Perhentian Ecology

2014 EXPEDITION REPORT

Authorship

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Synopsis

This report details the findings of the 2014 Expedition to the Perhentian Islands, Malaysia, by a small team of students from the University of Exeter and Falmouth University. The project was a feasibility study aimed at assessing the potential for a much larger ecological expedition in the future, with students from the aforementioned institutions.

Attempting to assess the survey sites previously used by the Coral Cay Conservation study, we discovered that significant land-use change had rendered many of them inaccessible, due to the succession of the rainforest. The growth of tourism as the dominant island industry since the previous study was undoubtedly one reason for this, with once numerous plantations being abandoned in favour of imported food.

Through testing Coral Cay's methodologies (including survey techniques), we were able to record sightings of a variety of species, including a small number who's presence had yet to be confirmed on the islands. With the vast majority of species, we were able to collect an array of video and photo evidence. Further secondary research post-expedition has revealed further species that are unconfirmed but that are known to present on the islands.

Whilst the invaluable marine environment's issues are becoming recognised through the work of *Reef Check Malaysia, Blue Temple Conservation* and *Ecoteer,* little attention has been paid to the plight of the terrestrial environment. Despite news headlines every year in the Malaysian press about litter issues, we observed that the current system is not working, leading to large amounts of litter washing up on beaches as well as being found deeper into the jungle. This issue, coupled with the rapid tourist development of the island and sewage pollution issues, leads us to warn that Perhentian's terrestrial environment is at risk of being severely compromised, with troubling ecological consequences.

Overview

Perhentian Ecology was a feasibility study carried out entirely by students from the University of Exeter and Falmouth University. The team consisted of William Burton (Geography), Simon Rolph (Conservation Biology and Ecology) and Joshua Gray (Marine and Natural History Photography). With the support of *Ecoteer*, a social volunteer enterprise based in Malaysia, and the cooperation of *Perhilitan,* the marine and wildlife authorities, the expedition was aimed at replicating a survey previously carried out by Coral Cay in 2003/2004, and assessing whether a large ecological expedition from the universities was appropriate in the future. The previous Coral Cay study was part of a wider scheme of study, using volunteer programs to create basic species indexes of most islands on Malaysia's east coast. A comparison of species and biodiversity was then made between several islands, including Pulau Redang and Tioman.

The Perhentian Islands

The Perhentian Islands are a pair of islands of the north eastern coast of Peninsular Malaysia, within the administrative state of Terengganu. There are two inhabited islands, Pulau Perhentian Besar (Big Island) and Pulau Perhentian Kecil (Little Island), as well as a series of other smaller islands. Kecil is the most developed, with the largest settlement being the fishing village in which some 2000 locals reside. The village features a limited number of shops, a fishing dock and a new mosque that is currently under development. There are resorts dotted around Kecil, however by far the highest density of these is to be found around the Northern 'Long Beach', a popular backpacking destination and the

home of Perhentian nightlife. There are a number of plantations within the rainforest on Kecil that are no longer used, and we also discovered a few abandoned resorts also. We were informed by villagers that no food is grown on the islands anymore and that it is all imported.

Pulau Perhentian Besar is a considerably larger island, featuring a great number of resorts and dive schools in particular. There are a few buildings housing support workers, but apart from this, development on Besar appears to be exclusively aimed at the tourism industry. As is to be expected, this development is centered on the beaches of Flora Bay on the Western side of the island for the most part, with the eastern side of the island remaining difficult to access due to the lack of a suitable landing beach. The rocky foreshore, bent vegetation and lack of sediment strongly suggests that this coast bears the brunt of the storms in the monsoon season. We reason that it would be easier to launch a 2 day excursion to the eastern side of Besar through the rainforest, as opposed to a potentially dangerous landing on the tiny beach on that side of the island. It is also worth noting that there is no phone signal on that coast, and thus safety and communication must be considered.

The Growth of Tourism in Malaysia

Currently, tourism is Malaysia's 3rd largest source of foreign exchange income, and is 1st in South East Asia when ranked by tourist arrivals, remaining 9th in the world. Tourism is predicted to grow globally at a rate of 4% (UNWTO), however the growth of tourism in Malaysia has consistently remained above this for a number of years. At the time of the publication of the Coral Cay study, tourist numbers for all of Malaysia were at 10.58 million, bringing in 21.3 billion ringgit in receipts. 10 years later, in 2013, 25.72 million people visited Malaysia, bringing in 65.44 billion ringgit's worth of receipts. This represents a staggering 143% increase in tourist numbers, and a 207% increase in tourist receipts, in a time period of just 10 years. It is clear, therefore, that on a national level, Malaysia has experienced a highly significant boost in tourism. Whilst these figures are on a national level, these numbers have inevitably filtered down to the Perhentian Islands, a highly popular backpacking destination in itself. Amid the surge of tourist numbers, the stakeholders on the Perhentians have been trying to reinvent the image of the islands somewhat in order to attract a different kind of clientele, in a move away from the traditional backpacker image. This is evidenced by a number of new upmarket resorts that have been opened, including the new 'Alunan Boutique Resort'.

With reportedly just one full-time fisherman left on the islands, the scale of which the economy has become dominated by the tourism trade cannot be underestimated. Whilst this can be lucrative, it does put the islands at risk from external shock factors that may dissuade visitors, such as conflict, air disasters or a global recession. During the year of our visit, MH370 disappeared and MH17 was shot down either side of our arrival. Chinese visitor numbers dipped by some 20% in April (Xinhua.net), and the military incidents in Sabah further compounded the situation. Such an annus horribilis for the Malaysian national carrier is unlikely to occur again however, and by the end of the year, tourist numbers had mostly rebounded to their original levels. Discounting a major

natural disaster, then, the Perhentian Islands do not appear to be as vulnerable to shocks as it might seem.

The Coral Cay Study

To the best of our knowledge, the Coral Cay study in 2003/2004 was the first and most extensive ecological study of the Perhentian Islands. Earlier research may exist within Malaysian University archives, however we are ultimately unaware of any other research relating to the islands in an ecological capacity.

The Coral Cay organisation is internationally renowned for science research, utilizing volunteers to carry out marine and occasionally terrestrial studies of habitat. The Perhentian Island survey was one of several along the eastern coast of Malaysia, with the group also surveying Pulau Redang and Pulau Tioman. On the website, the group states that '*Our success is based on a holistic approach within three key areas: 1. scientific data gathering in support of environmental conservation 2. community outreach and education and 3. capacity building'.* It is very important to note, however, that only the first aspect of this was completed on the Perhentians. For unknown political reasons, believed to be due to the inappropriate behavior of some volunteers, Coral Cay were asked to leave the islands. To this end, the crucial Community Outreach, Education and Capacity Building aspects of their work was not completed. This, in many ways, has unfortunately limited the usefulness of Coral Cay's work, and it has not been capitalized on to its full value.

This incident actually caused significant damage to community-foreign relations on the islands, making it difficult for any follow-up work to take place. It is only though the dogged persistence of the Malaysian volunteering NGO, Ecoteer that this barrier has been worn down. Their professionalism, high standards, and more importantly, communication with the island community itself has made further research possible once again.

Coral Cay's research on the islands provides a valuable baseline species index, as well as biodiversity comparisons between Besar and Kecil, coupled with species diversity comparisons with the other East Coast islands.

Additional work was later carried out by Dr. Lee Grismer of La Sierra University, USA. Spending time on the islands, he has discovered 2 endemic species *Cnemapsis Perhentianensis (*Grismer, 2006) and *Scincella Perhentianensis (*Grismer, 2008), as well as recording new species for the islands.

