Frontier Cambodia Environmental Research

REPORT 3

Conservation Studies in Botum Sakor National Park, Cambodia – Interim Report

October 2008 – December 2008

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Perryman, R.J.Y., Irwin, R., Drijfhout, M., Steer, M.D. & Fanning, E. (eds).

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Chapter 1. Introduction

1.1. Area and camp overview

Botum Sakor National Park is located near the southwest border of Cambodia, spanning the three districts of Kaoh Kong, Kiri Sakor and Botum Sakor in Kaoh Kong Province. It is one of Cambodia's six staffed National Parks, covering an area of 183,408 ha. (1826 km²). The majority of Botum Sakor's area comprises gently sloping lowland and flood plains. The area consists of lowland evergreen forest, *Melaleuca* woodland, grassland, mangrove forest and swamp forest with patches of oncasperma palm. The climate is characterised by tropical monsoons and the area has two high tides per day with a range of approximately 1.5 m. The population of Botum Sakor National Park is unknown (Daltry, J.C. and Traeholt, C. 2003). Disturbance in the past was however known to be extremely high with an estimated 229 km² (~30 km²/year) of evergreen forest lost from 1997-2002 through illegal logging (Traeholt *et al*. 2005). The Ministry of Environment park rangers are now supported by WildAid and with the development of a management plan disturbance levels are thought to be decreasing.

1.2. History and rationale of program

Botum Sakor constitutes one of the protected areas in the Cardamom mountains priority landscape and is protected by the Ministry of Environment (MoE). Its protection is managed by the Department of Nature Conservation and Protection (DNCP).

No research from Botum Sakor has previously been published, with the exceptions of Daltry and Traeholt (2003), which focuses mainly on the Southern Cardamoms, and Traeholt *et al*. (2005), a study on pileated gibbons *(Hylobates pileatus)*. This lack of information makes it difficult to design a conservation strategy for the protected area, and in turn, for the wider south-western area of Cambodia. Since April 2005, Frontier and the DNCP have conducted a joint forest research project in Botum Sakor. This studies the biodiversity of the area and trains national park and DNCP staff in scientific field techniques. This research phase was at the beginning of the 4th year of research in Botum Sakor (14th phase) and comprised ten weeks of surveying.

1.3. Current phase overview

The aims of Frontier-Cambodia in Botum Sakor National Park between October-December 2008 were to continue the program of baseline biodiversity research which began in March 2005, providing information on the area's biological value and conservation importance. There was a continuation of studies which aimed to assess the diversity of lepidopteran, amphibian, reptile and small mammal species.

Between October and December, much emphasis was placed on the development of avifaunal surveys which aimed to develop a comprehensive species list with relative abundance estimates for each species. Species of conservation importance were identified while the diversity of riverine habitat was estimated using EstimateS software (Colwell 2006). The identification of species which are globally threatened, have restricted ranges, or are indicators of the health of the environment could potentially lead to the designation of Botum Sakor National Park as a Birdlife International Important Bird Area or Secondary Bird Area within Cambodia. Density analysis studies on hornbills from July-September were continued, while encounter rates of key bird species were calculated along the Preaek Kon Tourt river.

An additional focus was placed on orchid species. Orchids are useful as indicators of ecosystem health, though there has been limited work on orchids within Cambodia. This study developed new methodology, aiming to develop species lists and identify species of conservation importance.

1.4. Objectives from October-December 2008

- Continue biodiversity surveys according to Frontier standard techniques (Society for Environmental Exploration 2003), by bucket pitfall trapping for reptiles and amphibians, Sherman trapping for small mammals and canopy trapping for butterflies and moths.
- Survey the avifauna of riverine habitat and calculate the relative abundance of each species identified using Mackinnon List (Bibby *et al*. 2000**)** methodology.
- Estimate the density of all hornbill species along the Preaek Kon Tourt river.
- Calculate encounter rates for key bird species along the Preaek Kon Tourt river.
- Continue and expand surveys of orchid species in order to develop a species inventory and identify species of conservation importance.
- To study all other aspects of the area's flora and fauna through opportunistic observation and targeted investigation (using direct and indirect evidence) - including studies of birds and larger land mammals.

1.5. Research work program overview

Due to previous experience of staff members, emphasis was placed on ornithological surveys, small mammal trapping and butterfly trapping, while orchid survey methodologies were developed.

The techniques currently utilised by Frontier-Cambodia have been established since before the beginning of the Botum Sakor National Park biodiversity assessment. Each method is designed to capture and/or identify different species within each site's habitat. The following chapters document our studies in Botum Sakor from October-December 2008:

1. Ornithological surveys
2. Opportunistic records
3. Orchid surveys
4. Trapping of butterflies and moths
5. Trapping of small mammals

Chapter 2. Ornithological Studies: July-December 2008 (Alexander Royan)

2.1. Introduction

The knowledge of bird distribution in Cambodia is poor compared to that in most other countries. There are approximately 535 bird species thought to occur in Cambodia (Setha and Poole 2007) but this species list is expected to reach 600 as survey efforts are increased and unexplored areas investigated. There are only a small number of recent studies that have aimed to document the species of south-western Cambodia (e.g. Daltry and Kuy 2003; Steinheimer *et al*. 2000), and as yet there have been no studies on the avifauna of Botum Sakor National Park. Daltry and Kuy (2003) conducted opportunistic surveys in the southern Cardamom mountains. A total of 137 species were identified, including several globally threatened species and several sub-species endemic to the Cardamom mountains ecoregion (which includes Botum Sakor). Daltry and Kuy conclude that with increased survey effort future surveys are likely to find further species. We conducted four separate ornithological studies in Botum Sakor; systematic bird surveys concerning the creation of a species inventory for the park; an avifaunal diversity survey, estimating avian biodiversity within the park; a riverine biodiversity survey to create population density estimates of key species associated with rivers; and a hornbill survey to estimate population size of two species of hornbill within the park.

2.2. Study sites

Two study sites were used for ornithological studies. All habitats present at the two sites were surveyed. The first study site (site A) was situated in the north of the park (N: 11º14.732, E: 103º21.092) at an altitude of approximately 100 masl. This comprised an area of evergreen and semi-evergreen broadleaved forest and grassland habitat. The study site was in close proximity to the route 48 highway, which was used as a line transect for surveys. Disturbance appeared to be fairly high in the surrounding area with evidence of selective logging and poaching activity found.

The second study site (site B) was situated approximately 15 km along the Preaek Kon Tourt river (N: 11º09.750, E: 103º22.751) at an altitude of approximately 5 masl, 3 km south of the route 48 highway. The surrounding habitats were more diverse than that at site A. It consisted largely of semi-evergreen broadleaved river-edge forest and grassland. Melalucea and mangrove habitat in brackish waters stretched for about 8 km from the sea and small patches of oncasperma palm were located within the study area. Disturbance levels at study site B appeared to be somewhat higher than that at site A, with much evidence of intense logging activity whilst snare traps and other evidence of poaching was regularly encountered.

2.3. Systematic bird surveys

2.3.1. Introduction

This study reports on systematic bird surveys conducted in Botum Sakor National Park between July and December 2008. The aims of these surveys were to establish a comprehensive avifaunal inventory for the national park and provide insight into the distribution of species within the region with particular emphasis on species of conservation importance.

2.3.2. Methods

Existing paths, rivers and roads were used for systematic rapid assessment surveys using line transect methodology (Bibby *et al*. 2000). Systematic surveys were conducted between 06:00 and 09:00 while afternoon walks and boat trips were conducted between 16:00 and 19:00. Total survey effort was 70 hours or 81 km at site A and approximately 50 hours or 156.35 km along rivers at site B. Visual identifications were based upon the field guides 'Birds of South-East Asia' and 'A Field Guide to the Birds of Cambodia' (Robson 2007; Setha and Poole 2007) while audio identifications were based upon reference CDs (e.g. Birds of Tropical Asia 3.0, Scharringa 2005). Ministry of Environment rangers assisted with species identifications.

At site A five transects of 8.1 km total length which covered all types of present habitat were used. Data were collected using the Mackinnon Lists method (Bibby *et al*. 2000) on all transects. Individual birds within 200m either side of transects were recorded, in the order in which they were observed. At site B, approximately 21 km of the Preak Kon Tourt was divided into 6 line transects whilst 3km of side rivers were also surveyed. All individual birds within 50m of the river bank were recorded, in the order in which they were observed. with data also collected using the Mackinnon Lists method (Bibby *et al*. 2000). Abundance data collected from the Mackinnon List method will be reported on at a later date. During surveys an observer with much bird surveying experience acted as a principal observer whilst 2 or 3 inexperienced volunteers acted as secondary observers. All data were analysed by the principal observer.

In addition to reporting on species that were recorded during systematic surveys from this study, additional species were recorded opportunistically between April 2005 and December 2008. These records were also scrutinised by the principal observer before being reported.

2.3.3. Results

A total of 180 species were recorded during systematic surveys whilst an additional 19 species having been recorded opportunistically providing a total avifaunal diversity estimate of approximately 199 species. A total of 119 species were recorded at site A whilst 136 species were recorded at site B. There were large differences found in the avifauna between sites with 44 species recorded at site A which were not present at site B many of which were species restricted to broadleaved forests. At site B there were 61 species recorded that were not recorded at site A. As expected most of these species have distributions that are restricted to or near to various freshwater and coastal habitats. A total of 75 species were shared between sites.

2.3.4. Species of conservation concern

Five species were registered that are of conservation concern as they are globally threatened or near threatened. The green peafowl (*Pavo muticus*) and lesser adjutant (*Leptoptilos javanicus*) are listed as vulnerable to extinction, and the darter (*Anhinga melanogaster*), great hornbill (*Buceros bicornis*) and grey-headed fish eagle (*Icthyophaga icthyaetus*) are listed as near threatened (IUCN 2007). Fourteen biome-restricted species were identified (Kim Hout *et al*. 2003). Seven species are restricted to Indochinese moist tropical forest and seven are restricted to Indo-Malayan Tropical Dry Zone (see appendix). Three sub-species endemic to the Cardamom Mountains Ecoregion were identified during the study: the ochraceous bulbul (*Alophoixus ochraceus cambodianus*), striped tit babbler (*Macronous gularis saraburiensis*) and white-bellied yuhina (*Yuhina zantholeuca canescens*). Also, 30 species that are listed in CITES appendices were recorded (see appendix).

2.3.5. Species accounts

Species of Global Conservation Concern

Green Peafowl (*Pavo muticus*)

There was one recording of this globally threatened species by means of track identification using local guides at site A in an area of grassland habitat in close proximity to a large river. Five audio recordings were made at site B all of which were in close proximity to the Preaek Kon Tourt River with the first audio record made on 28th October 2008. All other audio records were in early November. Four recordings were made approximately 15 km along the river in an area of dense semi-evergreen forest and the third record was made close to the Kon Tourt village near agricultural land. Historically this species was widespread throughout Asia but through hunting and habitat fragmentation this species now only occurs in reduced fragmented populations (BirdLife International, 2001). Conversations with park rangers and local hunters suggest that this species is not targeted by hunters due to a particular respect that local people have for the species beauty and possibly more significantly due to the low trade value of this species compared to other hunting targets such as Asian slow loris *Nycticebus coucang* or sunda pangolin *Manis javanica*. It is quite possible that Botum Sakor contains a healthy population of this globally threatened species. There are reliable reports of a large roost near the village of Chamkar Leu on the east cost while the Preaek Ta Ok and Stueng Ko in particular contain good quality green peafowl habitat. Species-specific studies during the breeding season could potentially provide an estimate of density within Botum Sakor.

Lesser Adjutant (*Leptoptilos javanicus*)

There were 13 recordings of this globally threatened species. Eleven of these were at the most western parts of the Preaek Kon Tourt particularly around open grasslands and meadows, while there were only two records at the eastern end of the river near brackish waters. Despite possessing a large range throughout south and southeast Asia, populations are thought to be decreasing with egg collecting, felling of nesting trees and loss of wetland habitats being reported as the principal causes (Birdlife International, 2001). Future studies will aim to determine the extent of this species range and whether or not this species is breeding within Botum Sakor.

Great Hornbill (*Buceros bicornis*)

There were eight recordings of this near threatened species at site A all of which were in areas of tall canopy evergreen forest with seven out of the eight recordings in July. At site B this species was regularly encountered within close proximity to the Preaek Kon Tourt River, usually found perched in the tallest trees. Groups of up to five individuals were observed at this location. Observations also increased as the wet season came to a close and rains became less frequent suggesting some degree of population movement between Botum Sakor and other forested areas such as the Cardamom Mountains or higher altitude areas of Botum Sakor. At site B the first record was on 9th November 2008 and observations became more frequent throughout this month and December. Systematic studies are currently being undertaken that aim to estimate the density of this species in Botum Sakor.

Darter (*Anhinga melanogaster*)

There was only one observation of this species in an area of brackish water close to mangrove habitat at the beginning of October 2008. The low number of records suggests that this species exists at low densities within Botum Sakor. Future surveys along other rivers such as Preaek Ta Ok will aim to investigate this. This is the first modern time record of this species in the southwest of Cambodia (see Engelbach, 1948).

Grey-headed Fish-Eagle (*Icthyophaga icthyaetus*)

Two observations were recorded of this species at site B. Both observations were made approximately 15 km along the Preaek Kon Tourt River above an area of high quality evergreen forest approximately 100 masl near

the route 48 highway. This species was distinguished from the lesser fish-eagle (*Ichthyophaga humilis*) by the white tail with terminal black band. Lesser fish-eagle was not recorded in this study.

Species of Regional Conservation Concern

Wreathed Hornbill (*Aceros undulatus*)

This species was only recorded at site B with numbers of observations increasing with the onset of the dry season. Sightings of this species have been recorded at Site A during the dry season out with the survey period of this study suggesting a degree of regional migration as with the great hornbill. Noticeably more common than the great hornbill, groups of three or four individuals were regularly observed while on one occasion a group of 12 was observed.

Green Imperial Pigeon (*Ducula aenea*)

Threatened in both Laos and Thailand (Setha and Poole 2003) this species was found to be extremely common at both study sites and is potentially the commonest pigeon species in the area. Records were largely of individuals or pairs however a group of approximately 30 individuals was observed at study site A.

Black Kite (*Milvus migrans*)

There were three records of this species at site A all of which were from the route 48 highway near forest edge and meadow habitat. There was a single record of this species from the Preaek Kon Tourt River at site B in October 2008.

White-bellied Sea Eagle (*Haliaeetus leucogaster*)

Only recorded at site B there were five observations of this species. One observation was over freshwater 15 km along the Preaek Kon Tourt River whilst four observations of four separate individuals were recorded from a boat survey on brackish waters close to the river mouth. There appears to be at least one breeding pair close to the river mouth.

Woolly-necked Stork (*Ciconia episcopus*)

There were three recordings of this species at site A and eight at site B. As with the lesser adjutant all observations were close to grassland habitat. This species appeared to be more widespread in its distribution within Botum Sakor compared to lesser adjutant as there were recordings at both study sites and its distribution appeared to be more even along the Preaek Kon Tourt River.

Black-and-red Broadbill (*Cymbirhynchus macrorhynchos*)

The presence of this species is known from a single observation at the western end of the Preaek Kon Tourt River at site B where the river is narrow and densely vegetated.

Golden crested Myna (*Ampeliceps coronatus*)

A single group of approximately six individuals was recorded over the Preaek Kon Tourt River at site B in an area of semi-evergreen river edge forest.

Hill Myna (*Gracula religiosa*)

This species was observed to be common at both study sites and was recorded on a daily basis. Observations were more frequent at site B than site A. Observations were largely of pairs however groups of six or seven individuals were occasionally observed at both study sites.

2.3.6. Discussion

Avifaunal diversity in Botum Sakor National Park was estimated at approximately 200 species. Botum Sakor has a substantial bird community and this level of diversity is comparable to other protected areas such as Kirirom and Ream National Parks (Goes *et al*., 1998), Phnom Samkos Wildlife Sanctuary (Steinheimer *et al*., 2000) and the southern Cardamoms (Daltry & Kuy 2003; Pilgrim & Pierce, 2003). There is a large diversity of habitats within Botum Sakor with various forests, freshwater and coastal habitats present. This variation in ecosystems suggests that Botum Sakor may be a important area for many bird communities.

Five species were identified that are of particular conservation interest due to their global status while the presence of a potentially unhunted population of green peafowl is particularly interesting. There also appears to be a substantial population of lesser adjutant and great hornbill although populations here are likely to be somewhat smaller than those in other areas of Cambodia such as Tonle Sap and the Cardamom Mountains. It also remains unclear as to whether or not these species are breeding within Botum Sakor. Surveys in habitats not covered in this study such as the Preaek Ta Ok and the relatively undisturbed small mountain range in the northwest of the park may result in the recording of additional species.

Areas which contain several species of conservation importance should be afforded high levels of protection in order to preserve bird communities. High levels of disturbance were noted at both study sights while disturbance levels are potentially higher on the western and southern sides of the park. Evidences of illegal logging and poaching were encountered during the study while the planned development of a power station and possible tourist resorts in the southwest adjacent to Kaoh Sdach Island will undoubtedly threaten important bird habitats.

At present Botum Sakor meets two criteria for the designation as an Important Bird Area (IBA). Criteria A1 is met as there are substantial populations of species which are of global conservation concern and criteria A3 is met as Botum Sakor also possesses significant numbers of a bird species whose distribution is confined to one biome (Kim Hout *et al*., 2003). Therefore, it is recommended that Botum Sakor should be designated as an IBA. Until population densities of key species can be estimated this designation should be at the national level. Initial studies and conversations with locals suggest that diversity within Botum Sakor is highest around the Preaek Ta Ok, north through the Preaek Kon Tourt and NH 48 highway, and west towards the small mountain range. Any IBA designation should encompass these areas.

Further studies within Botum Sakor are planned with the aim of determining more detailed information on the distribution of key species within the park. Areas of the park which are important for key species such as the lesser adjutant and green peafowl should be identified and future conservation measures aimed at preserving these habitats. A small number of observations of great hornbill resulted in accurate distance data being collected and it is an objective of future fieldwork to estimate the density of this species. A number of species of global conservation interest that occur in the southwest of Cambodia such as black-necked stork (Daltry & Kuy 2003), brown hornbill (Goes *et al*., 1998) chestnut-headed partridge (Daltry & Kuy 2003; Goes *et al*., 1998; Steinheimer *et al*., 2000), milky stork (Daltry & Kuy 2003), silver oriole (Daltry & Kuy 2003; Pilgrim & Pierce 2006) and white-winged duck (Daltry & Kuy 2003) were not recorded in this study. It is a key objective of future surveys to further investigate the presence or absence of these species so that their distribution and habitat requirements can be further analysed and their status assessed.

2.4. Avifaunal diversity survey

2.4.1. Introduction

This study reports on avifaunal diversity estimates from two study sites in Botum Sakor. Diversity estimates were calculated using the computer programme EstimateS (Colwell 2006).

