather conditions at the time of the point count should be recorded. Point counts of birds (by sight or call) will be conducted at 10 different points along the transect a 200m intervals. No settling down period should be allowed with counts starting immediately. Then over the next 10 minutes for each species the following details should be recorded: species, number of individuals, whether the bird(s) was seen or heard, and the approximate distance of the bird from the observer (recorded at 5m intervals). A minimum of 4 repetitions of each transect in each camp is required to ensure that data collected is representative of the population.

The abundance and diversity of understory birds will also be assessed using mist nets. Mist nets are unable to sample canopy and mid-canopy species adequately, but does allows for quantitatively reliable data to be produced for tropical understory birds, allows for the identification of birds that are shy or seldom vocal, minimises observer bias, and produces results that are easily repeatable. Mist nets surveys will run 5 days per week at each research camp using a suitable existing clearing along one of the sample routes with enough space to erect two 12m long mist nets 2.5 meter high. The location of this mist net site will be marked and the GPS location recorded. All mist netting will be conducted at various sites in the forest. Mist netting with occur in the afternoons between 4.00pm and 6:00pm.

The opening and closing time of the nets will be recorded each session and nets will be checked every 20 minutes for the duration of the survey. When birds are found in the net, the time of capture will be noted. The birds will be taken out of the net, placed in a cotton bag for holding whilst other birds are being processed. Ringing will be used to control for recaptures. The birds will be weighed (to the nearest gm) and standard morphological measurements taken. The birds will be released close to the net site but far enough away to avoid them being immediately re-trapped.

The point count and mist net data will be used to calculate the abundance of endemic species such as the Silktail – an endemic flycatcher found only in the Natewa forests and a nearby island.

5. Pacific Island Ecology lectures

Lecture 1 Island Biogeography and Endemism

- Geography of South Pacific islands (Melanesia, Micronesia, Poynesia) and how they formed
- Waves of human settlement in Melaneia, Micronesia and Polynesia and the influence this had on the native fauna
- Ecological associations between groups of islands in the region
- What is a species followed by a brief look at the process of evolution and the importance of islands in this process.
- How you can predict the numbers of species on any island dependent on its distance from the mainland, its size and physical complexity
- The formation of Fiji and the differences in species composition between the islands

Lecture 2 - The Biodiversity and Biogeography of Fiji

- Endemism and Fiji and ecology of key endemic species
- Habitat types on Fiji
- A summary of recent biodiversity research on Fiji
- Recent extinctions on Fiji and the impact of the mongoose releases
- Nature conservation initiaives on Fiji

Lecture 3 – Survey techniques

- Sampling arthropods using pitfall, flight intercept, light and pooter traps
- Genetic bar coding as a method of speeding up identification of arthropods
- Standard search times, pitllines and spotlighting to survey herpetofuana
- Soundscape analysis methods for surveying birds, amphibians and Orthopetera
- Point and transect counting for birds and why mist nets reveal only a subsample for the species present
- Camera trapping using mark release recapture and randomencounter model models
- Distance sampling as a method of surveying species that can be seen

Lecture 4 – Threats to Pacific islands and recent extinctions

- Habitat destruction on Pacific islands
- Introduction of alien species – rats, goats, pigs, mongoose on Fiji, brown tree snake on Guam
- Introduced diseases and invertebrate pests that have caused problems on Pacific islands
- Arrival of Man on tropical Pacific islands and extinctions of species
- Extinctions in recent times

- The IUCN Red Data threat classifications
- Which Fiji species are classified as Endangered

Lecture 5 – Successful conservation stories from the South Pacific
- Sovi Basin Conservation Area (Fiji),
- Tetepare Island and Bauro Highlands Conservation Area (both Solomon Islands),
- Takitumu Conservation Area (Cook Islands),
- Pohnpei Island (Federated States of Micronesia),
- Adelbert Ranges (Papua New Guinea)
- How the RED+ scheme works and the potential benefits to the Natewa Peninsula
- Why Biosphere Reserve status would benefit Natewa Bay and how to achieve the status

6. Learning outcomes from week 1

The students should achieve the following learning outcomes from the fieldwork, practical's, lectures and discussions/activities:
- Be able to define and understand the main Fijian habitats.
- Have an insight into the ecological and cultural heritage of Fiji
- Understand the meaning of Biodiversity and the importance of the area as a biological hotspot.
- Consider how island species may have evolved and spread.
- Understand the importance and use of taxonomy and classification in field research work.
- Use (taxonomic) keys to identify taxa amphibians and reptiles (and understand how different populations are determined from field data.
- Understand the impact of alien/invasive species on island populations.
- Understand the threats and conservation issues in Fiji
- Be able to describe the biology of birds and identify common island species.
- Describe and carry out important survey techniques for invertebrate and freshwater fish populations.
- Understand how conservation works with particular reference to Fiji as a case study.
- Consider the impacts of humans on the flora and fauna of Fiji
- Have an understanding of the interaction between an organism's physiology and it's ecological function, distribution, behaviour and phylogenetic history.

