
Frontier Cambodia Environmental Research

REPORT 4

**Fauna and flora diversity studies in Botum Sakor National Park,
Cambodia**

April 2005 – September 2009



**Frontier Cambodia
January 2010**

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Royan, A., Lyon, M., Irwin, R., Ward, E., Belle, E.M.S. & Fanning E.

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The Ministry of Environment is responsible for management and protection of all national parks in Cambodia. The DNCP works with various organisations to ensure Cambodia's natural resources are preserved for present and future generations.

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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. This 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). However, human disturbance in the past is 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 and 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 on the biodiversity of Botum Sakor National Park 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 pioneering biodiversity study of the area aims at developing comprehensive species lists for the flora and fauna of Botum Sakor and improving knowledge of the density and distribution of species of conservation interest within the park. This information will contribute towards the design, implementation and future evaluation of management plans for the region, whilst the training of national park and DNCP staff in scientific field techniques will ensure the future sustainability of the project.

1.3. Research work program overview

Prior to the construction of the route 48 highway along the northern boundary of the NP, the forests of Botum Sakor were connected to those of the southern Cardamom mountains providing a large area of protected forest. Therefore, much of the fauna in the Cardamom forests could be expected to also occur in Botum Sakor NP. Key species of conservation interest found in the southern Cardamoms include Asian elephant (*Elaphus maximus*), fishing cat (*Prionailurus viverrinus*), gaur (*Bos gaurus*), pileated gibbon (*Hylobates pileatus*), silvered langur (*Trachypithecus cristatus*) and tiger (*Panthera tigris*) (Traeholt & Lundahl 2003).

The bulk of the Frontier-Cambodia research programme has consisted of studies which aim to assess the general diversity of large and small mammal, avian, reptilian, amphibian and lepidopteran species within Botum Sakor. Species-specific studies have also been carried out which aim to produce more detailed information on the abundance and distribution of species of particular conservation interest such as the endangered Dhole (*Cuon alpinus*) and Great Hornbill (*Buceros bicornis*). Research has

also been carried out on bio-indicator species such as orchids and butterflies, for which there is very little information despite their widespread use as indicators of general ecosystem health.

September 2009 saw the completion of the 54th month of the study in Botum Sakor (18 phases), each phase comprising ten weeks of surveying. The study has therefore achieved a total of 180 weeks of survey effort to date. This report documents the research carried out by Frontier-Cambodia in Botum Sakor from April 2005 to September 2009 and contains species lists and accounts compiled for mammals, birds, reptiles, amphibians and lepidopera to date.

Chapter 2. Mammals

2.1 Mammal diversity and species accounts

2.1.1 Methods

Evidences of mammal species have been collected using a number of methodologies. Small Sherman traps have been used to capture small mammals such as rats and treeshrews. Three large box traps were used to capture civets. Sand transects facilitated track identification. Bat species were captured using harp traps positioned across forest paths and camera trapping took place for a period of 10 weeks between October and December 2005. Many species were identified opportunistically through sightings and track and scat identifications. In addition, interviews with park rangers, fishermen and forest users were conducted in order to obtain presence/absence information on species of conservation interest. Species-specific studies on dhole (*Cuon alpinus*) and pileated gibbon (*Hylobates pileatus*) aimed at assessing their density also took place and are reported on later in this chapter.

2.1.2 Results

Confirmed species

A full mammalian species list can found in appendix 1.

A total of 44 mammal species have been identified and their presence confirmed by camera trap photographs, captures or sightings from reliable sources within Frontier-Cambodia. The presence of large-toothed ferret badger (*Melogale personata*), hairy-nosed otter (*Lutra sumatrana*), smooth otter (*Lutra perspicillata*) and hog deer (*Axis porcinus*) has also been confirmed through other studies (Holden pers. comms 2009). Of these, 12 species are of conservation interest due to their status on the IUCN red list. Eight species are listed as endangered, two species are listed as vulnerable and two are listed as globally near threatened (IUCN 2007). The presence of eleven species remains unconfirmed, as evidence has been limited to track identification, descriptions from interviews or uncertain identifications from sightings.

Confirmed species accounts

Sunda Pangolin (*Manis javanica*) - Endangered

A single individual was confiscated from a poacher by park rangers in August 2008 in the north of the park near the NH 48 highway.

Asian Slow Loris (*Nycticebus bengalensis*) - Endangered

This species is known from three sightings. Two sightings were in the north of the park near the route 48 highway and another was on the Preaek Kon Tourt River during the dry season.

Indochinese Silvered Langur (*Trachypithecus germaini*) - Endangered

Small groups of this species with up to six individuals have been encountered along the Preaek Kon Tourt, Preaek Ta Ok, Stueng Ko and Preaek Dum Bong rivers, all at low densities. There are at least three separate groups along the Preaek Kon Tourt. Fishermen also report that this species is found along Preaek Ta Nun. Groups will apparently come close to villages and eat rice from the paddy fields that may suggest that this species has received direct persecution as a result of this activity.

Pileated Gibbon (*Hylobates pileatus*) - Endangered

Traeholt *et al.* (2005) estimated Botum Sakor to contain over 2000 groups of this species with a density of 1.55 groups per km². This species is regularly encountered in the more undisturbed evergreen and semi-evergreen forests in the northern areas of the park but appears to become less abundant on the southern side of the Preaek Kon Tourt suggesting the findings of Traeholt *et al.* (2005) to be an overestimate. Direct persecution of this species appears to be minimal if non-existent as interviewees report that this species is not hunted, firstly due to its beauty and secondly, and probably more significantly, due to this species being extremely difficult to hunt. However, the completion of the route 48 highway has separated Botum Sakor NP from the southern Cardamoms, fragmenting the populations. A study aimed at determining the density of this species in different areas of the park is reported on in section 2.3.

Dhole (*Cuon Alpinus*) – Endangered

Sightings of this species have been recorded in the large meadow system in the north of the park just south of the route 48 highway while a scat sample thought to be of dhole was taken from a meadow near the extreme south of the Preaek Ta Ok. Interviewees at the village of Kompong Phlu in the centre of the park have given a good description of two groups of dhole on the either side of Preaek Kompong Phlu. Therefore, there could be several groups within the NP, although at present there has only been a confirmed sighting from the one area in the north. A study investigating the density of dhole within Botum Sakor is reported on in section 2.2.

Fishing Cat (*Prionailurus viverrinus*) - Endangered

This species has been recorded through track identification (Frontier-Cambodia, in prep) and the species presence was confirmed when two juveniles, which had apparently been isolated after a forest fire, were found being raised by a family in a fishing village on the Preaek Kon Tourt (Royan 2009a). Confirmation of this endangered species in Botum Sakor is of particular conservation significance and a full account of this species is given in section 2.4.

Asian Elephant (*Elephas maximus*) - Endangered

Tracks and dung of this species are fairly regularly encountered on paths in forest and interspersed meadows to the north of the park. There is thought to be one group that permanently resides within the NP located in the small mountain range to the west while there are potentially one or two more groups in the north which are likely to move between the NP and the southern Cardamoms (Maltby pers. Comms, 2009). Evidences of both groups of elephants and individuals have been found.

Hog Deer (*Axis porcinus*) - Endangered

A small population of this species was recently identified in Botum Sakor NP close to the park HQ first through track identification (Timmins pers. comms 2008) and then confirmed by a camera trap photograph (Holden pers. comms 2009). The results of interviews suggest that this species was once found throughout the park but heavy hunting pressure restricted this species to an area of secondary forest and scrub habitat around the park HQ and neighbouring agricultural land. The proximity of this population to the park HQ would suggest that it faces no continued persecution, however, park rangers believe the population to number only a few individuals.

Large-spotted Civet (*Viverra megaspila*) – Vulnerable

This species is known from a single camera trap photograph in 2005 from the north of the park. Though this species is not particularly sought in the civet trade, snares are still regularly found throughout the protected area. The massive trend of deforestation in lowland areas of Cambodia is likely to have much more of a serious impact on it than on altitudinally wide-ranging ground-dwelling species (Duckworth, J. W *et al*, 2009).

Sambar (*Rusa unicolor*) - Vulnerable

Sambar appears to be widespread in distribution with tracks of this species regularly encountered. However, this species is said to be easy to hunt and is the principal target of many poachers while skeletal fragments of this species have been found next to snares. Consequently, density could be expected to be lower in areas close to villages and the less policed areas of the park.

Black Giant Squirrel (*Ratufa bicolor*) – Near Threatened

These squirrels are found fairly frequently on trees overhanging rivers during the wet season, but moves towards the centre of the park in the dry season as the coastal rivers become saline. The species appears to be hunted for food using slingshots.

Leopard (*Panthera pardus*) – Near Threatened

This species is known to occur in Botum Sakor NP from one sighting in the north of the park near NH 48 and through track identification on a sand bank on the Preaek Kompong Phlu. Park rangers report that tracks of this species are found regularly in the more undisturbed hills to the north west while one or two individuals may occur in the evergreen forests near the route 48 highway.

Long-tailed Macaque (*Macaca fascicularis*) - Least Concern/Not currently at risk

This macaque species is widespread in its distribution within Botum Sakor and it is regularly encountered. Evidence of poaching has been found, whereby groups are identified and a large circular band of forest is cut around the group. Traps are set around the perimeter of the circle and captured individuals are presumably sold for food.

Unconfirmed Species accounts

Asian Black Bear (*Ursus thibetanus*) and Sun Bear (*Helarctos malayanus*) – Vulnerable

One interviewee provided a good description of these species by reporting of two bear species, one large species with a white chest and a smaller species with a yellow chest. Frontier-Cambodia has found evidences of bear species through track identification and tree scratchings throughout the NP, however, the species cannot be distinguished conclusively without photographic evidence.

Asian Golden Cat (*Catopuma temnickii*) – Vulnerable

This species has been initially identified through track identification. This species is known to occur in the southern Cardamoms (Traeholt & Lundahl 2003) and therefore its presence in Botum Sakor NP may not be surprising. However, track identification between cat species can be difficult and this report should be treated with caution.

2.1.3 Discussion

Of the 44 confirmed mammal species that have been identified in Botum Sakor NP over a quarter of the species are of conservation interest due to their global status. Eight of these are of particular interest as they are listed as endangered. Areas with a high portion of species of global conservation interest should be afforded greater levels of protection. All of the globally threatened species listed in this report have been previously recorded in the Cardamom region with the exception of the hog deer (e.g. see Long *et al.*, 2000 & Traeholt & Lundahl 2003). Although Botum Sakor NP contains a smaller area of suitable habitat for these species compared to other protected areas, it should be considered when developing future conservation programmes. It may also contain important populations of fishing cat due to the forested lowland coastal landscape, and an estimated 10% of the global population of pileated gibbon (Traeholt *et al.*, 2005) and one of only two known populations of hog deer in Cambodia (see Maxwell *et al.*, 2006).

Current threats facing mammals in Botum Sakor NP are largely from poaching, particularly through snares, and the opportunistic hunting of small mammal species such as civets, small cats and giant squirrels for food. Sambar, muntjac and wild pig are thought to be the most common hunting targets. However, snares may also indirectly target species such as fishing cat, leopard cat, large spotted civet and dhole. Hog deer appear to have been reduced to a small population around the park headquarters through excessive hunting, while park rangers report that Sunda pangolin and Asian slow loris are also targeted by poachers due to their value in the Chinese medicinal trade. The route 48 highway was recently completed along the northern boundary of the NP which isolates it from the southern Cardamom Mountains. Although this is unlikely to have an effect on larger mammal species, populations of pileated gibbon, Indochinese silvered langur and Asian slow loris, which are largely arboreal species, have become further fragmented. Therefore, populations of these species within Botum Sakor should be considered separate to those in other areas. In addition, the planned development of a power station in the southwest of the NP adjacent to Khao Sdach could potentially threaten mammal habitats. How much further development projects will infringe on the protected zone is currently unclear.

The following key species, known to occur in the Cardamom region, have not been found in Botum Sakor NP: banteng *Bos javanicus*, clouded leopard *Neofelis nebulosa*, gaur *Bos gaurus*, southern serow *Capricornis sumatraensis*, oriental small-clawed otter *Aonyx cinerea*, pig-tailed macaque *Macaca nemestrina* and stump-tailed macaque *Macaca arctoides*. Interviews with local people suggest banteng, clouded leopard and gaur have never occurred in Botum Sakor NP, at least within the lifetime of interviewees. Of the other key species, the oriental small-clawed otter may occur in the NP as there is much suitable habitat present, however, the absence of pig-tailed macaque, southern serow and stump-tailed macaque suggests that they are probably restricted to higher altitude.

2.2 Confirmation of the endangered fishing cat (*Prionailurus viverrinus*)

The presence of this species in Botum Sakor was confirmed on 20th January 2008 with the discovery of two juveniles in a small fishing village on the Preaek Kon Tourt River in the northwest of the park. BSNP is likely to contain suitable habitats for the fishing cat as it includes a combination of large wetland areas and forests and grasslands. This discovery suggests that this species might well have a widespread distribution within the park. However, several anthropogenic pressures such as hunting could threaten its survival.

The sighting of this species in BSNP and its implications are discussed in details in Royan (2009a).

2.3 Relative density of dhole (*Cuon alpinus*)

2.3.1 Introduction

Dhole (*Cuon alpinus*) or Asiatic dog is a medium sized Canidae species which occurs in low densities (Grassman *et al* 2005) over a widely distributed fragmented range throughout Asia (Iyengar, *et al.* 2004). Despite their wide distribution and adaptability to habitat type both mountainous and lowland (Iyengar, *et al.* 2004), from deciduous and tropical forest to open plains (Venkaturaman 1999), *C. alpinus* has a decreasing population and is currently listed as endangered (IUCN 2008). The decrease in dhole is greatly influenced by massive habitat degradation and loss (Iyengar, *et al.* 2005; Durbin *et al* 2008) combined with a reduction in preferred prey availability via poaching (Iyengar, *et al.* 2004; Venkaturaman, 1995; 1999; Durbin *et al* 2008). These factors promote indirect effects by increasing interspecific prey competition with sympatric carnivores such as tiger (*Panthera tigris*) and leopard (*P. pardus*) (Karanth and Sunquist 1995; Venkaturaman, 1995, 1999; Durbin *et al* 2008). Dhole have also suffered from previous persecution (Venkaturaman 1999; Iyengar, *et al.* 2005) and are prone to disease spread from local domestic dogs (Venkaturaman 1999; Durbin *et al* 2008).

Despite being of conservation concern and holding a protected status under section II of the Wildlife Act (1972), there is a scarcity of research into the dhole within south east Asia (Grassman *et al* 2005). Irrespective of Cambodia being acknowledged as a suitable conservation system for the species by the IUCN (Durbin *et al* 2008), very little data is available on the status of dhole within this country (WWF 2006). Botum Sakor potentially represents a suitable conservation habitat for dhole, with evidence of both the presence of dhole itself and suitable prey species, including muntjac (*Muntiacus muntjac*), sambar (*Cervus unicolor*) and wild pig (*Sus scrofa*). A survey to assess the relative density

of dhole was initiated in the hope of quantifying *C.alpinus*' local status, and the importance of BSNP in supporting this protected, endangered species.

2.3.2 Methods

Line transects along existing paths and game trails encompassing both meadow and forest were used to assess the relative density of *C. alpinus* within Botum Sakor (Koh Kong province). Thirteen line transects, 1-2km in length, were carried out on foot between the 25th and 27th January 2009, and a second survey between 26th and 28th February to identify potential dhole scats (faecal matter and tracks). Scats were initially identified by (and differentiated from other species via) scat size, scat composition (excreted prey hair, bone and tooth size) and the known use of latrines sites (group faecal excretions) along trails and upon exposed soil (Karanth and Sunquist 1995). Samples of each scat were recorded by GPS location (Garmin GPS 76). Samples were measured by width at widest point and whether they were deposited in a latrine or a singular excretion manner. A sample at each location was removed by sterilised forceps and placed in labelled, sealed specimen bag.

