



**Opwall Schools' Booklet  
Fiji 2020**

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## 1. Study area

This expedition is based on the Natewa Peninsula 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 whilst the second week is spent at the marine research centre that has been established by the Opwall teams on the peninsula.

*Figure 1. Map of Fiji showing main locations students 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 Vanua Levu which is the second largest island in the archipelago and represents 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 means that a large number of the species found in Fiji are endemic. Over half of all Fiji's vascular plants can be found nowhere else, and many 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.

The Fiji Islands were first colonised 3,300 to 4,000 years ago the islands of Fiji's 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) estimated Fiji's forest cover to be 56% of the total land area (1,014,0800 ha). Alarming, since the 1960's about 15% of the forests in Fiji have been completely cleared. Most (87.9%) of the land in Fiji is communally owned as "iTaukei land" through traditional Fijian landowning units called Mataqali (pronounced matangali). As such, the state has limited control over land use and not much capacity to designate protected areas or reserves. In Fiji, only approximately 68 km<sup>2</sup> of moist forest is currently protected in reserves. This reserve system protects less than 1% of remaining forests, and as such there is a strong need for an expanded network of reserves encompassing many islands in order to protect regional endemics.

The Natewa Peninsula, where the field sites are located, 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 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 Natewa Silktail; a bird which is exclusively confined to the Peninsula.

## 2. Research and Conservation Objectives

### Results of the first three years of survey and plans for the next five years

In 2013 the Nambu Conservation Trust decided to create a community managed National Park on their mataqali land (mataqali are land owning family groups). Note this move was against a background of continuing deforestation of the Peninsula's forests to make way for more plantations of Kava or to harvest previously planted mahogany. This move to protect, rather than exploit, the forest was an important step given that >95% of the best remaining forest on Fiji is on mataqali land. The neighbouring Vusaratu mataqali also agreed to include their land in any protected area development and to participate in these surveys. In 2017 the first surveys were conducted in this area by the Opwall teams and these concentrated mainly around the Natewa forest camp. In 2018 and 2019 teams became much more mobile and began to explore other areas of the peninsula and the results from these three years of surveys were published as a report on the biological value of the Natewa peninsula (see <https://www.opwall.com/uploads/2020/01/The-Biological-value-of-the-Natewa-Peninsula-V2.pdf>).

The main findings of the first three years of the Opwall surveys are:

- The Natewa Peninsula encompasses approximately 55000 ha of the south-eastern section of Vanua Levu, Fiji, and retains large expanses of tropical lowland and hill forest.
- The biodiversity of the Peninsula possesses an extremely high conservation value. To date, a total of three native mammal species, 51 bird species, 12 herpetofauna species, 25 butterfly species, 61 gastropod species, and 84 tree species have been detected in the study area.
- This diversity is impressively representative of species assemblages across Fiji as a whole, given the size of the study area. The Natewa peninsula comprises only around 3.1% of the total land area

of the Fijian archipelago, but 59% of terrestrial birds, 50% of native terrestrial mammals and 40% of reptiles known to occur nationally have been found here.