Land-Use Change

Perhaps the most significant change we recorded from the Coral Cay report to the present is not explicitly ecological, instead being more geographical, but it has inherently ecological consequences.

Through our numerous treks to reach our 22 survey sites on Besar & Kecil, we noted how significantly the economy, and therefore the land-use, had changed. The islands used to be nearly self-sufficient, with large plantations on Kecil growing various crops. The fishing village was obviously used as a major fishing dock, and though this industry still exists on the islands, it does not appear to be as major as it once was. The marked change in industry, from a more agrarian focus to near-purely tourism focus, was noted heavily throughout Kecil in particular. Several of Coral Cay's survey sites were based at plantations, and we were surprised to find that the trails to these plantations were overgrown, and, upon arrival at the plantations, each and every one was slowly being reclaimed by the rainforest, with secondary vegetation permeating the once-productive areas. A few trails were so overgrown that they were impenetrable, demonstrating the dramatic shift in just over 10 years.

Figure 2: Resort Development, Kecil

Figure 1: Deforestation, Kecil

We also discovered a few older tourist resorts that were rotting away in the jungle, though we could not confirm whether this was for economic reasons or due to land ownership issues. These were a haunt of the Long Tailed Macaque in particular. We asked locals whether any food was now grown on the islands, with one local stating explicitly that all food was now brought in from the mainland, with the exception of some fish. This underlines the dramatic shift in economy, and further demonstrates the move away from sustainability that the islands have experienced in recent years. Whereas previously, the islands catered to Malaysian cuisine, the upsurge in visitors from Europe- Germany, the UK and Nordic/Scandinavian countries in particular has led to the need for western cuisine to be provided. Western food is now widespread on the islands and will undoubtedly have had to be shipped in from the mainland. This illustrates how globalization through the growth of tourism is not only changing the economics and environment of the island, it is also influencing the culture.

Mammal Species

1. **Large Non-Volant Mammal Species**
   Long Tailed Macaque

The Coral Cay study suggested that primates had been extirpated from Kecil, however we can confirm that there is a population of Long-Tailed Macaques in existence on the islands. Whilst we are unsure as to their origin- whether they were introduced or not, they seem to have a healthy population, and, like all long-tailed macaques, showed typical territorial aggression during encounters with ourselves and other tourists alike. These primates were found on the western side of Kecil, along the pathway that circles the island. We believe that these are the only primates on Kecil, however due to their territorial nature, coupled with the ever increasing development in Northern Kecil, human-macaque conflict is likely to increase considerably. We are already aware of stories of campsites being raided, and with little known about the Macaque population, more research into the size of the population would aid any mitigation strategies that are to be put in place.

Figure 3: Long-Tailed Macaque, Kecil

Dusky Leaf Monkey

On Besar, we found the recorded population of Dusky Leaf Monkeys, which is a unique subspecies only found on that island specifically. Previous study has noted that due to their isolated and limited range, the primates are at risk of a variety of stochastic threats. These monkeys are regular sighted around the Turtle Beach on Besar, as well as on a few other trails heading a little deeper into the jungle. Further work is needed to assess the size and health population, as recommended by CITES. The species is listed as near-threatened and is thus the most vulnerable primate on the islands. With such a small range, it is imperative that research is carried out into the population, and that development encroaching on their territory is restricted. The upside of this is that the Dusky Leaf Monkey is an incredibly charismatic species, being very docile and allowing tourists incredible views. As such, they are an ideal species to focus on ecotourism efforts. The unique subspecies could become one of the Perhentian 'Big 5', and is an ideal target for guided jungle treks. We were fortunate enough to come across them both on our own transects through the jungle, and also on established trails, and they are incredibly inquisitive primates, allowing fantastic views. We recorded groups of up to 10 at a time, with at least 3 juvenile monkeys in that number.

Figure 4: Dusky Leaf Monkey, Besar

Civet

Confirming the presence of Civets on the islands were one of Coral Cay's recommendations, and this is something I was able to achieve after the expedition. Through secondary information, kindly provided by Neil Hinds at *Blue Temple Conservation (Pers Comms),* and also through social media accounts, we have been able to confirm the presence of Civets on Kecil, in the long beach area, though we were unable to make any assessments of the population. I also have a limited amount of photographic evidence from a visitor to the islands. We are aware of someone keeping a Civet as a pet, and it is possible that perhaps it has been released, but further research is required to confirm this and the potential size of the population. I have tentatively identified the civet as a Common Palm Civet.

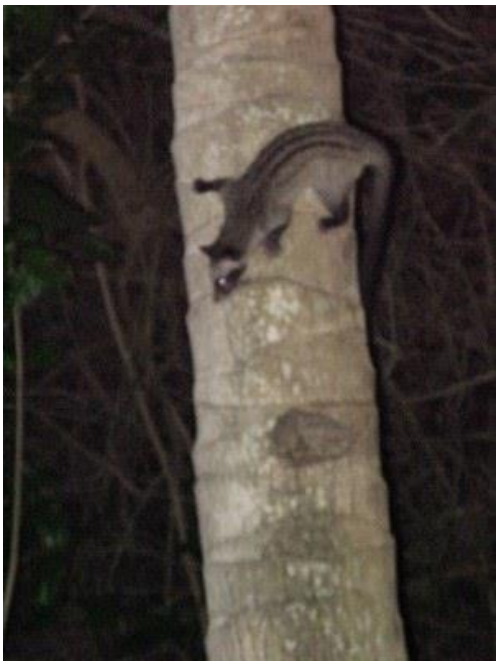


Figure 5: Common Palm Civet, Kecil

Domestic Cat

By far the most common mammal on the islands, the domestic cat can be found virtually everywhere on the Perhentians, though they are found in greatest numbers on Kecil, with the highest density found around the fishing village. It is apparent that the population is not controlled, with numerous litters of kittens, and many cats looked visibly malnourished, and fleas and ticks were very common. The effect of cats on the small mammals and avifauna of the area surrounding the fishing village has undoubtedly been significant. Whilst inevitably, some cats will have homes with locals, the size and behavior of the population has made it clear that there are numerous semi-feral cats. It is likely that the damage has already been done to Kecil to this end, but I believe that Besar should, where possible, be protected from a similar issue, as the disruptive impact of cats on ecosystems that have not been in contact with them before is well-documented. Management of this issue is undoubtedly complicated, however. In the UK, Scottish Wildcat populations have been protected from hybridization though the subsidised neutering of cats in the area, however without a commitment from the islanders, this is unlikely to be successful on the Perhentians. At the very least, discussions should take place with the fishing village community about the cat population to see if they perceive it as an issue or not.

2. Small Non-Volant Mammal Species

Rodents

Whilst small mammal surveys did not form part of our study methodology, it is worth noting that the enormous cat population (especially focused around the

fishing village on Kecil), will have inevitably had a significant impact on the small mammal population noted by the Coral Cay study.

Squirrels

The Plantain Squirrel is common on both Besar and Kecil, frequenting resorts where it has adapted to human habitation and is known to interact with tourists. We observed a different species of squirrel, believe to be the Slender Squirrel, deeper into the jungle on Besar, however we cannot confirm the identification due to a lack of photographic evidence.

Figure 6: Plantain Squirrel, Besar

3. Volant Mammal Species

Bats

The research completed by Coral Cay into the bat species of the Perhentian islands was impressive in itself, and we don't believe that their efforts could be improved upon without significant input from a Malaysian university, including in the terms of equipment. Harp netting and mist netting may produce more bat species, and any bat survey on the islands needs to use these techniques due to the presence of both new world and old world bats. An additional survey technique that has yet to be trialled on the islands is that of ultrasound analysis. The use of audio recording equipment and subsequent sound analysis, such as that offered by *Anabat* and other companies, would possibly reveal additional bat species, and would be ideal for working out presence and absence in certain areas. However, this technique obviously cannot be used for old world bats, of which there are at least 3 species on the islands.