Once back at base camp these samples were transferred and preserved in sample pots containing 100% ethanol. This could allow further DNA analysis for species confirmation at a convenient future point. The preservation of scats in this manner and therefore the DNA, also allows the phylogenetic status of the park population to be assessed. Due to the fragmented and potentially isolated population a sub-species of dhole cannot be dismissed. Any remaining scat presence was removed from transect site so as not to interfere with the second re-assessment of transects allowing relative density calculations.

It is important to note that dhole scats were not analysed genetically at this stage, therefore we cannot affirm with complete certainty that all scats identified belonged to dholes, their scats being very similar to the ones of other large carnivores such as the Asian golden cat, leopard, and domestic dog.

All transects were walked again with scats identified and counted between 10th July and 10th September. The relative density of dhole was calculated using the equation. $R = S/(LnD)$ where R is relative density, S is the number of scats found on the second walk, Ln is the total length of transects and D is the number of days between surveys.

An estimate of the number of packs the NP could potentially contain was calculated by taking the range sizes of two individuals surveyed in Grassmann *et al.* (2005) and the average range size of two packs in Woodroffe and Ginsberg (1998) and extrapolating this to the size of BSNP.

2.3.3 Results

From a total length of 48.44 km walked over the two surveys a total of 38 scats were counted. This provides an encounter rate of 0.78 scats per kilometre of transect.

A total of 21 scats were counted on the second walk. The number of days between surveys was 132

and total length of linear features was 24.22 km. Therefore, R can be calculated as 0.0066 individuals/ km². Applied to the area of BSNP (1834 km²), an estimated 12 individuals are found within the park boundary.

2.3.4 Discussion

In a study by Grassmann *et al.* (2005), range size of two separate Dhole packs were estimated at 12 km² and 49.5 km² per pack, based on radio-telemetry of two adult male dholes in Phu Khieo Wildlife Sanctuary, Thailand. This estimate, when applied to the area of Botum Sakor, suggests that between 37 and 153 packs of dhole could be found within the park boundary. In a study by Woodroffe and Ginsberg (1998), average range size was estimated at 68.8 km² (an average based on the results of the study of two packs). This estimate suggests the area of Botum Sakor could support 27 packs. With a population estimate of only twelve individuals within the boundaries of BSNP, the methodology used in this study has clearly resulted in a gross underestimation of the true population size in light of the results of the studies described above.

The range sizes calculated by Grassmann *et al.* (2005) is likely to provide a better insight into the number of packs found within Botum Sakor NP. It is likely that the differences in range size estimates can be attributed to the availability of prey (Macdonald, 1983), with the pack occupying a smaller range size in the Grassman study inhabiting an area of high prey density, removing the need to hunt further afield. Prey density could be expected to be relatively low in Botum Sakor due to a history of high hunting pressure on prey species such as wild pig, muntjac, sambar and hog deer. Therefore, the number of dhole packs could be expected to be nearer the lower estimate of 27 based on the range size estimate of Woodroffe & Ginsberg.

Dhole scats are not encountered readily enough to allow for this methodology to be used accurately. Scats were only found on meadow paths presumably because scats break down quicker within forest habitat. A different methodology should be employed in order to study dhole population dynamics.

2.4 Population density and distribution of Pileated Gibbon (*Hylobates pileatus*)

2.4.1 Introduction

The pileated gibbon (*Hylobates pileatus*) is currently listed as endangered (IUCN 2009) due to habitat degradation, fragmentation and hunting throughout its range. The species is thought to be restricted to three regions; southwest Thailand, Cambodia west of the Mekong river and a small area of Laos. The largest population is thought to reside in the Cardamom mountain region of southwest Cambodia and adjacent southeast Thailand (IUCN, 2009). The status of this species in Cambodia was assessed by Treaholt *et al.* (2005) who estimated a total population of approximately 40,000 individuals, but concluded that this figure should be treated with caution as the survey effort was relatively small at each location. A survey of the four largest protected areas in southeast Thailand provided an estimate of 12,000 individuals while the species was also recorded in 13 small protected areas but density estimates were not calculated (Phoonjampa & Brockelman, 2008).

Within Botum Sakor National park, Traeholt *et al.* (2005) estimated a density of 1.55 groups of pileated gibbon per km² suggesting that approximately 2,000 groups could reside within the park boundary. However, at the time there was no management plan for the national park, with substantial amounts of illegal logging. Traeholt *et al.* (2005) reported the pileated gibbon population to be decreasing, predicting it to potentially reach a critically low number by 2055. The purpose of this study is to compliment and expand the survey of Traeholt *et al.* (2005) to other areas of the national park by repeating the survey methodology in several locations. This will allow a more accurate estimate of the species density in this area and make further assessments of the threats to pileated gibbons local population.

2.4.2 Methods

Surveys were conducted using triangulation methodology as implemented by Traeholt *et al.* (2005) (Figure 1). Four surveys were conducted in total over two phases of research (each phase comprises 10 weeks). The first two surveys were completed during Jan-Mar 2009, with a further two being completed during Apr-Jun 2009.

All surveys were conducted at four sites; A, B, C and D.

Site A is situated in an area of evergreen forest that has previously been subjected to selective logging but still retained patches of tall canopy.

Site B is located in an area of largely semi-evergreen forest with smaller canopy height at the western end of the Preaek Kon Tourt (also known as Preaek Phkum).

Site C encompasses an area of predominantly low canopy of semi-evergreen forest with evidence of previous heavy logging.

Site D represents a forest of good canopy height with dispersed areas of bamboo and palm spp.

At each survey location, three listening posts (LPs) were arranged in the shape of an equilateral triangle with a distance of 1 km between each LP. Two to three observers were positioned at each LP with a local guide between 07:00 and 12:00. One team member acted as a principal observer responsible for records from the same LP for the duration of the survey to maintain standardised data collection. Surveys at each site were conducted for five consecutive days (with the exception of survey 4 which ran for 5 study days but with only 4 being consecutive) to assure all groups were heard within the locality. The survey time was allocated on the premise that groups of pileated gibbons have been found to call on average every 2 days (Brockelman & Srikosamatara 1993). This was also in accordance with the previous survey by Traeholt *et al.* (2005), who began surveys at 06:00. However, sunrise during this study was at 06:30 and no gibbon groups were recording calling before 07:00 on pilot studies. Surveys therefore began at 07:00. Observers estimated the distance and bearing to gibbon groups within 1 km of the LP, as in agreement with Traeholt *et al.* (2005). Estimates over 1 km were considered to be inaccurate. Where possible observers obtained visual confirmation of calling groups and recorded the GPS location to ascertain and confirm accurate distance records. Prior to the start of each survey observers standardised their distance estimates by having a joint practice during pilot studies. Data were plotted using GPS (Garmin GPS 76) and groups were identified from the proximity of recorded data points. However, the results section also includes some audio records which were not triangulated; therefore we can expect our results to produce a slight overestimation of the population size.

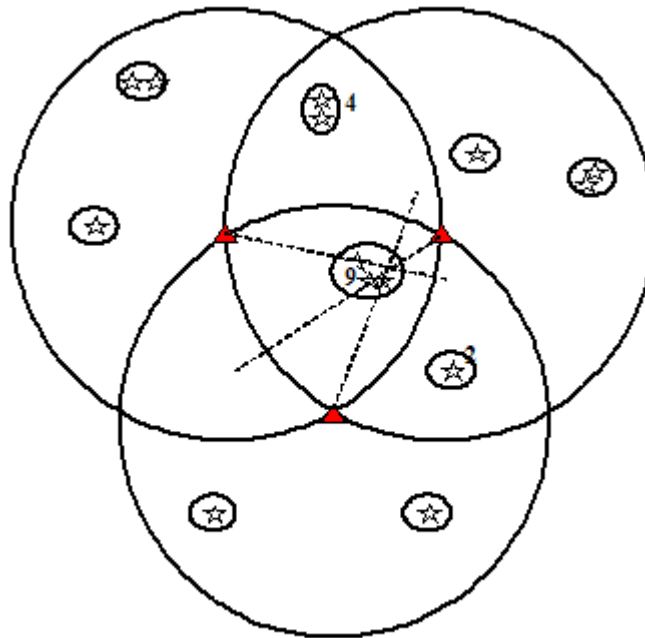


Figure 1. Triangles represent listening posts and stars audio recordings. A total of 23 recordings resulted in the identification of 9 groups. Figure taken from Traeholt *et al.* (2005).

2.4.3 Results

Site	Audio records	Number of groups	Density estimate km ²
A	27	11	1.71
B	10	8	1.25
C	11	7	1.09
D	16	11	1.71

Table 1. Total audio records (the amount of potential groups recorded by each LP, not the total amount of groups heard), group sightings and corresponding density estimates for Pileated gibbon.

These four surveys resulted in a mean density estimate of 1.44 groups per km². Botum Sakor National park is estimated to contain approximately 1330 km² of forest, therefore, applying the mean density estimate to the national park's forested area provides a total estimate of 1915.2 groups of pileated gibbon within the park boundaries. As the majority of groups recorded were of a pair; the number of individuals within the national park can be estimated at approximately 3830.4.

2.4.4 Discussion

With an endangered status and a decreasing population size due to habitat degradation, it is essential that reliable and accurate pileated gibbon population estimates are obtained to assess, implement and

manage conservation strategies for both species and remaining habitat. Botum Sakor offers an opportunity to monitor the progress of this species within a protected area of variable habitat quality. Traeholt *et al.* (2005) estimated the number of pileated gibbon groups within Botum Sakor at approximately 2000. The estimate produced by this study of 1915.2 groups, is therefore considered comparable. The discrepancy in estimates is likely due to the quality difference in surveyed habitat, with this survey incorporating forest areas with higher levels of disturbance, and an increased survey effort. However, the impact of the NH 48 highway, which was completed after the study by Traeholt and colleagues may also played a role.

Both of the surveys were conducted in the same locality as Traeholt *et al.*, in the forests between the Preaek Kon Tourt River and NH 48 highway. This area can largely be described as potential good quality gibbon habitat with the possibility of supporting a higher density of groups relative to other areas of park. A decreasing Gibbon density has been observed further southward within the park (Alex Royan *pers. comm*). Therefore, density estimates calculated by this study and Traeholt *et al.* (2005) may have produced a higher estimate than the average density supported in the park. It is therefore suggested that future studies should aim to survey areas of the park that contain a variation of forest composition and habitat quality to allow more accurate estimates of density.

Chapter 3. Birds

3.1 Avian diversity and species accounts

Until Frontier started carrying out baseline surveys, the bird distribution in Cambodia was not very well known. Only 533 bird species had been recorded (Tan SETHA & POOLE 2003), but it is believed that up to 600 species could be found within the park.

The aim of this study was to conduct systematic bird surveys in Botum Sakor National Park between July and December 2008 in order to establish a comprehensive avifaunal inventory and get some insights into the distribution of these species, with a particular focus on species of conservation importance. A total of 180 species were recorded during systematic surveys, whilst an additional 16 species were recorded opportunistically from past studies providing a total avifaunal diversity estimate of 196 species. A full avian species list can be found in appendix 2.

Six species are of particular conservation interest as they are listed as globally threatened or near threatened by the IUCN (2010): the white-winged duck *Cairina scutulata* (endangered), the green peafowl *Pavo muticus* and lesser adjutant *Leptoptilos javanicus* (both vulnerable) and the oriental darter *Anhinga melanogaster*, great hornbill *Buceros bicornis* and grey-headed fish eagle *Ichthyophaga icthyaetus* (all near threatened).

The avifaunal inventory is discussed in great details in ROYAN (2009b).

3.2 First record of the endangered white-winged duck (*Cairina scutulata*)

The white-winged duck (*Cairina scutulata*) is one of the rarest waterfowl species in Asia and is listed as endangered (Birdlife International, 2008). Populations have become highly fragmented, largely due to the loss of riverine habitat, and population estimates range around 1,000 individuals, with records of approximately 450 in India (A. CHOUDHURY *in litt* 2007), 150 in Indonesia (Birdlife International, 2001) and several hundred in Indochina (J.C. EAMES *in litt* 2007; W. DUCKWORTH *in litt* 2006). There are also records from Bhutan (CHOUDHURY 2007) and Bangladesh (A. CHOUDHURY *in litt* 2007). In Cambodia, *C. scutulata* has been recorded in the Tonle Sap region (F. GOES *in litt* 2000) and the Areng valley in the southern Cardamom Mountains (DALTRY & KUY 2003).

C. scutulata was recorded in Botum Sakor National Park (NP) on 9 March 2009 on the Preaek Kompong Phlu River (UTM 317887, 1223504; Altitude -5 m). A single individual was observed on the river bank whilst conducting boat surveys at 1000 on a freshwater section of the river with dense largely semi-evergreen forest on either side. The bird was observed approximately 2.5 km from a freshwater swamp (Lac Chak), which is more characteristic of *C. scutulata* habitat than that at which it was observed. The area also contains many large grasslands which were largely dry at the time of observation, but form large wetlands during the wet season. The individual was distinguished from other similar species (particularly female comb duck *Sarkidiornis melanotos*) and feral ducks by the distinctive white wing coverts which were clearly seen, the black-speckled white hood, dark underparts and body size. The individual was observed by the author on three occasions as the bird moved down the river ahead of the boat. The author has much experience of surveying the avifauna of

Botum Sakor NP (e.g. Royan 2009b). This is the most southerly and only coastal record of *C. scutulata* in Cambodia.

The status and distribution of *C. scutulata* in Botum Sakor NP is unclear at present. It is reported to occur in the southern Cardamom in low numbers (Daltry & Kuy 2003), while most of the local people in Botum Sakor appear to be unfamiliar with this species, suggesting that it is not present in large numbers. However, the presence of this species in Botum Sakor NP at the beginning of the breeding season is particularly interesting and suggests the duck may be nesting there.

Despite Botum Sakor NP being a protected area, evidences of illegal activities are regularly encountered. Noose snares are regularly used for hunting small mammals and ground dwelling birds, while selective logging (which commonly occurred before WildAid started supporting park rangers) will have removed potential *C. scutulata* nesting habitat. Most of the forest and freshwater riverine habitat suitable for *C. scutulata* is located within the protected zone. However, there is much planned construction within the development zones around the coast, including tourist resorts and a power station. It is unclear if these developments will infringe on the protected zone and if land concessions within the protected zone will be assigned for development projects.

The discovery of *C. scutulata* strengthens the case for the protection of avifaunal communities within the NP and the recommendation that Botum Sakor NP is designated as an Important Bird Area (Royan 2009b).

3.3 Breeding status of bird species of global and regional conservation interest

3.3.1 Methods

Observations of key bird species within Botum Sakor National Park (NP) were conducted between 13th January and 11th June 2009. This time period was chosen as the breeding season of most bird species falls within this time. Surveys were conducted in the north and east areas of the NP, primarily in areas around the Preaek Kon Tourt, Preaek Ta Ok and Preaek Kompong Phlu rivers. Data were collected in an ad hoc manner as other Frontier-Cambodia surveys were conducted within the chosen time period.

3.3.2. Results

Species of global conservation concern

Lesser Adjutant – Vulnerable

Five sightings of *L. javanicus* were obtained, four of which were of individuals with a single sighting of a pair of unknown sex. No evidences of breeding were obtained for this species. When interviewed, local people were familiar with the type of nest that this species constructed, but reported to have never seen such a nest.

Green Peafowl – Vulnerable

A pair of *P.muticus* was seen flying across Preaek Kon Tourt on 21st May 2009. Reports of *P.muticus* breeding on mass at the village of Chamkar Leu on the east coast of the NP were obtained. No evidence of nests was found, although locals reported to regularly see pairs of birds in this area.

Milky Stork – Vulnerable

Four individuals were seen on mudflats at the Preaek Ta Ok/Kompong Som estuary (GPS:331403, 1227787) on 12th May 2009. This was the first record of *Mycteria cinerea* in Botum Sakor NP and the species appears to be a dry season visitor when water levels are low and mudflats on the estuary are exposed.