2.4.2. Methods

At both study sites A and B, the total number of species and individuals were recorded each day allowing the diversity estimator programme EstimateS (Colwell 2006) to be used to estimate species diversity. Only species recorded in the forest and meadow habitat were used to predict diversity at Site A while only species recorded around riverine habatitat were used to predict diversity at Site B. Total survey effort was 70 hours or 81 km at site A and approximately 50 hours or 156.35 km or boat surveys at site B. The Chao 1 estimator and the Chao 2 and MMMeans estimators recommended by Herzog *et al.* (2002) were used to predict diversity.

2.4.3. Results

At Site A a total of 119 species were identified from surveys and opportunistic sightings. A total of 32 days of data were collected. Using the Chao 1 estimator species diversity within forest and meadow habitat was estimated at 155 species (95% CIs 134 and 209); the Chao 2 estimator estimated diversity to be 150 species (95% CIs 133 and 188) while the MMMeans estimator produced an estimate of 144 species. Using the average of these three estimates provides an avifaunal diversity estimate of 150 species. It is estimated that approximately 84% of species present within the forest and meadow habitat were recorded during the project.

At Site B 136 identified species were recorded, and used to estimate diversity. A total of 15 days of data were collected. Using the Chao 1 estimator species diversity was estimated at 168 species (95% CIs 142 and 226); the Chao 2 estimator estimated diversity to be 235 species (95% CIs 175 and 361) while the MMMeans estimator produced an estimate of 144 species. Using the average of these three estimates provides an avifaunal diversity estimate of 182 species. It is estimated that approximately 63% of species present were recorded during the project.

2.4.4. Discussion

Bird diversity was estimated to be higher at site B than at site A. This was expected as the diversity of habitat was greater at site B than at site A. At site A, only species identified in meadow or evergreen broad-leaf habitat were used to estimate diversity. However at site B species identified on the river, in river edge forest, meadow habitat, melaluca forest, mangrove forest and brackish water habitat were all used to estimate diversity.

It could be concluded that site B is a more important area for bird conservation in Botum Sakor National Park. However, species composition was somewhat different between the two study sites (*See section 3.9*). Site A contained a larger number of species restricted to broad-leaf forest, while site B contained a larger number of species whose distributions are restricted to riverine or coastal habitats.

In addition, the number of days for which data were collected was lower at site B than that at site A (15 compared to 32 respectively). The Chao 2 estimator is more sensitive to sample size than the other estimators used and consequently the Chao 2 estimator provided a large diversity estimate which is probably inaccurate. This swayed the average diversity estimate from the three estimators upwards. Consequently, with a larger sample size we might expect a smaller diversity estimate for site B closer to that of site A.

2.5. Riverine biodiversity survey

2.5.1. Introduction

This survey documents encounter rates for bird species associated with rivers along the Preaek Kon Tourt river, with density estimates for Botum Sakor National Park produced for key species.

2.5.2. Methods

The full 22.75 km length of the Preaek Kon Tourt river, and 1.6 km of a subsidiary river, were divided into 7 transects. Transects were surveyed between 07:00 and 10:00 to correspond with the greatest period of bird activity. Late afternoon transect surveys were also conducted between 16:00 and 18:00. Survey teams consisted of 3 or 4 individuals, one person acting as principal observer because they had significantly more experience in bird surveys. All kingfishers, large raptors, hornbills, storks and and any other species of conservation importance were recorded. Each transect was surveyed on at least 3 occasions. The total length of surveys along fresh water was 130.85 km, while the total length of freshwater and brackish water surveys was 156.35 km².

For species whose distribution cannot be expected to extend into brackish water, such as the hornbills and kingfishers, their encounter rate was calculated as the total number of observations/total length of freshwater transects surveyed. For those species whose distribution can be expected to extend throughout freshwater and brackish waters their encounter rates were calculated as total number of observations/total length of freshwater and brackish water transects surveyed.

Density estimates were calculated large raptors and storks as their distribution will extend from the river, and population density estimates for these birds can be applied to the whole national park (1826 km²). It was estimated that during surveys observers had a visibility range of 500 metres on either side of the river in which to observe birds in flight. The total area survey was then estimated as 1 km x total survey length. The estimated density for species within this area was then extrapolated to the whole national park.

2.5.3. Results

Species	Total Observations	Survey Area (km²)	Encounter Rate (Individuals/km²)	Density Estimate (Individuals in national park)
Osprey	2	156.35	0.013	24
White-bellied sea eagle	6	156.35	0.038	70
Grey-headed fish eagle	2	156.35	0.013	24
Woolly-necked stork	4	130.85	0.026	47
Lesser adjutant stork	9	130.85	0.06	106

Table 1: Encounter rates and density estimates of large raptors, storks and hornbills

Table 1 displays encounter rate and density data for all identified large raptors and storks. Some other large raptor species were identified during the study (e.g. oriental honey buzzard) but density estimates were not included due to identification difficulties. Great hornbills were counted, but results were not produced for this species, as surveys were largely conducted after the period of greatest great hornbill activiy (between 05:00 and 07:00). It was therefore likely that density estimates based on hornbill activity would be underestimated.

Species	Total Observations	Total Survey Length (km)	Encounter rate (individuals/km)
Black-capped kingfisher	23	130.85	0.19
Common kingfisher	2	130.85	0.02
Blue-eared kingfisher	2	130.85	0.02
White-throated kingfisher	1	130.85	0.01
Oriental darter	1	130.85	0.01

Table 2: Encounter rates of kingfishers and darter

Table 2 displays encounter rate data for all kingfishers identified during the study and the darter species present in the park. Four species of kingfisher which have previously been identified in Botum Sakor (*see section 3.9*) were not observed during this study and so are not listed in table 2. The black-capped kingfisher was by far the most common kingfisher identified on the Preaek Kon Tourt. Insignificant numbers of 4 other species of kingfisher were recorded.

2.5.4. Discussion

Density estimates for the national park were applied to 3 species of large raptor and 2 stork species. This assumes that encounter rates for the Preaek Kon Tourt river are standard across the whole park. This is unlikely to be true as the habitat is highly heterogeneous, and species distributions are likely to be uneven across the park. The white-bellied sea eagle, grey-headed fish eagle and osprey are all water dependent, and as most of the survey effort was conducted along rivers, density estimates of these species for the whole park are likely to be overestimated. However, with an estimate of 500m visibility on either side of the river, it is also likely that surveys would have not recorded many birds perched on trees within the study area. These factors make the results of raptor density estimates unreliable. It would perhaps be more appropriate to extrapolate the actual encounters of these species to the total length of river-edge habitat available in the park to estimate population size. Alternatively, direct counts of these species throughout different areas of the park will provide a better estimate of species density.

Though also associated with riverine habitats, lesser adjutant and woolly-necked stork have been observed in other areas of the park. Woolly-necked stork has been observed in the drier north of the park and in meadow systems around the Preaek Ta Ok river. Density estimates for these species may not be as dependent on habitat homogeneity. Future studies should attempt to ascertain levels of dependence on riverine habitat for stork species.

Encounter rates were obtained for four species of kingfisher and oriental darter. Of these species only the larger black-capped kingfisher was recorded on a regular basis. As this large species is strongly associated with large streams and rivers, its encounter rate estimate should be reliable. However, the other 3 kingfisher species are generally associated with small forest streams, a habitat type not surveyed during this study. The survey method used was therefore deemed inappropriate for these species. The oriental darter was observed on only 1 occasion. This globally near threatened species is likely to occur in Botum Sakor in extremely low densities and it is unlikely that a viable population exists in the park. It is known to occur in neighbouring rivers such as the Preaek Chipat and Preaek Sre Amble, but it is unlikely that this one observation suggests a significant population living along the Preaek Kon Tourt river.

2.6. Hornbill survey

2.6.1. Introduction

There are thought to be four hornbill species in Cambodia: the great hornbill (*Buceros bicornis*), wreathed hornbill (*Aceros undulatus*), brown hornbill (*Anorrhinus tickelli*) and the oriental pied hornbill (*Anthracoceros albirostris*). Two of these species; the great hornbill and brown hornbill, are of global conservation concern as they are listed as globally near-threatened (Birdlife International 2001). The wreathed hornbill is of regional conservation importance as it is threatened in Thailand. To date, Frontier has identified the great hornbill, wreathed hornbill and oriental pied hornbill within Botum Sakor National Park, though as yet no information on their abundance, density or distribution has been obtained. Hornbill species are often the some of the first to disappear in heavily disturbed forests as their density is associated with the number of tall trees in the forest, which are particularly threatened by logging. Logging has been identified as a serious threat in Botum Sakor by Frontier, with potentially serious implications for hornbill populations.

The aims of this study were to identify hornbill species within Botum Sakor during systematic bird surveys and use distance data (Buckland *et al*. 1993) to estimate species density.

2.6.2. Methods

Existing paths, rivers and roads were used for systematic rapid assessment surveys using line transect methodology (Bibby *et al*. 2000). Systematic surveys were conducted between 06:00 and 09:00, while afternoon walks and boat trips were conducted between 16:00 and 19:00. Total survey effort was approximately 50 hours or 156.35 km. Visual identifications were based upon the field guides 'Birds of South-East Asia' and 'A Field Guide to the Birds of Cambodia' (Robson 2007; Setha and Poole 2007), while audio identifications were based upon reference CDs (e.g. Birds of Tropical Asia 3.0, Scharringa 2005). Ministry of Environment rangers assisted with species identifications. During transects the distance to the individual or group was estimated visually, and measured using a measuring tape where possible.

Data analysis was based on line transect distance sampling outlined by Buckland *et al*. (1993). The Distance programme (Laake *et al*. 1993) was used to estimate the density of hornbill species. The highest density result was not used so as to remove outliers as suggested by Andriolo *et al*. (2005).

2.6.3 Results

It was estimated that oriental pied hornbills density in Botum Sakor National Park was 8.664/km^2, with anomalous results removed. Site density observations ranged from 3.31-22.65/km^2. Wreathed hornbills were estimated at a density of 1.877/km^2, with observations ranging from 0.69-5.08/km^2 at different sites. Extrapolated to the whole national park area, this gives population estimates of 15,820 oriental pied hornbills, and 3427 wreathed hornbills within Botum Sakor.

2.6.4. Discussion

The oriental pied hornbill is the most common hornbill species found in Botum Sakor National Park, and has been observed by Frontier in most areas. It is not associated with riverine habitats. Previous studies have estimated that up to 20,000 individuals may be present in the park, and this general estimate is backed up by the study from October-December. The wreathed hornbill is also quite common, and associated with evergreen broad-leaf forest areas which comprise a significant area of the park. It is therefore likely that wreathed hornbills are fairly evenly distributed across Botum Sakor, and that the population size is reasonable. It is hoped that future surveys will confirm these healthy populations of hornbill. With regard to great hornbills, studies were not able to accurately determine density estimates within the park, as great hornbills are not active at the same time as oriental pied and wreathed hornbills. Future studies should be able to develop population density estimates for this species.

2.7. Summary of proposed outputs and future directions

By the end of the October-December 2008 research phase, the sampling effort from ornithological studies should be such that writing a journal article is a realistic aim. This paper would be an overall analysis of the diversity of avifauna in Botum Sakor with species accounts on those recorded species which are of conservation importance at the global and regional scale. This would use data that has been systematically collected but could also mention past records from Frontier providing their credibility can be ascertained. As the Cambodian Journal of Natural History has recently been developed Frontier should aim to produce an output for this. It may also be possible to write an article on hornbill densities in Botum Sakor National Park.

Chapter 3. Opportunistic records (Alexander Royan)

3.1. Introduction

This report documents the results of opportunistic field records of mammal, reptile and amphibian species recorded by Frontier staff between October and December 2008.

3.2. Methods

During previous projects, research assistants were encouraged to make a note of opportunistic sightings of reptiles and amphibians, and also to identify scat samples and tracks of mammals. Sightings were recorded in a separate book with notes made on date, sighting, location and observer. Species were identified using field guides (Cox *et al*. 1998, King *et al*. 1975, Lekagul 1988, Lekagul & Round 1991, Lim & Lee 1990, Robson 2000, Stuart *et al*. 2001) and by consulting in-country specialists. Where possible, two voucher specimens (one male, one female) were taken for previously undetected species which could not be identified in the field. Notes were made on species' status (IUCN, 2008), the type of evidence utilised in forming a species record, and the location of the record.

3.3. Results

Species	Common name	Status	Evidence	Location	No.
Muntiacus vaginalis	Northern red muntjac		Sighing/tracks	Throughout	Unk.
Rusa unicolor	Sambar Deer	VUL	Tracks	N11°09.440E103°22.942' N11°10.038E103°20.949' N11°10.517E103°20.604' N11°10.406E103°20.860'	Unk.
Ratufa bicolor	Black giant squirrel	NT	Sighting/audio	River edge throughout	Unk.
Callosciurus finlaysonii	Variable squirrel		Sighting/audio	Throughout	Unk.
Tamiops rodolphii	Cambodian striped squirrel		Sighting	Throughout	Unk.
Tragulus javanicus	Lesser mouse deer		Sighting/audio	Throughout	2
Prionailurus viverrinus	[Fishing cat]	END	Tracks	N11°09.224E102°20.166' N11°10.172E103°20.864' N11°09.220E103°22.981'	3
Macaca fascicularis	Long-tailed macaque		Sighting/audio	N11°09.936E103°21.430' N11°09.750E103°22.751'	Unk.
Hylobates pileatus	Pileated gibbon	END	Audio	Throughout on north of river	Unk.
Sus scrofa	Eurasian wild pig		Tracks	Throughout	Unk.
Trachypithecus cristatus	Silvered langur	NT	Sighting/audio	N11°09.610E103°22.893'	6
Arctogalidia trivirgata	Small-toothed palm civet		Sighting	Throughout	4
Paguma larvata	Masked palm civet		Sighting	N11°09.750E103°22.751'	3
Tupaia belangeri	Northern tree-shrew		Sighting	Throughout	Unk.
Lutrogale perspicillata	[Smooth-coated otter]	VUL	Sighting/audio	N11°10.038E103°21.590' N11°09.856E103°22.046'	2
Cuon alpinus	Dhole	END	Tracks/scat	N11°10.514E103°20.292'	1
Helarctos malayanus	[Malayan sun bear]	VUL	Tracks	N11°09.253E103°22.991'	1
Elephas maximus	Asian elephant	END	Tracks	N11°09.097E103°20.833'	1

Table 3: Opportunistic sightings of mammals between October-December 2008; species in [] are unconfirmed records
Status: END, *endangered;* VUL, *vulnerable;* NT, *near threatened*

A total of 17 species of mammal were identified this phase through opportunistic sightings, scat samples and track identification. Of this total, 9 species are of particular interest due to their global status. The Asian elephant *(E. maximus)*, fishing cat *(P. viverrinus)*, pileated gibbon *(H. pileatus)* and dhole *(C. alpinus)* are listed as endangered. The smooth-coated otter *(L. perspicillata)* and sambar deer *(R. unicolor)* are listed as vulnerable, while the silvered langur *(T. cristatus)* and black giant squirrel *(R. bicolor)* are listed as globally near threatened (IUCN, 2008). The Malayan sun bear *(H. malayanus)* is an unconfirmed record, due to track identification difficulties, but this species is the most likely to be the one recorded due to the low altitude of the tracks found. This species is also listed as vulnerable to extinction. This was the first time that silvered langur had been recorded on the eastern side of the park. There was one previous record from the west of the park at Preaek Dumb Bang, of an individual captured by locals.

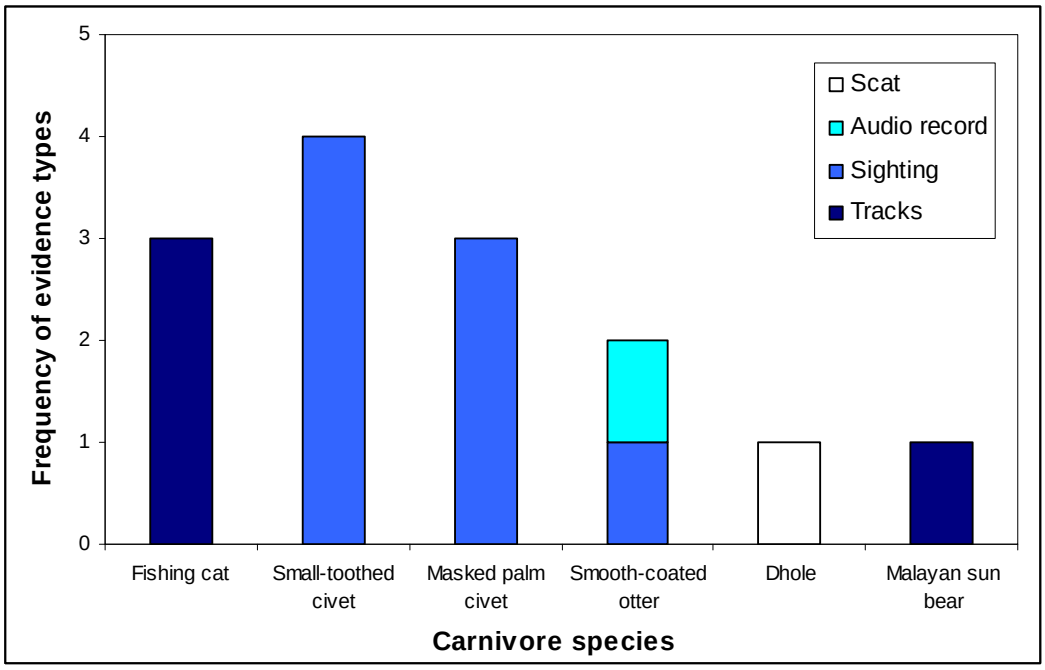

Figure 1: Evidence of carnivore species in Botum Sakor from October-December 2008

This figure shows the frequency of records of some of the key carnivore species found within Botum Sakor National Park. Particularly interesting are the three track records indicating fishing cat presence in the park. This endangered species is in decline throughout its range in South-East Asia, but there have been some unconfirmed sightings in Botum Sakor. The park contains ideal fishing cat habitat, and it is likely that a healthy population of cats may exist within the park. Future studies will attempt to ascertain population densities of this species in Botum Sakor. The potential presence of dhole within Botum Sakor is also interesting as this species is endangered, highly range restricted, and populations are assumed to be in decline.

Species	Common name	Evidence	Location	No.
Calotes versicolor	Garden fence lizard	Sighting	N11°09.750E103°22.751'	2
Dendrelaphis pictus	Common bronzeback tree snake	Sighting	N11°09.750E103°22.751'	1
Trimeresurus gramineus	Bamboo pit viper	Sighting	N11°09.891E103°21.936'	1
Mabuya macularia	Speckled forest skink	Sighting	N11°09.750E103°22.751'	2
Lygosoma isodactylum	Even-toed supple skink	Sighting	N11°09.655E103°22.747'	1
Mabuya longicaudata	Long-tailed skink	Sighting	N11°09.750E103°22.751'	1
Lygosoma bowringii	Bowring's supple skink	Sighting	N11°09.655E103°22.747'	2
Gekko gecko	Tokay gecko	Audio	N11°09.891E103°21.936'	2
Cyptoblepharus boutoni	Striped tree skink	Sighting	N11°09.750E103°22.751'	1
Oligodon taeniatus	Striped kukri snake	Sighting	N11°09.217E103°22.338'	1
Calloselasma rhodostoma	Malayan pit viper	Sighting	N11°09.750E103°22.751'	1

Table 4: Reptile opportunistic sightings from October-December 2008

Species	Common name	Status	Evidence	Location	No.
Hylarana mortenseni	Mortensen's frog	VUL	Audio	River side at base camp	2
Rana fasciata	Long-toed frog		Sighting/Photo	Base camp	2
Micryletta inornata	Ornate narrow-mouthed frog		Sighting	N11°09.622E103°22.735'	1
Polypedates leucomystax	Common tree frog		Sighting	Base camp	1
Kalophrynus interlineatus	Striped sticky frog		Sighting	N11°09.416E103°22.477'	2
Rana erythrae	Red-eared frog		Sighting	Base camp	1

Table 5: Amphibian opportunistic sightings from October-December 2008

A total of 11 species of reptile and six species of frog were recorded, all of which have previously been recorded by Frontier.

