

**BIOLOGICAL SURVEYS IN THE CENTRAL CARDAMOM MOUNTAINS**

**Conservation International, Cambodia Program, Phnom Penh**

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## Executive Summary

This report describes the biodiversity survey of the Central Cardamoms Protected Forest, Cambodia, conducted as part of the Cardamoms Conservation Program between January and December 2004. The survey involved a study of the baseline biodiversity and habitat associations of mammals, birds, reptiles, amphibians, and fish in the Central Cardamoms and closely contiguous areas (described for the purposes of this report as the CCPF). Supplementary studies investigated the status of selected globally threatened species.

Before 2002, the CCPF was ungazetted and did not have a formally demarcated boundary. The area has now been designated a Protected Forest and all logging concessions have been cancelled within its boundaries. The CCPF covers over 400,000 hectares of evergreen forest, dry dipterocarp forest, pine forest, grasslands, and wetland habitats, with an elevational range of approximately 50–1,500m. This area contains a wide variety of lowland and mid-altitude habitats surrounding a core central plateau, of which about 60,000ha has an elevation over 1,000m. The CCPF is managed by the Cardamoms Conservation Program (CCP), which is a partnership between Conservation International (CI) and the Forestry Administration (FA).

The CCPF contains approximately 3,000 inhabitants, distributed through three areas: O'Som, Thma Bang/Tatai Leu, and the Areng valley.

The surveyed areas were found to contain a very high diversity and abundance of threatened species. Twelve mammal species, two birds, seven reptiles, one amphibian, and one fish recorded during this survey are classified as Globally Threatened (IUCN, 2004), and many others are classified as Near Threatened or Data Deficient. Many of the species recorded, particularly the small mammals and amphibians, are too poorly studied to be designated IUCN status at this time. Potentially undescribed species were discovered, including a rodent (*Rattus sp*), at least one species of shrew (*Crocidura sp*), a snake (*Oligodon sp*), several frogs (e.g., *Philautus sp* and *Polypedates sp*), a skink (*Scincella sp*), and a caecilian (*Ichthyophis sp*). The species richness and IUCN status for the surveyed taxa are summarised in Table 1.

**Table 1:** Summary of species richness and globally threatened status for surveyed taxa

	No. of Species	New records for Cardamom Mountains	No. of Globally Threatened Species
<b>Mammals</b>	57	10	12
<b>Birds</b>	93	3	2
<b>Reptiles</b>	55	9	7
<b>Amphibians</b>	29	7	1
<b>Fish</b>	43	33	1

The CCPF contains some of the most important hill river systems and swathes of contiguous evergreen forest in Cambodia. Habitat destruction within the CCPF is occurring at a comparatively low rate. Current levels of logging, land clearance for agriculture, and charcoal production in the CCPF are low and the evergreen forests appear to be in good condition. NTFP collection is causing minimal damage except for activities that focus on globally threatened plant species such as the Critically Endangered agar wood (*Aquilaria crassna*), although NTFP collectors may engage in hunting activities while in the forest. Alteration to natural fire regimes is having an unknown but possibly detrimental impact on biodiversity in

grassland and pine forests. Snaring and hunting is threatening the survival of populations of globally threatened mammals and birds, particularly large cats, bears, dhole, wild cattle, and chestnut-headed partridge. The wholesale collection of tortoises and turtles within the CCPF is threatening the survival of at least six globally threatened species. Over-collection of the Asian arowana or dragonfish is seriously threatening the survival of remaining populations. Grazing by domestic animals is minimal, but has been observed in the fringes of the CCPF around villages and is causing damage to naturally occurring grasslands and marshes. Land-grabbing is becoming problematic and will lead to severe environmental fragmentation and degradation if allowed to continue. Wetlands in and around the CCPF are threatened by over-fishing and conversion for agriculture. A significant number of globally threatened species, especially turtles and waterbirds, face local extinction in the near future unless this trend in wetland degradation is halted. Lowland forest and associated globally threatened wildlife within the Areng and Tatai valleys are threatened through infrastructure development. Increased infrastructure in these areas support essential economic development of traditional communities but could also facilitate illegal land-grabbing and wildlife trade activities, and must be closely monitored and controlled.

The lowland wetlands on the eastern side of the Areng valley and the upland marshes to the east and north of O'Som represent the most significant still-water bodies in the CCPF, both in terms of size and biological importance. These wetlands are home to the world's largest known wild populations of Critically Endangered Siamese crocodiles, and contain globally threatened freshwater turtles, otters, and water-birds. Wetlands within the Areng Valley are threatened by over-fishing or conversion to agriculture, but the upland marshes around O'Som show fewer signs of disturbance. It is essential that immediate support be given to the conservation of wetlands in order for them to remain a viable and integral part of the CCPF.

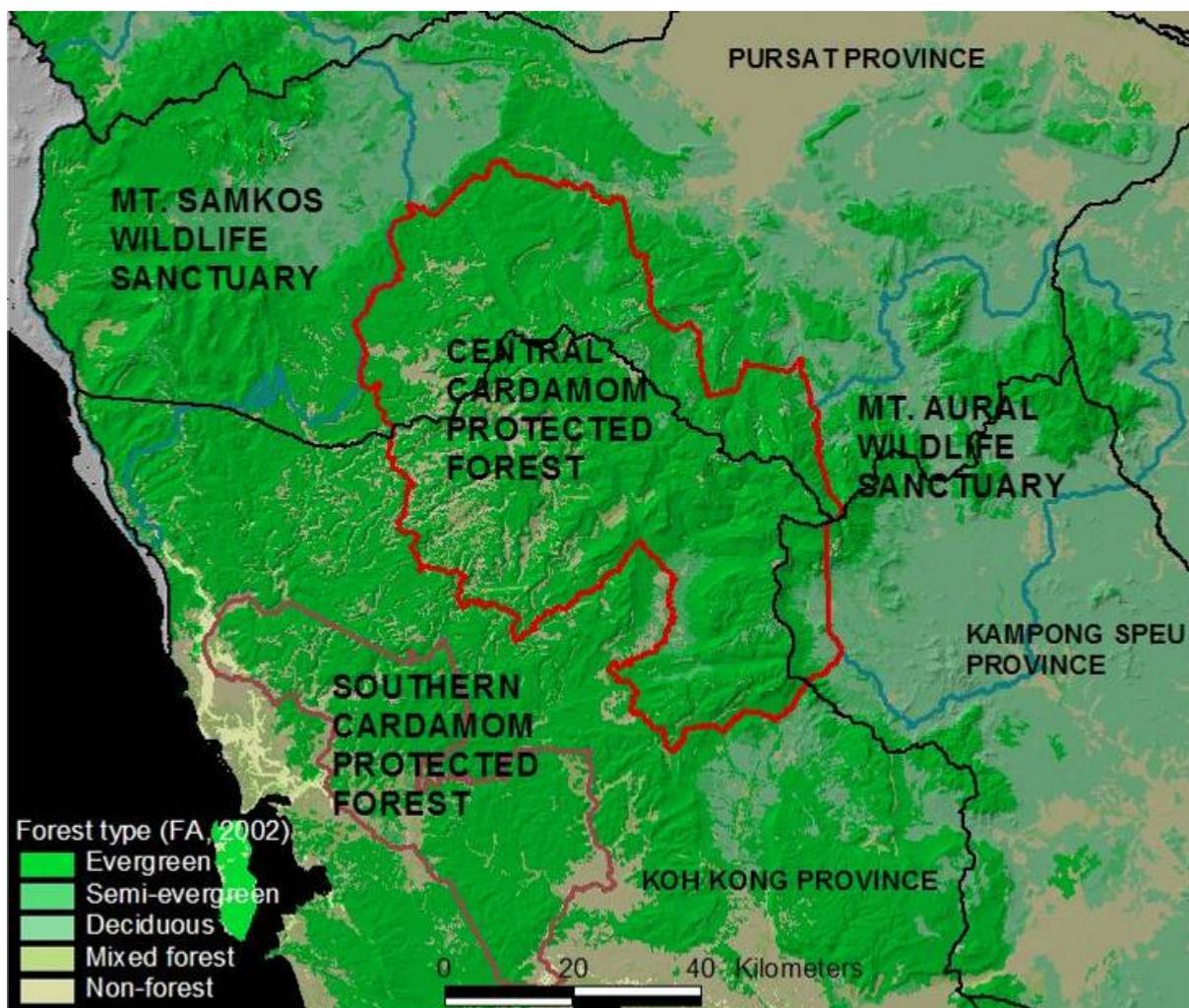
Mid-elevation evergreen forests (> 500m elevation) appear to be in good condition. Surveys and camera-trapping within this habitat found significant numbers of globally threatened species including gaur, dhole, serow, Asiatic black bear, pileated gibbon, chestnut-headed partridge, green peafowl, elongated tortoise, and impressed tortoise.

Based on the findings of this and other surveys, the globally threatened fauna of the Central Cardamoms have been prioritised either for further surveying (to confirm the presence of species which still await verification), or for monitoring (to assess their status over time). This priority-setting exercise identified the following species as highest priorities for surveying to assess their possible presence: tiger; banteng; white-winged duck; Cantor's giant softshell turtle; and yellow-headed temple turtle. These species are all classified as Endangered and are under continuing or increasing global threat (IUCN, 2004).

The highest priority species for monitoring are: dhole; Asian elephant; Siamese crocodile; elongated tortoise; and Asian arowana. These species are all classified as Endangered or Critically Endangered (IUCN, 2004). In addition the Asiatic black bear, Malayan sun bear, impressed tortoise, chestnut-headed partridge, and silver pheasant should also be monitored. These species cover a wide range of habitats and threats within the CCPF, so monitoring would not only provide an assessment of their status, but also indicate hunting and snaring pressure, human presence in the forest, freshwater management, and effectiveness of enforcement and community activities. Monitoring these species would also provide an indication of the status of other globally threatened or hunted species. For example, assessing dhole populations could be used to infer the presence of lower density carnivores e.g., Asian golden cat or clouded leopard, and would also reflect prey abundance.

## Introduction

The Cardamom Mountains in southwest Cambodia have been recognized as an internationally important region for biodiversity conservation. They form part of the Indo-Burma Biodiversity Hotspot (Conservation International, 2004) and represent one of the largest, most diverse, and least developed forest regions in mainland Southeast Asia (Daltry & Momborg, 2000). Spanning approximately one million hectares (10,000 km<sup>2</sup>), the relatively intact forests of the Central Cardamom Protected Forest (CCPF) and two adjoining Wildlife Sanctuaries (Phnom Aural and Phnom Samkos) provide critical habitat for a wide range of wildlife, including many endemic and globally threatened species (see Figure 1). The CCPF itself covers approximately 402,000 ha and was established in 2002 when the Cambodian government cancelled existing logging concessions in the area.



**Figure 1:** Map of southwest Cambodia

Biological research in Cambodia has been extremely limited in scope and there remains a paucity of data for almost all taxa. This is primarily due to many years of civil unrest. Following the signing of the Paris Peace Accords in 1991 and the surrender of the final elements of the Khmer Rouge in early 1999, conservation organisations have conducted biological surveys in southwest Cambodia. These include:

A preliminary wildlife survey in the Cardamom mountains region of southwest Cambodia – FFI, 1999

Cardamom Mountains Biodiversity Survey – FFI, 2000

Wildlife Survey of Kirirom National Park – WCS, 2000

Social and Ecological Surveys of Phnom Aural Wildlife Sanctuary – FFI, 2002

Mini-RAP Assessment of the Silver Road Logging Concession, Cardamom Mountain area, Cambodia – CI, 2003

Biodiversity Assessment of the Southern Cardamoms and Botum-Sakor Peninsular – WildAid, 2003

These surveys began to identify patterns of biodiversity within the landscape. However, the status and features of the region's fauna and flora remained poorly described, and further survey efforts were needed to guide effective conservation action.

## Goal and Objectives

The purpose of the 2004 surveys was to achieve the following goal:

*To identify survey and monitoring priorities for the effective conservation of the CCPF's vertebrate fauna*

CI's 2004 surveys aimed to build upon prior research in the Cardamom Mountains. Due to the size of the Cardamoms and the logistical constraints to working in this area, previous faunal surveys within the CCPF, though rigorous, produced incomplete inventories and typically lacked detailed information on priority species. Further surveys were therefore essential to provide a more comprehensive inventory of selected vertebrate taxa and to provide detailed information on the distribution, population status, and threats to priority species.

Therefore, the primary objective was as follows:

**Objective 1: *Collect baseline biodiversity data for selected taxa that will be used to identify and prioritise species and sites for management action within the Central Cardamom Protected Forest***

Priority species are defined within the context of this report as globally threatened (based on the IUCN Red List), restricted range, or currently undescribed. Definitions of priority species for monitoring also took feasibility into account (e.g. costs, sample size, and logistics).

### **Activities:**

1. Build on existing mammal, bird, reptile, amphibian, and freshwater fish data for the CCPF in order to reaffirm and raise the biological importance of the region and provide detailed information on which prioritisation and monitoring of selected species will be based.
2. Confirm the presence and distribution of priority species and identify those in short-term danger of local extinction.
3. Assess the generic and idiosyncratic threats affecting priority species in order to develop effective responses.
4. Identify priority habitats and sites based on the presence of globally threatened or irreplaceable (restricted range) species.
5. Produce appropriate conservation recommendations based on the survey findings.

The manpower that is required to conduct broad-ranging biological surveys and monitoring in the Cardamom Mountains is well beyond the scope of any one field team. However, through collaboration with partner NGOs and by integrating national research capacity, surveying and monitoring of selected globally threatened species becomes feasible. Field scientists can provide hands-on training and support in appropriate survey methods to Khmer students, graduates, and government counterparts. This will provide essential data while strengthening existing capacity in the national ability to monitor conservation outcomes.

Therefore, the second objective for the 2004 research survey was:

## Objective 2: *To develop national research capacity*

### Activities:

1. Recruit students and graduates from Phnom Penh universities as counterparts for research activities.
2. Train and mentor graduates to be able to implement research projects independently.

## Study Area

The study areas covered a range of habitats, locations, and elevations across the CCPF. Figure 2 shows the distribution and approximate size of the surveyed sites.



**Figure 2:** Map of survey sites in and around the CCPF

Habitat definitions have differed for each survey that has been conducted in the Cardamom Mountains. For our surveys we defined habitats based on Daltry (2002), though making every effort to integrate botanical knowledge from all previous surveys (see Appendix 1). These habitat definitions are currently under review. A comprehensive, workable set of definitions will be produced for use across southwest Cambodia, providing habitat mapping capacity as well as continuity for future surveys.



# Mammals

Annette Olsson



Photos:

Top left: Camera trap photograph of a gaur *Bos gaurus*

Top right: Camera trap photograph of an Asiatic black bear *Ursus thibetanus*

Centre: Shamel's horseshoe bat *Rhinolophus shameli*

Bottom left: Camera trap photograph of a serow *Naemorhedus sumatraensis*

Bottom right: Releasing a common palm civet *Paradoxurus hermaphroditus*

# Mammals

## Introduction

Due to the size, variety of habitats, and large area of relatively undisturbed contiguous forest in the Cardamom Mountains, this region is home to a wide diversity of common and globally threatened mammal species.

Large mammals are probably the most well studied animal group in Cambodia. Five surveys have been conducted in the Cardamom Mountains in the last four years, and have provided significant data on the mammal fauna of this region. FFI conducted mammal surveys in Phnom Samkos Wildlife Sanctuary and the CCPF (Daltry & Momberg, 2000); FFI also carried out social and ecological surveys in Phnom Aural Wildlife Sanctuary (Daltry, 2002); CI conducted a rapid assessment of the Silver Road logging concession south of Thma Bang (CI, 2003); and WildAid conducted mammal surveys within the southern Cardamoms and Botum Sakor National Park (Daltry & Traeholt, 2003). Short biological assessments have also been conducted in the neighbouring Kirirom National Park (Kong & Tan, 2000).

Small mammals, defined for the purposes of these surveys as the orders Insectivora, Scandentia, Rodentia and Chiroptera, have received relatively little attention in Cambodia. The first systematic small mammal survey in Cambodia was conducted as recently as 2000, decades later than small mammal surveys in most of SE Asia. This has left Cambodia with a severe paucity of data for this group. Small mammal surveys were conducted at five sites in Mt Samkos Wildlife Sanctuary and the CCPF during the 2000 FFI survey and at seven sites in and around the Southern Cardamoms Protected Forest during the 2003 WildAid survey. Dr. Ken Aplin and Angela Frost (CSIRO, Australia) have carried out rodent trapping at sites in central and northern Cambodia over the last few years as part of a pest management project, but their results have not yet been published. The bat fauna of Cambodia has become the focus of study in recent years. An inventory was conducted during the 2000 FFI survey, and WCS have undertaken bat surveys at different locations throughout the country.

## Survey area and methods

Systematic small mammal surveys were conducted in four main areas in the Central Cardamoms, as shown in Table 2. These areas represent a variety of altitudes and habitats including riparian forest, lowland and hill evergreen forest, pine forest, grassland, and marshland. Opportunistic trapping was carried out on four additional occasions.

## Trapping

Pitfall traps were used to catch insectivores and small rodents. The method consisted of three 50m-long drift fences, with pitfall traps positioned at both ends and at 10m intervals. The pitfall trap buckets were 45cm deep and 30cm wide. The trap array also included one large pitfall (90cm deep and 60cm wide) to capture large species. The pitfalls captured animals alive, providing the opportunity to either release individuals unharmed or to retain them as voucher specimens.

Live-traps were employed to capture insectivores and rodents. Two different models were locally made: aluminium box traps (9 x 10 x 32cm) and mesh traps (16 x 16 x 40cm). Two 400-metre transects were set up in representative areas at each site, with a trapping station every 10 m. One trap was placed on the ground within 2 metres of each trapping station. On each transect, 20 box traps and 20 mesh traps (alternating) were employed.

Additionally, 20 mesh traps were placed in suitable trees at heights between 2 and 20 m along both transect lines, to increase the likelihood of capturing squirrels, tree shrews, and arboreal rats. In total, 40 box traps, 40 mesh traps, and 20 arboreal mesh traps were used at each surveyed site.