Grey-headed Fish Eagle – Near Threatened

A nest of *Ichthyophaga ichhyaetus* was first observed on 7th March 2009 (AR observation) with a single male next to a small freshwater lake near the village of Kompong Phlu (GPS:315926, 1223929). Breeding *I. ichhyaetus* was confirmed on 14th May 2009, when a juvenile was seen perched in the nest.

Great Hornbill – Near Threatened

An individual male was seen calling next to the Preaek Kon Tourt on 22nd May 2009 and a further two audio records were obtained from the same location on 8th June and 9th June 2009. No pairs of *B. bicornis* or evidence of a nest were obtained during the period of study.

Darter – Near Threatened

This species has previously been recorded on Preaek Ta Ok (Royan *In Review*) but no observations of this species were made during the period of study.

White-winged duck – Endangered

The single individual was sighted on the Preaek Kompong Phlu River on 9 March 2009, the beginning of the breeding season (see section 3.2 above).

Species of regional conservation concern

Black-and-red Broadbill

Ten nests with breeding pairs were identified over a 14 km stretch of Preaek Kon Tourt (0.71 nests/km). The majority of nests were on fallen trees or in the water next to broadleaved forest, while one nest was located in mangrove habitat. Nest construction appeared to be in early April, with some nests still active at the end of the survey period in early June.

Ruddy Kingfisher (*Halcyon coromanda*)

Two individuals were observed calling at the Preaek Kon Tourt ferry port (GPS:329490, 1233600) in mangrove habitat on 17th April 2009. An individual was again seen at the same location on 21st May 2009.

Green Imperial Pigeon

This species was frequently observed throughout the survey area. At the beginning of the survey period most sightings were of pairs, while larger groups (presumably including fledglings) were encountered more often at the end of the survey period.

Wreathed Hornbill

Six observations were recorded throughout the survey period. Two observations were of individuals while four were of pairs, although only one pair was confirmed as of both sexes. No evidence of nests or nest constructions were obtained.

White-bellied Sea Eagle

A pair was observed fighting a third individual at the Preaek Ta Ok/Kompong Som estuary in December 2009 (AR observation), a behaviour which suggests that a pair was nesting in the area. A juvenile was later recorded at the same location on 14 May 2009. This species is regularly observed in the area and probably supports more than one pair.

Hill Myna

This species was commonly observed throughout the survey period, with pairs of birds regularly recorded. One nest with an active breeding pair was recorded in deciduous forest (GPS:314971, 1224603) on 6th March 2009.

Woolly-necked Stork

This species was recorded on four occasions. One record was made of five individuals in flight over the Preaek Kon Tourt on 10th May 2009 and another of a pair of birds also on the Preaek Kon Tourt on 28th April 2009. The other two records consisted of individuals. As with *L. javanicus*, no evidence of nests or nest construction was found.

3.3.3 Discussion

Of the species recorded, conclusive evidence of breeding activity was obtained for grey-headed fish eagle, black-and-red broadbill, green imperial pigeon, hill myna and white-bellied sea eagle. Green peafowl are also almost certainly breeding within BSNP, although evidence from this survey were limited to the sighting of a single pair and reports from local sources. The record of calling ruddy kingfisher indicates that mature individuals are present in the NP, but conclusive evidence of their breeding status was not obtained. The sighting of a single white-winged duck at the beginning of the

breeding season suggests that this species may be nesting in the NP. This is of particular interest due to the endangered status of this species and its presence in Botum Sakor represents the most southerly record of this species in Cambodia. Further study into this species will seek to confirm the breeding status of this species in the area.

Although no conclusive evidences of breeding woolly-necked stork were obtained, this species has been found in past surveys to have a fairly widespread distribution and was encountered more frequently than lesser adjutant (*Royan pers. comm*). Therefore, this species could be expected to be breeding within the NP and further investigation is required. No evidence of breeding activity for either great or wreathed hornbill were recorded other than a single sighting of a pair of wreathed hornbills. It appears that these species are not breeding within the survey area or are breeding at low densities. The survey area has suffered from extensive selective logging in the past which will have reduced the number of mature trees with nesting opportunities for these large birds. Surveys in the less disturbed hills to the north west of the NP may be more likely to find evidence of breeding great and wreathed hornbill. Similarly, lesser adjutant does not appear to be nesting within the survey area. Most observations of this species within the NP are of individual birds with pairs being rarely seen. It is possible that there is a degree of migration during the breeding season.

3.4 Hornbill survey

3.4.1 Introduction

There are thought to be four hornbill species found 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, being listed as globally near threatened (Birdlife International 2001), while the wreathed hornbill is of regional conservation importance as it is threatened in Thailand. Frontier-Cambodia has identified the great hornbill, wreathed hornbill and oriental pied hornbill within Botum Sakor National Park. Hornbills are often the first species to disappear in heavily disturbed forests as their density is associated with the number of tall trees in the forest and are threatened by logging. Frontier has indeed identified logging as a serious threat in Botum Sakor, with potential 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.

3.4.2 Methods

Existing paths, rivers and roads were used for systematic rapid assessment surveys using line transect methodology (Bibby *et al.* 2000) at two study sites. See section 3.1.2 for a description of each site, survey work session and full methodology.

Total survey effort was 70 hours or 81 km at site A and approximately 59.5 hours or 184 km or boat surveys at site B. Site A was surveyed between 10th July and 3rd September 2008, while site B was surveyed between 10th October and 13th December 2008 and then again between 14th January and 3rd March 2009. Visual identifications were based upon the field guides Birds of South-East Asia and a

Field Guide to the Birds of Cambodia (Robson 2007; Seta and Poole 2007) while audio identifications were based upon reference CDs (e.g. Birds of Tropical Asia 3.0, Scharringa 2005). Experienced Ministry of Environment rangers assisted with species identifications. During transects the distance to the cluster or individual bird was estimated visually using a measuring tape where possible.

Data analysis was based on line transect distance sampling as outlined by Buckland *et al.* (1993). The ‘Distance’ programme (Buckland *et al.* 1993) was used to estimate the density of hornbill species. The highest value result was excluded so as to remove outliers as suggested by Andriolo *et al.* (2005).

3.4.3 Results

Only oriental pied hornbill and great hornbill were recorded at site A, while all three hornbill species were recorded at sites B and C. Density analysis was only conducted on oriental pied hornbill and wreathed hornbill as there were too few sightings of great hornbill.

At site A distance data was collected from 32 observations of oriental pied hornbills. Wreathed hornbill was not recorded at site A during the period of this study but has been seen opportunistically at the site during the dry season (Royan *pers. obs.* 2009). At site B, distance data was collected from 17 observations of oriental pied hornbill and 11 observations of wreathed hornbill, while at site C data was collected from 15 observations of oriental pied hornbill and 10 observations of wreathed hornbill.

Density calculations are displayed in Table 1. Analyses where outliers were both included and removed were performed for site A and site B data sets; however, the smaller survey effort at site C did not produce enough data for analysis with outliers removed. For site A, the half normal function was identified as the model of best fit and was obtained with a hazard-rate detection function with a cosine adjustment. For site B and site C data analyses, a uniform detection function with cosine adjustment was identified as the model of best fit.

	Oriental Pied Hornbill (individuals/km ²)		Wreathed Hornbill (individuals/km ²)	
	Outliers included	Outliers removed	Outliers included	Outliers removed
Site A	6.2 (2.3 – 16.7)	15.1 (4.8 – 47.2)	NA	NA
Site B	7.8 (2.9 – 21.1)	8.7 (3.3 – 22.7)	1.3 (0.5 – 3.2)	1.9 (0.7 – 5.1)
Site C	10.0 (3.1 – 32.2)	NA	10.0 (2.8 – 36.5)	NA
Mean Density	8.0 (2.3 – 32.2)	11.9 (3.3 – 47.2)	5.7 (0.5-36.5)	1.9 (0.7 – 5.1)
Population Estimate	10,640 (3,059 – 42,826)	15,827 (4,389 – 62,776)	7,581 (665 – 48,545)	2,527 (931 – 6,783)

Table 1. Density outputs from Distance4.0

Population estimates were obtained by extrapolating the mean density of individuals/km² to 1,330 km² which is the total estimated area of forest in Botum Sakor National Park (Traeholt *et al.* 2005).

3.4.4 Discussion

Three species of hornbill were recorded during the study but density data were obtained only for the wreathed and oriental pied hornbill. The population of the regionally threatened wreathed hornbill was estimated approximately between 2,500 and 7,500 individuals, while the population of oriental pied hornbill was estimated as being between approximately 10,500 and 16,000 individuals (including and excluding the outliers respectively). Botum Sakor contains substantial populations of both species. Great hornbill was observed during the study however, the infrequency of sightings and the apparent lack of association with riverine habitat compared to the other two species meant density data could not be obtained.

Future objectives are to repeat this study between April and June 2010 so that year round density estimates can be calculated. This will allow for investigation of fluctuations in density due to possible migrational movements. Forest paths at greater altitude and further away from the Preaek Kon Tourt will also be systematically surveyed for presence of great hornbill.

Chapter 4. Amphibians & Reptiles

4.1 Amphibian and reptile diversity and species accounts

To date 69 reptile species have been recorded. This species list consists largely of many different species of snake. Of particular interest are the two species of turtle and one species of tortoise recorded. The elongated tortoise is listed as endangered, the Asiatic soft-shelled turtle is listed as vulnerable and the Asian leaf turtle is listed as near threatened. Evidence of both the regionally threatened Saltwater crocodile (*Crocodylus porosus*) and critically endangered Siamese crocodile (*Crocodylus siamensis*) were also recorded (see section 4.2). A full reptile inventory can be found in Appendix 3.

Only 26 species of amphibian have been recorded in Botum Sakor to date. However, other studies in the Cardamoms have found large numbers of amphibian species. Since Botum Sakor is more diverse in terms of the number of ecosystems present, it may be expected that amphibian diversity is considerably higher. The Mortensen's frog (*Rana mortenseni*) and Spine-Glanded Mountain Frog (*Paa fasciculispina*) are of particular interest as they are endemic to the south west of Cambodia and the Thailand-owned section of the Cardamom mountain range. A full species inventory for amphibians can be found in Appendix 4.

Species accounts

Elongated Tortoise (*Indotestudo elongate*) - Endangered

One individual was confiscated from poachers in May 2006 by park rangers. This species has otherwise not been encountered in the park. This species is heavily exploited for the turtle food trade and consequently is listed as endangered.

Asiatic Soft-shelled Turtle (*Amyda cartilaginea*) – Vulnerable

One individual was captured from the Preaek Kon Tourt in July 2005 near the village of Kon Tourt.

Asian Leaf Turtle (*Cyclemys dentata*) – Near Threatened

One individual of this species was encountered on the Preaek Kon Tourt near the village of Kon Tourt. Although thought to still be fairly common across much of its range, this species is listed as near threatened as it is often found in the turtle food trade.

Siamese crocodile (*Crocodylus siamensis*) - Critically endangered

A siamese crocodile was spotted in Botum Sakor along the Preaek Chan Trong River near the village of Kompong Phlu (FFI 2003), but its presence was not confirmed in subsequent visits of the site; however, this species was also recorded on Preaek Kon Tourt (See section 4.2 below).

Mortensen's frog (*Rana mortenseni* / *Hylarana mortenseni*) & Spine-glanded mountain frog (*Paa fasciculispina*) – Endemic

Both of these species are thought to be endemic to the south west of Cambodia and the Thailand-owned area of the Cardamom Mountains. The Mortensen's frog was found to be common in Botum Sakor while the spine-glanded mountain frog appears to be somewhat less common. The Mortensen's frog is also listed as Data Deficient (IUCN 2007); however the restricted range of these species suggests that they may qualify for a threatened status at a later date.

4.2 Crocodile Surveys

4.2.1 Introduction

Cambodia is thought to contain two species of crocodile, the saltwater crocodile (*Crocodylus porosus*) and the Siamese crocodile (*Crocodylus siamensis*). The saltwater crocodile is listed as least concern (IUCN, 2009) as it is very common in other countries such as Australia and Papua New Guinea. However, it is regionally threatened in south-east Asia and thought to be absent from much of its former range (IUCN 2007). Saltwater crocodiles are thought to be restricted to Koh Kong Province in Cambodia. The Siamese crocodile is listed as globally critically endangered and until recently was thought to be extinct in the wild (IUCN 2007). Cambodia retains the largest population of Siamese crocodile, most of which are found in the south west Cardamom mountains, with several scattered populations in the north and north east (Simpson *pers comm.* 2006).

Conclusive evidence of saltwater crocodile in Cambodia has not been recorded for a number of years. However, a recent survey by Flora and Fauna International (FFI) personnel in Botum Sakor National Park found crocodile tracks on the Preaek Ta Ok river, which were thought to be of the saltwater species. Siamese crocodile has been recorded in Botum Sakor along the Preaek Chan Trong River near the village of Kompong Phlu (FFI *pers comm.*, 2003), but the distribution of this species in both the dry and wet seasons is unknown and it is unclear if the species is breeding there.

Frontier was approached by FFI to conduct surveys in Botum Sakor National park between 6th and 14th March 2009. Financial support was provided by FFI and Sorn Piseth, a crocodile expert from the forestry administrations, provided technical assistance. The objectives of the survey were to survey freshwater watercourses around the village of Kompong Phlu for evidences of Siamese crocodile and the Preaek Ta Ok for evidences of saltwater crocodile.

4.2.2 Methods

Surveys were conducted near the village of Kompong Phlu between 6th and 9th March. The Preaek Kompong Phlu River was surveyed for 4.2 km (GPS: 0316350, 1224370 to 0317525, 1223268), initially by daytime boat surveys and afterwards by spotlighting after dark. Approximately 500m of the freshwater swamp, Lac Chakk (GPS: 0315600, 1224112) was surveyed, initially by walking and then by spotlighting. One km of the Preaek Chan Trong was surveyed by daytime boat surveys (GPS: 0316780, 1223884 to 0316658, 1223612) and spotlighting was carried out on areas that were approachable by foot (GPS: 0312120, 122482). Surveys were conducted on the Preaek Ta Ok between 9th and 12th March. The most southern end of the Preaek Ta Ok (2km between 0316812, 1217361 and 0315887, 1216336) was surveyed during daytime by boat and then through

spotlighting. A further 11 km of river (0315812, 1217361 to 0319309, 1221698) was again surveyed using boat and spotlighting in the evening and 6.5 km of a side river of unknown name (0318823, 1219818 to 0319124, 1217178) was surveyed by boat during daytime.

Increased survey effort was afforded to areas in which past crocodile evidence has been found, or in which local people had reported recent sightings of crocodiles. Water samples were taken in areas where crocodile evidence were found and salinity analyses were carried out by FFI.

4.2.3 Results

Evidence of Siamese crocodile were found at two locations, while evidence of saltwater crocodile were found at only one location. All Evidence was found by walking river banks and boat surveys; spotlighting did not record any evidences.

One set of tracks (stride 51cm; straddle 30cm; TFL 8cm; TFW 10cm; substrate sand; distance to water 1.5m; water depth 2.2m; altitude 1m; water sample 1) believed to be of Siamese crocodile was found on the Preaek Kompong Phlu (GPS: 0316742, 1223936) near to where it meets Preaek Chantrong. A dung sample was found next to Lac Chak which appeared to be several months old and was in small fragments (GPS: 0315600, 1224112; diameter 27.3mm; distance to water 7m; water depth 0.4m, 3m in wet season). Finally, a Siamese crocodile was observed on Preaek Kon Tourt.

Two sets of fresh tracks believed to be of saltwater crocodile due to the salinity of the water were found on Preaek Tromeany next to a former FFI camera trap position and an old crocodile path. The first set of tracks (0319309, 122198) were of a hand (THL 12cm; 13cm; substrate mangrove; distance to water 0.6m; water depth 3.2m; altitude -5m; water sample 4) while the second set of tracks were of a new slide mark and possible fresh claw marks (GPS: 0319250, 122129; water depth 3m; water sample 3).