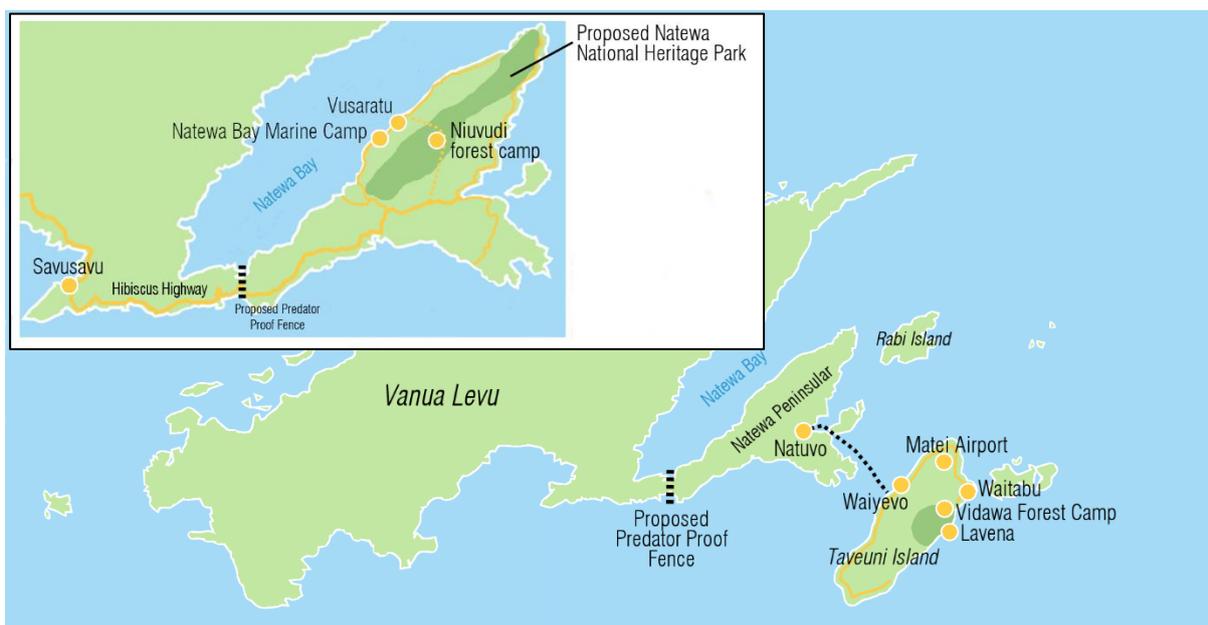
- Faunal groups in the Natewa Peninsula also display high incidence of endemism, with 31.3% of birds (15 species), 25% of herpetofauna (three species) 24% of butterflies (six species) 36.1% of gastropods (22 species) and 31% of trees (26 species) found here being entirely restricted to the Fijian archipelago.
- Numerous species are also very locally endemic to the study area. These most notably include the Natewa Silktail bird (*Lamprolia klinesmithi*) and Natewa Swallowtail butterfly (*Papilio natewa*), which are both entirely restricted to the study area. Note the Natewa Swallowtail butterfly described by the Opwall teams is the first new swallowtail butterfly described to science in over 50 years and wasn't discovered as expected from somewhere like the Amazon or Borneo but from a remote forest site in Fiji!
- A further six species and five sub-species found in the study area are endemic to Vanua Levu and its offshore islands.
- The forests of Natewa also provide valuable ecosystems services, both locally to communities living in the Peninsula via flood prevention, soil protection and crop pollination, and also to global society through the carbon stocks they sequester. Initial analysis put carbon stock estimates in the study area at 20,732,148 metric tons.
- The diverse ecological communities of the Natewa Peninsula are, however, highly threatened by anthropogenic pressures. Unregulated deforestation and forest degradation is extensive in the study area. Introduced Cane Toads, rodents, and most significantly the Small Indian Mongoose (*Herpestes auropunctatus*) also represent a serious threat to ground-nesting birds, reptiles, and other native wildlife. Between 175,000 and 400,000 mongooses are estimated to occur on the Peninsula.
- The urgent conservation status of biodiversity here (and the Fijian archipelago generally) is demonstrated by the number of threatened species present in the Natewa Peninsula. One native mammal, two herpetofauna species, and two tree species are considered by the IUCN to be globally Endangered. A further two bird species, one lizard, six gastropods, and two trees are considered to be Vulnerable, and one mammal, one bird, two gastropod and one tree species are considered to be Near-threatened. Particularly notable examples of threatened species include the Endangered Fijian Free-tailed Bat (*Chaerephon bregullae*), the Vulnerable Natewa Silktail (*Lamprolia klinesmithi*), and the Shy Ground Dove (*Alopecoenas stairi*).

In addition to the 2019 biodiversity research surveys (the 2019 survey report can be seen at <https://www.opwall.com/uploads/2020/01/Fiji-Terrestrial-Report-2019.pdf>), significant effort was put into consulting with the 52 local mataqali (that between them account for most of the landownership on the peninsula) about the possibility of the Opwall programme being expanded to other communities. Consultations were also completed regarding the creation of a national park, or similar protected area, on some of the best remaining forest to drive tourism visits and generate income to the local communities. This consultation process led to unanimous support for the concept of expanding the Opwall programme and developing ecotourism visits; signed letters from all mataqali on the peninsula were obtained

supporting this concept. Since that point the Fijian government has given FJD500,000 to the University of South Pacific (USP) who have the leading biodiversity research teams in Fiji to work with the Opwall teams to help design the new national park and identify the biodiversity value of such a protected area. Opwall has therefore applied for a 5-year research permit to help with this proposal and also to help develop ecotourism visits to the peninsula.