**Table 2:** Survey site description

Survey site	Date	Elevation (m)	Location	Habitat Description
Russei Chrum	19th Dec 2003 - 2nd Jan 2004	350 - 450	0314261E / 1322021N	Gallery forest along Russei Chrum River, in a matrix of disturbed lowland evergreen forest and grassland
Tatai Leu	21st Jan - 2nd Feb 2004	320 - 500	0341010E / 1307871N	Gallery forest along Tatai River, surrounded by disturbed lowland evergreen forest and bamboo thicket
Knorgl Strol	20th Feb - 6th March 2004	600 - 850	0359829E / 1290149N	Pine forest with grass understorey on ridge and plateau, and hill evergreen forest on slopes
Areng	18th March - 9th April 2004	170 - 220	0344000E / 1287000N	Gallery forest along Areng River in a matrix of lowland evergreen forest, grassland, and marshes
Areng*	23 <sup>rd</sup> August – 3 <sup>rd</sup> September 2004	200	0341912E / 1286744N	Gallery forest along Areng River in a matrix of lowland evergreen forest, flooded grassland, and marshes
Knorgl Louk*	23 <sup>rd</sup> September – 5 <sup>th</sup> October 2004	1,100-1,300	0355451E / 1315930N	Montane forest, grassland, pine forest
Knorgl Louk*	3 <sup>rd</sup> – 11th November 2004	1,100-1,300	0355451E / 1315930N	Montane forest, grassland, pine forest
Veal Sre Prang*	3 <sup>rd</sup> – 17 <sup>th</sup> December 2004	550	03148806E / 1349166N	Matrix of hill evergreen forest, grassland and marsh

\*Opportunistic trapping

### Trapping protocol

Traps were in place for eight nights at each survey site. Box and mesh traps were baited either with ripe bananas or with roasted coconut and peanut butter, and were checked and re-baited twice daily - in the early morning (6-9am), and the afternoon (4-6pm). Pitfall traps were not baited. All captured individuals were identified, sexed, measured and weighed. Released individuals were uniquely marked by fur-cutting to ensure individual recognition, which was necessary for abundance estimates.

### Mist nets and harp traps

Three mist nets (1 x 9m; 2 x 6m) were used to catch bats. The nets were set up in suitable positions (e.g., over streams, across flight-paths) within each habitat. The nets were in operation during dusk when most bats are very active, but on a few occasions they were open throughout the night. They were monitored constantly to prevent captured bats damaging both themselves and the nets.

### Specimen collection and identification

Representative individuals of every small mammal species were kept as voucher specimens. They were fixed and stored in ethanol (70%). DNA samples were taken for all specimens (stored in 90% ethanol). Rodents were exported to, and will be formally identified by Ken Aplin (CSIRO, Australia). Insectivores will be identified by Angela Smith (Harrison

Institute/UEA, UK), and bats by Paul Bates (Harrison Institute, UK). Following their formal identification, these records will be co-published in the scientific literature. Field species identifications were made using Aplin *et al.* (2003), Bates and Harrison (1997), Corbet and Hill (1992), Francis (2001), and Lekagul and McNeely (1988).

### **Medium and Large mammals**

As large mammals are difficult to trap, alternative methods were employed to confirm their presence and relative abundance in the survey areas:

Opportunistic observations were recorded during diurnal and nocturnal walks. At night, strong torches were used to observe animals based on direct sightings and eye shine. Animal tracks, scats, scratch marks and other evidence were recorded. Measurements, photographic evidence, and casts of tracks (using plaster of paris) were taken.

Large mesh traps (40 x 40 x 80cm) were placed in suitable locations at each survey site (based on observed tracks and signs) for opportunistic sampling of medium-sized mammals such as mongoose, otter and civet, which can be highly problematic to identify to species solely from tracks.

A small number of camera traps were employed opportunistically around several survey sites. They were in operation for 5-30 days during each session.

### **Camera trapping**

Camera traps are vital tools to survey animals that are not readily observed or trapped, and for animals that do not leave clear footprints or whose prints can be confused with other species. Furthermore, camera trapping can be used to assess the relative abundance of species within an area based on the number of photos taken of each species within a given period of time. Camera trapping can also provide photographs of people conducting illegal activities within the survey area, which can be used both as indicators of threat levels and to support enforcement activities.

Camera trapping was conducted in and around the CCPF from March 2001 to April 2004. Camera traps of the brands “Cam Trakker” and “Photo scout” were used. Up to 13 camera traps were used at each survey site; see Table 3 for descriptions of surveyed sites.

The camera traps were positioned at suitable sites within the survey area where the presence of large mammals was suspected through observations, tracks and signs, or the presence of animal trails and water sources. Cameras were also occasionally placed along disused logging roads or paths.

The areas in front of the camera traps were baited with a liquid scent (Hawbaker’s Wildcat Lure No.2; S. Stanley Hawbaker & Sons – Fort Loudon, PA). This extract is known to attract a wide variety of mammal species. The lure was dripped onto a log, rock, or branch, which was then placed about 2m in front of the camera.

After activation, the cameras were left in place for 3-6 weeks. The cameras were then either removed, or their batteries and film replaced for another 3-6 week period.

**Table 3:** Camera-trap survey site description

Survey site	Date	Elevation (m)	Location	Habitat Description
Rolerk	Mar 2001	1100	0366282E/ 1302225N	Hill evergreen forest/pine forest/grassland
Northern Stoeng Tatai	Mar-April 2001	400	0338727E/ 1311847	Lowland dry evergreen forest
Stoeng Kep	12th Nov 2001 to 2 <sup>nd</sup> Feb 2002	350	0322661E/ 1297789N	Lowland dry evergreen forest
Areng Valley	21 <sup>st</sup> Nov 2001 to 2 <sup>nd</sup> Feb 2002	200	0344675E/ 1287342N	Gallery forest along Areng River in a matrix of lowland evergreen forest, grassland, and marshes
Da Kramon	24 <sup>th</sup> Jan 2002 to 23 <sup>rd</sup> Feb 2002	350-500	0338021E/ 1298617N	Evergreen forest
GAT Road	8 <sup>th</sup> Feb 2002 to 8 <sup>th</sup> April 2002	100	0319984E/ 1281773N	Dry evergreen forest/deciduous forest/grassland
Stoeng Di	13 <sup>th</sup> Mar 2002 to 5 <sup>th</sup> May 2002	400	0345811E/ 1311698N	Lowland dry evergreen forest
GAT Road	13 <sup>th</sup> Dec 2002 to 16 <sup>th</sup> Feb 2003	100	0316501E/ 1284730N	Dry evergreen forest/deciduous forest/grassland
Northeast of Thmar Bang	Mar 2003	200	0329247E/ 1298723N	Lowland dry evergreen forest
Russei Chrum	26 <sup>th</sup> Dec 2003 to 3 <sup>rd</sup> April 2004	350	0316284E/ 1322841N	Secondary dry evergreen forest, near river. Grassland.
GAT Road	28 <sup>th</sup> Jan 2004 to 7 <sup>th</sup> April 2004	100	0309530E/ 1281812N	Dry evergreen forest/deciduous forest/grassland
Areng Valley	29 <sup>th</sup> March to 5 <sup>th</sup> April 2004	200	0344685E/ 1287674N	Riverine, sandbank on river

## Results & Discussion

In total, 57 mammal species were recorded for the CCPF for which there are voucher specimens, camera-trap photographs, or valid confirmed observations. Of these, twelve (21% of the total) are classified as globally threatened (IUCN, 2004). This takes the total number of mammal species recorded for the Cardamom Mountains to approximately 79.

### Small Mammals

Over a total of 3,284 small-mammal trap-nights, 576 pitfall trap-nights, and 725 mist-net hours we recorded eleven bat species, two species of tree shrew, and at least eight rodent and two insectivore species. The average capture success for the small mammal traps was 2.6%. See Appendix 2 for the list of recorded species.

Of these, ten species are new records for the Cardamom Mountains, and up to six species are new records for Cambodia. Some of the rats and shrews appear to be morphologically distinct from known species and may be new to science. However, small mammals are notoriously difficult to identify in the field; skull extractions and measurements, dentition analysis, comparison with reference material, and DNA analysis is often necessary for precise identifications. Tissue samples are currently in the process of being sequenced for selected voucher specimens.

Several voucher specimens from the rodent genera *Maxomys* and *Niviventer* are externally different to previously recorded species for the country and may be new records for Cambodia, or even new to science. Due to the paucity of small mammal surveys in Cambodia it is not unexpected that additional species are still to be found (Ken Aplin, pers. comm.). DNA analysis will confirm the identification of these specimens.

During the survey, shrews were captured in pitfall traps. These surveys represent the first time this method has been systematically applied in Cambodia, and no shrews have previously been recorded from Cambodia. We found at least two different species - analysis of voucher specimens and DNA will provide identifications.

During the WildAid surveys, small tree shrews resembling the lesser tree shrew *Tupaia minor* were observed on several occasions. We also observed a similar looking tree shrew in gallery forest at 200m altitude in the Areng Valley. Attempts to trap the individual were not successful. This species has not previously been recorded in the region, but these observations suggest either that it does occur, or that a similar species inhabits this area. A voucher specimen and tissue analysis is necessary to confirm the identification of this animal.

Eleven species of bat were recorded during this survey. Two species, *Myotis horsfieldi* and *Rhinolophus lepidus*, are new records for Cambodia. Both species are found throughout the CCPPF. Another species, *Rhinolophus shameli*, is listed as near threatened on the IUCN list (IUCN, 2004). Very few individuals of *R. shameli* have been found in Cambodia.

The findings show that the diversity of small mammals is relatively high in the area. However, the number of bat species recorded is likely to be well below the realistic number of species present in the area. Bats occupy different niches within the forest and several additional methods need to be applied (i.e. canopy trapping and cave searching) to record more species. Furthermore, more effort is needed at different locations and times to efficiently record all species existing in the area.

### **Camera Trapping**

A total of 5,735 trap-nights resulted in 1,401 photographs, of which 937 (67%) were of wildlife. A total of 28 mammal species, 7 bird species, and 1 reptile species were recorded; see Appendix 3 for full list.

The most abundant species (based on the number of photographs) was the wild pig *Sus scrofa*, accounting for 27% of the photos. Red muntjac *Muntiacus muntjac*, sambar deer *Cervus unicolor*, and leopard cat *Prionailurus bengalensis* accounted for 17%, 12% and 7% of the photographs respectively. Many species were represented only by one or a few photographs; see Appendix 3. Nine percent of the photographs showed people (not including the research team) and 24 percent of the photos had been triggered by vegetation in front of the camera or were due to malfunction of the sensors.

The species found during this survey are representative of the mammalian fauna in Cambodia. The high numbers of species present indicate an overall healthy state of the mammal communities. In particular, ungulates were found in high numbers, providing an adequate prey base for large carnivores. However, apart from dhole, the population densities of these top predators appeared to be very low, probably due to hunting pressure.

We failed to record the presence of several mammal species which occur in comparable habitats elsewhere in Cambodia. These include the leopard, marbled cat, and linsang. These species are cryptic and shy, and typically occur in low densities. They have been recorded in Cambodia on only a small number of occasions. These animals are nocturnal and partly arboreal, which makes them difficult to record using terrestrial camera traps, or to find their tracks and signs. To increase the chance of finding these species in the future, a proportion of the camera traps will be placed at suitable locations in the tree canopy.

Tracks and sightings of otters were common, but the species identification was not conclusively determined. We also failed to record the presence of fishing cats. Fishing cats and otters are dependant on wetland habitats where their main food source, fish, is plentiful. Previous camera trapping activities have not focused on the periphery of wetlands. In the future, camera-trapping will target these sites and species.

### **Priority species for conservation**

The status of the **Dhole** (*Cuon alpinus*) has recently been revised, and it has been upgraded from Vulnerable to Endangered on the IUCN red list (IUCN, 2004), with an estimated mere 2,500 adult individuals surviving in the wild. The threats to this species are mainly habitat degradation, depletion of prey, and transfer of diseases from domestic dogs. Dholes have been recorded on camera traps in a number of localities in the CCPF, typically with multiple animals (maximum of six) on each photo. Tracks resembling dhole prints have often been found within the Cardamom Mountains, though they are possible to confuse with domestic dogs. The human population living in and around the protected areas is low, with accordingly low numbers of domestic dogs, which may keep interaction and disease transfer at a low level. Furthermore, dholes prey on a wide range of medium and large mammals, most of which are still numerous within the protected area. These factors may have contributed to the fact that the dhole appears to be relatively common in the CCPF.

However, the impact on disease transfer from domestic dogs and the level of persecution from local communities is not clear. To ensure the continuous presence of healthy populations of these enigmatic Endangered animals, these threats need to be assessed and managed.

**Otters** are dependent on freshwater habitats, so conflicts occur as people often live near water-bodies and are dependent on the same food sources, i.e. fish. Many otters are killed due to the overlap of their activities with those of humans. Furthermore, many otter habitats are being degraded or converted to agriculture, and chemical pollution of water sources, dams, and low food supply due to over-fishing is severely threatening these animals. These factors are contributing to a rapid decline in otter populations across their ranges.

Otter tracks were found on sandbanks along the Russei Chrum River and the Areng River. Photographs and casts were taken; see Appendix 7. Up to four species of otter could occur in the Cardamom Mountains: the Eurasian otter (*Lutra lutra*), Smooth-coated otter (*Lutrogale perspicillata*), Asian small-clawed otter (*Aonyx cinerea*), and the Hairy-nosed otter (*Lutra sumatrana*). *L. lutra* has been tentatively confirmed in the CCPF by previous surveys (see Daltry & Traeholt, 2003), whereas *Aonyx cinerea* and *Lutrogale perspicillata* were only predicted to occur. One specimen of *L. sumatrana* is held at Phnom Tamao Wildlife Rescue Centre. This individual was found in southwest Cambodia, indicating the presence of this species within the region.

*Lutrogale perspicillata* is IUCN-listed as Vulnerable (A1acd and A2cde) due to hunting for skins, over-fishing, and habitat alteration. *Aonyx cinerea* and *Lutra lutra* are classified as Near Threatened and *L. sumatrana* as Data Deficient, indicating similar trends as for *L. lutra* and *Lutrogale perspicillata*.

Due to the low population pressure from villages in and around CCPF, and the presence of clean and undisturbed waterways, the Cardamom Mountains could hold relatively large viable populations of otters. However, dams, roads, and mining activities are planned regionally which may threaten these otter populations, as well as other water-dependant mammals. Confirming the presence and distribution of otter populations and protecting them within the region are important steps for their long-term conservation. It would be ideal to set up a national otter survey group whose role is to identify otter key habitats on a national level, confirm the number of species present in Cambodia, survey their distribution and abundance, and assess the level of threats to each species.

**Wild cattle** tracks were frequently observed on the upland plateau in pine forest, montane evergreen forest, and grassland. The tracks are most likely to be from gaur (*Bos gaurus*), as this species appears to be more abundant than the Endangered banteng (*Bos javanicus*). Large and small tracks were often observed, indicating the presence of adults and juveniles. Several camera trap photos revealed gaur, all at high elevation. At one location, a photo showed a gaur and the following photo showed a hunter with gun, clearly indicating that this species is threatened by hunting. We recorded no photos of banteng.

The gaur is Vulnerable (IUCN, 2004), and these observations and records are important and positive signs for the conservation of this species. Further research is now necessary both to estimate the numbers of gaur in the CCPF and to assess the possible presence of banteng. This should involve camera trapping at mid to high elevation, where most signs were found.

**Elephant** dung was found in and around a large cave in the Knorgl Strol mountain area (approximately 650m altitude). Also, sounds that were likely from elephants were heard in the Areng valley, and one camera-trap photograph of an elephant was recorded from lowland evergreen forest. The Asian elephant is Endangered (IUCN, 2004) and the continued presence of suitable habitat in the Cardamom Mountains and adjacent forests may be important for the long-term future of this species.

**Two species of bear** inhabit this region: the Malayan Sun bear *Helarctos malayanus*, and the Asiatic black bear *Ursus thibethanus*. Both bear species are widespread in Asia, but both are threatened due to hunting and habitat loss throughout their range. The Asiatic black bear is listed as Vulnerable (IUCN, 2004) and the Sun bear is listed as Data Deficient but, due to high hunting pressure and population declines, it is a candidate species for Red List status.

Bear tracks and scratch marks were found on many occasions and in different habitats. Track size indicated that they were from Malayan sun bears. There was one observation of an Asiatic black bear. Camera trap photos frequently showed Malayan sun bears, but only rarely showed Asiatic black bears. Previous surveys also frequently recorded tracks and signs, indicating that the population of Malayan sun bears in the Cardamoms are relatively large and that the Asiatic black bear, though threatened, still exists in the area. Due to the large forested area and the relatively low hunting pressure, the Cardamoms may be a stronghold for these species. It is important for the conservation of these species that additional research be

conducted to assess their distribution, range, abundance, and levels of threats.

**Large cat** scats were found in Russey Chrum Valley; see Appendix 7. The size and consistency of the scats indicates either leopard or tiger. In late 2003, tiger prints were recorded in the CCPF (see Appendix 7). Three toes were missing on one foot, indicating that the tiger may have been injured by a snare. Villagers have also reported sightings and signs of tigers, the latest being in February 2005. However, camera-trap efforts have not yet yielded confirmation of either tigers or leopards in the area. If these species are still surviving in the Cardamom Mountains, it is doubtful whether the populations are viable. As hunting pressure on the tiger is still high, the survival of this species in the region is dependant on high levels of direct protection, improved enforcement of wildlife law within Cambodia's justice system, and possibly the future use of ex-situ conservation strategies (e.g. captive breeding and re-introduction).

Camera trap photographs recorded **Asian golden cat** and **clouded leopard** which, although only recorded in fairly low numbers, confirms they still occur in the area. These Vulnerable species (IUCN, 2004) are hunted for use in traditional medicine and for trophies, and are becoming rare throughout their range. Tigers and leopards are preferred by hunters and traders, but when these species are not easy to find the focus will shift to more abundant species such as golden cat and clouded leopard, and the pressure on them will increase. The golden cat appeared to be the most common medium-sized cat in the CCPF, and two were reliably observed by members of the research team during the surveys.

**Pangolins** are heavily hunted both for food and for medicinal purposes, and many are exported to Vietnam and China. Pangolins are relatively small in size and therefore easy to smuggle across borders. Large numbers of pangolins have been confiscated around the CCPF by forest rangers. Camera traps have only recorded two pangolins in four years and the research team has made no observations. Global numbers of pangolins are declining rapidly, leaving this species in acute need of conservation action. Pangolins do not figure on either the IUCN red list or CITES appendix, but it is a strong candidate for Red List assessment. Also, increased effort should be put into reducing trade of this increasingly threatened species.

**Slow lorises** are facing similar problems as pangolins. They are easily located (by eye shine) and quickly caught. Very few lorises were observed throughout our surveys, in spite of many man-hours searching for them at night. Dried slow lorises are occasionally found in markets for use in traditional medicines. This primate is a relatively slow breeder and high hunting pressure may be having a serious impact on the populations.

**Pileated gibbons** were recorded (by their calls and occasional sightings) at all surveyed sites. This species is classified as Vulnerable (IUCN, 2004), and appears to be very abundant in the region.