7. Week 2 Itinerary

The students will complete six days of training in marine ecology at Natewa Bay Marine Research Centre. The work of Operation Wallacea is helping to establish a marine research centre and groups will be staying in two-person tents with views of the bay.

At Natewa Bay Marine Research Centre the students have the option of completing their PADI Open Water dive qualification (see section 12). If they are already dive trained or don't want to learn to dive then they can do the Pacific Island Reef Ecology Course (with the practical's done either by diving or snorkelling – see section 10). A third alternative is to complete their theory and confined water practicals before coming out and then just do their 4 open water dives to achieve the PADI Open Water qualification (see section 12) and then move onto the reef ecology course. Students will be occupied in the evenings through a series of science talks, documentary viewings and discussions/activities relative to the ecology course.

8. Coral Reef Ecology Course

Table 2 shows an example timetable of the activities that students undertaking the Pacific Island Coral Reef Ecology Course will complete over the week. The contents of the timetable are comprehensive but the timing of the sessions will vary for each group. The practical element of the reef ecology course can be completed by either 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 Pacific Island Coral Reef Ecology course is designed specifically with 16 – 18 year old high school students in mind. It covers a range of topics suitable to support A-Level and international equivalent biology and geography students over a range of different syllabuses. Lectures will be supported by in-water practicals. In addition to the lectures, a discussion/activity element will be sure to engage the students and get them thinking themselves of the importance of the study topic.

Table 2. Indicative timetable for students completing the Pacific Island 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.

Day	Schedule for reef ecology students
Saturday afternoon	Welcome lecture Allocation to groups for diving and practical sessions Dive documentation
Saturday evening	Lecture 1 – Introduction to coral reef ecology Designation of mini projects
Sunday morning	Check dive/snorkel Lecture 2 – Identification of coral and algal Species
Sunday afternoon	Dive/snorkel practical 1 – algal identification skills
Sunday evening	Lecture 3 – The importance of mangrove and seagrass habitats
Monday morning	Dive/snorkel practical 2 – coral identification skills Lecture 4 – Identification of ecologically important invertebrate species
Monday afternoon	Dive/snorkel practical 3 – coral identification skills
Monday evening	Lecture 5 – Identification of coral reef fish
Tuesday morning	Dive/snorkel practical 4 – invertebrate identification skills Lecture 6 – How to survey a coral reef
Tuesday afternoon	Dive/snorkel practical 5 – fish identification skills
Tuesday evening	Lecture 7 – Global threats to coral reefs
Wednesday morning	Dive/snorkel practical 6 – fish identification skills Lecture 8 – Methods to protect the world's coral reefs
Wednesday afternoon	Dive/snorkel practical 7 – practice transect survey
Wednesday evening	Lecture 9 – Conservation project strategies
Thursday morning	Fun Dive/Snorkel
Thursday afternoon	Practice transect dive/snorkel
Thursday evening	Mini project presentations
Friday morning	In water activities via snorkelling
Friday afternoon	Packing
Friday evening	Documentary/film viewing
Saturday am	Depart Natewa Bay Marine Research Centre

Lecture 1: Introduction to Coral Reef Systems

- Why are coral reefs important?
- What are coral reefs and how are they formed?
- Where are coral reefs found?
- Types of coral reefs
- The different zones of a coral reef
- Reefs of Fiji

Activity 1: General feedback session on dive skills and their experience on the reef.
Practical 1: 'Reef Structure and Topography': Check dive/snorkel – PADI Skin Diver course with DM

Lecture 2: Coral Reef Primary Production

- Competition for space on coral reefs
- Scleractinian (hard) corals as ecosystem architects
- Macroalgae (seaweed) distribution, morphology, and their use of pigments
- What happens when the balance between corals and algae goes wrong?