Colugo

The Sunda Flying Lemur or Malayan Colugo is known to inhabit Perhentian Besar, and we discovered a single individual on a transect towards survey site B11 on Besar. The Colugo is commonly found close to resorts on Besar, though it is believed that they are not present on Kecil.

Figure 7: Colugo, Besar

Bird Species

Whilst the Coral Cay study found just 30 species of birds, which is already quite a low figure, we found even less. Across our jungle transects and survey sites, the most common birds were the White Rumped Sharma and Purple Throated Sunbird, which were found in good numbers across both islands. It was evident that there is a strong population of White Bellied Sea Eagles present on the islands, with numerous individuals spotted on both islands. We also located a nest near the path from the fishing village to the adjacent Petani beach. Our bird surveys were limited by strictly following Coral Cay's methodology, and also due to the fact that we were not permitted to mist net. Naturally, therefore, we didn't record as many species. We also did not spend as much time on the islands as the Coral Cay study, and undoubtedly this would have increased the number of birds sighted.

Figure 8: Female Purple-Throated Sunbird

We used a fixed point count strategy, testing this methodology coupled with stratified sampling on Kecil on numerous occasions. This method was generally effective at revealing the most common birds in the area, however it also had several drawbacks. Along popular jungle trails, such as those connecting beaches, interruptions from passersby were common, sometimes scaring species off. To this end, point counts may more effective deeper into the rainforest, off the beaten track. This technique is not entirely reliable, however, because certain species are highly unlikely to be recorded in this manner. Ground-dwelling birds such as the Nicobar Pigeon, for example, are highly unlikely to be discovered using this technique, instead requiring flush walks into the most undisturbed parts of the rainforest. Another method, mist-netting, was clearly successful in the case of Coral Cay, but was beyond the boundaries of our permit. Whilst it is somewhat obvious that intensive mist netting efforts would reveal more understory birds in the more disturbed parts of the rainforest, we also noted a number of birds in the canopy of the rainforest, that were simply impossible to identify due to the density of the canopy.

Figure 9: White Rumped Sharma

It would be highly beneficial, but logistically very difficult, to be able to place mist nets in the canopy, however it is possible and provides important ecological benefits. In the future, a combination of bird survey methods would be the most effective. We believe that a combination of flush walks, mist-netting (canopy and understory) and point counts would be ideal techniques, offering a multi-faceted, holistic approach.

Figure 10: Black-Naped Terns, Besar

Very little is known about the canopy dwelling bird species of the Perhentian Islands. We visited in the peak of the dry season, which also limited the number of species present on the islands. No research has been carried out on the Perhentian Islands during the monsoon season, where the climatic change should have a significant change in the species make-up of the islands. The Perhentian Islands also falls within the East Asian-Australasian flyway, one of the great migration routes, though comparatively little research has been completed on it. It is logical that migratory birds may spend the monsoon season on the islands, or at least that the islands will be a stopping-off point for some as they continue their journey southwards. No research has been completed in this area, and it would near-certainly add a number of species to the island inventory. Currently, data only exists for the dry season, and the lack of information on monsoon bird species represents a significant deficiency in ecological data for the East Coast Islands of Malaysia.

Family (Binomial)	**Species (Common Name)**	**IUCN**	**2004 Notes (Numbers recorded are cumulative totals of multiple birds, a relative, not absolute measure of abundance)**	**2014 Notes (These are merely observations and must be treated as such)**
Accipitridae	White-Bellied Sea Eagle	LC	Consistently recorded in small numbers at most survey sites.	Often seen soaring by the coastline or hunting over the water. Sometime seen as adult pairs. A number of juveniles were also seen with a brown colouration.

Apodidae	Edible-nest Swiftlet	LC	One recorded on Kecil and one on Rawa.	This a species we are unsure about. There are hiruidine species present and can be seen in large numbers circling other settlements or headlands of the islands. The best look we got at them was at PIR. To be determined. Potential species: • Edible Nest Swiftlet (11-12cm, darker rump patch, darker underside) • Germain's Swiftlet (11-12cm, lighter rump patch, paler underside, all underside pale) • House swift (14-15cm, white rump patch, white throat, slight notch)
Apodidae	House Swift	LC	Seen but not recorded.	Possibly seen, ID to be confirmed.
Apodidae	Asian Palm-swift	LC	Seen but not recorded.	Not seen.
Ardeidae	Chinese Pond Heron	LC	One recorded at B0.	Not seen.
Ardeidae	Pacific Reef Egret (dark morph)	LC	Not recorded.	Often seen flying alone, or as a pair across the water by the coast. Also seen hunting in the shallows. Seen on Kecil and Besar.
Columbidae	Nicobar Pigeon		Uncommon on Besar, 11 on Susu, not recorded on Kecil.	One individual on Kecil on an early morning walk, our strategy was not effective for finding Nicobar pigeon. One individual seen on Besar on the train between PIR

				and Flora, in the afternoon.
Columbidae	Feral Pigeon (Rock Dove)		Not recorded.	Seen in small numbers in the Fishing Village. A variety of colour morphs from resembling rock doves to plain white.
Columbidae	Emerald Dove		Uncommon on Besar, Kecil and Susu.	Heard on Kecil on an early morning walk.
Columbidae	Pied Imperial Pigeon		Very common at all survey sites.	Seen and heard all over both islands. Often seen flying from tree to tree in the distance at higher elevations.
Halcyonidae	White-collared Kingfisher	LC	3 recorded on Susu.	Not seen.
Hirundinidae	Pacific Swallow		Locally common, most recorded at B12 (flora bay).	Seen in the Fishing Village but in largest numbers at PIR.
Hirundinidae	Barn Swallow	LC	Two recorded at B0.	Not seen.
Hirundinidae	Dusky Crag Martin	LC	Seen but not recorded.	Whilst Coral Cay recorded this species, we suggest that this may have been a misidentification given how far the Perhentians are outside of its usual range.
Laniidae	Tiger Shrike	LC	Seen but not recorded.	Not seen.
Motacillidae	Forest Wagtail	LC	Seen but not recorded.	Not seen.
Muscicapidae	White-Rumped Sharma		Recorded at all survey sites except Susu and Rawa. Common on both islands.	Seen and heard all over both islands, very common. Also found caged in the village (10+) caged birds. Apparently they sell for a good price, may be linked to the mist net we found on Kecil.
Muscicapidae	Magpie Robin	LC	One recorded at B0.	Not seen.
n/a	Flycatcher sp.	n/a	One recorded at Susu.	Not seen.