# Birds

Cole Burton



Photos:

Top left: Common kingfisher *Alcedo atthis*

Top right: Camera trap photo of a chestnut-headed partridge *Arborophila cambodiana*

Centre: Collared scops-owl *Otus bakkamoena*

Bottom left: Juvenile green pigeon *Treron* sp.

Bottom right: Black-and-red broadbill *Cymbirhynchus macrorhynchos*

# Birds

## Introduction

Relative to the other taxa, a significant amount of recent work has focused on establishing baseline diversity and important habitat associations for bird species in the Cardamom Mountains. Nevertheless, most avian surveys in the Cardamoms have been short and highly localized in nature.

Long & Swan (in Daltry & Momberg, 2000) reported 82 species from the Central Cardamoms, including the endemic Cambodian Laughingthrush, *Garrulax ferrarius*, but did not record any globally threatened species. Long *et al.* (2002) recorded 91 species at Veal Veng, of which the most significant were the globally threatened (Vulnerable) Lesser Adjutant, *Leptoptilos javanicus*, and the near-threatened Grey-headed Fish Eagle, *Ichthyophaga ichthyaetus* and Great Hornbill, *Buceros bicornis*. Pierce & Pilgrim (2003) observed 107 bird species within the disturbed habitats of the Silver Road concession, including 18 new records for the Cardamoms and two species of conservation concern: the Silver Oriole (*Oriolus mellianus*, Vulnerable) and Great Hornbill (Near Threatened). Daltry & Kuy (2003) reported 39 species from the upper Areng Valley, including White-winged Duck (*Cairina scutulata*, Endangered), Green Peafowl (*Pavo muticus*, Vulnerable) and Black-necked Stork (*Ephippiorhynchus asiaticus*, Near Threatened). In their directory of Important Bird Areas (IBAs) in Cambodia, Seng *et al.* (2003) identified the Central Cardamoms as an important area for the conservation of the endemic Chestnut-headed Partridge and the Great Hornbill. In total, approximately 350 bird species have been recorded across the Cardamom Conservation Landscape.

## Survey areas and methods

Bird surveys were focused in three lowland areas of the Central Cardamoms (Table 4): Russei Chrum Valley; the northern boundary of Tatai Lieu commune (around the large broken bridge on the Tatai River); and sections of the upper Areng Valley. Incidental bird observations were made, particularly in the vicinity of the Thma Bang CCP headquarters.

**Table 4:** Site details and dates of avian surveys in the Central Cardamom Protected Forest.

Site	Location <sup>1</sup>	Dates	General Habitat	Elevation	Comments
Russei Chrum	315065, 1322261 313880, 1321887	Dec 22 - 31	Gallery and Lowland Evergreen Forest	~ 380 m	Survey
Tatai Lieu	340993, 1307528 340561, 1306931 340267, 1308700	Jan 22 - 28	Gallery and Lowland Evergreen Forest	~ 460 m	Survey + Incidental
Areng Valley	335250, 1282662 344697, 1287340 353191, 1302594	Feb 13 Mar 11 - 16 Mar 21	Gallery and Lowland Evergreen Forest, Agricultural land	~ 175 m	Survey + Incidental
Thma Bang	330287, 1291818 328984, 1292136	Jan 28 - 29 Feb 15 Mar 17 - 20	Gallery and Lowland Evergreen Forest, Agricultural land	~ 400 m	Incidental

The surveys were conducted along roads, paths, and rivers in the general vicinity of the research team base camps. Birds were identified by visual observation using 8x binoculars. Songs and calls were also noted but were rarely used as a sole basis for identification (and are indicated in the results where used). Most surveys were undertaken between the hours of

0700 and 1000, but opportunistic observations were made at all times while in the study areas. Two surveys were conducted by boat; one along the Russei Chrum River and one along the Areng River. Birds captured opportunistically during surveys for other taxa were also identified.

A rough index of relative abundance was calculated by recording the frequency of individual observations for each species, using the following categories: Rare (only 1 observation), Uncommon (2-5 observations), Common (6-10 observations) and Abundant (>10 observations). An attempt was made to sample different habitats within the survey area (e.g. riverine, marsh, forest edge, dense forest). Species identifications were made using Robson (2000) and Lekagul and Round (1991), with nomenclature following Robson (2000) where discrepancies occurred.

## Results & Discussion

A total of 93 bird species were recorded in and around the CCPF during these surveys (8 of those could only be identified to genus; see Appendices 3 & 4). It was noted that the method outlined above was biased by the conspicuousness of a given species and its behaviour. This represents fairly low species diversity, as the bird surveys focussed on simplified lowland forest. Four species were only recorded in camera-traps, four were identified through opportunistic captures (two by hand, one in a mist-net, and one in a small mammal mesh trap), one was made on the basis of calls alone (Asian Koel), and the others were made through visual observations. Although careful attention was paid to all species identifications, a few identifications made with a lower degree of certainty are noted in Appendix 3.

Two additional but unconfirmed sightings are worth mentioning because of their potential significance: one sighting of a duck consistent with the White-winged Duck was made in Russei Chrum valley, and an observation of a hornbill consistent with the White-crowned Hornbill was made near O'Som village. The brief nature of these observations renders the identifications uncertain, and both require confirmation.

A rough species-accumulation curve plotting the total number of species against the number of survey days in each of the three main sites shows that although the number of new species was levelling off, it was continuing to increase (Figure 3). Many birds were briefly observed but could not be identified, suggesting that further survey effort would result in considerably more species identifications.

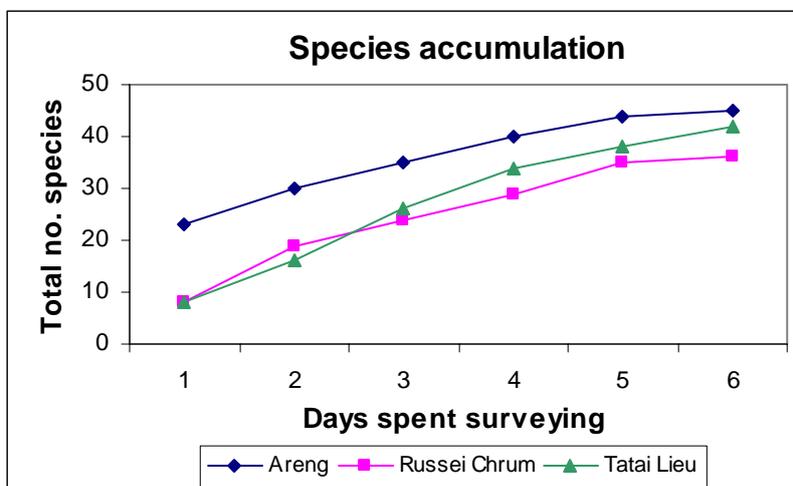


Figure 3. The cumulative number of bird species observed plotted against the survey effort for three sites.

## **New Regional Records**

Fifteen of the species represent new records for the CCPF, with three of those also representing new records for the Cardamom Mountains. The new species for the Cardamom Mountains are the Black-browed Reed Warbler, Chinese Sparrowhawk, and Common Moorhen, and the additional new species for the CCPF are the Lesser Fish Eagle, Oriental Bay Owl, Black-headed Bulbul (recorded as provisional by Boonratana, 1999), Changeable Hawk Eagle, Common Tailorbird, Oriental Darter, Long-tailed Broadbill, Osprey, Racket-tailed Treepie, Cattle Egret, Oriental Reed Warbler, and Green Imperial Pigeon. Perhaps the most significant of these is the Oriental Darter, a globally near-threatened species for which the only record from the Cardamoms dates back to the 1930's (Engelbach, 1948 in Net, 2001). If confirmed, the potential record of the White-crowned Hornbill would represent an expansion of the known distribution of this globally near-threatened species.

Two globally threatened and five near-threatened bird species were documented during this study. A brief description for each of these species is given below (further details can be found within the species-specific references cited in BirdLife International (2003) and Daltry & Kuy (2003)). Additional details are also provided for other species of conservation concern relevant to this study.

## **Priority Species for Conservation**

### **Green Peafowl *Pavo muticus***

#### **IUCN Status: Vulnerable**

The Green Peafowl is listed in CITES Appendix II. It has a small, rapidly declining and severely fragmented population, with rapid decline due to high hunting levels for meat and feathers, collection of eggs and chicks, and a reduction in the extent and quality of its habitat (BirdLife International, 2003). The global population is estimated at 5,000-10,000 individuals. This species has previously been recorded in the Cardamom Mountains by Steinheimer *et al.* (2000) and Swan & Long (2002), and has also been photographed during CI's on-going camera-trapping program.

One Green Peafowl call was heard from the edge of the Areng River (near 0344697, 1287340) in March 2004, and one male and female were observed at that site in June 2004. This is the same location where Daltry & Kuy (2003) observed a male peafowl in February 2003. Feathers from a male peafowl were collected from a site further upstream (near 0352621, 1301691). Again, Daltry and Kuy (2003) reported observing peafowl from this same location. While detailed data are lacking, the scarcity of peafowl observations during this survey suggests that they occur at low densities in these portions of the CCPF.

### **Oriental Darter *Anhinga melanogaster***

#### **IUCN Status: Near Threatened**

This is an uncommon species and is declining throughout Asia, with perhaps as few as 4,000 individuals remaining in South Asia (Birdlife International, 2003). In Cambodia, the darter was reportedly abundant in the early 1960s, with flocks totalling several thousand observed on the Mekong. However, it is currently a local resident found only in small numbers. A single historical record of an Oriental Darter exists from Bokor National Park (Engelbach, 1948 in Net, 2001), but none of the recent bird surveys in the Cardamom region have reported observing this species. As with many other Asian waterbirds, it is primarily threatened by habitat loss, disturbance (at feeding grounds and colonies), hunting, and pollution (Birdlife International, 2003).

Oriental Darters were observed in the upper Areng Valley, at two localities (approximate coordinates: 0343941, 1287031 and 0335250, 1282662). These represent significant observations as this rare species has not been documented in the Cardamoms since 1935-36.

**Black-necked Stork *Ephippiorhynchus asiaticus***

**IUCN Status: Near Threatened**

The Black-necked Stork occurs in Pakistan, Nepal, India, Bangladesh, Sri Lanka, Myanmar, Thailand, Laos, Cambodia, Indonesia, Papua New Guinea and Australia. The combined populations of South-East Asian black-necked storks are thought not to exceed 400 individuals, and are in steep decline (Birdlife International, 2003). It is threatened by a variety of factors across its range, including drainage of wetlands, felling of nest trees, development, encroachment of agriculture or aquaculture, hunting, and excessive capture for zoos. Within Cambodia this species was previously fairly common but there have been few recent records, with only very small numbers breeding around Tonle Sap (Birdlife International, 2003). It has been recently observed in the upper Areng Valley (Daltry & Kuy, 2003).

Two observations of a Black-necked Stork were made in a wetland area in the upper Areng Valley. Both observations were of single individuals (possibly the same individual), one that flew up from a marshy grassland area near 0352621, 1301691, and the other that flew overhead at 0353191, 1302594. This is the same vicinity in which a pair of Black-necked Storks was observed in February 2003 and two pairs in March 2002 (Daltry & Kuy, 2003). This suggests that wetlands in the upper Areng Valley may represent an important habitat for this species.

**Great Hornbill, *Buceros bicornis***

**IUCN Status: Near Threatened**

The Great Hornbill is listed on CITES Appendix I and occurs in southern China, India, Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Laos, Vietnam, Cambodia, Peninsular Malaysia, and Indonesia; it is considered to be rare in Cambodia (Birdlife International, 2003). The abundance of this species is generally correlated with the density of large trees and it is therefore most common in unlogged forest, with logging representing a significant threat to its habitat. It is also particularly susceptible to hunting pressure as it is a large, conspicuous bird that visits predictable feeding sites (such as fruiting trees) and its casques are kept or sold as trophies (Birdlife International, 2003). Great hornbills have been observed during other surveys in the Cardamom region (Steinheimer *et al.*, 2000; Swan & Long, 2002; Long *et al.*, 2002; Pierce & Pilgrim, 2003; Daltry & Kuy, 2003).

Many Great Hornbills were observed during this study. They were frequently observed in the Areng Valley, where several individuals were seen in tall trees along the river's edge (e.g. near 0335250, 1282662; 0344697, 1287340; and 0351060, 1299554). One pair was observed along the Russei Chrum River (near 0313880, 1321887) and a single individual was seen adjacent to the Tatai River in Thma Bang (0328984, 1292136). They were commonly observed in mid-altitude forest (400-900m a.s.l.) across the central plateau of the CCPEF. The high frequency of Great Hornbill observations (relative to other species of conservation concern), in conjunction with the many records from previous studies, suggests that the Cardamoms represent an important area for this species. Informal discussions with local villagers supported the notion that this species is common in the Central Cardamoms.

**Lesser Fish Eagle *Ichthyophaga humilis***

**IUCN Status: Near Threatened**

The Lesser Fish Eagle is listed under CITES Appendix II and occurs in northern India, Nepal, Bhutan, southern China, Myanmar, Thailand, Laos, Vietnam, Cambodia, Peninsular Malaysia and east Malaysia, Brunei, and Indonesia. Widespread declines in this species are related to loss of forest habitat along rivers, over-fishing, pesticide use, and increasing human disturbance of waterways (Birdlife International 2003). The Lesser Fish Eagle's distribution and status in Cambodia are not well known; it has recently been recorded in Bokor National Park (Net, 2001) and in the Samling concession near Kirirom National Park (Kong & Tan, 2002).

One observation of a Lesser Fish Eagle was made along the Tatai River (0340427, 1307187), and another sighting was made along the Areng River (approximately 0335250, 1282662). This species was distinguished from the similar Grey-headed Fish Eagle by a lack of an evident dark terminal band on the tail (following Robson, 2000.) These observations corroborate suggestions in Net (2001) and Daltry & Kuy (2003) that the Lesser Fish Eagle may have been overlooked in Cambodia in the past and may be present at low densities along medium- to small-sized forested rivers in the Cardamom region.

### **Silver Pheasant *Lophura nycthemera***

This species was recorded during CI's camera-trapping surveys in the Cardamoms. It is not globally threatened but is listed on CITES Appendix II and is highlighted by Birdlife International as a species restricted to the Sino-Himalayan Subtropical Forest Biome, for which the Central Cardamoms represent important habitat (Seng *et al.* 2003). It has also been previously recorded from Phnom Aural and Phnom Samkos Wildlife Sanctuaries and the Central Cardamoms near Thma Bang, with the local subspecies, *L.n. lewisi*, reportedly endemic to the Cardamom Mountains (Steinheimer *et al.* 2000, Swan & Long 2002).

### **Additional species**

In addition to the above-mentioned species, the following nine species that were observed during these surveys are listed in CITES Appendix II: Oriental Pied Hornbill, Wreathed Hornbill (also considered to be At Risk in Laos and Near Threatened in Thailand), Hill Myna (considered to be Near Threatened in Thailand), Oriental Honey-buzzard, Changeable Hawk Eagle, Osprey, Oriental Bay Owl, Collared Scops Owl, and Vernal Hanging Parrot. Other species of regional conservation significance include the Green Imperial Pigeon, listed as Vulnerable in Thailand and At Risk in Laos, and the Woolly-necked Stork, listed as Critical in Thailand and At Risk in Laos (Duckworth *et al.* 1999 and Round 2000). While none of these species are currently noted to be of conservation concern in Cambodia, their status could change quickly and it may be important to monitor their populations and threats.

The White-winged Duck, *Cairina scutulata*, is a Globally Endangered species (IUCN, 2004) that has been tentatively reported from the upper Areng Valley (Daltry and Kuy, 2003). The global population of this species was estimated to be 450 individuals in 1997, with only 130 individuals remaining across Laos, Thailand, Vietnam and Cambodia (BirdLife International, 2003). One observation of a duck consistent with this species was made along the Russei Chrum River (near 0315065, 1322261), but was not made with an adequate level of certainty to confirm the identification. The sighting consisted of a brief glimpse of a dark-bodied duck with distinct white wing patches at a locality where honking calls had been heard. These observations were also supported by anecdotal evidence from local guides that this species occurs in the area (they mimicked its honking call). This tentative record needs more detailed research, but if confirmed it would represent a record of considerable conservation significance for this species.

The brief observation consistent with a female White-crowned Hornbill, *Aceros comatus*, has to be considered doubtful until confirmed by a more detailed observation. The observation was made while travelling through mixed forest and banana plantation near to O'Som village in January 2004. It consisted of a brief sighting of a relatively large hornbill in flight with a black body and white, shaggy head. No other obvious markings were noted at the time. Should the presence of this globally near-threatened species be confirmed in the Cardamoms, it would represent a significant expansion of its known range from Southern Thailand and Peninsular Malaysia.

It is also important to mention the Chestnut-headed Partridge, *Arborophila cambodiana*, a Vulnerable (IUCN, 2004) endemic species for which the Cardamom Mountains represent a critically important habitat (Seng *et al.*, 2003). This species was not observed, but was photographed in the CCPF during CI's camera-trapping surveys. It has also been recorded in Phnom Aural and Phnom Samkos Wildlife Sanctuaries (Swan & Long, 2002; Steinheimer *et al.*, 2000) and near Kirirom National Park (Daltry & Kuy, 2003). The Chestnut-headed Partridge is listed as Vulnerable due to its very small population size (estimated at 100-1,000 individuals), which is inferred to be declining and undergoing severe fragmentation related to ongoing large-scale logging operations and high levels of hunting (BirdLife International, 2003). The Chestnut-headed Partridge is currently the focus of survey efforts in the CCPF being conducted by a Khmer team and supported by CI, therefore more information on its distribution and status will hopefully be forthcoming.

### **Threats to Bird Conservation in the Cardamom Mountains**

The primary threats to bird conservation in and around the CCPF are related to conversion of wetland habitats, hunting for local consumption, and collection for the pet trade. Given that the CCPF is officially protected from logging and that the human density within its boundaries is quite low, threats to habitat appear to currently be relatively low. Nevertheless, the threat of illegal logging exists, and the Cardamom region is likely to undergo considerable population growth with its associated pressures on forest resources.

Participatory Rural Analyses (PRAs) conducted during February 2004 in the Tatai Lieu and Chum Noab communes as part of the CCP's Participatory Land Use Planning (PLUP) program identified catching wild birds as important livelihood activities, with "wild pigeons" (pigeons and doves), "water chickens" (waterbirds) and "wild chickens" (Red Junglefowl) being specifically mentioned. Other bird species most likely to be affected by hunting and collection include partridges and pheasants, hornbills, and parrots. Steinheimer *et al.* (2000), Daltry & Kuy (2003), and CI rangers have reported observing the remains of birds caught in generic snares, and direct evidence of hunting birds was observed during the surveys. Many bird snares were found in lowland evergreen forest around villages, particularly Tatai Leu village, where hundreds of bird snares were removed. Captive birds were observed, including those designated for local consumption (e.g. Emerald Dove) and those being kept as pets (e.g. Hill Myna). One live Lesser Adjutant was also confiscated in March 2004 by CCP enforcement staff.