Activity 2: Primary Productivity Quiz
Practical 2: Coral and algal identification skills (DIVING/SNORKELLING)

Lecture 3: The Importance of Coral Reef Fish

- The coral reef food web
- Identification and ecology of common reef fish families
- Common Pacific reef fish species
- Feeding guild examples and key species
- Specialists
- Fisheries exploitation

Activity 3: Fish Quiz
Practical 3: Fish identification skills (DIVING/SNORKELLING)

Lecture 4: Coral Reef Invertebrates

- What is an invertebrate?
- Taxonomy
- Marine invertebrate feeding ecology
- Common marine invertebrates found on coral reefs
- Case study: The Crown of Thorns Starfish

Activity 4: Reef Invertebrate Quiz
Practical 4: Invertebrate identification skills (SNORKELLING)

Lecture 5: How to Survey a Coral Reef

- Why do we survey coral reefs?
- Which method(s) to use?
- Rapid habitat surveys
- Benthic and invertebrate assessment techniques
- Fish assessment techniques
- Measuring abiotic factors
- The use of technology
- The Operation Wallacea reef monitoring program

Activity 5: Survey Design Challenge

Practical 5: Underwater survey techniques 1 (DIVING/SNORKELLING)

Lecture 6 – The Ecology of Seagrass and Mangroves
- The ecology of tropical seagrass beds
- Seagrass importance and threats
- The ecology of mangroves
- Mangrove importance and threats
- Habitat connectivity

Activity 6: Debate: Hotel Owner versus Conservationist
Practical 6: Underwater survey techniques 2 (DIVING/SNORKELLING)

Lecture 7: Global Threats to Coral Reefs
- What should a healthy reef be like?
- Anthropogenic impacts on coral reefs(overfishing, pollution, tourism . . . .)
- Natural impacts on coral reefs(temperature, storms, disease, acidification . . . .)

Activity 7: Discussion Activity: The Global Aquarium Trade
Practical 7: Assessing coral reef health (DIVING/SNORKELLING)

Lecture 8: Marine Conservation
- The value of coral reefs (re-visited)
- Top down management (MPAs, zonation, ICZM)
- Bottom up management (ownership, education, community involvement)
- Alternative livelihoods

Activity 8: Fun Quiz!
Practical 8: Fun Dive!

9. 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. Instructors will also have students complete a 200m continuous surface swim or a 300 m swim with mask, fins and snorkel.

Table 3. 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.

Day	Activity
Saturday morning	Welcome lecture Allocation to groups for diving and practical sessions Dive documentation
Saturday afternoon	Dive theory
Saturday evening	Lecture 1 – Introduction to coral reef ecology
Sunday am	Confined water
Sunday pm	Confined water
Sunday evening	Dive theory + lectures
Monday am	Confined water
Monday pm	Open Water 1
Monday evening	Dive theory
Tuesday am	Open water 2
Tuesday pm	Open water 3
Tuesday evening	Dive theory exam
Wednesday am	Open water 4 & Dive certification
Wednesday pm	Fun dive!
Wednesday evening	Lecture 9 – Conservation project strategies
Thursday morning	Fish ID Dive
Thursday afternoon	Fish ID Dive
Thursday evening	Mini project presentations/Documentary
Friday morning	In water activities via snorkelling
Friday afternoon	Packing
Friday evening	Documentary or 'Trivia Night'
Saturday am	Depart Natewa Bay Marine Research Centre

10. 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.

Once referral students have successfully completed the final stages of their PADI Open Water course, they will be able to progress on to the Coral Reef Ecology course Although there will not be enough time to run the full course, referral students will be able to join at a stage where they can get the chance to learn about the application of survey techniques in the marine environment and how that supports the management of coral reefs.

11. Academic Benefits

Apart from the most obvious values of going on an expedition such as contributing towards conservation, the physical challenge and adventurous travel, the experience can also benefit a student by increasing their chances of gaining entry to university or being successful in a job application and impressing at interview. This can be achieved in many different ways but it will often depend upon which country and educational system a learner is from. Common to most countries the experience will:

- Enhance their understanding of course syllabuses
- Allow learners to gain specific qualifications such as:
- Research Qualifications e.g. Extended Essays for IB and UK EPQs
- University Course Credits
- Creativity, Action and Service (CAS) for IB
- Universities Award from ASDAN

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 many education systems worldwide.

We are able to support the dissertation essay style research question; however individual scientific investigations (in which students design and collect their own data) are more difficult to facilitate given the short amount of time students are present on-site.

It is a great 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.

Much of the research they will be able to get involved with is specific to their expedition location. The projects that students will come into contact with range from students helping to collect data through to working and learning alongside the scientists where primary data collection by school students is less practical or more difficult.

