Biological surveys

of the Mekong River between Kratie and Stung Treng towns, northeast Cambodia, 2006-2007

Edited by Mark R. Bezuijen, Robert Timmins and Teak Seng

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WWF Greater Mekong - Cambodia Country Programme

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ទន្លេមេគង្គគឺជាបេះដូងនៃប្រទេសកម្ពុជា។ ទន្លេនេះហូរចូលមកក្នុងប្រទេសកម្ពុជាតាមខេត្តស្ទឹងត្រែង និងបន្តហូរឆ្ពោះទៅទិសខាងត្បូងកាត់ភូមិភាគកណ្តាលនៃផ្ទៃប្រទេសទាំងមូល និងឆ្លងកាត់តាមរាជធានីភ្នំពេញមុននឹងហូរចាក់ទៅដែនដីសណ្តោរនៃទន្លេមេគង្គក្រោម។ បឹងបួរ ដៃទន្លេ និងទំនាបលិចទឹកទន្លេមេគង្គរាប់បញ្ចូលទាំងបឹងទន្លេសាបផង សុទ្ធសឹងជាទីជម្រកដែលទ្រទ្រង់ដល់ការរស់នៅពពួកសត្វ និងរុក្ខជាតិដ៏សំបូរបែបក្នុងនោះមានទាំងពពួកសត្វដែលរងការគំរាមកំហែងជាសាកលដូចជា ត្រី កន្ធាយ និងក្រពើ ព្រមទាំងពពួកសត្វស្លាបទឹកដែលបន្តពូជនៅទីនោះផងដែរ ។ ទន្លេមេគង្គក៏ជាផ្នែកមួយនៃមរតកវប្បធម៌របស់ប្រទេសកម្ពុជាផងដែរ ពោលគឺប្រជាពលរដ្ឋខ្មែរបាន និងកំពុងរស់នៅដោយពឹងអាស្រ័យលើធនធានទន្លេមេគង្គតាំងពីរាប់ពាន់ឆ្នាំកន្លងមកហើយ ។ ផលនេសាទទឹកសាបរួមចំណែកច្រើនជាង៥0%នៃផលចាប់សរុបរបស់ប្រទេសកម្ពុជា ហើយប្រជាជនកម្ពុជាយ៉ាងតិចមួយភាគបីប្រកបរបរចិញ្ចឹមជីវិតដោយការនេសាទ និងលក់ផលត្រី។

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របាយការណ៍នេះបង្ហាញពីទីកន្លែងមួយដែលមានសារសំខាន់ខ្ពស់បំផុតសំរាប់ថ្នាក់ជាតិនិងសាកល និងរួមចំណែកយ៉ាងសំខាន់ក្នុងការផ្តល់នូវចំណេះដឹង និងការយល់ដឹងអំពីជីវចម្រុះនៃទន្លេមេគង្គ។ របាយការណ៍នេះពិពណ៌នាអំពីលទ្ធផលនៃការសិក្សាអង្កេតលើជីវចម្រុះទន្លេមេគង្គដែលបានធ្វើឡើងដោយក្រុមអ្នកស្រាវជ្រាវពីស្ថាប័នរដ្ឋាភិបាល និងអ្នកជំនាញការអន្តរជាតិនៅក្នុងឆ្នាំ ២00៦ និង ២00៧ នៅតាមដងទន្លេមេគង្គក្នុងខេត្តក្រចេះ និងស្ទឹងត្រែងដែលស្ថិតនៅភាគខាងជើងនៃប្រទេសកម្ពុជា ។ រុក្ខជាតិថ្មីមួយប្រភេទត្រូវបានកត់ត្រាជាលើកដំបូងសម្រាប់វិទ្យាសាស្ត្រ ក៏ដូចជាការកត់ត្រាថ្មីៗសម្រាប់ប្រទេសកម្ពុជាផងដែរនូវប្រភេទរុក្ខជាតិ ត្រី និងល្មូនដែលមានដោយកម្រ។ គេក៏បានកត់ត្រាពីនិគមន៍សត្វស្លាបចំនួនពីរប្រភេទធំបំផុតលើពិភពលោក និងហ្វូងសត្វស្លាបផ្សេងទៀតស្ថិតក្នុងវ័យបន្តពូជដែលមានច្រើនបំផុតនៅតំបន់អាស៊ីអាគ្នេយ៍រួមទាំងសំបុកសត្វកន្ធាយមួយប្រភេទដែលជិតផុតពូជផងដែរ។ តំបន់នេះធ្លាប់មានដង់ស៊ីតេប្រជាជនរស់នៅក្នុងកម្រិតទាប ហើយច្រាំងទន្លេលើវិសាលភាពជាច្រើនគីឡូម៉ែត្រនៅតែបានបន្តទ្រទ្រង់ដល់ការដុះលូតលាស់នៃព្រៃធម្មជាតិនៅឡើយ ។ តំបន់នេះក៏ជាប្រភពធនធានធម្មជាតិសំខាន់ៗជាច្រើនប្រភេទផងដែរ សម្រាប់សហគមន៍មូលដ្ឋានដែលអាចនេសាទត្រីបានជាច្រើននៅឡើយ ដោយសារតែទីជម្រកនៅទីនោះពុំទាន់ទទួលរងនូវការបំផ្លិចបំផ្លាញ ហើយសម្ពាធនៃការនេសាទនៅ

មានកម្រិតទាបនៅឡើយបើប្រៀបធៀបនឹងកន្លែងដទៃទៀត ។ ក្រៅពីនេះ នៅមានសត្វចំនួនពីរប្រភេទទៀតដែលជិតផុតពូជគឺសត្វ ផ្សោតទន្លេមេគង្គ និងសត្វក្តាន់ដែលគេបានរកឃើញថាជាហ្វូងចុងក្រោយបង្អស់នៅសេសសល់ក្នុងតំបន់ឥណ្ឌូចិន ។

ក្រុមស្រាវជ្រាវក៏បានចងក្រងទុកជាឯកសារផងដែរពីកត្តាគំរាមកំហែងនានាជាច្រើនចំពោះជីវចម្រុះទាំងនេះដែលរួមមានទាំង ការកើនឡើងយ៉ាងឆាប់រហ័សនៃការតាំងទីលំនៅលើកោះ និងច្រាំងទន្លេ កំណើនការនេសាទ ការបរបាញ់សត្វព្រៃយ៉ាងពេញទំហឹង និង សកម្មភាពរានឆ្ការព្រៃធម្មជាតិដែលនៅសេសសល់ ។ បើពុំមានការគ្រប់គ្រងទេនោះ គុណតម្លៃនៃជីវចម្រុះនានាដូចដែលបានរៀបរាប់ខាង លើនេះនឹងត្រូវធ្លាក់ចុះឬក៏បាត់បង់ក្នុងអំឡុងពេល១០ឆ្នាំក្រោយនេះ ។

ក្រោមកិច្ចសហប្រតិបត្តិការយ៉ាងជិតស្និទ្ធជាមួយអាជ្ញាធរខេត្តក្រចេះ និងស្ទឹងត្រែង ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ កំពុងតែបោះជំហានទៅមុខយ៉ាងឆាប់រហ័សក្នុងការអភិរក្សជីវចម្រុះដ៏មានតម្លៃទាំងនេះ ។ នៅក្នុងសិក្ខាសាលាដែលបានរៀបចំឡើងនៅ ក្នុងខែកុម្ភៈ ឆ្នាំ២០០៨ ស្ថាប័នថ្នាក់ជាតិ និងថ្នាក់ខេត្ត បានឯកភាពគ្នាក្នុងការកំណត់ផ្នែកមួយនៃតំបន់សិក្សាស្រាវជ្រាវនេះសម្រាប់ជា " ទីតាំងគ្រប់គ្រងពិសេស " ។ ការគាំទ្រថ្នាក់ជាតិក៏បានអះអាងឡើងវិញផងដែរអំពីការបង្កើតឱ្យមានតំបន់ការពារសត្វក្តាន់ ។ ព័ត៌មាន ដែលប្រមូលបាននៅក្នុងអំឡុងពេលនៃការសិក្សាអង្កេតបានផ្តល់ជាមូលដ្ឋានគ្រឹះ សំរាប់ការគ្រប់គ្រងផ្នែកតូចមួយនេះនៃអាងទន្លេមេគង្គ ហើយខ្ញុំសូមអបអរសាទរដល់ក្រុមអ្នកសិក្សាស្រាវជ្រាវដែលបានផ្តល់នូវរបកគំហើញទាំងនេះ ។

រដ្ឋមន្ត្រីក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ

FOREWORD

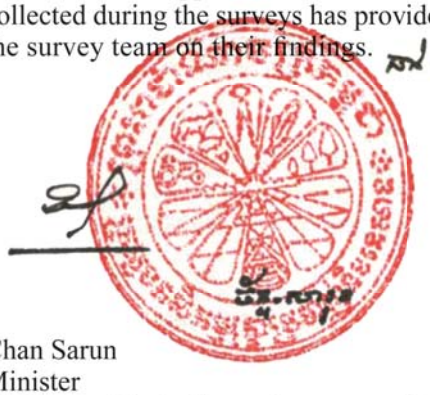
The Mekong River forms the heart of Cambodia. Entering Cambodia in the province of Stung Treng, the river flows south through the center of the nation and past the capital, Phnom Penh, before draining into the Mekong Delta. Its floodplains, tributaries and lakes, including the Tonle Sap Great Lake, support a rich assemblage of fauna and flora, including populations of globally threatened fish, turtles, crocodiles and breeding colonies of waterbirds. The river also forms an integral part of Cambodia's culture: Khmer people have depended upon its resources for thousands of years and today, inland fisheries contribute over 90% of Cambodia's total fish catch and at least one-third of the population is involved in fish capture and sale.

Cambodia, like other nations in the Mekong Basin, now faces a major challenge to balance biodiversity conservation with the needs of its growing human population. New economic development, especially water-based infrastructure, is placing new pressures on wetland resources. The importance of maintaining the Mekong's resources for biodiversity, national food security and development is well-recognised by the Royal Government of Cambodia, and is reflected in the targets of the National Biodiversity Strategy and Action Plan (2002) and Cambodia's Millenium Development Goals. To achieve these goals, a critical first step is to document the Mekong's biodiversity and natural resources: baseline information is urgently required for many areas to assist national and provincial government agencies to review the impact of proposed river developments and to identify wetland conservation priorities.

The current report describes an area of very high national and global importance and makes a significant contribution to our knowledge and understanding of the biodiversity of the Mekong River. The report describes the results of biodiversity surveys conducted in 2006 and 2007 along the Mekong River in Kratie and Stung Treng Provinces, northeast Cambodia, by a team of government agencies and international specialists. In this remote region of the Mekong, a new plant species for science was discovered, as well as new national records of other rare plants, fish and one reptile. The largest global populations of two bird species were found, as well as some of the largest breeding colonies in Southeast Asia of other bird species and nests of an endangered giant turtle. Human populations were low and many kilometers of riverbank still supported natural vegetation. The area also provides critical natural resources for local communities, who reported that large fish catches are still possible because habitats are intact and fishing pressures are low compared to other areas. Two other critically endangered species were already known to occur in the area, the Mekong population of the Irrawaddy Dolphin, and the last-known population of Hog Deer in Indochina.

The team also documented many threats to these outstanding values, including rapid human settlement of islands and riverbanks, and increasing fishing, intensive wildlife hunting, and rapid clearance of the remaining natural forests. Without management, many of the biodiversity values documented in this area will decline or be lost within the next 10 years.

The Ministry of Agriculture, Forestry and Fisheries, in close collaboration with provincial government offices in Kratie and Stung Treng Provinces, is moving rapidly to conserve these values. At a workshop in February 2008, national and provincial agencies agreed that part of the area will be designated as a "special management site". National support was also reconfirmed for the designation of a protected area for Hog Deer. The information collected during the surveys has provided a basis for management of this section of the Mekong and I congratulate the survey team on their findings.



Chan Sarun
Minister
Ministry of Agriculture, Forestry, and Fisheries

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ABRREVIATIONS AND CONVENTIONS

Abbreviations

AIT	Asian Institute of Technology
ARL	At Risk in Laos
asl	above sea level
c.	approximately
CARL	Conditionally At Risk in Laos
CI-IP	Conservation International – Indo-Burma Programme
CMDCP	Cambodia Mekong Dolphin Conservation Project
CMU	Chiang Mai University Herbarium
CORIN	Coastal Resources Institute of the Prince of Songkla University
DD(G)	Data Deficient (Globally)
FA	Forestry Administration
FiA	Fisheries Administration
GNT	Globally Near-threatened
GT	Globally Threatened
GT-CR	Globally Threatened-Critically Endangered
GT-EN	Globally Threatened-Endangered
GT-VU	Globally Threatened-Vulnerable
IFREDI	Inland Fisheries Research and Development Institute
IUCN	International Union for the Conservation of Nature
LKL	Little Known in Laos
MAFF	Ministry of Agriculture, Forestry and Fisheries
MIME	Ministry of Industry, Mines and Energy
MoE	Ministry of Environment
MoT	Ministry of Tourism
MRC	Mekong River Commission
MWBP	Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme
NGO	Non-government organisation
OLT	On-Line Table (data of current report for download at www.panda.org/greatermekong/survey)
PARL	Potentially At Risk in Laos
Thai-CR	Critical in Thailand
Thai-DD	Data Deficient in Thailand
Thai-EN	Endangered in Thailand
Thai-EW	Extinct in the wild in Thailand
Thai-NT	Near-Threatened in Thailand
Thai-VU	Vulnerable in Thailand
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

Conventions

Global Threat Categories for vertebrate fauna

These are categories from the *1996 IUCN Red List of threatened animals* (IUCN 2007). They relate to the threat to the survival of a taxon across its entire world range.

Globally Threatened - Critical (GT-CR): the taxon faces an extremely high risk of extinction in the wild in the immediate future. "Critically Endangered" is also used.

Globally Threatened - Endangered (GT-EN): the taxon faces a very high risk of extinction in the wild in the near future.

Globally Threatened - Vulnerable (GT-VU): the taxon faces a high risk of extinction in the wild in the medium-term future.

Globally Near-Threatened (GNT): the taxon is at Lower Risk but close to qualifying for Vulnerable.

Data Deficient (DD): a taxon for which there is inadequate information to make a direct, or indirect, assessment of its risk of global extinction in the wild. This category does not imply the taxon is certainly Globally Threatened; further data could show the taxon is presently secure globally.

Lists of protected vertebrate fauna in Cambodia

In Cambodia, fauna are divided by the government into "forest" or "aquatic" species and are under the jurisdiction of the Forestry or Fisheries Administrations respectively. "Forest species" are listed under the *Prakas* [law] *on Classification and List of Wildlife Species* (No. 020, MAFF, 25 January 2007) as "**Endangered**" (EN), "**Rare**" (RAR) or "**Common**" (COM). The criteria used to define these categories include consideration of IUCN and CITES listings and national distribution, abundance and apparent decline. "Aquatic" species are listed under the draft *Prakas on Endangered species for Cambodia fishery resources* as "**Endangered**" (EN), "**Vulnerable**" (VU) or "**Rare**" (RAR). (At the time of writing this listing was an incomplete draft and explanations of categories were unavailable).

Threat categories for vertebrate fauna in Lao PDR and Thailand

These are categories developed for birds, mammals, amphibians and reptiles in Lao PDR (Duckworth et al. 1999) and Thailand (Sanguansombat 2005; Nabhitabhata & Chan-ard 2005), and for fish in Thailand (Vidthayanon 2005). They relate specifically to the threat to survival of a species in these countries. Elsewhere in a taxon's world range, it may be secure, even numerous. Lists of "key species" given by these authors are considered appropriate for use in the current report because the fauna of Cambodia, Lao PDR and Thailand are similar and face similar threats. Risk categories are intended to be roughly equivalent to IUCN Red List global threat categories, applied at a national level (e.g. Lao risk categories ARL/ PARL/LKL are roughly equivalent to the global categories GT/ GNT/DD, Duckworth et al. 1999). National listings for amphibians, reptiles and fish are incomplete due to insufficient data for some species to make conservation risk status assessments.

From Duckworth et al. (1999):

At Risk in Lao PDR (ARL): this category is roughly

equivalent at a national level to the Globally Threatened categories of IUCN (1996). Minor amendments (see Thewlis *et al*. 1998) result in the exclusion of some species for which the only threat is long-term habitat loss and which might be considered "Vulnerable" following the criteria of IUCN (1996).

Potentially At Risk in Lao PDR (PARL): this category includes species (a) suspected to be At Risk in Lao PDR but where information about threats or species status is insufficient to make a firm categorisation, and (b) species on or close to the borderline of At Risk in Lao PDR.

Conditionally At Risk in Lao PDR (CARL): this category includes species which are not confirmed to be currently extant in Lao PDR, but if they are, will clearly be At Risk in Lao PDR. Usually, this judgment is made by analogy to the status of related species. This category is used with reptiles and mammals, but not birds: bird species now apparently extinct as breeders may recolonise from neighbouring countries, and some (perhaps all) of them continue to visit Lao PDR as non-breeders in small numbers. Thus, categorization of them as At Risk in Lao PDR is more appropriate.

Little Known in Lao PDR (LKL): this category provides for species where the conservation status is difficult to assess, i.e. those with detection or identification problems, or where fieldwork within their preferred range and habitats has been restricted, or where threats or species status are not clear for other reasons.

From Sanguansombat (2005):

Extinct in Thailand (Thai-RE): Species once known to occur in Thailand as breeders but now considered extinct there as a wild breeding population.

Critical in Thailand (Thai-CR): Equivalent to the corresponding global threat category, but based only on the Thai population.

Endangered in Thailand (Thai-EN): Equivalent to the corresponding global threat category, but based only on the Thai population.

Vulnerable in Thailand (Thai-VU): Equivalent to the corresponding global threat category, but based only on the Thai population.

Near-Threatened in Thailand (Thai-NT): Equivalent to the corresponding global threat category, but based only on the Thai population.

Miscellaneous definitions

The region "Indochina" indicates Cambodia, Lao PDR and Viet Nam.

The term "ecoregion" refers to a "geographically distinct assemblage of natural communities that (a) share a large majority of their species and ecological dynamics; (b) share similar environmental conditions; and (c) interact ecologically in ways that are critical for their long-term persistence" (Abell et al. 2000: 283).

Names of villages and islands follow the *Service Geographique De L'Indochine and USAMSFE* 1:50,000 topographic map series for the study area as far as possible. Some map names were not recognized by local communities and some islands did not have map names: for these, names provided by local residents are used. A gazetteer of standardized names is in Annex 1.

Common Khmer language elements for distinctive landscape features are *o* (river), *koh* (island), *trapeang* (pond), *boeng* (lake) and mountain/hill (*phnom*), and these are included in the full names of such features e.g. O Krieng River, Koh Norong Island. The Khmer prefix of *phum* (village) is excluded for brevity and because *phum* is often substituted by *koh* for communities on islands in the study area e.g. Dambong village.

Natural features. The following definitions were used in describing common or important landscape features in the context of the study area.

Beaches and sandbars: *Beaches*-Sand accumulations along the high-water mark i.e. always adjacent to unflooded areas on islands or the mainland, and only partly surrounded by water. *Sandbar*-sand formation surrounded by water and not attached to non-flooded areas. *Sand formations*-collective term for beaches and sandbars.

Deep pool: A section of the mainstream which is "significantly deeper than surrounding areas and holds water in the dry season, during which it may become disconnected from the main river. A deep pool is also defined ecologically as being of significance for the conservation of a number of fish species" (Chan 2005: 58).

Central section: Section of Mekong River mainstream mid-way between Kratie and Stung Treng Towns, which contains some of the highest conservation values and lowest human densities in the study area.

Channel: Area through which the Mekong River flows (between bank tops) at the height of the flood seasons (Timmins 2006).

Island: Areas above the tops of the banks which are never / very briefly inundated by flood waters and form islands in the channel during the wet season (Timmins 2006).

Riparian: When referring to flora (Section 3) this term refers only to vegetation within the river channel up to the top of the channel banks i.e. Aquatic Zones 1-6. It does not include vegetation above the high-water mark, which is termed "terrestrial".

For vertebrate fauna (Sections 4-7) "riparian" is used as a general term to denote the belt of relatively thick, tall vegetation which is often (but not always) present along the riverbanks in the study area and is often <50 m wide. In descriptions of fauna habitat, this term does not imply any floristic community, may collectively include vegetation along, just below or just above the high water mark, and acknowledges the critical value of this habitat for many fauna. The term is also used interchangeably with "riverbank forest".

The disparity of botanical and zoological definitions for this term is acknowledged but maintained in this report given its importance for describing botanical and fauna habitats.

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១-សារៈនៃការសិក្សាអង្កេតជីវចម្រុះទន្លេមេគង្គ: ការសិក្សាអង្កេតនេះបានផ្តោតជាសំខាន់នៅត្រង់ផ្នែកមួយនៃទន្លេមេគង្គរវាងទីរួមខេត្តក្រចេះ និងទីរួមខេត្តស្ទឹងត្រែង ។ ទីតាំងនេះជាផ្នែកមួយនៃតំបន់ដែលមានលក្ខណៈជលសាស្ត្រប្លែកពីគេ និងធំជាងគេមួយនៃទន្លេមេគង្គ ហើយដែលមានប្រវែង ៣៣0 គ.ម គិតចាប់ពីទីប្រជុំជនប៉ាក់សេ (ប្រទេសឡាវ) បន្តឆ្ពោះទៅភាគខាងត្បូងនៃទីរួមខេត្តក្រចេះ។ តំបន់នេះមានលក្ខណៈសំគាល់ពិសេសដោយមានជ្រលងទឹកហូរធំទូលាយ និងបែកជាដៃធំៗជាងគេចំនួនបីនៅត្រង់ចំណុចខាងជើងទីរួមខេត្តស្ទឹងត្រែង ពោលគឺទន្លេសេកុង សេសាន និងស្រែពកដែលដៃទាំងបីនេះអាចផ្តល់ធារទឹកប្រចាំឆ្នាំច្រើនជាង២៥% (MRC ២០០៥)។ ទីតាំងសិក្សានេះមានរបបទឹកប្រែប្រួលយ៉ាងខ្លាំងទៅតាមរដូវ ហើយកំពស់ទឹករវាងរដូវប្រាំង និងរដូវវស្សាខុសគ្នាច្រើនជាង១0ម៉ែត្រ។ មុនទសវត្សរ៍ឆ្នាំ១៩៩0 ការចេញ-ចូលក្នុងកន្លែងជាច្រើននៃតំបន់សិក្សានេះត្រូវស្ថិតនៅក្រោមការដាក់កំហិតដោយសារអស្ថិរភាពនយោបាយ និងការហាមឃាត់ដោយយោធា ហើយកាលនោះមានអ្នកស្រាវជ្រាវមួយចំនួនតូចប៉ុណ្ណោះដែលបានចូលទៅដល់ទីតាំងនេះ។ ទិន្នន័យដែលមានស្រាប់បានឱ្យដឹងថា ទីតាំងសិក្សាស្រាវជ្រាវនេះមានតំលៃខ្ពស់ខាងផ្នែកជីវចម្រុះ ប៉ុន្តែភាគច្រើននៅពុំទាន់មានការអះអាងច្បាស់នៅឡើយទេ។

២- ការសិក្សាអំពីជីវសាស្ត្រត្រូវបានធ្វើឡើងចំនួនបីដងតាមរដូវកាលដែលរួមមានលើកទីមួយ នៅដើមរដូវប្រាំង (ពេលដែលកំពស់ទឹកទន្លេស្រកចុះក្នុងខែ វិច្ឆិកា ឆ្នាំ ២០0៦) លើកទីពីរ នៅពាក់កណ្តាលរដូវប្រាំង (ពេលដែលកំពស់ទឹកចុះទាប គឺនៅចន្លោះខែមីនា និងមេសា ឆ្នាំ២00៧) និងលើកទីបី នៅរដូវវស្សា (ពេលដែលទឹកទន្លេមានកំពស់ខ្ពស់គឺនៅចន្លោះខែកក្កដា និងសីហា ឆ្នាំ២00៧)។ សម្រាប់ដំណាក់កាលនីមួយៗ ការសិក្សាអង្កេតបានប្រើពេលសរុបពី ១៥ ទៅ ២៥ថ្ងៃ ហើយរយៈពេលសរុបសំរាប់ការសិក្សាអង្កេតទាំងអស់ គឺ ២២0ថ្ងៃ។

៣- "ផ្នែកកណ្តាល"នៃទីតាំងសិក្សាស្រាវជ្រាវ: ការសិក្សាអង្កេតផ្តោតជាចំបងត្រង់ផ្នែកមួយនៃទន្លេដែលមានចម្ងាយសរុប ៥0គម ស្ថិតនៅរវាងទីរួមខេត្តក្រចេះ និងស្ទឹងត្រែង ។ ផ្នែកនេះត្រូវបានឱ្យឈ្មោះថា "ផ្នែកកណ្តាល"។ ផ្នែកនេះលាតសន្ធឹងចាប់ពីត្រង់ចំណុច ៤៩គ.ម នៅភាគខាងជើងនៃទីរួមខេត្តក្រចេះរហូតដល់ត្រង់ចំណុចដែលស្ថិតនៅចម្ងាយ ១៤ គ.ម ខាងជើងនៃព្រំប្រទល់ខេត្តក្រចេះ និងខេត្តស្ទឹង

ត្រែង។ នៅត្រង់ផ្នែកនេះ ដង់ស៊ីតេប្រជាជនមានកម្រិតទាបបំផុត ហើយទីជម្រកភាគច្រើននៅតាមដងទន្លេត្រង់ផ្នែកនោះពុំទាន់រងនូវការបំផ្លិចបំផ្លាញនៅឡើយ និងមានផ្សំដោយបណ្តុំរុក្ខជាតិដ៏សំបូរបែបដែលលិចទឹកតាមរដូវ ផ្ទុកខ្សាច់ ច្រាំងខ្សាច់ អន្លង់ជ្រៅៗ ទឹកជួរ ព្រៃនៅតាមច្រាំងទន្លេ និងកោះជាច្រើន។ នៅតាមផ្ទៃច្រាំងទន្លេដែលមានប្រវែងជាច្រើនគីឡូម៉ែត្រ និងកោះនានាពុំទាន់មានមនុស្សតាំងទីលំនៅទេ។ ទីជម្រកដែលនៅមានលក្ខណៈធម្មជាតិត្រង់ផ្នែកនេះនៃដងទន្លេ ចំនងជាកើតឡើងដោយសារកត្តារួមគ្នានៃដង់ស៊ីតេប្រជាជនទាប និងអស្ថិរភាពនយោបាយកាលពីពេលមុនដែលជាការកំហិតមិនឱ្យមានការសង់លំនៅដ្ឋានរហូតដល់ទសវត្សរ៍មុននេះ ។

៤- ព្រៃ និងរុក្ខជាតិ: ការសិក្សាអង្កេតនានាបានផ្តោតលើការធ្វើសារពើភ័ណ្ឌ និងការចងក្រងប្រមូលផ្តុំនូវប្រភេទរុក្ខជាតិថ្នាក់ខ្ពស់នៅតាមបណ្តោកោះផ្សេងៗ និងប្រភេទជម្រកក្នុងទឹកនៅតាមជ្រលងទឹកទន្លេ រួមជាមួយការប្រមូលផ្តុំប្រភេទរុក្ខជាតិថ្នាក់ទាបនៅក្នុងទឹក (ប្រភេទស្លែ) ម្តងម្កាលផងដែរ។ កម្រងទិន្នន័យស្តីពីរុក្ខជាតិ សេចក្តីអធិប្បាយសង្ខេបអំពីរុក្ខជាតិ និងបញ្ជីសារពើភ័ណ្ឌរុក្ខជាតិ និងទីជម្រកមានភ្ជាប់ដោយរូបថតត្រូវបានបង្កើតឡើង។ ឯកសារចងក្រងចំនួនបួនឈុតស្តីពីប្រភេទរុក្ខជាតិទាំងអស់ដែលបានជួបប្រទះ និងការប្រមូលផ្តុំសំណាករុក្ខជាតិ (ច្រើនជាង ៧00 សំណាក) ត្រូវបានរៀបចំឡើង និងបានដាក់ជូនទៅស្ថាប័ននានានៃប្រទេសកម្ពុជា និងវិទ្យាស្ថានអន្តរជាតិ។ នេះគឺជាបញ្ជីសារពើភ័ណ្ឌលំអិតដំបូងបង្អស់ស្តីពីរុក្ខជាតិនៅតាមបណ្តោកោះក្នុងតំបន់ទន្លេមេគង្គកម្ពុជា។

៥- ព្រៃចំបង៧ពីរបែបត្រូវបានបែងចែកដាច់ពីគ្នា ពោលគឺប្រភេទព្រៃក្នុងទន្លេ (ព្រៃដែលដុះនៅក្នុងទឹកទន្លេចាប់ពីបាតទន្លេរហូតដល់កន្លែងដែលកំពស់ទឹកអតិបរិមានៅរដូវវស្សាអាចលិចដល់) និងប្រភេទព្រៃដីគោក(ព្រៃដែលដុះនៅទីតាំងខ្ពស់ជាងទឹកជំនន់ទន្លេ)។ នៅក្នុងទន្លេមេគង្គមានព្រៃចំនួន "៦តំបន់" ដែលមានលក្ខណៈពិសេសទៅតាមទីតាំងនៅក្នុងចរន្តទឹកទន្លេ វិសាលភាព និងរយៈពេលនៃការលិចទឹកតាមរដូវកាលពោលគឺ "ព្រៃក្នុងទឹក" "តំបន់ទឹកជួរ" "តំបន់កៃកុំ" "តំបន់សំបូរដោយដើមអញ្ចែង" "ច្រាំងខ្សាច់" និង "តំបន់រុក្ខជាតិដុះកើល"។ គេអាចមើលឃើញព្រៃទាំង៦តំបន់នេះយ៉ាងច្បាស់នៅក្នុងអំឡុងពេលដែលទឹកទន្លេមេគង្គមានកំពស់ទាប(ខែកុម្ភៈដល់ខែឧសភា) និងអាចមើលឃើញតែចុងឈើប៉ុណ្ណោះនៅពេលកំពស់ទឹកខ្ពស់(ខែសីហា ដល់ខែកញ្ញា)។ រុក្ខជាតិដែលដុះក្នុងទន្លេមានរាប់ចាប់ពីពពួករុក្ខជាតិតិណទេសតូចៗដែលដុះនៅក្នុងទឹកប្រចាំឆ្នាំរហូតដល់ពពួកដើមឈើដែលមានកំពស់ខ្ពស់ជាង១៥ម៉ែត្រ។ ព្រៃតំបន់ដីគោកចំនួនបីបែបត្រូវបានកត់ត្រាពោលគឺ "ព្រៃស្រោងចម្រុះ និងព្រៃល្បោះ ព្រៃដែលលូតលាស់តាមរដូវ" "ព្រៃប្រស្សី និងព្រៃល្បោះ ព្រៃដែលលូតលាស់តាមរដូវ" និង "ព្រៃល្បោះ និងព្រៃដែលលូតលាស់តាមរដូវ"។

៦- រុក្ខជាតិថ្នាក់ខ្ពស់ចំនួន ៦៨៣ប្រភេទក្នុងអំបូរចំនួន ១២0 និងរុក្ខជាតិថ្នាក់ទាបចំនួន ៧ប្រភេទត្រូវបានកត់ត្រា ។ កម្រងទិន្នន័យស្តីអំពីប្រភេទរុក្ខជាតិ ទីជម្រក ភាពសំបូរបែប រយៈកំពស់ ទម្រង់នៃដើម ស្លឹក ផ្កា និងផ្លែ ត្រូវបានរៀបចំចងក្រង ។ លទ្ធផលខាងលើមានរាប់បញ្ចូលនូវរុក្ខជាតិមួយប្រភេទដែលពុំទាន់បានកត់ត្រានៅឡើយ និងរុក្ខជាតិ ២២ប្រភេទផ្សេងទៀតដែលជាកំណត់ត្រាថ្មីសម្រាប់ប្រទេសកម្ពុជា។ រុក្ខជាតិជាច្រើនប្រភេទ ពិសេសរុក្ខជាតិទន្លេ ត្រូវបានគេសង្ស័យថាមានតែនៅក្នុងទន្លេមេគង្គ និង/ឬ អាងទន្លេមេគង្គក្រោមប៉ុណ្ណោះ បើទោះជាប្រការនេះនៅពុំទាន់អាចអះអាងបាននៅឡើយក្នុងពេលបច្ចុប្បន្ននេះក៏ដោយព្រោះថាការប្រមូលទិន្នន័យអំពីរុក្ខជាតិនៅក្នុងតំបន់អាងទន្លេមេគង្គ និងតាមបណ្តាទន្លេដទៃទៀតនៅដែនដីគោកនៃតំបន់អាស៊ីអាគ្នេយ៍នៅមិនទាន់មានច្រើនគ្រប់គ្រាន់នៅឡើយទេ។

៧- រុក្ខជាតិប្រភេទថ្មីមួយប្រភេទសណ្ឋានដើមត្រាវ (*Amorphophallus* sp.nov.) ត្រូវបានរកឃើញតែនៅលើកោះមួយគត់ដែលស្ថិតនៅ "ផ្នែកកណ្តាល" នៃតំបន់អង្កេត ពោលគឺក្នុងតំបន់ "ព្រៃប្រស្សី និងព្រៃល្បោះ ព្រៃដែលលូតលាស់តាមរដូវ"។ គេពុំទាន់បានស្គាល់ ឬដឹងថាមានសំណាករុក្ខជាតិប្រភេទនេះនៅឡើយទេ ទោះជានៅក្នុងមណ្ឌលរក្សាទុកសំណាករុក្ខជាតិនានាដែលមានពេលបច្ចុប្បន្ន ឬអតីតកាលក៏ដោយ។ ដូច្នេះ គេចាំបាច់ត្រូវធ្វើការអង្កេតជាបន្ថែមទៀតដើម្បីបញ្ជាក់ឱ្យបានច្បាស់លាស់អំពីស្ថានភាព វបាយ និងអេកូឡូស៊ីនៃរុក្ខជាតិប្រភេទថ្មីនេះ។