# Reptiles & Amphibians

David Emmett



Photos:

Top left: A dead Siamese crocodile *Crocodylus siamensis* entangled in fishing net

Top right: An Asian giant pond turtle *Heosemys grandis*

Centre: Malayan pit viper *Calloselasma rhodostoma* on eggs

Bottom left: Juvenile Asiatic softshell turtle *Amyda cartilaginea*

Bottom right: Olive tree skink *Dasia olivacea* - first record of this genus from Cambodia

# Reptiles & Amphibians

## Introduction

South-east Asia has been described as the new frontier for work on amphibian systematics, and this also applies to the entire herpetofauna of the region which, though arguably one of the world's most diverse, is also one of the least known. Even within this poorly-studied region, the herpetofauna of Cambodia has been under-researched. Before 2000, very few amphibian surveys had been conducted in Cambodia, and reptile data were also available from only very few records. This is reflected in the Global Amphibian Assessment (2004), which lists 135 species for Vietnam (34 endemic), 129 species for Thailand (9 endemic), 65 species for Laos (3 endemic), but only 43 species (3 endemic) for Cambodia.

Since 2000, herpetological research has been conducted by FFI in the Phnom Samkos Wildlife Sanctuary and Central Cardamoms (Swan & Daltry, 2000; Daltry & Chheang, 2000), the Phnom Aural Wildlife Sanctuary (Daltry, 2002), and Veal Veng Marsh in the Central Cardamoms (near the southern border of Mount Samkos Wildlife Sanctuary) (Long *et al.*, 2002). CI conducted a rapid assessment of the Silver Road Concession Area in 2002, and WildAid surveyed localities within the Southern Cardamoms and Botum-Sakor Peninsular in 2003. These surveys reported approximately 36 amphibian and 80 reptile species across the Cardamom Mountain range.

## Survey areas

Herpetological surveys were conducted at six sites within the Central Cardamoms (see Table 5). The sites represent a wide range of elevation and habitats including riparian forest, lowland evergreen forest, pine forest, hill evergreen forest, bamboo, montane and lowland grassland, and marshland.

**Table 5: Survey sites**

Survey site	Date	Elevation (m)	Location	Habitat Description
Russei Chrum*	19th Dec 2003 - 2nd Jan 2004	350 - 450	0314261E / 1322021N	Gallery forest along Russei Chrum River, in a matrix of disturbed lowland evergreen forest and grassland
Tatai Leu*	21st Jan - 2nd Feb 2004	320 - 500	0341010E / 1307871N	Gallery forest along Tatai River, surrounded by disturbed lowland evergreen forest and bamboo thicket
Knorgl Strol*	20th Feb - 6th March 2004	600 - 850	0359829E / 1290149N	Pine forest with grass understorey on ridge and plateau, and hill evergreen forest on slopes
Areng*	18th March - 9th April 2004	170 - 220	0344000E / 1287000N	Gallery forest along Areng River in a matrix of lowland evergreen forest, grassland, and marshes
Areng	23 <sup>rd</sup> August - 3 <sup>rd</sup> September 2004	200	0341912E / 1286744N	Gallery forest along Areng River in a matrix of lowland evergreen forest, flooded grassland, and marshes
Knorgl Louk	23 <sup>rd</sup> September - 5 <sup>th</sup> October 2004	1,100-1,300	0355451E / 1315930N	Montane evergreen forest, grassland, pine forest
Knorgl Louk	3 <sup>rd</sup> - 11 <sup>th</sup> November 2004	1,100-1,300	0355451E / 1315930N	Montane evergreen forest, grassland, pine forest
Veal Sre Prang	3 <sup>rd</sup> -17 <sup>th</sup> December 2004	560	03148806E / 1349166N	Matrix of hill evergreen forest, grassland, and marshes

\* Pitfall trapping conducted

Lowland riparian forest and montane forest habitats were surveyed both during the dry and wet seasons. Five of the eight surveys were assisted by two Khmer graduates. They were trained in navigation and map-reading, faunal inventory methods, animal handling, photography, voucher specimen preservation, data collection, and logistical considerations. They conducted two herpetological surveys unsupervised.

## Methods

A variety of methods were used to sample reptiles and amphibians:

**Semi-structured interviews with local villagers** provided anecdotal information to guide research, but were not cited as stand-alone evidence for the presence of species. Interviews focused on globally threatened turtles and other species which are under high or increasing pressure through local consumption and the wildlife trade.

**Timed diurnal and nocturnal searches** were conducted to assess the diversity and population status of species across a range of habitats and altitudes through direct sampling. Through the use of a timed collecting technique it was possible to assess species accumulation rates, providing a measure of the completeness of species lists and providing rough comparisons between different areas and habitats.

**Pitfall trapping with straight-line drift fences** to assess species diversity, distribution, and relative abundance, and to attempt to capture rare, cryptic, and low-density ground-dwelling and fossorial species. Drift fences and pitfall trap arrays were positioned in representative areas for eight days at four sites (see Table 5), and consisted of three 50m-long drift fences with pitfall traps positioned at both ends of each drift fence and at 10m intervals. A single large (60L bucket) pitfall trap was included in the array to capture large amphibians and reptiles.

## Specimen identification and data collection

Preliminary identifications were made using Cox *et al* (1998), Ohler *et al* (2002), Stuart *et al* (2001), and Chan-ard (2003). Guidance was also given through identification of specimen photographs sent to the Chicago Field Museum. All captured reptiles and amphibians were described, measured, photographed, and representative voucher specimens and DNA samples taken. Large reptiles (i.e. monitor lizards, Indo-Chinese water dragons, pythons) and chelonians (turtles and tortoises) were not retained as voucher specimens unless found dead. Instead they were captured or trapped, then they were photographed, DNA samples were taken, and they were released at point of capture. Tortoises and turtles were uniquely notched before release to assess relative abundance of species. Detailed habitat, microhabitat, and locality information was recorded for every voucher specimen. All voucher specimens and DNA samples were sent to the Chicago Field Museum for formal identification except for caecilian specimens, which were sent to the British Museum of Natural History.

Records of reptiles and amphibians have only been included in this report if they are supported by voucher specimens or, for the species listed above, by verifiable photographs.

## Results

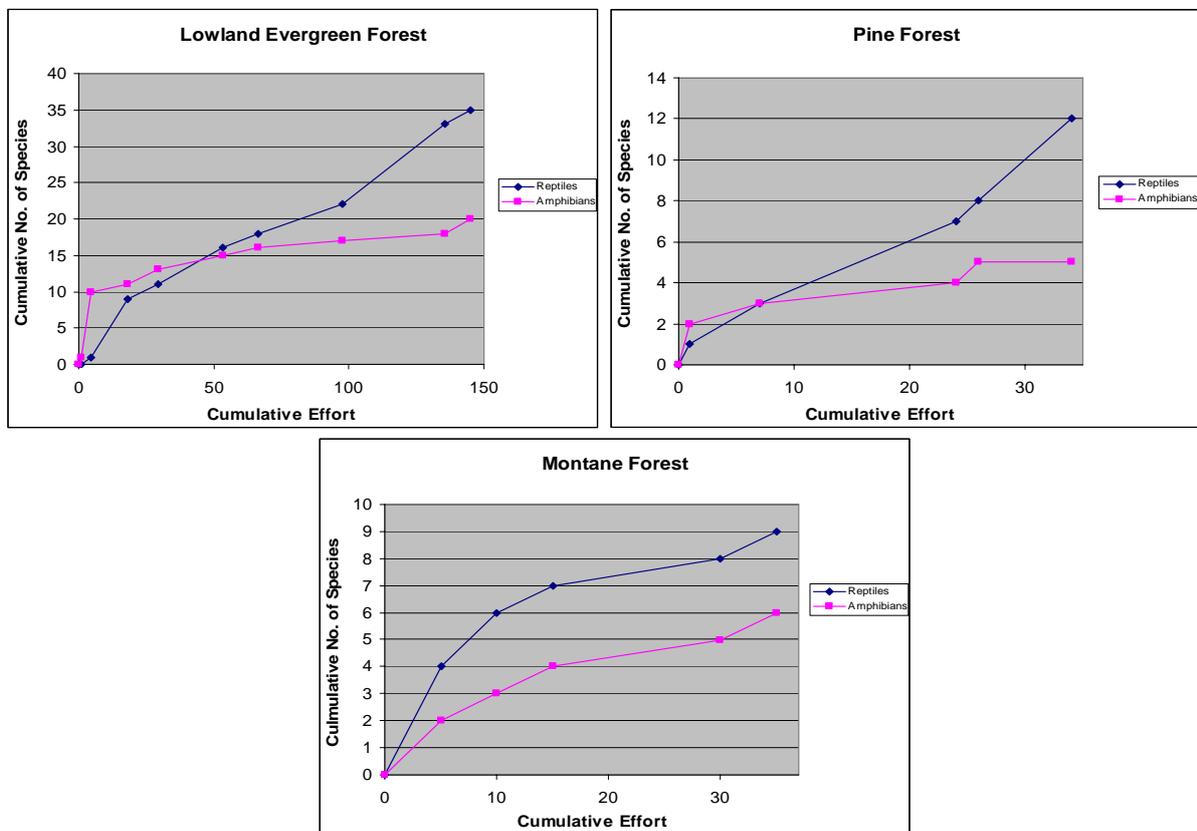
Specimens were captured during 576 pitfall trap nights and through timed searches. Based on preliminary identifications, we recorded at least 55 reptile and 29 amphibian species. Up to four reptile species and five amphibian species may be undescribed, but have not been

included in the total numbers unless there is no doubt that they are distinct species. Each species is listed in Appendix 4 with associated status (IUCN, 2004). Voucher specimens will be identified and catalogued at the Chicago Field Museum. The records will then be published in the scientific literature in greater detail, including descriptions, measurements, and detailed localities for each specimen.

Pitfall trapping proved to be extremely successful for a wide range of taxa. Traps in lowland evergreen forest were most productive, with one site yielding 53 specimens representing 17 different reptile, amphibian, and small mammal species (a capture rate of 37%). By adding one large pitfall trap to the array, more and larger specimens were captured. On average, over 30% of all animals captured in the array of 18 traps were found in the large pitfall trap.

Species accumulation curves were plotted for three major habitats to assess whether as nearly a complete inventory as possible was established within each habitat (see Box 1).

**Box 1:** Graphs showing reptile and amphibian species accumulation curves for a range of major habitats



These accumulation curves identify habitats where more species may remain to be found when using the methods outlined above. We found that the cumulative number of reptile species had not levelled off for any major habitat, but that the amphibian accumulation curves for lowland evergreen and pine forest appeared to be nearing asymptotes.

A large number of the reptile species found in the CCPF have been classified as globally threatened (IUCN, 2004). The Siamese crocodile *Crocodylus siamensis* is Critically Endangered and the elongated tortoise *Indotestudo elongata* is Endangered. The Asiatic softshell turtle *Amyda cartilaginea*, Asian giant pond turtle *Heosemys grandis*, black marsh turtle *Siebenrockiella crassicollis*, impressed tortoise *Manouria impressa*, and the Asian box

turtle *Cuora alboinensis* are classified as Vulnerable. The Asian leaf turtle *Cyclemys atripons* is Near Threatened.

One of the amphibian species, the spiny-breasted giant frog *Paa fasciculispina*, is classified as Vulnerable, and Mortensen's frog *Rana mortenseni* is Near Threatened. However, too few data exist for many amphibian species in Cambodia for them to be classified at this time.

## **Priority Species for Conservation**

### **Siamese crocodile *Crocodylus siamensis***

#### **IUCN Status: Critically Endangered**

The Siamese crocodile is arguably the highest priority vertebrate species for conservation in southwest Cambodia. The CCPF contains the two largest known populations of this species in the world. The Siamese crocodile is the subject of a long-term research project by FFI, so it was not a focal species for our surveys. At least four individuals were observed during timed searches around oxbow lakes in the Areng Valley and many signs (tracks and dung) were observed on sandbanks along the nearby Areng River, though this population is already well documented. We searched for signs of Siamese crocodiles along the upper Tatai River and the Russei Chrum River, but did not confirm their presence. In February 2004 a dead crocodile, a sub-adult approximately 1.2m-long, was found in the Areng valley, entangled in a fishing-net. A second individual, a 2.5m-long adult, was found dead in the same locality in December 2004 by CI rangers. This indicates that they remain directly threatened by local fishing activities. Collection of animals for crocodile farming, combined with the threat posed by inappropriate tourism development, also severely threaten wild populations.

### **Elongated tortoise *Indotestudo elongata***

#### **IUCN Status: Endangered**

A globally significant population of elongated tortoises was found in the Central Cardamoms, but they are threatened by potentially unsustainable collection. Carapaces belonging to this tortoise were found in every surveyed village in and around the CCPF. Populations in the upper Areng valley appeared to have been decimated by collection for local consumption and trade. However, many live individuals were found in the wild during this survey; an essential step toward conserving this species in its natural habitat. Photographs and DNA samples were taken, but no voucher specimens were collected. This species was distributed across a wide range of habitats and elevations. They were found in lowland evergreen forest; this is their preferred habitat (Cox *et al*, 1998). They were found in a number of different localities and appeared particularly common in the unprotected SilverRoad logging concession. Also, a juvenile elongated tortoise was found at an altitude of 830m a.s.l. in pine forest. This species is not typically associated with pine forest or high altitude (Van Dijk, pers. comm). The presence of a hatchling indicates that a breeding colony exists in this habitat.

### **Impressed tortoise *Manouria impressa***

#### **IUCN Status: Vulnerable**

One live adult impressed tortoise was found during a collaborative training field-trip between CI-Cambodia, the BP Tortoise and Turtle Project, and the University of Vientiane. The tortoise had been collected from Knorgl Strol (approximately 800m a.s.l.) by a local villager. It was photographed and DNA was taken. It was subsequently released on a neighbouring mountain, Knorgl Louk, where hunting pressure was significantly lower. Shells from this species were found both in the upper Areng valley and in O'Som village. The distribution and abundance of the shells suggests that the range of this rare species could cover the entire

montane plateau of the CCPF, and that the Cardamom Mountains may contain a globally significant population. For more details on this species, see Som *et al.* (2005).

### **Giant Asian pond turtle *Heosemys grandis***

#### **IUCN Status: Vulnerable**

This species had been tentatively confirmed to occur in the Cardamom Mountains based on anecdotal evidence and shell fragments (e.g., Daltry & Traeholt, 2003). We found carapaces from *H. grandis* in five different villages in and around the CCPF: Tatai Leu, Thma Bang, Areng, ChumNoab, and O'Som. One extremely large live adult was found in Areng village that had apparently been captured from marshland within the Areng Valley. It was measured and photographed, DNA was taken, and it was released in a secure location nearby. A second live giant Asian pond turtle, also a large adult, was confiscated by CI rangers in O'Som village. The presence of these individuals, combined with information from semi-structured interviews and the frequent presence of large carapaces, many recently acquired, indicate that wild populations exist in lowland to mid-altitude wetlands but are severely threatened due to over-collection of adult turtles.

### **Black marsh turtle *Siebenrockiella crassicollis***

#### **IUCN Status: Vulnerable**

This semi-aquatic turtle was found during CI's wet season field-training with the BP Tortoise and Turtle Project. It was located in lowland marshes and flooded grassland within the Areng valley, and is the first record of this turtle in the Cardamom Mountains. The turtles were well hidden but were located by a hunting dog during timed searches. The presence of this species highlights the dangers of relying on shell fragments and anecdotal evidence - no shells were found in any of the neighbouring villages - probably because shells from this species are sold for medicinal purposes - and very few interviewees (<10%) stated that this species occurred in the area. For more information on this species, see Som *et al.* (2005).

### **Asiatic softshell turtle *Amyda cartilaginea***

#### **IUCN Status: Vulnerable**

This aquatic turtle appears to be fairly common and widespread in the CCPF, but it is a focal species for trade. It was frequently observed both in the wild and in captivity. Hatchlings were captured in flooded lowland backwaters, and shell fragments were found in every surveyed village and in hunting camps throughout the CCPF. They were found in a wide range of elevations (150-650m a.s.l.) and wetland sites, including Russei Chrum River, DeChan River (near O'Som village), Tatai River, Areng River and associated lakes, and Veal Veng marsh. Anecdotal evidence suggested that it was most prevalent in the Areng River, but extensive surveys and assessments of threats in this area showed that the population was highly threatened through over-collection for trade and subsequent depletion of remaining populations by local communities for subsistence. Turtle hooks and traps were found throughout the upper Areng River by CCP rangers, and local villagers stated that hunters and traders from Chipat visited the area to collect or buy turtles. However, local collection played a significant role. During the dry season in 2004, CI rangers confiscated at least twenty large adult softshell turtles from local villagers as they were transporting them to Chipat, and juvenile turtles were often observed in captivity in three different villages: ChumNoab, Thma Bang, and Tatai Leu. Turtles were usually captured by villagers with turtle hooks or in fishing nets or fish-traps. The juveniles were kept alive either for local consumption or to sell to traders. This species can tolerate low levels of sustainable exploitation due to its ecology: it matures at a relatively early age and produces many eggs each year. However, exploitation of adult softshell turtles will rapidly destroy local populations.

**Asian Box turtle *Cuora amboinensis***

**IUCN Status: Vulnerable**

This turtle has a patchy distribution within the CCPF, most likely because its preferred habitat is lowland wetlands, a habitat which is under-represented in the Cardamom Mountains. Shells and one captive juvenile of this species were found at only one locality, near O'Som. Interviews with local communities around the CCPF suggest that Asian box turtles still occur in low numbers in a few wetlands, but that it is more abundant in lowland lakes and marshes towards the coast. For more information, see Som *et al.* (2005).

**Asian leaf turtle *Cyclemys atripons***

**IUCN Status: Near Threatened**

This turtle species was abundant and widespread in the CCPF. It was trapped in significant numbers in the upper reaches of the Tatai River and was found in all major rivers, streams, and marshes. Photographs were taken of each captured individual for identification purposes and to show the variety in patterning and colouration of this species, particularly among juveniles. DNA samples were also taken, but no voucher specimens were collected. Carapaces were found in every surveyed village around the CCPF, and in late 2004 CCP rangers in O'Som village confiscated shells and plastrons representing at least 55 individual Asian leaf turtles. This species still appears to be plentiful in the CCPF and surrounding areas, but the high levels of exploitation observed will probably reduce populations to the low levels currently seen for other species if allowed to continue.