4.2.4 Discussion

The presence of Siamese crocodiles in Botum Sakor has been suspected through track identifications (FFI 2003); however the discovery of a dung sample should confirm the presence of this species. The discovery of a fresh set of tracks from past survey areas also indicates the extent of this species distribution during the dry season in which many of the watercourses become saline. It appears that during the dry season this species is restricted to the Preaek Chantrong and freshwater areas of the Preaek Kompong Phlu between the start of the saline water and the village of Kompong Phlu. No nests were found and the breeding status of Siamese crocodile in Botum Sakor National Park remains unclear, although local fishermen report seeing crocodiles of various sizes including young juveniles.

Local fishermen have reported that the Preaek Ta Ok River supports a large number of crocodiles but that they are only seen during the wet season when the water level is high and less saline. The discovery of a fresh set of saltwater crocodile tracks is significant as it indicates that this species is also present on this river in the dry season. However, the distribution and density of this species remains unclear. Future survey work in the wet season is essential to determine which of the two species local people are seeing on this river in the wet season.

Chapter 5. Lepidoptera

147 species of butterfly have been identified in Botum Sakor to date, through opportunistic sighting and/or capture using mist nets. All were identified at least to family level, with most identified to species, subspecies and even sex. A full butterfly inventory for Botum Sakor can be found in appendix 5.

5.1 Introduction

Lepidoptera (butterflies and moths) are a hugely diverse order with approximately 27,000 described species from the oriental region alone (Hepper, 1991). The group is a key biological indicator family for a variety of reasons: they are easy to collect and identify, have a short life span, and often have a narrow geographical range. These factors can make them particularly sensitive to environmental change and disturbance may impact upon populations within a short time frame, allowing for conservation measures to be implemented before the ecosystem is irreversibly damaged. Areas with thriving populations of indicator species suggest well-preserved habitat and intact ecosystems, affording them greater conservation importance and providing an incentive for their protection.

Despite the importance of Lepidoptera as indicator species, the group is greatly understudied in Cambodia. Only one research project has previously studied moths in the country, 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.

This study surveys the butterfly and moth communities in four different habitats in Botum Sakor National Park. The objectives of this study are two-fold: (1) to compile a species list for the region and (2) to compare communities across the varying habitats of Botum Sakor with a view to better understand their use as indicators of the health of such habitats. With respect to moths, the study focusses upon larger moths with wingspans of at least 3.5cm, and a species list was compiled by making detailed sketches and specimen photographs. A thorough knowledge of the Lepidoptera community in Botum Sakor will be a valuable tool in future management plans and biodiversity monitoring for the region.

5.2 Methods

Butterflies

A total of four trap-sites were studied for ten nights each, using six 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. Trap heights were also varied with two traps set at 2, 4 and 6 metres. Three rotten bananas were used as bait for each trap-site, with bait renewed approximately every five days. Each canopy trap-site was checked in the morning between the hours of 6.30am and 8am and then again in the afternoon between the hours of 3pm and 4pm. Notes on habitat and vegetation were also taken for each canopy trap. Due to the lack of identification literature for Cambodian butterflies, identification of a number of individuals was not possible. In such cases as these, only the number of captures was recorded.

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 were made.

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. Here the habitat structure was dense forest, and a torch light was attached above the bait. This was checked at 8pm and again at 5am. Notes were taken on the general habitat and tree species.

5.3 Results

A full species list for Lepidoptera can be found in Appendix 5. Unfortunately, due to the lack of identification material, a moth species list could not be compiled. Further work will aim to rectify this.

Total captures

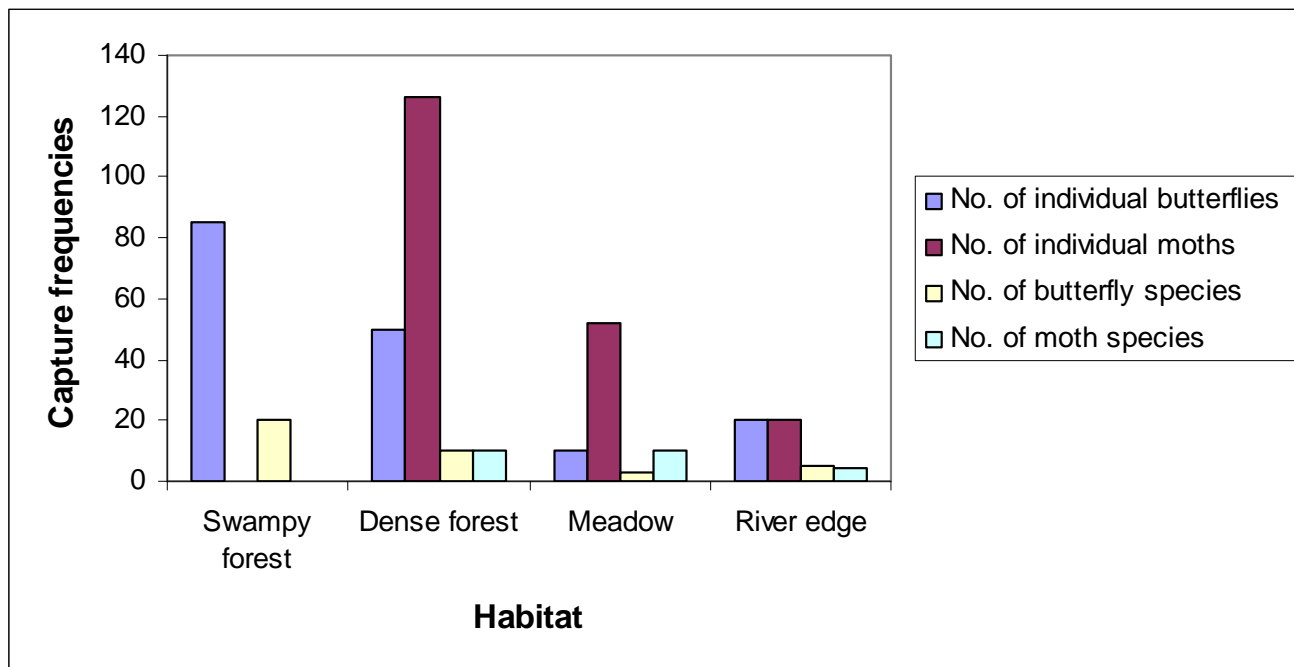


Figure 2. Absolute capture frequencies of Lepidoptera for each habitat type between October and December 2008.

Figure 2 shows the swampy forest habitat recorded the highest number of butterfly captures, and highest butterfly diversity of all surveyed habitats with 85 individual captures, comprising 20 different species. Unfortunately, moth species were not able to be surveyed in this location, so results cannot be compared. Of the three habitat types surveyed, individual moth captures were highest in the dense

forest habitat. There were 126 captures made in total at this location, 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 habitat. The meadow habitat recorded the lowest number of butterfly captures, with only ten individuals and just three recorded species. The river-edge habitat had only one mutually exclusive species, and low individual capture rates, indicating a preference for non-riperian habitats by lepidopteran species.

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.

Per-trap capture rates

The results above may be misrepresentative if data is skewed by one particularly productive trap. Figures 3 and 4 show the average capture rate across all traps for each habitat, giving a more reliable representation of population density and species diversity in the different habitats.

Butterflies

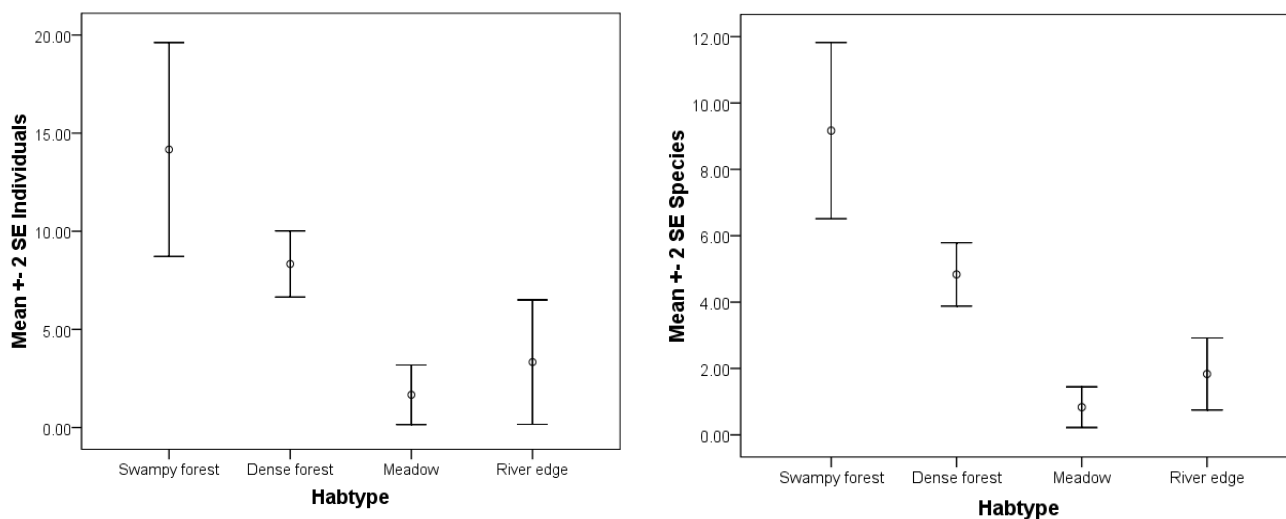


Figure 3. Average trap capture rate and associated standard error for (a) individual butterflies and (b) species for each habitat between October and December 2008.

A one-way ANOVA was used to compare both individual and species per-trap capture rates between the four habitats surveyed. After natural logarithm transformation to adjust for un-homogeneous variance between groups, we found a significant difference in both the individual capture rate ($F=13.22$, $p<0.001$) and the number of species caught per-trap ($F=23.15$, $p<0.001$) between habitats, (Figure 3).

Post-hoc analysis using Tukey HSD test indicated that individual capture rates were significantly higher in the swampy forest habitat compared with both the meadow ($p<0.001$) and the river edge ($p=0.002$). Furthermore, the same results were found for per-trap species captures; the number of species caught was significantly higher in the swampy forest habitat compared with the meadow ($p<0.001$) and river-edge ($p<0.001$) habitats.

Individual captures were also significantly higher in the dense forest habitat compared with both the meadow ($p=0.002$) and river-edge ($p=0.032$). Again, the same pattern is observed in the number of

species caught; species number was significantly higher in the dense forest habitat compared with the meadow ($p < 0.001$) and river-edge ($p = 0.011$) habitats. No significant difference was observed in the individual or species capture rates between the swampy and dense forest habitats ($p = 0.134$), nor between the meadow and river edge habitats ($p = 0.328$).

Taken together, results suggest that the swampy and dense forest habitats support a significantly larger butterfly community with greater species richness than either the meadow or river-edge habitats.

Moths

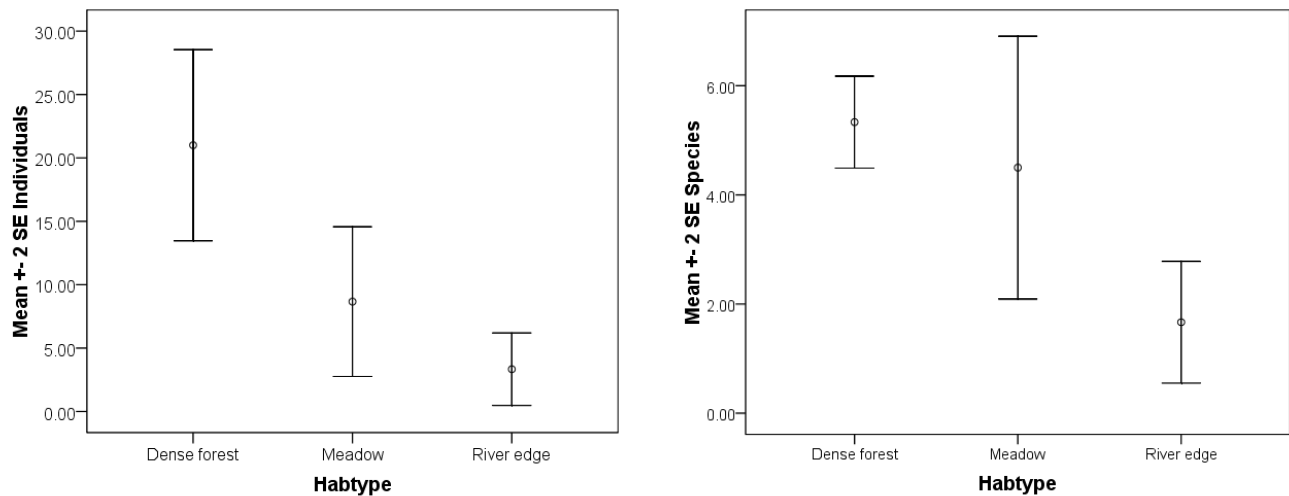


Figure 4. Per-trap capture rate for (a) individual moths and (b) species for each habitat from October-December 2008.

Compared with the butterfly results, proportionately fewer moth species were recorded. One-way ANOVA analysis indicated that there was a significant difference between the three habitats surveyed in both the number of individuals captured ($F = 7.18$, $p = 0.007$) and the number of species captured ($F = 4.47$, $p = 0.03$).

Figure 4 shows that 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. Indeed, post-hoc analysis using Tukey HSD test found the dense forest habitat to be significantly higher in both the number of individuals captured ($p = 0.007$) and the number of species captured ($p = 0.026$) compared to the river-edge habitat. However, with a mean of approximately 5 species each, the dense forest and meadow habitat showed a similar low number of species captured, and no significant difference in either the number of individuals or species captured.

These results suggest that the dense forest habitat supports a greater number of individual moths, comprising a greater number of different species than the river edge habitat. This is a similar result to that found for the butterfly community. Unfortunately, moth trapping in the swampy forest was not carried out. However, the results of both the butterfly and moth surveys taken together suggest that

closed-canopy environments are favoured by Lepidoptera.

Species richness

Figure 5 shows 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 Hesperidae and Riodinidae.

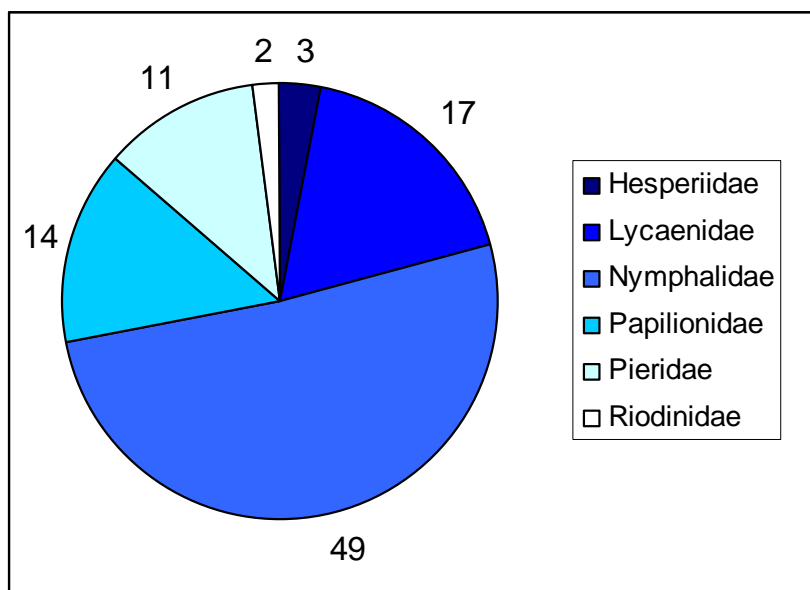


Figure 5. Total number of butterfly species recorded by family

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

Table 2. Mean number of butterfly species captured in each family at 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, but mainly in the swampy forest 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. The Amathusiidae family was recorded most frequently in the river edge habitat.