៨- "ផ្នែកកណ្តាល" នៃតំបន់សិក្សាស្រាវជ្រាវ គឺជាកន្លែងដែលមានអាទិភាពខ្ពស់បំផុតសំរាប់ការអភិរក្សរុក្ខជាតិ ។ ជាទូទៅ ប្រភេទព្រៃក្នុង

ទន្លេនៅត្រង់ "ផ្នែកកណ្តាល" នៃកន្លែងស្រាវជ្រាវនេះនៅមានលក្ខណៈល្អប្រសើរនៅឡើយ ផ្ទុយទៅវិញប្រភេទព្រៃនៅតាមតំបន់ដីគោកបានក្លាយជាព្រៃរំលឹចរីល ឬត្រូវបានរានឆ្ការ។ នៅខាងក្រៅ "ផ្នែកកណ្តាល"នេះ ព្រៃធម្មជាតិបានក្លាយជាព្រៃរំលឹចរីលឬភាគច្រើនត្រូវបានរានឆ្ការនៅតាមកន្លែងជាច្រើននៃដងទន្លេ ច្រាំងទន្លេ និងទំនាបលិចទឹក។ "តំបន់ព្រៃដែលសំបូរដោយដើមឆ្នាទឹក និងអព្ភែង" "តំបន់ច្រាំងខ្សាច់" និង "តំបន់រុក្ខជាតិដុះកើល" គឺជាតំបន់ព្រៃដែលទទួលរងនូវការគំរាមកំហែងខ្លាំងជាងគេក្នុងចំណោមព្រៃនៅតាមតំបន់នានាក្នុងទន្លេ និងត្រូវបានចាត់ទុកថាមានអាទិភាព "ខ្ពស់" សម្រាប់ការគ្រប់គ្រង ចំណែកព្រៃនៅតាមតំបន់បឹបែបផ្សេងទៀតក្នុងទន្លេត្រូវបានចាត់ទុកថាមានអាទិភាព "មធ្យម" (សូមអានចំណុចទី១០)។

៩- សត្វស្លាប: ដើម្បីកំណត់អាទិភាពសម្រាប់ការអភិរក្សនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវ និងដើម្បីបង្កើនកិច្ចប្រឹងប្រែងក្នុងការសិក្សាអង្កេតឱ្យមានប្រសិទ្ធិភាព ការអង្កេតនានាបានផ្តោតតែទៅលើ "ប្រភេទគោលដៅ" ជាជាងប៉ុនប៉ងកត់ត្រាគ្រប់ប្រភេទសត្វទាំងអស់មានក្នុងតំបន់ (ដែលរាប់បញ្ចូលទាំងប្រភេទសត្វជាច្រើនដែលមានអាទិភាពទាបសម្រាប់ការអភិរក្ស)។ ប្រភេទសត្វគោលដៅដែលបានរាប់បញ្ចូលគឺ ប្រភេទសត្វស្លាបទឹកដែលទទួលរងនូវការគំរាមកំហែងជាសកល ឬក្នុងតំបន់ (រនាល ក្រសា ទាទឹក ក្អែកទឹក រំពេ) អកត្រី ទីទុយត្រី កេងកង ត្រចៀកកាំ និងសត្វស្លាបនៅតាមវាលស្មៅ)។ ការអង្កេតនានាបានផ្តោតជាសំខាន់តែទៅលើទីតាំងតាមផ្លូវទឹក និងព្រៃតាមច្រាំងទន្លេ និងធ្វើការសង្កេតខ្លះៗនៅតាមទំនាបលិចទឹកដែលនៅជិតៗ ដោយមានការយកចិត្តទុកដាក់តិចតួចទៅលើទីកន្លែងដែលស្ថិតនៅឆ្ងាយពីដងទន្លេ។

១០- ការអង្កេតនានាបានបញ្ជាក់ថា ទីតាំងសិក្សាស្រាវជ្រាវនេះមានសារសំខាន់ជាសកលសម្រាប់ការអភិរក្សសហគមន៍សត្វស្លាបជាច្រើនប្រភេទ និងមានសារសំខាន់ដោយមិនអាចជំនួសបាននៅក្នុងបរិបទនៃសហគមន៍សត្វស្លាបនៅដែនដីគោកនៃតំបន់អាស៊ីអាគ្នេយ៍ ។ សត្វស្លាបសរុបចំនួន ៣៨ប្រភេទនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះត្រូវបានកត់ត្រា និងចាត់ជាអាទិភាព "ខ្ពស់បំផុត" "ខ្ពស់" ឬ "មធ្យម" សម្រាប់ការគ្រប់គ្រងដែលរួមមានរហូតដល់ប្រាំប្រភេទដែលត្រូវបានចាត់ថាមានអាទិភាព "ខ្ពស់បំផុត" (ត្រយ៉ងចំកសរំពេទន្លេ សត្វកស ត្រដក់តូច និងត្រដក់ធំ) (សូមអានត្រង់ចំណុចទី ៤ និង ១០) ។ ទីតាំងសិក្សាស្រាវជ្រាវមានលក្ខណៈពិសេសជាសកលយ៉ាងហោចណាស់សំរាប់ការអភិរក្សយ៉ាងហោចណាស់សត្វចំនួនពីរប្រភេទ គឺសត្វត្រយ៉ងចំកស (ដែលនៅទីនេះអាចមានសត្វស្លាបប្រភេទនេះក្នុងចំនួនច្រើនបំផុតនៅលើពិភពលោក) និងសត្វខ្ចប់ដីមេគង្គ និងអាចមានពពួកសត្វដ៏ទៃទៀតដូចជារំពេទន្លេ សត្វកស សត្វកដបខ្មៅសៃ ក្នុងចំនួនច្រើនជាងគេនៅឥណ្ឌូចិន និងក៏អាចជាកន្លែងតែមួយគត់ក្នុងប្រទេសកម្ពុជាដែលមានពពួកសត្វត្រចៀកកាំក្នុងវ័យបន្តពូជផងដែរ។

១១- ទីជម្រកដ៏មានសារសំខាន់បំផុតសំរាប់សត្វស្លាប គឺតំបន់ព្រៃដ៏ល្អនៅក្នុងដងទន្លេមេគង្គ ព្រោះតំបន់ទាំងនោះ ពិសេសកន្លែងដែលមានទិដ្ឋភាពជាបណ្តុំវាលខ្សាច់ ស្មៅ គុម្ពព្រៃ និងកញ្ចុំព្រៃដែលគោកផុតពីទឹកទៅតាមរដូវ ។ ទីជម្រកទាំងនេះច្រើនតែមាននៅត្រង់"ផ្នែកកណ្តាល" នៃទីតាំងសិក្សានេះប៉ុណ្ណោះដែលជាទីតាំងដ៏សំខាន់បំផុត និងមានអាទិភាពខ្ពស់សម្រាប់ការអភិរក្សសត្វស្លាបនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះ។ តំបន់ទំនាបលិចទឹកពិសេសកន្លែងដែលសំបូរទៅដោយស្មៅខ្ពស់ៗ ព្រៃ និងភក់ល្បាប់ក៏ជាជម្រកដ៏សំខាន់សម្រាប់សត្វស្លាបផងដែរ ប៉ុន្តែគេចាំបាច់ត្រូវតែធ្វើការសិក្សាបន្ថែមទៀតដើម្បីកំណត់អំពីសារសំខាន់នៃទីជម្រកបែបនេះសម្រាប់ការអភិរក្ស ។

១២- យ៉ាងហោចណាស់មានសត្វស្លាបចំនួន ១៣ប្រភេទ នៅក្នុងទីជម្រកតាមដងទន្លេក្នុងតំបន់ឥណ្ឌូចិនដែលគេពុំបានសង្កេតឃើញនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះឡើយ ទោះបីនៅទីនេះមានទីជម្រកសមស្របសំរាប់ពួកវាក៏ដោយ ពោលគឺសត្វស្លាបប្រភេទទាំងនេះទំនងជាផុតពូជពីតំបន់សិក្សាស្រាវជ្រាវនេះ (សូមអានឧបសម្ព័ន្ធ៧)។ ការបាត់បង់សត្វស្លាបទាំងនេះអាចបណ្តាលមកពីផលប៉ះពាល់រួមគ្នាជាច្រើននៃកត្តាមនុស្ស រួមមានការបរបាញ់ក្នុងមូលដ្ឋាន និងការបាត់បង់ទីជម្រកនៅក្នុងអាងទន្លេមេគង្គ ។ ការគំរាមកំហែងចំពោះប្រភេទអាទិភាពដែលមាននៅសេសសល់ ពិសេសនៅត្រង់ "ផ្នែកកណ្តាល" នៃទីតាំងសិក្សានេះមានលក្ខណៈធ្ងន់ធ្ងរ (សូមអានខាងក្រោម)។ បើពុំមានវិធានការអភិរក្សសមស្របទេនោះ សត្វស្លាបច្រើនជាង ២២ប្រភេទស្ថិតក្នុងអាទិភាព"ខ្ពស់បំផុត" និងអាទិភាព "ខ្ពស់" អាចត្រូវបាត់បង់ពីតំបន់ស្រាវជ្រាវនេះ។

១៣- ថនិកសត្វធំៗ: ដើម្បីកំណត់អាទិភាពសម្រាប់ការអភិរក្សនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវ និងដើម្បីបង្កើនកិច្ចប្រឹងប្រែងលើការអង្កេតឱ្យមានប្រសិទ្ធិភាព ការសិក្សាបានផ្តោតតែទៅលើថនិកសត្វដែលមាន"ទំហំធំ" (ប្រភេទក្នុងអំបូរថនិកសត្វ ដែលក្នុងនោះគេអាចកំណត់បានប្រភេទស្ទើរតែទាំងអស់នៅក្នុងកន្លែងអង្កេតផ្ទាល់) និងពុំរាប់បញ្ចូលពពួកថនិកសត្វដែលមានទំហំតូចៗឡើយ ឧទាហរណ៍: ពពួកសត្វកកេរ និងប្រភ្សៃវតូចៗ។ ប្រភេទគោលដៅមានរាប់បញ្ចូល ពពួកពានរ ភេ ក្តាន់ សត្វមានម្រាមបួន និងជ្រីង (*Pteropus* spp.) ដែលសុទ្ធសឹងតែជាប្រភេទទទួលរងនូវការគំរាមកំហែងជាសកល ឬរងការគំរាមកំហែងប្រចាំតំបន់។ តំបន់សិក្សានេះផ្តល់ លក្ខខ័ណ្ឌសមស្របដល់ការរស់នៅនៃសត្វផ្សោតទន្លេមេគង្គដែលកម្មវិធីអភិរក្សសព្វថ្ងៃកំពុងតែផ្តោតការយកចិត្តទុកដាក់ការពារ ហើយការអង្កេតពេលនេះ មិនបានផ្តោតលើសត្វប្រភេទនេះទេ។ ការអង្កេតនានា បានផ្តោតជាចំបងតែទៅលើផ្លូវទឹកក្នុងទន្លេមេគង្គ និងតំបន់ព្រៃតាមច្រាំងទន្លេនេះតែប៉ុណ្ណោះ ដោយឡែកការសង្កេតខ្លះៗបានធ្វើផងដែរនៅតាមទំនាបលិចទឹកដែលស្ថិតនៅមិនឆ្ងាយពីដងទន្លេ។

១៤- ទោះតំបន់សិក្សាស្រាវជ្រាវអាចមានសារសំខាន់ជាសកលចំពោះថនិកសត្វចំនួនច្រើនជាងបីប្រភេទក៏ដោយ ពោលគឺ (សត្វក្តាន់ សត្វស្វាព្រាម និងសត្វភេ) វាមានសារសំខាន់សំរាប់ការអភិរក្សកម្រិតតំបន់សម្រាប់ក្រុមថនិកសត្វមាឌធំៗជាច្រើនប្រភេទផ្សេងទៀតផងដែរ។ ថនិកសត្វ ១ប្រភេទ (សត្វក្តាន់) ត្រូវបានចាត់ជាអាទិភាព "ខ្ពស់បំផុត"សម្រាប់ការគ្រប់គ្រង។ ថនិកសត្វមួយប្រភេទទៀត (សត្វស្វាព្រាម) ត្រូវបានចាត់ជាប្រភេទអាទិភាព"ខ្ពស់" និង ថនិកសត្វមួយប្រភេទទៀត (ប្រើស) ត្រូវបានចាត់ជាប្រភេទអាទិភាព "មធ្យម"។ ថនិកសត្វចំនួន ៥ ប្រភេទផ្សេងទៀត (ស្វាក្តាម រមាំង ជ្រីងមធ្យម និង/ឬជ្រីងធំ និងភេខ្លួនរលោង) អាចត្រូវដាក់ចូលក្នុងប្រភេទ"អាទិភាពខ្ពស់" ហើយថនិកសត្វ១ប្រភេទផ្សេងទៀត(ភេក្បាលសំប៉ែតនិង/ឬភេរោមច្រមុះ)អាចត្រូវចាត់ថាមានអាទិភាព"មធ្យម" (សូមអានចំណុចទី ៥ និង១០)។ ចំពោះសត្វភេ គេនៅពុំទាន់ដឹងច្បាស់អំពីចំនួនឯកត្តៈសរុបដែលអាចធានាភាពគង់វង្សនៃពូជសត្វភេនៅតំបន់សិក្សាស្រាវជ្រាវនេះនៅឡើយទេ ដោយសារ វាមានចំនួនឯកត្តៈសរុបតិចតួចពេក និងលំបាកក្នុងការអនុវត្តវិធានការការពារប្រកបដោយប្រសិទ្ធិភាព។ ចំពោះប្រភេទសត្វស្វាក្តាម រមាំង ជ្រីង និងប្រភ្សៃវ គេនៅពុំទាន់ដឹងច្បាស់លាស់ពីអាទិភាពគ្រប់គ្រងនៅឡើយទេ ដោយសារភាពមិនប្រាកដប្រជាអំពីសារសំខាន់នៃចំនួនឯកត្តៈសរុបនៃប្រភេទសត្វទាំងនេះនៅក្នុងទីតាំងអង្កេតនេះ។

១៥- ទីជម្រកសំខាន់បំផុតសម្រាប់ថនិកសត្វដែលមានមាឌធំនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវ គឺបណ្តុំស្មៅខ្ពស់ៗនៅក្នុងទំនាបលិចទឹកភាគខាងត្បូងនៃតំបន់សិក្សានេះ ដោយសារទីតាំងនោះមានវត្តមានសត្វក្តាន់។ ព្រៃនៅតាមច្រាំងទន្លេ ពិសេសនៅត្រង់ "ផ្នែកកណ្តាល" នៃតំបន់សិក្សានេះមានសារសំខាន់បំផុតសំរាប់ការរស់នៅរបស់សត្វស្វាព្រាម។ បណ្តុំផ្លូវទឹកនៅ "ផ្នែកកណ្តាល" នៃទីតាំងសិក្សានេះ និងក៏អាចរាប់បញ្ចូលទាំងព្រៃឈើ ផ្លូវទឹកតូចៗ និងភក់ល្បាប់ដែលមានគ្រប់រដូវកាលនៅតំបន់ទំនាបលិចទឹកផងដែរនោះ គឺជាកន្លែងលាក់ខ្លួនចុងក្រោយបំផុតសម្រាប់សត្វភេនៅក្នុងកន្លែងសិក្សានេះ។

១៦- យ៉ាងហោចណាស់មានថនិកសត្វមាឌធំៗចំនួន ១១ប្រភេទដែលមាននៅតាមតំបន់ព្រៃទំនាបនៅឥណ្ឌូចិនដែលគេពុំបានសង្កេតឃើញនៅក្នុងតំបន់សិក្សានេះទេ ទោះជាតំបន់នេះមានជម្រកសមស្របសម្រាប់សត្វទាំងនេះក៏ដោយ។ ថនិកសត្វមាឌធំៗចំនួន ១១ប្រភេទខាងលើនេះទំនងជាផុតពូជពីតំបន់សិក្សានេះហើយ (សូមអានឧបសម្ព័ន្ធ៧)។ ការបាត់បង់នេះ អាចបណ្តាលមកពីកត្តាមនុស្ស ជាពិសេសការបរបាញ់នៅក្នុងតំបន់សិក្សានេះ និងនៅតាមតំបន់ជិតខាង។ ការគំរាមកំហែងចំពោះប្រភេទថនិកសត្វជាអាទិភាពដែលនៅសេសសល់តិចតួចទាំងនេះមានលក្ខណៈធ្ងន់ធ្ងរខ្លាំងណាស់ (សូមអានចំណុចខាងក្រោម)។ ប្រសិនបើគ្មានវិធានការគ្រប់គ្រងទាន់ពេលវេលាទេ ប្រភេទថនិកសត្វជាអាទិភាពដែលមានរហូតដល់ ៨ប្រភេទដែលចាត់ថាមានអាទិភាព "ខ្ពស់បំផុត" "ខ្ពស់" និង "មធ្យម" អាចនឹងត្រូវបាត់បង់ពីតំបន់សិក្សាស្រាវជ្រាវនេះ។

១៧- ថលជលិកសត្វ និងឧរង្គសត្វ: ការសិក្សាអង្កេតនានា បានផ្តោតទៅលើការធ្វើសារពើភ័ណ្ឌ និងការប្រមូលផ្តុំនូវប្រភេទថលជលិកសត្វ

និងឧរង្គសត្វដែលបានប្រទះឃើញនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវដោយផ្តោតជាពិសេសលើស្ថានភាពរបស់សត្វអណ្តើក និងសត្វក្រពើភ្នំ /ក្រពើត្រី (Siamese crocodile)។ ភាគច្រើននៃការសិក្សាអង្កេតបានផ្តោតការយកចិត្តទុកដាក់ទៅលើជម្រកនៅក្នុងទន្លេមេគង្គដែលស្ថិតនៅត្រង់ "ផ្នែកកណ្តាល" នៃតំបន់សិក្សាស្រាវជ្រាវនេះ រួមទាំងជម្រកនៅក្នុងទឹក និងព្រៃនៅតាមច្រាំងនៃកោះនានា។ បន្ថែមទៅលើការសិក្សាអង្កេតចំនួនបីលើកដែលក្រុមអ្នកស្រាវជ្រាវបានធ្វើកន្លងមក ការអង្កេតលើកទីបួនដែលផ្តោតលើសត្វអណ្តើក និងកន្ទាយត្រូវបានធ្វើឡើងដោយក្រុមអភិរក្សសត្វអណ្តើកកម្ពុជា។ ការសិក្សានេះទំនងជាការធ្វើសារពើភ័ណ្ឌជាលក្ខណៈប្រព័ន្ធដំបូងបង្អស់អំពីថលជលិកសត្វ និងឧរង្គសត្វនៅតាមដងទន្លេមេគង្គក្នុងប្រទេសកម្ពុជា។

១៨- សត្វសរុបចំនួន ៥៦ប្រភេទ (កង្កែប ១៦ប្រភេទ អណ្តើក ៦ប្រភេទ បង្កួយ/ផ្លែន ១៧ប្រភេទ និងសត្វពស់ ១៧ប្រភេទ) ត្រូវបានកត់ត្រារួមបញ្ចូលទាំងសត្វអណ្តើកចំនួន ៦ប្រភេទដែលរងការគំរាមកំហែងជាសកល សត្វតុកកែ ១ប្រភេទដែលជាកំណត់ត្រាថ្មីរបស់ប្រទេសកម្ពុជា (*Hemiphyllodactylus yunnanensis*) សត្វពស់ព្រលឹត ១ប្រភេទដែលជាកំណត់ត្រាថ្មីលើកទី២របស់ប្រទេសកម្ពុជា (*Homalopsis nigroventralis*) និងដែនជម្រករបស់សត្វពស់ព្រលឹត ១ប្រភេទផ្សេងទៀត (*Enhydris longicaudas*) ដែលមានវិសាលភាពរាលដាលរយៈចំងាយប្រមាណ ៣០០គ.ម នៅប៉ែកខាងជើងតំបន់បឹងទន្លេសាប។ ក្រាហ្វិកតំណាងប្រភេទសត្វដែលបានរកឃើញបង្ហាញឱ្យដឹងថា ការសិក្សាអង្កេតនានាបានរកឃើញកង្កែបប្រភេទភាគច្រើន ប៉ុន្តែមិនបានរកឃើញគ្រប់ប្រភេទសត្វល្មូនឡើយ។ ការប្រៀបធៀបរវាងភាពសំបូរបែបនៃប្រភេទសត្វ និងសមាសភាពរបស់ប្រភេទសត្វដោយផ្អែកទៅលើទិន្នន័យមានស្រាប់មួយចំនួនដែលបានមកពីការសិក្សាស្រាវជ្រាវមុនៗនៅក្នុងប្រទេសកម្ពុជា បង្ហាញឱ្យឃើញថាជម្រកក្នុងទឹកទន្លេ និងជម្រកក្នុងទំនាបលិចទឹកទន្លេមេគង្គពុំមែនជាកន្លែងដែលមានសត្វទាំងនេះរស់នៅសំបូរបែបដូចនៅតាមតំបន់ជួរភ្នំ ឬតំបន់ភ្នំនៅក្នុងប្រទេសកម្ពុជាឡើយ។

១៩- តំបន់សិក្សាស្រាវជ្រាវនេះមានសារសំខាន់ជាសកលយ៉ាងហោចណាស់សម្រាប់សត្វកន្ទាយ១ប្រភេទ (កន្ទាយក្បាលកង្កែប)និងអាចផ្តល់អំណោយផលដល់កន្ទាយ ដែលនៅសេសសល់ក្នុងវ័យបន្តពូជក្នុងចំនួនច្រើនជាងគេក្នុងអាងទន្លេមេគង្គ។ សត្វល្មូនរហូតដល់ចំនួន ៦ប្រភេទ និងសត្វអណ្តើក/កន្ទាយទាំងអស់(កន្ទាយក្បាលកង្កែប កន្ទាយអាស៊ី អណ្តើកសោម អណ្តើកក្របីក្បាលល្បឿង អណ្តើកសាកល និងអណ្តើកព្រិច) សុទ្ធតែត្រូវបានចាត់ទុកជាអាទិភាព "ខ្ពស់" សម្រាប់ការគ្រប់គ្រងនៅក្នុងតំបន់សិក្សានេះ។ សត្វពស់ព្រលឹត ១ប្រភេទ (*Enhydris longicaudas*) អាចស្ថិតនៅក្នុងអាទិភាព"មធ្យម"សម្រាប់ការគ្រប់គ្រង។ ចំពោះអណ្តើកក្របីក្បាលល្បឿង អណ្តើកសាកល និងពស់ព្រលឹត (*Enhydris longicaudas*) គេនៅពុំទាន់ដឹងច្បាស់អំពីអាទិភាពសម្រាប់ការគ្រប់គ្រងនៅឡើយទេ ដោយសារភាពមិនច្បាស់លាស់អំពីសារសំខាន់នៃចំនួនឯកត្តៈរបស់ប្រភេទសត្វទាំងនោះនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះ។ សម្រាប់តំបន់ស្រាវជ្រាវនេះ គេមិនបានចាត់បញ្ចូលថលជលិកសត្វប្រភេទណាមួយជាអាទិភាពសម្រាប់ការគ្រប់គ្រងឡើយ។

២០- ភាពបិតថេរនៃជម្រកដែលមិនទាន់ទទួលរងនូវការបំផ្លិចបំផ្លាញនៅឡើយក្នុងទន្លេមេគង្គនៅត្រង់ "ផ្នែកកណ្តាល" នៃតំបន់ស្រាវជ្រាវនេះបង្ហាញថា ទីតាំងនេះរួមចំណែកដល់ការថែរក្សាចំនួនឯកត្តៈនៅកម្រិតតំបន់នៃសត្វអណ្តើកគ្រប់ប្រភេទដែលត្រូវបានចាត់ជាអាទិភាព។ "ផ្នែកកណ្តាល"នៃតំបន់ស្រាវជ្រាវនេះ គឺជាកន្លែងតែមួយគត់ដែលមានការអះអាងថាជាកន្លែងបន្តពូជរបស់សត្វកន្ទាយក្បាលកង្កែប ទោះបីសហគមន៍មូលដ្ឋានបានរាយការណ៍ថា កន្ទាយប្រភេទនេះធ្វើសំបុកនៅតាមផ្នូកខ្សាច់ និងច្រាំងខ្សាច់ដែលគោកតាមរដូវចាប់ពីអន្លង់កាំពី (ក្បែរទីរួមខេត្តក្រចេះ) រហូតដល់ភាគខាងជើងនៃ "ផ្នែកកណ្តាល" ក៏ដោយ។ តំបន់ទំនាបលិចទឹកនៅខាងលិចនៃទីរួមខេត្តក្រចេះអាចមានសារសំខាន់ ដោយសារគេសង្កេតឃើញមានអណ្តើកសាកល និងសត្វពស់ (*Enhydris longicaudas*)។

២១- សត្វល្មូនមួយប្រភេទ (ក្រពើត្រី/ក្រពើភ្នំ *Siamese Crocodile*) ទំនងជាបានផុតពូជ ឬជិតផុតពូជពីតំបន់សិក្សាស្រាវជ្រាវនេះ ។ សហគមន៍មូលដ្ឋានបានរាយការណ៍ថា ឃើញមានក្រពើប្រភេទនេះកាលពីជាង ៤០ឆ្នាំកន្លងមក ប៉ុន្តែបច្ចុប្បន្ន ពុំឃើញមានទេ ឬមានដោយកម្រ

បំផុត ។ កាលពីមុន សត្វក្រពើនៅក្នុងតំបន់សិក្សានេះត្រូវបានគេបរបាញ់សម្រាប់លក់ ហើយប្រការនេះអាចជាមូលហេតុចំបងដែលនាំឱ្យមានការធ្លាក់ចុះជាប្រវត្តិសាស្ត្រនៃចំនួនសត្វក្រពើប្រភេទនេះ ។ "ផ្នែកកណ្តាល"នៃតំបន់សិក្សាស្រាវជ្រាវទំនងជានៅរក្សាបានទីជម្រកពងកូន និងជាប្រភពចំណីអាហារសម្រាប់សត្វប្រភេទនេះ ហើយអាចមាននៅសល់សត្វប្រភេទនេះមួយចំនួនផងដែរ ពោលគឺវត្តមានដោយកម្រ ឬ អវត្តមានរបស់វា អាចបង្ហាញអំពីការគាបសង្កត់ជាបន្តមកលើការបង្កកំណើតនៃសត្វក្រពើប្រភេទនេះដោយសារការគំរាមកំហែងពីសកម្មភាពរបស់មនុស្ស ។ ទោះជាពុំមានសេចក្តីរាយការណ៍អំពីការបរបាញ់ណាមួយនាពេលថ្មីៗនេះក៏ដោយ ប៉ុន្តែពងក្រពើឬសត្វក្រពើដែលគេធ្លាប់ប្រទះឃើញអាចនឹងត្រូវគេប្រមូលយកឬចាប់យក ។ សំបុកពងរបស់សត្វក្រពើប្រភេទនេះងាយនឹងសំគាល់បានជាបង្ហូរ ហើយដោយសារមានមនុស្សចេញចូលជាញឹកញាប់នៅតាមច្រាំងទន្លេភាគច្រើនដើម្បីបរបាញ់ និងនេសាទ មានតែសំបុកមួយចំនួនតូចប៉ុណ្ណោះដែលអាចគេចផុតពីភ្នែកអ្នកទាំងនោះ ។ ការគំរាមកំហែងចំពោះសត្វអណ្តើក និងកន្ធាយជាអាទិភាពចំនួន ៦ប្រភេទមានកម្រិតខ្ពស់ណាស់ដោយសារមានការបរបាញ់ និងការជួញដូរជាលក្ខណៈពាណិជ្ជកម្មពុំមានការត្រួតពិនិត្យ ហើយបើពុំមានការគ្រប់គ្រងទេនោះ ប្រភេទសត្វមួយចំនួននឹងអាចបាត់បង់ពីទីតាំងសិក្សាស្រាវជ្រាវ ។

២២- ត្រី: ការសិក្សាអង្កេតនានាបានផ្តោតទៅលើការធ្វើសារពើភ័ណ្ឌត្រីគ្រប់ប្រភេទទាំងអស់ ដែលប្រទះឃើញនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះដោយប្រមូលយកព័តិមានខ្លះៗអំពីសិប្បីសត្វ និងវង្កសត្វ ។ ការអង្កេតនានាដែលបានធ្វើឡើងរួមមាន ការប្រមូលសំណាកនៅតាមផ្លូវទឹកក្នុងទន្លេមេគង្គ ជាពិសេសត្រង់"ផ្នែកកណ្តាល"នៃតំបន់សិក្សាស្រាវជ្រាវនេះ និងការចុះផ្ទាល់តាមទីផ្សារក្នុងទីរួមខេត្ត តាមភូមិនានា និងការជួបប្រាស្រ័យជាមួយអាជីវករលក់ត្រី។ គំរូសំណាកសម្រាប់ប្រភេទត្រីមួយចំនួនត្រូវបានប្រមូលយក និងផ្ញើជូនទៅបណ្តាស្ថាប័នជាតិ និងអន្តរជាតិ ។ ប្រភេទត្រីភាគច្រើនដែលបានប្រទះឃើញត្រូវបានថត និងចងក្រងទុកជាឯកសារ ។

២៣- ត្រីដែលមានដើមកំណើតក្នុងស្រុកសរុបចំនួន ២២៣ប្រភេទ (៣៧ អំបូរ) ពពួកសិប្បីសត្វដែលបរិភោគបាន និងដែលមានដើមកំណើតក្នុងស្រុកសរុបចំនួន ១៧ប្រភេទត្រូវបានកត់ត្រាទុក និងសិប្បីសត្វដែលមានដើមកំណើតពីក្រៅស្រុកសរុបចំនួន ៥ប្រភេទ (ត្រីចំនួន ៨ ប្រភេទ និងខ្យងមួយប្រភេទត្រូវបានសង្កេតឃើញនៅតាមទីផ្សារប៉ុណ្ណោះ)។ ពូជត្រីដែលមានប្រភពក្នុងស្រុករួមមាន បបែលចំនួន ១ ប្រភេទ ពពួកត្រីស្ថិតនៅក្នុងលំដាប់ Cypriniforms សរុបចំនួន ១០៦ប្រភេទ ពពួកត្រីឥតស្រកាសរុបចំនួន ៥៥ប្រភេទ ពពួក Percomopha (ប្រភេទដូចត្រី Perch ចំនួន២៦ប្រភេទ អន្ទង់ Spiny/swamp eels ចំនួន៧ប្រភេទ ប្រភេទត្រីកាបូ ឬត្រីក្រពើ Pipefish មួយប្រភេទ ប្រភេទត្រីរាងសំប៉ែត (Flatfishes) ចំនួន ៧ប្រភេទ និងពពួកកំពតចំនួន ៦ប្រភេទ) និងពពួក Bonyfish សរុបចំនួន ១៤ប្រភេទ (ពពួក Sardines និង Anchovies ចំនួន ៦ប្រភេទ ពពួក Featherbacks ចំនួន ៤ប្រភេទ ពពួកត្រីម្ជុលចំនួន ៣ប្រភេទ និងអន្ទង់ ១ប្រភេទ។ ចំនួនអតិបរិមានៃប្រភេទត្រីដែលបានកត់ត្រានៅរដូវក្រាំងគឺ ១៩៥ប្រភេទ និងចំនួនអប្បបរិមារបស់ប្រភេទត្រីដែលបានកត់ត្រានៅរដូវវស្សាគឺ ១៧៤ប្រភេទ ។ ភាពសំបូរបែបនៃប្រភេទត្រីនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវមានលក្ខណៈស្រដៀងគ្នាទៅនឹងបណ្តាទីតាំងដែលស្ថិតនៅក្បែរគ្នារួមទាំងតំបន់ស៊ីផាន់ដននៃប្រទេសឡាវផងដែរ ប៉ុន្តែតំបន់សិក្សាស្រាវជ្រាវខាងលើនេះមានប្រភេទត្រីច្រើនជាបង្ហូរ បើធៀបនឹងតំបន់ផ្សេងៗទៀតនៅអាងទន្លេមេគង្គក្រោម និងឆ្លុះបញ្ចាំងពីភាពខុសប្លែកគ្នាកម្រិតខ្ពស់នៃប្រភេទជម្រកប្រចាំរដូវកាល ។ ប្រភេទត្រីដែលរងការគំរាមកំហែងជាសកលចំនួន ១១ប្រភេទ និងត្រីចំនួន ៦ប្រភេទផ្សេងទៀតដែលត្រូវបានចាត់ទុកថា រងការគំរាមកំហែងនៅក្នុងប្រទេសកម្ពុជានិង/ឬ ប្រទេសថៃក៏ត្រូវបានអះអាងថា មាននៅក្នុងតំបន់សិក្សានេះផងដែរ ។ ប្រភេទដែលជាកំណត់ត្រាថ្មីមួយសំរាប់ប្រទេសកម្ពុជានោះគឺ (a minnow *Toxabramis* sp.) ដែលជាផ្នែកមួយនៃតំបន់នៅក្នុងរបាយទឹកឆ្នែងរស់នៅសម្រាប់ប្រភេទដែលទើបរកឃើញថ្មីមួយគឺ *Minyclupeoides dentibranchialus* និងសំណាកត្រីចំនួនពីរប្រភេទដែលគេស្គាល់តិចតួចប៉ុណ្ណោះ ពោលគឺ Bagrid catfish (*Hemibagrus sp.*) អន្ទង់ច្រមុះវែង (*Macrognathus* sp.) ក៏ត្រូវបានកត់ត្រាទុកផងដែរ ។