**Water monitor *Varanus salvator* & Clouded monitor *Varanus bengalensis***

These large lizards have CITES II and I status respectively due to widespread trade for meat and skins. They are distributed across tropical Asia (Cox *et al.*, 1998), but over-collection has led to crashes in populations of both species in many areas. Many *V. salvator* were observed along rivers and wetlands in the Central Cardamoms, including an exceptionally large adult (>2m total length) in Russei Chrum Valley. This species was common in gallery forest from 150-400m a.s.l., particularly along the Tatai and Areng Rivers. One sub-adult was captured in a mammal trap, and a large adult was captured near Veal Sre Prang. They were photographed for confirmation, a DNA sample was taken, and then they were released unharmed. One *V. bengalensis* was found in lowland dry evergreen forest, trapped in a snare. It appeared to be uninjured, so it was photographed to confirm identification and then released.

**Reticulated python *Python reticulatus***

This python has CITES II status due to its popularity both in the skin trade and the pet trade. As with the water monitor, this species has suffered population crashes in many areas due to over-collection. However, it was fairly common in the Central Cardamoms. Large pythons were observed in the Areng and Tatai valleys, and even in farmland near to Thma Bang. One large dead reticulated python was found near the upper Tatai River, measuring 4.85m in length. It appeared to have died of natural causes, and was preserved as a voucher specimen.

**Cardamom banded gecko *Cyrtodactylus intermedius***

This species has a restricted global range and previous assessments stated that it is restricted to mature evergreen forest at moderate altitude, making it potentially at risk from habitat loss (e.g. Daltry & Momberg, 2000). We found this species distributed across almost the entire range of surveyed habitats and altitudes, from pristine hill evergreen forest (>850m altitude) to degraded lowland evergreen forest (<150m altitude). Many of these beautiful geckos were captured in pitfall traps or observed on trees at night, and two voucher specimens were collected. This species was frequently observed in disturbed areas such as alongside logging

roads and beneath road-bridges, and it was even found within buildings in Thma Bang village. This shows that the Cardamom banded gecko is more widely distributed and consequently much less threatened by habitat loss and disturbance than previously assumed.

### **Spiny-breasted giant frog *Paa fasciculispina***

#### **IUCN Status: Vulnerable**

This frog is classified as Vulnerable due to its restricted range. It was found along streams in pristine hill evergreen forest at approximately 800-1,000m altitude, where it was fairly common. Two voucher specimens were taken.

### **Mortensen's frog *Rana mortenseni***

#### **IUCN Status: Near Threatened**

This frog is classified as Near Threatened due to a restricted global range and loss of habitat. The IUCN Red List states that further studies are needed to determine the species' range, habitat requirements and population status. This species was abundant in the CCPF, but restricted to gallery forest from about 200-500m a.s.l. alongside rivers (not still-waters). It was most abundant beside rivers with a rocky substrate, and was heard calling from beneath large rocks and undercut banks. It was never found far from flowing water, even during the wet season. This species was replaced by *Rana sf montivaga* above about 500m altitude.

### **Smith's frog *Rana faber***

This species has only recently been described (Ohler *et al.*, 2002) and is only known from the Cardamom Mountains. It was very common along streams in hill evergreen forest at about 800-1,000m altitude. Voucher specimens were collected. Similar-looking frogs were captured from 500-700m altitude, though their colouration and morphology showed much closer affinities to *Rana montivaga* (B. Stuart, pers. comm.). This species was replaced by *R. faber* at around 800m. Voucher specimens were collected.

### **Caecilian *Ichthyophis sp***

Two large sub-adult caecilians were captured at an altitude of 220m a.s.l. from the upper Tatai River. Both were taken as voucher specimens. They represent an un-striped form that does not correspond to any known species. They were assigned to the genus *Ichthyophis* based on DNA sequencing of the voucher specimens by the British Museum of Natural History, but adult type specimens need to be collected for this new species to be described.

### **Horned frog *Megophrys sf auralensis***

This frog was captured during the wet season at 1,200m altitude in low canopy montane evergreen forest with fern understorey and waterlogged soil. It is similar to *Megophrys auralensis*, a newly described species (Ohler *et al.*, 2002) which is currently known only from the Cardamom Mountains. Voucher specimens were collected.

## **Discussion**

The reptiles and amphibians recorded during this survey represent a very significant addition to the herpetofauna of the Cardamom Mountains. In addition to confirming species that had previously only been tentatively stated as occurring in southwest Cambodia, we also confirmed the presence of at least nine reptile and seven amphibian species that had not been previously recorded for the Cardamoms. Of these, at least three reptiles and three amphibians (over 7% of the total species found) are also new records for Cambodia. We found high diversity and abundance of globally threatened, restricted range, and trade-threatened reptile

and amphibian species, and collected detailed data on species distribution and habitat requirements, upon which protection and conservation actions will be based.

The CCPF is a highly significant area for protecting populations of elongated tortoises (EN), Asiatic softshell turtles (VU), and Asian leaf turtles (NT). These species were widely distributed and appeared to be fairly abundant. It is also an important area for protecting Asian box turtles (VU), black marsh turtles (VU), giant Asian pond turtles (VU) and impressed tortoises (VU), though these species appeared to be more patchily distributed. The montane forests and streams within the CCPF held highly significant populations of the spiny-breasted giant frog (VU) as well as several recently described and apparently restricted-range amphibians such as Smith's frog and the Cardamom horned frog. The low- to mid-altitude streams and rivers held highly significant populations of the restricted range Mortensen's frog (NT). All of these amphibian species were abundant.

Referring to the Global Amphibian Assessment (2004) and based on this survey alone, we can see that the CCPF contains over 60% of Cambodia's currently known amphibian fauna, and that this survey has increased the species records for the country by at least 7% (not taking tentative species identifications into account).

When combined with the detailed species lists from previous surveys, the result is a fairly comprehensive inventory of the reptiles and amphibians of the Cardamom Mountains. The total number of reptiles now stated as occurring in the Cardamom Mountains stands at approximately 90 species, and the amphibian fauna is now stated as totalling over 40 species (based on Ohler et al, 2002; CI, 2003; Daltry & Traeholt, 2003). However, these totals should be treated with a degree of caution as a proportion of species recorded by other surveys were not substantiated by formally identified voucher specimens and are therefore subject to possible misidentification. That said, what is clear from these combined statistics is that the Cardamom Mountains contain a rich and diverse herpetofauna, a significant proportion of which are globally threatened.

The species accumulation curves, community interviews, and previous reports (e.g., Daltry & Traeholt, 2003) all indicate that additional species remain to be found. Many of these are likely to be common, widespread species and therefore of limited conservation interest. However, globally threatened, rare, and restricted-range species are by definition often amongst the last species to be discovered in an area (Gaston and Rodrigues, 2003) and indeed, interviews do suggest the possible presence of additional globally threatened turtle species. These include the yellow-headed temple turtle *Hieremys annandalii* (Endangered), big-headed turtle (Endangered), and Malayan snail eating turtle *Malayemys subtrijuga* (Vulnerable), all of which, if found in the CCPF, would be of high conservation significance.

Lowland dry dipterocarp woodlands were under-represented in this survey, so several species that are associated with this habitat (e.g., Reeve's butterfly lizard *Leiolepis reevesii*) were not recorded. This habitat was not surveyed as few areas of dipterocarp woodland are found within the Central Cardamoms and, in those areas to the north of the CCPF where this habitat does predominate, landmines are a serious hazard.

The snake family Elapidae (e.g., cobras and kraits) is not well represented in this survey because species within this family are highly venomous and therefore were not captured due to the risk of potentially fatal bites. Cobras (*Naja* sp) were observed on several occasions but could not be confirmed to species. One banded krait *Bungarus fasciatus* was photographed (see Appendix 7) and has been recorded as it cannot easily be misidentified.



# Fish

Emily Rubidge



Photos:

Top left: Asian arowana or dragonfish *Scleropages formosus*

Top right: Unknown species of 'blackfish' *Tor sp*

Centre: Shoal of fish in upper Areng River

Bottom left: Sampling fish diversity in the Russei Chrum River

Bottom right: Fish collection from a montane stream

# Fish

## Introduction

A disproportionate amount of the world's biodiversity resides in tropical Asia, with incredible species richness and high levels of endemism (Braatz *et al.*, 1992). Freshwater biodiversity contributes significantly to this elevated biological status. For example, 105 families of freshwater fishes reside in tropical Asian waters, compared to 74 in Africa and only 60 in South America (Dudgeon, 2000). The Mekong River alone is currently thought to support about 500 species, and the actual number is almost certainly greater (Rainboth, 1996). In a recent biodiversity hotspot analysis, the Indo-Burma hotspot came out top for the highest number of freshwater fish species, and in fact was shown to have about 20% more species than any other hotspot (M. Smith pers. comm.). This hotspot analysis also represents a conservative estimate of the true biodiversity, because much of the region remains under-surveyed.

One such under-surveyed area is southwest Cambodia. This region contains a number of relatively short coastal drainages originating in the Cardamom Mountains. The Cardamom Mountains were recognized as a "critical freshwater priority landscape" in 2001 because it is within the range of the globally Endangered Asian arowana or dragonfish, *Scleropages formosus* (*treynak*), and because the habitat is highly intact due to its protected status (Baltzer *et al.*, 2001). In addition, because it is isolated from the Mekong basin where most freshwater fish research has been focused in Cambodia, there is high potential to record new freshwater fish species for Cambodia, and perhaps even species unknown to science that may be endemic to these drainages.

There have been few documented freshwater fish surveys in the Cardamom Mountains. Two rapid assessment surveys were conducted in Veal Veng district in Pursat province in 2000, and in three drainages in Koh Kong province (Russei Chrum River, Kagn Chonne River, and Sala Munthun (Dammaksla) River) in 2001 (Baird *et al.*, 2000; Baird and Sok, 2002). These surveys documented 21 species of freshwater fish for the area.

The objective of this study was to conduct preliminary assessments of the diversity of freshwater fish in three drainages of the Cardamom Mountain Protected Forest, including two previously un-sampled drainages (Tatai River and Areng River). An additional objective was to confirm the presence of *S. formosus* in the area. Although these fish were known to occur (local knowledge) and predicted by scientists to occur (e.g., Rainboth 1996, Baird *et al.*, 2000) there was no physical evidence (i.e. a photograph or a specimen) confirming their presence. Because of the high conservation importance of this species, and the pressure they are under from the pet trade, a confirmed documentation of their presence and distribution was critical to initiate protection and conservation activities.

## Methods

### *Study Area*

This study took place in three river drainages of the CCPF. The majority of streams, rivers, and lakes in Cambodia eventually flow into the Mekong River, which flows south through Vietnam to the South China Sea. By contrast, in southwestern Cambodia, there are a number of short coastal drainages that are isolated from the Mekong River and drain southwest into

the Gulf of Thailand. The drainages sampled within this southwestern section in this study were Russei Chrum River, Tatai River, and Areng River.

### *Sampling*

Fish sampling took place between Dec 2003 and March 2004. Gillnets were used (with mesh sizes of 7cm, 4.5cm, 4cm, 3.5cm, 3cm, and 2.5cm), as were dip nets (fine mesh) and a scoop net (0.5cm mesh). A variety of habitats were sampled within each river (see Table 6). In general, gill nets were set each night at 1600 and removed at 0600 the following morning. Inventories of gill net catches were taken each morning. The scoop nets and dip nets were used in small pools and rapid water. Rocks and vegetation were disturbed in an attempt to flush benthic fish out from beneath rocks or from aquatic vegetation. The species names and the number of captured individuals of each species were recorded for each sample. Voucher specimens were taken when necessary and fixed in 10% formalin.

**Table 6:** Site details and dates of fish surveys in the CCPE.

Site	Location	Dates	Habitat	Elevation
Russei Chrum	315064/1322261 314441/1321952 314441/1321952	Dec 21-30, 2003	River approx 20m wide, 2m deep, soft mud bottom, some rocks, slow-moving, some rapids	~ 380 m
Russei Chrum	315064/1322261	Dec 27-28, 2003	Ephemeral pond	~ 350m
Tatai Lieu	0340991/1307534 0341110/1308016 0337655/1305516 0340606/1307490	Jan 22-30, 2004	River approx 15-25m wide, alternating pools and riffles, rock slabs and sand	~ 450 m
Areng Valley	339389/1285536 344697/1287340 351060/1299554 335250/1282662	Feb 13 Mar 11 - 16 Mar 21	River approx 15-40m wide, 2-6m deep, slow current, some riffles, sandy substrate	~ 175 m

### *Species-specific sampling*

In the Areng River there was additional sampling effort focusing on the Asian arowana or dragon fish *Scleropages formosus*, a species that is currently classified as Endangered (IUCN, 2004) and listed as CITES Appendix I (UNEP-WCMC, 2004). A local guide was hired from Areng Village to assist in nocturnal searches at a locally known dragon fish collection site in the Areng River. Spotlights were used to locate the surface fish from observations of eye shine. The purpose of this sampling method was to locate dragon fish, and then attempt to scoop them into a dip net and photograph an individual. In addition, the guide set out and closely observed a cotton gill net (mesh size 10cm) across the pool.

### *Species identification*

Identifications were made using macroscopic characters of individuals following Kottelat (2001) and Rainboth (1996). Where discrepancies existed between the two references, nomenclature followed Kottelat (2001).

## **Results & Discussion**

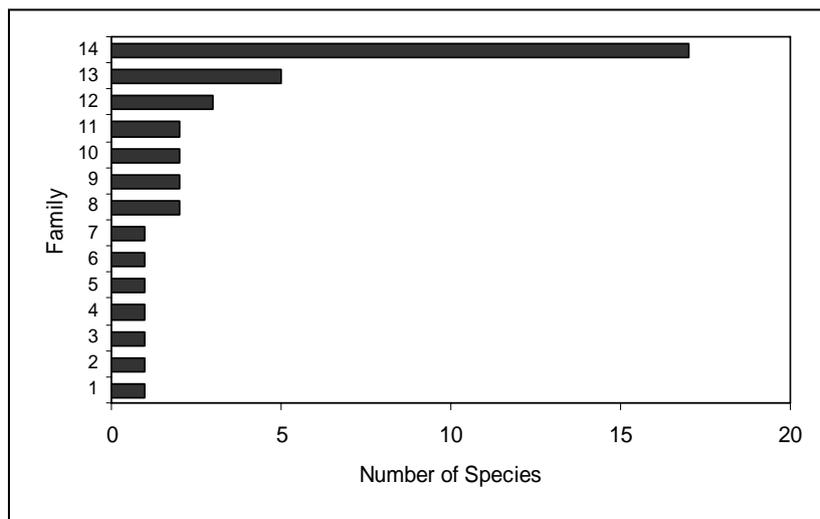
Forty-three species of fish in 14 Families (five Orders) were found, 33 of which are new records for the Cardamom Mountains. These results bring the total number of fish species recorded from drainages originating in the Cardamom Mountains to 54.

The family Cyprinidae (carps, minnows and barbs) dominated the collections with 20 species, more than three times as many species as the next most abundant group, Balitoridae (hillstream loaches; Figure 4). Three or fewer species were observed in the other 12 families, with six families being represented by only one species (Anabantidae, Cobitidae, Gobiidae, Osteoglossidae, Pristolepididae, and Sisoridae).

A total of 783 individual fish were captured, then either taken as voucher specimens or released. This included 187 from Russei Chrum River, 286 from Tatai River, and 310 from the Areng River. Fifteen species were identified from Russei Chrum River, 23 from the Tatai River, and 34 from the Areng River, see Appendix 6. All voucher specimens have been compared with museum specimens where possible. The majority of species identifications have been confirmed by the University of Michigan Fish Division Collection’s Manager Doug Nelson and/or catfish expert, Dr. Heok Hee Ng. However, fourteen of the forty-four species collected are still considered “questionable” identifications and require expert review (listed as unconfirmed in Appendix 6).

*Results of Dragon fish sampling*

During our study of the dragon fish *Scleropages formosus* we observed five fish, two of which were photographed (see Appendix 7). They were captured in gill nets strategically placed by our guide. The fish were in the gill nets for a very short time and were unharmed.



**Figure 4:** Diagrammatic representation of the number of species occurring in each freshwater fish family

Families are numbered as follows: 1. Anabantidae; 2. Clariidae; 3. Cobitidae; 4. Gobiidae; 5. Pristolepididae; 6. Sisoridae; 7. Osteoglossidae; 8. Osphronemidae; 9. Bagridae; 10. Siluridae; 11. Mastacembelidae; 12. Channidae; 13. Balitoridae; 14. Cyprinidae.

The results of this preliminary study indicate that the freshwater systems studied in the CCPF provide important habitats for a diversity of freshwater fish species. Although the fish diversity is likely lower than in central Cambodia (i.e. the Mekong River drainage), there is a need for continued sampling in the area, particularly in high elevation areas where there is an increased likelihood of endemism. A combination of further concentrated sampling effort and specific taxonomic expertise (e.g. CI’s AquaRap assessment program) would undoubtedly increase the number of species found in the area and provide a more complete and comprehensive analysis of the freshwater fish diversity in the CCPF.

## Priority Species for Conservation

### **Asian arowana or Dragonfish *Scleropages formosus***

The highest priority for freshwater fish conservation in the CCPF, and indeed in southwest Cambodia, is the Endangered Asian arowana or dragon fish *Scleropages formosus*. This species has recently been informally re-assessed and now fulfils the IUCN criteria for Critically Endangered due to heavy exploitation for the pet trade and habitat loss (W. Rainboth & M. Smith, pers. comm.). One site was found in the Areng River which harboured a significant population of this species, and at least two more river systems were found in and around the CCPF which potentially harbour important dragonfish populations. There have been very few studies of *S. formosus* in the wild so, given the exceptionally high conservation and economic significance of this species, the populations in southwest Cambodia provide an extremely important opportunity for much-needed ecological research and in situ conservation. However, these populations are under enormous and increasing pressure due to unsustainable exploitation of juveniles for the pet trade. Increased access to breeding sites in the Areng Valley has exacerbated the problem for this population, so immediate and sustained management will be necessary to prevent the local extinction of this fascinating and ancient species.

### **‘Blackfish’ *Tor sp***

At least one species from the genus *Tor* was found in the Cardamom Mountains. The species identification remains unknown, though it has been tentatively assigned as *Tor sf siensis*. This genus is typically very uncommon and extremely susceptible to forest loss, and is typically one of the first species to disappear when riparian habitats become degraded (Rainboth, pers comm.). This species was highly prized by local fishermen in the Cardamom Mountains, but still appeared to be common in many areas. One specimen was collected from the Areng River and deposited at the University of Michigan. Further specimens will be sought from other river systems to clarify the identification and distribution of this rare fish.