3.4. Discussion

Botum Sakor has a large number of mammal species of high conservation concern. Five species listed as endangered, and a further three species listed as vulnerable to extinction were recorded. Opportunistic sightings of reptiles, amphibians and butterflies found no new records but did record Mortensen's frog (*H. mortenseni*), particularly interesting as its global status is data deficient, and the range-restricted red-eared frog (*R. erythrae)*.

Mortensen's frog is listed as vulnerable to extinction, as its distribution is thought to be confined to southwest Cambodia and the western sections of the Cardamom mountains in Thailand. This species was found to be common within the study area, and is of particular interest to research scientists. Prior to this record, the red-eared frog had previously only been recorded in the Cardamom mountains, so its presence in the park is of interest to researchers. This species appears to be common in Botum Sakor and was also described as being common throughout its range in the Cardamoms by Daltry *et al*. (2003).

With findings of such a large number of rare mammal species it should be a key objective of future Frontier research phases to collect as much distribution information on these species as possible. Producing a scientific output documenting the mammal species list that we have obtained should be regarded as a matter of urgency. Objectives of research commencing February 2009 are to use local interviews to obtain distribution information on key mammal species and use this to compliment data Frontier has already obtained.

Chapter 4. Trapping of Lepidoptera (Rosie Irwin)

4.1. Introduction

Lepidoptera are a hugely diverse order with approximately 27,000 described species from the oriental region alone (Hepper, 1991). Research was carried out on butterfly and moth species in different habitats in Botum Sakor National Park.

4.1.1. Butterflies

Butterflies are a key indicator family for a variety of reasons. They are easy to collect and identify, have a short life span, and a narrow geographical range. These factors make them particularly sensitive to environmental change. This means that any environmental disturbance may impact upon populations in the area within a short time frame, allowing for conservation measures to be implemented before the ecosystem is irreversibly damaged. Areas with large numbers of indicator species suggest well preserved habitat and intact ecosystems and are therefore afforded greater conservation importance and protection.

4.1.2. Moths

In previous research phases, Frontier had collected any moth species found opportunistically, with no real experimental design. Only one research project has previously studied moths in Cambodia, in the Cardamom Mountains of the south-west (*Daltry and Momberg, 2000*). This study was carried out over a period of 12 nights on a "snout moth" super-family. 1427 specimens were taken, and a total of 292 species identified. Frontier aimed to study any of the larger moths with wingspans of at least 3.5cm, and compile a species list by making detailed sketches and specimen photographs.

4.2. Methods

4.2.1. Butterflies

A total of four trap-sites were studied for ten nights each, using six hand-made Blendon's canopy traps (three with metal plates and three with plastic). At each trap-site a different habitat type was observed, with traps separated at a roughly equal distance of 50m. They were placed in pairs of one plastic and one metal trap, so as not to bias any results towards the new plastic traps. Trap heights were also varied with two at 2m, 4m and 6m. Three rotten bananas were used as bait for each trap-site, with bait renewed approximately every 5 days. Each canopy trap-site was checked in the morning between the hours of 6.30am-8am and then again in the afternoon between the hours of 3pm-4pm. Any captures were recorded in appropriate data sheets in the morning and afternoon relating to each day and particular trap. Notes on habitat and vegetation were also taken for each canopy trap. Due to the lack of knowledge of Cambodian butterflies, we were unable to identify many of the species.

4.2.2. Moths

Moth species present in the traps were recorded using the same method as for butterflies, though captures were only recorded in the morning. Again due to lack of identification material we decided only to note how many captures there were. We photographed and sketched only the large 'hawk-like' (*Sphingidae*) moths and took a specimen if possible (*See: Appendix 1e*).

A new, different method of capture, 'sticky-traps' was trialled on this project. A sugary and sticky bait food (boiled condensed-milk) was painted on two trees on an open track near camp (butterfly trap-site 1), so that they could be easily checked every 30mins for captures. A further two trees were also baited at trap-site 2 – dense forest this time with attached torch light above the bait. This was checked at 8pm and again at 5am. Notes were taken on the general habitat and tree species.

4.3. Results

4.3.1. Total captures

	No. of individual butterflies	No. of individual moths	No. of butterfly species	No. of moth species
Swampy forest	**85**	**n/a**	**20**	**n/a**
Dense forest	**50**	**126**	**10**	**10**
Meadow	**10**	**52**	**3**	**10**
River edge	**20**	**20**	**5**	**4**

Table 6: Total captures of lepidoptera from October-December 2008

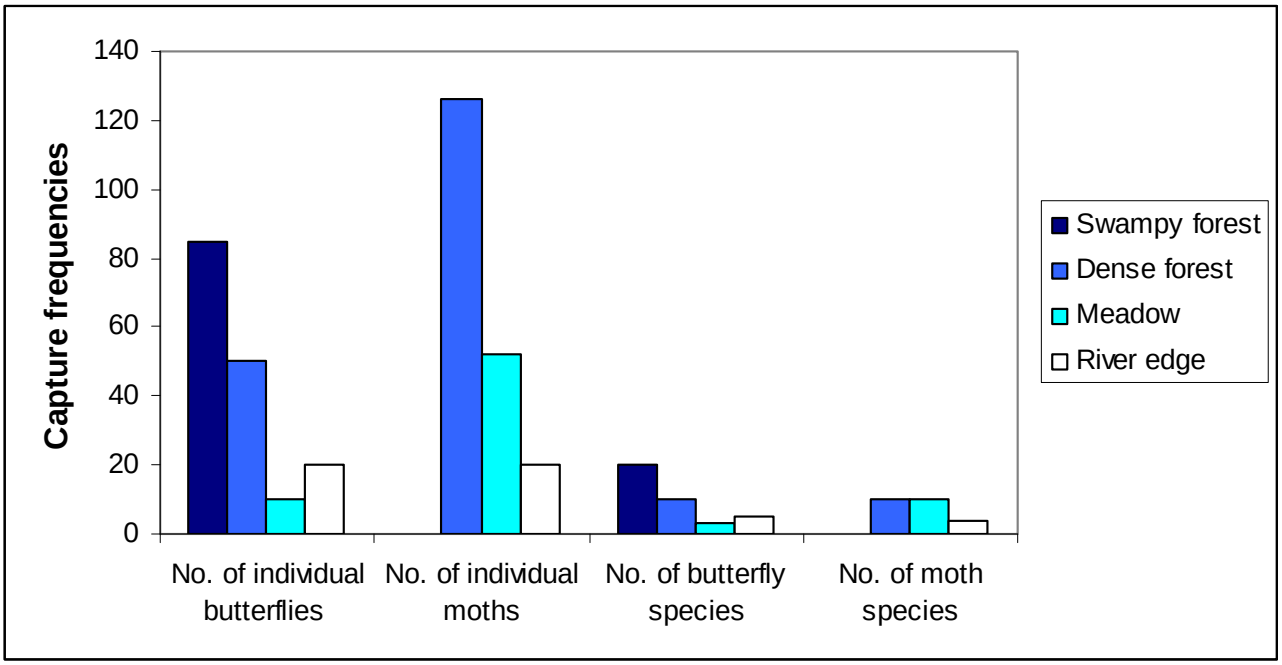

Figure 2: Capture frequencies of Lepidoptera by habitat type from October-December 2008

The swampy forest habitat recorded the highest number of butterfly captures, and highest lepidopteran diversity of all surveyed habitats; with 85 individual captures, and 20 species recorded. Unfortunately, moth species were not surveyed in this location, so results cannot be compared. Records in the dense forest habitat show that moths preferred this out of the 3 habitat types surveyed. There were 126 captures made in total here, more than twice the capture-rate for butterflies in the same habitat. The dense forest and meadow habitats both had a total of 10 moth species observed, with four species exclusive to each. However, the meadow habitat recorded the lowest number of butterfly captures, with only 10 individuals and just 3 recorded species. The river-edge habitat had only one mutually exclusive species, and low individual capture rates, indicating that most lepidopteran species prefer non-riparian habitats.

There were no recorded captures using the 'sticky trap' method, with or without the addition of the torch, either at the forest edge, or in the dense forest habitat.

4.3.2. Per-trap capture rates

Data from individual traps in different habitat are presented giving a clearer picture of population density and species diversity in the different habitats than total results, which do not make it obvious if data is skewed by one particularly productive trap.

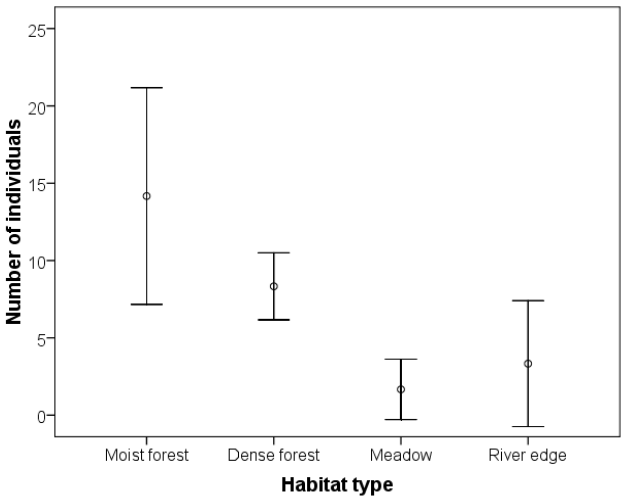

Fig. 3: Per-trap capture rates for individual butterflies in different habitats

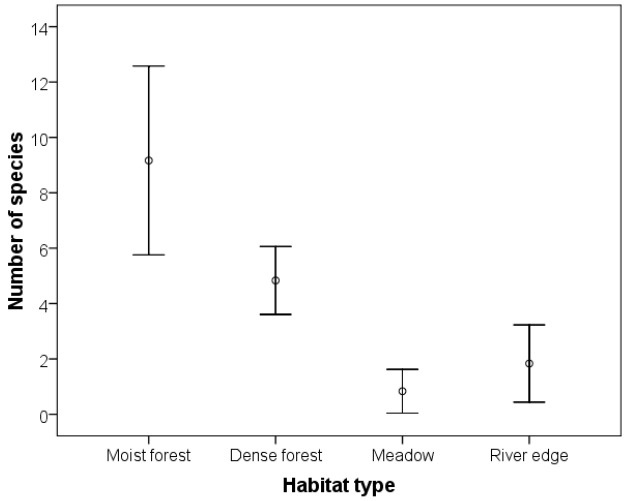

Fig. 4: Per-trap capture rates for butterfly species in different habitats

Results suggest that no particular species dominate the preferred habitat types of swampy and dense forest. For example, in the swampy forest, a mean of 14.16 captures were made per trap, with a mean of 9.16 species recorded. The meadow habitat was the least preferred, with a mean of 1.66 captures per trap and less than 1 species recorded per trap. Captures in river edge habitat were also few.

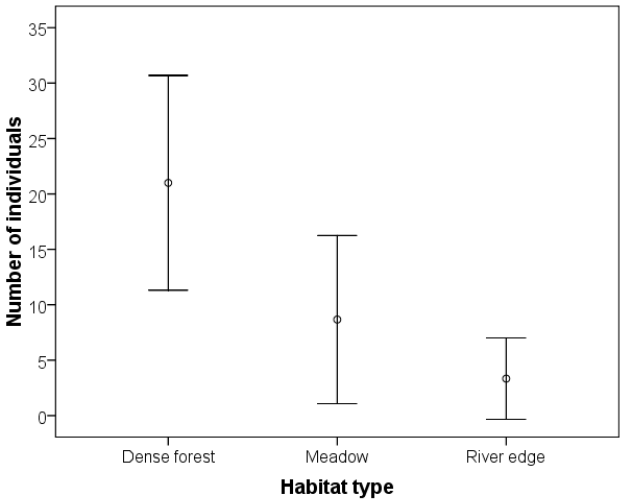

Fig. 5: Per-trap capture rates for individual moths in different habitats

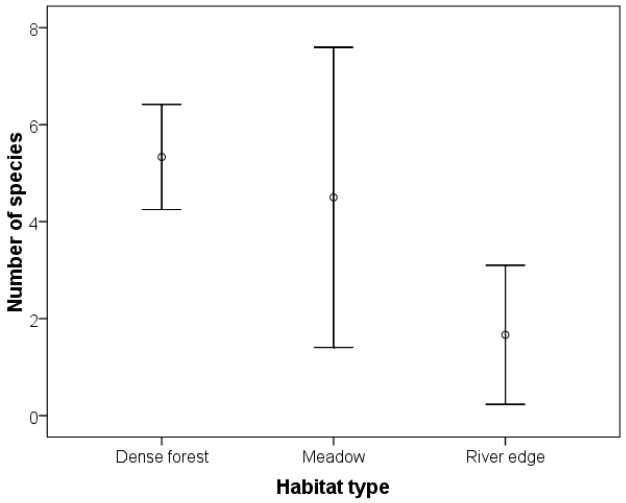

Fig. 6: Per-trap capture rates for moth species in different habitats

Results for moths differed from those for butterflies, as proportionately fewer species were recorded compared to number of individuals captured. Most individuals were captured in the dense forest habitat, with a mean of 21 moths per trap. This was the highest mean capture-rate for all lepidoptera in any habitat type, and far higher than the mean of 8.66 individual butterflies recorded in the same habitat. However, with a mean of around 5 species for each, the dense forest recorded a similarly small number of species as the apparently less populated

meadow habitat, and this is reflected in the total result of 10 species recorded in both of these habitats. The river edge habitat again produced few captures.

4.3.3. Lepidopteran species richness

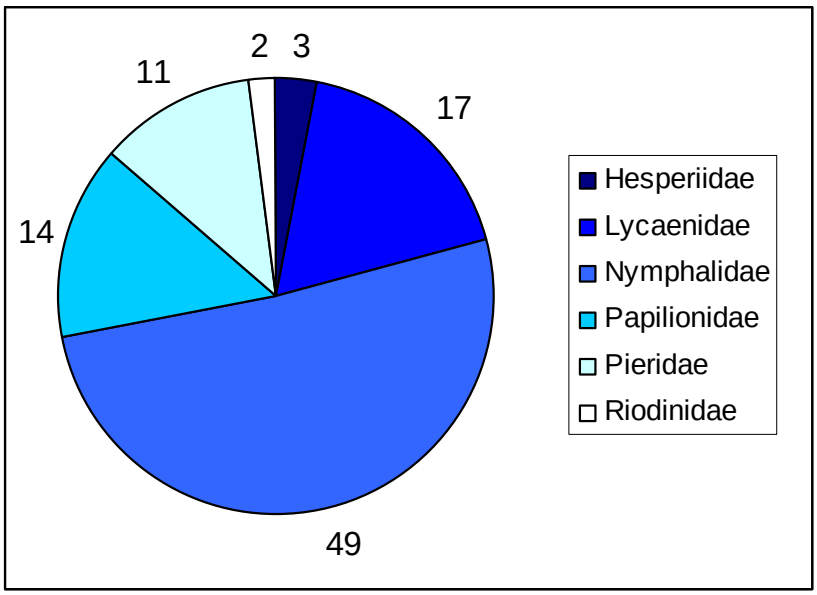

Figure 7: Total number of butterfly species recorded by family

The most species of butterfly recorded in one family was for Nymphalidae, with a total of 49 species recorded. There were records of more than ten species in each of the Lycaenidae, Papilionidae and Pieridae families, with very few species records for Hesperiidae and Riodinidae.

	HABITAT			
FAMILY	**Swampy Forest (1)**	**Dense Forest (2)**	**Open Meadow (3)**	**River Edge (4)**
Nymphalidae	44	42	0	7
Satyridae	38	3	9	1
Amathusiidae	3	5	0	12
Lycaenidae	0	0	1	0

Table 7: Mean number of butterfly species across each family represented in each of the four habitat types.

Nymphalidae was the most commonly recorded butterfly family, preferring dense and swampy forest. The Satyridae family was also frequently recorded in the swampy forest habitat. The Amathusiidae family was recorded most frequently in the river edge habitat. The common evening brown butterfly (*Melanitis leda:* Satyridae) was the most common species caught, with 25 captures in the swampy forest and meadow habitats combined.

Regarding moths, a total of 14 different species were successfully recorded in photographic and detailed sketch form (*See: Appendix 1e*). Six specimens were successfully processed and labelled to allow identification by an expert. Species code No. 5 ('Flame') was captured the most, with a total of 65 captures across the 3 trap-sites/habitats, the most recorded in dense forest (habitat 1). Species code No. 3 ('Woody') was also common, with 38 captures across the trap-sites.

There were no recorded captures using the 'sticky trap' method, with or without the addition of the torch, either at the forest edge, or in the dense forest habitat.

4.4. Discussion

4.4.1. Butterflies

The occurrence of butterflies in temperate and tropical forest ecosystems has been linked to site level patterns of disturbance, as well as habitat variation at landscape and regional scales (*Dodd et al. 2008*). Lepidoptera often only feed on one particular type of food plant or one individual species of plant, and because some of these plants may be sensitive perennials and only occur in specific habitats, this restricts the habitat range of the associated butterfly species. In disturbed forests, these specialist butterfly species may be particularly affected by habitat fragmentation as they may be unable to reach food patches separated by forest gaps.

We assessed the density and species richness of different butterfly families in meadow and river-edge habitats, and two types of forest habitat. Forest habitats generally recorded a higher density of butterfly captures, with gap habitats such as meadow and river-edge recording fewer individual and species captures. Per-trap capture rates showed that the proportion of species found, in relation to individual captures, was similar in all habitat types surveyed (*see: Figures 3 and 4*). These factors suggest that no butterfly species were completely restricted from the natural meadow gap habitat, but that individuals preferred to remain within the denser forest. However, compared to the meadow and river-edge habitat, the swampy forest habitat had a high percentage of old and new palm growth, with recent cutting and clearing evident. This could explain the high percentage of disturbance indicator families, such as *Nymphalidae* and *Satyridae* (*See: Table 7*), which were not found as frequently in the meadow habitat. The most commonly recorded butterfly, the common evening brown *(M. leda)* is a well known generalist disturbance-indicator species (e.g. Hirowatari *et al. 2007*), and was particularly common in the swampy forest habitat.

Butterflies may have avoided the river-edge habitat because of the predation threat posed by birds and bats, such as chestnut-headed bee-eater *Merops leschenaultia*. The results suggest that the presence of water is preferred by many butterfly families, but that preferred habitats also contain large amounts of surrounding vegetation for food and shelter.