២៤- តំបន់សិក្សាស្រាវជ្រាវនេះមានសារសំខាន់ជាសកលក្នុងការរួមចំណែកដល់ការថែរក្សាប្រភេទត្រីនៅកម្រិតតំបន់ និងជាច្រកបម្លាស់ទីសម្រាប់ត្រីនៅក្នុងអាងទន្លេមេគង្គក្រោមផងដែរ។ ទីតាំងដែលមានសារសំខាន់បំផុតសម្រាប់ការអភិរក្សត្រីគឺ "ផ្នែកកណ្តាល" ដែលនៅមានទីជម្រកល្អនៅឡើយសម្រាប់ត្រីក្នុងការធ្វើចរាចរបន្តពូជ រកចំណី និងលាក់ខ្លួន រួមទាំងព្រៃលិចទឹកប្រចាំរដូវដែលលាតសន្ធឹងលើវិសាលភាពធំទូលាយ ទឹកជួរសំបូរដោយថ្ម ផ្ទុកខ្សាច់ និងអន្លង់ខ្សាច់ដែលមានទឹករាក់ៗជាច្រើនកន្លែង។ តំបន់ស្រាវជ្រាវនេះ គឺជាកន្លែងមួយក្នុងចំណោមកន្លែងមួយចំនួនតូចនៅក្នុងអាងទន្លេមេគង្គក្រោមដែលមាន "អន្លង់ជ្រៅ" ស្ថិតនៅរាយប៉ាយទូទាំងតំបន់សិក្សាស្រាវជ្រាវនេះ និងជាជម្រកលាក់ខ្លួនសម្រាប់ត្រី ជាពិសេសសម្រាប់ប្រភេទត្រីដែលមានទំហំធំ។ ជួរទឹកដែលមានថ្មជាច្រើនទាំងនោះ គឺជាទីតាំងដ៏សំខាន់សម្រាប់ការពងកូនរបស់ប្រភេទត្រីមួយចំនួន ។

២៥- ត្រី គឺជាប្រភពដ៏សំខាន់នៃប្រូតេអ៊ីនសំរាប់សហគមន៍នៅក្នុងតំបន់សិក្សាស្រាវជ្រាវ ហើយជាក់ស្តែងសហគមន៍ទាំងអស់ធ្វើការនេសាទសម្រាប់ចិញ្ចឹមក្រពះ និង/ឬដើម្បីប្រាក់ចំណូល។ យ៉ាងហោចណាស់មានត្រីចំនួន ១៣១ប្រភេទ និងសិប្បីសត្វចំនួន ១៨ប្រភេទត្រូវបានសង្កេតឃើញមានលក់នៅតាមទីផ្សារ។ អាស្រ័យដោយកំណើនយ៉ាងឆាប់រហ័សនៃចំនួនប្រជាជន ពិសេសនៅ"ផ្នែកកណ្តាល"នៃតំបន់ស្រាវជ្រាវនេះ ការនេសាទហួសកម្រិត គឺជាការគំរាមកំហែងធ្ងន់ធ្ងរបំផុតចំពោះប្រភេទត្រីដែលមានសារសំខាន់ខាងសេដ្ឋកិច្ច។ នៅកន្លែងផ្សេងទៀតក្នុងទីតាំងសិក្សានេះ ការបាត់បង់ និងការរិចរិលទីជម្រករបស់ត្រីក៏ជាការគំរាមកំហែងចំបងមួយផងដែរ ដោយសារព្រៃភាគច្រើននៅតាមច្រាំងទន្លេត្រូវបានរានឆ្ការ ហើយទំនាបលិចទឹកដ៏ធំនៅជិតទីរួមខេត្តក្រចេះបានក្លាយជាដីដាំដំណាំ ។

២៦- ការគំរាមកំហែងចំពោះជីវចម្រុះ: សព្វថ្ងៃនេះផលប៉ះពាល់ដ៏ខ្លាំងបំផុតចំពោះជីវចម្រុះ គឺសកម្មភាពរបស់មនុស្សនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះ ជាពិសេសនៅ "ផ្នែកកណ្តាល"នៃតំបន់ស្រាវជ្រាវនេះដែលរួមមានទាំងការតាំងទីលំនៅថ្មី និងការបម្លែងដីព្រៃទៅជាដីកសិកម្ម ការដុតព្រៃធម្មជាតិ កំណើនសំពាធនៃការនេសាទ និងការបរបាញ់សត្វព្រៃ។ ព្រៃធម្មជាតិនៅតាមបណ្តោយច្រាំងទន្លេ (ដែលជាគោលដៅសម្រាប់ការតាំងទីលំនៅ) តំបន់ព្រៃ និងស្មៅខ្ពស់ៗនៅក្នុងតំបន់ទំនាបលិចទឹក និងទីជម្រកនានានៅតាមផ្លូវទឹកទន្លេមេគង្គកំពុងទទួលរងនូវការរានឆ្ការ ឬវិចរិលយ៉ាងឆាប់រហ័ស។ ចំពោះសត្វស្លាប ថនិកសត្វមាឌធំៗ អណ្តើក បង្គួយ និងសត្វពស់ធំៗ ដែលរងការគំរាមកំហែងរួចមកហើយនោះ ការបរបាញ់ដោយគ្មានការត្រួតពិនិត្យ កំពុងតែបង្កឱ្យមានផលប៉ះពាល់ធ្ងន់ធ្ងរបំផុតចំពោះចំនួនឯកត្ត:សរុបនៃពពួកសត្វទាំងនេះនៅក្នុងមូលដ្ឋាន។ កន្លែងសិក្សាស្រាវជ្រាវនេះស្ថិតនៅក្នុងតំបន់ពាណិជ្ជកម្មសត្វព្រៃដែលមានបណ្តាញរឹងមាំ ហើយសត្វនានាដែលបរបាញ់បានពីក្នុងមូលដ្ឋាននេះ ត្រូវបានលក់នៅតាមទីកន្លែងនានាក្នុងប្រទេសកម្ពុជា ឡាវ វៀតណាម និងអាចមានលក់ចេញរហូតដល់ប្រទេសចិនផងដែរ។ ការអង្កេតនានាបានអះអាងអំពីវត្តមាននៃអ្នកជួញដូរសត្វព្រៃនៅក្នុង "ផ្នែកកណ្តាល" នៃទីតាំងសិក្សានេះជាពិសេសនៅក្នុងភូមិកោះខ្សែរ និងភូមិខ្សាច់លាវដែលបានទិញសត្វព្រៃពីភូមិនានានៅជុំវិញទីនោះ ហើយដឹកឆ្ពោះទៅកាន់ទីរួមខេត្តក្រចេះឬស្ទឹងត្រែងដើម្បីលក់បន្តទៅឈ្មួញដទៃទៀត។ ចំពោះសត្វស្លាបដែលធ្វើសំបុកនៅលើដីផ្ទាល់ និងយ៉ាងហោចណាស់ថនិកសត្វមួយប្រភេទ (ក្តាន់) ផ្តែស្រុកក៏ជាការគំរាមកំហែងចំបងមួយដែរ ដោយសារវាប្រមាញ់សត្វពេញជំទង់ និងពងសត្វ។ ចំពោះត្រី ការគំរាមកំហែងចំបងៗកើតចេញពីកំណើនការនេសាទដែលគ្មានការហាមឃាត់ និងអាចជាការនេសាទដែលគ្មាននិរន្តរភាព អាចបណ្តាលឱ្យមានការថយចុះប្រភេទដែលមានតម្លៃសេដ្ឋកិច្ច។

២៧- កត្តាចំនួនពីរដែលបង្កឱ្យមានការគំរាមកំហែងមកលើ"ផ្នែកកណ្តាល"នៃកន្លែងសិក្សាស្រាវជ្រាវនេះ គឺកំណើនចំនួនប្រជាជន និងការអភិវឌ្ឍសេដ្ឋកិច្ចនៅក្នុងខេត្ត និងតំបន់។ ចំនួនប្រជាជននៅ"ផ្នែកកណ្តាល"នៃតំបន់ស្រាវជ្រាវនេះកំពុងតែកើនឡើងដោយសារការហូរចូលនូវជនចំណូលថ្មីដោយគ្មានការដាក់កំហិត និងការពង្រីកភូមិដ្ឋាន។ ការគំរាមកំហែងទាំងនេះទើបតែកើតមាននាពេលថ្មីៗនេះ (អ្នកចំណូលថ្មីភាគច្រើនបានតាំងទីលំនៅត្រង់ "ផ្នែកកណ្តាល" នៃកន្លែងសិក្សាស្រាវជ្រាវនេះអស់រយៈពេលតិចជាង១០ឆ្នាំ) ហើយនេះគឺជាសញ្ញាបង្ហាញ

ពីសកម្មភាពមនុស្សដែលបានធ្វើឱ្យបាត់បង់ព្រៃភាគច្រើននៅលើច្រាំងទន្លេ និងការថយចុះនៃប្រភេទជាច្រើននៅកន្លែងដទៃក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះ។ ប្រសិនបើគ្មានវិធានការគ្រប់គ្រងទេនោះ កំណើនចំនួនប្រជាជន និងកំណើនសម្ពាធមកលើធនធានធម្មជាតិនឹងបង្កឱ្យមានការថយចុះ ឬក៏បាត់បង់ប្រភេទសត្វច្រើនដែលរស់នៅក្នុង "ផ្នែកកណ្តាល" នៃកន្លែងសិក្សាស្រាវជ្រាវនេះ។

២៨- ការគំរាមកំហែងដែលអាចកើតមាន កើតឡើងតាមរយៈការអភិវឌ្ឍថ្មីៗក្នុងតំបន់ទាំងនៅក្នុង និងនៅជិតកន្លែងសិក្សាស្រាវជ្រាវនេះ ដែលរួមទាំង ហេដ្ឋារចនាសម្ព័ន្ធទំនប់វារីអគ្គីសនី ការពង្រីកបណ្តាញផ្លូវថ្នល់ និងការផ្តល់ដីសម្បទានសេដ្ឋកិច្ចថ្មីៗ (សូមអានចំណុចទី៩)។ ទំនប់វារីអគ្គីសនីមួយនៅ "សំបូរ" ត្រូវបានលើកស្ទឹសាងសង់កាត់ទន្លេមេគង្គនៅក្នុងកន្លែងសិក្សានេះ ហើយយ៉ាងហោចណាស់មានគម្រោងអភិវឌ្ឍន៍ធនធានទឹកចំនួន ៦៤គម្រោងត្រូវបានគ្រោង ឬកំពុងសាងសង់នៅក្នុង ឬនៅជិតទន្លេសេកុង សេសាន និងទន្លេស្រែពក (Oxfam America 2005)។ បណ្តាញផ្លូវដែលមានស្រាប់កំពុងត្រូវបានកែលំអជាថ្មី នឹងនាំឱ្យមានការចេញចូលកាន់តែច្រើនឡើងទៅក្នុង "ផ្នែកកណ្តាល" នៃកន្លែងសិក្សាស្រាវជ្រាវនេះ ហើយសំណើដីសម្បទាន (ជាពិសេសសំរាប់ដាំដើមឈើ) នៅទូទាំងខេត្តក្រចេះ និងខេត្តស្ទឹងត្រែងអាចនាំឱ្យមានចំណោកស្រុកនៃសហគមន៍នានា និងកំណើនអ្នកចំណូលថ្មីមកកាន់តំបន់សិក្សាស្រាវជ្រាវនេះ។ ប្រសិនបើគ្មានការវាយតំលៃលើផលប៉ះពាល់សង្គម និងបរិស្ថានឱ្យបានសមស្របទេនោះ ការអភិវឌ្ឍន៍ទាំងនេះអាចរួមចំណែកបង្កឱ្យមានផលប៉ះពាល់ធ្ងន់ធ្ងរដល់ជីវចម្រុះ និងការចិញ្ចឹមជីវិតរបស់សហគមន៍មូលដ្ឋាននៅក្នុងកន្លែងសិក្សាស្រាវជ្រាវនេះ។

២៩- ការអភិរក្សជីវចម្រុះ: អាទិភាព និងវិធានការនានាសំរាប់ការគ្រប់គ្រងក្នុងវិស័យអភិរក្សលើកន្លែងសិក្សាស្រាវជ្រាវត្រូវបានធ្វើអត្តសញ្ញាណដោយផ្នែកលើលក្ខណៈវិនិច្ឆ័យនៃការកំណត់លំដាប់អាទិភាពដែលក្រុមអ្នកសិក្សាស្រាវជ្រាវបានបង្កើតឡើង ហើយដែលនឹងនាំឱ្យមានការចុះបញ្ជីប្រភេទសត្វ និងរុក្ខជាតិដែលជាប់ជា "អាទិភាព" ពោលគឺបណ្តាប្រភេទដែលមានចំណាត់អាទិភាព "ខ្ពស់បំផុត" "ខ្ពស់" ឬ "មធ្យម" សំរាប់ការអភិរក្ស។ វិធានការគ្រប់គ្រងបានត្រូវបង្កើតឡើងដោយផ្អែកលើអេកូឡូស៊ី និងរបាយនៃប្រភេទសត្វជាអាទិភាព និងការគំរាមកំហែងនានាក្នុងពេលបច្ចុប្បន្ននៅក្នុងតំបន់សិក្សាស្រាវជ្រាវ។ សំរាប់ប្រភេទរុក្ខជាតិ/ព្រៃ សត្វស្លាប ថនិកសត្វមាឌធំៗ និងល្មួន វិធានការចាំបាច់សម្រាប់ការគ្រប់គ្រងរួមមាន ចំណាត់វិធានការទៅតាមប្រភេទ និងតាមទីតាំងជាក់លាក់នៅក្នុងតំបន់សិក្សាស្រាវជ្រាវ (សូមអានចំណុច១០.១ និង១០.២)។ វិធានការដែលមានអាទិភាពខ្ពស់ជាងគេ គឺការដាក់បញ្ចូល"ផ្នែកកណ្តាល"នៃតំបន់សិក្សានេះទៅជា "តំបន់គ្រប់គ្រងពិសេស" ដើម្បីការពារព្រៃធម្មជាតិ និងទីជម្រកសត្វដែលនៅសេសសល់តិតតួចចុងក្រោយនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះ តាមរយៈការគ្រប់គ្រងទីតាំងនីមួយៗដោយផ្ទាល់ និងការដាក់កំហិតលើការតាំងទីលំនៅ និងការប្រើប្រាស់ធនធានធម្មជាតិដោយសហគមន៍មូលដ្ឋាន។ តំបន់ទំនាបលិចទឹកនៅប៉ែកខាងលិចនៃទីរួមខេត្តក្រចេះ កំពុងត្រូវបានកំណត់ជាតំបន់ការពារសត្វក្តាន់ដែលនឹងផ្តល់ប្រយោជន៍យ៉ាងហោចណាស់សម្រាប់សត្វអណ្តើក និងសត្វពស់ជាអាទិភាពមួយប្រភេទផងដែរ។

៣០- ចំពោះប្រភេទជាច្រើនដែលរស់នៅក្នុងទឹក ពិសេសត្រីដែលធ្វើចរាចរយៈឆ្ងាយ ចំណាត់វិធានការតាមទីតាំងជាក់លាក់មិនអាចគ្រប់គ្រាន់ដើម្បីថែរក្សាចំនួនឯកត្តៈក្នុងប្រភេទទាំងនោះបានឡើយក្នុងទីតាំងសិក្សានេះ ដោយសារប្រភេទទាំងនោះពឹងអាស្រ័យទៅធនធាននានាទាំងនៅខាងក្នុង និងខាងក្រៅកន្លែងសិក្សាស្រាវជ្រាវនេះ។ ការអភិរក្សប្រភេទសត្វទាំងនេះ ទាមទារឱ្យមានការផ្លូចផ្តើមនៅកម្រិតផ្នែរងទឹកភ្លៀងដើម្បីការពារធនធានទាំងនេះឱ្យបានតាមវិសាលភាពពេញលេញរបស់វា និងទៅតាមរដូវដែលជាប្រការចាំបាច់សម្រាប់ការបន្តពូជ រកចំណី និងបំលាស់ទី (សូមអានចំណុច ១០.៣)។

៣១- សិក្ខាសាលាថ្នាក់ខេត្ត: សិក្ខាសាលាមួយជាមួយស្ថាប័នរដ្ឋាភិបាល និងអង្គការមិនមែនរដ្ឋាភិបាលត្រូវបានរៀបចំកាលពីថ្ងៃទី១២ និង ១៣ខែ កុម្ភៈឆ្នាំ ២០០៨ នៅទីរួមខេត្តក្រចេះដើម្បីបង្ហាញលទ្ធផលនៃការសិក្សាអង្កេតអំពីជីវចម្រុះ និងលើកអនុសាសន៍ (សូមអានឧបសម្ព័ន្ធ៨)។ សកម្មភាពជាគន្លឹះដែលចាំបាច់ដើម្បីផ្តួចផ្តើមឱ្យមានចំណាត់ការជាបន្តក្នុងបំណងធ្វើការអភិរក្សជីវចម្រុះនៅក្នុងកន្លែងសិក្សាស្រាវជ្រាវត្រូវបានកែលំអ និងឯកភាពគ្នាក្នុងចំណោមសិក្ខាកាមទាំងអស់នៅក្នុងសិក្ខាសាលា ពិសេសអំពីតម្រូវការចាំបាច់ដើម្បីកំណត់ "ផ្នែកកណ្តាល"នៃកន្លែងសិក្សាស្រាវជ្រាវនេះឱ្យទៅជា"តំបន់គ្រប់គ្រងពិសេស"និងការពារចំនួនឯកត្តៈសរុបនៃសត្វក្តាន់ចុងក្រោយបង្អស់នៅក្នុងតំបន់ឥណ្ឌូចិន (សូមអានអនុសាសន៍)។

កំណត់ត្រាថ្មីរបស់ប្រភេទសត្វ និងរុក្ខជាតិដែលត្រូវបានកត់ត្រាក្នុងអំឡុងពេលសិក្សាអង្កេតក្នុងឆ្នាំ ២០០៦ និង ២០០៧

ល.រ	ឈ្មោះវិទ្យាសាស្ត្រ	កំណត់សំគាល់	បញ្ជីក្រហម IUCN	អាទិភាពអភិរក្ស *
	រុក្ខជាតិ			
១	*Amorphophallus sp.nov.*	កំណត់ត្រាថ្មីសំរាប់វិទ្យាសាស្ត្រ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹងប៉ុន្តែអាចស្ថិតនៅក្នុងអាទិភាពខ្ពស់បំផុត
២	*Desmodium flexuosum*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
៣	*Indigofera zollingeriana*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
៤	*Rhodamnia cinerea*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
៥	*Brachystelma kerrii*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
៦	*Diospyros oblonga*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
៧	*Ardisia attenuata*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
៨	*Calcareoboea bonii*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
៩	*Kaempferia simensis*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១០	*Typhonium laoticum*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១១	*Brachycorythis helferi*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១២	*Habenaria viridiflora*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១៣	*Liparis rheedii*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១៤	*Liparia siamensis*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១៥	*Nervilia punctata*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១៦	*Nervilia calcicola*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១៧	*Vandopsis gigantea*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១៨	*Fimbristylis brunneoides*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
១៩	*Fimbristylis jucunda*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
២០	*Murdannia discreta*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
២១	*Amorphophallus koratensis*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
២២	*Cryptocoryne crispatula*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
២៣	*Acacia leucophloea*	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	មិនត្រូវបានដឹង
	ល្មូន			
២៤	*Hemiphyllodactylus yunnanensis* (តុកកែ)	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	អាទិភាពទាប/មិនសូវសំខាន់
	ត្រី			
២៥	*Toxabramis sp.* (a minnow)	កំណត់ត្រាថ្មីសំរាប់ជាតិ	ពុំមាននៅក្នុងបញ្ជីរឡើយ	អាទិភាពទាប/មិនសូវសំខាន់

កំណត់សំគាល់: ក្នុងចំណោមប្រភេទសត្វ និងរុក្ខជាតិខាងលើ ពុំមានប្រភេទសត្វណាមួយស្ថិតនៅក្នុងបញ្ជីក្រហមរបស់អង្គការ IUCN ឬក៏ស្ថិតនៅក្នុងច្បាប់នៃប្រទេសកម្ពុជាឡើយ។ រូបភាពនៃប្រភេទសត្វ និងរុក្ខជាតិមួយចំនួនដែលមាននៅក្នុងតារាងខាងលើមានបង្ហាញជូននៅក្នុងឧបសម្ព័ន្ធទី៣។ សូមពិនិត្យមើលតារាងទី ២៥ (ផ្នែកទី ១០.១.២) និងឧបសម្ព័ន្ធទី ៦ សំរាប់ប្រភេទសត្វ និងរុក្ខជាតិដែលត្រូវបានកំណត់ជាប្រភេទ " អាទិភាពអភិរក្ស " សំរាប់អន្តរាគមន៍នៃការគ្រប់គ្រងនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវ។

អនុសាសន៍

អនុសាសន៍ខាងក្រោមត្រូវបានលើកឡើងដោយផ្អែកលើការចាត់ជាលំដាប់នូវប្រភេទសត្វ និងរុក្ខជាតិដើម្បីកំណត់អាទិភាពគ្រប់គ្រងខ្ពស់បំផុត ស្ថានភាពនៃការគំរាមកំហែង របាយ និងអេកូឡូស៊ីរបស់សត្វទាំងនោះនៅក្នុងតំបន់សិក្សា។ សេចក្តីព្រាងអនុសាសន៍ ត្រូវបានរៀបចំឡើងជាលើកដំបូងដោយក្រុមអ្នកសិក្សាស្រាវជ្រាវ បន្ទាប់មកត្រូវបានកែសម្រួល និងរៀបចំបង្ហើយនៅក្នុងសិក្ខាសាលាមួយជាមួយស្ថាប័នថ្នាក់ខេត្ត និងថ្នាក់ជាតិ (ឧបសម្ព័ន្ធ ៨)។ សេចក្តីលំអិតបន្ថែមមាននៅក្នុងផ្នែកទី ១០។

ទីតាំង និងប្រភេទសត្វនៅក្នុងអាទិភាពគ្រប់គ្រង

១- រាល់ធនធាន និងមូលនិធិដែលមានសម្រាប់ការគ្រប់គ្រង ត្រូវតែផ្តោតលើយ៉ាងហោចណាស់សម្រាប់ប្រភេទ "ជាអាទិភាព"ចំនួន៤៨ ដែលមាននៅក្នុងតារាងទី២៩ (ផ្នែក ១០.១) និងទីតាំងចំនួន ២ដែលផ្តល់អំណោយផលដល់ប្រភេទអាទិភាពទាំងនេះរួមទាំង "ផ្នែកកណ្តាល" នៃតំបន់សិក្សាស្រាវជ្រាវ និងតំបន់ទំនាបលិចទឹកនៅខាងលិចនៃទីរួមខេត្តក្រចេះ។ សកម្មភាពគ្រប់គ្រងជាក់លាក់សម្រាប់គ្រប់ប្រភេទអាទិភាព និងទីតាំងទាំង ២ខាងលើនេះ មានបង្ហាញជូននៅក្នុងផ្នែកទី ១០.១.២ និង ១០.២។

"ផ្នែកកណ្តាល"

២- ត្រូវកំណត់ "ផ្នែកកណ្តាល" ឱ្យទៅជា "តំបន់គ្រប់គ្រងពិសេសរបស់ខេត្ត" ។ សំណើព្រំប្រទល់សម្រាប់តំបន់គ្រប់គ្រងពិសេសមានបង្ហាញនៅក្នុងរូបទី១០ និង១១ និងធ្វើឡើងដោយផ្អែកលើទីតាំងនានានៃប្រភេទអាទិភាព ។ ទីតាំងនេះគួរតែគ្របដណ្តប់ដងទន្លេមេគង្គ និងទីជម្រកនានានៅតាមផ្លូវទឹកក្នុងទន្លេនេះ លើចម្ងាយប្រហែល ៥៦ គ.ម (តាមបណ្តោយដងទន្លេ) និងមានក្រឡាផ្ទៃប្រមាណ ៣៣.៨០៨ ហិកតា។ ការទទួលបាននូវកិច្ចគាំទ្រជាផ្លូវការសម្រាប់ទីតាំងនេះ គឺជាមូលដ្ឋានគ្រឹះសម្រាប់គ្រប់គ្រងតំបន់នេះ។

៣-រដ្ឋបាលជលផល នឹងសម្របសម្រួលរាល់សកម្មភាពអភិរក្សនៅក្នុងតំបន់គ្រប់គ្រងពិសេសនេះដែលនឹងមានការចូលរួមសហការពីស្ថាប័នពាក់ព័ន្ធនានានៅថ្នាក់ខេត្ត និងថ្នាក់ជាតិ។

៤- ត្រូវកំណត់ និងអនុវត្តតំបន់គ្រប់គ្រងយ៉ាងហោចណាស់ចំនួនពីរសំរាប់ដំបានដំបូងនេះនៅក្នុង "ផ្នែកកណ្តាល" នៃតំបន់សិក្សានេះពោលគឺ "តំបន់ប្រើប្រាស់ច្រើនយ៉ាង"មួយ និង"តំបន់ការពារ"មួយ។ ព្រំប្រទល់តំបន់គ្រប់គ្រង ដែលបានស្នើសុំមានបង្ហាញជូននៅក្នុងរូបទី ១១ និងធ្វើឡើងដោយផ្អែកលើរបាយនៃប្រភេទអាទិភាព និងការធ្វើផែនទីលំនៅដ្ឋានជាលើកដំបូង។ ការកំណត់តំបន់គ្រប់គ្រង នឹងផ្តល់ឱកាសសម្រាប់ការបែងចែកកន្លែងសំរាប់សហគមន៍ប្រើប្រាស់ និងសម្រាប់អភិរក្សជីវចម្រុះហើយនេះជាប្រការចាំបាច់នៅក្នុងរយៈពេលខ្លីដើម្បីការពារធនធានធម្មជាតិដែលមាននៅសេសសល់មុនពេលឈានទៅដំណើរការតាមបែបផែននៃការចូលរួមដើម្បីកំណត់ព្រំប្រទល់សម្រេច។

៥- "តំបន់ប្រើប្រាស់ច្រើនយ៉ាង" គួរតែមានរួមបញ្ចូលដីនៅជុំវិញភូមិ និងកន្លែងតាំងទីលំនៅ ហើយរាល់កិច្ចប្រឹងប្រែងគួរតែផ្តោតលើការកែលំអរជីវភាពរស់នៅ និងគាំទ្រដល់ការគ្រប់គ្រងធនធានធម្មជាតិដោយសហគមន៍ ពិសេសធនធានជលផល និងព្រៃឈើ។ "តំបន់ការពារ" គួរតែរាប់បញ្ចូលព្រៃដែលមាននៅសល់តាមច្រាំងទន្លេ និងទីជម្រកក្នុងទឹក និងគួរតែលាតសន្ធឹងយ៉ាងហោចណាស់ ៥០ម ពីច្រាំងទន្លេ និងគ្របដណ្តប់ព្រៃនៅតាមច្រាំងទន្លេ ។ ការតាំងទីលំនៅ ការរានឆ្ការព្រៃ និងការបរបាញ់ (រួមទាំងការបណ្តើរឆ្កែ) គួរត្រូវហាមឃាត់នៅក្នុងតំបន់នេះ ហើយគួរតែមានការដាក់កំហិតលើសកម្មភាពផ្សេងៗរបស់មនុស្សនៅក្នុងតំបន់នេះ ឧទាហរណ៍: ការធ្វើនេសាទតាមរដូវកាល ។

៦- ត្រូវជូនដំណឹងជាបន្ទាន់ដល់អាជ្ញាធរ និងសហគមន៍មូលដ្ឋានទាំងអស់ដែលរស់នៅក្នុងចំងាយយ៉ាងតិច ៣0 គ.មពី "ផ្នែកកណ្តាល" (ចំងាយអតិបរិមាដែលប្រជាជននៅក្នុងសហគមន៍ធ្វើដំណើរទៅកាន់"ផ្នែកកណ្តាល"ដើម្បីទាញយកផលពីធនធានធម្មជាតិ)អំពីការកំណត់ជាបឋម និងទីតាំងថ្មីនៃតំបន់គ្រប់គ្រងទាំងនេះ ។ ក្រុមមន្ត្រីរបស់ស្ថាប័នពាក់ព័ន្ធនៅថ្នាក់ខេត្ត និងស្រុកអាចចុះធ្វើការនៅសហគមន៍គោលដៅទាំងអស់ដើម្បី ១)ផ្សព្វផ្សាយព័ត៌មានស្តីអំពីការកំណត់ទីតាំងថ្មី និងតំបន់គ្រប់គ្រងទាំងពីរខាងលើ ។ ២) ធានាថាមេភូមិទាំងអស់បានយល់ដឹងអំពីតំបន់គ្រប់គ្រងទាំងនេះ និងហាមឃាត់អ្នកចំណូលថ្មីពីការតាំងទីលំនៅក្នុង"តំបន់ការពារ" ។ ៣)គួសបញ្ជាក់ថាដំណើរការកំណត់ជាចុងក្រោយនូវតំបន់ប្រើប្រាស់តាមបែបផែននៃការចូលរួមនឹងមានអនុវត្តតាមក្រោយ ។ ៤) សម្រាប់ជនចំណូលថ្មីដែលកំពុងធ្វើការរានឆ្ការដី ប៉ុន្តែដែលនៅពុំទាន់បានបង្កើតជាលំនៅស្ថានអចិន្ត្រៃយ៍ ជួយពួកគេក្នុងការផ្លាស់ទៅទីកន្លែងថ្មីនៅក្នុងតំបន់ប្រើប្រាស់ច្រើនយ៉ាងវិញ។

៧- រៀបចំចុះធ្វើការសិក្សាអង្កេតដោយឆាប់រហ័សលើផ្នែកសេដ្ឋកិច្ចសង្គមនៅក្នុង "ផ្នែកកណ្តាល" ដើម្បីចងក្រងជាឯកសារអំពីទីតាំង និងទំហំនៃភូមិទាំងអស់ ការតាំងទីលំនៅថ្មី ចំនួនប្រជាជនរស់នៅទីនោះនាពេលបច្ចុប្បន្ន និងកម្មសិទ្ធិដីធ្លី ។ ការសិក្សានេះនឹងជួយបំពេញបន្ថែមនូវព័ត៌មានដំបូងដែលបានប្រមូលក្នុងអំឡុងពេលនៃការសិក្សាជីវចម្រុះ(ផ្នែកទី៨)និងជួយដល់ការងារកំណត់ជាចុងក្រោយនូវទីតាំងតំបន់គ្រប់គ្រង និងរៀបចំផែនការប្រើប្រាស់ដីធ្លី ។

៨- ផ្តួចផ្តើមឱ្យមានវិធានការគ្រប់គ្រងសម្រាប់ប្រភេទសត្វ និងរុក្ខជាតិជាក់លាក់នៅក្នុង "ផ្នែកកណ្តាល" ដែលមានបង្ហាញនៅក្នុងតារាងទី២៩ (ផ្នែក១0,១,២) ។ សកម្មភាពសំខាន់ៗមានរាប់បញ្ចូល កម្មវិធីសហគមន៍ដើម្បីការពារសំបុកសត្វស្លាបទឹក កន្ទាយក្បាលកង្កែប និងប្រភេទផ្សេងៗទៀត និងសកម្មភាពល្បាតដើម្បីពង្រឹងការអនុវត្តច្បាប់ជាតិនៅត្រង់គ្រប់ច្រកធ្វើពាណិជ្ជកម្ម និងទីផ្សារ និងសហការជាមួយសហគមន៍មូលដ្ឋានដើម្បីការពារប្រភេទសត្វ រុក្ខជាតិ និងទឹកន្លែងនានាដែលមានតម្លៃខ្ពស់បំផុតសម្រាប់ជីវចម្រុះ។

៩- រៀបចំផែនការគ្រប់គ្រងនៅតាមទីតាំងជាក់លាក់ដោយមានរួមបញ្ចូលទាំង គោលដៅ ពេលវេលា និងថវិកាដើម្បីបន្សុីគ្នា និងពង្រីកសកម្មភាពដែលបានលើកឡើងក្នុងអនុសាសន៍លេខ២-៨ និងកំណត់ឱ្យបានច្បាស់លាស់ពីសកម្មភាពបន្ត។ សកម្មភាពបន្តមានរាប់បញ្ចូលនូវ:

- រៀបចំឱ្យបានស្រេចបាច់នូវការកំណត់ព្រំប្រទល់តំបន់គ្រប់គ្រង និងបទបញ្ជាសម្រាប់តំបន់នីមួយៗតាមបែបផែនដែលមានការចូលរួមពីសំណាក់សហគមន៍មូលដ្ឋាន និងស្ថាប័នពាក់ព័ន្ធផ្សេងៗទៀត ។
- ពង្រឹងសមត្ថភាពនៅថ្នាក់ខេត្តសម្រាប់ការអភិរក្ស" ប្រភេទអាទិភាព" ដោយរាប់បញ្ចូលវគ្គបណ្តុះបណ្តាលអំពីការល្បាតសម្រាប់មន្ត្រីល្បាត ។
- ពង្រឹងការគ្រប់គ្រងធនធានធម្មជាតិដោយសហគមន៍មូលដ្ឋាននៅក្នុង "តំបន់ប្រើប្រាស់ច្រើនយ៉ាង" ពិសេសធនធានមច្ឆជាតិ និងព្រៃឈើ ។ គម្រោងកែលំអជីវភាពរស់នៅគួរផ្តោតទៅលើភូមិចំនួន0៦ដែលស្ថិតក្នុងតំបន់ដែលមានតម្លៃខ្ពស់បំផុតខាងជីវចម្រុះពោលគឺ ភូមិកំពង់ភ្នៅ ភូមិអូរកាក់ ភូមិពុងតាជា ភូមិកោះខ្សែរ ភូមិខ្សាច់លាវ និងភូមិកោះដំបង ។
- ធ្វើអត្តសញ្ញាណទំនាក់ទំនងរវាងការអភិរក្សជីវចម្រុះ និងអេកូទេសចរដែលគ្រោងសម្រាប់តំបន់នោះ ។
- ធ្វើអត្តសញ្ញាណ និងស្វែងរកធនធាន និងមូលនិធិសម្រាប់ការគ្រប់គ្រងទីតាំង ។