Nectariniidae	Purple-throated Sunbird		Common. On both Besar and Kecil. Not recorded on small islands.	Locally common, inhabiting trees in more open areas such as Mira beach, by the village reservoir and the front of Ombak Dive Resort. Both males and females present, males are much easier to ID because they are more colourful.
Nectariniidae	Olive-backed Sunbird		Uncommon on Besar and Kecil.	One juvenile seen outside Ecoteer house (Kecil).
Nectariniidae	Little spiderhunter	LC	1 recorded on Rawa.	Not seen.
Oriolidae	Black-naped Oriole	LC	Uncommon, one recorded on Besar and not recorded on Kecil. Small numbers recorded on small islands.	Occasionally seen flying over the fishing village. Seen in good number (6+) on the old plantation to the east of Kecil flying between treetops. Not seen on Besar, but it is likely they are found there.
Phylloscopidae	Artic Warbler	LC	Uncommon on Besar but 7 recorded on one survey site in Kecil.	Not seen.
Pycnonotidae	Red-whiskered Bulbul	LC	Not recorded.	Uncommon in Malaysia, three specimens in cages in the Fishing Village by the toilets.
Scolopacidae	Common Sandpiper	LC	4 recorded at B0.	Not seen.
Sternidae	Black-naped Tern	LC	Locally common, 47 recorded at B8.	Most reliably seen on the rocks by turtle point (PIR snorkelling site) in small numbers. Occasionally off the coast or further out to sea either alone or in a small group.
Sturnidae	Asian Glossy Starling	LC	Only recorded on small islands.	Common in the Fishing Village with a population (20+ individuals) usually seen perched around the large building between the police

				station and the beach. Also present is smaller numbers in other locations such as Mira beach.
Timaliidae	Babbler sp.	n/a	Two recorded at Susu.	Not seen
Tytonidae	Barn Owl	LC	One recorded at B7.	Not seen.

Reptile, Amphibian and Snake Species

Figure 11: Killed Reticulated Python, Kecil

The Coral Cay study recorded a high number of reptile species, which corresponds with the high herpetological diversity found on the other east coast islands, Pulau Tioman and Redang in particular. Within the boundaries of our research permit, we trialled visual encounter surveys (VES) with success. This method was efficient and largely effective, revealing a wide variety of species across both Besar and Kecil, and more importantly across all known families of reptile species. Beyond this, the use of pitfall traps in certain locations may be a beneficial addition, particularly in order to identify some of less common species on the islands. The logistics of this are more difficult, however, and this also requires an expanded research permit.

This technique failed to provide any snake records, however, and a different technique needs to be implemented to reveal valuable data on the elusive snake species of the Perhentians. A number of the recorded Perhentian snake species are arboreal. 8/9 snake species on the islands are diurnal, and thus it is evident that is necessary to perform surveys at night, something that we lacked the equipment to do. This method would be best implemented with a number of nighttime VES, along set transect routes. The use of powerful touches is required, whilst ideally a DSLR-type camera is needed to take sufficient quality images for basic identifications. It is highly likely that additional

snake species will be discovered through intensive surveying on Besar, Kecil, Susu Dara Besar, Susu Dara Kecil and Rawa.

We were able to add one new amphibian species to the island's records that of a Common Greenback Frog, found in a pool on Besar, whilst we were also able to provide supporting records for a number of other species. Through correspondence with Dr. Lee Grismer (Pers. Comms), I have combined the records of the Coral Cay study with Dr. Grismer's and our own in order to complete the most up-to-date record of Perhentian Herpetofauna and amphibians to date. It is inevitable that with further study, this

database will be added to, however for the first time this data is easily accessible to all, and thus will be easy to add to in the future.

Family	Scientific Name	Common Name	Location	Found By	Notes
Bufonidae	Bufo Parvus	Lesser Malacca Toad	Kecil	Coral Cay, Grismer, PIER	
Bufonidae	Duttaphyrnus Melanostictus	Common Asian Toad	Besar	Grismer, PIER	
Microhylidae	Kaloula Pulchra	Banded Bullfrog	Besar, Kecil	Coral Cay, Grismer, PIER	
Rhacophoridae	Theloderma Licin	Smooth Frog	Besar, Kecil	Grismer	
Rhacophoridae	Polypedates Leucomystax	Common Tree Frog	Besar, Kecil	Coral Cay, Grismer, PIER	
Ranidae	Hylarana Erythraea	Common Green Frog	Besar	Grismer, PIER	
Icthyophiidae	Icthyopsis Sp.	N/A	Besar	Grismer	Likely to be new species'.
Agamidae	Acanthosaura Armata	Armoured Pricklenape	Besar, Kecil	Coral Cay, Grismer, PIER	
Agamidae	Bronchocela Crisatella	Green Crested Lizard	Besar, Kecil	Coral Cay, Grismer, PIER	
Agamidae	Draco Sumatranus*	Common Gliding Lizard	Besar	Grismer	* Likely to be same species
Agamidae	Draco Volans*	Flying Dragon	Besar	Coral Cay, PIER	* Likely to be same species
Gekkonidae	Cytodactylus Quadrivirgatus	Marbled Bent-Toed Gecko	Besar	Coral Cay, Grismer,	
Gekkonidae	Gehyra Mutilata	Four Clawed Gecko	Besar, Kecil	Grismer	
Gekkonidae	Gekko Gecko	Tokay Gecko	Kecil	Coral Cay, Grismer, PIER	
Gekkonidae	Gekko Moncarchus	Spotted House Gecko	Besar, Kecil	Coral Cay, Grismer, PIER	
Gekkonidae	Gekko Smithi	Smith's Green-Eyed Gecko	Besar	Coral Cay, Grismer, PIER	
Gekkonidae	Cnemapsis Perhentianensis	Perhentian Island Rock Gecko	Besar	Grismer (Zootaxa)	Endemic Species
Gekkonidae	Hemidactylus Frenatus	Common House Gecko	Besar, Kecil, Susu Dara, Rawa	Coral Cay, Grismer, PIER	
Gekkonidae	Hemidactylus Platyrus	Flat-Tailed House Gecko	Besar	Grismer, PIER	
Gekkonidae	Lepidoctylus Lugubris	Common Smooth-Scaled Gecko	Susu Dara Kecil	Grismer	
Gekkonidae	Ptychozoon Kuhli	Kuhl's Flying Gecko	Besar	Coral Cay, Grismer, PIER	
Gekkonidae	Ptychozoon Linotum	Smooth-Backed Gliding Gecko	Besar	Coral Cay*, Grismer	Outside of survey period
Scincidae	Dasia Olivacea	Olive Tree Skink	Besar	Coral Cay, Grismer, PIER	
Scincidae	Eutropis Multifasciata	Many-Lined Sun Skink	Besar, Kecil	Coral Cay, Grismer, PIER	
Scincidae	Eutropis Longicaudata	Long-Tailed Sun Skink	Besar, Kecil	Coral Cay, Grismer, PIER	
Scincidae	Lygosoma Quadrupes	Short-Limbed Supple Skink	Rawa, Besar		
Scincidae	Sphenomorphus Perhentianensis	Perhentian Islands Forest Skink	Besar	Grismer (Zootaxa)	Endemic Species
Varanidae	Varanus Nebulosis	Clouded Monitor Lizard	Besar	Grismer	*Possibly Same Species
Varanidae	Varanus Salvator	Water Monitor Lizard	Besar, Kecil	Coral Cay, Grismer, PIER	
Varanidae	Varanus Bengalensis	Bengal Monitor Lizard	Besar, Kecil	Coral Cay, PIER	*Possibly Same Species
Tyhplopidae	Ramphotyphlops Braminus	Brahminy Blindsnake	Besar	Grismer	
Boidae	Python Reticulatus	Reticulated Python	Besar, Kecil, Susu Dara	Coral Cay, Grismer, PIER	
Colubridae	Ahaetulla Prasina	Oriental Whipsnake	Besar	Coral Cay, Grismer	
Colubridae	Boiga Dendrophila*	Gold-Ringed Cat Snake	Besar	Coral Cay, Grismer	
Colubridae	Chrysopelea Ornata	Golden Tree Snake	Besar	Coral Cay	
Colubridae	Dendrelaphis Pictus	Painted Bronzeback	Besar	Coral Cay	
Colubridae	Dryocalamus Davisoni*	Blanford's Bridle Snake	Besar	Coral Cay	
Colubridae	Gonyosoma Oxycephalum*	Red-Tailed Green Ratsnake	Besar	Coral Cay	
Colubridae	Lycodon Capucinus	Common Wolf Snake	Besar, Kecil	Coral Cay, Grismer	
Colubridae	Lycodon Subcintus	Banded Wolf Snake	Besar	Grismer	Unconfirmed
Viperidae	Tropidolaemus Wagleri	Wagler's Pit Viper	Besar, Kecil	Coral Cay, Grismer	