Regarding moths, a total of 14 different species were successfully recorded in photographic and detailed sketch form. 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 frequently recorded in dense forest. Species code No. 3 ('Woody')

was also common, with 38 captures across the trap-sites.

5.4 Discussion

Butterflies

The occurrence of butterflies in temperate and tropical forest ecosystems has been linked to the level of disturbance, as well as habitat variation at landscape and regional scales (Dodd *et al.* 2008). Lepidoptera often only feed on one particular species or type 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 swampy (moist) forest, dense forest, meadow and river-edge habitats. Forest habitats generally recorded a higher density of butterfly captures, with 'gap' habitats such as meadow and river-edge recording fewer individuals and species. 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, 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 swamp forest habitat.

The low number of individuals and species captured in the river-edge habitat may be attributed to the predation threat posed by birds and bats, such as the Chestnut-Headed Bee-Eater *Merops leschenaultia*. The apparent preference of butterflies for closed-canopy habitats may be due to a reliance on sufficient surrounding vegetation for food and shelter.

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

The number of species recorded 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 tend to prefer different habitat types. However, 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 2), but still reflect the large morphological and ecological variation within the expanded Nymphalidae family.

The Nymphalidae family had the greatest species diversity recorded out of all families recorded (Appendix 2). 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, their larvae being 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. Lycaenidae indeed had the second highest 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 Hesperidae families suggests that these families may be disproportionately represented within Botum Sakor National Park.

The fact that many species of the Amathusiinae sub-family (previously Amathusiidae) were found in the river-edge habitat 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 above 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 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.

Moths

During this research phase, there was a considerably higher capture rate of moths than for butterflies; 184 of a total of 203 moths captured could be clearly identified to 14 different species. Considerably greater numbers of moths were found in the dense forest habitat compared with the river-edge habitat. Per-trap capture rates showed similar results to those for butterflies, although we were unable to survey moth density in the swampy forest habitat.

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

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.

Chapter 6. Flora

6.1 Floral diversity

23 species of tree have been identified to date, despite a lack of relevant field guides making floral identification difficult. Species have been identified by using park rangers to identify species by their Khmer name and using references to identify the scientific name. The diversity of ecosystem in Botum Sakor suggests that there could be a high diversity of floral species with the possibility of species of conservation interest. To date, two species listed as endangered have been identified.

Species accounts

Anisoptera costata & *Hopea pierrei* – Endangered

These two species belong to the *Dipterocarpaceae* family of tropical rainforest trees. Both these species are targeted by loggers and through over exploitation, are now listed as endangered. *H. pierrei* in particular still appears to be fairly common within Botum Sakor. The presence of this species within a protected area suggests that Botum Sakor could potentially contain populations important for the conservation of this species at the national level.

Single species studies

6.2 Orchid surveys

6.2.1 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 (Hágsater and Dumont, 1998)

A four week pilot study was conducted in July to September 2008, which investigated the distribution and abundance of orchid species within Botum Sakor. This study utilized two existing transects used in bird surveys consisted of dense, mainly evergreen lowland forest with some areas of secondary regenerating forest with some evidence of large trees being cleared previously. With a total of 99 individuals recorded, consisting of 15 different species, there is sufficient evidence from this short pilot study to confirm the viability of further orchid research encompassing a larger area, with a comparison of any patch-forming disturbance and various habitat types. Furthermore, two species identified in this study, *Thesticulosa thecostele* and *Adenocos vesiculosa*, are thought to be the first record of both species in Cambodia. This highlights the potential of further research to strengthen the case for this region as an area of considerable biological interest.

We aimed to expand the pilot study into 2 different types of forest, to develop a more comprehensive species list, and to investigate the abundance and diversity of these species. 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.

6.2.2 Methods

Transects

Rather than creating new transects for the orchid survey, two already existing forest transects used in bird surveys were used. These transects were already established tracks, 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	Mainly large trees with re-growth of palm and large vines. Some large gaps present. Much deadwood and

	leaf-litter.	leaf-litter.
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Transect (m)	B 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 4. Habitat and vegetation composition for each site (A1-5 and B1-5) and transect study area.

Recording specimens

All orchids were photographed and a specimen taken if possible. The following parameters were recorded; height above the ground, microhabitat, species type (Epiphyte, Geophyte or Terrestrial), percentage 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. 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.

6.2.3 Results

Site records

All individuals 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 one additional species found outside the transect area. This was recorded as an opportunistic finding in the overall project site area.

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 5). 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 only 2 of these records on transect B (See table 6). 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

Table 5. Frequency of individual and species records along each transect.

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, glabrous, 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 - <i>Dendrobium keithii</i>	37	38
Sp. 2 - <i>Adenoncos vesiculosa</i>	51	18
Sp. 3 – <i>Dendrochilium spp.</i>	56	2
Sp. 4 – <i>Dendrochilium spp.</i>	16	8
Sp. 5 – Unknown species	23	41

Table 6. Abundance of most frequently recorded species along transects A and B.

6.2.4 Discussion

Compared to the pilot 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 seed layer, 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 6) 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 destruction 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 4 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 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.

Chapter 7. Conclusion

Frontier-Cambodia have completed four years and six months of biological surveys in Botum Sakor National Park to date. This pioneering research is by far the most comprehensive study undertaken in the National Park, results of which will be invaluable to the conservation of the region which is threatened by human developments both at local, national and international levels.

The primary objective of Frontier-Cambodia is to compile comprehensive species lists for all major taxa in Botum Sakor. To date, 49 mammal species have been confirmed in the NP, over a quarter of which are of conservation interest due to their global population status, including populations of dhole, fishing cat, pileated gibbon and hairy-nosed otter. Avian diversity is currently estimated at 196 species, at least six of which are of conservation concern including lesser adjutant, a potentially un hunted population of green peafowl and most southerly record of white-winged duck in Cambodia. A total of 69 and 26 reptile and amphibian species have been identified respectively. Of particular interest is the presence of a potentially breeding population of Siamese crocodile, which are listed as critically endangered and until recently were presumed extinct. A total of 147 species of butterfly have also been identified.

The level of biodiversity within Botum Sakor can be largely attributed to the diversity of habitats within the region, including woodland, freshwater wetland and coastal habitats. The high level of biodiversity and endemism within Botum Sakor documented by Frontier-Cambodia, and the presence of substantial populations of numerous threatened species is strong evidence to support the further protection of this region. Avian biodiversity is comparable to other Cambodian national parks such as Kirirom (Goes *et al*, 1998), a designated Important Bird Area. The large number of avian species of conservation concern and the presence of a number of species that are restricted to one biome, is strong evidence for the designation of Botum Sakor as an IBA.

The research programme has identified and conducted species-specific studies into the density and distribution of the endangered pileated gibbon, dhole and critically endangered Siamese crocodile in Botum Sakor. There was found to be a substantial pileated gibbon population within the region, comparable to a previous study by Traeholt *et al* (2005). However, the population estimate is suspected to be biased due to the relatively undisturbed forest habitat in which the survey was conducted. Habitat degradation due to human activities such as logging is thought to have a detrimental affect on gibbon populations. The population estimate is predicted to decrease after further research extends the survey to more disturbed regions of the park. Surveys of dhole and Siamese crocodile, though confirming the presence of these species within the park, have been unable to produce reliable density estimates to date. This is largely due to a low sign encounter rate, making the methodology used inappropriate to the studies. Methodology will be revised in future phases to allow for more accurate predictions of population size.

A number of species identified in Botum Sakor have specific habitat requirements, such as the endangered fishing cat, which rely on the rare lowland wetland forests of Botum Sakor. Furthermore, many large mammal species (such as Asian elephant) move throughout large home ranges or are territorial (such as dhole), so require sufficient expanses of connected habitat. These factors make certain species particularly sensitive to habitat fragmentation caused by human disturbances. Logging is particularly prevalent within the region, with an estimated 229 km² (~30 km²/year) of evergreen

forest lost from 1997-2002 through illegal logging (Traeholt *et al.* 2005). The completion of the NH 48 highway running through the north of the park, has removed connectivity between the Southern Cardamoms and Botum Sakor. It is important that further research efforts aim to accurately estimate the population density and distribution of these species, to aid long-term monitoring of population dynamics with respect to habitat fragmentation.

Research efforts have also been directed towards improving knowledge of a number of bio-indicator groups. Much research has been directed at surveying the lepidopteran community of Botum Sakor, for which very little information was previously available. 147 species of butterfly have been identified to date, with future survey effort expected to identify greater diversity. Butterflies are known indicators of ecosystem health in terrestrial environments, as they respond quickly to environmental change. Indicators of disturbance have also been identified and found to correlate with high levels of forest clearance and cutting. The research programme has also included orchid surveys, which are good indicators of disturbance due to their transient and irregular distribution patterns. All species identified were epiphytic, many of which grow specifically on a certain host. However, population dynamics were found to be complex, with the abundance of orchids positively associated with recent disturbance, but negatively associated with other plant species which thrive in disturbed areas. Further study will elucidate the finer details of population dynamics for both of these indicator groups, which will prove valuable for further assessment of general ecosystem health.

Despite high levels of disturbance within Botum Sakor, Frontier-Cambodia have identified a high level of biodiversity and significant populations of numerous species of conservation concern. The presence of high levels of biodiversity, endemism and threatened species, however, further highlights the importance of protecting these habitats. Poaching is the biggest threat to many mammal species, which are either directly hunted or indirectly caught in snares. Logging also continues to be prevalent in the region, removing vital habitat for countless species. With the planned construction of a power station in the southwest of the NP adjacent to Khao Sdach, it is vital that the biodiversity of Botum Sakor continues to be monitored to minimise the affect these developments have on populations. The information gathered by Frontier-Cambodia and others will contribute towards much-needed management plans for the region, which must promote the sustainable use of forest resources for the benefit of both local livelihoods and wildlife.

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Appendices

Appendix 1: Mammal inventory

Confirmed species

Common name	Scientific name	Status	Evidence	Location
Short-tailed gymnure	<i>Hylomys suillus</i>	LC	Capture	BC 062
South-east Asian shrew	<i>Crocidura fuliginosa</i>	LC	Capture	Throughout
Northern treeshrew	<i>Tupaia belangeri</i>	LC	Capture	Throughout
Sunda short-nosed fruit bat	<i>Cynopterus brachyotis</i>	LC	Capture	BC 064
Lesser false-vampire	<i>Megaderma spasma</i>	LC	Capture	BC 064
Acuminate horseshoe bat	<i>Rhinolophus acuminatus</i>	LC	Capture	BC 071
Least horseshoe bat	<i>Rhinolophus pusillus</i>	LC	Capture	BC 071
Shamel's horseshoe bat	<i>Rhinolophus shameli</i>	LC	Capture	BC 071
Malayan horseshoe bat	<i>Rhinolophus malayanus</i>	LC	Capture	BC 071
Intermediate roundleaf bat	<i>Hipposideros larvatus</i>	LC	Capture	BC 071
Round-eared tube-nosed bat	<i>Murina cyclotis</i>	LC	Capture	BC 071
Hardwicke's woolly bat	<i>Kerivoula hardwickii</i>	LC	Capture	BC 071
Sunda pangolin	<i>Manis javanica</i>	END	Capture	BC 083
Asian slow loris	<i>Nycticebus coucang</i>	VUL	Sighting	BC 083, Preaek Kon Tourt, Preaek Ta Ok
Indochinese silvered langur	<i>Trachypithecus germaini</i>	END	Audio; Sighting	Preaek Kon Tourt, Preaek Dum Bong, Preaek Kompong Phlu
Long-tailed macaque	<i>Macaca fascicularis</i>	LC	Audio; Sighting	Preaek Kon Tourt, Preaek Ta Ok
Pileated gibbon	<i>Hylobates pileatus</i>	END	Audio; Sighting	Throughout
Dhole	<i>Cuon alpinus</i>	END	Scat; Sighting; Tracks	Meadows between Preaek Kon Tourt and NH 48, Kompong Phlu?

Large-toothed ferret badger	<i>Melogale personata</i>	DD	Schank <i>et al.</i> (<i>In Litt</i>)	Road Kill on NH 48
Hairy-nosed otter	<i>Lutra sumatrana</i>	END	Timmins pers.comms.2009	
Smooth otter	<i>Lutrogale perspicillata</i>	VUL	Holden pers.comms.2009	
Small Indian civet	<i>Viverricula indica</i>	LC	Camera Trap Photograph	BC 054
Large-spotted civet	<i>Viverra megaspila</i>	VUL	Camera Trap Photograph	BC 054
Masked palm civet	<i>Paguma larvata</i>	LC	Sighting; Tracks	BC 084
Common palm civet	<i>Paradoxurus hermaphroditus</i>	LC	Capture; Sighting; Tracks	BC 054, 083, 084, 091
Small-toothed palm civet	<i>Arctogalidia trivirgata</i>	LC	Sighting; Tracks	Preaek Kon Tourt
Leopard	<i>Panthera pardus</i>	NT	Sighting; Tracks	Kompong Phlu, BC 053
Leopard cat	<i>Prionailurus bengalensis</i>	LC	Capture; Tracks	Throughout
Fishing cat	<i>Prionailurus viverrinus</i>	END	Sighting; Tracks	Preaek Kon Tourt
Asian elephant	<i>Elephas maximus</i>	END	Sighting; Tracks	Near NH 48, Preaek Ta Chan, Mountains near Preaek Dumb Bong
Eurasian wild pig	<i>Sus scrofa</i>	LC	Sighting; Tracks	Throughout
Lesser mousedeer	<i>Tragulus kanchil</i>	LC	Sighting; Tracks	Throughout
Red muntjac	<i>Muntiacus muntjak</i>	LC	Audio; Sighting; Tracks	Throughout
Hog deer	<i>Axis porcinus</i>	END	Holden pers.comms.2009	Ranger Station
Sambar	<i>Rusa unicolor</i>	VUL	Skeletal fragments; Tracks	Throughout
Black giant squirrel	<i>Ratufa bicolor</i>	NT	Audio; Sighting	Preaek Kon Tourt, Preaek Kompong Phlu
Variable squirrel	<i>Callosciurus finlaysonii</i>	LC	Audio; Sighting	Throughout

Cambodian striped squirrel	<i>Tamiops rodolphii</i>	LC	Sighting	BC 054, BC 083, BC 084
Indochinese ground squirrel	<i>Menetes berdmorei</i>	LC	Sighting	BC 061
House rat	<i>Rattus rattus</i>	LC	Capture	BC 064
Red spiny maxomys	<i>Maxomys surifer</i>	LC	Capture	Throughout
Fawn-coloured mouse	<i>Mus cervicolor</i>	LC	Capture	BC 062
Long-tailed climbing mouse	<i>Vandeleuria oleracea</i>	LC	Sighting	BC 091
Burmese hare	<i>Lepus peguensis</i>	LC	Sighting	BC 071

Unconfirmed species

Common name	Species name	Status	Evidence	Location
Asian Black Bear	<i>Ursus thibetanus</i>	VUL	Interviews	Mountains in north west?
Sun bear	<i>Helarctos malayanus</i>	VUL	Tracks	BC 052, 083, 084
Small Asian mongoose	<i>Herpestes javanicus</i>	LC	Tracks	BC 072
Asian golden cat	<i>Catopuma temminckii</i>	NT	Tracks	BC 061
Niviventer species	<i>Niviventer sp.</i>		Capture	Throughout
Bamboo rat species			Sighting; Tracks	BC 052, 084
Porcupine species			Tracks	Unknown

Status: VUL: Vulnerable; NT: Near Threatened, END: Endangered, DD: Data deficient, LC: Least concern