Some butterfly species are actually attracted to large gaps in the forest canopy, such as natural glades, and gaps caused by natural or man-made tracks, for example the meadow habitat. These are likely to be larger butterflies, with morphologies adapted for faster flight (Hill et al. 2001). It is expected that smaller butterfly species will utilize small areas with large patches containing a high density of suitable foodplants. These butterflies are the least likely to venture into gaps, such as meadow and river-edge habitats. Large butterflies are able to cover greater distances in order to exploit foodplants which may be scattered across a larger area. These butterflies are likely to exploit gaps in order to travel between food patches. It would be interesting to investigate the morphologies and size of butterflies found in different habitat types, but more work is needed into species of butterfly and migratory patterns within different habitat types in Botum Sakor.

The number of species records for each of the main butterfly families may give better clues as to how butterflies are affected by habitat disturbance in Botum Sakor National Park, as different families prefer different habitat types. Recent reclassifications of some butterfly families into sub-families meant that the field guides used to identify species in the field were not always up to date. The previously outright Satyridae, Danaidae and Amathusiidae families have now been renamed as the subfamilies Satyrinae, Danainae and Amathusiinae respectively, and placed within the expanded Nymphalidae family (Wahlberg et al. 2003). Records regarding habitat preferences of the most commonly sampled butterflies are therefore outdated in terms of taxonomy (*see Table 7*), but still reflect the large morphological and ecological variation within the expanded Nymphalidae family.

The greatest number of species records of all the butterfly families recorded was for Nymphalidae. This is a very large family of butterflies, with around 5000 species worldwide. It has many generalist, disturbance-indicator species, characteristic of secondary forest, with wide distributions and larvae that are able to feed on a broad range of host plants. With over half of the species recorded in this family, results suggest that butterfly species in Botum Sakor are threatened by habitat disturbance. The Lycaenidae, or gossamer-winged butterflies,

are another large butterfly family, with around 6000 species. This was reflected in that Lycaenidae had the second-most number of species recorded in Botum Sakor from October-December. The relatively high number of species recorded in the Papilionidae and Pieridae families compared to the Riodinidae and Hesperiidae families suggests that these families may be disproportionately represented within Botum Sakor National Park.

The finding that many species of the Amathusiinae sub-family (previously Amathusiidae) were found in the river-edge habitat in relation their abundance in other habitats is interesting, especially in view of the contrasting results for other Nymphalidae families such as Satyrinae (Satyridae). Amathusiinae are a sub-family of large butterflies, so this data supports the suggestion that large butterflies may be more abundant in gap habitats, whilst morphologically smaller sub-families such as Satyrinae are found more frequently in dense forests.

Previously, potential anomalies in data due to man-made gaps (bucket lines) were largely avoided by clearing as little as possible where needed, and hanging traps away from the bucket lines. Doubling the amount of traps also helped to produce more reliable data for future analysis of habitat preference and disturbance levels. There are many factors involved in why butterflies may prefer particular habitat types, and further research is required to determine which factors are important in determining density patterns within Botum Sakor.

4.4.2 Moths

During this research phase, there was a considerably higher capture rate for moths than for butterflies. 184 of a total of 203 moths captured could be clearly identified to 14 different species (*See: Appendix 1e*). Considerably greater numbers of moths were found in the dense forest habitat compared with the river-edge or meadow habitats. Per-trap capture rates showed similar results to those for butterflies, though we were unable to survey moth density in the swampy forest habitat. Moth captures were few in the meadow and river-edge habitats.

Daltry and Momberg (2000) found a difference in butterfly species recorded between high altitude and low altitude forest types, and differences between moist open areas, areas of green vegetation growth near water sources, and areas of damp, moist forest. Like many butterflies, some moth species prefer particular micro-habitats with specific food plants. Any disturbance to these micro-habitat types can greatly affect populations of a particular species.

We predicted fewer captures in the meadow due to potential predation by bats in the area. Variation in the abundance and species richness of insects, especially moths, is believed to have implications for the suitability of foraging habitat of insectivorous bats in temperate forest ecosystems (Burford, et al. 1999; in Dodd et al. 2008). A combined study of moth density with surveys of bat populations in the area would be desirable for future studies in Botum Sakor, in order to investigate any plausible relationship between the presence of bats in different habitats, and the density and type of moth species recorded.

4.5. Conclusions

Very little is yet known regarding lepidopteran diversity in general, or areas of high diversity in Cambodia which may in need of protection. With regard to moths, there has been especially little or no research carried out in any of the protected areas of Cambodia. With a greater number of traps used in trap-sites, future phases will hopefully yield better capture rates, as well as a better understanding of habitat preference and diversity of both butterflies and moth species present in Botum Sakor.

The high capture rate of moths using only banana bait is encouraging for future studies which could use more reliable equipment such as a small blacklight trap/generator. If successful, research methods such as this could be performed in conjunction with mist-netting for any insectivorous bats in the area, and related to habitat preferences and disturbance rates.

Chapter 5. Orchid Study (Rosie Irwin)

5.1. Introduction

Orchids thrive in places where other plants are not able to. Their fascinating ecology and diversity in shape and colour interests scientists, researchers and the public alike. Of all the Indochinese countries, Cambodia has the fewest records of orchid species: 164 species in 61 genera (*Schuiteman and Vogel, 2000*). Orchids are among the most threatened of all plant species. The destruction of forests, swamps and grasslands in which they grow is the greatest threat to their survival, along with the illegal collection for the horticultural or (supposed) medicinal trade.

We aimed to expand on the pilot study undertaken between July-September into 2 different types of forest, to find out which species could be observed, photographed and documented, and to look at the abundance and diversity of individual plants. This short 6 week study may be transferred to other parts of the national park, to allow greater comparison between different habitat types and investigation into effects of any human disturbance present. The study will hopefully allow the future development of a species list, and a better idea of current orchid numbers growing in this part of Cambodia's protected forest region.

5.2. Methods

5.2.1. Recording specimens

The orchids were photographed and a specimen taken if possible. Parameters recorded included; height above the ground, microhabitat, species type (Epiphyte, Geophyte or Terrestrial), canopy cover, the name of the tree or plant to which the orchid was attached, and any water association, as well as some general habitat notes on the study area (*See: Table: 8a&b*). Orchids were identified using *Schuitemann & Vogel* (2000). Each orchid was given a code number and a relevant description, and if possible a sketch and scale photograph was made for future reference.

5.2.2. Transects

Rather than creating a new transect for the orchids, we decided to use the already existing forest transect used in bird surveys. This transect was already an established track, used by locals and rangers, along with any poachers and loggers that may be operating in the area.

Transect A was approximately 1km long from the edge of a meadow habitat into the forest. Transect B was also approximately 1km long, through forest and meadow edge habitat. Five points were measured 60m apart from the end of both transects in the meadow-edge habitat. At each point we cut 20m into the forest, perpendicular to the transect on both sides, using a measuring tape. Any orchids observed within 4m either side of the small 20m sub-transects were recorded, up to a height of 8m.

Transect A ran through dense broad-leaf and partly evergreen forest, with a relatively high number of large trees, although some parts had been cleared in the past, and there was partial regeneration growth of small trees in the area. There was a high presence of deadwood, thick leaf- litter and some palm trees.

Transect B passed through some relatively dense, mainly broad-leaf lowland forest; some areas were sparse with successional growth onto the adjacent open meadow habitat. There was evidence of logging of large trees, as well as palm cutting. There was a large amount of deadwood throughout, with a high presence of palm and creepers. A vast majority of the area was moist or wet forest with a huge amount of mulch and heavy leaf-litter at ground level.

Transect A (m)	LEFT TRANSECT	RIGHT TRANSECT
Site A1 (60)	Regenerating forest with large tree presence and high percentage of lianas, deadwood and leaf-litter.	Regenerating forest with high percentage of deadwood and leaf-litter. Low canopy cover with no palm. Many lianas and vines.
Site A2 (180)	Regenerating forest with few large trees, much leaf-litter and deadwood. Dense shrub layer with canopy cover on average 60%.	Few large trees present some palm growth. Little deadwood, large amount of leaf-litter.
Site A3 (240)	Little canopy cover with some large gaps. Large tree presence and much deadwood and leaf-litter. Some palm growth.	Large amounts of deadwood and leaf-litter. Some palm growth.
Site A4 (300)	Dense forest with mainly small tree growth and few large trees. High presence of deadwood and leaf-litter. No palm.	Thick shrub layer with large lianas and vines. Small amount of palm with mainly small tree growth. Canopy cover 40-60%
Site A5 (360)	Large tree presence with a high percentage of palm. Dense with lianas and vines, deadwood and leaf-litter.	Mainly large trees with re-growth of palm and large vines. Some large gaps present. Much deadwood and leaf-litter.

Table 8a:- Habitat and vegetation composition for each site (A1-5) and transect study area.

Transect B (m)	LEFT TRANSECT	RIGHT TRANSECT
Site B1 (60)	Some boggy wet areas. Small tree growth with a high percentage of lianas and vines.	Ground boggy with small tree growth, high percentage palm. Successional growth on meadow with large vines, lianas and much leaf-litter.
Site B2 (120)	High percentage of vines and lianas. Large palm cut 5 months previously with large forest gaps. Mainly shrubs and small trees.	Mainly small tree growth with palm re-growth. Some large trees with much deadwood and leaf-litter.
Site B3 (180)	Some palm growth with low canopy cover. High percentages of lianas and vines, deadwood and leaf-litter.	High percentage of palm. Low canopy cover with some large trees. Much deadwood and leaf-litter.
Site B4 (240)	Large tree presence with canopy gaps. Wet boggy areas with much deadwood and leaf-litter.	Large palm growth with cutting evidence. Much deadwood and leaf-litter.
Site B5 (300)	Area cut largely for palm with large forest gaps 5 months previously. Some large trees present.	Low canopy cover (30-60%). Some boggy wet areas and re-growth of palm. Much deadwood and leaf-litter.

Table 8b - Habitat and vegetation composition for each site (B1-5) and transect study area.

5.3. Results

5.3.1. Site records

All individuals found and recorded were the epiphytic variety of orchid. These were found growing on fallen deadwood and some large vines, but mainly on large trees present in the area. Individuals were recorded at an average of 9m from transects. A total of 363 orchids were recorded from the study area of 3200m² (transects A and B) providing a density estimate of 0.11 plants/m². A total of 15 different species were recorded, with an additional species found outside the transect area. This was taken as an opportunistic finding in the overall project site area (*see: Table: 9a+b*).

A total of five specimens were taken from the two study transects. Transect A had a total of 212 individuals and 13 species. Transect B had a total of 151 individuals and 11 different species. All specimens collected were from site A. Site A2 had the highest number of individuals at 59 and sites A3(L), A5(R) and B2(L) had the highest number of species at 7 each (*See: Table 9a+b*). Orchids were recorded on a total of 25 different species of tree and one species of palm. A further 35 individual plants were recorded growing on deadwood and 21 on vines and creepers. Transect A had a greater diversity of tree species (21), over twice the number of tree species found along transect B (10). Along both transects A and B, a total of 59 orchid epiphytes were recorded living on one tree species, of the *Ternstroemia* (Theaceae) genus. Transect A also had a large number of individuals growing on deadwood.

Dendrobium keithii (Dendrobiinae) was the most abundant orchid species, with 75 individuals recorded. This amounted to approximately a quarter of the orchids recorded in the survey. The next most abundant species was identified as *Adenoncos vesiculosa (Aeridinae)*, with 69 individual records along the two transects. An orchid new to Frontier, of the *Dendrochilum* subfamily, was recorded 58 times, but with only 2 of these records on transect B (*See: Table 10*). In relation to the area covered in this survey compared with the previous survey, almost 7 times the number of orchids recorded from October-December than from July-September. There was no statistical difference found between sites in terms of the number of individuals recorded ($t= -1.729$, $d.f.= 18$, $p= 0.101$), We did however find a significant difference in the number of species recorded between the two sites ($t=2.529$, $d.f.= 18$, $p= 0.021$). This suggests that the two sites can support the same number of individual orchids, but that site B was unsuitable for some species.

SITE (Right/Left transect)	No. Individuals Transect A	No. Individuals Transect B	No. of Species Transect A	No. of Species Transect B
1 (R)	10	15	4	4
1 (L)	5	13	4	3
2 (R)	29	0	6	0
2 (L)	30	23	6	7
3 (R)	23	23	6	5
3 (L)	22	11	7	2
4 (R)	22	13	6	4
4 (L)	14	17	6	5
5 (R)	28	14	7	6
5 (L)	29	22	6	4

Tables 9a+b: Frequency of individual and species records along each transect.

5.3.2. Species records

Adenoncos - (Sp. T4464) Small monopodial epiphytes. Stems elongated with several leaves arranged in two rows. Flowers small to very small, resupinate, green or yellowish. Evergreen lowland forest. Approximately 15 species; 4 in Thailand, one in Vietnam, not yet recorded in Laos or Cambodia (*Schuiteman and Vogel. 2000*).

Biermannia - (**Sp. T4466**) Mainly epiphytes found in lowland forest habitat. Considered rare with 12 species; 1 in Thailand, 2 in Vietnam, not yet recorded in Cambodia (*Schuiteman and Vogel. 2000*). The flowers are quite large, pale lemon yellow with some reddy-brown spots on the inner parts of the petals.

Dendrochilum - Found in lowland evergreen and montane forest. 280 species; 2 in Thailand, not yet recorded in Cambodia. None found with flowers or seeds. This family was found at both sites with at least 2 species recorded (*Schuiteman and Vogel. 2000*). The pseudobulbs of this plant 'DOCH-AMOM' are used in traditional Cambodian medicine for stomach pain.

Dendrobium - Sp. 1+15 (Sp. T4463) Small to large epiphytic or terrestrial plants. Leaves in two rows and flowers can be very small to large. Lowland and montane deciduous and evergreen forest. 153 species are recorded in Thailand, 94 in Vietnam and only 22 in Cambodia. (Schuiteman and Vogel, 2000). Flower (Sp. 15) is small and yellow-pale white.

Micropera - (Sp. T4469). Mainly epiphytic plants in lowland forest habitat. There are approximately 13 species; one in Thailand, one in Vietnam and 1 in Cambodia (*Schuiteman and Vogel. 2000*). Leaves are many in two rows laterally flattened, glabouous, deciduous and duplicate. Flower very small yellow in colouration and red/brown markings on the inner parts of the petals.

Pteroceras - (Sp. T4468). Epiphytes in lowland and montane forest. 20 species recorded; 4 in Thailand, 3 in Vietnam, and 1 in Cambodia (*Schuiteman and Vogel. 2000*). Few leaves, arranged in two rows, glabrous, deciduous and dorso-ventrally flattened, duplicate. Flowers are small and white, cream colour with slight green colouration and purple/pink spots on the inner parts of the petals.

Thecostele - (Sp. T4465) Sympodial epiphytes with very short rhizomes and pseudobulbs present. Flowers are small and cream coloured with purple spots. One species *(Thecostele alata*), found in Thailand, Laos and Vietnam, not yet recorded in Cambodia (*Schuiteman and Vogel. 2000*).

Unknown - Sp. 5 (T4467)

Species Recorded	Frequency on transect A	Frequency on transect B
Sp. 1 - *Dendrobium keithii*	37	38
Sp. 2 - *Adenoncos vesiculosa*	51	18
Sp. 3 – Dendrochilum species	56	2
Sp. 4 – Dendrochilium species	16	8
Sp. 5 – Unknown species	23	41

Table 10: Abundance of most frequently recorded species along transects A and B.

5.4. Discussion

Compared to the pilot July-September study, this study recorded a much higher density of plants. Twice the number of orchids were recorded on transect A, with only a slight increase in area studied. This may be due to the previous site studied being recently disturbed, allowing little time for trees and associated epiphytic plants to recover. In this phase of research, site B had been cut for palm planting. Palm is encouraged to spread by the creation of large canopy gaps. These trees also take a stronghold in the soil seedlayer, thus reducing the floral diversity present. Orchids were not found to grow substantially on palm. There was considerably lower tree diversity along transect B compared to the July-September site, and compared to transect A during this research phase. These factors are likely to explain why a significantly lower density of orchid species were found on transect B.

Many epiphytic orchid species are host specific (Hágsater and Dumont, 1998); they may even only occur on specific portions or ages of host substrates. A large percentage of species recorded were only found on the shrub of the *Ternstroemia* genus. The most commonly found species, *Dendrobiinae Dendrobium keithii* and *Aeridinae Adenoncos vesiculosa*, were found to grow on many types of tree and shrub, and also on deadwood and vines. These generalist species are likely to have a higher tolerance level to disturbance and changing micro-climates. However, there was a considerably lower density of *Adenoncos vesiculosa* (*Table 10*) recorded along transect B compared to transect A. As transect B was estimated to run through more disturbed habitat, this suggests that disturbance may be detrimental to even more generalist species. Species such as the Dendrochilum orchid new to Frontier were found considerably more often in the less-disturbed habitat along transect A. This is likely to be because of the lack of an associated tree species along transect B. More work into identifying orchids present in Botum Sakor, and their host tree species is needed to determine the effects of selective logging and habitat destructuion on orchids in the area.

Occurrence of many temperate orchids is associated with disturbance, noted for their brief and irregular appearance in many of their stations. Site A2 (left) recorded the highest orchid density, with 30 individuals and 6 different species. Table 8a shows an abundance of new growth in the shrub-layer as well as some older trees still present thus allowing for a larger spectrum of micro-habitats; light intensity, moisture and humidity levels. Often a greater amount of epiphytes can be found in areas subject to limited patch-forming disturbance (gaps) either natural (fires in Botum Sakor) or human induced (selective logging). However the selective removal of timber may also lead to the removal of certain orchid species or other epiphytes (*Hágsater and Dumont, 1998*). Any illegal logging in the park could potentially increase the amount of opportunistic species such as palm and inversely decrease the abundance and diversity of epiphytic orchids growing there. This is a further reason why the Ministry of Environment (MoE) and the park director need to tighten protection on the park as part of an extensive conservation and community based management plan.

In a recent biodiversity assessment report by Wildlife Alliance and Flora Fauna International *(FFI)* in 2003, 5 sites were surveyed for canopy flora diversity using rope climbing equipment. They found the sandstone area of Botum Sakor to have the highest number of species of orchid plants compared to other plants recorded (ferns, others) and compared with the other 4 sites sampled. This information alone supports the need to investigate a larger area with a longer study of orchids and general floral diversity in the park. Conservation actions directed to the habitat level will protect a myriad of other species as well as orchids (Hágsater and Dumont 1998). The current health of a habitat and its basic floral diversity has huge resonating effects of importance on all other taxa living in Botum Sakor and the unique Cardamom Mountain eco-region.

5.5. Conclusions

There is sufficient evidence from the extension of the original pilot study to a larger area that Botum Sakor has an already huge potential for new and exciting orchid discoveries. Relatively recent research in the area indicates Botum Sakor as having a high percentage of epiphytic orchid plants growing in the canopy layer and below. The area has more than half of the 56 epiphytic orchid plant species recorded in the Southern Cardamoms by Daltry and Traeholt (2003).