Conservation Issues

Poaching

Figure 12: Poaching, Besar

The Coral Cay study revealed that a significant amount of poaching had been taking place on the island, with shotgun shells found, mist nets, and evidence of disturbed bat roosts on Kecil as well as the smaller Susu Dara and Rawa. We are pleased to report that we did not discover as much evidence of poaching. We did not find any shooting paraphernalia, however we did discover a mist net not far from the fishing village on Kecil, though the net was clean, and was manned at the time. As the Coral Cay study stated, White-Rumped Sharmas are believed to be targeted for the cage-bird industry, and this particular mist net was within the territory of a White Rumped Sharma that we had seen in the area previously. Thus, it follows that it was being specifically targeted. We also saw an unknown individual on Besar at the back of Flora Bay placing some sort of medium-sized mammal trap down, made of cast iron. We could not confirm whether this was for poaching or pest-control, though the size of it was certainly more than big enough for most of the island's small mammal species. Another visit by a team member, Joshua Gray, in 2015, revealed that mist netting had begun on Besar, near to the PIR resort.

Research Challenges

Future research on the Perhentians is something that we should be working towards, however we noted a number of limitations that need to be carefully considered. Assuming that research in the immediate future will be on a small scale, likely with significant non-expert involvement, these issues present a series of challenges that could hinder future research.

Awareness and Understanding

A major obstacle to successful ecological research with real, measurable impacts is the lack of community awareness and understanding of the environment around them. Whilst the marine aspect of this has been improved through the hard work of Ecoteer, the terrestrial ecology is under threat from a variety of human causes. We believe that these are largely a result of a lack of environmental education and awareness amongst the island community. Bird life on the islands is under threat from mist-netting, which has been reported on both Besar and Kecil. The small number of avifauna around inhabited areas speaks for itself in this regard, with many birds, including the relatively common White-Rumped Sharma being found in cages in the fishing village. It is unlikely that the culprits understand the damage this can cause to an ecosystem, however with a jungle

entirely devoid of birdsong around mist netting sites, it is practice that needs to be prevented. During our time around the fishing village, we heard numerous stories from reliable witnesses of children killing both Monitor Lizards and Cats for fun. With little apparent affinity for the jungle from many community members, that children are not discouraged from doing this is a source of concern for the future.

However, it is difficult to blame the children for practices that are learnt and instilled from adults, and indeed they could potentially be generations-old traditions. It is common to find dead snakes around the fishing village, where they have been killed by villagers. This is understandable, perhaps (whilst we would prefer translocation), as a Reticulated Python will quite happily raid the village for chickens and whatever else they can find. It is sad, however, that YouTube contains videos of tourist vendors 'playing' with Pythons and other snakes in front of tourists on Long Beach, Kecil, however. This dangerous activity is only going to make the snakes be more aggressive and thus further their reputation as dangerous animals that should be killed. The folly of these behaviors is matched only by their ecological consequences. Perhaps the saddest indictment of the lack of environmental awareness in the island communities is that of 2 White-Bellied Sea Eagle chicks, stolen from their nest and then kept in the domain of a village family. Without the training, awareness or resources to care for the young Eagles, both chicks died. Thankfully, the Sea Eagle population numbers are high and therefore should not be considered at risk. The risk, however, to more vulnerable species is paramount however, and should not be underestimated. From our observations, coupled with the Coral Cay study, it is evident that significantly higher biodiversity is found in areas away from human influence on the islands. It is little wonder why.

Whilst we cannot be sure whether this is a past practice or present, at some point large amounts of litter have been deposited in the rainforest. Tourists are inevitably responsible for an amount of this, but the near-industrial scale suggest a large amount has been dumped in the rainforest, particularly on Kecil, perhaps as a last-resort in the absence of refuse collections from the mainland. Whilst for the villagers, it remains out-of-sight and out of mind, the ecological damage such indiscriminate dumping can cause is well documented and remains a concern. Without an understanding of why such methods are damaging, however, those responsible cannot really be blamed. As a tourist island, it makes logical sense to hide any existing issue away from visitors; the fact that visitors have begun to notice, as derived from a huge amount of reports on TripAdvisor, for example, illustrates how the practice is having a detrimental impact on the reputation of the Perhentians.

Lastly, there are few people on the Perhentian Islands equipped with terrestrial wildlife identification and ecological skills, and this does pose a problem for future research. It is becoming increasingly important for conservation and ecological research projects to include a community facet, and thus one of the aims of conservation on the Perhentian Islands must be to involve the community. The Turtle Conservation project on the islands has successfully targeted the community with marine conservation efforts, however further work needs to be completed on the terrestrial environment.

Economy

Ecological research, by its nature, relies on an amount of funding in order to collect accurate and reliable data. Ecological equipment in particular can be very expensive, and this represents a problem for Perhentian research. In earlier sections, it has been suggested that HARP trapping and sonogram analysis is conducted to further the chiroptera dataset. A HARP trap alone will cost £1750 (NHBS), or 10,288 MYR at the time of going to press. Sonogram analysis, such as ANABAT hardware of the cheaper SM2 will cost upwards of £1000 also. Additional mammal trapping is also recommended, yet mammal traps can cost upwards of £100 each (though cheaper varieties are available), and a number would be required. It is evident that without significant funding, such research is largely economically unviable at the time being.

In hindsight, the sheer amount of equipment and material support offered by Coral Cay was unprecedented and made an invaluable contribution to the faunal data of the islands. The chances of such a holistic, comprehensive project occurring again on the islands are perhaps slim, however future research does not need to be so wide-ranging at least. A more focused, slow build-up of data would be a much more economically viable option. The length of expeditions are often limited by the size of the budget, as everyday expenses such as accommodation and food quickly build up in size, Thus, in the long-term, I argue that short-term, intensive expeditions are of limited value other than in the initial period of scientific exploration; long-term data collection, involving as many local partners as is possible represents an opportunity for data of greater value than could otherwise be achieved.

Logistics

Firstly, there is the issue of getting equipment to the Perhentians, which in the case of large or fragile and expensive kit can be a complicated and difficult exercise. Where to store the equipment when it is not in use is another issue, however from our time on the Perhentians, it became apparent that a building in the style of Ecoteer House, or the Blue Temple Conservation building, would be ideal. The creation of a research station in this vein would be of great benefit, providing accommodation, storage, a cooking area and internet access. The Perhentians does have a relatively fast internet connection, and this is a great asset to have as an ecological expedition. Again, however, this incurs a cost. If relevant, it may be worth trying to coordinate with local resorts in order to secure cheaper rates.

Secondly, all research on the Perhentian Islands requires a permit from PERHILITAN, even for non-invasive surveys with passive survey techniques. Survey methods involving trapping are highly likely to require a permit from the Economic Planning Unit, and this, in turn, will likely stipulate that the research must be Malaysian-led or have a strong Malaysian contingent at the bare minimum. Whilst this is not a negative, it is sensible to keep abreast of this if coming from abroad.