Appendix 2: Avian inventory

Common Name	Scientific Name	Status	Evidence	Location
[Chinese Francolin]	<i>Francolinus pintadeanus</i>	LC	A	Forest next to NH 48
Blue-breasted Quail	<i>Coturnix chinensis</i>	LC	V	BC 083
Barred Buttonquail	<i>Turnix suscitator</i>	LC	V	BC 084
Scaly-breasted Partridge	<i>Arborophila chloropus</i>	LC, IMTF	VA	BC 083
Red Junglefowl	<i>Gallus gallus</i>	LC	VA	Throughout
Green Peafowl	<i>Pavo muticus</i>	END/ ITDZ/II	VA	Preaek Kon Tourt, Preaek Ta Ok, Preaek Kompong Phlu
White-winged Duck	<i>Cairina scutulata</i>	END	V	Preaek Kompong Phlu
Lesser Whistling-duck	<i>Dendrocygna javanica</i>	LC	V	Preaek Kon Tourt
Heart-spotted Woodpecker	<i>Hemicircus canente</i>	LC	VA	BC 083, 084, 091
Grey-capped Pygmy Woodpecker	<i>Dendrocopos canicapillus</i>	LC	VA	BC 083, Kompong Phlu
Lesser Yellownape	<i>Picus chlorolophus</i>	LC	VA	BC 084
Laced Woodpecker	<i>Picus vittatus</i>	LC	VA	Throughout
Rufous Woodpecker	<i>Celeus brachyurus</i>	LC	V	Kompong Phlu village
Common Flameback	<i>Dinopium javanense</i>	LC	VA	Throughout
Greater Flameback	<i>Chrysocolaptes lucidus</i>	LC	VA	BC 083
Great Slaty Woodpecker	<i>Mulleripicus pulverulentus</i>	LC	VA	BC 084, 091
Linneated Barbet	<i>Megalaima lineata</i>	LC/ITDZ	VA	Throughout
Green-eared Barbet	<i>Megalaima faiostriata</i>	LC/IMT F	VA	Throughout
Blue-eared Barbet	<i>Megalaima australis</i>	LC	VA	Throughtout
Coppersmith Barbet	<i>Megalaima haemacephala</i>	LC	A	BC 083
Great Hornbill	<i>Buceros bicornis</i>	NT/I	VA	BC 083, 084, 091
Wreathed Hornbill	<i>Aceros undulates</i>	LC/II	VA	Throughout
Oriental Pied Hornbill	<i>Anthracoceros albirostris</i>	LC/II	VA	Throughout
Indian Roller	<i>Coracias benghalensis</i>	LC	V	Throughout
Dollarbird	<i>Eurystomus orientalis</i>	LC	VA	Preaek Kon Tourt, Preaek Ta Ok
Orange-breasted Trogon	<i>Harpactes oreskios</i>	LC	VA	BC 083, 084, 091
Common Kingfisher	<i>Alcedo atthis</i>	LC	V	Throughout
Blue-eared Kingfisher	<i>Alcedo meninting</i>	LC	VA	Throughout
Black-backed Kingfisher	<i>Ceyx erithacus</i>	LC	V	Preaek Chipat near Andoung Tuek
Pied Kingfisher	<i>Ceryle rudis</i>	LC	V	Preaek Ta Ok

Stork-billed Kingfisher	<i>Halcyon capensis</i>	LC	VA	Preaek Kon Tourt, Preaek Ta Ok
Ruddy Kingfisher	<i>Halcyon coromanda</i>	LC	V	Preaek Kon Tourt
White-throated Kingfisher	<i>Halcyon smyrnensis</i>	LC	V	Preaek Kon Tourt
Black-capped Kingfisher	<i>Halcyon pileata</i>	LC	V	Throughout
Collared Kingfisher	<i>Todiramphus chloris</i>	LC	V	Preaek Kon Tourt
Large Hawk Cuckoo	<i>Hierococcyx sparverioides</i>	LC	V	Preaek Ta Chan
Coral-billed Ground Cuckoo	<i>Carpococcyx renauldi</i>	LC/IMT F	A	BC 083
Drongo Cuckoo	<i>Surniculus lugubris</i>	LC	VA	BC 083
Asian Koel	<i>Eudynamys scolopacea</i>	LC	V	Preaek Kon Tourt near Andoung Tuek
Little Bronze Cuckoo	<i>Chrysococcyx minutillus</i>	LC	V	BC 084
Green-billed Malkoha	<i>Phaenicophaeus tristis</i>	LC	VA	BC 083, 084
Greater Coucal	<i>Centropus sinensis</i>	LC	VA	Throughout
Lesser Coucal	<i>Centropus bengalensis</i>	LC	V	Preaek Kon Tourt fishing village
Blue-bearded Bee-eater	<i>Nyctyornis amictus</i>	LC	V	
Green Bee-eater	<i>Merops orientalis</i>	LC	A	Preaek Kon Tourt
Blue-tailed Bee-eater	<i>Merops philippinus</i>	LC	VA	Old temple meadow, NH 48, Preaek Ta Ok
Chestnut-headed Bee-eater	<i>Merops leschenaulti</i>	LC	VA	Throughout
Vernal Hanging Parrot	<i>Loriculus vernalis</i>	LC/II	VA	Throughout
Red-breasted Parakeet	<i>Psittacula alexandri</i>	LC/II	VA	Throughout
Crested Treeswift	<i>Hemiprocne coronata</i>	LC	V	BC 083, Preaek Ta Ok
[Germain's Swiftlet]	<i>Collocalia germani</i>	LC	V	BC 084
[Silver-backed Needletail]	<i>Hirundapus cochinchinensis</i>	LC	V	BC 083
Brown-backed Needletail	<i>Hirundapus giganteus</i>	LC	V	Throughout
Asian Palm Swift	<i>Cypsiurus balasiensis</i>	LC	V	BC 083
Fork-tailed Swift	<i>Apus pacificus</i>	LC	VA	Throughout
House Swift	<i>Apus affinis</i>	LC	V	BC 083
Collared Scops Owl	<i>Otus bakkamoena</i>	LC/II	VCP	BC 071
Collared Owlet	<i>Glaucidium brodiei</i>	LC/II	A	BC083
Buffy Fish Owl	<i>Ketupa ketupu</i>	LC/II	V	Preaek Kon Tourt
Oriental Bay Owl	<i>Phodilus badius</i>	LC/II	VP	Preaek Dumb Bong
Brown Hawk Owl	<i>Ninox scutulata</i>	LC/II	A	BC091
Great-eared Nightjar	<i>Eurostopodus macrotis</i>	LC	VA	Throughout
Large-tailed Nightjar	<i>Caprimulgus macrurus</i>	LC	VA	Throughout
[Savanna Nightjar]	<i>Caprimulgus affinis</i>	LC	VA	BC084
Rock Pigeon	<i>Columba livia</i>	III	VA	Ranger Station

Green Imperial Pigeon	<i>Ducula aenea</i>	LC	VA	Throughout
Mountain Imperial Pigeon	<i>Ducula badia</i>	LC	VA	BC083
Spotted Dove	<i>Streptopelia chinensis</i>	LC	VA	Ranger Station/Ferry Port
Red-collared Dove	<i>Streptopelia tranquebarica</i>	LC	V	BC083
[Barred Cuckoo Dove]	<i>Macropygia unchall</i>	LC	A	BC083
Pink-necked Green Pigeon	<i>Treron vernans</i>	LC	VA	Throughout
Thick-billed Green Pigeon	<i>Treron curvirostra</i>	LC	V	Preaek Kon Tourt
Emerald Dove	<i>Chalcophaps indica</i>	LC	V	BC083
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	LC	V	Preaek Kon Tourt
Ruddy-breasted Crake	<i>Porzana fusca</i>	LC	V	Preaek Ta Ok
Common Snipe	<i>Gallinago gallinago</i>	LC	VA	BC084
Whimbrel	<i>Numenius phaeopus</i>	LC/WV/ PM	VA	Preaek Kon Tourt/Saline area
Common Redshank	<i>Tringa tetanus</i>	LC/WV/ PM	V	Preaek Kon Tourt/Saline area
Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC	V	Preaek Kon Tourt
Kentish Plover	<i>Charadrius alexandrinus</i>	LC	V	Preaek Ta Ok Ferry Port
Grey-headed Lapwing	<i>Vanellus cinereus</i>	LC	V	Preaek Kon Tourt Ferry Port
Red-wattled Lapwing	<i>Vanellus indicus</i>	LC	V	Preaek Kon Tourt Ferry Port
Common Tern	<i>Sterna hirundo</i>	LC	VA	Kampong Som
Jerdons's Baza	<i>Aviceda jerdoni</i>	LC/II	V	Preaek Ta Chan
Black Baza	<i>Aviceda leuphotes</i>	LC/II	V	Preaek Kon Tourt Ferry
Oriental Honey-buzzard	<i>Pernis ptilorhyncus</i>	LC/II	VA	Throughout
Black Kite	<i>Milvus migrans</i>	LC/II	V	BC083
Brahminy Kite	<i>Haliastur indus</i>	LC/II	V	Kampong Som
White-bellied Sea Eagle	<i>Haliaeetus leucogaster</i>	LC/II	VA	Kampong Som/Preaek Kon Tourt
Grey-headed Fish Eagle	<i>Ichthyophaga ichhyaetus</i>	NT/II	V	NH 48, Lac Chakk
Osprey	<i>Pandion haliaetus</i>	LC/II/ WV/PM	V	Preaek Kon Tourt, Preaek Ta Ok
Black-shouldered Kite	<i>Elanus caeruleus</i>	LC/II	V	Preaek Kon Tourt Ferry
Crested-serpent Eagle	<i>Spilornis cheela</i>	LC/II	V	Throughout
Shikra	<i>Accipiter badius</i>	LC/II	V	Throughout
Rufous-bellied Eagle	<i>Hieraaetus kienerii</i>	LC/II	V	BC083
Changeable Hawk Eagle	<i>Spizaetus cirrhatus</i>	LC/II	V	Throughout
Darter	<i>Anhinga melanogaster</i>	NT	V	Preaek Kon Tourt Ferry, Preaek Ta Ok

Little Cormorant	<i>Phalacrocorax niger</i>	LC	V	Preaek Ta Ok
Little Egret	<i>Egretta garzetta</i>	LC	V	Throughout
Intermediate Egret	<i>Mesophoyx intermedia</i>	LC/III	V	Preaek Ta Ok
Cattle Egret	<i>Bubulcus ibis</i>	LC/III	V	Andoung Tuek
Chinese Pond Heron	<i>Ardeola bacchus</i>	LC/WV	VA	Preaek Kon Tourt
Javan Pond Heron	<i>Ardeola speciosa</i>	LC	VA	Throughout
Grey Heron	<i>Ardea cinerea</i>	LC	V	Preaek Kon Tourt
Purple Heron	<i>Ardea cinerea</i>	LC	V	Preaek Ta Ok
Little Heron	<i>Butorides striatus</i>	LC	V	Throughout
Malayan Night Heron	<i>Gorsachius melanolophus</i>	LC	VA	BC083
Yellow Bittern	<i>Ixobrychus sinensis</i>	LC	V	BC083
Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i>	LC	V	Lac Chakk – Kompong Phlu village
Lesser Adjutant	<i>Leptoptilos javanicus</i>	VUL	V	Throughout
Wooly-necked Stork	<i>Ciconia episcopus</i>	LC	V	Throughout
Hooded Pitta	<i>Pitta sordida</i>	LC	V	NH 48
Blue-winged Pitta	<i>Pitta moluccensis</i>	LC/IMT F	A	BC 083
Black-and-red Broadbill	<i>Cymbirhynchus macrorhynchos</i>	LC	V	Preaek Kon Tourt
Banded Broadbill	<i>Eurylaimus javanicus</i>	LC	V	Throughout
Dusky Broadbill	<i>Corydon sumatranus</i>	LC	VA	BC 083
Blue-winged Leafbird	<i>Chloropsis cochinchinensis</i>	LC	VA	Throughout
Golden-fronted Leafbird	<i>Chloropsis aurifrons</i>	LC	V	Preaek Ta Chan
Common Iora	<i>Aegithina tiphia</i>	LC	VA	Preaek Kon Tourt Village
Great Iora	<i>Aegithina lafresnayeii</i>	LC	V	BC 084
Asian Fairy Bluebird	<i>Irena puella</i>	LC	VA	Throughout
Tiger Shrike	<i>Lanius tigrinus</i>	LC	V	BC 083
Brown Shrike	<i>Lanius cristatus</i>	LC	V	BC 083
Red-billed Blue Magpie	<i>Urocissa erythrorhyncha</i>	LC	V	BC 083
Rufous Treepie	<i>Dendrocitta vagabunda</i>	LC	V	Preaek Dumb Bong
Racket-tailed Treepie	<i>Crypsirina temia</i>	LC/ITDZ	VA	BC 083
Large-billed Crow	<i>Corvus macrorhynchos</i>	LC	VA	Preaek Kon Tourt Village
Black-naped Oriole	<i>Oriolus chinensis</i>	LC	A	Throughout
Black-hooded Oriole	<i>Oriolus xanthornus</i>	LC	VA	BC 083
Scarlet Minivet	<i>Pericrocotus flammeus</i>	LC	VA	BC 083, BC 084
Ashy Minivet	<i>Pericrocotus divaricatus</i>	LC	V	Throughout
Black Drongo	<i>Dicrurus macrocercus</i>	LC	V	BC 084
Ashy Drongo	<i>Dicrurus leucophaeus</i>	LC	VA	Throughout
Bronzed Drongo	<i>Dicrurus aeneus</i>	LC	VA	Throughout
Spangled Drongo	<i>Dicrurus hottentottus</i>	LC	VA	Throughout

Greater Racket-tailed Drongo	<i>Dicrurus paradiseus</i>	LC	VA	Throughout
Bar-winged Flycatcher-shrike	<i>Hemipus picatus</i>	LC	V	NH 48
Black-naped Monarch	<i>Hypothymis azurea</i>	LC	VA	Throughout
Pied Fantail	<i>Rhipidura javanica</i>	LC	V	Preaek Ta Ok
Asian Paradise-flycatcher	<i>Terpsiphone paradisi</i>	LC	VA	NH 48
Common Woodshrike	<i>Tephrodornis pondicerianus</i>	LC	VA	BC 083
Asian Brown Flycatcher	<i>Muscicapa dauurica</i>	LC/WV/ PM	V	Throughout
[Brown-streaked Flycatcher]	<i>Muscicapa willamsoni</i>	LC	V	BC 084
Mugimaki Flycatcher	<i>Ficedula mugimaki</i>	LC/WV/ PM	VA	NH 48
Red-throated Flycatcher	<i>Ficedula parva</i>	LC/WV/ PM	V	BC 084
Little Pied Flycatcher	<i>Ficedula westermanni</i>	LC	V	NH 48
Siberian Blue Robin	<i>Luscinia cyane</i>	LC/WV	V	BC 084
Oriental Magpie Robin	<i>Copsychus saularis</i>	LC	VA	BC 083, Preaek Ta Ok
White-rumped Shama	<i>Copsychus malabaricus</i>	LC	V	BC 084
Common Myna	<i>Acridotheres tristis</i>	LC	VA	Andoung Tuek
White-vented Myna	<i>Acridotheres grandis</i>	LC	V	Preaek Ta Ok
Golden-crested Myna	<i>Ampeliceps coronatus</i>	LC/IMT F	V	Preaek Kon Tourt
Hill Myna	<i>Gracula religiosa</i>	LC/II	VA	Throughout
Black-collared Starling	<i>Sturnus nigricollis</i>	LC/ITDZ	V	Andoung Tuek
Vinous-breasted Starling	<i>Sturnus burmannicus</i>	LC	V	Andoung Tuek
[Sand Martin]	<i>Riparia riparia</i>	LC	V	NH 48
Asian House Martin	<i>Delichon dasypus</i>	LC	V	NH 48
Barn Swallow	<i>Hirundo rustica</i>	LC/WV/ PM	V	Throughout
Pacific Swallow	<i>Hirundo tahitica</i>	LC/WV	V	Kampong Som
Red-rumped Swallow	<i>Hirundo daurica</i>	LC	V	Kabal Kanol
Black-headed Bulbul	<i>Pycnonotus atriceps</i>	LC	V	Throughout
Black-crested Bulbul	<i>Pycnonotus melanicterus</i>	LC	VA	Throughout
Stripe-throated Bulbul	<i>Pycnonotus finlaysoni</i>	LC/IMT F	VA	Throughout
Yellow-vented Bulbul	<i>Pycnonotus goiavier</i>	LC	VA	BC 083, 084
Streak-eared Bulbul	<i>Pycnonotus blanfordi</i>	LC/ITDZ	V	NH 48
Sooty-headed Bulbul	<i>Pycnonotus aurigaster</i>	LC/ITDZ	VA	NH 48
Ochraceous Bulbul	<i>Alophoixus pallidus</i>	LC	VA	Throughout
Grey-breasted Prinia	<i>Prinia hodgsonii</i>	LC	VA	NH 48
Plain Prinia	<i>Prinia inornata</i>	LC	VA	BC 083

