



**Fauna & Flora International in collaboration with the Government of Cambodia,
Ministry of Environment and Wildlife Protection Office**

BIOLOGICAL SURVEY OF THE CARDAMOM MOUNTAINS, SOUTHWESTERN CAMBODIA



INTERIM REPORT April 2000

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EXECUTIVE SUMMARY

Preliminary findings from the first major biological survey of the Cardamom Mountains, Southwest Cambodia, conducted between January and April 2000, confirm that this region contains exceptionally high biodiversity and an outstanding number of globally threatened species. Organised by Fauna & Flora International, the nine-week survey was conducted in the Mount Samkos Wildlife Sanctuary and the Central Cardamom Mountains. While large mammals and their habitats were the primary focus of the research, many other taxonomic groups were surveyed by ten international specialists. Local capacity building was an important objective of the project, and ten Cambodian counterparts from the Wildlife Protection Office and Ministry of Environment participated in the surveys, led the botanical work, and received extensive one-to-one training in wildlife research techniques.

By the mid-point of the survey, the biologists' checklist already contained at least 30 species of large mammals, well over 100 birds, 64 reptiles, 30 amphibians, 30 small mammal species and numerous plants and insects; many of which have never previously been recorded in Cambodia. A wide range of globally threatened species were shown to be present in relatively high numbers, including tiger (*Panthera tigris*), Asian elephant (*Elephas maximus*), Asiatic wild dog (*Cuon alpinis*), gaur (*Bos frontalis*), pileated gibbon (*Hylobates pileatus*), Siamese crocodile (*Crocodylus siamensis*), elongated tortoise (*Indotestudo elongata*), various hornbills and green peafowl (*Pavo muticus*).

The fauna and flora were not uniformly distributed. The Cardamom Mountains contain a variety of distinct natural habitats, each with their own characteristic wildlife communities. The dry and mixed deciduous forests in the foothills, for example, were found to support the highest density of large mammals such as elephant, fishing cat (*Prionailurus = Felis viverrinus*) and sambhar deer (*Cervus unicolor*: an important prey for tiger); whereas the evergreen forests at higher elevations support a greater proportion of endemic species, such as the chestnut-headed partridge (*Arborophila cambodiana*) and Cardamom banded gecko (*Cyrtodactylus intermedius*). Many plants, several hundred invertebrates and approximately 20 of the small vertebrates found in the montane zone above 900 metres could not be identified using conventional sources, and some of these may be species new to science.

Although the wildlife and their habitats appeared to be largely intact, threats and problems are mounting rapidly. For example, the survey team found evidence of illegal hunting of a wide range of animals both for personal consumption and commercial trade, as well as illegal logging practices and forest clearance for new housing and farms. Returning refugees are starting to settle in this region, and the United Nations Development Programme is facilitating human settlement at the very heart of the Mount Samkos Wildlife Sanctuary. Both of the designated wildlife sanctuaries exist only on paper: they are not marked and have no management.

While the full implications of this survey have yet to be evaluated and discussed, suggested goals for long term conservation are broadly as follows:

- More detailed ecological, social and economic evaluation of the Cardamom Mountains region.
- Establishment of active management in the two designated protected areas: the Mount Samkos Wildlife Sanctuary and Mount Aural Wildlife Sanctuary.
- Establishment of a new area in the Central Cardamom Mountains that protects sufficiently large tracts of lowland evergreen forest and riverine habitats
- Establishment of rigorous and reliable monitoring programmes in areas outside of the protected areas.
- Human development and welfare programmes integrated with biodiversity conservation needs.

These should lead to an agreed spatial plan and zoning of the whole Cardamom Mountain Range and its associated lowland forest and wetland habitats to ensure the protection of globally important biological diversity and the regionally important watershed. This will require maintenance of forest cover, active protection measures and integration of conservation, logging and human development.

A full report on the survey's findings and recommendations is due to be published by July 2000.