Thirdly, the natural environment of the islands can make surveying difficult. Whilst the well-used trails are relatively easy to navigate and survey, in other areas the terrain is

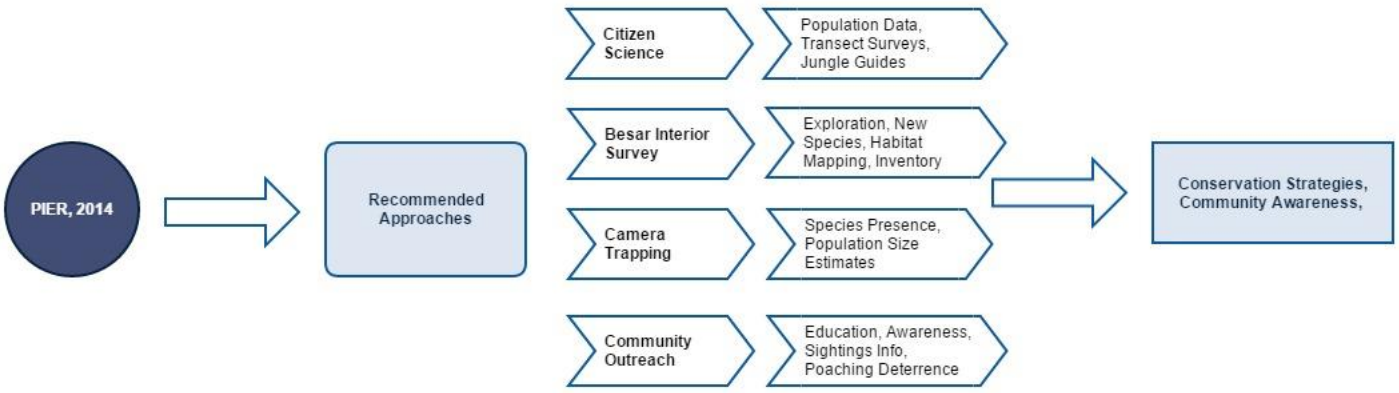
particularly challenging. This is particularly the case on Northern Besar, where we struggled to make significant inroads into the jungle due to the steep, uneven and very densely vegetated terrain. To those unfamiliar with the jungle, research is rendered impossible in such an environment. Ideally, you would actually trek into the primary rainforest on Besar from Flora Bay, spending a couple of days there at a time in order to complete surveys. In all likelihood, this is beyond the reach of anything less than academics and particularly committed students. The risk factor to the untrained is too high in these areas. Carrying heavy equipment into these areas will be challenging and thus care must be taken to reconnoiter and plot routes.

Obviously, most research days on Besar or Kecil will involve a boat trip at some point, and carrying expensive equipment on these can be risky on rough days. Coordinating a large team would be complicated also. However, if additional research is to be carried out on Susu Dara and Rawa, transport becomes much more complicated with tides, distance and time spent surveying all becoming issues. Again, it may be sensible to camp overnight on these islands if possible in order to complete at least a baseline data collection.

One additional issue is that by cutting additional trails into Besar's untouched, pristine hinterland, the rainforest would become more accessible and thus might become more vulnerable to human influences. This would be to the detriment of the Nicobar Pigeon population, as well as other elusive species such as *Acanthosaura Armata,* or the Armoured Pricklenape. This therefore needs to be carefully managed, and any access routes should be obscure and difficult to locate. With a known history of poaching, it is important that this inner section of Besar is not compromised.

Solutions to the Research Challenges

The issues detailed above do pose difficulties to research on the islands, however these can be mitigated against successfully in order to carry out efficient ecological or environmental research, both economically and with community involvement. What I propose below is a research plan that relies on existing island assets, forges community



relationships, is economically viable and crucially, is efficient and effective at producing data.

Education

If the long-term environmental future of the islands is to be secured, it is critical that the next generation of residents are targeted and educated on the ecology of the islands around them. This means getting involved with the local community school on Kecil, something that Ecoteer has gone to great lengths to do with marine conservation. More focus needs to be placed on the terrestrial environment, however, and we envisage a variety of methods in order to not only teach, but also to enthuse children about the natural world around them. Taught lessons will be an obvious method, however what better way for children to learn is there than by being out in the field, learning not by textbook but in practice? To this end, after a period of time, it might be an option to run mini-field trips out into the jungle along safe trails, with simple activities such as drawing a monkey at earlier ages to very basic practical scientific skills in later years. Another option would be to run an out-of-school 'Nature Club'. It is important to note that education and community involvement must become a central pillar of any future research on the islands, in order for it to have any meaningful affect from a social point of view. Collecting data is fine, but to be able to expand research out to the community is the hallmark of a strong science communication practice.

Ecoteer's efforts to educate children in the primary school on Kecil are highly laudable and speak volumes of their great efforts to raise awareness amongst the future island generations of the value of their marine environment. We were fortunate enough to use Ecoteer House as our base, and the NGO does fantastic work within the community, operating on a low-key, social level in order to complete larger, environmental goals. This can be seen with the pioneering of recycling projects, beach clean-ups and other initiatives, however perhaps their most relevant contribution has been their Turtle Conservation efforts, initially supporting the fisheries department and now taking a more prominent role in protecting the Perhentian's most vulnerable species (though they fall outside the remit of this report). The PhD of Long Seh Ling, an impressive figure within the Ecoteer organization, promises to shed light on this area.

Community & Tourist Outreach

Further efforts need to made, however, to build the awareness and appreciation of the island's natural habitat and species. Whilst to an extent this has been implemented within the local school, we believe that an even more effective approach would be to hold a '*BioBlitz'* event, within the community. In this instance, a *Bioblitz* would bring together regional experts, for example from the MNS and UMT, and hold an interactive, day-long event. Bringing such highly-regarded experts to the islands, and getting them to lead intensive surveys in a short period of time could add a potentially unprecedented quality and quantity of data. An ideal base location for this would be in the fishing village square, where there is plenty of space for people, stalls and activities. Simple things like displaying different species of insects from the island's rainforest, leading guided tours of the jungle with expert guides, having a sightings board, talks and presentations would all

make the event a great success. Getting locals involved in practical surveys is also an ideal way to enthuse the population about the environment on their doorstep. Education on the dangers of snake species, particularly given the amount that get killed by locals on the islands, would also not go amiss, whilst poaching could also be approached conscientiously. An annual *Bioblitz* on the islands could be a fantastic way to kick-start an ecotourism campaign, and it is a method that is gaining recognition not only in the UK, but world-wide also.

Whether a *BioBlitz* event takes place or not, it would be a sensible move for the Perhentians to feature some form of regular presence from the Malaysian Nature Society or a similar entity- even a Wildlife Outreach programme from Ecoteer. On a regular basis, stalls would be held outside popular resort areas, such as Flora Bay and Long Beach, as well as in the Fishing Village, through which leaflets, maps and information can be disseminated. Being able to show photographs of the wildlife, and promoting the guided wildlife walks would further the impact of this operation. Offering children's activities, and having a daily sightings board would also be a valuable contribution.

Lastly, as another way to involve the adult population of the islands, it may be possible to screen wildlife documentaries with Bahasa Melayu subtitles or translations for a large audience, as a major event within the community. This would offer a more light-hearted, entertaining and informal approach to building the community's awareness of wildlife.

Citizen Science

The most efficient way of collecting ecological data on the Perhentian Islands, in the long term, would be through the use of citizen science. This approach would be led by a scientist or scientists, but involve islanders and perhaps tourists as participants, contributing to data collection. Citizen science is becoming an increasingly common way to collect data on a global scale, offering considerable benefits in the terms of citizen science efforts have to be well directed, with relatively simple methodologies and goals in order to retain interest from a community. There are three common citizen science approaches, however in the case of the Perhentians unique circumstances, I believe a 'Contributory Project' would be the most applicable. In this method, the project is entirely designed by scientists, and volunteers are involved in a purely practical data-collection capacity.