Striated Grassbird	<i>Megalurus Palustris</i>	LC	V	Ranger Station
Bright-headed Cisticola	<i>Cisticola exilis</i>	LC	VA	Kabal Kanol
Asian Stubtail	<i>Urosphena squameiceps</i>	LC	V	NH 48
Lanceolated Warbler	<i>Locustella lanceolata</i>	LC/WV/ PM	VA	BC 084
Golden-bellied Gerygone	<i>Gerygone sulphurea</i>	LC	VA	BC 083
Common Tailorbird	<i>Orthotomus sutorius</i>	LC	VA	NH 48, BC 084
Dark-necked Tailorbird	<i>Orthotomus atrogularis</i>	LC	VA	NH 48
Dusky Warbler	<i>Phylloscopus fuscatus</i>	LC/WV/ PM	V	BC 084
Arctic Warbler	<i>Phylloscopus borealis</i>	LC/PM	VA	BC 083, 084
White-crested Laughingthrush	<i>Garrulax leucolophus</i>	LC	VA	Throughout
[Abbott's Babbler]	<i>Malacocincla abbotti</i>	LC	A	NH 48
Puff-throated Babbler	<i>Pellorneum ruficeps</i>	LC	VA	Throughout
Striped-tit Babbler	<i>Macronous gularis</i>	LC	VA	Throughout
White-bellied Yuhina	<i>Yuhina zantholeuca</i>	LC	VA	NH 48
Indochinese Bushlark	<i>Mirafra marionae</i>	LC	VA	BC 083
Yellow-vented Flowerpecker	<i>Dicaeum melanoxanthum</i>	LC	VA	BC 084
Scarlet-backed Flowerpecker	<i>Dicaeum cruentatum</i>	LC	VA	Throughout
Purple-throated Sunbird	<i>Nectarinia asiatica</i>	LC	VA	Throughout
Purple Sunbird	<i>Nectarinia asiatica</i>	LC	V	Preaek Kon Tourt
Crimson Sunbird	<i>Aethopyga siparaja</i>	LC	VA	BC 083, 084
Brown-throated Sunbird	<i>Anthreptes malacensis</i>	LC	VA	BC 083
Ruby-cheeked Sunbird	<i>Anthreptes singalensis</i>	LC	VA	BC 083, 084
Olive-backed Sunbird	<i>Nectarinia jugularis</i>	LC	VA	BC 083, 084
Little Spiderhunter	<i>Arachnothera longirostra</i>	LC	VA	BC 083, 084
White Wagtail	<i>Motacilla alba</i>	LC	V	Preaek Kon Tourt Ferry
Yellow Wagtail	<i>Motacilla flava</i>	LC/WV/ PM	V	NH 48
Grey Wagtail	<i>Motacilla cinerea</i>	LC/WV/ PM	VA	BC 083
[Paddyfield Pipit]	<i>Anthus rufulus</i>	LC	VA	Ranger Station
White-rumped Munia	<i>Lonchura striata</i>	LC	V	NH 48

Records largely obtained from July 2008 to July 2009.

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

Status: EMD: Endangered, VUL: Vulnerable; NT: Near Threatened, LC: Least Concern, 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, C: Mist Net Capture, P: Photograph.

Appendix 3: Reptile inventory

Genus	Species	Common name	Location	Evidence
Agamidae				
<i>Acanthosaura</i>	<i>armata</i>	Horned tree lizard	062 and 064	Specimen 3614T
<i>Calotes</i>	<i>emma alticristatus</i>	Northern forest crested lizard	052 TS1	Specimen
<i>Calotes</i>	<i>versicolor</i>	Garden fence lizard	052 TS3	Specimen
<i>Draco</i>	<i>maculatus</i>	Spotted Gliding Lizard	064 TS3	Specimen 3622T
<i>Draco</i>	<i>melanopogon</i>	Black bearded gliding lizard	TS3, 062	Photograph
<i>Draco</i>	<i>taeniopterus</i>	Barred gliding lizard	052 and 064	Specimen 3625T
<i>Draco</i>	sp.	Gliding lizard	Near village, 1.5km from 053 BC	Specimen
<i>Physignathus</i>	<i>cocincinus</i>	Indochinese Water dragon	Riverside 061	Sighting
Aniliidae				
<i>Cylindrophis</i>	<i>ruffus</i>	Red-tailed Pipe Snake	054 TS3, line 1 bucket 9.	Specimen
Bataguridae				
<i>Cyclemis</i>	<i>dentate</i>	Asian leaf turtle	Near village, 1.5km from 053 BC	Photograph
Boidae				
<i>Python</i>	<i>reticulates</i>	Reticulated python	Park HQ; near 053 BC	Specimen; photograph
Colubridae				
<i>Ahaetulla</i>	sp.	Whip Snake sp.	053, 054 Butterfly Transect	Sighting
<i>Ahaetulla</i>	<i>nasuta</i>	Long nosed whip snake	Near BC072	Sighting
<i>Ahaetulla</i>	<i>prasina</i>	Oriental Whip Snake	053 and 064	Specimen 3620T
<i>Boiga</i>	<i>cyanea</i>	Green cat snake	054 TS2 VP2	Photograph
<i>Boiga</i>	<i>dendrophila</i>	Mangrove snake	E: 103°19'42.5" N: 11°05'40.5"	Sighting
<i>Dendrelaphis</i>	<i>pictus</i>	Common Bronzeback	Near 052 TS2	Photograph
<i>Elaphe</i>	<i>flavolineata</i>	Common malayan racer	TS3 Base camp, in river, 062	Photograph
<i>Elaphe</i>	<i>oxycephalum</i>	Red-tailed Rat Snake	064 TS3	Sighting
<i>Elaphe</i>	<i>prasina</i>	Green Tree Racer?	Channel from Park HQ	Sighting

<i>Enhydris</i>	<i>bocourti</i>	Bocourt's water snake	Widespread	Photograph, specimen
<i>Homalopsis</i>	<i>buccata</i>	Puff-faced water snake	Widespread	Photograph
<i>Enhydris</i>	<i>enhydris</i>	Rainbow water snake	BC071	Sighting
<i>Honalopsis</i>	sp.	Water snake sp.	Base camp063	Specimen
<i>Lycodon</i>	<i>capucinus</i>	Common wolf/house snake	053 BC	Sighting
<i>Lycodon</i>	<i>laoensis</i>	Laotian or Indo-Chinese Wolf Snake	BC061	Sighting
<i>Oligodon</i>	<i>fasciolatus</i>	Banded Kukri Snake	caught by Ngait 061	Sighting
<i>Oligodon joyntsoni</i>	<i>joyntsoni</i>	Grey Kukri Snake	Forest Path	Sighting
<i>Oligodon</i>	<i>mouhoti</i>	Cambodian Kukri Snake	Forest near trapsite 3	Sighting
<i>Oligodon</i>	<i>purpurascens</i>	Brown Kukri Snake	Butterfly Transect	Photograph
<i>Oligodon</i>	<i>taeniatus</i>	Striped Kukri Snake	Near BC072	Spec. 3664T
<i>Pareas</i>	<i>carinatus</i>	Keeled Slug Snake	053 TS1 VP2	Specimen
<i>Pareas</i>	<i>margartiophorus</i>	White-spotted or northern mountain slug-snake	064, TS1	Specimen 3612T
<i>Psammodynastes</i>	<i>pulverulentus</i>	Common Mock Viper	Path into 053 BC	Sighting
<i>Ptyas</i>	<i>mucosus</i>	Common Rat Snake	Roadside 083	Sighting
<i>Ptyas</i>	<i>korros</i> (possibly <i>mucosus</i>)	Indo-chinese Rat Snake (possibly Common)	054 BC	Sighting
<i>Rhabdophis</i>	<i>nigrocinctus</i>	Green Keelback	Path to village, before stream crossing in forest	Sighting
<i>Rhabdophis</i>	<i>subminiatus</i>	Red-necked Keelback	061 and 064	Specimen 3624T
<i>Xenochrophis</i>	<i>piscator</i>	Chequered Keelback	Sat Camp 064	Specimen 3610T
Elapidae				
<i>Bungarus</i>	<i>candidus</i>	Malayan or blue krait	BC071	Photo
<i>Bungarus</i>	<i>fasciatus</i>	Banded Krait	053 BC; in river near Kompong Pluh	Photograph
<i>Calliophis</i>	<i>maculiceps</i>	Small spotted coral snake	Path past sat camp A, 072	Spec. 3665T
<i>Naja</i>	<i>kaouthia</i>	Monocellate Cobra	Widespread	Sighting
<i>Naja</i>	<i>siamensis</i>	Indochinese spitting cobra	Near waterfall, base camp 063	Skin specimen

<i>Ophiophagus</i>	<i>Hannah</i>	King cobra	River	Sighting
Gekkonidae				
<i>Cyntodactylus</i>	<i>intermedius</i>	Cardamom slender-toed gecko	052 TS2	Specimen
<i>Gekko</i>	<i>gecko</i>	Tokay gecko	Widespread	Photograph
<i>Hemidactylus</i>	<i>frenatus</i>	Spiny-tailed house gecko	Base camp 064	Specimen 3615T, 3616T, 3618T
<i>Hemiphyllodactylus</i>	<i>typus</i>	Minature gecko	Base camp 063	Specimen
<i>Ptychozoon</i>	<i>lionotum</i>	Smooth-backed gliding gecko	Near TS1, 072	Sighting
Lacertidae				
<i>Takydromus</i>	<i>sexlineatus</i>	Long-tailed lizard	Widespread	Specimen
Scincidae				
<i>Dasia</i>	<i>olivacea</i>	Olive tree skink	Bucket captures, 062	Sighting
<i>Lipinia</i>	<i>vittigera</i>	Striped Tree Skink	054 and 064	Specimen 3604T
<i>Lygosoma (riopa)</i>	<i>bowringii</i>	Bowring's supple skink	Widespread	Specimen
<i>Lygosoma</i>	<i>khoratense</i>	Khorat supple skink	TS1 064	Specimen 3601T
<i>Lygosoma (riopa)</i>	<i>Sp.</i>	Supple skink sp.	Widespread	Specimen
<i>Lygosoma (riopa)</i>	<i>Sp.</i>	Supple skink sp.	TS1 064	Specimen 3605T
<i>Lygosoma (riopa)</i>	<i>Sp.</i>	Supple skink sp.	TS3 064	Specimen 3626T
<i>Mabuya</i>	<i>macularia</i>	Speckled forest skink	Widespread	Specimen
<i>Mabuya</i>	<i>multifasciata</i>	Many-lined sun skink	Widespread	Specimen
<i>Mabuya</i>	<i>sp.</i>	Unknnown skink sp.	TS1 064	Specimen 3603T
<i>Scincella</i>	<i>reevesii</i>	Speckled leaf litter skink	Bucket captures, 062	Sighting, Specimen taken 063
<i>Sphenomorphus</i>	<i>maculatus</i>	Streamside skink	Widespread	Specimen
<i>Tropidodophorus</i>	<i>microlepis</i>	Small-scaled water-skink	On path between TS1 and base camp 063	Specimen
<i>Unknown</i>		Skink sp.	053 TS1	Specimen
<i>Unknown</i>		Skink sp.	063 TS3	Specimen
Testudinidae				
<i>Indotestudo</i>	<i>elongata</i>	Elongated tortoise	Confiscated from poachers, 062	Photograph
Trionychidae				
<i>Trionyx (Amyda)</i>	<i>Cartilagineus (cartilaginea)</i>	Asiatic Soft-shelled turtle	Near village near 053 BC	Photograph
Typhlopidae				
<i>Ramphotyphlops</i>	<i>braminus</i>	Common blind or flowerpot snake	TS3 071	Spec. 3646T

<i>Typhlops</i>	<i>muelleri</i>	Mueller's Blind Snake	054 and 064	Specimen 3623T
Varanidae				
<i>Varanus</i>	<i>bengalensis</i>	Bengal Monitor	Widespread	Sighting, photograph
<i>Varanus</i>	<i>salvator</i>	Water Monitor	Upstream from 053 BC	Prints
Viperidae				
<i>Calloselasma</i>	<i>rhodostoma</i>	Malayan pit-viper	Widespread	Photograph, specimen
<i>Trimeresurus</i>	<i>banburiensus</i>	Kanburi pit-viper	TS1, 064	Sighting
<i>Trimeresurus</i>	<i>macrops</i>	Big-eyed Pit-viper	Path to nearby village	Photograph
<i>Trimeresurus</i>	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: NT: Near threatened, END: Endangered, VUL: Vulnerable.

Appendix 4: Amphibian inventory

Genus	Species	Common name	Locality	Evidence
Bufonidae				
<i>Bufo</i>	<i>melanostichus</i>	Black-spined toad	Widespread	Specimen
<i>Bufo</i>	<i>parvus</i>	Indochinese Dwarf Toad?	Quadrat	Specimen
Ichthyophiidae				
<i>Ichthyophis</i>	<i>kohtaoensis</i>	Koa Tao Island Caecilian	062 TS2	Sighting
Microhylidae				
<i>Calluella</i>	<i>guttutata</i>	Striped spadefoot frog	072 TS3	Spec. 3671T
<i>Microhyla</i>	<i>heynomsi</i>	Dark-sided Chorus Frog	Quadrat	Specimen
<i>Microhyla</i>	<i>berdmorei</i>	Berdmore's chorus frog	063 TS1	Specimen
<i>Microhyla</i>	<i>ornata</i>	Ornate chorus frog	071 TS2	Spec. 3643T
<i>Micryletta</i>	<i>inornata</i>	Inornate froglet	052 TS2	Specimen
<i>Kalophrynus</i>	<i>pleurostigma</i>	Red-sided sticky frog	Widespread	Specimen
<i>Kalophrynus</i>	<i>interlineatus</i>	Striped sticky frog	063 TS1	Specimen
Ranidae				
<i>Cancrivora</i>	<i>gravenhorst</i>	Mangrove Frog?	Quadrat	Specimen
<i>Fejervarya</i>	<i>limnocharis</i>	Rice Field Frog	062 TS2	Sighting
<i>Limnonectes</i>	<i>paramacrodon</i>	Peat Swamp Frog?	Widespread, 064	Specimen 3607T
<i>Limnonectes</i>	?	Unknown frog	071 TS2	Spec. 3645T
<i>Micrixalus</i>	<i>baluensis</i>	Dwarf Mountain Frog?	Quadrat	Specimen
<i>Occidozyga</i>	<i>martensii</i>	Marten's puddle frog	Widespread	Specimen
<i>Occidozyga</i>	Sp.	Puddle frog sp.	052 TS1	Specimen
<i>Occidozyga</i>	<i>lima</i>	Common Puddle Frog	054 TS3	Sighting
<i>Paa</i>	<i>fasciculispina</i>	Spiny-breasted Frog	062 Turtle traps	Specimen 3994T
<i>Rana</i>	<i>erythraea</i>	Green-backed frog	By 053 TS2 turtle pool	Specimen
<i>Rana</i>	<i>lymnocharis</i>	Grass Frog	Quadrat	Specimen
<i>Rana</i>	<i>macroductyla</i>	Stripe-backed frog	052 TS3	Specimen
<i>Rana/Hylarana</i>	<i>Mortenseni</i>	Mortensen's frog		Sighting/audio
Rhacophoridae				
<i>Chrixalus</i>	<i>nongkhorensis</i>	Nang Khor bushfrog	BC072	Spec. 3672T
<i>Polypedates</i>	<i>leucomystax</i>	Common tree frog	Widespread	Specimen 3617T
<i>Polypedates</i>	<i>mutus</i>	Northern tree frog	Widespread	Specimen 3608T
Unknown				
Unknown		Frog sp.		Specimen
<i>Bufo</i>		Toad sp.	062 TS1	Specimen 3700T
Unknown		Frog sp.	Sat Camp 064	Specimen 3609T
<i>Bufo</i>		Toad sp.	064 TS3	Specimen 3621T