Four of the orchid samples taken in the last six months of research which have been approximately identified to species level have not yet been recorded as being found in Cambodia *(Thesticulosa thecostel, Adenoncos vesiculosa, and Dendrobium keithii*, and an additional *Biermannia* species*)*. This should encourage local and higher authorities and surrounding communities operating or living in and around the park boundaries to strengthen the protection of its remaining unique patchy habitat. More and more floristic studies are being carried out on orchid plants across the globe, however many areas including the Indochina region are relatively unknown to science. Simple management techniques such as management of patch disturbance and by creating seed banks could be included. Thoughtful protection, management and restoration of natural habitats are the best and cheapest method of preserving biological diversity (*Hágsater and Dumont 1998*).

Chapter 6. Trapping of small mammals (Margreet Drijfhout)

6.1. Introduction

During this research program, Frontier utilised two different capture methods for measuring small vertebrate biodiversity. Captures rates were high, but no new mammal species were discovered.

6.2. Methods

6.2.1. Bucket pitfall Lines

Three trap-sites were studied during the project, with three 33m bucket-pitfall lines laid at each. Each line comprised 11 buckets spaced at 3m intervals (ten 25L buckets and one 45L bucket in the centre of the line, linked by a 0.5 m high drift fence of plastic sheeting). The larger buckets were used to attempt to trap larger animals that could climb out of the smaller traps. The drift fence was dug into the substrate and pegged with stakes to keep it stable. This would help to channel any passing animals into the buckets. Two trap-sites were located in semi-evergreen broad-leaf forest. The first was positioned in an area close to a large meadow and river, while the second was positioned deeper into the forest. The third trap-site was located close to a small meadow and can be classified as semi-evergreen river edge forest. Where applicable, bucket pitfall lines were laid parallel to the border of the forest and meadow, in order to trap animals travelling between habitats. Notes on vegetation within a one-meter radius around each bucket were collected.

Traps were checked between 09:00 and 11:00 and between 15:00 and 17:00 throughout the 10-day study period, to minimise exposure and limit predation on the captured animals. Captured animals were identified using field guides (Cox *et al.*, 1998; Thy & Holden, 2008). All animals captured were released.

6.2.2. Sherman traps

Traps were originally set in three different locations, for 10-day study periods. However, the third trap-site was moved from its original location, due to theft (see below). Two trap-sites were located in semi-evergreen broad-leaf forest. The first was positioned in an area close to a large meadow and river (Preaek Kon Tourt), while the second was positioned deeper into the forest. The third trap-site was originally positioned at the border of a meadow and semi-evergreen river edge forest. However, on day 3 it was discovered that about half of the traps at trap-site 3 had been stolen. The remaining ten traps were relocated to a similar area, closer to the river.

At each trap-site (with the exception of trap-site 3), two lines of 12 and 11 small Sherman traps were installed. Traps were positioned 3 metres from each other, near tree roots, heavy undergrowth, logs and burrow entrances. Trap-site 3 had two trap-lines during the first three days and only one trap-line (comprising 10 traps) during the remaining 7 days at the different location. Notes on vegetation within a one-metre radius around each trap were collected. The traps were baited with fried coconut, and set from late afternoon each day. They were checked early each morning between 07:00 and 10:00. All animals captured were released.

The sex, weight and morphometrics of the animals captured were recorded, including; snout to vent length (SVL), tail length, ear length and hind foot length. Identification was based on the field guide ‘Mammals of South-East Asia’ (Francis, 2001). Where possible, species were given a unique fur-clip and released in order to estimate recapture rates.

6.3. Results

6.3.1. Bucket pitfall Lines

A total of 20 species were identified from 120 captures, excluding observational sightings. None of the species recorded were new to Frontier. There were 79 captures at trap-site 1, 19 at trap-site 2, and 22 at trap-site 3.

For further data analysis we are awaiting the results of a principal component analysis of trap vegetation against capture rates.

6.3.2. Sherman traps

Three species of mammal were captured in Sherman traps during the study. Due to the inconsistency in location and number of trap-days per location, the data collected for trap-site 3 was discarded. After discounting recaptures, 7 rats were captured at trap-site 1 and 18 at trap-site 2. Previous Frontier reports identified all the rats that were caught as the yellow rajah rat *(Maxomys surifer)*. However, the guidebook used in the field (Francis, 2001) does not mention this species specifically. Therefore it was decided that it was not accurate to identify all the rats caught as yellow rajah rats. One white-bellied rat species *(Niviventer spp.)* was recorded at trap-site 1, though this may also be an inaccurate identification due to the poor information on rats in the guidebook. Five northern treeshrews were captured at trap-site 1 and four in trap-site 2.

For further data analysis we are awaiting the results of a principal component analysis of trap vegetation against capture rates.

6.4. Discussion

During the previous research phase from July-September, the total number of captures in bucket pitfall traps was very low due to continuous flooding of the buckets during the rainy season. The October-December research phase was at the beginning of the dry season, and the climate appeared to be much better for capture amphibians and reptiles. Trap-site 1 was especially productive, with many more amphibian captures than at the drier trap-sites 2 and 3.

With regards to the Sherman traps, an objective for research between October-December was to use a large number of traps to enable surveys comparing a greater variety of habitats. Unfortunately, this was difficult to implement, due to traps being stolen, and the limited accessibility of the various different habitats. It was suggested in the previous Frontier science report that proximity to water bodies within riparian habitats could be an interesting variable to study, while surveying within riparian habitats might return a greater capture rate of the same and different species. This was incorporated into the methodology during this research phase. However, with only three species recorded during the Oct-Dec phase, and two in the previous phase, results were unpromising.

Though capture rates were fairly high, no new species were found in either the bucket pitfall traps or the Sherman traps between October and December. As this was also the case in the two previous phases, these methods of research seem to have been explored fully. Therefore, it has been decided to curtail this method of research, and focus on different species that are less well studied.

Chapter 7. Proposed work programme for next phase

7.1. Overview

It is most likely that future research will be conducted along the Preaek Kon Tourt river. Frontier has undertaken much research in this area, and expected budget constraints limit expansion into new areas.

7.2. Objectives

- Calculate the relative density of dhole through scat identification and line transect methodology.
- Calculate the absolute density of great hornbill along the Preaek Kon Tourt.
- Calculate the absolute density of pileated gibbon using triangulation methodology as the start of a monitoring programme recommended by Traeholt *et al*. (2005).
- Use group interviews to obtain distribution info on species of conservation interest and use this to compliment existing data.
- Survey sand banks for signs of otters and other species of interest.
- Develop an inventory of floral species with medicinal properties.

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Appendices 1.1. Avian inventory Botum Sakor National Park, 2005-2008

Common Name	Scientific Name	Status	Evidence	Study site	Habitat and Distribution info
Chinese Francolin	*Francolinus pintadeanus*		A	A	Heard only
Blue-breasted Quail	*Coturnix chinensis*		V	A	
Barred Buttonquail	*Turnix suscitator*		V	B	
Scaly-breasted Partridge	*Arborophila chloropus*	IMTF	VA	A	
Red Junglefowl	*Gallus gallus*		VA	AB	Notably more common at site B than site A
Green Peafowl	*Pavo muticus*	VUL/IT DZ/II	VA	AB	See species accounts
Lesser Whistling-duck	*Dendrocygna javanica*		V	B	
Heart-spotted Woodpecker	*Hemicircus canente*		VA	AB	
Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*		VA	A	
Lesser Yellownape	*Picus chlorolophus*		VA	A	
Laced Woodpecker	*Picus vittatus*		VA	AB	
Rufous Woodpecker	*Celeus brachyurus*		R		Secondary habitat near grassland
Common Flameback	*Dinopium javanense*		VA	AB	
Greater Flameback	*Chrysocolaptes lucidus*		VA	A	
Great Slaty Woodpecker	*Mulleripicus pulverulentus*		VA	B	
Linneated Barbet	*Megalaima lineata*	ITDZ	VA	AB	
Green-eared Barbet	*Megalaima faiostricta*	IMTF	VA	AB	
Blue-eared Barbet	*Megalaima australis*		VA	AB	
Coppersmith Barbet	*Megalaima haemacephala*		A	A	
Great Hornbill	*Buceros bicornis*	NT/I	VA	AB	See species accounts
Wreathed Hornbill	*Aceros undulates*	II	VA	B	See species accounts
Oriental Pied Hornbill	*Anthracoceros albirostris*	II	VA	AB	Recorded in a variety of habitats; common throughout
Indian Roller	*Coracias benghalensis*		V	AB	
Dollarbird	*Eurystomus orientalis*		VA	AB	
Orange-breasted Trogon	*Harpactes oreskios*		VA	AB	
Common Kingfisher	*Alcedo atthis*		V	AB	Recorded on both large and small rivers and observed fishing from flooded forest paths.
Blue-eared Kingfisher	*Alcedo meninting*		VA	AB	Recorded on both large and small rivers
Black-backed Kingfisher	*Ceyx erithacus*		V	B	One record on a wide stretch of river
Pied Kingfisher	*Ceryle rudis*		R		Frontier record on Steung Ko (also known as Preaek Kompong Phlu)
Stork-billed Kingfisher	*Halcyon capensis*		VA	B	One record on wide strech of river next to cultivation
Ruddy Kingfisher	*Halcyon coromanda*		V	B	One record from an individual captured by a fisherman; 1st record Cardamom region

White-throated Kingfisher	*Halcyon smyrnensis*		V	B	One record on wide stretch of river next to cultivation
Black-capped Kingfisher	*Halcyon pileata*		V	B	Most common kingfisher species along Preaek Kon Tourt
Collared Kingfisher	*Todiramphus chloris*		V	B	One record from Preaek Kon Tourt
Large Hawk Cuckoo	*Hierococcyx sparverioides*		V	B	One observation above an undisturbed forest river in evergreen forest
Coral-billed Ground Cuckoo	*Carpococcyx renauldi*	IMTF	A	A	One record in evergreen forest
Drongo Cuckoo	*Surniculus lugubris*		VA	A	
Asian Koel	*Eudynamys scolopacea*		V	B	
Little Bronze Cuckoo	*Chrysococcyx minutillus*		V	B	
Green-billed Malkoha	*Phaenicophaeus tristis*		VA	AB	
Greater Coucal	*Centropus sinensis*		VA	AB	
Lesser Coucal	*Centropus bengalensis*		V	AB	
Blue-bearded Bee-eater	*Nyctyornis amictus*		R		Frontier record on Preaek Kon Tourt
Green Bee-eater	*Merops orientalis*		A	AB	
Blue-tailed Bee-eater	*Merops philippinus*		VA	B	One record from an area of cultivation bordering the Preaek Kon Tourt
Chestnut-headed Bee-eater	*Merops leschenaulti*		VA	B	
Vernal Hanging Parrot	*Loriculus vernalis*	II	VA	A	
Red-breasted Parakeet	*Psittacula aexandri*	II	VA	AB	
Crested Treeswift	*Hemiprocne coronata*		V	AB	
[Germain's Swiftlet]	*Collocalia germani*		V	B	Uncertain identification
[Silver-backed Needletail]	*Hirundapus cochinchinensis/caudacutus*		V	AB	Uncertain identification
Brown-backed Needletail	*Hirundapus giganteus*		V	AB	
Asian Palm Swift	*Cypsiurus balasiensis*		V	A	
Fork-tailed Swift	*Apus pacificus*		VA	AB	
House Swift	*Apus affinis*		V	A	
Collared Scops Owl	*Otus bakkamoena*	II	R		Frontier record on Steung Ko
Collared Owlet	*Glaucidium brodiei*	II	A	A	
Buffy Fish Owl	*Ketupa ketupa*	II	V	B	
Oriental Bay Owl	*Phodilus badius*	II	R		Recorded on Preaek Kon Tourt by author at sea level altitude
Brown Hawk Owl	*Ninox scutulata*	II	A	B	
Great-eared Nightjar	*Eurostopidus macrotis*		VA	AB	
Large-tailed Nightjar	*Caprimulgus macrurus*		VA	AB	
[Savanna Nightjar]	*Caprimulgus affinis*		VA	B	Uncertain identification
Rock Pigeon	*Columba livia*	III	VA	AB	
Green Imperial Pigeon	*Ducula aenea*		VA	AB	See species accounts
Mountain Imperial Pigeon	*Ducula badia*		VA	A	Recorded at an altitude of approximately 100 masl

Spotted Dove	*Streptopelia chinensis*		VA	B	
Red-collared Dove	*Streptopelia tranquebarica*		V	A	
[Barred Cuckoo Dove]	*Macropygia unchall*		A	AB	Heard only; 100 masl
Pink-necked Green Pigeon	*Treron vernans*		VA	AB	
Thick-billed Green Pigeon	*Treron curvirostra*		V	AB	
Emerald Dove	*Chalcophaps indica*		V	A	
White-breasted Waterhen	*Amaurornis phoenicurus*		V	B	
Ruddy-breasted Crake	*Porzana fusca*		R		Frontier record on Steung Ko
Common Snipe	*Gallinago gallinago*		VA	AB	
Whimbrel	*Numenius phaeopus*	WV/PM	VA	B	First recorded on 02/11/08
Common Redshank	*Tringa totanus*	WV/PM	V	B	First recorded on 10/09/08
Marsh Sandpiper	*Tringa stagnatilis*		R	B	Recorded by author on Preaek Kon Tourt during dry season when river is saline
Kentish Plover	*Charadrius alexandrinus*		V	B	
Grey-headed Lapwing	*Vanellus cinereus*		R		Frontier record on Preaek Ta Oak Estuary; 2nd record SW
Red-wattled Lapwing	*Vanellus indicus*		V	B	
Common Tern	*Sterna hirundo*		VA	B	
Jerdons's Baza	*Avicela jerdoni*	II	R	B	Recorded by author over undisturbed tall canopy evergreen forest
Black Baza	*Aviceda leuphotes*	II	V	AB	
Oriental Honey-buzzard	*Pernis ptilorhyncus*	II	VA	AB	
Black Kite	*Milvus migrans*	II	V	AB	See species accounts
Brahminy Kite	*Haliastur indus*	II	V	B	Three observations; one 15 km inland and one at river mouth
White-bellied Sea Eagle	*Haliaeetus leucogaster*	II	VA	B	See species accounts
Grey-headed Fish Eagle	*Icthyophaga icthyaetus*	NT/II	V	B	See species accounts
Osprey	*Pandion haliaetus*	II/ WV/PM	V	B	First recorded on 10/09/08
Black-shouldered Kite	*Elanus caeruleus*	II	V	B	
Crested-serpent Eagle	*Spilornis cheela*	II	V	AB	
Shikra	*Accipiter badius*	II	V	AB	
Rufous-bellied Eagle	*Hieraaetus kienerii*	II	V	A	Two observations over meadow and evergreen forest at extreme north of park
Changeable Hawk Eagle	*Spizaetus cirrhatus*	II	V	AB	
Darter	*Anhinga melanogaster*	NT	V	B	See species accounts
Little Cormorant	*Phalacrocorax niger*		V	B	One record from both the Preaek Kon Tourt and Preaek Ta Ok
Little Egret	*Egretta garzetta*		V	B	
Intermediate Egret	*Mesophoyx intermedia*	III	V	B	

Cattle Egret	*Bubulcus ibis*	III	V	B	
Chinese Pond Heron	*Ardeola bacchus*	WV	VA	B	First recorded on 11/10/08
Javan Pond Heron	*Ardeola speciosa*		VA	B	Not observed in breeding plumage throughout duration of study
Grey Heron	*Ardea cinerea*		V	B	
Purple Heron	*Ardea cinerea*		R		Frontier record on Preaek Ta Ok
Little Heron	*Butorides striatus*		V	B	
Malayan Night Heron	*Gorsachius melanolophus*		VA	A	**Single observation on a small stream within dense evergreen forest; 1st SW**
Yellow Bittern	*Ixobrychus sinensis*		V	AB	
Lesser Adjutant	*Leptoptilos javanicus*	VUL	V	B	See species accounts
Wooly-necked Stork	*Ciconia episcopus*		V	AB	See species accounts
Hooded Pitta	*Pitta sordida*		V	A	Specimen found on route 48 highway near evergreen forest at 100 masl; 1st record since 2000
Blue-winged Pitta	*Pitta moluccensis*	IMTF	A	A	Only recorded during wet season
Black-and-red Broadbill	*Cymbirhynchus macrorhynchos*		V	B	See species accounts
Banded Broadbill	*Eurylaimus javanicus*		V	B	
Dusky Broadbill	*Corydon sumatranus*		VA	A	
Blue-winged Leafbird	*Chloropsis cochinchinensis*		VA	AB	
Golden-fronted Leafbird	*Chloropsis aurifrons*		V	A	
Common Iora	*Aegithina tiphia*		VA	B	
Great Iora	*Aegithina lafresnayei*		V	B	
Asian Fairy Bluebird	*Irena puella*		VA	AB	
Tiger Shrike	*Lanius tigrinus*		V	AB	1st record Cardamom region
Brown Shrike	*Lanius cristatus*		V	AB	
Red-billed Blue Magpie	*Urocissa erythrorhyncha*		V	A	
Rufous Treepie	*Dendrocitta vagabunda*		R		Frontier record on Steung Ko
Racket-tailed Treepie	*Crypsirina temia*	ITDZ	VA	AB	
Large-billed Crow	*Corvus macrorhynchos*		VA	B	Only one record from an area of cultivation
Black-naped Oriole	*Oriolus chinensis*		A	AB	
Black-hooded Oriole	*Oriolus xanthornus*		VA	A	
Scarlet Minivet	*Pericrocotus flammeus*		VA	A	
Ashy Minivet	*Pericrocotus divaricatus*		V	AB	
Black Drongo	*Dicrurus macrocercus*		V	B	
Ashy Drongo	*Dicrurus leucophaeus*		VA	AB	
Bronzed Drongo	*Dicrurus aeneus*		VA	AB	
Spangled Drongo	*Dicrurus bottentottus*		VA	AB	
Greater Racket-tailed Drongo	*Dicrurus paradiseus*		VA	AB	