តំបន់ធំនាបលិចទឹកនៅខាងលិចទីរួមខេត្តក្រចេះ (តំបន់ការពារសត្វក្តាន់)

១០- រៀបចំកំណត់ជាផ្លូវការនូវ "តំបន់ការពារសត្វក្តាន់"។ បច្ចុប្បន្ន រដ្ឋបាលព្រៃឈើខេត្តក្រចេះកំពុងរៀបចំបែបបទសម្រាប់ដាក់ស្នើជា "តំបន់ការពារធម្មជាតិ" ដើម្បីការពារសត្វក្តាន់ដែលមានសេសសល់ចុងក្រោយបង្អស់នៅឥណ្ឌូចិន ។ តំបន់ការពារនេះគ្របដណ្តប់ភាគច្រើននៃតំបន់ធំនាបលិចទឹកនៅភាគខាងលិចទីរួមខេត្តក្រចេះ។ ការគ្រប់គ្រងទីតាំងនេះ ក៏នឹងមានសារៈប្រយោជន៍ផងដែរចំពោះ "ប្រភេទអាទិភាព" ផ្សេងៗទៀត ។

១១- ផ្តួចផ្តើមឱ្យមានវិធានការគ្រប់គ្រងដើម្បីការពារសត្វក្តាន់ និងទីជម្រករបស់វា។ សកម្មភាពដែលលើកស្នើមានបង្ហាញជូននៅក្នុងតារាងទី៣0(ផ្នែក១0,២)និងបានលើកឡើងដោយផ្អែកលើលទ្ធផលនៃការសិក្សា និងបណ្តាអនុសាសន៍ដែលបានលើកឡើងដោយ Maxwell et al.. (២00៦) ។ អនុសាសន៍ទាំងនោះ រួមមាន:

- រក្សាទុកនូវកំលាំងអនុរក្សនាពេលបច្ចុប្បន្ននៅទីតាំងនេះ និងពង្រឹងសមត្ថភាពសហគមន៍ និងសមាជិកនៃក្រុមរបស់មន្ត្រីរដ្ឋាភិបាលលើការរៀបចំផែនការល្បាត ការប្រមូលទិន្នន័យ និងការងារតាមដាននៅទីតាំង។
- ត្រួតពិនិត្យ និងតាមដានលើការពង្រីកដីកសិកម្មនៅក្នុងតំបន់ដែលបានស្នើជាតំបន់ការពារ ។
- ធ្វើការ "វាយតំលៃផលប៉ះពាល់បរិស្ថាន និងសង្គម" ដើម្បីវាយតំលៃផលប៉ះពាល់ដែលអាចកើតមានបណ្តាលពីកិច្ចការពារទីតាំងនោះមកលើជីវភាពរបស់ភូមិទាំង ១៥ ដែលស្ថិតនៅក្នុងតំបន់ស្នើការពារនេះ។
- កំណត់វិធីសាស្ត្រដើម្បីកាត់បន្ថយការបំផ្លាញដំណាំដោយសារសត្វជ្រូកព្រៃ ដោយពុំចាំបាច់ដាក់អន្ទាក់ ឬសម្លាប់សត្វនោះ។
- រៀបចំ និងអនុវត្តផែនការគ្រប់គ្រងតំបន់ការពារសត្វក្តាន់ បន្ទាប់ពីតំបន់នោះត្រូវបានប្រកាសជាផ្លូវការ ។

១២. បង្កើតសកម្មភាពអភិរក្សសម្រាប់ការពារប្រភេទសត្វអាទិភាពដទៃទៀតដែលមាននៅក្នុងតំបន់ធំនាបលិចទឹកទាំងនេះ។ ប្រភេទទាំងនេះមានរាប់បញ្ចូលនូវអណ្តើកសកល ពស់ព្រលឹត (*Enhydris longicauda*) និងអាចរាប់បញ្ចូលទាំងសត្វភេផងដែរ។ សកម្មភាពដែលស្នើឡើងមានបង្ហាញនៅក្នុងតារាងទី ២៥ (ផ្នែក ១0,១,២) ។

ទីតាំងផ្សេងៗទៀតក្នុងតំបន់សិក្សាស្រាវជ្រាវ

១៣- អនុវត្តសកម្មភាពគ្រប់គ្រងនៅតាមទីតាំងផ្សេងទៀតដែលមានប្រភេទសត្វ និងរុក្ខជាតិអាទិភាព ។ យ៉ាងហោចណាស់មានទីតាំងចំនួន ៤ផ្សេងទៀតនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះដែលទ្រទ្រង់ប្រភេទអាទិភាពដែលរួមមាន: វត្តមួយនៅលើកោះត្រែង ទំនាបលិចទឹកភាគខាងត្បូងទីរួមខេត្តក្រចេះ អន្លង់កាំពី ខ្សែទឹកទន្លេមេគង្គចាប់ពីអន្លង់កាំពីបន្តឆ្ពោះទៅ "ផ្នែកកណ្តាល" នៃទីតាំងសិក្សានេះ (រូបទី១0) ។ សំណើសកម្មភាពមានបង្ហាញជូននៅក្នុងតារាងទី ៣0 (ផ្នែកទី១0,២) ។ សកម្មភាពនៅក្នុងទីតាំងទាំងនេះគួរត្រូវអនុវត្តនៅពេលដែលបានទទួលមូលនិធិ និងធនធានគ្រប់គ្រាន់សម្រាប់ "ផ្នែកកណ្តាល" និងតំបន់ធំនាបលិចទឹកខាងលិចទីរួមខេត្តក្រចេះ។

វិធានការសំរាប់កម្រិតតំបន់ទេសភាព និងពត៌មានដែលខ្វះខាត

១៤- វិធានការការពារសម្រាប់ទីតាំងជាក់លាក់ មិនគ្រប់គ្រាន់សម្រាប់អភិរក្សប្រភេទសត្វក្នុងទឹកខ្លះៗនៅក្នុងទីតាំងសិក្សានេះបានឡើយ ជាពិសេសសម្រាប់ប្រភេទត្រីដែលធ្វើចរាចរ ដូច្នេះចាំបាច់តម្រូវឱ្យមានសកម្មភាពបន្ថែមផ្សេងៗទៀតដើម្បីថែរក្សាជម្រកសំខាន់ៗដែលស្ថិតនៅខាងក្រៅតំបន់សិក្សា ។ ការគ្រប់គ្រងប្រភេទសត្វ និងរុក្ខជាតិទឹកសាបជាច្រើនប្រភេទក៏ត្រូវជួបប្រទះនឹងការលំបាកដោយសារកង្វះទិន្នន័យគោលពីស្ថានភាព របាយ និងអេកូឡូស៊ីផងដែរ។ អនុសាសន៍នានាសម្រាប់សកម្មភាពសំខាន់ៗនៅកម្រិតតំបន់ទេសភាពមាន

បង្ហាញជូននៅក្នុងផ្នែកទី ១០.៣ និងរួមបញ្ចូលប្រការនានាដូចខាងក្រោម:

- ពង្រឹងសមត្ថភាពនៅថ្នាក់ខេត្តដើម្បីគ្រប់គ្រងប្រភពធនធានវារិសត្វនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវនេះ ។
- ត្រូវធានាថាតំបន់សិក្សាស្រាវជ្រាវនេះត្រូវបានបញ្ចូលទៅក្នុងកិច្ចផ្តួចផ្តើមថ្នាក់ជាតិ និងថ្នាក់តំបន់ ដើម្បីគ្រប់គ្រងទីជម្រកនានាសម្រាប់ត្រីដែលធ្វើចរាចរនៅក្នុងអាងទន្លេមេគង្គក្រោម ។
- បង្កើត និងពង្រឹងទំនាក់ទំនង និងការផ្លាស់ប្តូរព័ត៌មានរវាងស្ថាប័នគ្រប់គ្រងនៅក្នុងតំបន់សិក្សាជាមួយនឹងស្ថាប័នគ្រប់គ្រងទីតាំងផ្សេងទៀតចំនួនយ៉ាងហោចណាស់ចំនួនពីរ ពោលគឺ ទីតាំងតំបន់រ៉ាមសារ (ក្នុងខេត្តស្ទឹងត្រែងនៃប្រទេសកម្ពុជា) និងតំបន់ស៊ីផាន់ដន (ក្នុងប្រទេសឡាវ) ។ ទីតាំងទាំងបីនេះ មានសារសំខាន់ណាស់សម្រាប់ថែរក្សាសត្វ និងរុក្ខជាតិជាច្រើនប្រភេទដែលរស់នៅពឹងអាស្រ័យលើរបបទឹកទន្លេមេគង្គចាប់ពីទីប្រជុំជនប៉ាក់សេ (ប្រទេសឡាវ) បន្តមកភាគខាងត្បូងរហូតដល់ទីរួមខេត្តក្រចេះ ។
- ធ្វើការសិក្សាអង្កេតស្ថានភាពគោលនៃពពួកវារិសត្វដែលគ្មានឆ្អឹងកងនៅក្នុងតំបន់សិក្សានេះ (ការសិក្សាពីពេលមុនបានបង្ហាញថា អាងទន្លេមេគង្គ គឺជាមជ្ឈមណ្ឌលនៃប្រភេទដែលមានតែក្នុងកន្លែងដើមរបស់វា ជាពិសេសពពួក gastropods និងសត្វឥតឆ្អឹងកងផ្សេងទៀត ។
- ពិនិត្យឡើងវិញអំពីស្ថានភាពបច្ចុប្បន្ន និងវិសាលភាពនៃកិច្ចការពារប្រភេទអាទិភាពដែលស្ថិតនៅក្រោមកិច្ចការពាររបស់ច្បាប់ជាតិ និងដីការរបស់ខេត្ត និងវាយតំលៃអំពីភាពចាំបាច់ក្នុងការធ្វើវិសោធនកម្ម ។
- បង្កើតយុទ្ធសាស្ត្រមួយដើម្បីកំណត់ផលប៉ះពាល់នៃគម្រោងអភិវឌ្ឍន៍ ដែលអាចកើតមានមកលើអេកូឡូស៊ី និងជលសាស្ត្រនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវ ពិសេសពីទំនប់វារីអគ្គីសនី និងសម្បទានដីធ្លី ។
- បង្កើតស្ថានីយស្រាវជ្រាវអន្តរជាតិនៅក្នុងតំបន់សិក្សាដែលផ្តោតលើជីវចម្រុះទឹកសាប ។ ស្ថានីយនេះ អាចផ្តល់ការគាំទ្រដល់និស្សិតជាតិនិងអន្តរជាតិដែលកំពុងធ្វើការសិក្សាស្រាវជ្រាវជីវចម្រុះទឹកសាប ផ្តល់ចំណេះដឹងថ្មីៗអំពីអេកូឡូស៊ីនៃអាងទន្លេមេគង្គក្រោម និងពង្រឹងសមត្ថភាពនៅថ្នាក់ជាតិ និងខេត្តអំពីការគ្រប់គ្រងជីវចម្រុះទឹកសាប ។

សកម្មភាពបន្ថែនៃការគ្រប់គ្រង

១៥- គេចាំបាច់ត្រូវចាត់វិធានការគ្រប់គ្រងបន្ថែន ដើម្បីថែរក្សានូវធនធានធម្មជាតិនានាដែលមាននៅ "ផ្នែកកណ្តាល" នៃតំបន់ស្រាវជ្រាវនេះ ដើម្បីជាប្រយោជន៍នៃការអភិរក្សជីវចម្រុះ និងសហគមន៍មូលដ្ឋាន ។ ស្ថាប័នគ្រប់គ្រង និងអង្គការផ្សេងៗទៀតត្រូវឆក់យកឱកាសដើម្បីរៀបចំ និងអនុវត្តវិធានការប្រកបដោយប្រសិទ្ធភាពនៅក្នុងទីតាំងនេះ ដោយហេតុថាទីតាំងនេះមានទំហំតូច រីឯផលប៉ះពាល់ព្រមទាំងសកម្មភាពគំរាមកំហែងមួយចំនួនធំទើបតែចាប់ផ្តើមនៅក្នុងរយៈពេល១០ឆ្នាំមុននេះប៉ុណ្ណោះ ហើយដង់ស៊ីតេប្រជាជននៅទីនេះមានកម្រិតទាបនៅឡើយ ។ ឱកាសសម្រាប់ការពារតំបន់នេះមានតិចតួចប៉ុណ្ណោះ ហើយប្រសិនបើគេពុំចាត់វិធានការគ្រប់គ្រងទេនោះ អត្រានៃការបរបាញ់សត្វព្រៃសព្វថ្ងៃនេះ ការតាំងលំនៅដ្ឋានថ្មី និងការបាត់បង់ទីជម្រកនឹងអាចនាំឱ្យមានការបាត់បង់ ឬថយចុះដ៏ធ្ងន់ធ្ងរនូវព្រៃដែលនៅសេសសល់តាមច្រាំងទន្លេ និងពពួកប្រភេទសត្វ និងរុក្ខជាតិអាទិភាពជាច្រើននៅក្នុង"ផ្នែកកណ្តាល"នៃទីតាំងស្រាវជ្រាវនេះ ។

SUMMARY

This report describes the results of the first systematic biological surveys of a 130-km section of the Mekong River in northeast Cambodia. Surveys were undertaken over a nine month period between November 2006 and August 2007, in a collaborative initiative between the Fisheries and Forestry Administrations and the World Wide Fund for Nature (WWF). Surveys were conducted by a team comprising government personnel and international specialists, and focused on the riverine habitats within the Mekong River channel and some adjacent floodplains, to document vegetation and flora, birds, large mammals, amphibians, reptiles and fish. Findings include the presence of one undescribed taxon, 24 other new records for the Cambodian flora and fauna (see table at end of Summary), intact riverine habitats, and some of the largest breeding populations in the Mekong River Basin or globally for a range of threatened taxa. Ranking criteria and recommendations were developed to identify and conserve taxa of highest management priority within the study area.

1. **Background**. Surveys focused on the section of Mekong River between Kratie and Stung Treng Towns, in Kratie and Stung Treng Provinces. This river section forms the largest portion of a hydrologically distinct 330-km unit of the Mekong River, which extends from Pakse Town (Lao PDR) south to Kratie Town, and is characterized by a wide, braided channel which receives >25% annual flow volume from three large tributaries north of Stung Treng Town, the Se Kong, Se San and Srepok Rivers (MRC 2005). The study area experiences large seasonal fluctuations in flow volume and a 10+ m range in water level between the dry and wet seasons. Until the 1990s, parts of the study area were under restricted access due to political instability and military restrictions, and few researchers had visited the area. Available data indicated the study area supported high biological values, but this was largely unconfirmed.

2. Between 2006 and 2007, biological surveys were conducted in three seasonal periods: the early dry season (receding water levels, November 2006), the mid-dry season (low water levels, March-April 2007) and the wet season (high water levels, July-August 2007). Surveys were each of 15-25 days duration and a total of 220 field days were conducted.

3. **"Central section"**. Surveys largely focused on a 56-km section of river mid-way between Kratie and Stung Treng Towns, termed here the "central section". This river section extends from 49 km north of Kratie Town to 14 km north of the Kratie-Stung Treng provincial border. It supports the lowest human densities and most intact riverine habitats within the study area, comprising a diverse and rich mosaic of seasonally flooded riverine vegetation, sandbars, beaches, deep pools, rocky rapids, riverbank forest and numerous islands. Many kilometers of riverbank and islands remain unsettled. The intactness of habitats in this river section appears to have resulted from a combination of low regional population densities and previous political instability, which restricted local settlement until the last decade.

4. **Vegetation and flora**. Surveys focused on the inventory and collection of vascular plants on islands and aquatic habitats within the mainstream, with opportunistic collection of bryophytes (mosses). A plant database, vegetation profiles, and a photographic inventory of flora and habitats were developed. Four plant collections (over 700 specimens) were compiled for all species encountered and submitted to Cambodian and international institutions. This is the first relatively detailed flora inventory for islands within the Cambodian Mekong River.

5. Two principle kinds of vegetation were delineated, riverine (vegetation in the river channel to the highest water level attained in the wet season) and terrestrial (on land above the flood level of the river). Six riverine "zones" are present, which are characterised by their location within the channel and extent and duration of seasonal submergence: "Aquatic", "Rapids", "Kai Kum", "Acacia-Anogeissus", "Beach" and "Strand". Most riverine zones are exposed during periods of lowest water level (February-May) and only the uppermost zone is exposed during highest water level (August-September). The riverine flora range from small annual aquatic herbs to trees 15+ m tall. Three terrestrial facies were recorded: "Mixed Evergreen and Deciduous, Seasonal, Hardwood Forest", "Bamboo and Deciduous, Seasonal, Hardwood Forest", and "Deciduous, Dipterocarp, Seasonal, Hardwood Forest".

6. A total of 683 species of vascular plants from 120 families and seven species of bryophytes were recorded. A database was compiled for these species on habit, habitat, abundance, elevation, life mode, leafing, flowering, and fruiting phenology. These records include one undescribed taxon and 22 other new records

for the Cambodian flora. Many taxa, particularly riverine taxa, are suspected to be endemic to the Mekong River and/or the Mekong Basin, although this cannot be confirmed at the current time due to insufficient botanical collection in the basin and other rivers of mainland Southeast Asia.

7. The new species, *Amorphophallus* sp. nov. (Araceae) was located on a single island in the "central section" in "Bamboo and Deciduous, Seasonal, Hardwood Forest". No specimens are known from any current or historic herbarium collections. Further surveys are required to clarify the status, distribution, and ecology of this species.

8. The "central section" is the highest priority for flora conservation in the study area. In general, riverine vegetation in this section is mostly intact while the terrestrial vegetation ranges from degraded to cleared. Outside the "central section", natural vegetation has been degraded or largely cleared from most sections of river, riverbank and floodplains. "Acacia-Anogeissus", "Beach" and "Strand" are the most threatened of the riverine zones and are ranked as "high" management priority; the other three riverine zones are ranked as "medium" priority (Section 10).

9. **Birds**. To identify conservation priorities in the study area and maximize survey effort, surveys focused on a suite of "target species" rather than attempt to record all taxa (which would include many species of low conservation priority). Target species included globally or regionally threatened waterbirds (storks, herons, ducks, cormorants, terns), fish-eagles, fish-owls, hornbills, resident martins and swallows, and grassland birds. Surveys focused largely on the Mekong River channel and riverbank forest, and some visits to nearby floodplains, with less effort away from the mainstream.

10. Surveys confirmed that the study area is globally significant for the conservation of bird communities and irreplaceably significant in the context of mainland Southeast Asian bird communities. A total of 38 species recorded in the study area were ranked as "very high", "high" or "medium" management priority, including up to five species of "very high" priority: White-shouldered Ibis, River Tern, Woolly-necked Stork, Lesser and Greater Adjutant (storks) (Sections 4,10). Globally, the study area is critical for conservation of at least two species, White-shouldered Ibis (potentially the largest global population) and Mekong Wagtail, and may support the largest Indochinese populations of River Tern, Woolly-necked Stork and Pied Kingfisher, as well as the only known breeding colonies of Plain Martin in Cambodia.

11. The most important habitat for birds are the well vegetated areas of the Mekong channel, particularly those areas forming a mosaic of seasonally exposed sand, grass, shrub and tree patches. This habitat is largely confined to the "central section", which is the most important and highest priority site for bird conservation in the study area. Floodplains, especially with remnant areas of tall grass, forest and permanent marshes, are also a significant habitat for birds, although further studies are warranted to determine their conservation significance.

12. At least 13 bird species which occur in riverine habitats of Indochina were absent in the study area despite the presence of apparently suitable habitat (Annex 7). This may be due to the cumulative impacts of human factors including local hunting and loss of habitat in the Mekong River Basin. Threats to remnant priority taxa, especially in the "central section", are severe (below). Without management, 22+ taxa of "very high" and "high" priority could soon disappear from the study area.

13. **Large mammals.** To identify conservation priorities in the study area and maximize survey effort, surveys focused on "large" mammals (defined here as mammalian families in which most species are identifiable in the field) and did not include smaller mammals e.g. rodents and small bats. Target species included globally or regionally threatened primates, otters, Hog Deer, ungulates, and large fruit bats (*Pteropus* spp.). The study area supports most of the Mekong population of the Irrawaddy Dolphin, which is the focus of an ongoing conservation programme; the current survey did not include this species. Surveys focused largely on the Mekong River channel and riverbank forest, and some visits to nearby floodplains, with less effort away from the mainstream.

14. The study area is regionally significant for the conservation of large mammal communities, although it may be globally significant for 3+ species, Hog Deer, Silvered Leaf Monkey, and otters. One species was ranked as "very high" priority for management (Hog Deer), one as "high" priority (Silvered Leaf Monkey) and one as "medium" priority (Sambar). Another five species may be "high" priority (Long-tailed Macaque, Eld's Deer, Large and/or Lyle's Flying-Foxes, Smooth-coated Otter) and another may be "medium" priority

(Eurasian and/or Hairy-nosed Otter) (Sections 5,10). For otters, the viability of populations in the study area is unclear due to the low numbers present and difficulty in implementing effective protection measures. For Long-tailed Macaque, Eld's Deer and large fruit bats, management priority is unclear because of uncertainty over the significance of the study area populations.

15. The most important habitat for large mammals in the study area is the mosaic of tall grass formations on floodplains in the southern parts of the study area, solely because of the presence of Hog Deer. Riverbank (riparian) forest, primarily in the "central section", is critical for the survival of Silvered Leaf Monkey. The mosaic of channel habitats in the "central section", and potentially also forests, streams and permanent marshes in floodplain areas, are the last refugia in the study area for otters.

16. At least 11 large mammal species which occur in the lowland forests of Indochina were absent in the study area, despite the presence of apparently suitable habitat (Annex 7). This is probably due to human factors, especially hunting in the study area and nearby regions. Threats to remnant priority taxa are severe (below). Without management, up to eight taxa of "very high", "high", or "medium" priority could soon disappear from the study area.

17. **Amphibians and reptiles**. Surveys focused on the inventory and collection of all amphibian and reptile taxa encountered within the study area, with attention to the local status of turtles and Siamese Crocodile. Most survey effort focused on riverine habitats of the Mekong River in the "central section", including aquatic habitats and riverbank forest on islands. In addition to the three surveys conducted by the team, a fourth survey, focusing on turtles, was conducted by the Cambodian Turtle Conservation Team. This appears to be the first systematic inventory of amphibians and reptiles along the Mekong River in Cambodia.

18. A total of 56 species (16 frogs, six turtles, 17 lizards, 17 snakes) were recorded, including six globally threatened turtle species, one new record for Cambodia (a gecko *Hemiphyllodactylus yunnanensis*), a second country record for a watersnake (*Homalopsis nigroventralis*), and a range extension for another watersnake (*Enhydris longicauda*, *c.*300 km north from the Tonle Sap Lake region). Species incidence curves suggest that surveys detected most frog species, but did not detect all reptiles. Comparison of species richness and composition with limited available data from other studies in Cambodia indicates that the riverine and floodplain habitats of the Mekong River support a lower richness than mountainous or hilly regions of Cambodia.

19. The study area is globally significant for at least one turtle species, Cantor's Giant Softshell Turtle, and may support the largest remaining breeding populations in the Mekong River Basin. Up to six reptile species, all turtles, are of "high" management priority for the study area (Cantor's Giant Softshell Turtle, Asiatic Softshell Turtle, Giant Asian Pond Turtle, Yellow-headed Temple Turtle, Malayan Snail-eating Turtle, Elongated Tortoise). One species may be of "medium" priority, a watersnake *Enhydris longicauda*. For Yellow-headed Temple Turtle, Malayan Snail-eating Turtle, Elongated Tortoise and *Enhydris longicauda*, management priority is unclear because of uncertainty over the significance of the study area populations. No amphibians were ranked as a management priority for the study area.

20. The persistence of intact riverine habitats in the "central section" suggests this site contributes to the maintenance of regional populations of all priority turtle species. The "central section" is the only site in the study area where Cantor's Giant Softshell Turtle has been confirmed to breed, although local communities report this species nests along seasonal sandbars and beaches from Kampi Pool (near Kratie Town) north to the "central section". Floodplains west of Kratie Town are potentially important for the occurrence of Malayan Snail-eating Turtle and *Enhydris longicauda*.

21. One reptile, the Siamese Crocodile, may be locally extinct, or nearly so, in the study area. Local communities report this species was previously common over 40 years ago, but is now absent or extremely rare. Crocodiles in the study area were apparently hunted for commercial sale and this is probably the principle cause for historic population declines. The "central section" appears to retain suitable breeding habitat and food resources for this species, and some individuals may persist: its current rarity or absence may indicate continued suppression of recruitment due to human threats. Although no current hunting was reported by local communities, it seems likely that any eggs or individuals located by people are collected. The mound nests of this species are relatively obvious and as most riverbanks are visited by people for hunting and fishing, it is possible that few nests remain undetected. For the six priority turtle species, threats are high

due to uncontrolled harvesting and commercial sale, and without management, some species could disappear from the study area.

22. **Fish.** Surveys focused on the inventory of all taxa encountered in the study area, with opportunistic collection of shellfish and aquatic crustaceans. Surveys comprised sampling within the Mekong River channel, principally in the "central section", and visits to large urban markets, villages and fish traders. Voucher specimens were obtained for some species and submitted to Cambodian and international institutions. A photographic collection was developed of most taxa encountered.

23. A total of 223 native fish species (37 families), 17 native edible molluscs, and six native aquatic crustaceans were recorded, as well as nine exotic species (eight fish and one snail, observed in markets only). Native fish comprised one elasmobranch (a stingray), 106 cypriniforms, 55 catfishes, 47 percomopha (26 perch-like taxa, seven spiny/swamp eels, one pipefish, seven flatfishes, six puffers), and 14 other bonyfish (six sardines and anchovies, four featherbacks, three needlefishes, one true eel). The maximum and minimum number of fish species recorded was in the dry- (195) and wet (174) -seasons respectively. Fish species richness in the study area is consistent with nearby sites, including the Siphandon region (Lao PDR), but is relatively high compared with other regions of the Lower Mekong Basin, and reflects the high diversity of seasonal habitats. Eleven globally threatened fish and six species classified as nationally threatened in Cambodia and/or Thailand were confirmed to occur. One new record for Cambodia (a minnow *Toxabramis* sp.), a range extension for a newly described species *Minyclupeoides dentibranchialus*, and specimens of two little-known taxa, a bagrid catfish *Hemibagrus* sp. and a long-nosed spiny eel *Macrognathus* sp., were recorded.

24. The study area is globally important in contributing to the maintenance of regional fish populations and migration corridors in the Lower Mekong Basin. The most important site for fish conservation is in the "central section", which retains intact aquatic habitats utilized by fish for migration, breeding, foraging and/or refugia, including extensive stands of seasonally-flooded vegetation, rocky rapids, sandbars and sandy shallows. The study area is one of few known locations in the Lower Mekong Basin which supports "deep pools", which are located throughout the study area and provide critical refugia for fish, especially large-bodied species. Rocky rapids provide critical spawning sites for some species.

25. Fish are the most important source of protein for communities in the study area and virtually all communities conduct fishing for subsistence and/or cash income. At least 131 fish species and 18 shellfish species were observed for sale at local markets. Over-fishing is the greatest threat to fish of economic importance, due to rapidly increasing human populations, especially in the "central section". Elsewhere in the study area, loss and degradation of fish habitats are also a key threat: most riverbank vegetation has been cleared and floodplains near Kratie Town have been extensively cultivated.

26. **Threats to biodiversity.** Currently, the highest impacts to biodiversity are from human activities within the study area, particularly the "central section", including new settlement and conversion to agricultural land, burning of natural vegetation, increasing fishing pressure, and wildlife hunting. Natural vegetation along riverbanks (targeted for settlement), areas of forest and tall grass in floodplain areas, and riverine habitats within the Mekong channel, are being rapidly cleared or degraded. For most threatened birds, large mammals, turtles, large lizards and large snakes, uncontrolled hunting is causing the highest impacts to local populations. The study area lies within a region of well organized wildlife trade, where local fauna is sold elsewhere in Cambodia, Lao PDR, Viet Nam, and possibly China. Surveys confirmed the presence of established wildlife traders in the "central section", especially Koh Khnhaer and Saitlieu Villages, who purchase wildlife from many surrounding villages and transport them to Kratie or Stung Treng Towns for re-sale to other dealers. For ground-nesting birds and at least one mammal (Hog Deer), domestic dogs are also a principle threat as they hunt adults and eggs. For fish, the principle threats are from increasing, unregulated and potentially unsustainable forms of fishing, which may result in declines of economically valuable species.

27. In the "central section", two causal factors are responsible for these threats: increasing population growth, and provincial and regional economic development. Within the "central section", human populations are increasing due to uncontrolled in-migration and expansion of established villages. These threats are relatively new (most new migrants have resided in the "central section" for less than 10 years) and are symptomatic of the human activities which have led to the loss of most natural riverbank vegetation and decline of many species elsewhere in the study area. Without management, human population growth and increasing

pressures on natural resources will cause the decline or loss of many taxa in the "central section".

28. Potential threats arise from new regional development within and near the study area, including hydropower infrastructure, expanding road networks, and new economic land concessions (Section 9). One dam, Sambor, is proposed across the Mekong mainstream within the study area, and at least 64 water development projects are planned or under construction within the nearby Se Kong, Se San and Srepok Rivers (Oxfam America 2005). Existing road networks are being upgraded and resulting in greater access to the "central section", and proposed land concessions (principally timber plantations) throughout Kratie and Stung Treng Provinces may result in displacement of communities and increased immigration to the study area. Without proper environmental and social impact assessment, these developments may contribute to severe cumulative impacts to biodiversity and local livelihoods in the study area.

29. **Biodiversity conservation**. Conservation management priorities and actions for the study area were identified through ranking criteria developed by the survey team, which resulted in the listing of "priority" taxa i.e. those ranked as "very high", "high", or "medium" conservation priority. Management actions were developed based on the ecology and distribution of priority taxa and current threats within the study area. For most priority flora and vegetation, birds, large mammals and reptiles, critical actions comprise species- and site-based actions in the study area (Sections 10.1, 10.2). The highest priority is the designation of the "central section" as a "special management site", to protect the last remnant natural vegetation and fauna habitats in the study area through establishing site-based management and regulating settlement and natural resource use by local communities. Floodplains west of Kratie Town are currently being designated as a protected area for Hog Deer, which will also benefit at least one priority turtle and snake.

30. For many aquatic taxa, especially migratory fish, site-based actions will be insufficient to maintain populations within the study area because these taxa depend upon resources both within and outside the study area. Conservation of these taxa requires catchment-level initiatives to protect the full extent of spatial and seasonal resources required for breeding, foraging, and migration (Section 10.3).

31. **Provincial workshop.** A workshop with government agencies and non-government organizations was undertaken from 12-13 February 2008 in Kratie Town, to present the results of the biological surveys and develop recommendations (Annex 8). Key actions required to initiate follow-up activities for biodiversity conservation in the study area were refined and agreed by workshop participants, particularly the need to designate the "central section" as a "special management site", and protection of the last Hog Deer population in Indochina (see Recommendations).

New records for the Cambodian flora and fauna recorded during surveys in 2006 and 2007.				
No.	Scientific Name	Notes	IUCN Red List	Conservation priority*
	Flora			
1	*Amorphophallus* sp. nov.	New to science	No listing	Unknown; possibly "Very High Priority"
2	*Desmodium flexuosum*	New national record	No listing	Unknown
3	*Indigofera zollingeriana*	New national record	No listing	Unknown
4	*Rhodamnia cinerea*	New national record	No listing	Unknown
5	*Brachystelma kerrii*	New national record	No listing	Unknown
6	*Diospyros oblonga*	New national record	No listing	Unknown
7	*Ardisia attenuata*	New national record	No listing	Unknown
8	*Calcareoboea bonii*	New national record	No listing	Unknown
9	*Kaempferia siamensis*	New national record	No listing	Unknown
10	*Typhonium laoticum*	New national record	No listing	Unknown
11	*Brachycorythis helferi*	New national record	No listing	Unknown
12	*Habenaria viridiflora*	New national record	No listing	Unknown
13	*Liparis rheedii*	New national record	No listing	Unknown
14	*Liparia siamensis*	New national record	No listing	Unknown
15	*Nervilia punctata*	New national record	No listing	Unknown
16	*Nervilia calcicola*	New national record	No listing	Unknown
17	*Vandopsis gigantea*	New national record	No listing	Unknown
18	*Fimbristylis brunneoides*	New national record	No listing	Unknown
19	*Fimbristylis jucunda*	New national record	No listing	Unknown
20	*Murdannia discreta*	New national record	No listing	Unknown
21	*Amorphophallus koratensis*	New national record	No listing	Unknown
22	*Cryptocoryne crispatula*	New national record	No listing	Unknown
23	*Acacia leucophloea*	New national record	No listing	Unknown
	Reptile			
24	*Hemiphyllodactylus yunnanensis* (a gecko)	New national record	No listing	Low/negligible
	Fish			
25	*Toxabramis* sp. (a minnow)	New national record	No listing	Low/negligible

*Note. None of these taxa are listed under Cambodian legislation. Colour plates of some taxa are in Annex 3. See Table 29 (Section 10.1.2) and Annex 6 for taxa ranked as a "conservation priority" for management intervention in the study area.

RECOMMENDATIONS

Recommendations were developed based on the ranking of taxa to identify those of highest management priority, their threat status, distribution and ecology in the study area, and identification of key sites and habitats. Draft recommendations were first developed by the survey team and finalized in a workshop with provincial and national agencies (Annex 8). Further details are in Section 10.