As part of the ecotourism development, it was agreed to expand the Opwall programme and utilise facilities in different communities as well as the Niuvudi forest camp and Natewa Bay marine camp (managed by Vusaratu). In 2019 basing small groups at the village of Dakuniba was trialled and was a great success, so for 2021 onwards it was agreed that numbers of those participating in the Opwall programme would be increased and a second marine camp established at Dakuniba. Similarly, a second forest camp was agreed to be based in Moana from which it would be much easier to access the largely unexplored northwestern tip of the peninsula.

Taveuni Island which lies parallel to the Natewa peninsula has in many ways pioneered the community-based tourism approach around the creation of a protected forest area that Natewa is trying to replicate. The New Zealand government helped fund the linkage of three existing different types of protected area into a single Taveuni national park covering 110km<sup>2</sup> and to then train and help local communities surrounding the newly created park to provide different activities for tourists visiting the new park. In more recent times, after funding from New Zealand stopped, the level of financial benefit from ecotourism by these communities has declined. In order to provide some assistance to the Taveuni communities in continuing their ecotourism activities and to encourage interchange of ideas between the Taveuni and Natewa communities, Opwall has agreed over the next 5 year period (starting in 2021) to expand the intake of students on the Opwall programme so that there are also annual survey teams working from Vidawa for the forest surveys and Waitabu for marine surveys. Taveuni is an excellent comparative site to Natewa because it has not introduced the Small Indian Mongoose, which has caused biodiversity impacts on Natewa and also has a small ecotourism industry centred around the Taveuni national park, whereas in Natewa the Opwall teams make up 100% of the visitors at the moment. Note there are daily ferries from Natuvo on Natewa to Waiyevo on Taveuni so it is possible for teams to move between Natewa and Taveuni with relative ease.



*Figure 2. Research locations in Fiji for the 2020 – 2024 period*

Part of the next 5-year research permit objectives should be to complete funding applications with local universities and NGO's to reduce or eliminate the mongoose on Natewa. If a national park were to be created then reduction or elimination of any invasive species that has significantly reduced the native amphibians, reptiles, ground birds and snail fauna would be a useful step. However, simply removing mongoose from the peninsula would only be a temporary measure unless repopulation from the rest of the island was prevented. The Glenelg Trust, a wetland biodiversity protection NGO from Australia are working with Opwall and the Wallacea Trust to investigate the cost and funding for installing an invasive proof fence across the narrow neck of the peninsula in the same manner has been done extensively in parts of Australia and New Zealand. The lead scientist from the Glenelg Trust on the Natewa project was the person responsible for designing the Yorke peninsula project in Australia (see <http://theleadsouthaustralia.com.au/environment/feral-proof-fence-drives-biodiversity-revival/>).

In addition to the development of ecotourism activity and the submission of funding applications to reduce or eliminate the invasive species on the peninsula, another method of providing long term funding for local communities is to protect their forests through the REDD+ scheme. This is 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 protecting the forests is then counted towards the donor nations' national carbon budgets. Fiji has now signed up to the REDD+ scheme so could benefit from such donations. 20+ years ago much of the native forest on the Natewa peninsula had additional mahogany trees planted within the forest and there is now pressure from the Forestry department to harvest these trees. The REDD+ scheme provides a potential alternative income source and by not harvesting the trees there is significant carbon being saved and funding for protection of the forests could come through the REDD+ scheme. The Opwall teams have already completed detailed forest structure and carbon estimation on 100+ plots from different forest types across the peninsula and over the next five years additional carbon survey plots will be completed and the data from these surveys used to submit a REDD+ funding application.