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This survey was organised and implemented by the following (in alphabetical order): Mike Appleton, Ros Bansok, Roth Bunthoeun, Megan Cartin, Meas Chandamony, Pete Cutter, Dr Jenny Daltry, Chheang Dany, Jonathan Eames, Ben Hayes, Khou Eang Hout, Jeremy Holden, Ouk Kimsan, Barney Long, Kry Masphal, Oliver Maxwell, Frank Momberg, Meng Monyrak, Matthias Nuss, Sin Polen, Uck Siha, Dr Dave Smith, Frank Steinheimer, Steve Swan, Em Thol and Hunter Weiler. Many of the biologists kindly volunteered their time and expertise for free. The survey also greatly benefited from the advice and assistance of UNDP-Carrere, Kirstin Novell (Cat Action Treasury), David Ashwell (Global Witness), Dr Colin McCarthy (The Natural History Museum), Dr Paul Bates and Ditte Hendrichsen (Harrison Institute), Dr Peter Paul van Dijk (TRAFFIC Southeast Asia), the Wildlife Conservation Society, Col. David Mead (Conservation International), Marcus Hardtke (Arbeitsgemeinschaft Regenwald und Artenschutz) and GAT International.

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1. INTRODUCTION

This document summarises the initial findings and recommendations from the first major biological survey of the Cardamom Mountains in Southwest Cambodia. The survey forms part of Fauna & Flora International's (FFI) long-term strategy for supporting integration of wildlife and forest protection in Cambodia with post-conflict recovery activities in ways that will benefit both wildlife and people. The main goals and objectives of the survey are detailed in Appendix I. A full report of the survey findings and recommendations, dedicated to the memory of Cambodian conservationist Meas Chandamony, will be published in July 2000.

The Cardamom Mountains Region spans more than one million hectares and constitutes three main massifs: Mount Samkos, the Central Cardamom Mountains, and Mount Aural. Ranging up to 1,771 metres (Mount Aural), the mountains are cloaked with a variety of natural forest types according to altitude, aspect, geology and hydrology: dry deciduous forest, semi-deciduous forest, lowland evergreen forest, hill evergreen forest, bamboo thickets and pine forest. There are also sizeable areas of natural marshes and grassland (Ashwell, 1997; Momberg & Weiler, 1999). Human density is very low, and settlements are almost wholly confined to lowland areas near rivers.

Part of the range is protected, at least on paper: the Mount Samkos Wildlife Sanctuary (3,338 km²) to the East and the Mount Aural Wildlife Sanctuary (2,536 km²) to the West. Between the sanctuaries, the Central Cardamom Mountains have been parcelled into logging concessions (Momberg & Weiler, 1999).

Until 1998, security risks combined with lack of infrastructure prevented access to most forest areas in Cambodia, with the exception of the Northeast (Desai & Vuthy, 1996; Timmins & Soriyun, 1998). During the recent war, the Cardamom Mountains provided a strategic refuge for Khmer Rouge, who forced many local villagers to join their cause or flee to refugee camps in neighbouring Thailand. Therefore while valuable biological information has been gathered from aerial and satellite images (Ashwell, 1997) and interviews with hunters (Weiler *et al.*, 1999), very little on-the-ground biological work has occurred in these mountains to date. A limited ornithological survey was performed in 1944 (Engelbach, 1952), and a preliminary large mammal survey was conducted by a small FFI/ Wildlife Protection Office team in April 1999 (Boonratana, 1999). Many areas and most taxa have remained entirely unknown, hampering efforts to develop effective strategies for conservation.

The present survey was therefore primarily intended to produce baseline biodiversity data in order to identify priority species and habitats for protection. While the larger mammals and their habitats were the primary focus, a wide range of other taxa – including plants, bats and other small mammals, reptiles, amphibians and insects – were also surveyed and their conservation needs assessed. Ten foreign biologists, specialising in a wide range of Southeast Asian taxa, were recruited to implement the survey and provide one-to-one training to local counterparts from the Wildlife Protection Office (WPO) and Ministry of Environment (MoE). The biological studies were linked to further studies of human socio-

economics in this region by Oliver Maxwell and Frank Momberg, building on the needs assessment conducted in 1999 (Momberg & Rotha, 1999).

2. MATERIALS & METHODS

2.1 Capacity building

Before going into the field, a workshop was held in Phnom Penh on 19-20 January to introduce the Cambodian counterparts to wildlife survey techniques and to alert everyone to important health and safety issues. Counterparts were then assigned to work with different foreign biologists to enable them to learn survey methodologies by means of one-to-one training, reinforced with hands-on experience. Thanks to previous training by David Ashwell, the MoE team was able to lead the plant survey component of the survey largely independently. A number of the other staff, however, had little or no prior experience of fieldwork and required coaching in basic field techniques, such as map reading and use of global positioning systems. According to which biologist they were assigned to, the counterparts also learned more specialist procedures such as making plaster casts of mammal prints and setting up mist nets to catch bats and birds.