Priority taxa and sites

1. Available management resources and funds should focus on at least 84 "priority" taxa listed in Table 29 (Section 10.1) and two sites which support the majority of these taxa, the "central section" and floodplains west of Kratie Town. **Specific management actions for priority taxa and sites are in Sections 10.1.2 and 10.2**.

"Central section"

2. Designate the "central section" as a "provincial special management site". Recommended site boundaries are in Figures 10 and 11 and are based on the locations of priority taxa. This site would encompass *c.*56 km (river distance) of the Mekong River and habitats within the river channel, an area of *c.*33,808 ha. Securing official recognition for this site will establish a foundation for site management.

3. The Fisheries Administration will coordinate the conservation activities in this site, which will also involve a range of other provincial and national government agencies.

4. Delineate and implement at least two preliminary zones within the "central section": a "multiple-use zone" and "protection zone". Recommended zone boundaries are in Figure 11 and are based on the distribution of priority taxa and preliminary mapping of settlements. Zonation will enable preliminary allocation of areas for community use and biodiversity conservation and is necessary in the short-term to secure remaining natural resources, prior to a longer, participatory process to finalise zone boundaries.

5. The "multiple-use zone" should include lands around established villages and settlements and should be the focus of efforts to improve local livelihoods and support community management of natural resources, especially fisheries and timber. The "protection zone" should include remnant riverbank forest and aquatic habitats and should extend at least 50 m from the riverbank to encompass riverbank forest. Settlement, clearance and hunting (including dogs) would be prohibited in this zone and other human activities should be regulated e.g. seasonal fishing.

6. Immediately inform all local agencies and communities within at least 30 km north and south from the "central section" (the maximum distance recorded of communities which travel to the "central section" to harvest natural resources), of the site's new designation and the locations of preliminary zones. A team of personnel from provincial and district agencies could visit all target communities to: distribute information on the new site designation and zones; ensure village heads are aware of the zones and do not permit new immigrants to settle in the "protection zone"; clarify that a participatory process to finalise zone locations will be implemented; and, for migrants in the process of land clearance but which have not yet established homes, assist them to relocate to lands within the "multiple-use zone".

7. Conduct a rapid socio-economic survey in the "central section" to document: location and size of all villages and new settlements, current human population, and land ownership. This will supplement preliminary data collected during the biological surveys (Section 8) and assist in finalizing site zonation and landuse planning.

8. Initiate management actions for specific taxa within the "central section" described in Table 29 (Section 10.1.2). Key actions include community nest protection schemes for waterbirds, Cantor's Giant Softshell Turtle and other taxa, and the implementation of ranger patrols to enforce national legislation at known trade outlets, markets, and with local communities, to protect taxa and locations of highest biodiversity value.

9. Prepare a site-based management plan, including targets, timeframes and budgets, which consolidates and strengthens the actions described in Recommendations 2-8 and clearly identifies follow-up activities. Follow-up actions should include:

    - Finalise zone boundaries and define regulations for zones in a participatory process supported by local communities and other stakeholders.
    - Strengthen provincial capacity for conservation of "priority taxa", including the training of ranger patrols.
    - Strengthen community management of natural resources within the "multiple-use zone", especially of fish and timber. Livelihoods projects should focus on six villages located in areas of highest biodiversity value: Kampong Pnov, O Kak, Pontacheer, Koh Khnhaer, Satlieu and Koh Dambong.
    - Identify links between biodiversity conservation with eco-tourism ventures planned in the region.
    - Identify and secure resources and funds for site management.

Floodplains west of Kratie Town ("Hog Deer protected area")

10. Complete official designation of a "Hog Deer protected area". The Kratie Forestry Administration is currently finalizing a nomination for a protected area to protect the last known population of Hog Deer in Indochina. This includes most of the floodplain west of Kratie Town. Management of this site will also benefit a range of other "priority taxa".

11. Initiate management actions to protect the Hog Deer and its habitat. Recommended actions are in Table 30 (Section 10.2) and are based on the findings of the current survey and recommendations by Maxwell et al. (2006). These include:

    - Maintain the current ranger patrols in this site and strengthen the capacity of community and government team members in patrol planning, data collection and site monitoring.
    - Control and monitor expansion of agricultural land in the proposed protected area.
    - Conduct a "Social and Environmental Impact Assessment" to assess the potential impact of site protection, to the livelihoods of 15 villages located in the proposed protected area.
    - Identify methods to reduce crop predation by wild pigs which do not trap or kill Hog Deer.
    - After gazettement, develop and implement a management plan for the Hog Deer protected area.

12. Develop conservation activities for other priority taxa in these floodplains. These taxa include Malayan Snail-eating Turtle, a watersnake *Enhydris longicauda* and possibly, otters. Recommended actions are in Table 29 (Section 10.1.2).

Other sites in the study area

13. Implement management actions in other sites with priority taxa. At least four other locations in the study area support priority taxa: a monastery on Koh Chreng Island, floodplains south of Kratie Town, Kampi pool, and the Mekong channel from Kampi pool to the "central section" (Fig. 10). Recommended actions are in Table 30 (Section 10.2). Activities in these sites should only be implemented after funds and resources have been secured for the "central section" and floodplains west of Kratie Town.

Landscape-level actions and information gaps

14. Site-based actions will be insufficient to conserve some aquatic taxa in the study area, especially migratory fish, unless complemented by activities which maintain critical habitats outside the study area. For many freshwater taxa, management is also hindered by a lack of baseline data on status, distribution and ecology. Recommendations for landscape-level actions are in described in Section 10.3 and include the following.

    - Strengthen current provincial capacity to manage aquatic resources in the study area.

    - Ensure the study area is included within national and regional initiatives to manage habitats for migratory fish in the Lower Mekong Basin.

    - Establish and strengthen linkages and information exchange between management agencies in the study area with at least two other sites, the Stung Treng Ramsar site (Cambodia) and Siphandon region

(Lao PDR). Collectively, these three locations are critical for the maintenance of many taxa in the hydrological unit of the Mekong River extending from Pakse Town (Lao PDR) south to Kratie Town.

- Conduct a baseline survey of aquatic invertebrates (previous studies indicate the Mekong Basin is a center of endemism for freshwater gastropods and other invertebrates).

- Review the current status and extent of protection for priority taxa under national and provincial legislation, and assess whether amendments are required.

- Develop a strategy to identify potential ecological and hydrological impacts in the study area of planned development, especially hydropower dams and land concessions.

- Develop an international field research station in the study area which would focus on freshwater biodiversity. This could support national and international students undertaking research in freshwater biodiversity, contribute new ecological knowledge about the Mekong Basin, and strengthen provincial and national capacity for management of freshwater biodiversity.

Urgency for management

15. Immediate management action is required if the natural resources of the "central section" are to be maintained for the benefit of biodiversity conservation and local communities. Management agencies and other organizations have a unique opportunity to implement effective action in this site, because it is relatively small, most impacts and threatening activities have only begun in the last 10 years, and human densities are low. This window of time is small and without management, current rates of wildlife hunting, new settlement, and habitat loss may soon result in the loss or severe decline of most remnant riverbank forest and many priority taxa in the "central section".

1. INTRODUCTION

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Mark R. Bezuijen

1. Introduction

This report describes the results of the first systematic biological surveys of a 130-km section of the Mekong River in northeast Cambodia. Findings include the presence of undescribed taxa, new records for Cambodia, intact riverine habitats, and some of the largest breeding populations in the Mekong River Basin or globally for a range of threatened taxa.

Tropical Asian rivers support the world's highest human population densities and some of the most threatened ecosystems. Yet in Asia, the conservation of freshwater biodiversity embodies a relatively new concept for many governments and international aid agencies, which until recently have largely focused on terrestrial biota. Human demands from agriculture and industry dominate Asian water allocation policies, while in-stream flow needs for ecosystems have yet to be widely addressed (Dudgeon 2005). Management of freshwater biodiversity is also constrained by a paucity of data for freshwater taxa, rapid and usually unregulated economic development, and the complexities of river management, which may require catchment-level approaches between multiple stakeholders within and outside freshwater sites (Abell 2000, 2002, 2007; Dudgeon 2000a,b, 2003; Dudgeon et al. 2005). These challenges are nowhere more evident than the Mekong Basin, where water resources are shared between six nations and development is proceeding rapidly, yet often with insufficient data on freshwater biodiversity to inform decision-making processes. The current surveys confirm the presence of significant biological values in a rapidly developing region and indicate the urgency for baseline surveys of freshwater biodiversity elsewhere in the Mekong Basin.

1.1 The Mekong Basin

The Mekong River flows *c*.4,900 km through six countries, from China and Myanmar in the north, the "Upper Mekong Basin", through Cambodia, Lao PDR, Thailand and Viet Nam in the south, the "Lower Mekong Basin". It is the 12th longest river in the world and 21st largest river basin (over 795,000 km^2) and encompasses a range of physiographic regions, from cold, mountainous headwaters on the Tibetan Plateau to the lowlands of the Mekong Delta where it enters the South China Sea (MRC 2003). In the lower basin, inland capture fisheries are a critical component in the diet and income of over 55 million people: over 2.5 million tonnes of wild fish are caught annually, worth over USD2.5 billion, and represent an estimated one-quarter of global freshwater fish catches (Baran et al. 2007 and references therein). Aquatic animals, mainly wild fish, comprise 40-80% of animal protein for many lowland communities and over 80% of local income is from fishing (Meusch et al. 2003; MRC 2003). Approximately 700 fish species have been documented in the lower basin (Kottelat 2001a); other estimates range up to 1,700 species, but these are largely speculative. Many fish in the lower Mekong River are migratory, and the diet and income of most lowland communities is closely linked with the river's annual "flood pulse" and migration cycles of these species.

The lower Mekong River and its major tributaries also represent some of the best remaining examples of the riverine ecosystems of mainland Southeast Asia, and are of outstanding significance for wetland biodiversity (e.g. Duckworth et al. 1999; BirdLife International 2003a).

The basin is currently experiencing unprecedented economic development, focused largely on the expansion of infrastructure for hydropower and a regional transport network which will consolidate "economic corridors" between and outside the Mekong nations. Water development projects in the basin are often characterized by the absence of transparent and detailed environmental and social impact assessments, yet available reviews indicate that some dams, even with mitigation measures implemented, have caused severe impacts to fish migrations, water quality and the food security of local communities (Baran et al. 2007; Wyatt & Baird 2007; Trandem 2008). Management of freshwater in the Mekong is hindered by a lack of data on the status and ecology of many freshwater taxa, particularly fish and invertebrates, and baseline species inventories are absent for many regions. Such data are urgently required to inform national planning and define basin-wide freshwater conservation priorities.

4

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1.2 Mekong wetlands and management in Cambodia

Most of Cambodia (86%, 155,000 km^2) lies within the Mekong Plain, a physiographic unit of the Lower Mekong Basin centered around the Mekong River and Tonle Sap Lake, characterized by low (<200 m) elevations, gently undulating topography and a mosaic of seasonal floodplains and forest (MRC 2003). The plain extends from southern Lao PDR into central Cambodia, southeast Thailand, and southern Viet Nam, bounded by the Annamite Mountains in the east, Cardamom Mountains in the southwest, and Khorat Basin in the northwest (Fig. 1). The Mekong enters Cambodia in Stung Treng Province, flowing south through Kratie Province before joining with the Tonle Sap River near the capital, Phnom Penh.

Institutional management of wetlands in Cambodia is complex and involves at least seven ministries with overlapping jurisdictions (Torell et al. 2001; Oh et al. 2005). In the National Biodiversity Strategy and Action Plan (MoE 2002), management of freshwater resources is included under eight themes: Protection of Natural Resources, Animal Wildlife Resources, Freshwater Fisheries and Aquaculture, Forest and Wild Plant Resources, Energy Resources, Environmental Security, Land Use Planning, and Water Resources. Under the "Law on Fisheries 2007", the Fisheries Administration of MAFF is responsible for all "fishery domains": "permanent waters of the Mekong River, sea, rivers, tributaries, lakes, channels, streams, reservoirs, canals, flooded lands, mangrove forest" (Article 8: 4). Other wetland attributes e.g. floodplains, settlements within wetlands, and forested islands in the Mekong mainstream, are partly managed by other ministries. Until recently, most international support for wetland management has focused on Cambodia's inland fishery (Hortle et al. 2004; Campbell et al. 2006; Rab et al. 2006) and research of a small number of economically important fish species (Hill 1995).

1.3 Surveys in 2006 and 2007

In 2006, the Cambodia Fisheries and Forestry Administrations and the World Wide Fund for Nature (WWF) initiated a collaborative project to conduct systematic biological surveys of the Mekong River between Kratie and Stung Treng Towns in northeast Cambodia. Surveys were undertaken over a nine-month period between November 2006 and August 2007, by a team of government personnel and international specialists to document vegetation and flora, birds, large mammals, amphibians, reptiles and fish (Section 2.7).

Surveys were initiated on the basis of preliminary data gathered during brief visits by other researchers between 1999 and 2003, which indicated this region supports high biological values, including intact riverine habitats and the presence of threatened birds, mammals and fish (Timmins 2003 and references therein; see also Section 4.1). The persistence of these values was notable compared with more degraded and populated river sections nearby, and was partly due to restricted public access and unsafe conditions resulting from political instability, which lasted until the late 1990s in some parts of the study area. With the relaxation of security restrictions, new biological surveys were considered timely to identify conservation priorities for the study area, particularly in the light of increasing human pressures, including a proposed dam (Section 9.2). The results of the current surveys also contribute to a programme initiated by the Governments of Kratie and Stung Treng with The Wetlands Alliance (a partnership between AIT, CORIN, WorldFish Center and WWF; WAP 2007) to strengthen local capacity for wetland management in Kratie and Stung Treng Provinces.

The goals and objectives of the surveys in 2006 and 2007 were as follows.

Goals

1. To obtain baseline biological data and identify priorities for biodiversity conservation in the study area.

2. To raise national and provincial awareness about the biodiversity values of the study area, particularly among provincial agencies responsible for natural resource management.

Objectives

i. To document the diversity and richness of flora, birds, large mammals, amphibians, reptiles and fish along the Mekong River between Kratie and Stung Treng Towns.

ii. To assess the status of endemic, restricted-range and/or threatened taxa, specifically riverine vegetation, selected birds (storks, herons, ducks, cormorants, terns, fish-eagles, fish-owls, hornbills, resident martins and swallows, grassland birds), large mammals (Hog Deer, otters, primates), amphibians, reptiles (especially turtles and Siamese Crocodile) and fish (including threatened taxa of non-economic significance).

iii. To identify threats to biodiversity, especially threatened taxa.

iv. To identify biological conservation priorities, based on a systematic review of survey data, and to develop recommendations for management of biodiversity in the study area.

Chapters 2-8 of this report describe the study area, methods, the results of technical surveys, and observations of settlement and resource use. Chapter nine identifies current and potential threats to biodiversity in the study area, and chapter 10 describes management recommendations for the species and sites of highest conservation priority identified in surveys. The annexes include a gazetteer of standardized names for islands in the study area, maps of selected species, colour plates, lists of taxa recorded during surveys, and data used to rank conservation priorities.

Lists of taxa and additional data are available in an on-line table, referred to in the report as "OLT", which may be downloaded, with the report, at: www.panda.org/greatermekong/survey.

2. STUDY AREA AND METHODS

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Mark R. Bezuijen and Richard Zanre

2. Study area and methods

2.1 Overview

The study area is the section of Mekong River between Kratie and Stung Treng Towns (Kratie and Stung Treng Provinces) in northeast Cambodia, a distance of 130 km, and included all habitats within the river channel, as well as some floodplains adjoining the channel and sites south of Kratie Town (Fig. 1-3; Section 2.7). This river section is part of a distinct hydrological unit of the Mekong (Section 2.2), which supports a dynamic channel environment subject to large and rapid seasonal changes in flow volume, speed, water temperatures, a 10+ m range in water level, and habitats which are alternately exposed or inundated for varying duration. This has given rise to a rich and complex mosaic of channel habitats including perennial and seasonal waterways, rapids, deep pools, small and large islands, sandbars and beaches hundreds of metres long, rock outcrops, and seasonally flooded vegetation. Many flora and fauna within the channel are adapted to the seasonal "flood pulse" and some appear to be less well-represented, or absent, elsewhere in the Mekong Basin, including some riverine flora ("flooded forests"), migratory fish which feed, nest or take refuge in seasonal channel habitats, and sandbar-nesting birds (this volume; Claridge 1996; Daconto 2001; Seng et al. 2003; Baran et al. 2005; Timmins 2006; Baird 2007).

Over 40 islands are located in the mainstream between Kratie and Stung Treng Towns, with 18 islands over three kilometers long and the largest, Koh Rongnieu, *c*.37 km long and 5 km wide. Channel width ranges from 1-11 km, with the widest sections of channel located mid-way between these towns. Islands, and adjoining sections of mainland, have low relief (20-50 m asl). Koh Rongnieu is a dominant topographic feature of the study area; west of this island, the Mekong channel has permanent flow and is the principle transport route for boat traffic. North and east, numerous smaller islands divide the channel into a mosaic of small waterways which are shallow in the dry season and some of which cannot be accessed by boat. These islands, including Koh Kring and Koh Khlap (Fig. 1,2) support the lowest human densities in the study area and retain relatively extensive natural riverbank vegetation and diverse seasonal riverine habitats. Relatively small floodplains occur east, west and south of Kratie Town and extend 1-3 km from the river. In the dry season these are extensively cultivated but in the wet season are flooded to 3+ m depth. Surveys largely focused on a 56-km section of river mid-way between Kratie and Stung Treng Towns, termed here the "central section" (Section 2.7), which retains the most intact riverine habitats in the study area. A gazetteer of island names, locations and other landscape features is in Annex 1.

2.2 Climate and hydrology

Kratie and Stung Treng Provinces experience a pronounced seasonal monsoon cycle, with a "dry, cool" season from December-April (northeast monsoon) and a "wet, hot" season from May-October (southwest monsoon) (April and October are transitional months). In 2003 and 2004, mean annual temperatures at Stung Treng Town were 30.5/34^{o}C respectively and mean annual minima/maxima were 23/24^{o}C (lowest 11.5^{o}C) and 33/36.5^{o}C (highest 40^{o}C) (Try & Chambers 2006). Mean annual rainfall at Stung Treng Town over seven years (1994-2000) was 1,966 mm (1,441-2,600 mm) and mean monthly rainfall ranged from 0.9 mm (January) to 333.4 mm (September) (Try & Chambers 2006). At Kratie Town, mean annual rainfall over four years (1997-2000) was 2,050 mm (1,743-2,549 mm) and mean monthly rainfall ranged from 0 mm (January) to 469 mm (September) (Kratie meterological station unpublished data 2007).

The study area is located within a distinct hydrological unit which extends *c*.330 km, from Pakse Town (Lao PDR) south to Kratie Town (Fig. 1), characterized by a wide, braided channel which receives over 25% annual flow volume from three large tributaries north of Stung Treng Town, the Se Kong, Se San and Srepok Rivers (MRC 2005). The study area comprises *c*.40% of this unit (130 km), with 91 km in Kratie Province (straight-distance 82 km) and 39 km in Stung Treng Province (straight-distance 33 km). North of this unit, the Mekong hydrology is dominated by large tributaries in Lao PDR; south of this unit, the Mekong expands across the Cambodian floodplains, Tonle Sap River and Tonle Sap Lake (MRC 2005). At Kratie Town, mean monthly discharge ranges from 2,220 (April) to 36,700 (September) cubic metres per second (MRC 2005).

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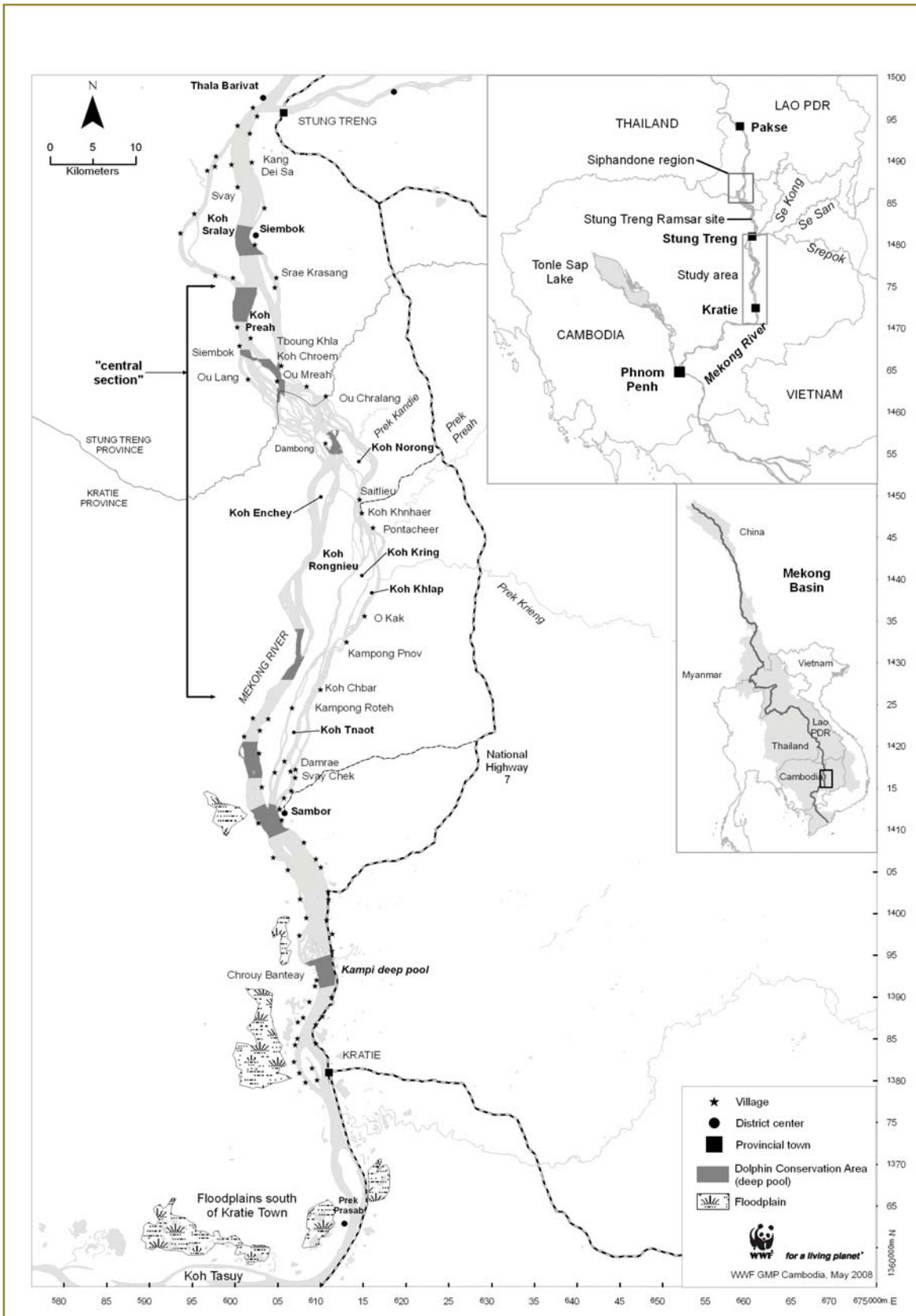

Figure 1. Map of study area (overview).

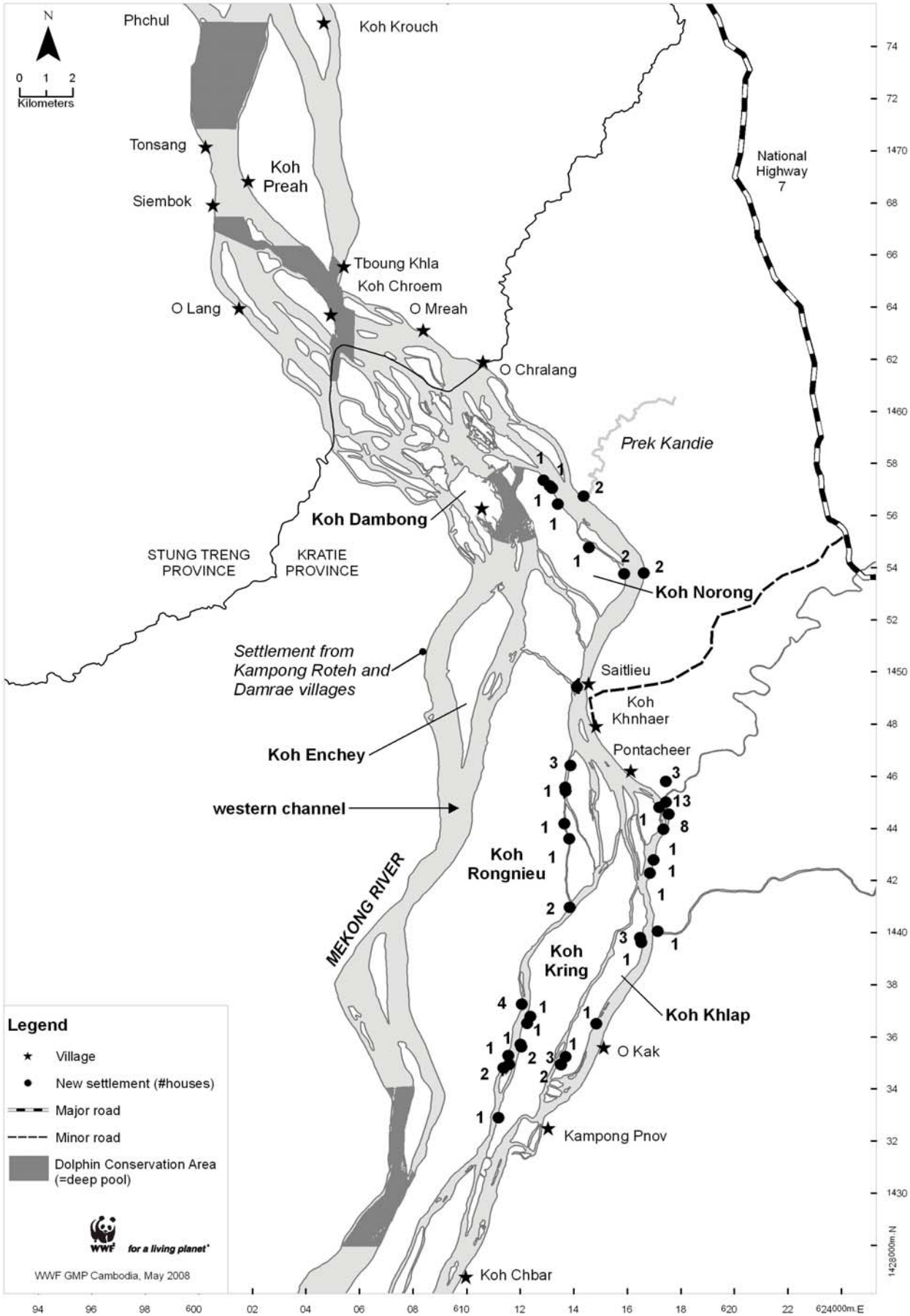

Figure 2. Map of study area ("central section").

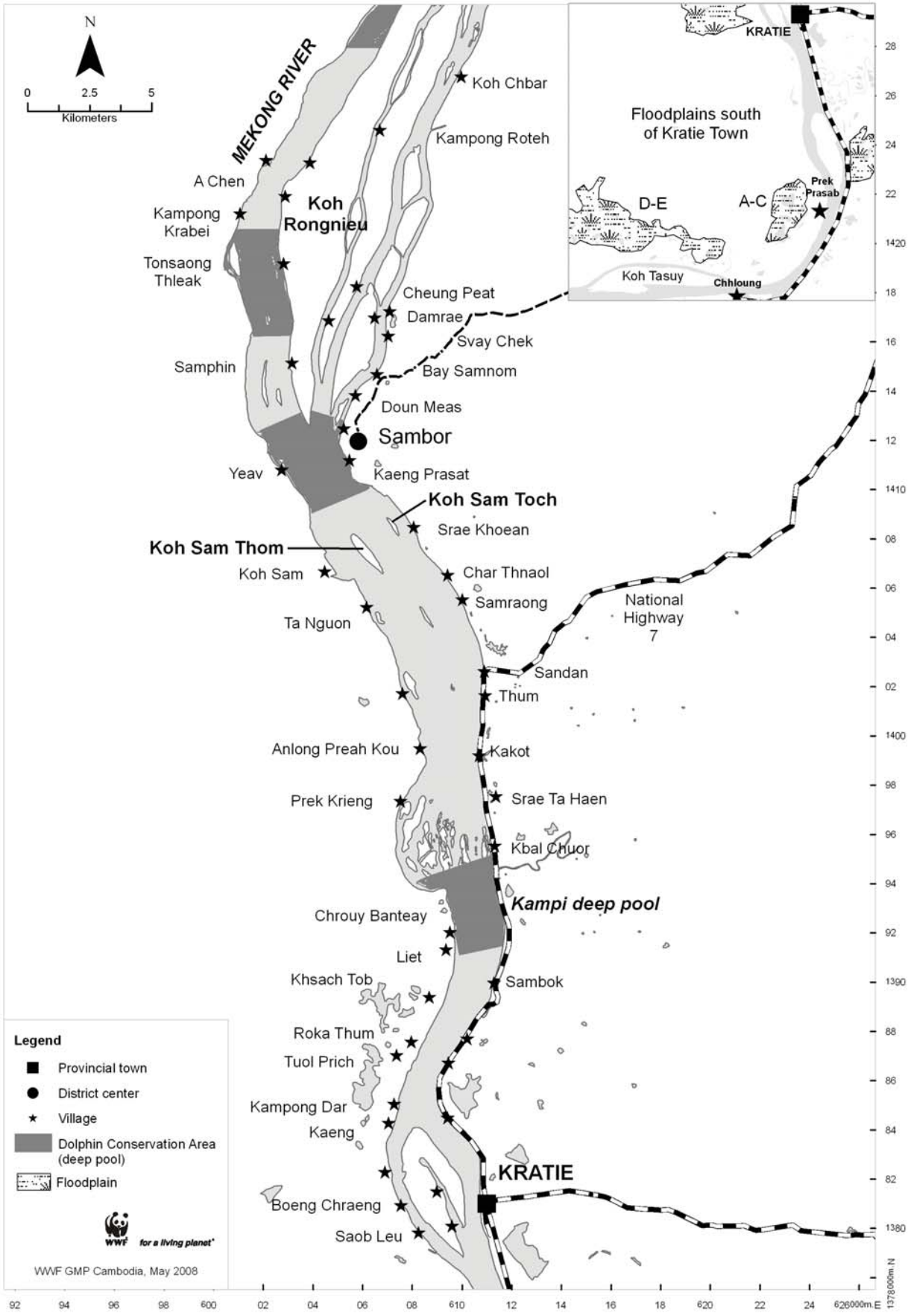

Figure 3. Map of study area (southern area near Kratie Town).

Few permanent tributaries enter the Mekong in the study area and most are less than 30 m wide. In the "central section", three permanent tributaries enter the Mekong: Prek Krieng and Prek Preah Rivers, over 70 m wide, and Prek Kandie, less than 20 m wide. The banks of these tributaries are steeply sloping and support degraded natural vegetation, some cultivation, and settlements. In the dry season, the lower reaches of these tributaries, within 1-3 kilometers of their confluence with the Mekong, are exposed or shallow, with numerous exposed rocks, sandbars, small beaches, rocky rapids, and emergent vegetation and wood debris. During surveys, water levels in the Mekong River were lowest in March, when large areas of the channel were exposed or less than 1 m depth; four months later (July) water levels had risen 7-10 m. Although extreme, this seasonal variation is relatively constant and the incidence of flooding is low (MRC 2005).

2.3 Geology, soils and vegetation

Riverine geology in the study area is dominated by Quaternary (present day) deposits of silts, clays and sands derived from river transport and in-situ weathering, which overlay a mosaic of bedrock strata. From Kratie Town north to Koh Chbar Island (Fig. 1) young alluvium predominates, with patches of Triassic sandstone bedrock near Sambor Town (MIME 2002). Along the river's east banks from Koh Chbar north to Stung Treng Town, the bedrock is Lower-Middle Jurassic formation (red terrane). From Kratie to Sambor Towns, soils overlaying this bedrock are Grey Hydromorphics (low fertility) and from Sambor north to Stung Treng Town, are Red-yellow podzols (low fertility) (Crocker 1962). Along the west banks the bedrock is a mosaic of Old alluvium, Triassic sandstone and Lower-Middle Jurassic formation (red terrane) (MIME 2002). Most soils are sandy and shallow, including alluvial lithosols (medium fertility) and small areas of shallow acid lithosols (low fertility) (Crocker 1962) and cannot support intensive cultivation. Outcrops of tufa (young freshwater limestone deposits) are visible on islands. Some islands and tributary entrances support brown alluvial soils (higher fertility) (Try & Chambers 2006).

Vegetation in the study area comprises "riverine" and "terrestrial" communities, with riverine flora located within the river channel up to the high-water mark and forming distinct zones based on extent and duration of submergence (Section 3). Much of the riverine vegetation experiences complete and prolonged submergence (over three months). Many islands retain natural terrestrial vegetation, including evergreen, deciduous and dipterocarp forest types, although none are pristine. Small seasonal ponds (*trapeang* in Khmer), streams, and grassy patches (*viel*) occur on islands and the mainland. Similar vegetation communities occur along the Mekong River 5-50 km north of the study area, in the Stung Treng Ramsar site and Siphandon region (Lao PDR) (Maxwell 2000; Daconto 2001; Timmins 2006). Floodplains near Kratie Town support a mosaic of seasonally-flooded shrubs, grasses, secondary forest and cultivated lands, which support a globally important population of Hog Deer (Maxwell et al. 2006).