This approach will observe simple Visual Encounter Survey methodologies, with the involvement of the island community. This will incorporate residents of the fishing village, as well as others who want to be involved. By involving the community in data collection, a huge impact can be made on their awareness of both island's environment and wildlife. By highlighting threatened species, such as the Dusky Leaf Monkey and the Nicobar Pigeon, the community should become more aware of their international importance and thus protect them from human threats. The data collected will be of great value to the islands, recording species densities and distributions on a series of dates on an annual basis. Crucially, if set-up correctly, the surveys will record fluctuations in populations, indicating the health of the Perhentians terrestrial environment over time.

This approach allows the community to learn about their own environment by being involved in the research themselves, and with the prospect of offering paid jungle walks whilst contributing research, it offers significant economic benefits. Crucially, if deployed correctly, citizen science could be a huge asset to research efforts on the islands. Simply by recording sightings and locational data, as well as other notes, it would be possible over time to draw up a picture of the Dusky Leaf Monkey population on Besar, for example. If locational data in a GPS form could be utilized, it would be possible to map species densities over distance; for example, which parts of Southern/Western Besar has the highest density of large Monitor Lizard. The versatility of the Citizen Science approach is a strength of the system, however it must be noted that certain elements will have to be focused, such as where transects take place, how data is collected and other related processes. Initially, I would recommend following a series of basic transects before potentially expanding in the future. It would be useful to have a comparative transect on Kecil for future comparisons of species density and locations, however the scheme would ideally be focused on Besar, due to its less-disturbed nature and potential importance as habitat for protected species.

The Perhentian Islands as an Ecotourism Destination

By far the most popular activity of visitors to the Perhentian Islands is diving and snorkeling, with numerous dive companies and resorts located across the islands, though especially on western Besar. The Perhentians have a reputation for offering world-class coral reefs, offering some of the best diving and snorkeling in the world. With the high volume of tourists, as well as boat traffic in certain areas, large swathes of coral are being damaged. Research by *Blue Temple Conservation* is expected to reveal significant degradation of the coral stocks. Whilst pollution is also an issue, further research is needed to assess the extent of this.

Thus, the marine environment is well-explored, much advertised, and thanks to ongoing awareness and education efforts from *Ecoteer* and *Blue Temple,* islanders are beginning to realise the value of the reefs, and what it means to the tourist economy on the islands. This, however, is in stark contrast to the awareness and perception of the rainforest. As this report has demonstrated, the Perhentians features a variety of interesting wildlife species, and certainly enough to make guided jungle trekking a viable activity. Through training locals in wildlife identification techniques, as well as basic jungle skills and health and safety skills, it would be very easy to add this as an extra facet to the Perhentians. With the data produced, and species found, there will be opportunities for the Perhentians to host lucrative conservation projects, attracting paying volunteers domestically and from abroad. Students are willing to pay for practical research and conservation experience with primates, for example.

The major environmental advantages of starting a guided jungle trail scheme are two-fold. Firstly, with the appropriate training, it will provide an unprecedented opportunity with which to build up a more thorough database of Perhentian Wildlife, simply through recording the visual encounters guides have in the rainforest. This is only going to boost

the ecological understanding of the islands, and may will assist any future studies to be undertaken by the MNS, UMT or Perhilitan. It is worth noting that there are numerous successful jungle guide organisations throughout Malaysia, notable examples being *JungleWalla Tours* on Langkawi, and the numerous options available in Taman Negara. There is an established tour guide training system in place, certified by Tourism Malaysia, incorporating a variety of levels of training for guides. The basic qualification, the green license, is achievable within 1 to 2 weeks and permits guiding only in certain locations, making this a sensible place to start for a pilot scheme.

The Perhentians have enough incredible wildlife to be a significant part of advertising for them. To draw attention to the terrestrial animals and ecology, it would be sensible to create a 'Perhentian Big 5', which would namely be the 5 most impressive animals on the islands, in the same vein of the African variant. The stand-out candidates for the Big 5 are probably the Dusky Leaf Monkey, Colugo, Long-Tailed Macaque, Water Monitor Lizard and Flying Fox. Other options include the Clouded Monitor Lizard, White-Bellied Sea Eagle, Flying Dragon and Oriental Whipsnake. It is possible to see all of these species relatively easily, however whether people should be encouraged to seek-out the temperamental Long-Tailed Macaque is another question altogether!

Future Research on the Perhentian Islands

The Perhentian Islands offer a wealth of research opportunities that have yet to be explored. In the section below, justification for further study is provided, possible streams of research are explored and research recommendations are made. Coupled with the previously discussed ideas, these plans will also vastly expand the islander's awareness and knowledge of their own natural environment. By involving the community, we hope to inspire the next generation to manage the islands more sustainably for future generations. It will also forge greater links between the islands and NGOs, such as the Malaysian Nature Society, as well as universities such as Universiti Malaysia Terrengannu.

Why is Further Research Needed?

Previous studies have proven that the Perhentians provide a valuable refuge for a vast number of species, a number of which are of a conservation interest globally, such as the Nicobar Pigeon and Dusky Leaf Monkey. The discovery of 2 endemic species in a relatively short study period by Dr. Lee Grismer underlines the potential for further herpetological endemicity. It is arguably likely that further new species exist on the Perhentians. Dr. Lee Grismer states (*Pers Comms)'The Perhentian Archipleago harbors a unique suite of species that comprise an integral component of the herpetofaunal biodiversity of Peninsular Malaysia. Being that two endemic species were discovered on the island during a few short surveys indicates that the island still remains underexplored and that the potential for additional endemic species and new island records is high. Protecting the environmental integrity of these islands will go a long way to protecting all the species of plants and animals that inhabit this archipelago'.* Crucially, this leads to the current plight of the Perhentians, with tourist numbers ever increasing, infrastructure that is struggling to keep up, and no shortage of potential development. Both the marine

environment and the terrestrial environment are under threat on the islands, and additional research is a necessity in order to understand the impacts of further development on a sensitive, valuable ecosystem. With the combination of the incredible marine biodiversity and also the faunal terrestrial biodiversity of the islands, it is also possible that further research will lead to them being more strongly protected in the future.

Camera Trapping

Camera Trapping would be a convenient method with which to prove the presence of large mammal species on the islands. On Kecil, the deployment of a small number of camera traps would be ideal to help estimate the size of the Long-Tailed Macaque population, as well as estimate their range. Camera traps will also help to conclusively prove the presence of Civet cats on the islands. However, they would be arguably more valuable in a greater number in central Besar, where apart from the Dusky Leaf Monkey, nothing is known of what exists deep into the jungle. There is the potential for Mouse Deer amongst other large mammals, and the camera traps would be a great asset in order to fully understand the faunal species of Besar. The camera traps would likely be sourced for loan from a higher education institution or from an NGO, and would be returned at the end of the research period. Camera trapping will inevitably form a major part of any further efforts to 'complete' the species inventory of the Perhentian Islands,, and it will offer an exciting insight into the unexplored jungle of Besar's interior.

Monsoon Bird Surveys

The islands form part of the East-Asian flyway, and yet no research has been performed on the value of the islands during the migratory monsoon season. It is logical that the islands will be an important refuge for migratory species over the winter, and thus we suggest that monsoon bird point count surveys are conducted during the Monsoon season where possible. Current research on the Perhentians has only taken place during the dry season, and this is something that needs to be addressed in the future; there is literally no data for monsoon bird species on the islands.