## Discussion and Conservation Recommendations

The purpose of the 2004 surveys was: *To identify survey and monitoring priorities for the effective conservation of the CCPF's vertebrate fauna.* The progress of CI's 2004 surveys towards that goal is discussed in this chapter. Recommended survey and monitoring priorities are discussed, and IUCN Red Listed species are listed in order of priority for conservation.

### Further Inventory

The extent to which further research focuses on inventory should be defined by assessing potential returns. With regards to large mammals and birds, our current biological knowledge is already sufficient to provide a good indication of the diversity of species across major habitats. Inventories of small mammals, reptiles, and amphibians are similarly detailed but clearly incomplete. Current knowledge of the plants, fish, and invertebrates in the Cardamom Mountains is inadequate. Invertebrate inventories are a low priority at this time, based on the more pressing need to ensure that sustainable populations of globally threatened vertebrate species persist in the wild. However, ichthyological and botanical inventories are a necessity.

The highest priority areas for further inventory are high elevation forest and montane streams, where further survey effort would likely result in the identification of different species from those recorded thus far, particularly for fish and amphibians (M. Smith pers comm., B. Stuart pers comm.). The Central Cardamoms contain over 60,000ha above 1,000m altitude but few surveys have been conducted in these montane areas, due primarily to logistical constraints. Other under-surveyed habitats include fernland, dry deciduous forest, and grassland.

### Assessing Candidate Species

As a global conservation organisation, Conservation International is committed to supporting and participating in the IUCN Red Listing process. A significant proportion of the species recorded in the Cardamom Mountains have not been assessed but could be highly threatened or geographically concentrated and, if assessed correctly using IUCN Red List Categories and Criteria, could be recognised as globally threatened.

This survey collected ecological data on a number of Data Deficient and Not Evaluated species, which will be made available to the relevant Specialist Groups or Red List Authorities. Future field studies should gather information on other candidate species, particularly recently described montane species. This will help to facilitate and expedite the Red List process for non-assessed taxonomic groups so that species can become Red Listed and formally incorporated into regional conservation planning.

### Priority Species

Our baseline knowledge of the vertebrate fauna in the Cardamom Mountains is now sufficient to begin prioritising species either for targeted surveying (to confirm the presence of species which still require verification), or for monitoring (to assess the status of selected species over time). First cut selection of species for surveying or monitoring was based on their IUCN Red List status. Further prioritisation was based on the global importance of known or predicted species populations in the Cardamoms, current trends (known or assumed) in status of these populations, known and predicted threats, potential collaboration with government and stakeholders, and cost (political, social, and financial).

Table 7 lists the selected priority mammal, reptile, bird, and fish species that are confirmed to occur, or are stated in literature as having occurred until recently, in the Cardamom Mountains. These species are listed in approximate order of priority for study or monitoring.

**Table 7:** Faunal species listed in order of priority for surveying and monitoring

COMMON NAME	SCIENTIFIC NAME	IUCN STATUS	REASON FOR PRIORITISATION	CONFIRMED IN CCPF	CONFIRMED IN CARDAMOM LANDSCAPE
<b><u>SURVEYING</u></b>					
<b>MAMMALS</b>					
Tiger	<i>Panthera tigris</i>	EN	Extremely rare, highly threatened, locally hunted	NO	YES
Banteng	<i>Bos javanicus</i>	EN	Possibly occurs in Southwest Cambodia, extremely rare, highly threatened, locally hunted	NO	NO
Eld's deer	<i>Cervus eldi</i>	VU	Possibly occurs in Southwest Cambodia, species ecology facilitates high hunting pressure	NO	NO
Fishing cat	<i>Prionailurus viverrinus</i>	VU	Extreme paucity of data, globally threatened by wetland conversion and hunting	NO	YES
Marbled cat	<i>Pardofelis marmorata</i>	VU	Extreme paucity of data, uncertain global status, regionally threatened by hunting	NO	NO
Hairy-nosed otter	<i>Lutra sumatrana</i>	DD	Unknown global status, apparently highly endangered, threatened by wetland degradation	NO	NO
Smooth-coated otter	<i>Lutrogale perspicillata</i>	VU	Unknown status in Cambodia, highly threatened by wetland degradation	NO	NO
<b>BIRDS</b>					
White-winged duck	<i>Cairina scutulata</i>	EN	Highly endangered species, threatened by wetland degradation, forest loss, and hunting	NO	YES?
<b>REPTILES</b>					
Yellow-headed temple turtle	<i>Hieremys annandellii</i>	EN	Highly threatened by trade and wetland conversion, occurs in Southwest Cambodia	NO	YES
Cantor's giant softshell turtle	<i>Pelochelys cantorii</i>	EN	Highly threatened, very rare, evidence suggests possible presence in Southwest Cambodia	NO	NO
Big-headed turtle	<i>Platysternon megacephalum</i>	EN	Highly threatened, very rare, evidence suggests possible presence in CCPF	NO	NO
<b><u>MONITORING</u></b>					
<b>MAMMALS</b>					
Dhole	<i>Cuon alpinus</i>	EN	Important global population; human conflict	YES	YES
Asian elephant	<i>Elephas maximus</i>	EN	Globally threatened; human conflict element	YES	YES
Asian black bear	<i>Ursus thibetanus</i>	VU	Highly threatened; locally hunted	YES	YES
Gaur	<i>Bos gaurus</i>	VU	Highly threatened; locally hunted	YES	YES
Clouded leopard	<i>Neofelis nebulosa</i>	VU	Globally over-exploited; unknown status in CCPF	YES	YES
Southern serow	<i>Naemorhedus sumatraensis</i>	VU	Unknown population status in CCPF	YES	YES
Asian golden cat	<i>Catopuma temminckii</i>	VU	Globally over-exploited; unknown status in CCPF	YES	YES
Pileated gibbon	<i>Hylobates pileatus</i>	VU	Important global population; locally hunted	YES	YES
Sunda pangolin	<i>Manis javanica</i>	NT	Unknown global status; highly trade threatened	YES	YES
Sun bear	<i>Ursus malayanus</i>	DD	Highly threatened; locally hunted	YES	YES
<b>BIRDS</b>					
Chestnut-headed partridge	<i>Arborophila cambodiana</i>	VU	Important global population, threatened	YES	YES
Green peafowl	<i>Pavo muticus</i>	VU	High global threat; locally hunted	YES	YES
Lesser adjutant	<i>Leptoptilus javanicus</i>	VU	Threatened by wetland conversion and hunting	YES	YES
Great hornbill	<i>Buceros bicornis</i>	NT	Important global population; locally hunted	YES	YES
<b>REPTILES</b>					
Siamese crocodile	<i>Crocodylus siamensis</i>	CR	Largest global population; locally threatened	YES	YES
Elongated tortoise	<i>Indotestudo elongata</i>	EN	Important global population; highly threatened	YES	YES
Impressed tortoise	<i>Manouria impressa</i>	VU	Rare; fragmented distribution; locally collected	YES	YES
Asiatic softshell turtle	<i>Amyda cartilaginea</i>	VU	Large population; major trade species	YES	YES
<b>FISHES</b>					
Dragonfish	<i>Scleropages formosus</i>	EN	High economic value; locally harvested	YES	YES

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; DD = Data Deficient

## TARGETED SURVEYING

The Surveying list in Table 7 (above) represents priority species which are potentially found in the Cardamom Mountains but which still require verification. These species should be the focus of targeted surveying as they are classified by IUCN as globally threatened with extinction, so their presence in viable populations within the Cardamom Mountains would be of global importance for the conservation of these species. By this definition, the leopard *Panthera pardus* is not prioritised for surveying as the future survival of this species is highly likely not dependent on potential populations in the Cardamom Mountains. Likewise, the Asian small-clawed otter *Aonyx cinerea* and common otter *Lutra lutra* are not listed. However, that is not to say that these species will be ignored – only that, when planning conservation actions for globally threatened species, they are low priority.

The only species which appears on the list for targeted surveying but which is not on the IUCN Red List is the hairy-nosed otter *Lutra sumatrana*. This species is classified as Data Deficient and is a high priority candidate species for IUCN Red List assessment. It is known from only a handful of localities and is considered highly threatened with extinction.

## MONITORING

The Monitoring list in Table 7 represents priority species that are confirmed for the Cardamom Mountains. For each of these species, targeted conservation activities should be implemented – note that several species already have research projects in place (e.g., Siamese crocodile – FFI; pileated gibbon - FFI). Conservation activities for each species should be evaluated through monitoring the status of populations to ensure they remain viable.

Most of the large mammal species could be monitored through systematic camera-trapping following CI's TEAM protocol (Sanderson, J. G., 2004; De Souza Martins *et al.*, 2005). The selected bird species may serve as useful focal species for monitoring, providing indicators of habitat quality and hunting pressures. Tortoises and turtles would require targeted research projects based on their known habitats. Monitoring the Asian arowana (dragonfish) would necessitate developing discrete conservation units around the sites where they occur outside of protected areas.

Small-scale research projects could be facilitated that would provide increased knowledge of the ecology and status of selected threatened species. This could involve local communities, researchers, universities, and partners in monitoring and conservation work. National and international Masters and PhD projects could also provide invaluable data.

## Priority Habitats and Areas

We analysed our survey results and attempted to identify priority habitats based on known distributions of globally threatened species. These highlighted two major habitats (see below). There is also strong coincidence with high diversity of non-threatened species in these areas, indicating that conservation of these habitats will protect a range of biodiversity in addition to focal globally-threatened species.

### 1. Wetlands and gallery forest

Examples of globally threatened species which would significantly utilise these habitats include the Siamese crocodile (Critically Endangered), fishing cat (Vulnerable), Asiatic softshell turtle (Vulnerable), giant Asian pond turtle (Vulnerable), black marsh turtle (Vulnerable), Asian box turtle (Vulnerable), Asian arowana (Endangered), white-winged duck (Endangered), green peafowl (Vulnerable), lesser adjutant (Vulnerable), and at least

one species of otter. The many observations of both threatened and near threatened waterbirds (e.g., storks, darter, fish eagle) also highlight the importance of wetland habitats as components of regional efforts for bird conservation.

## 2. Hill evergreen forest

Priority species for conservation in this habitat complement those found around wetlands and include the dhole (Endangered), gaur (Vulnerable), Malayan sun bear (Data Deficient), Asiatic black bear (Vulnerable), pileated gibbon (Vulnerable), pig-tailed macaque (Vulnerable), serow (Vulnerable), elongated tortoise (Endangered), impressed tortoise (Vulnerable), chestnut-headed partridge (Vulnerable), great hornbill (Near Threatened), spiny-breasted giant frog *Paa fasciculispina* (Vulnerable), and potentially geographically concentrated amphibians such as the Cardamom horned frog *Megophrys auralensis*. This habitat also contained high numbers of prey species such as wild pig, red muntjac, and sambar.

Note that human pressure was taken into account when assessing these species distribution patterns, as it is likely that current habitat affinities for many species reflect human influence as well as typical distribution or ranging behaviour.

As shown above, there were significant habitat associations for most globally threatened reptile, fish, and bird species. However, many other globally threatened taxa – particularly mammals – are generalists, utilising different sites and habitats throughout the year based on a number of factors such as prey distribution. Wide-ranging species of conservation importance include the Asian elephant, tiger, gaur, Asian golden cat, clouded leopard, dhole, Asiatic black bear, and Malayan sun bear. Conservation of these species will therefore necessitate activities which target wide-scale threats in addition to site-specific protection.

## Corridor-Level Planning and Partnerships

Southwest Cambodia now contains over 1.3 million ha of National Parks, Wildlife Sanctuaries, and Protection Forest. With so much to do on so many fronts, it is easy to become overwhelmed and diverted into a stream of activities that collectively fail to improve the situation. With such a large area to protect and monitor, conservation activities should not become either too focused or too thinly distributed, but should focus on key biodiversity areas and priority species. Corridor-level decisions should be strongly based on stakeholder partnerships and substantiated biological information.

Corridor-level conservation should now be placed on protecting known viable populations of threatened species within key biodiversity areas, be they Protected Areas (e.g., CCPF to conserve dhole *Cuon alpinus* (EN)), or discrete conservation sites (e.g. Sre Ambel to conserve the mangrove turtle *Batagur baska* (CR)). Conservation action will be most successful when species are protected in places where they are most likely to persist. Corridor-level surveys should research the distribution of the few remaining threatened species that do not currently have viable populations within protected areas e.g., banteng *Bos javanicus* (EN) or yellow-headed temple turtle *Hieremys annandalii* (EN) (see Table 7).

Corridor-level planning is now a high priority in southwest Cambodia. A biodiversity conservation corridor should be defined for the region which encompasses key biodiversity areas and other habitat and ecological processes that are critical to the survival of globally threatened and geographically concentrated species. This corridor should offer the

opportunity for stakeholders to improve human welfare through an integrated system of protected areas, a connectivity network, and compatible land and resource uses. It should conserve globally threatened species that are not well represented at the site scale. And it should conserve wide-ranging species. Biological corridors should be identified which would link protected areas (e.g., Southern Cardamom Protected Forest and Central Cardamoms Protected Forest) by linear strips of habitat, on the assumption that surrounding areas could eventually become unsuitable for sustaining significant biodiversity.

Therefore, a high priority for biological conservation in southwest Cambodia should be for partners and key stakeholders to combine and analyse their biological data. There should be a review of species potentially requiring conservation at the corridor scale (with emphasis on distribution, range, and global significance of known populations), an update of the status of selected globally threatened species in the key biodiversity areas within the proposed corridor (particularly those species listed in Table 7), and an assessment of corridor-level ecological processes.

Based on this, areas of connectivity between key biodiversity areas should be identified as needed to support wide-ranging globally threatened species within the biodiversity conservation corridor. These areas of connectivity need not necessarily require government designation as Protected Areas, but may only require formal demarcation and agreements with landowners (communities, individuals, etc.). The exact level of protection will obviously depend on the pressures that drive biodiversity and habitat loss in those areas.

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## Appendix 1: Habitat definitions

Habitat	Altitude (approx.)	Forest structure	Canopy height
<b>Lowland Dry Dipterocarp Forest (DD)</b>	10 - 400m a.m.s.l.	Open	Low (10-18m)
<b>Lowland Dry Evergreen Forest (DE)</b>	150 - 400m a.m.s.l.	Dense	Medium (20-30m)
<b>Gallery Forest (GF) - sub-category of Lowland Dry Evergreen Forest (DE)</b>	10 - 400m a.m.s.l.	Dense	Medium-High
<b>Hill Evergreen Forest (HE)</b>	400 - 900m (can be up to 1,200m) a.m.s.l.	Usually Dense	Usually High (30-50m)
<b>Lower Montane Evergreen Forest (LME)</b>	1,200 (can be as low as 900m) -1,500m a.m.s.l.	Dense	Medium (to 20m)
<b>Upper Montane Evergreen Forest (UME)</b>	1,500+ m a.m.s.l.	V. Dense	Low (to 10m)
<b>Bamboo Forest (BF)</b>	250-600m a.m.s.l.	Open	-
<b>Pine Forest (PF)</b>	1,200+ m a.m.s.l.	Open	Medium (to 20m)
<b>Fernland (FL)</b>	1,100-1,200m a.m.s.l.	-	-
<b>Grassland (GL)</b>	-	-	-
<b>Wetland (WL) – see below for categories</b>	-	-	-
<b>Cultivation (CU) – see below for categories</b>	-	-	-

These habitat types are defined by the following criteria (based on Campbell Webb in Daltry & Momberg, 2001):

### ***Lowland dry dipterocarp forest [DD]***

Open, fire-prone, level, seasonally dry woodland dominated by the family Dipterocarpaceae, mostly low canopy species that are partially deciduous and fire-resistant. Other tree families present include Combretaceae and Dilleniaceae. Scrubby understory with extensive stands of small bamboo (notably endemic *Vietnamosasa ciliata*) and clumps of shrubby Annonaceae and Dilleniaceae. Wet-season reveals a rich herb layer of annuals and geophytes not visible in the dry season. *Cycas* present as scattered populations and considerable epiphytic orchids. This vegetation type is occasionally referred to as dry deciduous, but that name is more properly applied to Lythraceae/Dilleniaceae-dominated woodland as found in Changwat Loei and Changwat Uttaradit, NE Thailand and present in Cambodia at, e.g., Mondulakiri Province.

### ***Lowland dry evergreen [DE]***

Dense to very dense seasonally dry forest on level to sloping ground dominated by Dipterocarpaceae, Fabaceae, Lythraceae and occasional Meliaceae, mostly moderately tall (canopy to c. 25 m) fully evergreen, non-fire resistant species. Understory is dense, with Rubiaceae, Apocynaceae dominating. Lianas present, particularly Fabaceae, Acanthaceae (*Thunbergia*), Rubiaceae (*Uncaria*) & Annonaceae (*Uvaria*). Mainly deciduous, with a few evergreen trees. Understorey often with bamboos. More species-diverse than dry dipterocarp. Less than one third of upper-storey trees are deciduous.

### ***Gallery Forest [GF]***

Lowland dry evergreen (DE) forest following a river course through dry deciduous forest.

### ***Hill evergreen [HE]***

Dense to very dense seasonally dry to occasionally evermoist on sloping to steeply sloping ground dominated by Fabaceae & Dipterocarpaceae (lower parts), Lauraceae and some Fagaceae (upper parts). Canopy height up to 30 m, with occasional emergents. Understory with much Rubiaceae, Mysinaceae, Euphorbiaceae & Zingiberaceae. Lianas common, especially Palmae (rattan), Vitaceae, Rhamnaceae and some Fabaceae. Dry areas with Araliaceae

and aborescent *Cycas*. Podocarpaceae, some arborescent Ericaceae (*Rhododendron*), and extensive epiphytic orchids are present at higher altitudes. Less than 40% of trees deciduous for more than 1 month. Buttresses common.

**Sub-categories:**

*Basalt Hill Evergreen*. Dark brown soils, large trees, uneven canopy layer. Restricted to soils derived from volcanic rocks (extrusions and volcanos), e.g., Thma Bang volcano, O'Som cardamom forest, much of Phnom Aural, parts of the Areng valley. Usually very dense and tall (up to 50m), except where soil is thin. Where the understorey is exposed to light, luxurious stands of gingers occur (*Amomom kravanh*), which give the Cardamom Mountains their name.

*Sandstone Hill Evergreen*. Orange, yellow or white, sandy soils, closed, even canopy. More widespread than Basalt HE. The 'dwarf' form (15-30m) is mixed into the tall evergreen sandstone forest, on shallow and/or poor soils: thin soil over bare sandstone rock, laterite pebble layers, and deep white sand soils with a thin black humus layer. Boundaries with the tall formation may be gradual or sharp. The 'tall' form (30m+) occurs on the more fertile, clay-rich soils of the hill slopes. This is the major timber-producing forest type. Dipterocarp species would have dominated this forest type, although after logging it is hard to know now how dominant they were. High densities of species from the Clusiaceae, Sapotaceae, Lauraceae and Myrtaceae families.