The current surveys confirmed that the river channel habitats of the study area are of outstanding global significance for fauna. This is largely due to a diverse mosaic of seasonal habitats, including deep pools, sandbars, seasonally submerged channel vegetation and riverbank forest, which support a wide range of fish, birds, large mammals, reptiles and amphibians. The study area is part of only two locations in the Lower Mekong Basin known to support "deep pools", which provide dry-season refugia for many aquatic taxa (the other is in northern Lao PDR). At least eight of 30 pools mapped between Kratie Town and the border with Lao PDR are located in the study area, and are 11-50 m deep (Hill 1995; MAFF 2005; Viravong et al. 2006).

2.4 Human geography

Cambodia is ranked 129 from 177 countries in the UNDP Human Development Index, indicating a large proportion of the population remains in poverty with little access to essential life services (UNDP 2006). Kratie and Stung Treng Provinces support some of the lowest human population densities in the Lower Mekong Basin, with 20-70 persons/km^2 in Kratie and 0-20/km^2 in Stung Treng (Hook et al. 2003). The populations of Kratie and Stung Treng in 2005 were estimated to be *c*.290,695 and 96,015 people respectively (Seila Programme 2005), less than four percent of the national population in 1998 (11.4 million, the most recent national census; NIS 1999; Huguet et al. 2000). The study area encompasses two provincial capitals (Kratie, Stung Treng), two district towns (Sambor, Siembok) and approximately 80 villages along the banks of the Mekong, with *c*.77,400 people (20% of the total population of both provinces) (from data in Seila Programme 2005) (Fig. 1). The lowest human densities in the study area are mid-way between Kratie and Stung Treng Towns, in the eastern channels of the "central section", which support only eight established villages: Kampong Pnov, O Kak, Pontacheer, Koh Khnhaer, Satlieu, Koh Dambong, Kampong Roteh and

Damrae (Fig. 2). In 2007, the total population of these villages was at least 5,553 people (from data in Seila Programme 2005; personal communication with village heads). These villages retain traditional land ownership over much of the "central section". This estimate does not include new settlements or seasonal visitation by non-residents: the total human population utilizing natural resources in the "central section" is almost certainly much higher.

Along both banks of the Mekong, extending at least 30 km north from Kratie Town and south from Stung Treng Town, there is extensive human settlement and a well-developed road network. Both towns are connected by National Highway 7 and two district roads access the "central section", a sealed road from Kratie to Sambor Town, and an unsealed road from National Highway 7 to Koh Khnhaer Village (Fig. 1). Rice cultivation is the principle subsistence activity in most settlements, supplemented by fishing. In the "central section", rapid immigration and expansion of established villages is resulting in new settlement, fishing, wildlife hunting and increased loss of remnant vegetation, especially along riverbanks.

2.5 Biogeography and conservation significance

Cambodia is located in the biogeographic unit "Indochina" (10a) of the Indomalayan Realm, which encompasses most of Cambodia, Lao PDR and Thailand, and parts of Viet Nam, Myanmar and Yunnan Province (China), and is characterized by globally high levels of species diversity and endemism (MacKinnon & MacKinnon 1986). Previous reviews have recognized the study area to be of outstanding global importance for biodiversity conservation. It is one of 13 sites in the Lower Mekong Basin ranked by WWF as "critically important" for some birds and mammals ("Mekong River and Major Tributaries", DF1) (Baltzer et al. 2001; Tordoff et al. 2005) and is located within a "WWF Global 200 Ecoregion" (No. 54, Indochina Dry Forest) (Olson et al. 2001), is one of 21 "important freshwater sites" in the lower basin for fish conservation (Kottelat 2001b), forms the majority of one Important Bird Area ("Mekong mainstream from Kratie to Lao border", KH023) defined by BirdLife International (Seng et al. 2003), and is one of 11 "Priority Sites" along the Mekong mainstream ("Kratie to Lao PDR") within the Indo-Burma Biodiversity Hotspot defined by Conservation International (CEPF 2007). The study area is currently not included within any "centre of global plant diversity" (the nearest "centres" are the Cardamom Mountains, southwest Cambodia, and Bolovens Plateau, southern Lao PDR) (Xianpu et al. 1995), although future botanical collection may reveal endemism of riverine flora. In another "ecoregional" classification (see *Conventions*), Wikramanayake et al. (2002) place the study area within the "Central Indochina Dry Forests Ecoregion (No. 72)", characterised by "globally outstanding" values including threatened large mammals.

These classifications reflect the unique ecological characteristics of this section of the Mekong and are derived principally on the basis of threatened birds and mammals, for which more data exists than other taxa. In general, most conservation classifications for the Mekong Basin and Southeast Asia are based on datasets for birds and mammals, due to the paucity of data for other taxa. Kottelat's (2001b) review remains the only attempt to objectively prioritise biodiversity conservation in the Lower Mekong Basin on the basis of aquatic taxa (fish), yet the author notes this was largely based on "best guesses of what may be present" (Kottelat 2001b: 40) due to the absence of field data for most areas. The study area, in conjunction with adjoining river sections, appears to be critical for the survival of many migratory fish in the Mekong River (Section 7; Baird 2007).

2.6 Provincial conservation initiatives

Provincial capacity to manage wetland resources is limited. In 2007, the Fisheries Administrations of Kratie and Stung Treng Provinces had 13 and three staff respectively, Kratie had two patrol boats with three operational engines and Stung Treng had no boat but one operational engine, for management of *c*.219 km of Mekong mainstream (throughout both provinces) as well as tributaries and other wetlands. Neither office had a land vehicle. Most staff lack technical training in wetland management.

There are currently no official protected sites in the study area. Nine "Deep Pool Conservation Areas" are proposed along the Mekong River between Kratie Town and the international border with Lao PDR, of which eight are in the study area (MAFF 2005). A protected area is currently under nomination by the Kratie Forestry Administration for a section of floodplain west of Kratie Town, to protect the only known Indochina population of Hog Deer (Maxwell et al. 2006) (Fig. 10). A key recommendation of the current surveys is that the "central section" be designated as a "special management site" (Section 10.2). There is only one ongoing biodiversity programme, the Cambodian Mekong Dolphin Conservation Project (2005-2010), which aims

to conserve the threatened Mekong population of the Irrawaddy dolphin and is based on dolphin research in the study area since 2001 (MAFF 2005; Beasely et al. 2007; Dove et al. 2008).

Three NGOs focusing on poverty alleviation in the study area, CED, CRDT and Oxfam, include activities linked with strengthening community management of natural resources, especially forestry, fisheries, riverbank habitats, and/or dolphin conservation. In 2006, The Wetlands Alliance initiated a programme of work in Kratie and Stung Treng Provinces to strengthen provincial capacity for wetland management, including the protection of "riparian forest" (WAP 2007), which should extend to at least mid-2009. Proposed ecotourism ventures in the study area highlight the presence of Irrawaddy Dolphin and the natural values of the "central section" (Asia Pacific Projects 2006; MoT 2008) and may offer new opportunities for linking biodiversity conservation with community involvement.

Elsewhere in the same hydrological unit (Section 2.2), two sites with similar habitats have received some support for biodiversity conservation. The Stung Treng Ramsar site, five kilometers north of the study area, was designated in 1999 and encompasses a 37 km section of river near the border with Lao PDR (Fig. 1). From 2004-2006, biodiversity surveys and some management activities were supported by the MWBP (Try & Chambers 2006; Timmins 2006). Forty-five kilometres north of the study area, in southern Lao PDR, the Siphandon wetlands (Fig. 1) have been proposed for Ramsar nomination (IUCN 2006). Community-based research and management of wild fisheries and the Irrawaddy Dolphin was conducted in Siphandon between 1993 and 1999 (Daconto 2001; Baird & Flaherty 2005; Baran et al. 2005). In 2006, an agreement for "Transboundary Wetland Management" was signed between Stung Treng and Champassak (Lao PDR) Provinces. In 2003, a national review of Important Bird Areas concluded the Mekong River in northeast Cambodia and its three major tributaries, the Se Kong, Se San and Srepok, are the least represented freshwater habitats in the Cambodian protected area system, and recommended that the Stung Treng Ramsar site is extended downstream to Kratie Town (Seng et al. 2003).

2.7 Survey localities and teams in 2006-2007

Surveys in 2006 and 2007 were undertaken over a nine-month period, by a team of government personnel and international specialists, to document vegetation and flora, birds, large mammals, amphibians, reptiles and fish (Table 1). Surveys were conducted in three seasonal periods: early dry season (receding water levels, November 2006), mid-dry season (low water levels, March-April 2007) and wet season (high water levels, July-August 2007). A fourth survey, for turtles, was conducted by the Cambodia Turtle Conservation Team. Surveys were each of 15-25 days duration and a total of 220 field days were conducted.

Table 1. Survey timing and teams in 2006-2007.

Survey	Team members*	Early Dry (receding water) (2006)	Dry (low water level) (2007)	Wet (high water level) (2007)	Field days
Vegetation	E. Khou, N. Narith, J. Maxwell, M.v.d. Bult, P. Palee, S.J. Ngundahn	10-23 November	10-25 March	29 July-13 August	45
Birds and mammals	N. Chea, S. Choum, E. Khou, B. Pech, R. Timmins	10 November-2 December	11 March-7 April	29 July-23 August	72
Amphibians and reptiles	B. Vinn, L. Seng, M.R. Bezuijen	10-23 November	10-25 March	29 July-13 August	45
Turtles	K. Chea, S. Kheng, C. Kim, S.V. Leng, Y. Sun		28 January-9 February		13
Fish	P. Chhem, L. Seng, N. Tum, C. Vidthayanon	10-23 November	10-25 March	29 July-13 August	45
Total days					220

*Full names are listed in "Authors and Contributors".

Survey locations included sites throughout the Mekong channel between Kratie and Stung Treng Towns (130 km), and some floodplains south and west of Kratie Town. Key survey localities visited by most teams are in Table 2 (see Sections 3-7 for additional details of specific sites visited by each team).

Table 2. Survey localities.

Locality	Coordinate	District	Province
Mekong River mainstream from Kratie to Stung Treng Towns	N12°29'36", E106°13'79" (Kratie Town) - N13°31'54", E105°57'55" (Stung Treng Town)	Sambor (Kratie), Siem Bok (Stung Treng)	Kratie, Stung Treng
"Central section" (Mekong mainstream mid-way between Kratie and Stung Treng Towns)	N13°17'55", E105°56'49" -N13°4'47", E106°13'47"	As above	As above
Prek Krieng River (surveys from entrance to <2 km upstream) (within "central section")	N12°55'38", E105°59'30"	Sambor	Kratie
Prek Preah River (surveys from entrance to to <2 km upstream) (within "central section")	N13°1'33", E106°4'46"	Sambor	Kratie
Floodplains west of Kratie Town	N12°30′, E105°57′	Prek Prasap	Kratie
Floodplains south of Kratie Town: (a) Boeng Thom, (b) Boeng Chhrea, (c) Boeng Prek/Boeng Meier, (d) Contoipreykien, (e) Boeng Rhung	(a) N12°18'39", E106°12'15", (b) N12°19'59", E106°00'40", (c) N12°30'47", E106°03'16", (d) N12°19'39", E106°00'47", (e) N12°22'45", E106°55'42"	Prek Prasap	Kratie

During the first survey (early dry season), water levels were receding rapidly and the extent of exposed channel habitat was visibly greater by the end of the survey. There was little cloud cover or rainfall, it was warm, and some waterways in the Mekong channel could only be accessed by walking. In the second (mid-dry season) survey, water levels were the lowest observed during surveys, most seasonal streams were dry, and large areas of the channel were exposed or shallow (<1 m depth). There was almost no cloud cover, and no rainfall, throughout this survey, and many waterways could only be accessed on foot. Boat passage even on large waterways and in the mid-channel was sometimes hindered by shallow, rocky rapids. In the third (wet season) survey, water levels were 7-10 m higher than four months previously and most channel habitats were submerged. There were more days with cloud cover than sun-days, rainfall occurred on most days and from 3-5 August 2007 it rained continuously. Most waterways could be accessed by boat.

"Central section". Most survey effort focused on a 56-km section of river mid-way between Kratie and Stung Treng Towns, termed here the "central section" (straight distance 49 km) (Fig. 2). This section begins 49 km north of Kratie Town (straight distance 44 km) and extends to the north end of Koh Preah Island, 14 km north of the Kratie-Stung Treng provincial border (straight distance 12.5 km). The northern end of the "central section" is 25 km south of Stung Treng Town (straight distance 21 km). The Kratie-Stung Treng provincial border intersects the "central section": at this point, the "central section" extends 42 km south into Kratie Province (straight distance 37 km) and 14 km north into Stung Treng Province (straight distance 12.5 km). It supports the lowest human densities and most intact riverine habitats within the study area, comprising a diverse and rich mosaic of seasonally flooded riverine vegetation, sandbars and beaches, deep pools, shallow rocky rapids, riverbank forest and numerous islands.

3. VEGETATION AND FLORA

James F. Maxwell, Khou Eanghourt, Pranee Palee, Martin van de Bult,
Sai Jai Ngundahn and Choeung Hong Narith



3. Vegetation and flora

3.1 Introduction

Gagnepain (1943) provides detailed information concerning the itineraries and biographies of pioneer French plant collecting in Indochina. Five people are known to have collected along the Mekong River between Kratie, Cambodia and Khone Island, Lao PDR. Their specimens are in the Paris Herbarium. Clovis Thorel (1833-1911), a physician-botanist, collected the first plant specimens along the Mekong River in Cambodia and Lao PDR during 1866-1868. J.B.L. Pierre (1833-1905), director of the Botanic Gardens, Saigon (1865-1877), collected extensively in Cambodia and especially along the Mekong River from Phnom Penh to Khone Island, Lao PDR. Pierre produced the five-volume *Flore Forestière* de Cochinchine (1879-1907). Francois Harmand (1845-1921) collected in Indochina during 1875-1877, including along the Mekong River at Kratie. Eugene Polaine (1887-1964), from the Paris Herbarium, made collections in Indochina during 1917-1936 and along the Mekong River from Kratie to Khone Island.

Maxwell (2000, 2001a) compiled a flora for the Siphandon area, southern Lao PDR during 1997-1998. His survey resulted in 131 families and 731 species of vascular plants along with a detailed plant database and vegetation map (2001). An unpublished, incomplete report by Meng Monyrak for IUCN listed 102 vascular plants in the Stung Treng Ramsar site. The material was identified by J. F. Maxwell and is deposited in CMU Herbarium, Thailand. Timmins (2006) surveyed this Ramsar site and included a chapter on vegetation and wildlife habitats. His descriptions were rudimentary and his suggested terminology for vegetation communities is not based on detailed floral inventories and is not supported.

The current surveys in 2006-2007 documented 120 families and 683 species of vascular plants, as well as seven bryophytes. A detailed plant database, vegetation profiles, and photographic inventory of flora and habitats, are included.

3.2 Methods

3.2.1 Sampling

Considering the large size of the study area, an opportunistic approach to collecting specimens was pursued in which as many islands were visited as possible, as well as the mainland. Three surveys were made over three seasonal periods (early dry, dry and wet seasons) in which all vegetation types were visited. Every flowering and fruiting species encountered was collected, while non-reproducing plants were identified in the field and recorded, and notes on vegetation types were made. At least four specimens were collected of each species and four complete collections were made. One collection was left in Cambodia, stored temporarily at WWF Cambodia. CMU (Thailand) maintains one collection, while two collections will be sent to the National Herbarium Netherlands, Leiden (Netherlands) and Harvard University Herbarium (USA). A complete set of photographs taken are at CMU and WWF Cambodia. Over 700 specimens were collected, and identified in CMU. A database of recorded vascular plants and bryophytes is in Annex 4.

3.2.2 Limitations

This report can only be considered a preliminary study since not all islands were surveyed throughout the year. Algae were not collected. A complete flora of the study area would require frequent and extensive collecting. Further collections, studies on forest dynamics, plant distributions, and observations on phenologies will add more information to the database and enable more detailed vegetation mapping. Management actions such as reforestation would require more precise information of the location of seed sources, planting sites, and habitat requirements.

Cover: *Amorphophallus* sp. nov., new species to science ©Pranee Palee. 1: Seedpods, *Telectadium edule*. 2: Bamboo+Decidious, Seasonal, Hardwood Forest (BB/DF). 3: *Anogeissus rivularis*, bent by river current. Photos 1-3 ©Mark Bezuijen/WWF. 4: *Bauhinia bracteata* ©Pranee Palee.

3.3 Results

There are two main kinds of vegetation in the study area, *viz*. riverine (riparian) and terrestrial (on land above the flood level of the river) (Figures 4a,b). The riverine vegetation includes all vegetation in the river to the highest water level attained in August-September. In general, riverine vegetation is under the responsibility of the Fishery Administration, while terrestrial vegetation is managed by the Forestry Administration. Terminology for riverine zones and terrestrial facies follows Maxwell (2000, 2001a).

3.3.1 Riverine vegetation

The Mekong River, due to its immense size, great seasonal fluctuations of water level (up to 10 m in the study area) and particular geomorphology, has developed a distinct and diverse riverine vegetation in the study area. Six vegetation zones have been distinguished in this system (Figures 4a,b). All of these zones are exposed during the lowest level of the river during February-May and only the uppermost zone can be seen, in part, during August-September when the water level is highest. These six zones are not always apparent in many areas due to the absence of bedrock which is vital for the development and stability of some zones. Shifting sandbars and ephemeral beach formations also tend to cause variation in the extent of some zones. Erosion of the margins of some islands has resulted in a steep drawdown area in which the upper riverine zones are often not present. Bedrock, essential for Zones 2-4, is often absent, thus these places usually have sand extending to the terrestrial vegetation. The five zones above the aquatic (river) zone include species which are both amphibious and seasonally rheophytic. The vegetation ranges from delicate annual aquatic herbs to trees up to 15 m tall. Many species found in the riverine vegetation are only known from the Mekong River. The vegetation tends to increase in height, density, and diversity from the lowest level of the river (*c*.20 m elevation) to the terrestrial vegetation (*c*.30 m).

Zone 1: Aquatic. The aquatic plants here are all herbs and are readily found in the river during the dry season when the water level, flow velocity, and turbidity is lowest. These plants are either floating or submerged and attached to the bottom, often on rocks (Annex 3 – Plate 1). All are obligate aquatics and cannot survive without water. *Potamogeton crispus* L. (Potamogetonaceae), *Najas indica* (Willd.) Cham. (Najadaceae), *Hydrilla verticillata* (L.) Roy., and *Vallisneria gigantea* Greab. (both Hydrocharitaceae), all monocots, are prevalent. *Ceratophyllum demersum* L. (Ceratophyllaceae) was the only dicot found. Algae were not collected.

Zone 2: Rapids ("Boong"). This zone is known as "Boong" in the Siphandon wetlands in Lao PDR, *c*.60 km north of the study area, and refers to open, rocky, sparsely vegetated habitat (Maxwell 2000, 2001a). This is the rocky to sandy area immediately above the aquatic zone with vegetation that is the first to be submerged and last to be exposed in the annual cycle of the river (Annex 3 – Plates 1,2). It consists of several deciduous herbs and shrubs, often scattered, with a general lack of trees. Herbs are common with *Fimbristylis cymosa* R. Br. (Cyperaceae), *Cryptocoryne crispatula* var. *crispatula* Engl. (Araceae) (Annex 3 – Plate 14), and the edible pteridophyte *Diplazium esculentum* (Retz.) Sw. (Athyriaceae). Shrubs, all deciduous, amphibious rheophytes, are mostly epilithic and grow in dense clusters in rocky places. *Telectadium edule* H. Baill. (Asclepiadaceae), *Homonoia riparia* Lour. and *Phyllanthus jullienii* Beille (both Euphorbiaceae), and *Xantonnea parviflora* (O. K.) Craib var. *salicifolia* (Pierre *ex* Pit.) Craib (Rubiaceae) are common shrubs. *Crateva magna* (Lour.) DC. (Capparaceae), a shrub or treelet, is also found here, but of lesser stature and frequency as in Zones 4 and 5. *Dalzellia carinata* (Lec.) C. Cuss. (Tristichaceae) is a tiny, epilithic, moss-like herb which grows in dense clusters on rocks in areas with a fast current close to the water level. This species was found in flower in March and is remarkable due its ability to survive in such an extreme habitat.

Zone 3: "Kai Kum". "Kai Kum" is the Lao name for *P. jullienii*, which dominates this zone in the Siphandon wetlands in Lao PDR (Maxwell 2000, 2001a). Places above Zone 2, which generally have more plant diversity and abundance, as well as more vigorous growth, are included here (Annex 3 – Plate 3). Water flow is less rapid here and in some instances Zone 2 merges with Zone 3 - a clear distinction being

difficult to make. This zone has several shrubs which are usually found in Zone 2, e.g. *Morinda pandurifolia* O.K. var. *oblonga* (Pit.) Craib (Rubiaceae), *Blachia siamensis* Gagnep. (Euphorbiaceae), and Paravitex sp. (Verbenaceae). *Homonoia riparia* is common, but *T. edule* is mostly absent. *Oxystelma esculentum* (L. f.) R. Br. (Asclepiadaceae), a vine, as well as most of the herbs found in Zone 2 are also present. The first trees are found here and include *Barringtonia acutangula* (L.) Gaertn. (Lecythidaceae), *Eugenia mekongensis* Gagnep. (Myrtaceae), and an occasional *C. magna*.

Zone 4: *Acacia-Anogeissus*. This zone is characterized by two seasonally rheophytic, deciduous trees which only grow in rocky places above Zone 3, *viz. Acacia harmandiana* (Pierre) Gagnep. (Leguminosae, Mimosoideae) and *Anogeissus rivularis* (Gagnep.) Lec. (Combretaceae), which both grow up to 15 m tall and become partly to completely submerged during August-September (Annex 3 – Plates 4-7). Their crowns are frequently bent downstream by the strong river current, where floating debris (logs etc) accumulate and remain during the dry season. Both species develop thick mats of fibrous, black adventitious roots in the lower 2-4 m of the trunk, which are also bent downstream. These two species are hosts for *Macrosolen cochinchinensis* (Lour.) Tiegh. (Loranthaceae), a common, hemi-parasitic shrub on the upper branches. Several species of *Ficus* (Moraceae), e.g. *F. benjamina* L., *F. rumphii* Bl., and *F. virens* Ait. (Miq.) Corn. also grow as epiphytic trees on both of the dominating trees. Figs (synconia) produced by these and other species of *Ficus* are an important food source for many birds, mammals, and fish.

This zone is often isolated or directly merging with terrestrial vegetation, and has some woody climbers that are absent from the lower zones. Some of these include: *Dalbergia volubilis* Roxb., *Paraderris elliptica* (Wall.) Adema, *Derris scandens* (Roxb.) Bth. (all Leguminosae, Papilionoideae), and *Hiptage triacantha* Pierre (Malpighiaceae). Herbs are common in this zone and often include some of those found in Zones 2 and 3. Also found in this zone are *Dichanthium caricosum* (L.) A. Camus (Gramineae), *Fimbristylis brunneoides* Kern, *F. jucunda* (Cl.) Kern (Cyperaceae) (all monocots); *Hemigraphis modesta* R. Ben. (Acanthaceae), *Rotula aquatica* Lour. (Boraginaceae), and *Paravitex* sp. (Verbenaceae) (shrubs), and *Microcos sinuata* (Wall. *ex* Mast.) Burr. (Tiliaceae) (a treelet). The invasive, spiny herb-shrub *Mimosa pigra* L. (Leguminosae, Mimosoideae) is abundant here and is spreading rapidly to other zones, and poses a threat to the native flora.

Zone 5: Beach. All open, sandy, seasonally inundated areas have been included in this zone (Annex 3 – Plate 8). Sandbars, as well as beaches, are common throughout the study area. Due to the lack of bedrock and sufficient organic nutrients, these sandy areas lack perennial, especially woody, vegetation as found in Zones 2-4. Annual herbs, which germinate and produce seeds during October-July, are numerous, but usually very sparse in abundance. Many of these plants also colonize disturbed and agricultural areas and are considered as weeds; these species are thus not unique to Zone 5, but most do not inhabit the other riverine zones.

Both dicots and monocots are well-represented, but pteridophytes (ferns) are absent. Some common dicots include: *Cleome viscosa* L. (Capparaceae), *Dentella repens* (L.) J. R. & G. Forst., and *Hedyotis pinifolia* Wall. *ex* G. Don (both Rubiaceae); *Eclipta prostrata* (L.) L. and *Grangea maderaspatana* (L.) Poir. (both Compositae); *Lindernia antipoda* (L.) Alst., *L. crustacea* (L.) F. Muell. var. *crustacea*, and *Scoparia dulcis* L. (all Scrophulariaceae); *Polygonum plebium* R. Br. (Polygonaceae), and *Phyla nodiflora* (L.) Greene (Verbenaceae). Monocots, especially Cyperaceae (sedges) and Gramineae (grasses) are also common. *Cyperus cuspidatus* Kunth, *Fimbristylis aestivalis* (Retz.) Vahl var. *aestivalis*, *F. dipascea* (Rottb.) Cl., and *F. jucunda* (Cl.) Kern (Cyperaceae) are frequently found. Some common Gramineae include: *Digitaria bicornis* (Lmk.) Roem. & Schult., *D. radicosa* (Presl) Miq., *Dactyloctenium aegyptium* (L.) P. Beauv., *Echinochloa colona* (L.) Link, *Leptochloa chinensis* (L.) Nees, and *Sorghum mekongense* (A. Camus) A. Camus (Photo 25)-the latter being restricted to this zone. *Saccharum arundinaceum* Retz. and to a lesser extent *S. spontaneum* L., both robust evergreen Gramineae, often form dense colonies on beaches close to the margins of terrestrial vegetation. These areas help reduce erosion.

Zone 6: Strand. This is the highest riverine zone and the last to be flooded and first to be exposed (Annex 3 – Plate 9). It consists mainly of woody dicots and directly abuts terrestrial vegetation, sometimes without a distinct beach below it. In most instances, the vegetation here is dense, evergreen, and quite diverse. *Ficus heterophylla* L. f. (Moraceae) is a common creeping vine/woody climber found in this Zone. *Polyalthia modesta* (Pierre) Fin. & Gagnep. (Annonaceae), a shrub, *Fluggea virosa* (Roxb. *ex* Willd.) Voigt (Euphorbiaceae), a treelet, and *Crateva magna*, a small tree, are common. Woody climbers include: *Ventilago harmandiana* Pierre (Rhamnaceae), *Derris scandens, Bauhinia bracteata* (Grah. *ex* Bth.) Baker ssp. *bracteata* (Leguminosae, Caesalpinioideae), *Combretum trifoliatum* Vent. (Combretaceae), and *Glossocarya siamensis* Craib (Verbenaceae). Trees are plentiful and form a closed, single canopy in most places. Many of these trees are restricted to

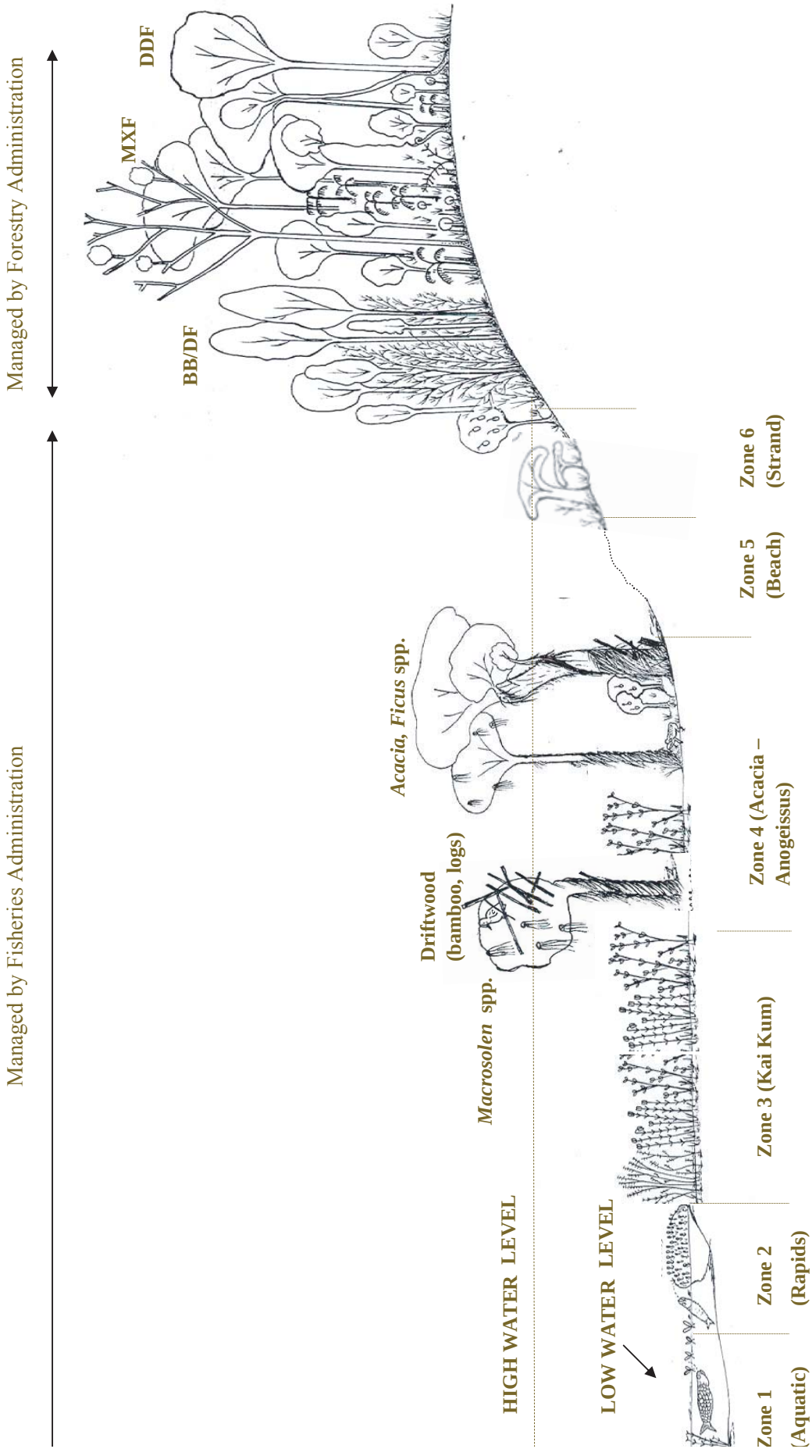

Figure 4a. Riverine Vegetation Zones 1-6 and terrestrial forest facies in the study area (cross-section). See text for details. Drawing by P. Palee.

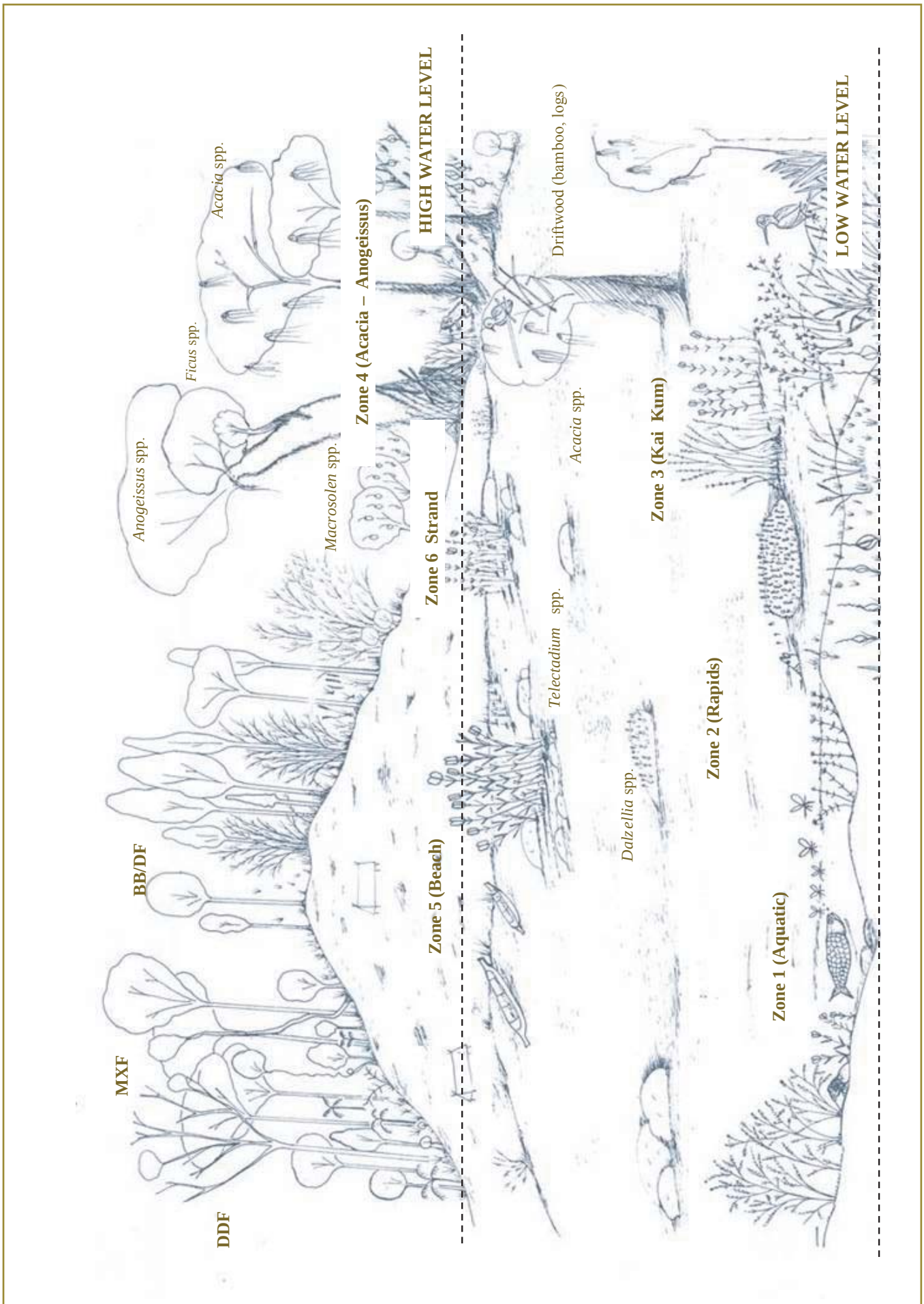

Figure 4b. Riverine Vegetation Zones 1-6 and terrestrial forest facies in the study area (overview). See text for details. Drawing by P. Palee.

this zone. Some common examples are: *Homalium brevidens* Gagnep. and *H. caryophyllaceum* (Zoll. & Mor.) Bth. (Flacourtiaceae), *Pterospermum diversifolium* Bl. (Sterculiaceae, Photo 26), *Quassia harmandiana* (Pierre) Noot. (Simaroubaceae), *Crudia chrysantha* (Pierre) K. Sch. (Leguminosae, Caesalpinioideae), *Combretum quadrangulare* Kurz (Combretaceae), *Cordia dichotoma* Forst. f. (Boraginaceae), *Mallotus (Trewia) nudiflorus* (L.) Kul. & Welz. (Euphorbiaceae), *Nauclea orientalis* (L.) L. (Rubiaceae), and *Salix tetrasperma* Roxb. (Salicaceae).