Appendix 5: Butterfly inventory

ID	Family	Genus	Species	Common name	Sex
048	Nymphalidae	<i>Polyura</i>	<i>arja arja</i>	Pallid Nawab	M
060	Nymphalidae	<i>Ypthima</i>	<i>baldus</i>	Common Five-ring	M
013	Amathusiidae	<i>Amathusia</i>	<i>phidippus adastatus</i>	Palm King	M
022	Amathusiidae	<i>Zeuxidia</i>	<i>amethysta masoni</i>	Saturn	M
041	Amathusiidae	<i>Amathusia</i>	<i>phidippus adastatus</i>	Palm King	
063	Amathusiidae	<i>Zeuxidia</i>	<i>amethysta masoni</i>	Saturn	F
095	Amathusiidae	<i>Discophora</i>	<i>spp.</i>	Duffer sp.	F
001	Danaidae	<i>Euploea</i>	<i>core</i>	Common Indian Crow	M
004	Danaidae	<i>Euploea</i>	<i>core</i>	Common Indian Crow	
012	Danaidae	<i>Euploea</i>	<i>mulciber</i>	Striped Blue Crow	M
033	Danaidae	<i>Euploea</i>	<i>radamanthus radamanthus</i>	Magpie crow	M
036	Danaidae	<i>Euploea</i>	<i>mulciber</i>	Striped Blue Crow	F
099	Danaidae	<i>Danaus</i>	<i>meanippus heggesippus</i>	Black Veined Tiger	
100	Danaidae	<i>Euploea</i>	<i>spp.</i>	Crow sp.	M
115	Danaidae	<i>Parantica</i>	<i>aglea melonoides</i>	Glassy Tiger	M
117	Danaidae	<i>Euploea</i>	<i>caramalzeman caramalzeman</i>	Large Blue Crow	M
135	Danaidae	<i>Danaus</i>	<i>genutia</i>	Common tiger	
167	Danasidae				
166	Danasidae?				
055	Hesperiidae	<i>Ancistroides</i>	<i>nigrita maura?</i>	Chocolate Demon	
069	Hesperiidae	<i>Notocrypta</i>	<i>paralysos asawa</i>	Common Banded Demon	
081	Hesperiidae	<i>Pyrroneura</i>	<i>spp.</i>		
010	Lycaenidae	<i>Arhopala</i>	<i>spp.</i>	Oakblue sp.	M
011	Lycaenidae	<i>Yasoda</i>	<i>tripunctata atrinotata</i>	Branded Yamfly	
015	Lycaenidae	<i>Arhopala</i>	<i>eumolphus eumolphus</i>	Green Oakblue	M
037	Lycaenidae	<i>Charana</i>	<i>mandarina mandarina</i>	Mandarin Blue	
046	Lycaenidae	<i>Drupaida</i>	<i>ravindra boisduvali</i>	Common Posy	F
085	Lycaenidae	<i>Arhopala</i>	<i>spp</i>	Oakblue sp.	M
086	Lycaenidae	<i>Arhopala</i>	<i>spp</i>	Oakblue sp.	M
096	Lycaenidae	<i>Hypolycaena</i>	<i>erylus himavantus</i>	Common Tit	M
105	Lycaenidae	<i>Acytolepis</i>	<i>puspa gisca</i>	Common Hedge Blue	M
109	Lycaenidae	<i>Arhopala</i>	<i>spp.</i>	Oakblue sp.	
110	Lycaenidae	<i>Zeltus</i>	<i>amasa amasa</i>	Fluffy Tit	F
111	Lycaenidae	<i>Castalius</i>	<i>rosimon rosimon</i>	Common Pierrot	F
113	Lycaenidae	<i>Chliaria</i>	<i>othona othona</i>	Orchid tit	

118	Lycaenidae	Unknown	Unknown		
121	Lycaenidae	<i>Loxura</i>	<i>atymnus continentalis</i>	Yamfly	F
123	Lycaenidae	<i>Spindasis</i>	<i>seliga seliga</i>	Silverline	F
125	Lycaenidae	<i>Hypolycaena</i>	<i>erylus himavantus</i>	Common Tit	M
139	Lycaenidae	<i>Anthene</i>	<i>emolus</i>	Ciliate blue	M
164	Lycaenidae	<i>Charana</i>		Blue or tit sp.	
165	Lycaenidae	<i>Anthene</i>	<i>emolus</i>	Ciliate blue	
168	Lycaenidae	<i>Parantica</i>	?	Glassy tiger?	
171	Lycaenidae				
172	Lycaenidae	<i>Acytoleps</i>			
Sighting only	Lycaenidae	<i>Catochrysoes</i>	<i>panormus</i>	Silver Forget-Me-Not	
Sighting only	Lycaenidae	<i>Zeltus</i>	<i>amasa</i>	Fluffy Tit	
007	Nymphalidae	<i>Tanaecia</i>	<i>julii odilina</i>	Common Earl	F
014	Nymphalidae	<i>Lexias</i>	<i>cyanipardus albopunctata</i>	Archduke sp.	F
017	Nymphalidae	<i>Tanaecia</i>	<i>jahnu</i>	Plain Earl	M
020	Nymphalidae	<i>Tanaecia</i>	<i>lepidea cognata</i>	Grey Count	M
023	Nymphalidae	<i>Parthenos</i>	<i>sylvia</i>	Clipper?	
024	Nymphalidae	<i>Cupha</i>	<i>erymanthis lotis</i>	Rustic	M
028	Nymphalidae	<i>Polyura</i>	<i>schreiber assamensis</i>	Blue Nawab	M
029	Nymphalidae	<i>Neptis</i>	<i>clinia</i>	Southern Sullied Sailor	M
030	Nymphalidae	<i>Charaxes</i>	<i>kahruba</i>	Variegated Rajah	F
031	Nymphalidae	<i>Terinos</i>	<i>terpander intermedia</i>	Royal Assyrian sp.	M
035	Nymphalidae	<i>Euthalia</i>	<i>evelina annamita</i>	Red Spot Duke	F
039	Nymphalidae	<i>Lexias</i>	<i>cyanipardus albopunctata</i>	Archduke sp.	F
040	Nymphalidae	<i>Tanaecia</i>	<i>julii odilina</i>	Common Earl	M
042	Nymphalidae	<i>Junonia</i>	<i>almana almana</i>	Peacock Pansy	F
047	Nymphalidae	<i>Tanaecia</i>	<i>julii</i>	Common Earl	
049	Nymphalidae	<i>Elymnias</i>	<i>hypermnestra</i>	Common Palmfly	
052	Nymphalidae	<i>Euthalia</i>	<i>evelina annamita</i>	Red Spot Duke	M
053	Nymphalidae	<i>Parthenos</i>	<i>sylvia gambrisius</i>	Clipper	M
057	Nymphalidae	<i>Moduza</i>	<i>procris procris</i>	Commander	M
061	Nymphalidae	<i>Lexias</i>	<i>cyanipardus albopunctata</i>	Archduke sp.	M
062	Nymphalidae	<i>Athyma</i>	<i>perius perius</i>	Common Sargeant	M
065	Nymphalidae	<i>Lebadea</i>	<i>martha martha</i>	Knight	F
071	Nymphalidae	<i>Euthalia</i>	<i>monina remias</i>	Eastern Baron	F
072	Nymphalidae	<i>Euthalia</i>	<i>lubentina lubentina</i>	Gaudy Baron	F
073	Nymphalidae	<i>Charaxes</i>	<i>bernardus hierax</i>	Tawny Rajah	F
074	Nymphalidae	<i>Euthalia</i>	<i>lubentina lubentina</i>	Gaudy Baron	M

076	Nymphalidae	<i>Euthalia</i>	<i>monina remias</i>	Eastern Baron	M
077	Nymphalidae	<i>Junonia</i>	<i>atlites atlites</i>	Grey Pansy	
080	Nymphalidae	<i>Tanaecia</i>	<i>lepidea cognata</i>	Grey Count	F
082	Nymphalidae	<i>Terinos</i>	<i>terpander intermedia</i>	Royal Assyrian sp.	M
083	Nymphalidae	<i>Polyura</i>	<i>arja arja</i>	Pallid Nawab	M
084	Nymphalidae	<i>Polyura</i>	<i>schreiber assamensis</i>	Blue Nawab	M
087	Nymphalidae	<i>Tanaecia</i>	<i>cocytus cocytus</i>	Lavendar Count	F
090	Nymphalidae	<i>Cirrochroa</i>	<i>tyche mithila</i>	Common Yeoman	F
091	Nymphalidae	<i>Neptis</i>	<i>spp.</i>	Sailor sp.	M
092	Nymphalidae	<i>Pandita</i>	<i>sinope sinope</i>		M
097	Nymphalidae	<i>Junonia</i>	<i>orithya ocyale</i>	Blue Pansy	F
126	Nymphalidae	<i>Tanaecia</i>	<i>jahnu</i>	Plain Earl	M
129	Nymphalidae	<i>Vendula</i>	<i>erota</i>	Cruiser	M
130	Nymphalidae	<i>Lebadea</i>	<i>martha martha</i>	Knight	M
137	Nymphalidae	<i>Euthalia</i>	<i>monina remias</i>	Eastern Baron	M
161	Nymphalidae	<i>Euthalia</i>	<i>lubentina</i>	Gaudy Baron	
170	Nymphalidae				
Sighting only	Nymphalidae	<i>Vendula</i>	<i>erota</i>	Cruiser	
019	Papilionidae	<i>Graphium</i>	<i>doson axion</i>	Common Jay	F
032	Papilionidae	<i>Graphium</i>	<i>megarus megapenthes</i>	Spotted Zebra	F
038	Papilionidae	<i>Losaria</i>	<i>coon doubledayi</i>	Common Clubtail	M
045	Papilionidae	<i>Papilio</i>	<i>memnon agenor</i>	Great Mormon	M
058	Papilionidae	<i>Papilio</i>	<i>nephelus chaon</i>	Yellow Helen	M
059	Papilionidae	<i>Papilio</i>	unknown	Yellow Helen	
088	Papilionidae	<i>Lamproptera</i>	<i>meges annamiticus</i>	Green Dragontail	F
089	Papilionidae	<i>Papilio</i>	<i>memnon agenor (form distantianus)</i>	Great Mormon	F
102	Papilionidae	<i>Graphium</i>	<i>sarpedon sarpedon</i>	Common bluebottle	M
103	Papilionidae	<i>Graphium</i>	<i>xenocles lindos</i>	Great Zebra	M
104	Papilionidae	<i>Papilio</i>	<i>demolion demolion</i>	Banded Swallowtail	F?
108	Papilionidae	<i>Papilio</i>	<i>demoleus malayanus</i>	Lime butterfly	F
112	Papilionidae	<i>Graphium</i>	<i>antiphates pompilius</i>	Five Bar Swordtail	M
131	Papilionidae	<i>Papilio</i>	<i>demoleus malayanus</i>	Lime Butterfly	M
133	Papilionidae	<i>Graphium</i>	<i>agamemnon</i>	Tailed jay	M
136	Papilionidae	<i>Graphium</i>	<i>arycles sphinx</i>	Spotted Jay	M
Sighting only	Papilionidae	<i>Lamproptera</i>	<i>curius</i>	White dragontail	
034	Pieridae	<i>Eurema</i>	<i>brigitta fruhstorferi</i>	Small Grass Yellow	F
044	Pieridae	<i>Eurema</i>	<i>hecabe</i>	Common Grass Yellow	
050	Pieridae	<i>Eurema</i>	<i>hecabe</i>	Common Grass Yellow	
054	Pieridae	<i>Delias</i>	<i>pasithoe siamensis</i>	Red-base Jezebel	F
101	Pieridae	<i>Leptosia</i>	<i>nina nina</i>	Psyche	

106	Pieridae	<i>Catopsilia</i>	<i>pomona pomona</i>	Lemon immigrant	F
107	Pieridae	<i>Catopsilia</i>	<i>scylla cornelia</i>	Orange emigrant	F
132	Pieridae	<i>Eurema</i>	<i>sari sodalis</i>	Chocolate grass yellow	M
144	Pieridae	<i>Appias</i>	<i>lyncida</i>	Chocolate albatross	
160	Pieridae	<i>Prioneris</i>	<i>philonome clemathe</i>	Red spot Sawtooth	M
163	Pieridae	<i>Eurema</i>		Grass yellow sp.	
173	Pieridae	<i>Eurema</i>			
Sighting only	Pieridae	<i>Hebonoia</i>	<i>glaucippe</i>	Great orange-tip	
056	Riodinidae	<i>Taxila</i>	<i>haquinus berthae</i>	Harlequin	M
070	Riodinidae	<i>Taxila</i>	<i>haquinus berthae</i>	Harlequin	M
124	Riodinidae	<i>Taxila</i>	<i>haquinus berthae</i>	Harlequin	M
138	Riodinidae	<i>Zemeros</i>	<i>flegyas</i>	Punchinillo	F
078	Satyrida	<i>Ypthima</i>	<i>Sp.</i>	Ring or Ringlet sp.	M
005	Satyridae	<i>Penthum</i>	<i>binghami mimetica</i>	Black Kaiser	F
006	Satyridae	<i>Ypthima</i>	<i>spp.</i>	Rings or Ringlet sp.	
008	Satyridae	<i>Melanitis</i>	<i>leda</i>	Common Evening Brown	F?
016	Satyridae	<i>Elymnias</i>	<i>nesaea apelles</i>	Tiger Palmfly	M
021	Satyridae	<i>Elymnias</i>	<i>hypermnestra meridionalis</i>	Common Palmfly	F
025	Satyridae	<i>Mycalesis</i>	<i>mineus</i>	Bushbrown sp.	M
026	Satyridae	<i>Mycalesis</i>	<i>spp.</i>	Bushbrown sp.	M
027	Satyridae	<i>Elymnias</i>	<i>hypermnestra meridionalis</i>	Common Palmfly	M
064	Satyridae	<i>Melanitis</i>	<i>leda</i>	Common Evening Brown	M
066	Satyridae	<i>Elymnias</i>	<i>nesaea apelles</i>	Tiger Palmfly	F
067	Satyridae	<i>Lethe</i>	<i>europa nilidana</i>	Bamboo Treebrown	F
075	Satyridae	<i>Orsotriaena</i>	<i>medus medus</i>	Nigger	M
093	Satyridae	<i>Ypthima</i>	<i>spp.</i>	Ring or Ringlet sp.	
094	Satyridae	<i>Ypthima</i>	<i>spp.</i>	Ring or Ringlet sp.	
098	Satyridae	<i>Melanitis</i>	<i>leda</i>	Common Evening Brown	M?
119	Satyridae	<i>Mycalesis</i>	<i>mnasicles perma</i>	Cyclops Bushbrown	F?
120	Satyridae	<i>Mycalesis</i>	<i>mineus</i>	Bushbrown sp.	
122	Satyridae	<i>Ypthima</i>		Rings or Ringlet sp.	
127	Satyridae	<i>Mycalesis</i>	<i>anaxias aemate</i>	White-bar Bushbrown	M
128	Satyridae	<i>Penthema</i>	<i>darlisa</i>	Blue Kaiser	F