2.2 Survey areas

Two main areas in the Cardamom Mountains were surveyed from 23 January to the beginning of April. The first was the centre of the Mount Samkos Wildlife Sanctuary, about 8 hours by road from Pursat. A semi-permanent base camp was established near Pramuoy. Travelling on foot with local guides and porters, the team was able to survey a wide range of habitats, from dry deciduous forest at 240m above sea level (a.s.l.) to the summit of Mount Samkos (1,717m a.s.l.). Most of the team surveyed both the Mount Samkos/Mount Komaoch complexes to the Southwest of the base camp, and the Mount Tumpor complex to the East.

The second main area to be surveyed was located in the GAT logging concession (Koh Kong Province) in the Central Cardamom Mountains. This concession is accessed by boat and logging road from Koh Kong. A base camp was established approximately two hours by motorbike north of T'Mar Bang village, from where the team could survey the high mountains and valleys in the heart of the range.

2.3 Research methods

A very wide range of techniques were used to survey the various faunal and floral groups, and these will be described in detail in the final report. In view of the main goals of this survey (Appendix I), the methods used were humane, largely non-destructive and geared towards obtaining information of immediate value to conservation.

The biologists endeavoured to spend approximately equal time at low, mid and high elevations, and record the wildlife found in each habitat. Using a methodology previously

used in Cambodia, the MoE plant team employed sophisticated multivariate techniques to analyse and describe the structure and diversity of vegetation communities across a range of elevations in both survey areas. Fertile, unidentified plants were collected and preserved for subsequent study at the Royal Botanic Gardens, Kew, and other leading institutions.

Large mammals were chiefly identified from their tracks, hunter trophies and camera traps. Birds were identified from their calls and by sight, but mist nets were used to capture a limited number of specimens (it is not normally possible to describe a new species or subspecies without having a preserved specimen). The zoologists working on other animal groups, such as amphibians and rodents, typically had to capture them for identification purposes, usually by hand or with various types of live traps. Although producing species checklists was the first priority, the biologists collected a variety of additional relevant autecological data, such as diet, relative density, microhabitat preferences and activity patterns.

As well as the ‘hard evidence’ collected using rigorous biological methods, the biologists and their counterparts conducted informal interviews with numerous local residents, poachers, wood-collectors and loggers in the survey areas to determine whether important species might have been overlooked, and to elucidate the threats to biodiversity in this region.

3. RESULTS

Data are currently being collated and analysed from the participating biologists, but preliminary findings can be summarised as follows:

3.1 Large Mammals

More than 30 species of large mammal were confirmed from tracks, scats, visual searches, bushmeat remains and camera trap photographs. The project mammalogists, all of whom were used to working in other areas in South and Southeast Asia, rated the Cardamom Mountains as being outstanding in terms of its density and diversity of large mammals. Confirmed species include globally threatened mammals such as gaur (*Bos frontalis* = *gaurus*), Asian elephant (*Elephas maximus*), Asiatic wild dog (*Cuon alpinus*), smooth-coated otter (*Lutra perspicillata*), Asiatic black bear (*Ursus thibetanus*), pileated gibbon (*Hylobates pileatus*) and the rare Indo-Chinese subspecies of tiger (*Panthera tigris*). Carnivore specialist Dr Dave Smith concluded that Mount Samkos Wildlife Sanctuary constituted ‘model habitat’ for tigers. While certain large mammals, notably serow (*Naemorhedus* = *Capricornis sumatraensis*), were recorded only at high elevations, lowland habitats appeared to be especially important for elephant, tiger, sambhar (*Cervus*



Mammalogist Pete Cutter shows Kry Masphal (Wildlife Protection Officer) how to measure the tracks of a leopard (*Panthera pardus*)

unicolor) and wild dog, among others. Lack of water may have driven many large mammals down to lower altitudes in the dry season, however. Local people reported that there had been little or no decrease in large mammal populations during their lifetimes, and in some places (e.g., south of T'Mar Bang village, Koh Kong Province), elephant numbers were said to be on the increase.