3.3.2 Terrestrial vegetation

Mainland areas adjacent to the Mekong River and all islands in the river have vegetation which is very different from riverine facies. All terrestrial areas are flat and lack relief. Some larger islands have seasonal ponds, exposed bedrock, and narrow, shallow flood/rain runoff channels. Due to centuries of human activities, the original (i.e. before humans arrived) vegetation now ranges from degraded to destroyed. There is no place in the study area that has not been disturbed by people with their associated settlements, cattle, annual fires, agriculture, and continuous logging. There are four basic forest types, none pristine, which often merge together.

Mixed Evergreen + Deciduous, Seasonal, Hardwood Forest (MXF). The original, pre-human impact, forest facies in much of the area was MXF, most of which has been cleared or degraded into other facies (Annex 3 – Plate 11). Only a few islands (e.g. Koh Norong, Koh Rongnieu) have vestiges of this forest, which is a mixture of evergreen + deciduous species (Maxwell 2000, 2001a, 2004). The understory and ground flora are mostly more evergreen than in other forest types, while the trees, up to 25 m tall, are a mixture of evergreen and deciduous species. Frequently seen herbs in MXF are: *Desmodium heterocarpon* (L.) DC. ssp. *angustifolium* Oha. (Leguminosae, Papilionoideae), *Justicia ventricosa* Wall. (Acanthaceae), *Calcareoboea bonii* (Pell.) Burtt. (Gesneriaceae)-all dicots; *Carex indica* L. var. *indica* (Cyperaceae), a monocot; and several pteridophytes, *viz. Selaginella roxburghii* (Hk. & Grev.) Spring var. *roxburghii* (Selaginellaceae), and Polypodiaceae epiphytes *Drynaria quercifolia* (L.) J. Sm., *Pyrrosia lanceolata* (L.) Farw., and *P. stigmosa* (Sw.) Ching. An understory of mostly evergreen shrubs and treelets, many spiny, consists of *Polyalthia evecta* (Pierre) Fin. & Gagnep. and *Desmos chinensis* L. (both Annonaceae), *Atalantia monophylla* (L.) DC. (Rutaceae), *Memecylon lilacinum* Zoll. & Mor. (Melastomataceae), *Ixora finlaysoniana* Wall. *ex* G. Don and *I. nigricans* R. Br. *ex* Wight & Arn. (Rubiaceae), and *Streblus asper* Lour. var. *asper* (Moraceae).

Evergreen trees, formerly common and now sparse and scattered, include: *Xylopia pierrei* Hance (Annonaceae), *Mammea siamensis* (Miq.) T. And. (Guttiferae), *Acronychia pedunculata* (L.) Miq. (Rutaceae), *Irvingia malayana* Oliv. *ex* Benn. (Irvingiaceae), *Lepisanthes tetraphylla* (Vahl) Radlk. (Sapindaceae), *Carallia brachiata* (Lour.) Merr. (Rhizophoraceae), *Eugenia fruticosa* (DC.) Roxb. and *E. grandis* Wight var. *grandis* (Myrtaceae), *Diospyros bejaudii* Lec. (Ebenaceae), *Chaetocarpus castanocarpus* (Roxb.) Thw., and *Drypetes roxburghii* (Wall.) Huru. (both Euphorbiaceae). Dicot woody climbers are frequent with: *Artabotrys hexapetalus* (L.f.) Bhar. (Annonaceae), *Celastrus paniculatus* Willd. (Celastraceae), *Tetrastigma harmandii* Pl. (Vitaceae), and *Dalbergia entadoides* Pierre *ex* Gagnep. (Leguminosae, Papilionoideae). The most obvious indicators of MXF are three species of *Calamus* (Palmae, rattans), *viz. C. rudentum* Lour., *C. siamensis* Becc. var. *siamensis* (the most common species), and *C. viminalis* Willd.

Bamboo + Deciduous, Seasonal, Hardwood Forest (BB/DF). This is the most prevalent and persistent forest type in the area (Annex 3 – Plate 10). Severely degraded or cleared MXF areas are replaced with BB/DF, thus many forested areas are a mixture of declining MXF and rapidly developing BB/DF—the absence of bamboo and lack of *Calamus* in BB/DF being a good indicator of the actual forest facies. The bamboo component of BB/DF consists almost entirely of *Bambusa bambos* (L.) Voss. *ex* Vilm. (Gramineae, Bambusoideae). This species, which is densely clumped, fire-resistant, and severely thorny, varies from dominating BB/DF to absent, which depends on the extent of logging and fire on each island. In general, BB/DF is more open, irregular and predominately deciduous, than MXF. Many BB/DF areas include much secondary growth, thus there is great variation in the composition of BB/DF on the islands. The ground flora includes many annual and deciduous dicots and monocots, most of which flower and fruit during the rainy season. Typical annual dicots are: *Crotolaria acicularis* Ham. *ex* Bth., *C. montana* Hey. *ex* Roth and *Mecopus nidulans* Benn. (all Leguminosae, Papilionoideae), *Borreria brachystema* (R. Br. *ex* Bth.) Val. and *Hedyotis verticillata* (L.) Lmk. (both Rubiaceae), *Lindernia ciliata* (Colsm.) Penn. and *Torenia violacea* (Aza. *ex* Blanco) Penn. (both Scrophulariaceae), *Dipteracanthus repens* (L.) Hassk. and *Justicia ventricosa* Wall. (both Acanthaceae).

Deciduous monocots are very diverse and provide most of the ground cover during the rainy season, which is best developed during July-September. Typical representatives are: *Murdannia edulis* (Stokes) Faden

(Commelinaceae), *Halopegia brachystachys* Craib (Marantaceae), Zingiberaceae with *Curcuma aurantiaca* van Zijp, *Globba schomburgkii* Hk. f. var. *schomburgkii*, and *Zingiber zerumbet* (L.) Sm. var. *zerumbet*. Orchidaceae are very prominent in BB/DF, with *Brachycorythis helferi* (Rchb. f.) Summ., *B. laotica* (Gagnep.) Summ., *Habenaria lucida* Wall. ex Lindl., *Liparis rheedii* (Bl.) Lindl. and *L. siamensis* Rol. *ex* Dow.; *Carex tricephala* Boeck. and *Fimbristylus dichotoma* (L.) Vahl ssp. *dichotoma* (both Cyperaceae) with *Aristida setacea* Retz., *Panicum notatum* Retz., and sometimes *Chrysopogon nemoralis* (Balan.) Holtt., (all Gramineae) also provide much cover.

Woody climbers in BB/DF are all deciduous and include: *Uvaria hahnii* (Fin. & Gagnep.) Sincl. (Annonaceae), *Capparis micracantha* DC. ssp. *micracantha* (Capparaceae), *Harrisonia perforata* (Blanco) Merr. (Simaroubaceae), *Calycopteris floribunda* (Roxb.) Lmk. and *Combretum latifolium* Bl. (both Combretaceae), *Ziziphus cambodiana* Pierre var. *cambodiana* and *Z. oenoplia* Mill. var. *oenoplia* (Rhamnaceae).

Trees in BB/DF are mostly deciduous, the tallest ones being 20-25 m tall. Selective logging has resulted in significant decreases in many tall trees with valuable wood which has been used to build houses and boats. Extensive timber extraction has resulted in the extirpation or severe depletion of tall trees on many islands. The most exploited trees are *Dipterocarpus alatus* Roxb. *ex* G. Don and *Hopea odorata* Roxb. (both Dipterocarpaceae), *Xylia xylocarpa* (Roxb.) Taub. var. *kerrii* (Craib & Hutch.) I. Niels (Leguminosae, Mimosoideae), *Sindora siamensis* Teysm. *ex* Miq. var. *siamensis* (Leguminosae, Caesalpinioideae), *Anogeissus acuminata* (Roxb. *ex* DC.) Guill. & Perr. and *Terminalia bellirica* (Gaertn.) Roxb. (both Combretaceae)-all deciduous, and *Irvigia malayana* Oliv. *ex* Benn. (Irvingiaceae), an evergreen species. As a result of the loss of forest integrity, erosion of soil organic material, fire, and depletion of wildlife, the forest facies has changed and is now dominated by trees which are not cut due to their inferior wood value, most of which produce small, wind-dispersed seeds that do not require animals for distribution.

Lagerstroemia cochinchinensis Pierre var. *ovalifolia* Furt. & Mont.-the most common component (Annex 3 – Plate 10) and *L. lecomtei* Gagnep. (Lythraceae), *Cratoxylum cochinchinense* (Lour.) Bl. and *C. formosum* (Jack) Dyer ssp. *pruniflorum* (Kurz) Gog. (Guttiferae), and *Terminalia triptera* Stapf (Combreataceae) are typical examples. *Canarium subulatum* Guill. (Burseraceae), *Schleichera oleosa* (Lour.) Oken (Sapindaceae), *Spondias pinnata* (L. f.) Kurz (Anacardiaceae), and *Vitex peduncularis* Wall. *ex* Schauer (Verbenaceae) are deciduous trees with animal-dispersed fruits that have not been extensively selected for logging. Many of these surviving trees have been damaged by fire or cutting and have coppicing trunks, irregular boles, and burned interiors. Annual fires during January-May, grazing, and continuous cutting of vegetation by encroachers has caused the elimination of seedlings and saplings of the tall, valuable tree species as well as deforming and otherwise damaging the growth of the remaining species.

Many secondary growth (SG) trees have become established in BB/DF especially with *Grewia eriocarpa* Juss. and *Microcos paniculata* L. (both Tiliaceae), *Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *stipulata* (Bignoniaceae), and *Trewia orientalis* (L.) Bl. (Ulmaceae) (see section "SG" below).

Deciduous, Dipterocarp, Seasonal, Hardwood Forest (DDF). Trees in DDF are typically scattered, the species well-distributed, and almost all deciduous (Annex 3 – Plate 12). Dipterocarpaceae are most abundant, thus the name for this forest type. The dominant dipterocarps are: *Dipterocarpus intricatus* Dyer and *D. tuberculatus* Roxb. var. *tuberculatus*, *Shorea obtusa* Wall. *ex* Bl. and *S. siamensis* Miq. var. *siamensis*. Other common trees in DDF are: *Dillenia pentagyna* Roxb. (Dilleniaceae), *Bombax anceps* Pierre var. *anceps* (Bombacaceae), *Berrya mollis* Wall. *ex* Kurz Tiliaceae), *Buchanania glabra* Wall. *ex* Hk. f. and *B. lanzan* Spreng. (Anacardiaceae), *Pterocarpus macrocarpus* Kurz (Leguminosae, Papilionoideae), *Terminalia alata* Hey. *ex* Roth (Combretaceae), *Careya arborea* Roxb. (Lecythidaceae), *Mitragyna rotundifolia* (Roxb.) O.K. and *Morinda tomentosa* Hey. *ex* Roth (both Rubiaceae), *Diospyros ehretioides* Wall. *ex* G. Don (Ebenaceae), and *Aporosa octandra* (B.-H. *ex* D. Don) Vick. var. *yunnanensis* (Pax & Hoffm.) Schot (Euphorbiaceae).

Throughout areas of lower elevations in northern Thailand and extending to the Siphandon wetlands, DDF normally has an oak (Fagaceae) component, especially *Quercus kerrii* Craib (Maxwell 2000, 2001a, 2004). No Fagaceae was found in the study area, although it is suspected that this species of *Quercus* used to be there. This species is exploited for its hard wood, which makes an excellent charcoal and construction wood, as well as a source of tannins. The nuts (acorns) require animals for distribution, thus reestablishment of this species may also have been retarded by loss of wildlife throughout the region. This kind of forest is also known as savanna and is a fire-climax facies with a very distinct flora that is most extensive on the eastern mainland in the vicinity of O Chralang Village and Koh Norong and Koh Rongnieu Islands. The general vegetation

structure is open and single-storied, while in the rainy season an often dense ground flora 1-2 m tall is present. Typically bamboos are absent and most woody climbers are found on termite hills (termitaria). During the dry season the trees are leafless and the ground flora is bare and usually burned, exposing the poor, rocky soil. Ponds are scattered throughout DDF (Annex 3 – Plate 13) and are dry from November to June. Due to disturbance DDF and BB/DF often merge forming irregular boundaries with a mixture of their respective species. In most instances the flora of BB/DF and DDF are different.

The ground flora in DDF is mostly deciduous with a peak of development and flowering during July-September. Domestic cows and water buffalo roam freely in these places. As in BB/DF the ground flora in DDF is very diverse and most luxurious in the rainy season, although the floras in these two kinds of forests are mostly different. Annual herbs include some common dicots, *viz. Salomonoia cantoniensis* Lour. (Polygalaceae), *Polycarpaea corymbosa* (L.) Lmk. (Caryophyllaceae), *Osbeckia setoso annulata* Gedd. (Melastomataceae), and *Heliotropium strigosum* Willd. (Boraginaceae Scrophulariaceae are very abundant with: *Lindernia spathacea* (Bon.) Bon., *L. viscosa* (Horn.) Bold., *Pierranthus capitatus* (Bon.) Bon., and *Pseudostriga cambodiana* Bon. Some annual monocots, also diverse, are: *Eriocaulon sexangulare* L. (Eriocaulaceae), *Murdannia gigantea* (Vahl) Bruck. (Commelinaceae); *Cyperus castaneus* Willd., *Fimbristylis adenolepus* Kern, *Liphocarpa microcephala* (R. Br.) Kunth and *L. hemisphaerica* (Roth) Goet.-all Cyperaceae. Gramineae compose the bulk of the ground flora and often form dense clusters. Examples of annual grasses are: *Andropogon chinensis* (Nees) Merr., *Capillipedium cinctum* (Steud.) A. Camus, *Enteropogon dolichostachya* (Lag.) Keng *ex* Laza., *Eragrostis bipinnata* (L.) Musc., *E. unioloides* (Retz.) Nees *ex* Steud., *Gymnopogon delicatulus* (Cl.) Bor, and *Microchloa indica* (L. f.) P. Beauv.

Deciduous dicot herbs are represented by *Eriosema chinense* Vogel (Leguminosae, Papilionoideae), *Knoxia brachycarpa* R. Br. *ex* Hk. f. (Rubiaceae), and *Euphorbia parviflora* L. (Euphorbiaceae). Deciduous monocots are far more abundant including: *Costus speciosus* (Koen.) J. E. Sm.; *Curcuma gracillima* Gagnep.; *Kaempferia siamensis* Siri. (all Zingiberaceae, Photo 49); *Habenaria acuifera* Wall. *ex* Lindl.; *H. mandersii* Coll. & Hemsl.; and, *H. rumphii* (Brogn.) Lindl. (Orchidaceae). Cyperaceae are well-represented with *Cyperus leucocephalus* Retz., *Rhynchospora rubra* (Lour.) Mak., and *R. longisetis* R. Br.. Robust, deciduous Gramineae are the most conspicuous component of DDF ground flora. Some common examples are: *Aristida chinensis* Munro, *Capillipedium annamense* A. Camus, *C. assimile* (Steud.) A. Camus, *Chrysopogon nemoralis* (Balan.) Holtt., *Ischaemum indicum* (Houtt.) Merr., and *Polytoca digitata* (L. f.) Druce.

Deciduous shrubs, scattered and mostly less than one meter tall, include: *Dillenia suffruticosa* (Griff.) Mart. (Dilleniaceae), *Ellipelopsis cherrevensis* (Pierre *ex* Fin. & Gagnep.) R. E. Fr. (Annonaceae), *Desmodium pulchellum* (L.) Bth. and *Lespedeza henryi* Schindl. (both Leguminosae, Papilionoideae) and *Bridelia harmandiana* Gagnep. (Euphorbiaceae).

DDF also includes several, mostly evergreen, epiphytes, e.g. *Hoya diversifolia* Bl. and *H. kerrii* Craib (Asclepiadaceae), vines; *Dendrophthoe pentandra* (L.) Miq. and *D. curvata* (Bl.) Miq. (Loranthaceae), hemi-parasitic shrubs, and several Orchidaceae, *Cleisomeria pilosulum* (Gagnep.) Seid. & Garay being the only one found with flowers. *Clitoria mariana* L. (Leguminosae, Papilionoideae), *Thunbergia similis* Craib (Acanthaceae) (both dicots); and *Smilax verticalis* Gagnep. (Smilacaceae) (a monocot) are the most common deciduous vines.

Seasonal ponds are scattered in DDF and support mostly annual, aquatic to amphibious herbs (see below).

Ponds. Shallow, rain-fed, ephemeral ponds are scattered in all terrestrial forest types, especially DDF, during July to October (Annex 3 – Plate 13). These habitats are dry from November to May. The amphibious to aquatic vegetation in ponds differs from riverine Zone 1 facies in being much more abundant, diverse, and with many more dicots. Almost all vascular plants found in ponds are rooted in mud, have an annual cycle from May to November, and include many more annuals than deciduous perennials.

Typical examples of dicots, all annuals, found in ponds are: *Nymphoides* (*Limnantherum tonkinense* Dop, Gentianaceae) and many Scrophulariaceae, *viz*. *Dopatrium micrantha* (Bth.) Bth., *Lindernia cambodgiana* (Bon.) Phil. and *L. viatica* (Kerr *ex* Barn.) Phil.. Annual monocots include Hydrocharitaceae with *Hydrilla verticillata* (L. f.) Roy., *Lagarosiphon roxburghii* Bth. and *Ottellia lanceolata* (Gagnep.) Dandy; *Sagittaria guaynensis* Humb. ssp. *lappula* (D. Don) Bogin and *S. trifolia* L. (Alismataceae, *Monochoria vaginalis* (Burm. f.) Presl (Pontederiaceae), and some *Typhonium flagelliforme* (Lodd.) Bl. (Araceae). Cyperaceae are well-represented with: *Cyperus compactus* Retz., *C. iria* L., *C. pilosus* Vahl; *Eleocharis acutangula* (Roxb.)

Schult., *Fimbristylis miliacea* (L.) Vahl, and *F. tetragona* R. Br. *Echinochloa colona* (L.) Link (Gramineae) is also common. No perennial dicots were found and only two deciduous, perennial monocots were seen, *viz.* *Cyperus brevifolius* (Rottb.) Hassk. (Cyperaceae) and *Ceratopteris thalictroides* (L.) Brongn. (Parkeriaceae, a pteridophyte).

Secondary Growth (SG) and Disturbed Areas (DA). Because of extensive disturbance and destruction of the terrestrial vegetation, much of the primary vegetation in the study area has not regenerated. Secondary growth species have successfully invaded and matured in disturbed areas. For convenience, herbaceous plants, i.e. weeds, are included here since these plants are the initial colonizers of open land and are succeeded by woody species that are different from the plants they have replaced.

Many of the first herbaceous invaders found in gaps, clearings, or fields are the same as found on sandbars and beaches (Riverine Zone 5) - but in far more abundance and most being rapidly growing, annual herbs. Some of the more widespread dicot weeds are: *Mimosa diplotricha* C. Wright *ex* Sauv. var. *diplotricha* (a scrambling vine) and *M. pudica* L. (Leguminosae, Mimosoideae), *Ludwigia hyssopifolia* (G. Don) Exell (Onagraceae), *Mollugo pentaphylla* L. (Aizoaceae), *Ageratum conyzoides* L. and *Eupatorium odoratum* L. (both Compositae), *Heliotropium indicum* L. (Boraginaceae), *Solanum nigrum* L. (Solanaceae), *Alternanthera sessilis* L. var. *sessilis* (Amaranthaceae), *Phyllanthus amarus* Schum. & Thonn. and *Phyllanthus urinaria* L. (Euphorbiaceae). The most common monocot weeds are perennial Gramineae, *viz. Eleusine indica* (L.) Gaertn., *Imperata cylindrica* (L.) P. Beauv. var. *major* (Nees) C. E. Hubb. *ex* Hubb. & Vaugh., *Phragmites vallatoria* (Pluk. *ex* L.) Veld., and *Thysanolaena latifolia* (Roxb. *ex* Horn.) Honda, the latter three species being robust and gregarious.

Woody SG species are fast-growing, weak-wooded, and short-lived. Trees predominate many DA/SG places with *Polyalthia cerasoides* (Roxb.) Bth. *ex* Bedd. (Annonaceae), *G. eriocarpa* Juss. and *Microcos paniculata* L. (both Tiliaceae), *Markhamia stipulata* (Wall.) Seem. *ex* K. Sch. var. *stipulata* (Bignoniaceae), *Antidesma ghaesembilla* Gaertn. (Euphorbiaceae), and *Trema orientalis* (L.) Bl. (Ulmaceae). *Harrisonia perforata* (Blanco) Merr. (Simaroubaceae), *Ziziphus cambodiana* Pierre var. *cambodiana* and *Z. oenoplia* Mill. var. *oenoplia* (Rhamnaceae) - all spiny; and *Anomianthus dulcis* (Dun.) Sincl. (Annonaceae) are common deciduous woody climbers present in degraded BB/DF and DA/SG.

3.3.3 Flora and species richness

A total of 683 species of vascular plants and seven species of Bryophyta (mosses) were collected and recorded during the study (Table 3). The vascular flora and Bryophyta are enumerated in an extensive database (Annex 4). The database includes data on habit, habitat, abundance, elevation, life mode, leafing, flowering, and fruiting phenology.

Table 3. Summary of flora recorded in the study area.

Division	Families	Species, subspecies, varieties
Angiospermae, Dicotyledonae	92	488
Angiospermae, Monocotyledonae	21	178
Pteridophyta	7	17
Bryophyta	7	7
Total	127	690

3.3.4 Rare species

From this preliminary study it is apparent that several species are rare to uncommon, some of them as a result of over-exploitation (trees) and others naturally so. Rare trees include *Hopea odorata* Roxb. (Dipterocarpaceae), *Cynometra dongnaiensis* Pierre (Leguminosae, Caesalpinioideae), *Duabanga grandiflora* (Roxb. *ex* DC.) Walp. (Sonneratiaceae), *Pouteria obovata* (R. Br.) Baeh. (Sapotaceae) (all dicots) and *Caryota maxima* Bl. (Palmae) (a monocot). *Brachystelma kerrii* Craib and *Ceropegia thorelii* Cost. (both Asclepiadaceae), *Aeginetia acaulis* (Roxb.) Walp. (Orobanchaceae) (a leafless ground parasite), *Burmannia wallichii* (Miers) Hk. f. (Burmanniaceae) (a monocot and delicate ground saprophyte), *Typhonium laoticum* Gagnep., in BB/DF, and *T. flagelliforme* (Lodd.) Bl. (Araceae), in BB/DF ponds are also rare. Several

pteridophytes are also in this category with *Helminthostachys zeylanica* (L.) Hk. and *Ophioglossum petiolatum* Hk. (both Ophioglossaceae), terrestrial and deciduous; and *Platycerium wallichii* Hk. (Polypodiaceae), a massive evergreen epiphyte.

3.3.5 New records

As far as can be determined from collecting records and publications, 23 new records have been found for the Cambodian flora. Notes on global distribution, forest type, and voucher specimens are provided here. The 23rd taxon is new to science and is discussed in Section 3.3.6.

1. *Desmodium flexuosum* Wall. *ex* Bth. (Leguminosae, Papilionoideae); Burma, Thailand DDF; 06-874 (Annex 3 – Plate 17)
2. *Indigofera zollingeriana* Miq. (Leguminosae, Papilionoideae); China, Taiwan, Lao PDR, Viet Nam, Indonesia; DA/SG; 07-123 (fruits)
3. *Rhodamnia cinerea* Jack var. *cinerea* (Myrtaceae); Thailand, Malay Peninsula, Borneo, Sumatra, Java; BB/DF-MXF; 07-600
4. *Brachystelma kerrii* Craib (Asclepiadaceae); southern China, Thailand, Viet Nam; DDF; 07-5
5. *Diospyros oblonga* Wall. *ex* G. Don (Ebenaceae); India, Burma, Thailand, Malay Peninsula, Indonesia; BB/DF; 07-598 (fruits)
6. *Ardisia attenuata* Wall. *ex* DC. (Myrsinaceae); China, Burma, Thailand, Viet Nam; MXF; Palee 1083 (Annex 3 – Plate 18)
7. *Calcareoboea bonii* (Pell.) Burtt (Gesneriaceae); Thailand, Lao PDR Viet Nam; MXF; 07-441
8. *Kaempferia siamensis* Siri. (Zingiberaceae); Thailand, DDF, 07-522
9. *Typhonium laoticum* Gagnep. (Araceae); Thailand, Lao PDR; ponds in DDF; 07-483
10. *Brachycorythis helferi* (Rchb. f.) Summ. (Orchidaceae); Assam (E. India), Burma, Lao PDR, Thailand; BB/DF, 07-450
11. *Habenaria viridiflora* (Rottl. *ex* Sw.) R. Br. (Orchidaceae); Sri Lanka, India, Thailand; DDF, 07-607
12. *Liparis rheedii* (Bl.) Lindl. (Orchidaceae); Viet Nam, Thailand, Malay Peninsula, Sumatra; BB/DF, 07-438
13. *Liparia siamensis* Rol. *ex* Dow. (Orchidaceae); Burma, Thailand, Lao PDR; MXF, 07-440
14. *Nervilia punctata* (Bl.) Schltr. (Orchidaceae); Malay Peninsula, peninsular Thailand, Sumatra, Java; BB/DF, 07-601 (leaves)
15. *Nervilia calcicola* Kerr (Orchidaceae); Malay Penisular, Thailand, Lao PDR; BB/DF, observed
16. *Vandopsis gigantea* (Lindl.) Pfitz. (Orchidaceae); China, Lao PDR, Thailand, Burma, Malay Peninsula; MXF, 07-155
17. *Fimbristylis brunneoides* Kern (Cyperaceae); Thailand, rv 2 & 3, 07-121
18. *Fimbristylis jucunda* (Cl.) Kern (Cyperaceae); Thailand, Lao PDR, Viet Nam; rv 2 & 3, 07-122
19. *Murdannia discreta* (Craib) Thit. & Faden (Commelinaceae); northern Thailand; DDF; 07-417
20. *Amorphophallus koratensis* Gagnep. (Araceae); Thailand, Lao PDR; bb/df; 07-145 (inflorescences), 07-425 (leaves) (Annex 3 – Plate 16)
21. *Cryptocoryne crispatula* Engl. var. *crispatula* (Araceae); Thailand, Lao PDR; rv 2 & 3; 06-811 (Annex 3 – Plate 14)
22. *Acacia leucophloea* (Roxb.) Willd. (Leguminosae, Minosoidae); Myanmar, Thailand, Viet Nam, Indonesia; BB/DF; observed only.

3.3.6 New species

One new species, *Amorphophallus* sp. nov. (proposed specific name *hemicryptus* Hett.) (Araceae, Maxwell 06-896) was found on the west side of Koh Kring Island on 16 November 2006 in BB/DF (Annex 3 – Plate 15). This species is being described by Wilbert Hetterscheid at Wageningen University, Netherlands. This species was not found in any other sites during surveys and no specimens are known from any current or historic herbarium collections. It appears the species may be rare and localized, although further surveys are required to document more information. Some of the unidentified species collected may perhaps be new, but taxonomic expertise for these is presently lacking.

3.4 Discussion

In recent years islands in the study area have experienced an accelerated rate of encroachment and clearance by settlers moving into the region. Uncontrolled human settlement has resulted in a wide range of impacts to vegetation. Riverine Zone 6 and the terrestrial forests are the most impacted and immediate action is required

to prevent irreparable degradation (Annex 3 – Plate 63). Riverine Zones 1-5 are less threatened but some, especially Zone 4, are subject to cutting and burning. Key threats to vegetation and suggested management actions are as follows.

- Designate specific islands for settlement and others for non-settlement. At least five islands could be designated as "settlement islands" as the terrestrial vegetation of these is highly degraded: Koh Thaan, Koh Khlee-ay, Koh Dambong, Koh Kondul, and Koh Tongdaeng. At least four islands should be considered as "non-settlement islands"; Koh Norong, Koh Rongnieu (central-north region), Koh Kring, and Koh Veng Thom. Koh Norong, Koh Rongnieu and Koh Kring Islands retain the most extensive and relatively intact terrestrial vegetation in the study area. The DDF on Koh Norong and Koh Rongnieu Islands is the most extensive and intact forest of this type in the study area and requires protection. Remnant MXF and BB/DF areas on Koh Kring, Koh Norong, Koh Rongnieu, and Koh Veng Thom are also important since they retain viable populations of many plants which are now absent on other islands.

- Conduct participatory planning and capacity building with key stakeholders to protect and manage remnant vegetation, including provincial government agencies, local communities, district leaders and schoolteachers. Discussions and training on the need for protection and effective conservation of key natural resources in the area should be explained, discussed, and agreed on along with official policies being implemented by the Cambodian Government. Capacity building for local communities should focus on methods to increase sustainability of soil and forest use, including training in modern agriculture methods to reduce soil erosion/degradation, a halt to burning, and management of grazing by domestic livestock.

- Promote proven techniques for sustainable forest management to local communities.

- Implement strict control and monitoring of in-migration, both seasonal and permanent.

- Implement clear policies on land use, land and grazing rights, and settlement locations and boundaries. Policies to be implemented as soon as possible include: a halt to logging and use of chain saws, especially of large, mature trees, and unregulated burning of forest.

- Restore deforested islands using indigenous vegetation.

- Control *Mimosa pigra* L. (Leguminosae, Mimosoideae), an invasive, naturalized, spiny, vigorous, herb-shrub from tropical America. This noxious weed is rapidly becoming established in Riverine Zones 4-6 and terrestrial areas. It develops dense growth and tolerates flooding, fire, and cutting. This species will become a serious environmental problem unless an effective control programme is established (Maxwell 2001b).

A key message to be promoted to local agencies and communities is that the remnant forests of the "central section" are a finite and rapidly diminishing resource for local communities. Current logging and clearance is unsustainable and it may take decades or centuries for new forests to develop. The unsustainability of current logging was confirmed in many sites in the study area, where valuable trees had been logged, but had not recolonised the site, and flora distinctive of secondary forest/degraded areas had colonized instead.

4. BIRDS

Robert Timmins

4. Birds

4.1 Introduction

The bird surveys reported here were the first detailed wide-ranging bird surveys of the Mekong River between Kratie and Stung Treng Towns and also included visits to some nearby floodplains. This stretch of the river had been previously surveyed systematically, but only by short duration surveys, that concentrated on the main, large, open water channels. The first of these surveys in recent times was on 10 February 1999, followed by another on 12 February 2000 (Anon. 1999; Goes 2000a; van Zalinge et al. 2002; C. Poole and J. W. Duckworth personal communication). Later observations in this stretch came from large commercial passenger "bullet" boats (Timmins 2003). In April 2006 the current author made a one day trip through the study area, which included some foot-based exploration of exposed channel bed areas (RJT unpublished data). Other observations in the area have come from visiting birdwatchers (e.g. Goes 2000c; Goes & Davidson 2001a, 2001b, 2002; Goes et al. 2004; Davidson 2005), aerial surveys (Mundkur et al. 1995) and surveys of Irrawaddy Dolphin (*Orcaella brevirostris*) (Timmins 2003). Little survey work has been done on the Mekong downstream of Kratie Town, although cursory observations were made by van Zalinge et al. (2002) and the current author in April 2000. On the basis of accumulated results the study area had already been recognised as potentially of considerable significance for global and regional bird conservation (Seng et al. 2003a; Timmins 2003, 2006; Tordoff et al. 2005).

The stretch of the Mekong between Stung Treng Town and the border with Lao PDR, which has been given Ramsar status, appears to be the area most similar, in the region, to the current study area, in terms of channel habitats and wildlife communities. This stretch of river has received significant survey work for birds and other fauna starting with brief surveys in April 1994 (Mundkur et al. 1995), with several other short duration surveys thereafter (Barzen 1994, 1995, 2002; van Zalinge 1995; Timmins & Men 1998; Seng et al. 2000b; Goes & Davidson 2001, 2002, 2003; van Zalinge et al. 2002), and culminating with extensive dry-season surveys in November-December 2005 and March-April 2006 (Timmins 2006).

The large Mekong tributaries of the northeast, the Se Kong, Se San and Srepok had also been relatively well covered (Le et al. 1997; Thewlis et al. 1998; Timmins & Men 1998; Tordoff et al. 2002; van Zalinge et al. 2002; Seng et al. 2003b; Timmins et al. 2003; Claassen 2003; Eames et al. 2004).