Bar-winged Flycatcher-shrike	*Hemipus picatus*		V	A	
Black-naped Monarch	*Hypothymis azurea*		VA	AB	
Pied Fantail	*Rhipidura javanica*		R		Frontier record on Steung Ko
Asian Paradise-flycatcher	*Terpsiphone paradisi*		VA	A	Rufous male morph
Common Woodshrike	*Tephrodornis pondicerianus*		VA	AB	
Asian Brown Flycatcher	*Muscicapa dauurica*	WV/PM	V	B	First recorded on 23/10/08
[Brown-streaked Flycatcher]	*Muscicapa willamsoni*		V	AB	Uncertain identification
Mugimaki Flycatcher	*Ficedula mugimaki*	WV/PM	VA	A	First recorded on 21/08/08; earliest recorded date
Red-throated Flycatcher	*Ficedula parva*	WV/PM	V	B	First recorded on 22/10/08
Little Pied Flycatcher	*Ficedula westermanni*		V	A	Lower altitudinal range extension of approximately 100m (Robson 2007)
Siberian Blue Robin	*Luscinia cyane*	WV	V	B	First recorded on 20/10/08
Oriental Magpie Robin	*Copsychus saularis*		VA	A	
White-rumped Shama	*Copsychus malabaricus*		V	AB	
Common Myna	*Acridotheres tristis*		VA	B	
White-vented Myna	*Acridotheres grandis*		R		Frontier record on Steung Ko
Golden-crested Myna	*Ampeliceps coronatus*	IMTF	V	B	See species accounts
Hill Myna	*Gracula religiosa*	II	VA	AB	See species accounts
Black-collared Starling	*Sturnus nigricollis*	ITDZ	V	A	
Vinous-breasted Starling	*Sturnus burmannicus*		R		Frontier record on Preaek Phkum
[Sand Martin]	*Riparia riparia*		V	A	Uncertain identification; WV first recorded on 28/08/08
Asian House Martin	*Delichon dasypus*		R		Frontier record on Preaek Ta Ok
Barn Swallow	*Hirundo rustica*	WV/PM	V	AB	First recorded on 27/08/08
Pacific Swallow	*Hirundo tahitica*	WV	V	B	First recorded on 02/11/08
Red-rumped Swallow	*Hirundo daurica*		V	B	
Black-headed Bulbul	*Pycnonotus atriceps*		V	B	
Black-crested Bulbul	*Pycnonotus melanicterus*		VA	AB	
Stripe-throated Bulbul	*Pycnonotus finlaysoni*	IMTF	VA	AB	
Yellow-vented Bulbul	*Pycnonotus goiavier*		VA	AB	
Streak-eared Bulbul	*Pycnonotus blanfordi*	ITDZ	V	A	
Sooty-headed Bulbul	*Pycnonotus aurigaster*	ITDZ	VA	A	
Ochraceous Bulbul	*Alophoixus pallidus*		VA	AB	
Grey-breasted Prinia	*Prinia hodgsonii*		VA	A	
Plain Prinia	*Prinia inornata*		VA	A	
Striated Grassbird	*Megalurus Palustris*		V	B	Scrub habitat near agricultural land; 1st SW
Bright-headed Cisticola	*Cisticola exilis*		VA	B	
Asian Stubtail	*Urosphena squameiceps*		V	A	1st record Cardamom region
Lanceolated Warbler	*Locustella lanceolata*	WV/PM	VA	B	First recorded on 20/10/08

Golden-bellied Gerygone	*Gerygone sulphurea*		VA	A	1st record Cardamom region
Common Tailorbird	*Orthotomus sutorius*		VA	AB	
Dark-necked Tailorbird	*Orthotomus atrogularis*		VA	A	
Dusky Warbler	*Phylloscopus fuscatus*	WV/PM	V	B	First recorded on 21/10/08
Arctic Warbler	*Phylloscopus borealis*	PM	VA	AB	First recorded on 15/07/08
White-crested Laughingthrush	*Garrulax leucolophus*		VA	AB	
[Abbott's Babbler]	*Malacocincla abbotti*		A	A	Heard only; 1st record Cardamom region
Puff-throated Babbler	*Pellorneum ruficeps*		VA	AB	
Striped-tit Babbler	*Macronous gularis*		VA	AB	
White-bellied Yuhina	*Yuhina zantholeuca*		VA	A	
Indochinese Bushlark	*Mirafra marionae*		VA	AB	
Yellow-vented Flowerpecker	*Dicaeum melanoxanthum*		VA	AB	
Scarlet-backed Flowerpecker	*Dicaeum cruentatum*		VA	AB	
Purple-throated Sunbird	*Nectarinia asiatica*		VA	AB	
Purple Sunbird	*Nectarinia asiatica*		V	B	
Crimson Sunbird	*Aethopyga siparaja*		VA	AB	
Brown-throated Sunbird	*Anthreptes malacensis*		VA	AB	
Ruby-cheeked Sunbird	*Anthreptes singalensis*		VA	AB	
Olive-backed Sunbird	*Nectarinia jugularis*		VA	AB	
Little Spiderhunter	*Arachnothera longirostra*		VA	AB	
White Wagtail	*Motacilla alba*		R		Frontier record on agricultural land near small stream
Yellow Wagtail	*Motacilla flava*	WV/PM	V	A	First recorded on 09/08/08
Grey Wagtail	*Motacilla cinerea*	WV/PM	VA	A	First recorded on 22/07/08
[Paddyfield Pipit]	*Anthus rufulus*		VA	B	
White-rumped Munia	*Lonchura striata*		V	A	

Common Name: [name], unconfirmed sighting or audio identification of species.

Status: Vul, Vulnerable; NT, Near Threatened; IMTF, Biome-restricted species for Indochinese Moist Tropical Forest; ITDZ, Biome-restricted species for Indo-Malayan Tropical Dry Zone; I, CITES Appendix I species; II CITES Appendix II species; III, CITES Appendix III species; WV, Winter Visitor; PM, Passive Migrant.

Evidence: A, Audio; V, Visual; VA, Visual and Audio; R, Species recorded opportunistically during other studies by Frontier and counterpart staff.

Habitat and Distribution info: 1st SW, first record of species in southwest Cambodia.

Appendix 2 Lepidopteran species seen or reported in Botum Sakor Park, 2005–2007.

Spec. ID no.	Family	Genus	Species	Common name	Sex
001	Danaidae	*Euploea*	*core*	Common Indian Crow	M
004	Danaidae	*Euploea*	*core*	Common Indian Crow	F?
005	Satyridae	*Penthum*	*binghami mimetica*	Black Kaiser	F
006	Satyridae	Ypthima	Spp.	Rings or Ringlet sp.	
007	Nymphalidae	*Tanaecia*	*julii odilina*	Common Earl	F
008	Satyridae	*Melanitis*	*leda*	Common Evening Brown	F?
010	Lycaenidae	*Arhopala*	*spp.*	Oakblue sp.	M
011	Lycaenidae	*Yasoda*	*tripunctata atrinotata*	Branded Yamfly	
012	Danaidae	*Euploea*	*mulciber*	Striped Blue Crow	M
013	Amathusiidae	*Amathusia*	*phidippus adastatus*	Palm King	M
014	Nymphalidae	*Lexias*	*cyanipardus albopunctata*	Archduke sp.	F
015	Lycaenidae	*Arhopala*	*eumolphus eumolphus*	Green Oakblue	M
016	Satyridae	*Elymnias*	*nesaea apelles*	Tiger Palmfly	M
017	Nymphalidae	*Tanaecia*	*jahnu*	Plain Earl	M
019	Papilionidae	*Graphium*	*doson axion*	Common Jay	F
020	Nymphalidae	*Tanaecia*	*lepidea cognata*	Grey Count	M
021	Satyridae	*Elymnias*	*hypermnestra meridionalis*	Common Palmfly	F
022	Amathusiidae	*Zeuxidia*	*amethysta masoni*	Saturn	M
023	Nymphalidae	*Parthenos*	*sylvia*	Clipper?	
024	Nymphalidae	*Cupha*	*erymanthis lotis*	Rustic	M
025	Satyridae	*Mycalesis*	*mineus*	Bushbrown sp.	M
026	Satyridae	*Mycalesis*	spp.	Bushbrown sp.	M
027	Satyridae	*Elymnias*	*hypermnestra meridionalis*	Common Palmfly	M
028	Nymphalidae	*Polyura*	*schreiber assamensis*	Blue Nawab	M
029	Nymphalidae	*Neptis*	*clinia*	Southern Sullied Sailor	M
030	Nymphalidae	*Charaxes*	*kahruba*	Variegated Rajah	F
031	Nymphalidae	*Terinos*	*terpander intermedia*	Royal Assyrian sp.	M
032	Papilionidae	*Graphium*	*megarus megapenthes*	Spotted Zebra	F
033	Danaidae	*Euploea*	*radamanthus radamanthus*	Magpie crow	M
034	Pieridae	*Eurema*	*brigitta fruhstorferi*	Small Grass Yellow	F
035	Nymphalidae	*Euthalia*	*evelina annamita*	Red Spot Duke	F
036	Danaidae	*Euploea*	*mulciber*	Striped Blue Crow	F
037	Lycaenidae	*Charana*	*mandarina mandarina*	Mandarin Blue	

038	Papilionidae	*Losaria*	*coon doubledayi*	Common Clubtail	M
039	Nymphalidae	*Lexias*	*cyanipardus albopunctata*	Archduke sp.	F
040	Nymphalidae	*Tanaecia*	*julii odilina*	Common Earl	M
041	Amathusiidae	*Amathusia*	*phidippus adastatus*	Palm King	
042	Nymphalidae	*Junonia*	*almana almana*	Peacock Pansy	F
044	Pieridae	*Eurema*	*hecabe*	Common Grass Yellow	
045	Papilionidae	*Papilio*	*memnon agenor*	Great Mormon	M
046	Lycaenidae	*Drupaida*	*ravindra boisduvali*	Common Posy	F
047	Nymphalidae	*Tanaecia*	*julii*	Common Earl	
048		*Polyura*	*arja arja*	Pallid Nawab	M
049	Nymphalidae	*Elymnias*	*hypermnestra*	Common Palmfly	
050	Pieridae	*Eurema*	*hecabe*	Common Grass Yellow	
052	Nymphalidae	*Euthalia*	*evelina annamita*	Red Spot Duke	M
053	Nymphalidae	*Parthenos*	*sylvia gambrisius*	Clipper	M
054	Pieridae	*Delias*	*pasithoe siamensis*	Red-base Jezebel	F
055	Hesperiidae	*Ancistroides*	*nigrita maura?*	Chocolate Demon	
056	Riodinidae	*Taxila*	*haquinus berthae*	Harlequin	M
057	Nymphalidae	*Moduza*	*procris procris*	Commander	M
058	Papilionidae	*Papilio*	*nephelus chaon*	Yellow Helen	M
059	Papilionidae	*Papilio*	unknown	Yellow Helen	
060		*Ypthima*	*baldus*	Common Five-ring	M
061	Nymphalidae	*Lexias*	*cyanipardus albopunctata*	Archduke sp.	M
062	Nymphalidae	*Athyma*	*perius perius*	Common Sargeant	M
063	Amathusiidae	*Zeuxidia*	*amethysta masoni*	Saturn	F
064	Satyridae	*Melanitis*	*leda*	Common Evening Brown	M
065	Nymphalidae	*Lebadea*	*martha martha*	Knight	F
066	Satyridae	*Elymnias*	*nesaea apelles*	Tiger Palmfly	F
067	Satyridae	*Lethe*	*europa nilidana*	Bamboo Treebrown	F
069	Hesperiidae	*Notocrypta*	*paralysos asawa*	Common Banded Demon	
070	Riodinidae	*Taxila*	*haquinus berthae*	Harlequin	M
071	Nymphalidae	*Euthalia*	*monina remias*	Eastern Baron	F
072	Nymphalidae	*Euthalia*	*lubentina lubentina*	Gaudy Baron	F
073	Nymphalidae	*Charaxes*	*bernardus hierax*	Tawny Rajah	F
074	Nymphalidae	*Euthalia*	*lubentina lubentina*	Gaudy Baron	M
075	Satyridae	*Orsotriaena*	*medus medus*	Nigger	M
076	Nymphalidae	*Euthalia*	*monina remias*	Eastern Baron	M
077	Nymphalidae	*Junonia*	*atlites atlites*	Grey Pansy	

078	Satyrida	*Ypthima*	*Sp.*	Ring or Ringlet sp.	M
080	Nymphalidae	*Tanaecia*	*lepidea cognata*	Grey Count	F
081	Hesperiidae	*Pyroneura*	*spp.*		
082	Nymphalidae	*Terinos*	*terpander intermedia*	Royal Assyrian sp.	M
083	Nymphalidae	*Polyura*	*arja arja*	Pallid Nawab	M
084	Nymphalidae	*Polyura*	*schreiber assamensis*	Blue Nawab	M
085	Lycaenidae	*Arhopala*	*spp*	Oakblue sp.	M
086	Lycaenidae	*Arhopala*	*spp*	Oakblue sp.	M
087	Nymphalidae	*Tanaecia*	*cocytus cocytus*	Lavendar Count	F
088	Papilionidae	*Lamproptera*	*meges annamiticus*	Green Dragontail	F
089	Papilionidae	*Papilio*	*memnon agenor* (form distantianus)	Great Mormon	F
090	Nymphalidae	*Cirrochroa*	*tyche mithila*	Common Yeoman	F
091	Nymphalidae	*Neptis*	*spp.*	Sailor sp.	M
092	Nymphalidae	*Pandita*	*sinope sinope*		M
093	Satyridae	*Ypthima*	*spp.*	Ring or Ringlet sp.	
094	Satyridae	*Ypthima*	*spp.*	Ring or Ringlet sp.	
095	Amathusiidae	*Discophora*	*spp.*	Duffer sp.	F
096	Lycaenidae	*Hypolycaena*	*erylus himavantus*	Common Tit	M
097	Nymphalidae	*Junonia*	*orithya ocyale*	Blue Pansy	F
098	Satyridae	*Melanitis*	*leda*	Common Evening Brown	M?
099	Danaidae	*Danaus*	*meanippus heggesippus*	Black Veined Tiger	
100	Danaidae	*Euploea*	*spp.*	Crow sp.	M
101	Pieridae	*Leptosia*	*nina nina*	Psyche	
102	Papilionidae	*Graphium*	*sarpedon sarpedon*	Common bluebottle	M
103	Papilionidae	*Graphium*	*xenocles lindos*	Great Zebra	M
104	Papilionidae	*Papilio*	*demolion demolion*	Banded Swallowtail	F?
105	Lycaenidae	*Acytolepis*	*puspa gisca*	Common Hedge Blue	M
106	Pieridae	*Catopsilia*	*pomona pomona*	Lemon immigrant	F
107	Pieridae	*Catopsilia*	*scylla cornelia*	Orange emigrant	F
108	Papilionidae	*Papilio*	*demoleus malayanus*	Lime butterfly	F
109	Lycaenidae	*Arhopala*	*spp.*	Oakblue sp.	
110	Lycaenidae	*Zeltus*	*amasa amasa*	Fluffy Tit	F
111	Lycaenidae	*Castalius*	*rosimon rosimon*	Common Pierrot	F
112	Papilionidae	*Graphium*	*antiphates pompilius*	Five Bar Swordtail	M
113	Lycaenidae	*Chliaria*	*othona othona*	Orchid tit	
115	Danaidae	*Parantica*	*aglea melonoides*	Glassy Tiger	M
117	Danaidae	*Euploea*	*caramalzeman caramalzeman*	Large Blue Crow	M

118	Lycaenidae	Unknown	Unknown		
119	Satyridae	*Mycalesis*	*mnasicles perma*	Cyclops Bushbrown	F?
120	Satyridae	*Mycalesis*	*mineus*	Bushbrown sp.	
121	Lycaenidae	*Loxura*	*atymnus continentalis*	Yamfly	F
122	Satyridae	*Ypthima*		Rings or Ringlet sp.	
123	Lycaenidae	*Spindasis*	*seliga seliga*	Silverline	F
124	Riodinidae	*Taxila*	*haquinus berthae*	Harlequin	M
125	Lycaenidae	*Hypolycaena*	*erylus himavantus*	Common Tit	M
126	Nymphalidae	*Tanaecia*	*jahnu*	Plain Earl	M
127	Satyridae	*Mycalesis*	*anaxias aemate*	White-bar Bushbrown	M
128	Satyridae	*Penthema*	*darlisa*	Blue Kaiser	F
129	Nymphalidae	*Vendula*	*erota*	Cruiser	M
130	Nymphalidae	*Lebadea*	*martha martha*	Knight	M
131	Papilionidae	*Papilio*	*demoleus malayanus*	Lime Butterfly	M
132	Pieridae	*Eurema*	*sari sodalis*	Chocolate grass yellow	M
133	Papilionidae	*Graphium*	*agamemnon*	Tailed jay	M
135	Danaidae	*Danaus*	*genutia*	Common tiger	
136	Papilionidae	*Graphium*	*arycles sphinx*	Spotted Jay	M
137	Nymphalidae	*Euthalia*	*monina remias*	Eastern Baron	M
138	Riodinidae	*Zemeros*	*flegyas*	Punchinillo	F
139	Lycaenidae	*Anthene*	*emolus*	Ciliate blue	M
144	Pieridae	*Appias*	*lyncida*	Chocolate albatross	
160	Pieridae	*Prioneris*	*philonome clemanthe*	Red spot Sawtooth	M
161	Nymphalidae	*Euthalia*	*lubentina*	Gaudy Baron	
162	Unknown				
163	Pieridae	*Eurema*		Grass yellow sp.	
164	Lycaenidae	*Charana*		Blue or tit sp.	
165	Lycaenidae	*Anthene*	*emolus*	Ciliate blue	
166	Danasidae?				
167	Danasidae				
168	Lycaenidae	*Parantica*	*?*	Glassy tiger?	
169	?				
170	Nymphalidae				
171	Lycaenidae				
172	Lycaenidae	*Acytoleps*			
173	Pieridae	*Eurema*			
Sighting	Lycaenidae	*Catochrysoes*	*panormus*	Silver Forget-Me-Not	

only					
Sighting only	Lycaenidae	*Zeltus*	*amasa*	Fluffy Tit	
Sighting only	Nymphalidae	*Vendula*	*erota*	Cruiser	
Sighting only	Papilionidae	*Lamproptera*	*curius*	White dragontail	
Sighting only	Pieridae	*Hebonoia*	*glaucippe*	Great orange-tip	

Appendix 3

Vertebrate species seen or reported in Botum Sakor Park, April 2005 – April 2008. Conservation status for birds taken from Birdlife International (2008), other species from IUCN (2008). Localities reflect location of evidence and do not indicate limit of species coverage or occupied area. Question marks after the common name indicates that identity of species is provisional only and awaits confirmation.