***Lower montane evergreen [LME]***

Dense seasonally evermoist on steep to very steep slopes, dominated by Lauraceae, Fagaceae and some Theaceae. Myrtaceae, Podocarpaceae & Ericaceae also common. Canopy height to 20 m, few emergents. Extensive epiphyte flora including orchids, ferns and Ericaceae (*Vaccinium*). Buttresses scarce (cf HE). Tree ferns of the genus *Cyathea* are an indicator of this forest type.

***Upper montane evergreen [UME]***

'Cloud forest'. Dense evermoist on steep slopes and summit area, dominated by Lauraceae, Theaceae and some Fagaceae. Hamamelidaceae occurring sporadically. Canopy height to 10 m, very few emergents. Very rich epiphyte flora with orchids dominating.

***Bamboo forest [BF]***

Open, seasonally very dry forest on level to steeply sloping ground dominated by arborescent bamboo (Poaceae). Tree families present include Dipterocarpaceae (*Hopea*) and Euphorbiaceae, although these tend to occur along permanent watercourses. The understory is very open with extensive areas of bare soil. Wet season reveals a rich but sparse herb layer with the monocotyledon families Araceae, Discoreaceae and Stemonaceae dominant. Difficult to penetrate. Bamboo is a semi-permanent end-stage in a succession after forests have been badly disturbed (e.g., clearance, heavy logging). The formation is definitely 'natural' in some areas, however.

***Pine Forest [PF]***

Coniferous forests on summits and ridges (lack of water). Stands dominated by *Pinus merkusii* occur at all elevations, although the largest extent of this forest type is at high elevation (the Kirirom plateau). Often mixed with DD species, this is a frequently burning vegetation type. Pines often grow to 20m tall.

***Grassland [GL]***

A large category, includes man-made grasslands (usually created from forest by over-burning and cattle grazing) and natural grasslands on thin or boggy soil (intergrade into marshes). Mainly grasses, few bushes or trees. In heavily burned areas, tough, wiry *Imperata* grass grows in nearly pure swathes. On pure white quartz sand, sundews (*Drosera burmanii*) and pitcher plants (*Nepenthes* spp.) grow, with some taller, fire-tolerant shrubs.

***Wetland [WL]***

**Categories:** Permanent/seasonal rivers or streams; permanent/seasonal freshwater lakes (over 8ha); permanent/seasonal freshwater ponds (below 8ha); bogs, marshes, swamps; saline/brackish lakes or ponds; intertidal marshes. Marshes on waterlogged soil are characterized by sedges.

***Cultivation [CU]***

**Categories:** wet rice paddies; pasture; newly cleared chamka; old chamka.

## Appendix 2: Mammals recorded in the CCPF during the 2004 survey

SCIENTIFIC NAME	COMMON NAME	IUCN Status	CITES Status	Record Type
<b>Order Insectivora</b>				
<i>Crocidua sp. A</i>	Shrew sp.A			T
<i>Crocidura sp. B</i>	Shrew sp. B			T
<b>Order Scandentia</b>				
<i>Tupaia belangeri</i>	Northern tree shrew		II	T
<i>Dendrogale murina</i>	Mainland slender-tailed tree shrew		II	T, O
<b>Order Rodentia</b>				
<i>Atherurus macrourus</i>	Brush-tailed porcupine			T, S
<i>Hystrix brachyura</i>	Malayan porcupine			O
<i>Callosciurus finlaysonii</i>	Variable squirrel			O
<i>Tamiops rudolphii</i>	Cambodian striped squirrel			O
<i>Menetes berdmorei</i>	Berdmore's squirrel			T
<i>Ratufa bicolor</i>	Black giant squirrel			O
<i>Maxomys surifer</i>	Red spiny rat			T
<i>Maxomys sp.</i>	Spiny rat sp.			T
<i>Niviventer langbianis</i>	Dark-tailed tree rat			T
<i>Niviventer sp.</i>	Tree rat sp.			T
<i>Berylmys berdmorei</i>	Lesser white-toothed rat			T
<i>Rattus sikkimensis</i>	Sikkim rat	VU		T
<i>Rattus rattus sp.</i>	Black rat			T
<i>Rattus sp.</i>	Rat sp.			T
<b>Order Chiroptera</b>				
<i>Cynopterus brachyotis</i>	Lesser short-nosed fruit bat			T
<i>Megaerops niphanae</i>	Tail-less fruit bat			T
<i>Hipposideros armiger</i>	Great Himalayan Leaf-nosed bat			T
<i>Hipposideros larvatus</i>	Horsfield's Leaf-nosed bat			T
<i>Megaderma spasma</i>	False vampire bat			T
<i>Rhinolophus luctus</i>	Woolly Horseshoe bat			T
<i>Rhinolophus lepidus</i>	Horseshoe bat			T
<i>Rhinolophus stheno</i>	Horseshoe bat			T
<i>Rhinolophus shameli</i>	Shamel's Horseshoe bat	NT		T
<i>Myotis horsfieldi</i>	Horsfield's mouse-eared bat			T
<i>Tylonycteris pachypus</i>	Lesser bamboo bat			T
<b>Order Primates</b>				
<i>Macaca fascicularis</i>	Long-tailed macaque	NT	II	O, S
<i>Macaca nemestrina</i>	Pig-tailed macaque	VU	II	O, S
<i>Hylobates pileatus</i>	Pileated gibbon	VU	I	O, H
<i>Nycticebus coucang</i>	Slow loris		II	O
<b>Order Carnivora</b>				
<i>Paradoxurus hermaphroditus</i>	Common palm civet			T
<i>Viverricula indica</i>	Small Indian civet			O, S
<i>Arctictis binturong</i>	Binturong			O
<i>Martes flavigula</i>	Yellow-throated marten			O
<i>Lutra/lutrogale sp</i>	Otter	LR/VU	I, II	S
<i>Ursus thibetanus</i>	Asiatic black bear	VU	I	O
<i>Helarctos malayanus</i>	Sun bear	DD	I	O, S
<i>Prionailurus bengalensis</i>	Leopard cat		II	S
<i>Catopuma temminckii</i>	Asian golden cat	VU	I	O
<i>Panthera tigris *</i>	Tiger	EN	I	S
<b>Order Proboscidea</b>				
<i>Elephas maximus</i>	Asian elephant	EN	I	S
<b>Order Artiodactyla</b>				
<i>Sus scrofa</i>	Wild boar			O, S
<i>Cervus unicolor</i>	Sambar deer			O, S
<i>Muntiacus muntjac</i>	Red muntjac			O, H, S
<i>Bos gaurus</i>	Gaur	VU	I	S

\* Record from 2003

O= observed, T= trapped, H= sounds, S= signs (tracks, scats, scratch marks, etc.)

EN = Endangered; VU = Vulnerable; NT = Near Threatened; LR = Low Risk; DD = Data Deficient

**Appendix 3:** Species recorded by camera traps in CCPF and buffer area (Mar 01–Apr 04)

SCIENTIFIC NAME	COMMON NAME	IUCN Status	CITES Status	% of total wildlife photographs
<b>Order crocodylia</b>				
<i>Crocodylus siamensis</i>	Siamese crocodile	CR	I	< 1
<b>Order Pholidota</b>				
<i>Manis javanica</i>	Sunda pangolin		II	< 1
<b>Order Rodentia</b>				
<i>Atherurus macrourus</i>	Brush-tailed porcupine			< 1
<i>Hystrix brachyura</i>	Malayan porcupine			4.3
<i>Menetes berdmorei</i>	Berdmore's squirrel			< 1
<i>Rattus/Maxomys</i>	Rat sp.			1.3
<b>Order Primates</b>				
<i>Macaca fascicularis</i>	Long-tailed macaque	NT	II	1.9
<i>Macaca nemestrina</i>	Pig-tailed macaque	VU	II	3.0
<i>Hylobates pileatus</i>	Pileated gibbon	VU	I	< 1
<b>Order Carnivora</b>				
<i>Paradoxurus hermaphroditus</i>	Common palm civet			2.0
<i>Viverra zibetha</i>	Large spotted civet			< 1
<i>Viverra zibetha</i>	Large Indian civet			1.1
<i>Herpestes javanicus</i>	Small Asian mongoose			< 1
<i>Herpestes urva</i>	Crab-eating mongoose			< 1
<i>Martes flavigula</i>	Yellow-throated marten			< 1
<i>Arctonyx collaris</i>	Hog badger			3.7
<i>Cuon alpinus</i>	Dhole	EN	II	4.0
<i>Ursus thibetanus</i>	Asiatic black bear	VU	I	< 1
<i>Helarctos malayanus</i>	Sun bear	DD	I	2.1
<i>Prionailurus bengalensis</i>	Leopard cat		II	6.8
<i>Pardofelis nebulosa</i>	Clouded leopard	VU	I	< 1
<i>Catopuma temminckii</i>	Asian golden cat	VU	I	1.2
<b>Order Proboscidea</b>				
<i>Elephas maximus</i>	Asian elephant	EN	I	< 1
<b>Order Artiodactyla</b>				
<i>Sus scrofa</i>	Wild boar			27.5
<i>Tragulus sp.</i>	Mouse deer			5.0
<i>Cervus unicolor</i>	Sambar deer			12.4
<i>Muntiacus muntjac</i>	Red muntjac			17.4
<i>Bos gaurus</i>	Gaur	VU	I	< 1
<i>Naemorhedus sumatraensis</i>	Southern serow	VU	I	< 1
<b>Birds</b>				
<i>Ardeola bacchus</i>	Chinese pond heron			< 1
<i>Lophura nycthemera</i>	Silver pheasant			2.6
<i>Gallus gallus</i>	Red junglefowl			3.3
<i>Pavo muticus</i>	Green peafowl	VU	I	< 1
<i>Arborophila cambodiana</i>	Chestnut-headed partridge	EN		< 1
<i>Glaucidium cuculoides</i>	Asian barred owlet			< 1
<i>Myiophonus caeruleus</i>	Blue whistling thrush			< 1

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; DD = Data Deficient

## Appendix 4: Bird species recorded in the CCPF during the 2004 survey

SPECIES Common Name	Scientific Name	STATUS	LOCATION & RELATIVE ABUNDANCE*				NOTES
			Rusei Chrum	Tatal Lieu	Thma Bang	Areng Valley	
Accipiter species	<i>Accipiter</i> sp.					R	
Ashy Drongo	<i>Dicurus leucophaeus</i>			U		R	<i>D. l. leucogenis</i> or <i>salangensis</i>
Ashy Minivet	<i>Pericrocotus divaricatus</i>		U				
Asian Brown Flycatcher	<i>Muscicapa dauurica</i>		R	U			
Asian Fairy Bluebird	<i>Irena puella</i>		A	A		C	
Asian Koel	<i>Eudynamis scolopacea</i>					U	Calls only
Asian Palm Swift	<i>Cypsiurus balasiensis</i>					U	Many swifts observed but not ID'd
Black-and-buff Woodpecker	<i>Meiglyptes jugularis</i>			R			
Black-and-red Broadbill	<i>Cymbirhynchus macrorhynchus</i>			R		U	
Black-browed Reed Warbler	<i>Acrocephalus bistrigiceps</i>		R				Caught by hand
Black-capped Kingfisher	<i>Halcyon pileata</i>		U		R	U	
Black-crested Bulbul	<i>Pycnonotus melanicterus</i>		C	A	U	U	
Black-headed Bulbul	<i>Pycnonotus atriceps</i>			R			
Black-naped Oriole	<i>Oriolus chinensis</i>		C			U	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	NT				U	
Blue Flycatcher species	<i>Cyornis</i> sp.		U				
Blue Rock Thrush	<i>Monticola solitarius</i>		U	R			<i>M. s. philippensis</i>
Blue Whistling Thrush	<i>Myophonus caeruleus</i>			R			Caught in small mammal trap
Blue-eared Kingfisher	<i>Alcedo meninting</i>			U		U	
Blue-winged Leafbird	<i>Chloropsis cochinchinensis</i>			C		U	
Brown Shrike	<i>Lanius cristatus</i>				R		
Brown-backed Needletail	<i>Hirundapus giganteus</i>			U	C	A	
Cattle Egret	<i>Bubulcus ibis</i>	CITES III		C			In rice field with water buffalo
Changeable Hawk Eagle	<i>Spizaetus cirrhatus</i>			R			
Chestnut-headed Bee-eater	<i>Merops leschenaulti</i>		C	A	A	A	
Chinese Sparrowhawk	<i>Accipiter soloensis</i>				R		Juvenile
Collared Scops Owl	<i>Otus bakkamoena</i>	CITES II		R			Caught in bat mist-net
Common Flameback	<i>Dinopium javanense</i>		R	U		R	Similar to <i>Chrysocolaptes lucidus</i>
Common Kingfisher	<i>Alcedo atthis</i>			R		R	Similar to <i>A. meninting</i>
Common Moorhen	<i>Gallinula chloropus</i>		R				Probable ID
Common Tailorbird	<i>Orthotomus cuculatus</i>					R	Probable ID
Crimson Sunbird	<i>Aethopyga siparaja</i>			R			
Dark-necked Tailorbird	<i>Orthotomus atrogularis</i>					R	Probable ID
Dollarbird	<i>Eurystomus orientalis</i>		U				
Drongo species	<i>Dicurus</i> sp.		U				Likely <i>D. macrocercus</i> or <i>D. aeneus</i>
Emerald Dove	<i>Chalcophaps indica</i>				C	U	
Great Hornbill	<i>Buceros bicornis</i>	NT, CITES I	R		R	C	
Greater Coucal	<i>Centropus sinensis</i>					R	
Greater Racket-tailed Drongo	<i>Dicurus paradiseus</i>		C			C	
Green Imperial Pigeon	<i>Ducula aenea</i>					R	Probable ID
Green Peafowl	<i>Pavo muticus</i>	VU, CITES II				U	Call and feathers only
Green Pigeon species	<i>Treron</i> sp.					U	Most likely <i>T. curvirostra</i>
Green-billed Malkoha	<i>Phaenicophaeus tristis</i>		U		U	R	
Green-eared Barbet	<i>Megalaima faiostrictrata</i>			R	R	R	Calls also heard frequently
Grey Wagtail	<i>Motacilla cinerea</i>		U	R		R	
Grey-capped Woodpecker	<i>Dendrocopos canicapillus</i>					R	
Heart-spotted Woodpecker	<i>Hemicircus canente</i>					R	
Hill Myna	<i>Gracula religiosa</i>	CITES II		C	U	C	
Javan Pond Heron	<i>Ardeola speciosa</i>		A	C	C	A	Some may have been <i>A. bacchus</i>
Lanceolated Warbler	<i>Locustella lanceolata</i>		R				Caught by hand
Large-billed Crow	<i>Corvus macrorhynchus</i>		A		U	U	
Lesser Coucal	<i>Centropus bengalensis</i>				R		
Lesser Fish Eagle	<i>Ichthyophaga humilis</i>	NT, CITES II		R		U	
Lesser Racket-tailed Drongo	<i>Dicurus remifer</i>		C			U	Difficult to distinguish from <i>D. paradiseus</i>
Lesser Whistling Duck	<i>Dendrocygna javanica</i>					C	
Little Egret	<i>Egretta garzetta</i>	CITES III				R	
Little Heron	<i>Butorides striatus</i>		U			U	
Little Spiderhunter	<i>Arachnothera robusta</i>			U			
Long-tailed Broadbill	<i>Psarisomus dalhousiae</i>					R ("Jar" site)	Site at ~ 359000, 1290000; 800m
Mountain Imperial Pigeon	<i>Ducula badia</i>			A		R	
Nightjar species	<i>Caprimuglus / Eurostopodus</i> sp.		A	U	U	R	
Nuthatch species	<i>Sitta</i> sp.					R	
Ochraceous Bulbul	<i>Alophoixus ochraceus</i>		C	C			
Oriental Bay Owl	<i>Phodilus badius</i>	CITES II		R			
Oriental Darter	<i>Anhinga melanogaster</i>	NT				U	
Oriental Honey-buzzard	<i>Pernis ptilorhynchus</i>	CITES II		R	R		
Oriental Pied Hornbill	<i>Anthracceros albirostris</i>	CITES II	R			A	
Oriental Reed Warbler	<i>Acrocephalus orientalis</i>		R				
Osprey	<i>Pandion haliaetus</i>	CITES II	U			U	
Racket-tailed Treepie	<i>Crypsirina temia</i>		U		R		
Red Junglefowl	<i>Gallus gallus</i>		C	C		U	<i>G. g. gallus</i> . Most observations calls
Red-throated Flycatcher	<i>Ficedula parva</i>			U		R	
Scarlet Minivet	<i>Pericrocotus flammeus</i>			C	U	U	
Scarlet-backed Flowerpecker	<i>Dicaeum cruentatum</i>		U		R		
Silver-backed Needletail	<i>Hirundapus cochinchinensis</i>					U	Difficult to distinguish from <i>H. giganteus</i>

Appendix 4 (continued)

SPECIES		STATUS	LOCATION & RELATIVE ABUNDANCE*				NOTES
Common Name	Scientific Name		Russei Chrum	Tatai Lieu	Thma Bang	Areng Valley	
Sooty-headed Bulbul	<i>Pycnonotus aurigaster</i>				C		Yellow undertail-coverts
Spangled Drongo	<i>Dicrurus hottentottus</i>			U			
Stork-billed Kingfisher	<i>Halcyon capensis</i>					C	
Striped Tit Babbler	<i>Macronous gularis</i>			R			Probable ID
Stripe-throated Bulbul	<i>Pycnonotus finlaysoni</i>		C	C			
Sunbird species	<i>Nectarinia</i> sp.		U	U			Female
Swallow species	<i>Hirundo</i> sp.				U		<i>H. daurica</i> or <i>H. striolata</i>
Two-barred Warbler	<i>Phylloscopus plumbeitarsus</i>		R				Other <i>Phylloscopus</i> also likely occur
Verditer Flycatcher	<i>Eumyias thalassina</i>		C	U			
Vernal Hanging Parrot	<i>Loriculus vernalis</i>	CITES II			U		
White-breasted Waterhen	<i>Amaurornis phoenicurus</i>		U				
White-crested Laughingthrush	<i>Garrulax leucolophus</i>			U	C	C	Most observations were calls
Woolly-necked Stork	<i>Ciconia episcopus</i>					U	
Wreathed Hornbill	<i>Aceros undulatus</i>	CITES II		U	R	C	

\* R = Rare (only 1 observation), U = Uncommon (2-5 observations), C = Common (6-10 observations) and A = Abundant (>10 observations).