To attract a significant increase of visitor numbers to the new Natewa national park, the development of a functioning dive centre so that the visitors can snorkel or dive on the reefs in Natewa Bay is important. During the first three seasons of the Opwall programme Ocean Ventures a locally run dive operation was established. Over the next 5 year period the idea would be to invest in the research equipment needed to complete quantitative assessments of the reef fish communities and coral reefs in this bay, which is claimed to be the largest bay in the South Pacific, but to date has had no peer reviewed publications on the marine ecology and value of the reefs

## **2020 Forest Survey Objectives**

- To date 114 plots 20m x 20m have been surveyed by Opwall teams for carbon levels and forest structure. In 2020 the objective is to increase the coverage of the peninsula in different forest

types and levels of disturbance to increase to at least 200 plots which should then allow the carbon storage across the peninsula to be estimated more accurately.

- One of the most important bits of information that has been requested by the University of South Pacific team that is charged with identifying the boundaries and economic benefits of a new Natewa Park, is understanding how the local communities utilise and benefit from the flora of the reserve. One of the objectives for 2020 is to complete a survey of a range of villages on the peninsula to gather ethnobotanical data.
- To date, only one population of the Natewa Swallowtail (*Papilio natewii*) has been discovered and gaining a better understanding of whether this species is truly limited to a tiny area of the peninsula is crucial. If so, it will probably qualify as the most threatened of all the surviving Swallowtail species. Data needs collecting on the food plants being used and their distribution across the peninsula and the whole of their range will need to be included within the proposed new national park boundaries. In addition a plan for the conservation of this species is being developed during 2020.
- To date, there have been expert led surveys of butterflies, land snails and spiders with a Natewa collection of butterfly and spider specimens due to be analysed by specialists at the Natural History Museum in London to describe additional species new to science or new records for the peninsula. The 2020 invertebrate surveys will concentrate on surveying Diptera using a range of sampling techniques to increase the species list of this Order from the peninsula. Having extensive lists of various species is a necessary step in proving the biological value of the Natewa peninsula.
- Analysis of point count data from the first 3 years work on the Natewa Peninsula suggest the population of the Natewa Silktail may be as low as 4000 birds, which is well below the previous estimates of 6000 – 12,000 birds. Additional point count data are needed particularly from areas with differing levels of forest disturbance because this species is negatively impacted by forest disturbance levels. Any additional observations on the breeding behaviour and success rates of the Natewa Silktail would be useful and an output from this years' survey work should be a proposed conservation plan for the species.
- Additionally, the standardised point count surveys need to be continued to census trends in local bird communities over time and also to determine relationships between avifauna community composition and habitat disturbance in the study area. This will allow for the first empirical appreciation of how forest clearance and degradation impacts upon Fijian bird communities; a key outcome in understanding the consequences of continued habitat destruction in the archipelago.
- Additional exploration of the forests needs to be completed both to confirm the presence of Yellow billed Honeyeater (recorded from Dakuniba and a new species for the peninsula) and the relative abundance of Friendly Ground Dove which appears to have been reduced by the presence of mongoose on the peninsula. In addition, the extinction of the Long-legged Warbler not recorded since 1973 from Vanua Levu needs to be confirmed from checking some of the very steep slopes that form the habitat for this species on Viti Levu.
- The constant effort mist netting also needs to be continued so data on plumage configuration, breeding times, movement patterns and longevity of endemic Fiji bird species can be established.

- The estimate of mongoose numbers on the peninsula vary from 175,000 to 400,000 animals and obtaining more precise data on the population levels of this invasive species and the impact it is having on the native fauna will be an important element of future funding applications for their removal from the Natewa Peninsula.

## 2020 marine research objectives

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<sup>2</sup>, 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. Whilst the Natewa Bay is not being proposed at this stage to be part of the new Natewa national park, it is likely to form a major additional attraction for visitors to the new national park. Having both a marine and a forest element to the proposed National Park would make the Park a more popular destination for visitors.

To date the surveys have resulted in species lists for the fish communities and identified a range of reefs to be monitored annually to determine changes. In 2020 the objective is to complete the following surveys:

- To describe from stereo video analyses, the fish communities in terms of species, abundances and size classes at 5m and 15m below Spring low water mark associated with a series of reefs around the Bay.
- To complete coral intercept surveys of the reefs studied for the fish communities to determine coral cover and distribution and abundance of macro-invertebrate species.
- To complete 3D mapping of the reefs studied for the fish communities to determine the physical complexity of the reefs (rugosity, fractal complexity etc).
- To use the Allen standardised methodology to provide data on the Bays' reefs to the international coral atlas project.