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. We have now developed an application system to ensure that the student will be able to realistically undertake such a project, that their choice of topic is appropriate to their expedition site, the science staff 'on-site' are aware of the project and where practical can assist in a constructive way before, during and after their expedition.

For more information visit the Opwall website - http://opwall.com/sixth-form-high-school/independent-research-projects/

Relevance of their expedition to the syllabus

Specific specifications for Biology, Geography and Environmental Studies have been reviewed for over 10 examination boards from around the world to see how relevant a student's expedition experiences will be when related to what they learn in their classroom. The tables in the appendix section show how this matching works although not all topics are relevant to all sites so have been grey-out.

12. Additional Reading

Most of the following are available from: http://www.nhbs.com or http://www.amazon.co.uk

General travel guides:
Lonely Planet Fiji: 7th edition (June 2006)
ISBN: 1741042887

The Rough Guide to Fiji: November 3, 2014
by Rough Guides
ISBN-10: 1409351335

Wildlife:
Fiji's Natural Heritage (Hardcover) May 2002
by Paddy Ryan
ISBN: 0908988141
(Written for the general reader as well as for the natural history enthusiast, Fiji's Natural Heritage is the only book that provides a comprehensive overview of Fiji's rich biodiversity. The Fiji Islands have a large number of endemic species. These and the introduced species are illustrated and described with their common, scientific and Fijian names given.)

A Guide to the Birds of Fiji and Western Polynesia: including American Samoa, Niue, Samoa, Tokelau, Tonga, Tuvalu and Wallis and Futuna.
By: Dick Watling
Paperback | Dec 2004 | Edition: 2 | #150272 | ISBN: 9829030040

Pocket Poster Guide to the Birds of Fiji - Volume 1 – Landbirds
By: Dick Watling
Poster | Dec 1999 | #99085

Pocket Poster Guide to the Birds of Fiji - Volume 2 - Sea and Shorebirds
By: Dick Watling
Poster | Dec 1999 | #99087 | ISBN: 9829030024

Reptiles and Amphibians of the Pacific Islands: A Comprehensive Guide
By: George R Zug
Paperback | Jul 2013 | #203590 | ISBN-13: 9780520274969

Palms of the Fiji Islands
By: Dick Watling

Paperback | Dec 2005 | #153678 | ISBN: 9829047024

Flora Vitiensis Nova: a New Flora of Fiji (Spermatophytes Only) - Comprehensive Indices Vol 6
By: Albert C Smith
Hardback | Dec 1996 | #182118 | ISBN: 0915809222

Reef and Shore Fishes of the South Pacific: New Caledonia to Tahiti and the Pitcairn Islands
By: John E Randall
Hardback | Jul 2004 | #144130 | ISBN: 0824826981

Fiji's Wild Beauty - A photographic guide to coral reefs of the South Pacific (Paperback) by Achim Nimmerfroh
Publisher: Nimmerfroh Dive Productions (12/2006)
Language: English
ISBN: 978-3-925919-82-4

Coral Reef Fishes: Indo-Pacific and Caribbean (Paperback) Dec 2001
by Ewald Lieske, Robert George
ISBN: 0691089957

Ecology, Conservation and Culture:
Climate Change in the South Pacific: Impacts and Responses in Australia, New Zealand, and Small Island States – Vol 2
Edited By: Alexander Gillespie and William CG Burns
ISBN 978-0-306-47981-6

Terrestrial Ecoregions of the Indo-Pacific: A Conservation Assessment
By: Eric Wikramanayake, Eric Dinerstein and Colby J Loucks
Series: World Wildlife Fund Conservation Assessment Series
Paperback | Dec 2001 | #122051 | ISBN: 1559639237

The Pacific Islands: Environment and Society
By: Moshe Rapaport
Paperback | Apr 2013 | Edition: 2 | #204506 | ISBN-13: 9780824835866

Biodiversity and Societies in the Pacific Islands
By: Sébastien Larrue (Editor), Arthur Lyon Dahl
Paperback | Apr 2013 | #209145 | ISBN-13: 9782853998772

Prehistory in the Pacific Islands: A Study of Variation in Language, Customs, and Human Biology
By: J Terrell
Paperback | Jun 1988 | #34038 | ISBN: 0521369568

Other:
Marine Life of Fiji & Tonga DVD (Region 2): A Video Identification Guide
By: Josh Jensen and Liz Harlin
DVD | region 2 | Apr 2007 | #166986

13. Appendices

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

Table 1: Biology

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 2: Geography and Environmental Science

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 which are to be first examined in 2017. 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 avaailable 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; WoodlandBush; 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			