## Appendix 5: Reptiles and amphibians recorded in the CCPF during the 2004 survey

COMMON NAME	SCIENTIFIC NAME	IUCN STATUS	NEW RECORD FOR CARDAMOMS	NEW RECORD FOR CAMBODIA	EVIDENCE
<b>REPTILES</b>					
<b>Crocodylidae</b>					
Siamese crocodile	<i>Crocodylus siamensis</i>	CR			P
<b>Testudinidae</b>					
Elongated tortoise	<i>Indotestudo elongata</i>	EN			P,D,Sh
Impressed tortoise	<i>Manouria impressa</i>	VU			P,D,Sh
<b>Bataguridae</b>					
Asian Giant pond turtle	<i>Heosemys grandis</i>	VU			P,D,Sh
Asian box turtle	<i>Cuora amboinensis</i>	VU			P,D,Sh
Black marsh turtle	<i>Siebenrockiella crassicollis</i>	VU	*		P,D
Leaf or Stream turtle	<i>Cyclemys atripons</i>	NT			P,D,Sh
<b>Trionychidae</b>					
Asiatic soft-shelled turtle	<i>Amyda cartilaginea</i>	VU			P,D,Sh
<b>Gekkonidae</b>					
Cardamom banded gecko	<i>Cyrtodactylus intermedius</i>				V,P,D
Flat-tailed gecko	<i>Cosymbotus platyurus</i>		*		V,P,D
Tockay gecko	<i>Gekko gekko</i>				P
Spiny-tailed house gecko	<i>Hemidactylus frenatus</i>				V,D
<b>Scincidae</b>					
Olive tree skink	<i>Dasia olivacea</i>		*	*	V,P,D
Many-lined sun skink	<i>Eutropis (Mabuya) multifasciata</i>				V,D
Striped tree skink	<i>Lipinia vittigera</i>				V,P,D
Bowring's supple skink	<i>Lygosoma bowringii</i>				V,P,D
Speckled forest skink	<i>Mabuya macularia</i>				V,P,D
Speckled leaf-litter skink	<i>Scincella reevesii</i>				V,P,D
Leaf-litter skink	<i>Scincella sp</i>		*		V,P,D
Starry forest skink	<i>Sphenomorphus stellatus</i>		*	*	V,P,D
Streamside skink	<i>Sphenomorphus maculatus</i>				V,P,D
Indian forest skink	<i>Sphenomorphus indicus</i>				V,P,D
<b>Agamidae</b>					
Horned tree lizard	<i>Acanthosaura sf armata</i>				V,P,D
Forest crested lizard	<i>Calotes emma</i>				V,P,D
Garden fence lizard	<i>Calotes versicolor</i>				V,P,D
Indochinese gliding lizard	<i>Draco indochinensis</i>				V,P,D
Gliding lizard	<i>Draco sf taeniopterus</i>				V,P,D
Indo-Chinese water dragon	<i>Physignathus cocincinus</i>				P,D
<b>Lacertidae</b>					
Long-tailed lizard	<i>Takydromus sexlineatus</i>				V,P,D

## Appendix 5 (Continued)

COMMON NAME	SCIENTIFIC NAME	IUCN STATUS	NEW RECORD FOR CARDAMOMS	NEW RECORD FOR CAMBODIA	EVIDENCE
<b>Varanidae</b>					
Water monitor	<i>Varanus salvator</i>				P,D
Bengal monitor	<i>Varanus bengalensis</i>				P
<b>Elapidae</b>					
Banded krait	<i>Bungarus fasciatus</i>				P
<b>Colubridae</b>					
Oriental whip snake	<i>Ahaetulla prasina</i>				V,P,D
Striped keelback	<i>Amphiesma stolata</i>				V,P,D
Mangrove snake	<i>Boiga dendrophila</i>				V,P,D
Grey cat snake	<i>Boiga ocellata</i>				V,P,D
Blanford's bridle snake	<i>Dryocalamus davisoni</i>				V,P,D
Bocourt's water snake	<i>Enhydris bocourti</i>		*		V,P,D
Red-tailed rat snake	<i>Gonyosoma oxycephalum</i>				V,P,D
Puff-faced water snake	<i>Homalopsis buccata</i>				V,P,D
Kukri snake	<i>Oligodon sp</i>		*		V,P,D
Keeled slug snake	<i>Pareas carinatus</i>				V,P,D
White-spotted slug snake	<i>Pareas margaritophorus</i>				V,P,D
Common mock viper	<i>Psammodynastes pulverulentus</i>				V,D
Indo-Chinese rat snake	<i>Ptyas korros</i>				V,P,D
Speckle-bellied keelback	<i>Rhabdophis chrysargus</i>				V,P,D
Green keelback	<i>Rhabdophis nigrocinctus</i>				V,P,D
Red-necked keelback	<i>Rhabdophis subminiatus</i>				V,P,D
Asiatic watersnake	<i>Sinonatrix percarinata</i>		*	*	V,P,D
Sunbeam snake	<i>Xenopeltis unicolor</i>		*		V,P,D
<b>Viperidae</b>					
Malayan pit viper	<i>Colloselasma rhodostoma</i>				V,P,D
White-lipped pit-viper	<i>Trimeresurus albolabris</i>				V,P,D
Pope's pit-viper	<i>Trimeresurus popeiorum/stejnegeri</i>				V,P,D
Vogel's pit viper	<i>Trimeresurus vogeli</i>				V,P,D
<b>Pythonidae</b>					
Reticulated python	<i>Python reticulatus</i>				V,P,D
<b>AMPHIBIANS</b>					
<b>Microhylidae</b>					
Striped spadefoot frog	<i>Calluella guttulata</i>	*	*		V,P,D
Striped sticky frog	<i>Kalophrynus interlineatus</i>				V,P,D
Berdmore's chorus frog	<i>Microhyla berdmorei</i>				V,P,D
Dark-sided chorus frog	<i>Microhyla heymonsi</i>				V,P,D
Ornate chorus frog	<i>Microhyla ornata</i>				V,P,D

## Appendix 5 (Continued)

COMMON NAME	SCIENTIFIC NAME	IUCN STATUS	NEW RECORD FOR CARDAMOMS	NEW RECORD FOR CAMBODIA	EVIDENCE
Chorus frog	<i>Microhyla sf annamensis</i>				V,P,D
Inornate froglet	<i>Micryletta inornata</i>				V,P,D
<b>Megophryidae</b>					
Cardamom horned frog	<i>Megophrys sf auralensis</i>				V,P,D
<b>Ranidae</b>					
Rice paddy frog	<i>Fejervarya limnocharis</i>				V,P,D
Rugose frog	<i>Hoplobatrachus rugulosus</i>				P
Koh Chang frog	<i>Limnonectes kohchangae</i>				V,P,D
Common puddle frog	<i>Occidozyga lima</i>				V,P,D
Marten's puddle frog	<i>Occidozyga martensii</i>				V,P,D
Spiny-breasted giant frog	<i>Paa fasciculispina</i>	VU			V,P,D
Green-backed frog	<i>Rana erythraea</i>				V,P,D
Smith's frog	<i>Rana faber</i>				V,P,D
Stripe-backed frog	<i>Rana macrodactyla</i>				V,P,D
Mortensen's frog	<i>Rana mortenseni</i>	NT			V,P,D
Millet's frog	<i>Rana milletti</i>				V,P,D
Frog	<i>Rana sp</i>		*		V,P,D
<b>Bufoidea</b>					
Black-spined toad	<i>Bufo melanostictus</i>				V,P,D
Indochinese dwarf toad	<i>Bufo parvus</i>				V,P,D
<b>Rhacophoridae</b>					
Nong Khor bushfrog	<i>Chirixalus nongkhorensis</i>		*		V,P,D
Treefrog	<i>Philautus sp</i>		*		V,P,D
Common treefrog	<i>Polypedates leucomystax</i>				V,P,D
Treefrog	<i>Polypedates sp</i>		*		V,P,D
Twin-spotted treefrog	<i>Rhacophorus bipunctatus</i>				V,P,D
Chantaburi warted treefrog	<i>Theلودerma stellatum</i>		*	*	V,P,D
<b>Ichthyophiidae</b>					
Caecilian	<i>Ichthyophis sp</i>		*	*	V,P,D

V=Voucher specimen, P=Photograph, D=DNA sample, Sh=Shell

New amphibian records for Cambodia were defined based on Global Amphibian Assessment ([www.globalamphibians.org](http://www.globalamphibians.org)) and recent peer-reviewed publications

## Appendix 6: Fish species recorded in the CCPF during the 2004 survey

Species	Family	Location Observed	ID Confirmed
<i>Anabas testudineus</i>	Anabantidae	Areng River	Yes
* <i>Balitora annamitica</i>	Balitoridae	Areng River	Yes
* <i>Barbonymus schwanenfeldii</i>	Cyprinidae	Areng River	Yes
* <i>Betta prima</i>	Osphronemidae	Russei Chrum, Tatai & Areng Rivers	Yes
<i>Channa gachua</i>	Channidae	Russei Chrum, Tatai & Areng Rivers	Yes
<i>Channa striata</i>	Channidae	Areng River	No
<i>Clarius batrachus</i>	Clariidae	Russei Chrum & Tatai Rivers	Yes
* <i>Clarius nieuhofi</i>	Clariidae	Russei Chrum & Tatai Rivers	No
* <i>Crossocheilus oblongus</i>	Cyprinidae	Areng River	Yes
* <i>Cyclocheilichthys apogon</i>	Cyprinidae	Russei Chrum, Tatai & Areng Rivers	Yes
* <i>Epalzeorhynchus kalopterous</i>	Cyprinidae		Yes
* <i>Garra cambodgiensis</i>	Cyprinidae	Tatai River	Yes
* <i>Garra fuliginosa</i>	Cyprinidae	Tatai River & Areng River	Yes
* <i>Glyptothorax fuscus</i>	Sisoridae	Areng River	Yes
<i>Hampala macrolepidota</i>	Cyprinidae	Russei Chrum, Tatai & Areng Rivers	Yes
* <i>Hemibagrus filamentus</i>	Bagridae	Russei Chrum, Tatai & Areng Rivers	Yes
* <i>Hemimyzon sp.</i>	Balitoridae	Areng River	No
* <i>Homaloptera orthogoniata</i>	Balitoridae	Tatai & Areng Rivers	No
* <i>Homaloptera smithi</i>	Balitoridae	Tatai & Areng River	No
* <i>Labiobarbus leptcheila</i>	Cyprinidae	Areng River	No
* <i>Lobocheilus gracilis</i>	Cyprinidae	Areng River	No
* <i>Luciosoma setigerum</i>	Cyprinidae	Areng River	Yes
* <i>Macrogathus semiocellatus</i>	Mastacembelidae	Russei Chrum & Tatai Rivers	No
* <i>Mastacembelus armatus</i>	Mastacembelidae	Russei Chrum, Tatai & Areng Rivers	Yes
* <i>Mystacoleucus marginatus</i>	Cyprinidae		Yes
* <i>Neolissochilus blanci</i>	Cyprinidae	Russei Chrum & Tatai Rivers	No
* <i>Trichogaster trichopterus</i>	Osphronemidae	Areng River	No
<i>Osteochilus hasselti</i>	Cyprinidae	Russei Chrum, Tatai & Areng Rivers	Yes
* <i>Osteochilus microcephalus</i>	Cyprinidae	Tatai & Areng Rivers	Yes
* <i>Osteochilus waandersi</i>	Cyprinidae	Areng River	Yes
* <i>Oxygaster anomalura</i>	Cyprinidae	Areng River	Yes
<i>Poropuntius deauratus</i>	Cyprinidae	Russei Chrum, Tatai & Areng Rivers	Yes
* <i>Pristolepsis fasciata</i>	Pristolepsidae	Areng River	Yes
* <i>Pseudomystus siamensis</i>	Bagridae	Areng River	Yes
<i>Rasbora pavei</i>	Cyprinidae	Russei Chrum, Tatai & Areng Rivers	Yes
* <i>Rasbora trilineata</i>	Cyprinidae	Areng River	No
* <i>Rhinogobius leavelli</i>	Gobiidae	Areng River	No
<i>Schistura nicholsi</i>	Balitoridae	Tatai & Areng Rivers	Yes
* <i>Scleropages formosus</i>	Osteoglossidae	Areng River	Yes
* <i>Serpenticobis sp.</i>	Cobitidae	Tatai River	No
<i>Silurichthys schneideri</i>	Siluridae	Russei Chrum & Tatai Rivers	Yes
* <i>Tor siensis</i>	Cyprinidae	Russei Chrum, Tatai & Areng Rivers	No
* <i>Wallago leeri</i>	Siluridae	Areng River	Yes

\*new records for the Cardamom Mountains

## Appendix 7: Survey photographs

### HABITATS



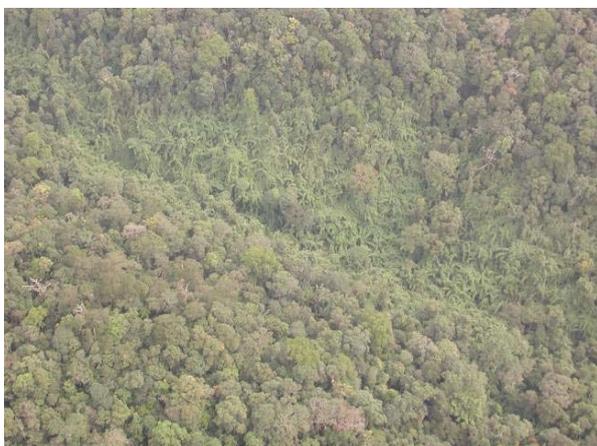
Pine forest and grassland habitat on montane plateau (>800m altitude) (Photo: Annette Olsson).



Areng River and riparian forest. Sandbanks showed tracks from Siamese crocodiles and otters (AO).



Aerial view of Knorgl Louk, showing hill evergreen and pine forest (Photo: CI).



Hill evergreen forest with bamboo (CI).



Breeding site for dragonfish *Scleropages formosus*, Areng River (Photo: Emily Rubidge).



Areng valley. Cleared lowland evergreen forest for agriculture (chamkar) (AO).

# TRAINING



Training university students in small mammal identification (David Emmett).



Heng Namyi practicing preparation of voucher specimen (AO).



Training students and rangers in use of compass, map, and GPS (AO).



Preparing mesh traps for live capturing of medium sized mammals (DE).



Setting up a camera-trap (AO).



Using scoop nets to capture small fish (ER).

## TRAINING / FISHES



Heng Sokrith checking small mammal trap. Catch: *Rattus sikkimensis* (IUCN: Vulnerable) (AO).



Common palm civet *Paradoxurus hermaphroditus*. This species was common and easily trapped using fruit or fish as bait. (DE).



Local guide setting a small mammal trap in a tree (AO).



Adult dragonfish *scleropages formosus* (IUCN: Endangered) (ER).



Fish sample from Russey Chrum River (ER).



*Tor* sp. New record of this rare genus for southwest Cambodia. Forest-dependant species (ER).

# MAMMALS



Brush-tailed porcupine *Atherurus macrourus* caught in a mesh trap (AO).



*Cynopterus brachyotis* fruit bat. This species was abundant at all surveyed sites (AO).



Two live pangolins *Manis javanica* confiscated from local hunters in CCPF (Photo: ER).



*Rhinolophus lepidus*, captured at 350m altitude in riparian forest. New species record for Cambodia (AO).



Above: First record of *Crocidura* shrews in Cambodia. At least two species were captured during the rainy season in pitfall traps (AO).

Right: releasing a rodent after identifying, measuring, weighing, and uniquely marking (DE).



# MAMMALS



Above: Tracks from otter (probably Eurasian or smooth-coated) found near Russey Chrum River (AO).



Right: Tracks from large cat (probably tiger) in CC PF (CI).



Scat from large cat (possibly leopard or tiger) found near Russey Chrum River (AO).



Camera-trap photograph of an Asiatic golden cat *Catopuma temminckii* (IUCN: Vulnerable).



Camera-trap photograph of the elusive large-spotted civet *Viverra megaspila*.



Camera-trap photograph of a pack of dhole *Cuon alpinus* (IUCN: Endangered).

## MAMMALS & BIRDS



Clouded leopard *Neofelis nebulosa* (IUCN: Vulnerable), camera-trap photograph



Malayan sun bear *Helarctos malayanus* (IUCN: Data Deficient), camera-trap photograph



Binturong *Arctictis binturong*, rare photograph (by community ranger team)



Asian elephant *Elephas maximus* (IUCN: Endangered), camera-trap photograph



Green peafowl *Pavo muticus* (IUCN: Vulnerable), camera-trap photograph



Chestnut-headed partridge *Arborophila cambodiana* (IUCN: Vulnerable), camera-trap photograph

## REPTILES



Siamese crocodile *Crocodylus siamensis* (IUCN: Critically Endangered), camera-trap photograph.



Juvenile elongated tortoise *Indotestudo elongata* (IUCN: Endangered). This species was found in lowland evergreen and pine forest (AO)



Impressed tortoise *Manouria impressa* (IUCN: Vulnerable), restricted to montane forest (DE).



Black marsh turtle *Siebenrockiella crassicollis* (IUCN: Vulnerable), found in lowland marshes (DE).



Juvenile Asian softshell turtles *Amyda cartilaginea* (IUCN: Vulnerable). Many softshell turtles are being collected by local villagers and traders (DE).



Asian leaf turtle *Cycllemys atripons* (IUCN: Near Threatened). Currently fairly common, but heavily impacted by trade and local consumption (DE).

## REPTILES



Indochinese water dragon *Physignathus cocincinus*, fairly abundant in riparian forest (AO).



Water monitor *Varanus salvator*, a trade-threatened species. Common in riparian forest, occasionally captured in large mammal and turtle traps (DE).



Mangrove snake *Boiga dendrophila*, rare in Cambodia but fairly abundant in CCPF where they are locally collected for food (AO).



Reticulated python *Python reticulatus*, threatened through collection for their meat and skin. They were widespread in the CCPF (AO).



This beautiful water-snake *Sinonatrix percarinatus* is a new record for Cambodia and a significant range extension (AO).



The banded krait *Bungarus fasciatus*. No voucher specimens were collected as this is a highly venomous species (Photo: Heng Sokrith).

# AMPHIBIANS



New species of *Ichthyophis* caecilian. Two were retained as voucher specimens (DE).



Unidentified frog *Rana* cf *nigrovittata*, found in fast-moving streams around 600m altitude (DE).



Above: Spiny-breasted frog *Paa fasciculispina* (IUCN: Vulnerable), common along streams above about 800m altitude (DE).

Left: The rare Chantaburi warted treefrog *Theloderma stellatum* (DE).



Horned frog *Megophrys* cf *auralensis*, found only in montane forest (DE).



The newly described Smith's frog *Rana faber* may be restricted to southwest Cambodia (DE).