### 3. Camps and travel to sites



Figure 3 Camps for 2020

The groups will all arrive together at Labasa airport on the Sunday lunch at the start of the expedition and will follow one of the following itineraries:

#### Expedition structure: Vusaratu homestay, Niuvudi camp and Natewa Bay Marine Camp

These groups will travel by bus on the Sunday and have a late lunch in Savusavu before travelling on by bus to Vusaratu village to spend Sunday and Monday night. On the Tuesday the groups will be dropped at the foot of the mountains and will trek up to Niuvudi camp arriving on the Tuesday lunch. From Tuesday lunch until Sunday morning the groups will be based in the Niuvudi camp and will complete a series of different surveys. On the Sunday they will be taken by vehicle to the Natewa Bay Marine Camp they will spend the second week, leaving early Saturday morning to be taken by bus back to Labasa airport to arrive by midday on the Saturday

### 4. Week 1 forest itineraries

School groups will follow the example timetable below. The groups will be split into 5 groups (ethnobotany, forest structure and carbon, Lepidoptera and Diptera, birds and mongoose surveys) of 5 – 6 students who will rotate between each of the different activities. The timetable below is for one of these groups and the other groups will complete the same activities albeit in a different order. Timetables will also vary slightly dependent on group size, and depending on fitness of students, weather conditions or operational issues.

Table 1. Example timetable in week 1

Day	Activity
Sunday evening	Arrive at Vusaratu. H&S talks and site orientation
Monday am	Practical demonstrations of Fijian culture, customs and agriculture
Monday pm	Practical demonstrations of Fijian culture, customs and agriculture
Monday evening	Intro lecture: Making the Natewa national park a reality
Tuesday am	Trek to Niuvudi

Tuesday pm	Ethnobotany surveys
Tuesday evening	Lecture 1: Geography, geology and island ecology in the Pacific
Wednesday am	Bird point count surveys
Wednesday pm	Bird mist net surveys
Wednesday evening	Lecture 2: Dispersal and colonisation
Thursday am	Forest structure and carbon surveys
Thursday pm	Forest structure and carbon surveys
Thursday evening	Lecture 3: Terrestrial biodiversity
Friday am	Mongoose surveys
Friday pm	Mongoose surveys
Friday evening	Lecture 4: Humans, extinctions and invasions
Saturday am	Lepidoptera and Diptera surveys. Those on camp combination 3, leave for Labasa
Saturday pm	Lepidoptera and Diptera surveys
Saturday evening	Lecture 5 – Disturbance and climate change End of forest week party
Sunday morning	Transfer to Natewa Bay marine site

### ***Forest structure and carbon surveys***

This team will be completing detailed forest mensuration in 20m x 20m squares in different forest types. 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.

### ***Ethnobotany surveys***

This team will be visiting different villages across the peninsula. With translators, the students will be helping the researcher by taking notes in response to questions about how wild plants are being used and harvested for food, building materials and medicines. In particular, details of what plant parts are being used, how are they being used, how are they collected and how often, what time of year are they harvested, is the entire plant harvested, how are the products, foods, medicines etc. prepared and by whom? The teams will also be collecting voucher specimens for confirmation of identifications.

### ***Lepidoptera and Diptera surveys***

The Lepidoptera part of this team has the objective of determining whether the newly described *Papilio natewii* which to date has been discovered from only one small area around the Niuvudi forest camp has populations elsewhere across the peninsula. This will involve checking areas for the food plant of the species and also completing butterfly sweep net surveys to determine the butterfly communities. In 2019 a number of new butterfly species records were added to the peninsula and it is possible that there are still more species to be discovered. In addition, collections will be made of Diptera specimens from a range of sites across the peninsula using a variety of methods: sweep netting, light traps, pitfall traps, flight intercept traps etc. Specimens captured will be brought back to camp for sorting into families.