Susu Dara, Rawa and Other Small Isles

Additional surveys on Susu Dara, Rawa and the other small islets off the coast of the Perhentians would be an ideal opportunity to assess the size of the Nicobar Pigeon population, as well as carry out more intensive bird and reptile/amphibian surveys.

Pulau Besar's Interior

The hinterland of Pulau Perhentian Besar is understudied, with very little being known about what species inhabit the region. Due to accessibility issues, the surveys within Besar would likely involve a number of days spent non-stop in the jungle, with night-time surveys as well as daylight surveys being essential. The herpetofauna of Besar's centre is likely to reveal new species for the island's inventory, whilst given Dr. Lee Grismer's previous discoveries in relatively inhabited parts of the Perhentians, there is a more than reasonable chance of discovering further endemic species. Surveying the centre of

Besar will also help reveal the size and health of the unique Dusky Leaf Monkey subspecies that inhabits the islands, work that is recommended by the IUCN. Little is known about the centre of Besar's avifauna, and the suggested study would be a great opportunity to add to this dataset.

Frustratingly the central areas of Northern Besar are the most undisturbed, the most unstudied but also the most difficult to access. Coral Cay studies indicated higher levels of biodiversity the further into Besar you go, and thus in many ways this untouched area offers the best chance of finding interesting species, especially those that are affected by human disturbance. Through our studies, we believe that this is the main habitat of the near-threatened Dusky Leaf Monkey, having found them on numerous occasions on the boundary of this area. The area around the Turtle Nesting Beach, on North-Western Besar, contains mango trees that the lutungs frequent as a source of food. Any research on the Dusky Leaf Monkey will have to focus on this area. This is also where we discovered a Nicobar Pigeon, another near threatened species, ironically after it was disturbed by a falling Dusky Leaf Monkey. The Nicobar Pigeon relies on small island groups as its main habitat, with the global population stretching from Palau to the Andaman Islands and beyond. However, they are hunted for food and its valuable gizzard stone, which together with widespread habitat loss has led to their Near Threatened status and also listing on CITES appendix 1. Nicobar Pigeons are ground-dwelling birds, preferring undisturbed areas, and thus the centre of Besar likely offers an important refuge for them, though the size of the populations is yet to be ascertained. The relative lack of predators only furthers the potential of Besar as an important Nicobar Pigeon habitat. The realities of accessing the area, however, put it out of reach for research by anything other than well-prepared, well trained professionals. Some areas around the coast appear to quite literally inaccessible, but with the use of a parang, blood, sweat and tears, the hinterland could be studied.

One additional issue is that by cutting additional trails into Besar’s untouched, pristine hinterland, the rainforest would become more accessible and thus might become more vulnerable to human influences. This would be to the detriment of the Nicobar Pigeon population, as well as other elusive species such as *Acanthosaura Armata,* or the Armoured Pricklenape. This therefore needs to be carefully managed, and any access routes should be obscure and difficult to locate. With a known history of poaching, it is important that this inner section of Besar is not compromised.

Conclusion

Firstly, this feasibility study has revealed that in the ten years since the Coral Cay study, much has changed on the Perhentians. Tourist development continues at an unrelenting rate, putting both the terrestrial and marine environment at risk due to current insufficient infrastructure. Waste disposal is an urgent issue on the islands, and whilst it appears to be at its worst now, it is a well-documented problem that strongly threatens to undermine the Perhentians reputation as a pristine tropical paradise. Vast quantities of litter were found in the jungle, where it apparently had been dumped. Even more litter was found on the beaches, and it speaks volumes that various local NGOs and dive groups have

organised beach cleans, only for the litter to be replaced in a couple of weeks due to more being thrown out to sea. A landfill site at the back of Flora Bay on Besar has flooded, contaminating local habitats and potentially forever disfiguring the landscape at the back of that beautiful part of the islands. Even more worrying is the ecological and also human threat posed by the lack of sufficient sanitation. Septic tanks are operating far above capacity and are not being cleaned; sewage is being pumped out into the same stretches of water that hundreds of thousands of tourists enjoy every year. The damage to the marine environment alone puts the Perhentian's success as a diving destination at risk, before you even consider the impacts this pollution may be having on people. To this end, it is clear that urgent investment needs to take place on the Perhentians in order to alleviate these issues. If the islands are to be sustainable as a tourist destination in the long term, serious efforts need to be made to firstly to firmly eliminate the waste issue.

Secondly, one of the critical findings of this study has been that a further broad ecological study, whilst interesting, would ignore the true needs of the islands. Research on the Perhentians needs to focus on assessing the current extent of the environmental issues that have been catalysed by rapid tourist development in the last 10 years. Revealing areas that have been most affected by this development; areas of the highest waste densities, water pollution and measuring the impact this has had on species in the area would be, as far as I can see, the most valuable research possible. Ensuring the economic sustainability of the island's tourist industry is of paramount importance to nearly all stakeholders alike, and it is crucial to understand that such research will help facilitate the measures that will secure the Perhentian Islands long-term sustainability as a popular tourist destination. By preserving the natural habitat of the Perhentian Islands, and protecting them not only as a Marine Park but also as an important refuge for terrestrial species in its own right, the islands will continue to thrive economically, whilst protecting the environment for future generations.

Thirdly, that being said, the Perhentians still represent an incredibly exciting opportunity for ecological research, and we believe that it is time this is capitalized on by Malay universities (if not foreign). Additional research will help further inform future development plans, and reveal more about these incredible islands. It is likely that further new species will be discovered on the Perhentians, and with entomology, for the most part entirely unstudied, it is almost guaranteed. There are so many streams of research on the Perhentians that have yet to be undertaken, and many of which could offer conclusions of real practical value. The islands offer ample opportunities for Malaysian Universities as well as those abroad, and these would bring further economic benefits to the Perhentians. Having said that, this report has also underlined the potential value of citizen science on the islands, as well as strategies for improving the community education and awareness of their natural environment. In the long-term, this will produce some valuable data, however in the short-term, this approach is focused on changing the community's conceptions of the environment around them; giving it value and showing them *why* the ecology is valuable. Through this method, we believe that we can inspire the current and next generation of islanders to look after the Perhentians

better than it has been in the past, and secure their long-term environmental sustainability for the future in a socially sustainable manner.

Ultimately, the Perhentian Islands represent an important collection of habitats and species that are an integral part of the wider Maritime Terrengannu ecosystem. A combination of research approaches, coupled with significant community engagement and education efforts offer the best opportunity to monitor and further protect these islands for the future.

Specific Recommendations

- An urgent investigation into the waste and pollution issues on the islands, and why the current system is ineffective, and thus how it can be improved.
- Guided Jungle Walks, providing valuable data, employment and economic benefit simultaneously.
- Malaysian Universities should be approached to see if they would be interested in conducting environmental studies on the islands with students.
- Community education and engagement efforts from national wildlife NGOs as well as Ecoteer is essential to their long term environmental sustainability of the islands.
- Explore further monitoring, evaluation and protection for particularly vulnerable species such as the Nicobar Pigeon and Dusky Leaf Monkey.
- Ultimately, a Sustainable Development plan must be conceived and implemented in order to secure the economic, environmental and social future of the islands.
- Monsoon bird surveys in order to assess the islands importance as a migration refuge.
- Investigate the potential rebranding of the islands as an 'Ecotourism' destination, promoting the terrestrial biodiversity in combination with the well-regarded marine habitat.

Appendix 1: Additional Images

Figure 14: Flying Gecko

Figure 13: Colugo