3.2 Birds

Well over 100 species of forest birds were recorded in the Mount Samkos Wildlife Sanctuary alone, with 15 new national records confirmed by the leaders of the ornithological survey. As well as many resident species, the Cardamom Mountains provide an important staging post for migrants. No new bird species were captured, but new subspecies may be described. While the mountain peaks were found to support fewer montane specialists than other, higher parts of Indochina, the Cardamom foothills are notable for their exceptionally high bird diversity and biomass. Certain IUCN Red List and CITES-listed species such as the green peafowl (*Pavo muticus*) and wreathed hornbill (*Rhytoceros undulatus*), which have become rare in other parts of their range, appeared to be fairly common in the Cardamom Mountains. Two known endemic birds, the Cambodian laughing thrush and chestnut-headed partridge (*Arborophila cambodiana*), were found to be abundant in the higher evergreen forests. A number of resident bird species are targeted for bushmeat for personal consumption, notably silver pheasant (*Lophura nycthemera*), partridges and hornbills.

3.3 Bats and other small mammals

Rodents were surveyed using live traps from 28 January to end-March. Approximately 15 species of rodents had been captured by the middle of the survey, but the final total will not be known until voucher specimens have been fully examined in specialist museums. The mammalogists predict that some of these will be new to science. 14 bat species were captured using harp traps and mist nets on Mount Samkos between 24 February and 8 March. Of these, 8 (57%) were new records for Cambodia, such as the globally threatened *Harpiocephalus mordax*. Further research in the mountain range is bound to yield more species.

3.4 Reptiles

64 species of reptiles (lizards, snakes, tortoises, turtles, and crocodiles) were found in the Cardamom Mountains between 24 January and 8 March 2000. Of these, as many as 23 (36%) are new national records for Cambodia, and at least one species is probably new to science. Impressive though these figures are, they probably fall far short of the actual diversity of reptiles. From work elsewhere in Cambodia and neighbouring countries, there could be a further 72 species yet to be recorded in the wider Cardamom Mountain region. The confirmed checklist includes a large number of endangered reptiles, such as the giant soft-shell turtle (*Pelochelys cantori*) and the Burmese python (*Python molurus*), as well as other species of economic, ecological, cultural and medical importance. Many of the reptiles were morphologically distinct from populations across the border in Thailand and



The spectacular Cambodian masked lizard
(*Acanthasaura crucigera*)

could be described as new subspecies. Perhaps the most significant finding of this survey was the discovery of apparently intact populations of Siamese crocodiles (*Crocodylus siamensis*) in many of the larger rivers and marshes in the Central Cardamom Mountains (Daltry & Dany, in press). This critically endangered species was believed to be virtually extinct in the wild (Ross, 1989) and has disappeared from most other parts of its range.

3.5 Amphibians

30 species of amphibians were found in the Cardamom Mountains within the first month of the survey. At least 8 (27%) are new national records for Cambodia. A further 11 species, chiefly from high elevations, have not yet been identified and probably include several species new to science. The confirmed checklist includes frogs that are locally used for human consumption (e.g., *Rana raja*) as well as important prey for other animals (e.g., *Rana = Limnonectes limnocharis*). From work elsewhere in Cambodia and neighbouring countries, there are probably well over 50 species of amphibians in the wider Cardamom Mountain region.

3.6 Insects

Owing to the great size of this group, a single superfamily of Lepidoptera, the Pyraloidea, were selected to provide a measure of insect diversity and endemism within different types of forest. Preliminary analyses suggest that the Cardamom Mountain Range harbours exceptional species richness: 1973 pyraloid moths were collected using light traps within just three weeks, of which one-quarter to one-third were estimated to be species new to science. Probably most are new national records for Cambodia. In addition, 100 flies, 15 dragonflies, 200 caddisflies, 20 wasps and 200 beetles were collected for identification by leading specialists.