Genus	Species	Common name	Conservation status	Locality	Evidence
AMPHIBIA					
Bufonidae					
Bufo	*melanostichus*	Black-spined toad		Widespread	Specimen
Bufo	*parvus*	Indochinese Dwarf Toad?		Quadrat	Specimen
Ichthyophiidae					
Ichthyophis	*kohtaoensis*	Koa Tao Island Caecilian		062 TS2	Sighting
Microhylidae					
Calluella	*guttutata*	Striped spadefoot frog		072 TS3	Spec. 3671T
Microhyla	*heynomsi*	Dark-sided Chorus Frog		Quadrat	Specimen
Microhyla	*berdmorei*	Berdmore´s chorus frog		063 TS1	Specimen
Microhyla	*ornata*	Ornate chorus frog		071 TS2	Spec. 3643T
Micryletta	*inornata*	Inornate froglet		052 TS2	Specimen
Kalophrynus	*pleurostigma*	Red-sided sticky frog		Widespread	Specimen
Kalophrynus	*interlineatus*	Striped sticky frog		063 TS1	Specimen
Ranidae					
Cancrivora	*gravenhorst*	Mangrove Frog?		Quadrat	Specimen

Fejervarya	*limnocharis*	Rice Field Frog		062 TS2	Sighting
Limnonectes	*paramacrodon*	Peat Swamp Frog?		Widespread, 064	Specimen 3607T
Limnonectes	*?*	Unknown frog		071 TS2	Spec. 3645T
Micrixalus	*baluensis*	Dwarf Mountain Frog?		Quadrat	Specimen
Occidozyga	*martensii*	Marten's puddle frog		Widespread	Specimen
Occidozyga	Sp.	Puddle frog sp.		052 TS1	Specimen
Occidozyga	*lima*	Common Puddle Frog		054 TS3	Sighting
Paa	*fasciculispina*	Spiny-breasted Frog		062 Turtle traps	Specimen 3994T
Rana	*erythraea*	Green-backed frog		By 053 TS2 turtle pool	Specimen
Rana	*lymnocharis*	Grass Frog		Quadrat	Specimen
Rana	*macrodactyla*	Stripe-backed frog		052 TS3	Specimen
Rhacophoridae					
Chrixalus	*nongkhorensis*	Nang Khor bushfrog		BC072	Spec. 3672T
Polypedates	*leucomystax*	Common tree frog		Widespread	Specimen 3617T
Polypedates	*mutus*	Northern tree frog		Widespread	Specimen 3608T
Unknown					
Unknown		Frog sp.			Specimen
Bufo		Toad sp.		062 TS1	Specimen 3700T
Unknown		Frog sp.		Sat Camp 064	Specimen 3609T
Bufo		Toad sp.		064 TS3	Specimen 3621T
AVIA					
Accipitridae					
Accipiter	*badius*	Shikra		River near BC064	Sighting
Accipiter	*gularis*	Japanese sparrowhawk		River 071	Sighting
Accipiter	*soloensis*	Chinese Sparrowhawk?	CITES	Approx. 1km from 053 BC	Sighting
Accipiter	*nisus*	Eurasian Sparrowhawk	CITES	Near 054 BC	Sighting
Aquila	sp.	Eagle species		Stueng Ta Ak	Sighting
Aviceda	*luephotes*	Black Baza	CITES	Widespread	Sighting
Butastur	*indicus*	Grey-faced Buzzard	CITES	Near 053 BC	Sighting

Buteo	*buteo*	Common Buzzard		Widespread 064	Sighting
Circus	*spilonotus*	Eastern Marsh Harrier		Over estuary	Sighting
Circus	*cyaneus*	Hen harrier	CITES	Riverside, 062	Audio
Elarus	*caeraus*	Black shouldered kite		Near Andoung Tuek	Sighting
Haliaetus	*leucogaster*	White-bellied sea eagle	Regionally threatened	Widespread over Preaek Phkum river	Sighting
Haliastur	*indus*	Brahminy Kite	Regionally threatened	Near estuary	Sighting
Hieraaetus	*Kienerii*	Rufous-bellied Eagle	CITES	Meadow 083	Sighting
Ichthyophaga	*ichthyaetus*	Grey-headed fish eagle	NT	052 TS2 by river	Sighting
Ictinaetus	*malayensis*	Black Eagle	CITES	Near Kompong Pluh village	Sighting
Milvus	*migrans*	Black kite	CITES	Grassy flooded meadow, BC1, 062	Sighting
Pernis	*ptilorhyncus*	Oriental honey buzzard		Widespread near river	Sighting
Spilornis	*cheela*	Crested serpent eagle		Widespread	Photograph
Spizaetus	*cirrhatus*	Changeable Hawk Eagle		Widespread	Sighting
Alcedinidae					
Alcedo	*meninting*	Blue-eared kingfisher		Widespread	Sighting
Alcedo	*atthis*	Common kingfisher		Widespread	Sighting
Ceryle	*rudis*	Pied kingfisher		River, 071	Sighting
Ceyx	*rufidorsa*	Rufous-backed kingfisher		053 BC	Sighting
Halcyon	*pileata*	Black-capped kingfisher		Widespread on Preaek Phkum river	Sighting

Halcyon	*coromanda*	Ruddy kingfisher	Riverside between AA04-AA05, 062	Audio
Halcyon	*capensus*	Stork-billed kingfisher	Widespread on Preaek Phkum river	Sighting
Halcyon	*smyrnensis*	White-throated Kingfisher	Widespread	Sighting
Trodiramphus	*chloris*	Collared Kingfisher	Mudflats near mouth of Preaek Phkum river	Sighting
Anatidae				
Anas	*acuta*	Northern pintail	Riverside, 062	Sighting
Anas	*poecilorhyncha*	Spot-billed duck	064	Sighting
Dendrocygna	*javanica*	Lesser whistling duck	On river, TS2, 062	Audio
Apodidae				
Apus	*affinis*	House swift	Widespread 071	Sighting
Apus	*pacificus*	Fork-tailed swift	Boat trip 063	Sighting
Collocalia	*germani*	Germains swiftlet	Grassland, TS3, 062	Audio
Cypsiurus	*balasiensis*	Asian palm swift	Riverside, BC1 062	Audio
Hirundapus	*caudacutus*	White-throated needletail	Widespread 064	Sighting
Hirundapus	*giganteus*	Brown-backed needle-tail	Riverside, TS2, 062	Audio
Hirundapus	*cochinchinensis*	Silver backed needletail	Riverside, AA05, 062	Audio
Ardeidae				
Ardea	*cinerea*	Grey Heron	Stueng Ta Ak	Sighting
Ardea	*purpurea*	Purple Heron	Stueng Ta Ak	Sighting
Ardeola	*bacchus*	Chinese pond heron	Widespread	Sighting

Ardeola	*speciosa*	Javan pond heron		Widespread	Sighting
Butorides	*striatus*	Little Heron		Widespread	Sighting
Egretta	*garzetta*	Little egret		Riverside, 062	Sighting
Gorsachius	*Melanolophus*	Malayan Night Heron		Forest stream 083	Sighting
Ixobrychus	*cinnamomeus*	Cinnamon bittern		Grassy flooded meadow, BC1 062	Sighting
Ixobrychus	*sinensis*	Yellow Bittern		Meadow 083	Sighting
Mesophyx	*intermedia*	Intermediate egret		River approx. 6km from 053 BC	Sighting
Bucerotidae					
Aceros	*undulatus*	Wreathed Hornbill	CITES	053 BC	Sighting
Anthracoceros	*albirostris*	Oriental pied hornbill	CITES	Widespread	Sighting
Buceros	*bicornis*	Great hornbill	NT	Widespread	Sighting
Buceros	*rhinoceros?*	Rhinocerous hornbill?		River, 071	Sighting
Campephagidae					
Coracina	*polioptera*	Indo-chinese cuckoo shrike		Riverside, 062	Audio
Pericrocotus	*flammeus*	Scarlet Minivet		Riverside, 062	Sighting
Tephrodornis	*gularis*	Common wood-shrike		Riverside, 062	Audio
Tephrodornis	*gularis*	Large wood-shrike		Several sightings 064	Sighting
Caprimulgidae					
Caprimulgus	*affinis*	Savannah nightjar		Widespread 071	Audio
Caprimulgus	*macrurus*	Large-tailed Nightjar		Widespread 083	Visual
Centropodidae					

Centropus	*sinensis*	Greater coucal		Widespread	Sighting
Centropus	*bengalensis*	Lesser coucal		Riverside, BC2, 062	Audio
Charadriidae					
Charadrius	*alexandrinus*	Kentish plover		Coast 072	Sighting
Vanellus	*cinereus*	Grey-headed lapwing		Estuary 071	Sighting
Vanellus	*indicus*	Red wattled lapwing		BC071	Sighting
Chloropseidae					
Aegithina	*tiphia*	Common iora		Riverside, AA04, 062	Sighting
Chloropsis	*cyanopogon*	Blue-winged leafbird		Riverside, 062	Audio
Chloropsis	*aurifrons*	Golden-fronted Leafbird		Near 054 BC	Sighting
Ciconiidae					
Ciconia	*episcopus*	Woolly-necked stork	Regionally threatened	Widespread	Sighting
Leptoptilos	*javanicus*	Lesser Adjutant		Widespread	Sighting
Columbidae					
Chalcophaps	*indica*	Emerald dove		Riverside BC2, 062	Audio
Columba	*livia*	Rock pigeon		Riverside, AA04, 062	Sighting
Ducula	*aenea*	Green Imperial Pigeon		Widespread	Photograph
Ducula	*badia*	Mountain Imperial Pigeon		Widespread	Sighting
Ducula	*bicolor*	Pied imperial pigeon		Riverside, 062	Sighting
Macropygia	*unchall*	Barred cuckoo dove		Riverside, 064	Sighting
Steptopelia	*tranquebarica*	Red-collared dove		Meadow near ranger station, 062	Audio
Steptopelia	*chinensis*	Spotted dove		Grassland, TS3, 062	Audio
Treron	*veranans*	Pink necked green pigeon		Riverside BC2, 062	Audio

Treron	*pompadoras*	Pompadour green pigeon	Riverside, 062	Sighting
Treron	*curvirostra*	Thick-billed green pigeon	E: 103°21'13.2" N: 11°09'47.8"	Sighting
Treron	*bicincta*	Orange-breasted Green Pigeon	Near 053 BC	Sighting
Coraciidae				
Coracias	*benghalensis*	Indian Roller	Widespread	Sighting
Eurystomus	*orientalis*	Dollar bird	Riverside BC2, 062	Audio
Corvidae				
Aegithina	*lafresnayei*	Great Iora	Several sightings 064	Sighting
Corvus	*macrorhynchos*	Large-billed crow	Riverside, 062	Sighting
Crypsirina	*temia*	Racket-tailed treepie	Riverside, TS2, 062	Sighting
Dendrocitta	*vagabunda*	Rufous treepie	River 071	Sighting
Dicrurus	aeneus	Bronzed Drongo	Widespread 064	Sighting
Dicrurus	*leucophaeus*	Ashy Drongo	Widespread	Sighting
Dicrurus	*macrocercus*	Black drongo	Riverside near Snakaar ranger station	Sighting
Dicrurus	*paradiseus*	Greater Racket-tailed Drongo	Widespread	Sighting
Dicrurus	*remifer*	Lesser Racket-tailed drongo	Widespread	Sighting
Dicrurus	*hottentottus*	Spangled Drongo	Widespread	Sighting
Garrulus	*glandarius*	Eurasian jay	Near base camp 063	Audio
Irena	*puella*	Asian fairy bluebird	E: 103°21'13.2" N: 11°09'47.8"	Sighting
Oriolus	*xanthornus*	Black hooded Oriole	Clearing near old village	Sighting
Oriolus	*chinensis*	Black-naped oriole	Near 053 BC	Sighting
Pericroctus	*divaricatus*	Ashy minivet	Meadow 071	Sighting
Rhipidura	*javanica*	Pied fantail	River, 071	Sighting
Terpsiphone	*paradisi*	Asian paradise flycatcher	River, 071	Sighting

Urocissa	*erythrorhyncha*	Red-billed Blue Magpie	Melaleuca near 053 BC	Sighting
Cuculidae				
Cuculus	*saturatus*	Oriental cuckoo	BC072	Sighting
Eudynamys	*scolopacea*	Common asian koel	Riverside, 062	Audio
Hierococcyx	*sparverioides*	Large Hawk Cuckoo	Riverside, 064	Sighting
Phaenicophaeus	*cunirestris*	Chestnut breasted Malkoha	072	Sighting
Phaenicophaeus	*tristis*	Green-Billed Malkoha	Riverside, 062	Audio
Surriculus	*lugabris*	Drongo-cuckoo	River 071	Sighting
Carpococcyx	*renauldi*	Coral-billed Ground Cuckoo	Evergreen forest, 083	Audio
Eurostopididae				
Eurostopodus	*macrotis*	Great-eared nightjar	BC 071	Sighting
Eurylaimidae				
Corydon	*sumatranus*	Dusky Broadbill	Roadside 083	Sighting
Cymbirhyndus	*macrohynchos*	Black and red Broadbill	053 BC	Photograph
Fringillidae				
Carduelis	*ambigua*	Black-headed greenfinch	River 071	Sighting
Lonchura	*striata*	White-rumped Munia	Roadside 083	Sighting
Hemiprocnidae				
Hemiprocne	*coronata*	Crested tree swift	Riverside, BC1 062	Audio
Hirundinidae				
Delichon	*dasypus*	Asian house martin	Widespread 064	Sighting
Hirunido	*daurica*	Red-rumped swallow	River 071	Sighting
Hirunido	*rustica*	Barn swallow	River 071	Sighting
Hirundo	*smithii*	Wire-tailed swallow	Riverside 064	Sighting
Hirundo	*tabitica*	Pacific swallow	Boat trip 063	Sighting
Riparia	*riparia*	Sand Marting	Roadside 083	Sighting
Laniidae				

Lanius	*cristatus*	Brown shrike	072	Sighting
Lanius	*tigrinus*	Tiger shrike	Park HQ 071	Sighting
Laridae				
Sterna	*anaethetus*	Bridled Tern	Over estuary	Sighting
Sterna	*hirundo*	Common Tern	Estuary off coast near Chamkar Leu village	Sighting
Sterna	*bergii*	Great Crested Tern	Estuary off coast near Chamkar Leu village	Sighting
Sterna	*bengalensis*	Lesser Crested Tern	Estuary off coast near Chamkar Leu village	Sighting
Sterna	*albifrons*	Little tern	Riverside TS2 062	Audio
Megalaimilae				
Megalaima	*australis*	Blue-eared barbet	River 071	Sighting
Megalaima	*haemacephala*	Coppersmith barbet	Near 054 BC	Sighting
Megalaima	*faostricta*	Green-eared barbet	Widespread	Sighting
Megalaima	*lineata*	Lineated barbet	Melaleuca near 053 BC	Sighting
Meropidae				
Merops	*viridis*	Blue-throated bee-eater	Riverside, BC1 062	Photograph
Merops	*leschenaultia*	Chestnut-headed bee-eater	Widespread- Melaleuca	Sighting
Merops	*philippinus*	Blue-tailed bee-eater	Riverside 064	Sighting
Merops	*orientalis*	Green bee-eater	Riverside, 062	Audio
Nyctyoris	*athertoni*	Blue-bearded bee-eater	E: 103°21'13.2" N: 11°09'47.8"	Sighting
Muscicapidae				

Copsychus	*malabaricus*	White-rumped shama	Meadow behind BC072	Sighting
Copsychus	*sauloris*	Oriental magpie robin	Melaleuca near 053 BC	Sighting
Cyornis	*hainanus*	Hainan Blue Flycatcher	Channel near 053 BC	Sighting
Ficedula	*mugimaki*	Mugimaki flycatcher	Riverside, 062	Sighting
Ficedula	*pana*	Red-throated flycatcher	River 071	Sighting
Ficedula	*westermanni*	Little Pied Flycatcher	Roadside 083	Sighting
Ficedula	*zanthopygia*	Yellow-rumped flycatcher	River 071	Sighting
Hypothynis	*azurea*	Black-naped monarch	052 TS2	Photograph
Muscicapa	*dauurica*	Asian brown flycatcher	River 071	Sighting
Muscicapa	*ferruginea*	Ferruginous flycatcher	River 071	Sighting
Pachycephala	*grisola*	Mangrove Whistler	Riverside, 064	Sighting
Saxicola	*torquata*	Common stonechat	River 071	Sighting
Zoothura	*citrina*	Orange-headed thrush	Satcamp A 071	Sighting
Nectariniidae				
Aethopyga	*saturata*	Black-throated sunbird	River 071	Sighting
Aethopyga	*siparaja*	Crimson Sunbird	Melaleuca near 053 BC	Sighting
Anthreptes	*malacensis*	Brown-throated sunbird	Widespread 064	Sighting
Archnothera	*longirostra*	Little spiderhunter	Riverside 062	Audio
Arthreptes	*singalensis*	Ruby cheeked sunbird	Riverside, 062	Sighting
Dicaeum	*chrysorrheum*	Yellow-vented flowerpecker	River 071	Sighting
Dicaeum	*Cruentatum*	Scarlet-backed flowerpecker	River edge near 053 BC E: 103°21'13.2" N: 11°09'47.8"	Sighting
Hypogramma	*hypogrammicum*	Purple-naped sunbird	Riverside, 064	Sighting
Nectarinia	*calcostetha*	Copper-throated sunbird	Riverside, BC1 062	Sighting

Nectarinia	*jugularis*	Olive-backed sunbird		Riverside, 062	Sighting
Nectarinia	*asiatica*	Purple sunbird		Riverside, 062	Sighting
Nectarinia	*sperata*	Purple-throated sunbird		Melaleuca near 053 BC	Sighting
Oriolini					
Hemipus	*picatus*	Bar-winged Flycatcher-shrike		Roadside 083	Sighting
Pandionidae					
Pandion	*haliaetus*	Osprey	CITES	Widespread near Stueng Ta Ak	Sighting
Paridae					
Parus	*major*	Great tit		Riverside, 062	Audio
Passeridae					
Anthus	*rufulus*	Paddyfield pipit		Riverside, BC2, 062	Audio
Motacilla	*alba*	White wagtail		Park HQ 071	Sighting
Motacilla	*cinerea*	Grey Wagtail		Small stream 083	Sighting
Motacilla	*flava*	Yellow wagtail		Riverside, 062	Sighting
Phalacrocoracidae					
Anhinga	*melanogaster*	Oriental Darter		Widespread	Sighting
Phalacrocorax	*niger*	Little cormorant		Riverside, AA02, 062	Audio
Phasinidae					
Francolinus	*pintadeanus*	Cinese Francolin		Evergreen forest near Road, 083	Audio
Coturnix	*chinensis*	Blue-breasted Quail		Secondary Habitat, 083	Sighting
Arborophila	*cambodiana*	Chestnut-headed partridge	VUL	Riverside, 062	Audio
Arborophila	*chloropus*	Scaly-breasted Partridge		Riverside 083	Sighting
Coturnix	*coromandelica*	Rain quail		Riverside, 062	Sighting

Gallus	*gallus*	Red junglefowl		BC064	Sighting
Pavo	*muticus*	Green Peafowl	CITES	River edge approx. 3km East of 053 BC.	Sighting
Picidae					
Celeus	*brachyurus*	Rufous Woodpecker		Clearing near old village	Sighting
Chrysocolaptes	*lucidus*	Greater flameback		Riverside, 062	Audio
Dendrocopos	*macei*	Fulvous breasted woodpecker		Riverside BC2, 062	Audio
Dendrocopus	*canicapillus*	Grey-capped pygmy woodpecker		Melaleuca near 053 BC	Sighting
Dinopium	*javanense*	Common Flameback		Melaleuca near 053 BC	Sighting
Hemicircus	*canente*	Heart spotted woodpecker		Forest BC1, TS2, 062	Sighting
Meiglytes	*jugularis*	Black and buff Woodpecker		E: 103°21'13.2" N: 11°09'47.8"	Sighting
Mulleripicus	*pulverulentus*	Great slaty woodpecker		Mango meadow 072	Sighting
Picus	*Canus*	Grey-headed woodpecker		Riverside, 062	Audio
Picus	*viffotus*	Laced Woodpecker		River edge near 053 BC E: 103°21'13.2" N: 11°09'47.8"	Sighting
Picus	*xanthopygaeus*	Streak throated woodpecker		Grassland, TS3, 062	Audio
Picus	*mineaceus*	Banded woodpecker		Riverside, 062	Audio
Picus	*chlorolophus*	Lesser Yellownape		Evergreen forest, 083	Sighting
Picus	*Erythropygius*	Black-headed Woodpecker		Roadside, 083	Sighting
Pittidae					
Pitta	*moluccensis*	Blue-winged Pitta		Melaleuca near 053 BC	Sighting