### ***Bird surveys***

Bird data will be collected using point counts from around the Niuvudi forest camp to compare the data with the previous surveys and on new transects established around the Moana camp. Each point count site should be a minimum of 200m apart and at least 3 replicates of each of the point count sites around the Niuvudi camp will be repeated during the season. In addition, though transects and new point counts will be completed once during the season in a range of different forest types across the peninsula. The point count surveys will be completed early mornings for the repeated transects and over a 10 minute period 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 0 -25m, 25 – 50, 50 -100m and >100m intervals). For the non-repeated transects the bird transects can be completed at any time of day but the timings to be recorded so MacKinnon lists can be made to determine the average length of time to see each species. During these surveys any chance observations of nesting sites for Fiji endemic species should be noted.

The plumage characteristics, breeding times, site fidelity and longevity of some of the endemic Fijian bird species will also be assessed using mist nets at constant effort sites around the Natewa camp. Mist nets surveys will run using a suitable existing clearing along one of the sample routes with enough space to erect six x 12m long mist nets 2.5 meter high. The location of this mist net site is marked and the GPS location recorded. 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), standard morphological measurements taken and New Zealand ring attached. The birds will be released close to the net site but far enough away to avoid them being immediately re-trapped.

### ***Mongoose surveys***

This team will be setting baited live funnel traps for mongoose. All mongoose captured will be injected with a PIT tag which has an individual number and released. The traps will be set on a grid basis and after a few days moved to another forest area and re-set. After a few days the traps will be returned to the original survey site but the traps placed in different positions to those of the original grid and the trapping

continued. All captured mongoose will be scanned to determine whether they have been previously tagged and released. Untagged animals will be injected with a PIT tag and released. The data will be used to estimate the densities of mongoose in different habitats so the estimate of the population size can be refined. All animals captured will be released. The droppings of the captured animals will be collected and later analysed to identify food types eaten by the mongoose.

### ***Pacific Island Ecology lectures***

This lecture series has been prepared by Professor Martin Speight from Oxford University and is based entirely on published papers on Pacific Islands over the last 10 years. The examples given in the lectures are referenced to primary sources and there are full notes below each slide. The teachers will have a copy of these lectures and the PowerPoints so that these can be repeated, if required, back at school or delivered to other classes that did not join the expeditions. The lectures however, will be delivered as a series of stories, rather than including all the details of each publication, so that the students gain an understanding of the ecology of the islands.

### ***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 and understand the main Fijian habitats.
- Have an insight into the ecological and cultural heritage of Fiji.
- 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 such as butterflies and birds (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 identify common island bird species.
- Describe and carry out survey techniques for butterflies and other macro-invertebrates.

## **5. Week 2 itinerary – marine week**

At Natewa Bay Marine Centre, the students have the option of completing their PADI Open Water dive qualification or if they are already dive trained or don't want to learn to dive then they can do the Pacific Reef Ecology Course (with the practicals done either by diving or snorkelling. Note some of the practicals involve working with the marine biologists on site. 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 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.

### **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 2. 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
Sunday am	Welcome lecture and allocation to groups for diving and practical sessions
Sunday pm	Dive documentation and dive theory
Sunday evening	Lecture: Marine biodiversity in the Pacific
Monday am	Confined water
Monday pm	Confined water
Monday evening	Dive theory + lectures
Tuesday am	Confined water
Tuesday pm	Open Water 1
Tuesday evening	Dive theory
Wednesday am	Open water 2
Wednesday pm	Open water 3
Wednesday evening	Dive theory exam
Thursday morning	Open water 4 & Dive certification
Thursday afternoon	Fun dive!
Thursday evening	Lecture 9 – Conservation project strategies
Friday morning	Fish ID Snorkel
Friday afternoon	Fish ID Snorkel
Friday evening	Lecture – Pacific Island marine conservation in practice
Saturday am	Depart for Labasa airport early morning

## Coral Reef Ecology Course

Table 3 shows an example timetable of the activities that students undertaking the Pacific 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 3. 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.**