3.7 Plants

The Cardamom Mountain Range supports a high diversity of plants. The vegetation can be broadly separated into elevational zones: the lower slopes are covered by mixed deciduous forests that grade into dry evergreen forest at an elevation of about 400 m a.s.l. Both types are broken up by dense stands of bamboo that have invaded disturbed (landslide or logged) areas. At around 1,000m a.s.l. the evergreen forest becomes conspicuously wetter, with many palms, tree ferns and a greater diversity of trees that include *Pinus merkusi*. Above about 1,300m a.s.l., the forest undergoes another transformation into a moist montane/cloud forest type. Here the trees become stunted (about 15m maximum canopy height), encrusted with mosses, lichens and epiphytes. *Quercus spp.* (oaks) appear in this zone. The forest on the high plateaus is punctuated by clearings of bare rock and grasses, with

Zingerveraceae (wild gingers) and *Rhododendron spp.* at the margins. The plant survey team's parataxonomist was able to identify only about 40% of the trees at the highest elevations, so dozens of unidentified specimens were collected and preserved. Many commercially important plants were recorded, such as *Calamus spp.* (rattan, widely used as a building material) above 300 m a.s.l., and 'kresna wood' (*Aquilaria sp.*, exported for perfume production). Data analysis has yet to be completed, but the survey team believes that some of the vegetation communities are unique to the Cardamom Mountains.

Botanist Khou Eang Hout, Ministry of Environment, preserves unidentified plants from the mountains



4. DISCUSSION

4.1 Conservation importance of the Cardamom Mountains

Although the present survey is the most extensive and detailed to have been conducted in the Cardamom Mountains to date, the species checklists are still far from complete. The total area actually visited represents only a tiny fraction of the total area of this region and, while fieldwork had to be conducted during the dry season for logistical reasons, this is in fact the worst time of year to survey most taxonomic groups (many animals were at their least active and fewer plants were flowering or fruiting at this time, hampering identification). The fact that such a great number of plants and animals were discovered in a short period in a relatively small area is testimony to the extraordinary biodiversity and pristine condition of the Cardamom Mountains. Further work is bound to yield more species and surprises.

Bearing in mind the limitations outlined above, this survey has nevertheless proven that this region is of exceptional conservation value. The Cardamom Mountains form arguably the most pristine wilderness remaining in mainland Southeast Asia. This range contains a great diversity of habitats (based on variations in altitude, geology, aspect and hydrology) which in turn support diverse communities of plants and animals, some unique to this mountain range. A number of globally threatened species that are rare or extirpated elsewhere in Asia, such as the tiger, Asian elephant, various hornbills and green peafowl, appear to occur in healthy numbers here. The remote nature of the Cardamom Mountains, coupled with the recent war, may have protected such species from over-hunting to date.

Two large species were especially sought after by our mammalogists, but were not found. Both the khting vor (*Pseudonovibos spiralis*) and Javan rhino (*Rhinoceros sondaicus*) have been reported in the Cardamom Mountains by local hunters/ wood collectors (Thouless, 1987; Weiler *et al.*, 1999). In view of the vast size of this region, however, these important and critically endangered species could still be present, albeit in low numbers. Failure to confirm the presence of these mammals was partly compensated by the discovery of seemingly intact populations of Siamese crocodiles in rivers on the southern slopes of the

Central Cardamom Mountains. This species was until recently considered to be virtually extinct in the wild (Ross, 1989), and the Cardamom Mountains may present its last real hope of survival.

From a preliminary analysis of the data gathered to date, it is unclear which habitats merit greatest conservation status. For example, the high mountain forests above 900m a.s.l. contain a number of known threatened mammals (e.g., serow), as well as endemic species that have evolved in the relative isolation of these peaks (e.g., chestnut-headed partridge). It may be significant that most of the small vertebrates and invertebrates that have not yet been identified were from this zone. These high forests also contribute to the Cardamom Mountain Range's important role as a watershed for the Mekong/ Tonle Sap and thus much of Cambodia's arable land (Momberg & Weiler, 1999).

In the foothills, on the other hand, the biologists discovered fewer endemic animals, but relatively high densities of endangered large mammals such as Asian elephants and tiger. This important zone also contains extensive areas of lowland evergreen forests, one of the most threatened and species-rich forest types in Southeast Asia. Even in the most accessible lowland areas, the team found no sign of alien invasive species. Large rivers and marshes in this zone support a wealth of threatened aquatic wildlife, including turtles, otters and crocodiles. To conserve maximum biodiversity in the Cardamom Mountains, it will therefore be necessary to protect a wide array of habitats.