Pitta	*sordida*	Hooded Pitta		072 TS1	Sighting
Psittacidae					
Loriculus	*vernalis*	Vernal hanging-parrot	CITES	Widespread	Sighting
Psittacula	*alexandri*	Red-breasted parakeet	CITES	On path to 052 TS3	Sighting
Pycononotidae					
Alophoixus	*pallidus*	Ochraceous bulbul		Widespread 083	Sighting
Iole	*propinqua*	Grey eyed bulbul		072	Sighting
Pycnonotus	*aurigaster*	Sooty-headed bulbul		Secondary habitat 083	Sighting
Pycnonotus	*blandfordi*	Streak-eared bulbul		River 071	Sighting
Pycnonotus	*melanicterus*	Black-crested bulbul		Clearing near old village	Sighting
Pycnonotus	*atriceps*	Black-headed bulbul		Riverside, TS2, 062	Audio
Pycnonotus	*finkysoni*	Stripe-throated bulbul		Widespread	Sighting
Pycnonotus	*goiavier*	Yellow-vented bulbul		Widespread	Sighting
Rallidae					
Amaurornis	*phoenicurus*	White-breasted Waterhen		Stueng Ta Ak	Sighting
Porzana	*fusca*	Ruddy-breasted crake		River 071	Sighting
Scolopacidae					
Numenius	*phaeopus*	Whimbrel		Near estuary	Sighting
Tringa	*tetanus*	Common Redshank		Near estuary	Sighting
Gallinago	*gallinago*	Common Snipe		Meadow 083	Sighting
Sittidae					
Sitta	*frontalis?*	Nuthatch sp. (velvet fronted?)		River 071	Sighting
Strigiformes					
Ketupa	*zeylonensis*	Brown fish owl	CITES	Riverside, 062	Sighting
Ninox	*scutulate*	Brown Hawk Owl	CITES	Preaek Phkum river, approx. 3km from 053 BC	Photograph

Otos	sp.	Scops owl	CITES	Melaleuca near 053 BC	Sighting
Ottus	*bakkaunoeria*	Collared scops owl		Caught in mist net BC071	Photograph
Phodilus	*badius*	Oriental bay owl		Preakh Dumb Bong village, 072	Photos
Glaucidium	*brodiei*	Collared Owlet		Secondary Habitat, 083	Audio
Sturnidae					
Ampeliceps	*coronatus*	Golden-crested myna		Riverside, 062	Audio
Aoridotheres	*grandis*	White-vented myna		BC071	Sighting
Aoridotheres	*tristis*	Common myna		Widespread	Sighting
Gracula	*religiosa*	Hill Myna	CITES	Widespread	Sighting
Sturnus	*contra*	Asian pied starling		Riverside, 062	Audio
Sturnus	*nigricollis*	Black-collared starling		Meadow near ranger station, 062	Audio
Sturnus	*burmannicus*	Vinous-breasted starling		Meadow within forest, 062	Sighting
Sylviidae					
Cisticola	*exilis*	Bright-headed cisticola		Riverside, 062	Audio
Cisticola	*cursitons*	Golden-headed fantail warbler		Riverside, 062	Audio
Cisticola	*juncidis*	Zitting cisticola		Riverside, 062	Sighting
Gerygone	*sulpurea*	Golden bellied gerygone		Grassy flooded meadow, BC1 062	Sighting
Megalurus	*palustris*	Striated grassbird		Riverside, 062	Sighting
Orthotomus	*sutorius*	Common tailor-bird		053 BC	Sighting
Orthotomus	*atrogularis*	Dark-necked tailorbird		Riverside, 062	Audio
Phylloscopus	*borealis*	Arctic Warbler		Widespread 083	Sighting
Phylloscopus	*fuscatus*	Dusky Warbler		Riverside 064	Sighting

Prinia	*hodgsonii*	Grey-breasted prinia		Bird hide, 063	Sighting
Prinia	*inornata*	Plain Prinea		Evergreen forest 083	Sighting
Prinia	*rufescens*	Rufescent prinia		Riverside BC2, 062	Audio
Urosphena	*squameiceps*	Asian stubtail		River 071	Sighting
Timaliidae					
Garrulax	*chinensis*	Black-throated laughingthrush		Riverside, 062	Audio
Garrulax	*leucolophus*	White-crested Laughingthrush		Widespread 083	Sighting
Macronous	*gularis*	Striped tit-babbler		Riverside, TS2 062	Sighting
Malacocincla	*abbottii*	Abbots babbler		Riverside, TS2 062	Sighting
Pellorneum	*ruficeps*	Puff-throated babbler		Evergreen forest 083	Sighting
Yuhina	*zantholeuca*	White-bellied Yuhina		Widespread	Sighting
Trogonidae					
Harpactes	*oreskios*	Orange-breasted Trogon		Widespread	Sighting
MAMMALIA					
Bovidae					
Bubalus	?	Wild water-buffalo/Gaur		Widespread	Prints
Cercopithecidae					
Macaca	*fascicularis*	Crab-eating macaque	NT,CITES	Widespread	Photograph
Macaca	*mullata*	Rhesus macaque		Near BC064	Sighting
Macaca	*nemestrina*	Pig-tailed macaque	VUL, CITES	TS1061	Sighting
Semnopithecus	*cristatus*	Silvered langur		BC072	Sighting + Capture
Presbytis	unknown	Langur sp.		053 BC	Sighting

Cervidae					
Cervus	*unicolor*	Sambar		Widespread	Prints
Muntiacus	*muntjak*	Common barking deer		Widespread	Call, prints (plaster cast, photograph) and sighting
Delphinidae					
Orcaella	*brevirostris*	Irrawaddy Dolphin	Data Deficient CITES	By Ta Ok ranger station	Sighting
Erinaceidae					
Hylomys	*suillus*	Lesser gynmure		063, TS2	Specimen
Felidae					
Felis	*chaus*	Jungle cat	CITES	Forest edge past 052 TS2	Sighting
Felis	*temmincki*	Asian Golden Cat	CITES, NT	61	Tracks
Panthera	*pardus*	Leopard	CITES, VUL	053 BC	Sighting
Panthera	*tigris*	Tiger	CITES, END	50km from 053 BC	Prints (photograph)
Prionailurus	*bengalensis*	Leopard Cat	CITES	Widespread	Prints (photograph)
Prionailurus	*viverinnus*	Fishing Cat	CITES, END	Around 054 BC	Prints (photograph)
Herpestidae					
Herpestes	*javanicus*	Small Asian Mongoose		Near BC072	Prints (photograph)
Hipposideridae					
Hipposideros	*bicolor*	Bicolored roundleaf bat		TS3 071	Spec. 3636T
Hipposideros	*larvatus*	Intermediate roundleaf bat		TS3 071	Spec. 3631T
Hylobatidae					

Hylobates	*pileatus*	Pileated Gibbon	CITES, VUL	Preaek Phkum downstream from 053 BC	Sighting
Hystricidae					
Unknown		Porcupine sp.		Path to Waterfall	Prints, digging
Leporidae					
Lepus	*peguensis*	Siamese hare		BC071	Photo
Lorisidae					
Nyeticebus	*coucang*	Slow Loris		Near BC072	Sighting
Megadermatidae					
Megaderma	*spasma*	False vampire bat		TS1 064 (during 071)	Capture, but escaped
Muridae					
Mus	*cervicolor*	Fawn-coloured mouse		Mammal traps, BC3 062	Specimen
Rattus	*surifer*	Yellow rajah rat		Widespread	Specimen
Rattus?	Sp.	Rat sp.		052 TS2	Specimen
Rattus?	Sp.	Rat sp.		Mammal traps, BC3 062	Sighting
Unknown	Sp.	Mouse sp.		052 TS1	Specimen
Unknown	Sp.	Mouse sp.		062 TS3	Specimen 3695T
Rattus	*rattus*	Black rat		TS3 064	Specimen 3619T
Rattus	Sp.	Rat sp.		TS3 064	Specimen 3627T
Mustelidae					
Aonyx	*cinerea*	Small clawed otter	CITES, NT	In river between BC and ferry crossing, 062	Sighting
Lutra	*lutra*	Eurasian otter	CITES, VUL	In river between BC and ferry crossing, 062	Sighting

Melogale	*personata*	Burmese ferret badger		On path to TS2, 072	Prints (photograph)
Proboscidea					
Elephas	*maximus*	Asian Elephant	CITES, END	61	Tracks
Pteropodidae					
Cynopterus	*brachyotis*	Lesser short-nosed fruit bat		Caught in mist net BC064	Photographs
Pteropus	*lylei*	Lyle's Flying Fox	CITES	Approx 1hr upstream from Ta Ok ranger station	Sighting
Unknown	Sp.	Fruit bat		052 TS1	Sighting
Rhinolophidae					
Rhinolophus	*acuminatus*	Dobson's horseshoe bat		TS3 071	Spec. 3640T
Rhinolophus	*malayanus*	Malayan horseshoe bat		TS3 071	Spec. 3634T & 3635T
Rhinolophus	*pusillus*	Least horseshoe bat		TS3 071	Spec. 3633T
Rhinolophus	*shameli*	Shamel's horseshoe bat		TS3 071	Spec. 3632T &3637T
Rhinolophus	*?*	Horseshoe bat sp.		On path to TS1, 072	Specimen
Rhizomyidae					
Rhizomus	Sp.	Bamboo Rat sp.		054 TS2	Sighting; prints
Sciuridae					
Callosciurus	*finlaysoni*	Variable Squirrel		Widespread	Sighting
Menetes	*berdmorei*	IndoChinese Ground Squirrel		BC061	Sighting
Ratufa	*bicolor*	Black Giant Squirrel	CITES	Near 053 BC	Sighting
Tamiops	*rodolphii*	Cambodian Striped Squirrel		Near 054 BC	Sighting
Soricidae					
Crocidura	*fuliginosa*	Southeast Asian White-toothed Shrew		Widespread	Specimens

Crocidura	*horsfieldi*	Horsefields Shrew		TS1&TS2 061	bucket capture
Suidae					
Sus	*scrofa*	Common Wild pig		Path to 052 TS2	Prints (Photograph and plaster cast)
Tragulidae					
Tragulus	*javanicus*	Lesser Mousedeer		Near village	Prints
Tupaiidae					
Tupaia	*belangeri*	Northern Treeshrew		TS2 and TS3 064	Captures
Tupaia	*glis*	Common Treeshrew	CITES	Widespread	Sighting, specimen
Ursidae					
Helarctos	*malayanus*	Malayan sun bear	Data deficient, CITES	052 TS1	Scratches on tree
Vespertilionidae					
Kerivoula	*harwichei*	Hardwicke's bat		TS3 071	Spec. 3642T
Murina	*?*	Tube-nosed bat sp.		TS3 071	Spec. 3639T
Viverridae					
Paguma	*Larvata*	Masked palm civet		Near BC072	Prints (photograph)
Paradoxurus	*hermaphroditus*	Common palm civet	CITES	Widespread	Prints (plaster cast, photograph); Camera trap photograph, sighting 063
Viverra	*megaspila*	Large Spotted Civet		Near 054 BC	Camera trap photograph
Viverricula	*malaccensis*	Small Indian Civet		Widespread	Prints (plaster cast, photograph) Camera trap photograph

REPTILIA

Agamidae					
Acanthosaura	*armata*	Horned tree lizard		062 and 064	Specimen 3614T
Calotes	*emma alticristatus*	Northern forest crested lizard		052 TS1	Specimen
Calotes	*versicolor*	Garden fence lizard		052 TS3	Specimen
Draco	*maculatus*	Spotted Gliding Lizard		064 TS3	Specimen 3622T
Draco	*melanopogon*	Black bearded gliding lizard		TS3, 062	Photograph
Draco	*taeniopterus*	Barred gliding lizard	CITES	052 and 064	Specimen 3625T
Draco	sp.	Gliding lizard	CITES	Near village, 1.5km from 053 BC	Specimen
Physignathus	*cocincinus*	Indochinese Water dragon		Riverside 061	Sighting
Aniliidae					
Cylindrophis	*ruffus*	Red-tailed Pipe Snake		054 TS3, line 1 bucket 9.	Specimen
Bataguridae					
Cyclemis	*dentate*	Asian leaf turtle	NT	Near village, 1.5km from 053 BC	Photograph
Boidae					
Python	*reticulates*	Reticulated python	CITES	Park HQ; near 053 BC	Specimen; photograph
Colubridae					
Ahaetulla	sp.	Whip Snake sp.		053, 054 Butterfly Transect	Sighting
Ahaetulla	*nasuta*	Long nosed whip snake		Near BC072	Sighting
Ahaetulla	*prasina*	Oriental Whip Snake		053 and 064	Specimen 3620T
Boiga	*cyanea*	Green cat snake		054 TS2 VP2	Photograph
Boiga	*dendrophila*	Mangrove snake		E: 103°19'42.5" N: 11°05'40.5"	Sighting

Dendrelaphis	*pictus*	Common Bronzeback		Near 052 TS2	Photograph
Elaphe	*flavolineata*	Common malayan racer		TS3 Base camp, in river, 062	Photograph
Elaphe	*oxycephalum*	Red-tailed Rat Snake		064 TS3	Sighting
Elaphe	*prasina*	Green Tree Racer?		Channel from Park HQ	Sighting
Enhydris	*bocourti*	Bocourt's water snake		Widespread	Photograph, specimen
Homalopsis	*buccata*	Puff-faced water snake		Widespread	Photograph
Enhydris	*enhydris*	Rainbow water snake		BC071	Sighting
Honalopsis	sp.	Water snake sp.		Base camp063	Specimen
Lycodon	*capucinus*	Common wolf/house snake		053 BC	Sighting
Lycodon	*laoensis*	Laotian or Indo-Chinese Wolf Snake		BC061	Sighting
Oligodon	*fasciolatus*	Banded Kukri Snake		caught by Ngait 061	Sighting
Oligodon joynsoni	*joynsoni*	Grey Kukri Snake		Forest Path	Sighting
Oligodon	*mouhoti*	Cambodian Kukri Snake		Forest near trap-site 3	Sighting
Oligodon	*purpurascens*	Brown Kukri Snake		Butterfly Transect	Photograph
Oligodon	*taeniatus*	Striped Kukri Snake		Near BC072	Spec. 3664T
Pareas	*carinatus*	Keeled Slug Snake		053 TS1 VP2	Specimen
Pareas	*margartiophorus*	White-spotted or northern mountain slug-snake		064, TS1	Specimen 3612T
Psammodynastes	*pulverulentus*	Common Mock Viper		Path into 053 BC	Sighting
Ptyas	*mucosus*	Common Rat Snake		Roadside 083	Sighting
Ptyas	*korros (*possibly *mucosus)*	Indo-chinese Rat Snake (possibly Common)	CITES	054 BC	Sighting

Rhabdophis	*nigrocinctus*	Green Keelback		Path to village, before stream crossing in forest	Sighting
Rhabdophis	*subminiatus*	Red-necked Keelback		061 and 064	Specimen 3624T
Xenochrophis	*piscator*	Chequered Keelback		Sat Camp 064	Specimen 3610T
Elapidae					
Bungarus	*candidus*	Malayan or blue krait		BC071	Photo
Bungarus	*fasciatus*	Banded Krait		053 BC; in river near Kompong Pluh	Photograph
Calliophis	*maculiceps*	Small spotted coral snake		Path past sat camp A, 072	Spec. 3665T
Naja	*kaouthia*	Monocellate Cobra	CITES	Widespread	Sighting
Naja	*siamensis*	Indochinese spitting cobra	CITES	Near waterfall, base camp 063	Skin specimen
Ophiophagus	*Hannah*	King cobra	CITES	River	Sighting
Gekkonidae					
Cyntodactylus	*intermedius*	Cardamom slender-toed gecko		052 TS2	Specimen
Gekko	*gecko*	Tokay gecko		Widespread	Photograph
Hemidactylus	*frenatus*	Spiny-tailed house gecko		Base camp 064	Specimen 3615T, 3616T, 3618T
Hemiphyllodactylus	*typus*	Minature gecko		Base camp 063	Specimen
Ptychozoon	*lionotum*	Smooth-backed gliding gecko		Near TS1, 072	Sighting
Lacertidae					
Takydromus	*sexlineatus*	Long-tailed lizard		Widespread	Specimen
Scincidae					
Dasia	*olivacea*	Olive tree skink		Bucket captures, 062	Sighting
Lipinia	*vittigera*	Striped Tree Skink		054 and 064	Specimen 3604T
Lygosoma	*bowringii*	Bowring's supple skink		Widespread	Specimen

(riopa)					
Lygosoma	*khoratense*	Khorat supple skink		TS1 064	Specimen 3601T
Lygosoma (riopa)	*Sp.*	Supple skink sp.		Widespread	Specimen
Lygosoma (riopa)	*Sp.*	Supple skink sp.		TS1 064	Specimen 3605T
Lygosoma (riopa)	*Sp.*	Supple skink sp.		TS3 064	Specimen 3626T
Mabuya	*macularia*	Speckled forest skink		Widespread	Specimen
Mabuya	*multifasciata*	Many-lined sun skink		Widespread	Specimen
Mabuya	*sp.*	Unknnown skink sp.		TS1 064	Specimen 3603T
Scincella	*reevesii*	Speckled leaf litter skink		Bucket captures, 062	Sighting, Specimen taken 063
Sphenomorphus	*maculatus*	Streamside skink		Widespread	Specimen
Tropidodophorus	*microlepis*	Small-scaled water-skink		On path between TS1 and base camp 063	Specimen
Unknown		Skink sp.		053 TS1	Specimen
Unknown		Skink sp.		063 TS3	Specimen
Testudinidae					
Indotestudo	*elongata*	Elongated tortoise	CITES END	Confiscated from poachers, 062	Photograph
Trionychidae					
Trionyx (Amyda)	*Cartilagineus (cartilaginea)*	Asiatic Soft-shelled turtle	VUL	Near village near 053 BC	Photograph
Typhlopidae					
Ramphotyphlops	*braminus*	Common blind or flowerpot snake		TS3 071	Spec. 3646T
Typhlops	*muelleri*	Mueller's Blind Snake	CITES	054 and 064	Specimen 3623T
Varanidae					
Varanus	*bengalensis*	Bengal Monitor	CITES	Widespread	Sighting, photograph
Varanus	*salvator*	Water Monitor	CITES	Upstream from 053 BC	Prints

Viperidae				
Calloselasma	*rhodostoma*	Malayan pit-viper	Widespread	Photograph, specimen
Trimeresurus	*banburiensus*	Kanburi pit-viper	TS1, 064	Sighting
Trimeresurus	*macrops*	Big-eyed Pit-viper	Path to nearby village	Photograph
Trimeresurus	Sp.	Pit-viper sp.	053 BC	Sighting
Unknown				
Unknown		Snake sp.		Photograph
Unknown		Snake sp.		Sighting
Unknown		Snake sp.		Sighting
Unknown		Snake sp.	063 BC	Specimen

Status: Vul, Vulnerable; NT, Near Threatened, CITES, CITES Appendix species