<b>Day</b>	<b>Schedule for reef ecology students</b>
Sunday am	Welcome lecture and allocation to groups for diving and practical sessions
Sunday pm	Dive documentation and practical 1 - check dive
Sunday evening	Lecture – Marine biodiversity in the Pacific Pacific Island Reef Ecology lecture 1 - Introduction to coral reef systems
Monday morning	Pacific Island Reef Ecology lecture 2 – Coral reef primary production Dive/snorkel practical 2 – coral and algal identification skills
Monday afternoon	Pacific Island Reef Ecology lecture 3 – The importance of coral reef fish Dive/snorkel practical 3 – coral reef fish identification skills
Monday evening	Pacific Island Reef Ecology lecture 4 Coral reef invertebrates
Tuesday morning	Dive/snorkel practical 4 – Invertebrate identification skills
Tuesday afternoon	Pacific Island Reef Ecology lecture 5 – How to survey a coral reef Dive/snorkel practical 5 – Underwater survey techniques
Tuesday evening	Pacific Island Reef Ecology lecture 6 – Mangroves and seagrass
Wednesday morning	Dive/snorkel practical 6 – Underwater survey techniques
Wednesday afternoon	Pacific Island Reef Ecology lecture 7 – Global threats to coral reefs Dive/snorkel practical 7 – Methods for assessing reef health
Wednesday evening	Pacific Island Reef Ecology lecture 8 – Marine conservation
Thursday morning	Dive/snorkel practical 8 – completing a coral intercept survey
Thursday afternoon	Dive/snorkel practical 9 – completing an Allen survey for coral reef health
Thursday evening	Practical 10 - Lab session analysing stereo video fish data
Friday morning	Preparation for mini presentations
Friday afternoon	Mini presentations
Friday evening	Lecture – Pacific Island marine conservation in practice
Saturday am	Depart for Labasa airport

### **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:** Coral intercept survey

## 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.

## 6. 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 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](mailto:schoolresearchprojects@opwall.com).

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

### ***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.

## **7. 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 – Land birds**

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



	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			◆				◆			◆	◆				◆	◆	
<b>Agriculture, Human activities, Conservation and Sustainability</b>	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																	
<b>Behaviour</b>	Animal behaviour; Primate Social behaviour; Courtship; Territory; Co-operative hunting; Herbivores; Grazing	◆		◆	◆			◆			◆	◆	◆			◆	◆	◆

Table 2: Geography and Environmental Science - *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	APE S	UK Geography A Levels AQA, Edexcel, eduqas and OCR
<b>Evolution, Classification and DNA</b>	Evolution; Speciation; Species; Endemism; Gene pool; Allopatric; Sympatric; Isolation; Variation; Adaptive radiation Adaptation; Wallace; Darwin	◆		<p>There has been a complete revision of UK Geography A levels.</p> <p>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:</p> <ul style="list-style-type: none"> <li>• human impact on ecosystems</li> <li>• ecosystems in general</li> <li>• biodiversity</li> <li>• sustainability</li> <li>• fair trade</li> </ul>
	Classification; Taxonomy; Binomial system; Dichotomous Keys			
	PCR; Genome sequencing; Genetic fingerprinting; DNA profile			
	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	◆	◆	

<b>Ecology and Ecosystems</b>	Succession; Climax community	♦		<ul style="list-style-type: none"> <li>• work of NGOs</li> <li>• deforestation</li> <li>• GIS</li> <li>• carbon trading</li> <li>• climate change</li> <li>• case studies linked to biomes such as rainforests.</li> </ul>
	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	♦	♦	
<b>Agriculture, Human activities, Conservation and Sustainability</b>	Sustainability	♦	♦	<p>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.</p> <p>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.</p> <p>Their IRPs are between 3,000 and 4,000 words and should take up 4 days minimum to achieve.</p> <p>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.</p> <p>Specific detailed exam board matching is available on request.</p>
	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	♦		
<b>Behaviour</b>	Animal behaviour; Primate Social behaviour; Courtship; Territory; Co-operative hunting; Herbivores; Grazing			

Table 3: Australia’s Biology and Environmental Science Specifications - *Highlighted in Black are topics that you might experience at your research site.* Key: Int. IB = International Bacc (2016); IB ESS = Env Systems and Societies (2017); QSS – Queensland Biology Senior Syllabus (2019); NSW – New South Wales (2018+); VCE – Victorian Curriculum Assessment Authority (2015 for 2016-20); WA – Western Australia (2017+), SA – South Australia (2020)

Topic	Biology and Environmental Science	International IB		Australian State Education Authorities				
	Years 11 and 12	ESS	Bio	NSW	QSS	VCE	WA	SA
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		◆			◆		◆