4.2 Threats to biodiversity

While the current levels of human disturbance and exploitation appear to be relatively minor and probably sustainable at present, pressures on this region are mounting and that important wildlife and habitats will be lost unless action is taken. New roads are under construction, criss-crossing the mountain range and opening the area up for the first time (e.g., the logging companies Yourysaco and GAT International are building two all-weather roads between Koh Kong and Pursat: the first could be completed by 2001). This will undoubtedly help illegal loggers and poachers to access more parts of the range rapidly and extract wood, trophies and other goods more easily.



A new logging road slices through evergreen forests in the Central Cardamom Mountains

Evidence was found of illegal hunting of a wide range of animals for personal consumption (e.g., binturong, elephant, gibbon, wild boar, hornbills, monitor lizard, turtles) and, to a lesser but growing extent, commercial trade (notably tiger). Animals are hunted using selective and non-selective snares, anti-personnel mines and guns. In virtually every case in which we noted wildlife materials being sold or transported, the hunters and dealers freely displayed the illegal materials and readily provided any details requested. This shows a worrying lack of concern for 'official' scrutiny, which may be indicative of inadequate law enforcement and/or a lack of awareness of Cambodia's wildlife laws among local

communities. In addition to illegal activities by nationals, the survey team was informed of Vietnamese and Thai poachers entering the mountain range with high power weapons.

Illegal logging practices were also observed both in the wildlife sanctuary and the Central Cardamom Mountains. This growing problem is compounded by encroachment by returning refugees, building new houses and farms. The survey team noted that the United Nations Development Programme was supporting the development of settlements at the very heart of the Mount Samkos Wildlife Sanctuary, as part of the post-war reconciliation process (both of the designated wildlife sanctuaries exist only on paper: they are not marked and have no management).

4.3 Provisional recommendations

While the full implications of this survey have yet to be evaluated and discussed in detail, suggested goals for long term conservation are broadly as follows:

- More detailed ecological, social and economic evaluation of the Cardamom Mountains region.
- Establishment of active management in the two designated protected areas: the Mount Samkos Wildlife Sanctuary and Mount Aural Wildlife Sanctuary
- Establishment of a new area in the Central Cardamom Mountains that protects sufficiently large tracts of lowland evergreen forest and riverine habitats
- Establishment of rigorous and reliable monitoring programmes in areas outside of the protected areas.
- Human development and welfare programmes integrated with biodiversity conservation needs

These should lead to an agreed spatial plan and zoning of the whole Cardamom Mountain Range and associated lowland forest and wetland habitats to ensure the protection of globally important biological diversity and the regionally important watershed. This will require maintenance of forest cover, active protection measures and integration of conservation, logging and human development.

To fulfil these recommendations, a substantial programme needs to be developed with support from a wide range of agencies and donors.

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APPENDIX I

Survey Goals

1. To produce baseline biodiversity data that will identify priority species and areas within the Cardamom Mountains for protection, and strengthen the capacity of the Wildlife Protection Office and Ministry of Environment to conserve and monitor them.
2. To make use of the information gained from the biodiversity assessment and socio-economic survey to ensure that post-conflict recovery and human assistance and development programmes can be integrated with wildlife and forest protection.

Objectives

1. To build the capacity of Cambodian conservationists in appropriate survey and monitoring techniques. Training should encompass all stages from survey design and implementation to data analysis and report presentation.
2. To document the diversity of various taxonomic groups across the range of habitats, and identify species of special conservation concern.
3. To evaluate the status, distribution and habitat use of endangered large mammals and other species of special conservation concern.
4. To identify the main threats to the biodiversity of the survey areas.
5. To identify current and probable future uses of the forests and wildlife by local people in and around the Cardamom Mountains, noting both sustainable and non-sustainable types of exploitation.
6. To identify priority areas for protection within the Cardamom Mountains, with reference to other protected areas in Cambodia, the known threats and their overall biological diversity and/or presence of globally threatened species.
7. To produce a comprehensive report that presents the survey methodology and findings together with a series of specific, practical and well-founded conservation management recommendations for the Cardamom Mountains.
8. To raise awareness of the Cardamom Mountains among potential donors and the wider conservation community through a variety of media including scientific papers, popular articles and slide presentations.