An ecologically similar area of the Mekong in extreme southern Lao PDR on the border with Cambodia, most often referred to as the Siphandon area, has received modest general bird and mammal survey attention on a number of occasions, beginning in 1993 (Timmins et al. 1993; Duckworth et al. 1994, 1999a; Thewlis et al. 1996, 1998; Evans et al. 2000; Cunningham 2001), with the most recent observations being those of M. Poulsen (personal communication). Rivers in Indochina and Thailand with large extents of exposed, vegetated bed in the dry season are rather infrequent, and information from surveys of such areas is even scarcer, but there is now a good dataset from the Mekong River channel above Vientiane, Lao PDR (Duckworth 1996, 1997; Duckworth et al. 2002; Duckworth & Tizard 2003; Fuchs et al. 2007). Some aspects of the fauna in this area are similar to that in the Ramsar site, but there are also notable differences. Bird and other faunal data on other river systems regionally is rather patchy, but especially within Indochina there is now a growing body of data (e.g. Duckworth et al. 1998a, 1998b; Evans & Timmins 1998; Thewlis et al. 1998; Evans 2001; Buckton & Safford 2004; Le et al. 2004; Claassen & Ou 2006; Fuchs et al. 2007) which has greatly aided in assessing status of riverine birds.

What was particularly missing from all of the above data sets was information on wet-season bird communities. Almost all riverine surveys have been carried out in the dry season or in the very early or very late stages of the wet season. Given the typical extreme regional variation in river conditions between wet- and dry-seasons, this knowledge gap was thought to be a significant impediment to conservation planning. A few opportunistic observations suggested that at least several of the riverine species of conservation concern undertook significant population movement during the wet season.

Cover: Grey-headed Fish-eagle (*Ichthyophaga ichthyaetus*). 1: White-shouldered Ibis (*Pseudibis davisoni*). 2: Woolly-necked Stock (*Ciconia episcopus*). 3: River Lapwing (*Vanellus duvaucelii*). Cover and photos 1-3 ©Chamnan Kim/Cambodia Turtle Conservation Team. 4: Green Peafowl (*Pavo muticus*) ©WWF-GMP/DNCP/FA Cambodia.

Prior to the current surveys, the study area represented the greatest gap in regional understanding of conservation status and priorities of riverine bird communities within Indochina and probably also Thailand. In particular the 2005-2006 surveys of the Ramsar site (Timmins 2006) showed that previous cursory surveys of that site had failed to detect many significant aspects of the site's conservation importance, and the same was considered almost certainly to be true for the study area.

4.2 Methods

4.2.1 Target species

In order to use survey time efficiently to assess conservation needs of birds within the study area, a suite of target species were selected as primary foci (Table 4). These species were primarily selected from lists of "Key Species", which are defined as: any species judged by IUCN to be "Globally Threatened", "Globally Near-Threatened" or "Data Deficient" (IUCN 2007); considered "At Risk in Lao PDR", "Potentially At Risk in Lao PDR", "Conditionally At Risk in Lao PDR" or "Little Known in Lao PDR" (Duckworth et al. 1999a); or, considered "Extinct", "Threatened", "Near-Threatened" or "Data Deficient" in Thailand (Nabhitabhata & Chan-ard 2005; Sanguansombat 2005) (see Conventions for further details). Target species were first and formost the species considered most likely to have conservation significant populations within the study area. A broad rather than narrow range of target species was selected, on the basis of previous records from the study area and/or nearby regions, to help ensure that the surveys adequately assessed bird communities (and threats to them) geographically and throughout significant study area habitats. The key objective for all target species was to assess their status and conservation needs within the study area.

4.2.2 Survey localities and dates

Bird surveys of the study area focused heavily on the Mekong channel and its remaining riparian forests, with relatively little survey effort in terrestrial habitats (Table 5).

Previous surveys in terrestrial habitats of northeast Cambodia and adjacent areas of Lao PDR (Thewlis et al. 1996, 1998; Timmins & Ou 2001; Timmins et al. 2003; Timmins 2006), and accumulated data on wildlife communities of such areas (e.g. Le et al. 1997), led the author to suspect that bird communities in terrestrial habitats adjacent to the Mekong River, including islands in the channel, would have low conservation significance. Several factors were central to this prediction. First, the terrestrial forest types (except riparian forest) remain vast and contiguous over north and east Cambodia and adjacent areas of Lao PDR and Viet Nam, and the extent of such habitat in the study area by comparison is relatively insignificant and fragmented between islands. Second, it is primarily localised wildlife habitats within it such as ponds and areas dominated by grass that appear to characterise the most significant tracts of this landscape for conservation. The study area has a relatively low density of inclusion of such localised terrestrial features.

Third, the study area has a relatively high human population density, and associated evidence of terrestrial forest degradation, when compared with less populated tracts of similar terrestrial habitats. Fourth, the species of concern associated with such terrestrial habitats are either those which remain widespread through the landscape, and thus need little more than representative protection of "landscape"-scale tracts of habitat (not likely feasible in the study area, and already catered for in several Cambodian, Lao and Vietnamese protected areas), or species whose status appears to be strongly negatively associated with human density and thus thought to be sensitive to human persecution and disturbance [i.e. Giant Ibis (*Pseudibis gigantea*), Sarus Crane (*Grus antigone*)] and thus unlikely to occur in the study area in significant numbers. A similar assumption was tested and supported by fieldwork in the Stung Treng Ramsar site (Timmins 2006). Some effort was expended on terrestrial surveys, but primarily to determine significance of such areas to White-shouldered Ibis (a primarily channel-associated species in the study area and elsewhere along the Mekong; this study and Timmins 2006).

Table 4. Target bird species surveyed in the study area.

Group / species	Survey goal / activities	Survey period
Spot-billed Duck (*Anas poecilorhyncha*)	Survey representative areas of river channel and floodplain for use by this species.	All
Hornbills (Bucerotidae), pigeons (Columbidae), parakeets (*Psittacula*) and Hill Myna (*Gracula religiosa*)	Survey representative areas of riparian forests and river channel habitats for these species.	All
Pied (*Ceryle rudis*) and Collared Kingfisher (*Todiramphus chloris*)	Survey representative areas of river channel for use by these species; attempt systematic counts.	All
Blue-tailed Bee-eater (*Merops philippinus*)	As above, with emphasis on assessing status of breeding colonies.	All
Fish owls (*Ketupa*)	Survey representative areas of the river channel for use by these species. Primarily Mekong channel and tributaries.	All
Masked Finfoot (*Heliopais personata*)	Surveys along representative river banks in Mekong channel and tributaries e.g. Prek Preah, Prek Krieng, and floodplain forests around and downstream of Kratie.	July-August
Breeding thick-knees (Burhinidae), plovers (*Charadrius*), lapwings (*Vanellus*), pratincoles (*Glareola*) and terns (*Sterna*)	Survey appropriate areas of river channel (i.e. those with an abundance of relatively open, sparsely vegetated sediments) for use by these species; attempt systematic counts. Mekong channel.	March-April
Fish-eagles (*Haliaeetus* / *Ichthyophaga*)	Survey representative areas of the river channel, tributaries and floodplain for use by these species; attempt systematic counts.	All
Vultures (*Sarcogyps*/*Gyps*)	Gather information from local people on reported nesting sites (none reported); record incidental observations of birds; make observations on livestock management.	All
Cormorants (*Phalacrocorax*) and Darter (*Anhinga melanogaster*)	Survey representative areas of river channel for use by these species; attempt systematic counts at roost sites; gather information from local people on reported nesting sites.	All
White-shouldered Ibis (*Pseudibis davisoni*)	Survey representative channel habitats for assessing the status of this species and comparative use of different channel habitats; survey terrestrial areas to determine comparative significance to channel habitats; gather information from local people on reported nesting sites, followed up by field visits if appropriate.	All
Other large waterbirds (Pelecanidae / Ciconiidae)	Gather information from local people on reported nesting sites; survey for birds in representative channel habitats and floodplain areas.	All
Resident martins and swallows (Hirundinidae)	Survey representative areas of the river channel for use by these species, with an emphasis on assessing status of breeding colonies; gather information from local people on presence of colonies. Mekong channel.	All
Mekong Wagtail (*Motacilla samveasnae*)	Survey representative areas of the river channel for use by this species; attempt systematic counts. Check for presence in other habitats.	All
Weavers	Survey representative areas for use by these species.	All
Grassland birds	Foot-based observational surveys of extensive tall grass formations in floodplain areas and in Mekong channel. Grassland areas of Mekong channel and floodplain.	All

Bird taxonomy follows Robson (2000). Species records which are provisional or unconfirmed are denoted [ ]; species presumed to have been present historically (no records in survey) are denoted †.

Table 5. Timing, effort and localities of bird surveys.

Survey period / location	Dates	Survey focus†	Camps	Effort (days)
November-December 2006				
Mekong Sambor to Kratie	11 Nov., 2 Dec.	General channel survey	0	<0.5
Eastern Channels	11-16, 17 Nov., 29 Nov.– 2 Dec.	All species, habitats	2	5.5“^
Koh Enchey area	16-20, 24 Nov.	All species, habitats	1	2.5
Koh Plong area	18 Nov., 2 Dec.	All species, habitats	0	0.5
Island cluster, ST border to Koh Dambong	19, 20-29 Nov.	All species, habitats	2	8.5“^
Koh Preah area	21 Nov.	General channel survey	0	<0.5
Contoipreykien floodplain area	3-4 Dec.	Birds of areas dominated by grass	*	1.5
Mekong channel south of Kratie	4-5 Dec.	Areas dominated by grass, general channel survey	0	1
Boeng Thom floodplain south of Kratie	5 Dec.	All floodplain species, habitats	*	0.5
March-April 2007				
Stung Treng - Kratie provincial border	11-14 March	River Tern/other sand nesting spp.	1	2.5
Island cluster, ST border to Koh Dambong	14-27, 31 March	All species, habitats	3	12.5
Koh Plong area	20, 27-28 March	All species, habitats	1	1.5
Koh Enchey area	20, 27, 28-31 March	All species, habitats	2	3
Eastern Channels	31 March – 5 April	All species, habitats	3	5
Sambor to Kratie	5-6 April	Areas with extensive shrubs and sand formations	0**	1.5^
Mekong below Kratie	7 April	Little Tern/other sand nesting spp.	0**	1
July-August 2007				
Mekong channel south of Kratie	29-31 July, 2-4 Aug	Areas dominated by grass, plus general channel birds	*[4]	3
Floodplains south, west of Kratie[$]	29 July-3 Aug, 5Aug	All floodplain species, habitats	*[4]	5º
Viel Ma-om near Tchroybantee-ayleur Village	6, 22-23 Aug	Birds of areas dominated by grass, hog deer	*	0.5
Sambor to Kratie	6, 22-23 Aug	General channel survey	*	<1
Koh Plong area	6, 8 Aug	All species, habitats	0	1”
Koh Enchey area	6-10, 20 Aug	All species, habitats	1	2.5
Eastern Channels	10-17, 21-22 Aug	All species, habitats	1&*	7^º
Island cluster, ST border to Koh Dambong	7, 17-21 Aug	All species, habitats	1	4^”º
Floodplain wetlands close to Sambor	22 Aug	Wetland birds, fruit bats	0	0.5º

ST=Stung Treng. † = In all areas any observations of species/habitats of significance were recorded. ^ = ponds visited in these areas (effort included in total). “ = tributaries were surveyed in these areas (effort included in total). * = survey of area was based out of village(s). ** = team overnight in Sambor/Kratie Towns. º = some survey time lost to rain. $ = floodplain areas visited: Boeng Chhrea, Contoipreykien, Prek Bang / Boeng Meier and Boeng Rhung.

Previous observations (e.g. Timmins 2003) indicated the quality of remaining channel habitats and riparian forests differed markedly within the study area. The river sections below Sambor Town and for *c*.25 km below Stung Treng Town are densely populated and little riparian forest remains. In the “central section” between these areas, habitat condition is better and human settlements are relatively sparse. Survey effort thus focused primarily on this section of the study area (Table 5). Some surveys were conducted in tributaries, to determine their significance for some species especially Masked Finfoot, fish-eagles and large waterbirds.

The floodplains of the Mekong, which become extensive from Sambor Town downstream, have received relatively little survey effort in their upper reaches. Their potential conservation status was recently highlighted with the discovery of a residual population of Hog Deer (Maxwell et al. 2006), while the value of some other Indochinese floodplain areas for bird communities has been well documented (Goes et al. 2001; Seng et al. 2003; Buckton & Safford 2004). In particular mounting evidence suggested that areas dominated by tall grass on river floodplains were not only a highly threatened wildlife habitat, but one which potentially supported a bird community of conservation concern. Some survey effort was thus devoted to surveys of floodplain areas, with particular attention paid to remaining areas of tall grass, permanent marshes, and possible use of tree and bush formations in the lowest-lying parts of the floodplain by Masked Finfoot. Opportunistic observations along the Mekong in April 2000 below Kratie Town (RJT unpublished data), suggested that this section might support different communities compared with upstream river sections, due to differences in physical attributes. A small amount of survey time was thus allocated to surveys of the channel below Kratie Town.

4.2.3 Survey methods

Data collection goals for many target species were similar and could be assessed simultaneously by many of the survey methods employed. Other species of note were recorded opportunistically. Systematic counts of other wetland species (including some common species) were undertaken occasionally. No attempt was made to conduct an inventory of the birds present at the sites visited. This would have entailed a different survey strategy and would not have provided many data of significance for wildlife conservation management. Similar sampling methods were employed for bird and mammal target species. All bird surveys were conducted by the author (RJT) and data presented in this section were collected by the author unless stated otherwise. Additional records of significance were made by M. Bezuijen (MB) during concurrent herpetofauna surveys. Two broad categories of surveys, boat-based and foot-based, were employed to survey target species.

1. Boat-based observation methods. Most field time was spent surveying from boats. Whenever possible the boat was paddled quietly to maximise encounters with wildlife. At other times the motor was used, particularly when travelling against the current, and when surveying more open stretches of the channel, where motor sound was less likely to cause significant disturbance and observations of wildlife vocalisations were not crucial. Generally if the motor was used while surveying, it was at a low speed and at its quietest. Target species and other riverine bird encounters were recorded and significant observations marked on 1: 50,000 maps or recorded with GPS. The extent and detail of records varied with species and circumstance e.g. all River Terns were recorded but White-vented Mynas (*Acridotheres grandis*) were only systematically recorded on a few occasions. In general, full systematic recording only took place for the first few hours of morning observations. Channel habitats were documented and notes were taken on condition of river banks and riparian forests. The same methodology was used in floodplain areas when travel by boat was possible.

2. Foot-based observation methods. These methods were primarily aimed at maximising a broad range of bird and large mammal encounters (especially of target species, Table 4). Two main approaches were employed, one for direct observation of wildlife and another for detection of wildlife signs, as detailed below.

(1) Direct wildlife observation. (a) Channel and floodplains. Channel surveys were opportunistic and followed no rigorous protocol. They emphasized stealth and concentrated on recording target species. Pace was varied depending on the potential of making encounters; habitat, terrain, time of day and species of focus were all factors affecting choice of pace. Periods of static watching were included. Effort focused on areas thought likely to be productive for recording target species (this included all types of channel habitat). Animal signs were also searched for during these surveys (below). An attempt was made to cover a sufficient number of areas, to allow a realistic assessment of the general status of birds and large mammals (especially target species) in each habitat and section of the channel. During such surveys, target species and other bird/mammal records were recorded and significant observations located with a GPS. The extent and detail of recording each encounter with a species varied with species and circumstance. In general full systematic recording only took place for the first few hours of morning observation. The same methodology was used in floodplain areas when travel by boat was not possible. (b) Terrestrial wetlands and areas dominated by grass. Some ponds and areas dominated by grass (i.e. lacking or with only very sparse woody vegetation) were visited. Local guides were asked to take the observer on routes to cover as many ponds and areas dominated by grass as possible within a day's survey. In these sites, bird and mammal observations (including signs, below) were systematically recorded, and habitat details recorded. The principle habitats used by target species is given in an on-line table ("OLT", at www.panda.org/greatermekong/survey) (see Annex 5).

(2) Detection of wildlife signs. During foot-based surveys of the channel and terrestrial areas, signs of large mammals, large reptiles and White-shouldered Ibis were searched for simultaneously, and especially during opportunistic channel surveys a significant amount of effort was engaged in looking for signs along the survey route when substrates were suitable. Some signs were traced and/or photographed.

3. Abundance. Abundance categories were assessed for each bird species encountered during the survey, in relation to its relative abundance as determined during the course of the survey. Abundance was assessed on a five-point scale based on the encounter frequency, taking into account the appropriateness of methods to detect a species, and other factors (including ecology) that affect the observability of a species (see Timmins & Ou 2001). For many species, abundance could not be assessed. These abundance categories are: *Abundant* – equivalent to groups being recorded an average of 15 times daily (or for flocking species flocks being recorded several times daily); *Common* – equivalent to being recorded daily; *Frequent* – equivalent to being recorded on over half of days; *Occasional* – equivalent to being recorded on fewer than half of days; *Present* – abundance not assessed.

Abundance estimates are described in individual species accounts (Section 4.3.2) and the OLT (see also Annex 5).

5. Roost counts. Systematic counts of cormorants and Darters at roosts sites, or flocks of these species flying to or from roosts (found either through interview with local people or incidentally while surveying the channel) were attempted. Counts were undertaken at dawn and dusk.

6. Wildlife habitat characterization. Notes on general characteristics of wildlife habitats were recorded, especially attributes of channel vegetation (i.e. structure, frequency of certain characteristic plant species, substrate types) in relation to observations of use of such areas by the channel bird community. More basic categorisation of other habitat types (terrestrial forests, riparian areas, floodplain habitats etc) was made.

7. Observations of human use. Incidental observations of human use (frequency of people observed in channel area, signs indicating the frequency of general use, abundance of signs of timber extraction, relative frequency of newly converted forest or areas dominated by grass to agricultural land, abundance of traps, etc.) were made whenever applicable during the survey.

8. Interviews with local people. Interviews focused on gathering first-hand information on a small subset of the target species. Each interviewee was asked about some or all of these species. For target birds, interviews primarily concentrated on local knowledge of the locations of nesting sites of large waterbirds (especially White-shouldered Ibis), vultures, cormorants and Darter, and when circumstances were appropriate also on the breeding status of martins and bee-eaters, and historical status of River Tern and breeding herons. During the wet season survey interviews were also conducted to elucidate the current and former status of Masked Finfoot, but results proved to be equivocal. Interviews were used on a daily basis to help refine daily survey strategy on the basis of local information of river and terrain conditions and especially to locate remnant areas dominated by tall grass on the floodplain, and ponds, marshes and areas dominated by grass in terrestrial areas. When time permitted, additional interviews about the local status of Siamese Crocodile and soft-shell turtles were conducted.

4.2.4 Limitations

No severe limitations were met during the survey. All major limitations were those that could be anticipated during survey planning, such as inevitable time constraints (more time can almost always produce more data) and the physical constraints of the study area (difficulties in surveying certain habitats and sites). The greatest limitation, resulting in lost field time, and not directly related to the latter two constraints was the occasional difficulty in finding appropriate boats and drivers for channel surveys, and knowledgeable guides for surveys of terrestrial ponds. However, even this limitation was rather minor in the author's experience.

4.3 Results

4.3.1 Overview

Bird communities documented in the study area were, much as expected, dependent upon the type of habitat found. This section briefly describes some key observations about the relationship between bird communities

and habitats in the Mekong River channel, and supplements a more detailed discussion in Timmins (2006) for the Stung Treng Ramsar site.

First, the population status of a significant number of bird species associated with the Mekong channel varied markedly within the study area. Relative to other regionally surveyed riverine areas and nearby river sections in the study area, the "central section" had little-disrupted bird communities, and possessed extensive and varied channel habitats in excellent condition (including large expanses of dry-season exposed channel bed with trees and shrubs) and riparian forests in good condition (still relatively non-degraded). Above and below the "central section", human density and habitat degradation (of riparian forest and channel vegetation) increases, and some bird species become scarce or are absent (Section 4.3.3).

Second, some species appear to be naturally associated with the lower stretches of the Mekong below Kampi (Fig. 3), which has a different character, becoming slow and broad with extensive sand formations. Little Tern was only found in this stretch, and the numbers of Small Pratincole (*Glareola lactea*) found there were very high. Indian Skimmer (*Rynchops albicollis*) historically may have favoured such habitat. Extensive tall grass formations in these same stretches also were notable, for instance in the presence of Striated Grassbird (*Megalurus palustris*) and Black-headed Munia (*Lonchura malacca*), not recorded elsewhere in the study area.

Third, the current surveys revealed some new data on the wet-season (July-August) status of some species, which were not documented by Timmins (2006), who did not conduct surveys in the wet season. No River Lapwings (*Vanellus duvaucelii*) or Small Pratincoles were found in the current wet-season survey. Few River Terns were observed, with all confirmed records from below Kratie Town, an area with no evidence of breeding. Brahminy Kites (*Haliastur indus*) and Large-billed Crows (*Corvus macrorhynchos*) were unexpectedly scarce, and only a single White-shouldered Ibis was found, in the "central section". Wet-season observations suggest that Chestnut-tailed (*Sturnus malabaricus*) and White-shouldered Starlings (*Sturnus sinensis*) are channel-and floodplain- residents contra assumptions of Robson (2000), while the lack of records of Black-naped Orioles (*Oriolus chinensis*) in July-August suggest, contra statements in Timmins (2006), that the species is probably only a non-breeding visitor. Numbers of Darters and cormorants were considerably lower in the wet season, and localised to the Mekong and floodplain south of the "central section". Non-breeding storks and pelicans showed a similar wet season distribution.

Fourth, three types of floodplain wildlife habitats stand out in the study area: areas dominated by tall grass, areas dominated by trees and shrubs, and permanent marshes. Areas dominated by tall grass had a bird community similar to other habitats dominated by grass (Timmins 2006). Perhaps most notable was the apparent absence of species including Striated Grassbird and Black-headed Munia, which is presently inexplicable. Timmins (2006) did not cover bird communities associated with floodplain areas, and while the observations from the current surveys were primarily opportunistic they give some indication of the types of communities present (see OLT). Floodplain areas dominated by trees and shrubs appear to have a community similar to that of channel areas dominated by trees and shrubs (Timmins 2006) and comprised of a mix of forest and wetland birds. However there are notable differences, for instance in the presence of Pink-necked Green Pigeon (*Treron vernans*) and Purple-throated Sunbird (*Nectarinia sperata*) in floodplain areas and the absence of species such as Mekong Wagtail. Cormorants and Darters are probably year-round residents of the floodplain, although no evidence of breeding could be found, and numbers in the wet season appear to be much lower than during the later part of the dry season. Blue-tailed Bee-eaters are probably also year-round floodplain residents, although there is probably an influx of birds during the wet season. Marsh areas had as expected a complement of common wetland birds, however numbers especially of jacanas (Jacanidae) and Cotton Pygmy-goose (*Nettapus coromandelianus*) seemed surprisingly low.

Fifth, the abundance of a few bird species appears to have a geographical basis probably in some way related to the relative abundance of floodplain habitats. For instance Yellow-vented Bulbul (*Pycnonotus goiavier*) was abundant in southern areas but scarce and local in the north.

4.3.2 Species accounts

This section presents accounts of species for which the study area is ranked to be of (or potentially of) "very high", "high" or "medium" priority for conservation intervention in the study area (see Section 10.1). Other species for which the study area is of lower conservation importance are listed in Annex 6. Most accounts are of wetland species i.e. associated with the Mekong channel, riparian forest or floodplains: the study area was considered to

be of low conservation importance for the non-wetland-associated species recorded during surveys and these are not discussed further. Distribution maps for some target species are in Annex 2.

Green Peafowl (*Pavo muticus*) (Globally Threatened–Vulnerable)
Common in much of the "central section"; seen or heard daily (Annex 3 – Plate 24). Records were concentrated in the complex areas of the channel below the Stung Treng border to the south end of Koh Enchey Island and between Koh Khvien and Kampong Pnov Village. The species was not found outside the "central section". This is a favoured quarry species which, together with its preference for open country habitats close to water, has led to its major global decline. The Cambodian population is still large and widespread, although undoubtedly in significant decline as human populations penetrate forest areas, which become cleared and fragmented. Loss from the study area is inevitable without conservation intervention. The study area could support a large population, one that could easily rival that of other regional conservation areas, due to the suitability of habitats in the "central section". The loss of this species from the study area would undermine the relatively little disrupted ecological community composition of the area. The species could potentially contribute to the area's ecotourism value. Several Cambodian conservation areas also have large populations (Brickle et al. in press).

Cotton Pygmy-goose (*Nettapus coromandelianus*) (At Risk in Lao PDR)
Single record of two birds, 22 August 2007, floodplain wetland east of Sambor Town. The paucity of records from floodplain areas and terrestrial ponds was surprising and suggests the species has probably declined substantially in numbers in the study area from historical times. Large numbers still congregate at other Cambodian sites, primarily in the dry season (e.g. Goes & Davidson 2002, 2003b; C. Poole personal communication), but away from these areas the species is relatively scarce and in decline.

Spot-billed Duck (*Anas poecilorhyncha*)
Numbers recorded during the November-December surveys were relatively few, and localised predominantly to the "central section"; away from this area birds were seen only between Sambor and Kratie Towns, mainly centred on the complex area of vegetated channel above Kampi. Encounters increased in the March-April survey by which point encounters were common within heterogeneous areas of the channel with considerable shrub formations of the "central section". Encounters once again decreased in the wet season survey within the "central section", although birds were still occasional to frequent. Away from the "central section" during the March-April survey, birds were also encountered commonly in the complex channel area above Kampi, and small numbers were seen in the Mekong channel below Kratie Town. They also appeared to be locally common in well vegetated channel areas above the "central section". During the wet season small numbers were recorded in floodplain wetlands along the Mekong stretch below Kratie Town.

The Stung Treng Ramsar site may support several hundred birds (Timmins 2006); in comparison the "central section" may support only a similar population size, despite its somewhat greater area. The species appears to only be a non-breeding visitor to Thailand away from the Mekong (Lekagul & Round 1991; Fuchs et al. 2007), and the Indochinese breeding population appears to be largely restricted to the Mekong and the Tonle Sap Lake area. The study area population is likely to represent a significant proportion of the regional breeding population, only likely to be matched by the core areas of the Tonle Sap Lake floodplain, the Stung Treng Ramsar site and perhaps a few areas in the Mekong Delta and/or some of the largest floodplain wetlands between Kratie Town and the Delta. The Mekong Delta also appears to have a significant breeding population (Buckton et al. 1999; Buckton & Safford 2004), although it is probably spread over a much wider area. The upper Lao Mekong perhaps has a significant (Duckworth et al. 2002) but smaller and more fragmented breeding population. The species has not been considered a high conservation priority in Indochina, largely due to oversight. In Thailand, the lack of breeding records is presumably the reason for not listing, yet the absence of breeding records in non-Mekong Thailand may be a further indication that the species is sensitive to hunting and presumably nest robbery. Sites in Indochina which support relatively high numbers of this species are areas with low human population densities and little-encroached wetland habitats; given the paucity of such remnant habitats the species should certainly be considered at risk regionally.

Rasmussen and Anderton (2005) split the southern resident races of this taxon in South and Southeast Asia from northern populations, with populations in northern Myanmar assigned to a species-level taxon (*A. p. zonorhyncha*) and the remaining populations in Southeast Asia assigned to *A. p. haringtoni*, which the authors keep with *A. poecilorhyncha*. South Asian populations were described as "fairly common on freshwater bodies… with some vegetation" (Rasmussen & Anderton 2005).

Oriental Pied Hornbill (*Anthracoceros albirostris*)
In the "central section", groups were abundant to common, and associated with riparian forest and channel areas with many trees. Outside the "central section", the species was recorded as far north as the northern end of Koh Preah Island, and in the Prek Bang/Boeng Meier floodplain area. This species is generally resilient to habitat perturbation and appears to adapt well to degraded areas, as long as suitable fruiting trees remain. The primary threat to the species is from hunting, generally for food, which has reduced it to very low densities or caused local extirpation across large parts of Indochina.

Great Hornbill (*Buceros bicornis*) (Globally Near-Threatened)
Two+ birds heard on 19 August 2007 in the Koh Veng Thom area in the "central section". The species is in widespread regional decline and is now largely confined to the largest tracts of remaining forest. Birds in the study area are perhaps itinerant or seasonal visitors from larger forest tracts to the east or west of the study area.

Pied Kingfisher (*Ceryle rudis*) (At Risk in Lao PDR)
Locally common in the study area, reaching relatively high densities in some river stretches (Annex 2 – Map 1); recorded commonly in floodplain areas during the wet season survey, with few records during the more cursory dry season visits to the floodplain. The study area may have one of the largest localised populations in Indochina. Birds may to some degree be naturally localised in riverine habitats, but the current distribution probably reflects (poorly understood) human pressures on the species. Areas with extensive sand formations (including accreting or eroding large, high sand formations contiguous with islands or the mainland), and which also have a low density of human habitation in the vicinity, appear to be favoured by the species. The highest density of birds found during the survey was in the area between the south end of Koh Tuk and north end of Koh Enchey Islands: probably 5-8 breeding groups use this area, which has many large sand formations and which in the dry season is relatively hard for people to access. The similarly complex channel area above Kampi probably has a similar density of birds, and Koh Chreng below Kratie Town, which is relatively non-complex but with extensive sand formations along its banks, probably has 5-9 breeding groups. In contrast the mainland banks (both east and west in the Koh Chreng stretch) have few Pied Kingfishers, yet appear to support similar soil characteristics; the main difference appears to be the number of people living adjacent to the river banks. Similarly, the Stung Treng portion of the study area, and the Stung Treng Ramsar site (Timmins 2006) appear to support few individuals, despite extensive apparently suitable habitat including complex sand formations (Timmins 2006).

Timmins (2006) summarised evidence of declines in the species in northern Cambodia and Lao PDR. The data presented here for the study area reinforces those conclusions especially in the contrast between the density of the species in the "central section" with that in the Stung Treng sections of the Mekong (both in the study area and the Ramsar site). Evidence for a decline in the Kratie section of the Mekong is somewhat less compelling, however the low numbers in the lower portions of the eastern channels, and along the least complex channel sections below Sambor, are certainly indicative. The species has disappeared from most of Lao PDR for uncertain reasons, yet remains common in many areas of Cambodia and Viet Nam. It is thus a species for which priority is not high or immediate, but one that warrants periodic review, especially as the study area appears to be on the edge of what might be a wave of decline.

Use of the floodplain may be largely seasonal, with a suggestion of fewer birds using the Mekong channel during the wet season survey (arguably greater visibility of birds because of less channel complexity, but if anything a lower encounter rate with the species than in the dry season), and circumstantial evidence of greater numbers on the floodplain in the wet season (see above). Certainly use of terrestrial non-floodplain wetlands by Pied Kingfishers occurs only commonly during the wet-season. Birds were found frequently in such areas during the wet season, but not in the dry season in the surveys of this project or in the author's experience in similar habitats elsewhere (e.g. Timmins & Men 1998; Timmins et al. 2003; Timmins 2006).

Buffy Fish Owl (*Ketupa ketupu*) (Near-Threatened in Thailand; Little Known in Lao PDR) and Tawny Fish Owl (*K. flavipes*) (Little Known in Lao PDR)
Both species may be present in the study area. One fish owl with plumage features of Tawny/Buffy and which was as large or larger than Brown Fish Owl (suggesting Tawny Fish Owl) was seen along a small tributary in the Koh Plong area on 8 August 2007. Two relatively small fish owls were disturbed from dense tree growth in the channel in the Koh Krabei area on 16 March 2007. Feathers found close by confirmed they were Buffy or Tawny Fish Owls, and comparison of feathers (especially the length of primary feathers) with similar feathers from presumed Tawny Fish Owl from Lao PDR, suggest the study area birds were Buffy Fish Owl. Brown Fish Owl, on the basis of confirmed records, is by far the commonest of the fish owls in Indochina, while the

status of the other two species is enigmatic. Tawny has yet to be confirmed in Cambodia. Fish owls, even Brown, appear relatively scarce, especially away from well forested landscapes.

Spotted Wood Owl (*Strix seloputo*) (Vulnerable in Thailand; Little Known in Lao PDR)
Probably frequent to common within channel areas with extensive formations of trees, although actual records of birds encountered during the day, and night-time vocalizations, were relatively scarce. Status in the study area appeared similar to the Stung Treng Ramsar site (Timmins 2006) and in both areas seems less abundant than Brown Fish Owl but more abundant than other fish owl species. Local status in riparian forest is difficult to assess, but there were no vocal records from the few campsites in such habitat. In Indochina the status of this species is enigmatic, with few if any areas found in which the species appears to be common. Wooded areas of the Tonle Sap Lake floodplain may also support significant populations (Goes 2001b). Otherwise, the sporadic regional records of the species suggest that it is probably otherwise naturally associated with riverine habitats, in open forest formations, in level lowland areas (e.g. Lekagul & Round 1991; Duckworth et al. 1999b; Wells 1999; Robson 2000), and thus at least regionally potentially at risk from the synergistic factors of habitat loss and hunting.

Yellow-footed Green Pigeon (*Treron phoenicoptera*) (Vulnerable in Thailand; At Risk in Lao PDR)
The most common green pigeon in riparian forest and wooded channel areas of the study area, and encountered in all survey periods. The species was common to abundant in extensive areas of such habitat in the "central section" during at least the November-December and July-August surveys. The species was not detected in wooded areas of the floodplain. This species is regionally associated with forest mosaics of the lowlands, with potentially a riparian forest association. Numbers recorded during the surveys (usually low tens per day with flocks of over 60) accord well with those in the Stung Treng Ramsar site (Timmins 2006) and together are the highest recorded in the author's experience, and also appear to be high in comparison to other available records (e.g. Le et al. 1997; Round 1998; Thewlis et al. 1998; Timmins & Ou 2001). At risk in the study area from hunting and habitat loss.

Green Imperial Pigeon (*Ducula aenea*) (Near-Threatened in Thailand; At Risk in Lao PDR)
Recorded in riparian forest and wooded channel habitats of the study area, and encountered in all survey periods. The species was common (usually several small flocks daily, with occasional large flocks of over 25) in extensive areas of such habitat in the "central section", and was especially noticeable during the November-December and July-August surveys. The species was not detected in wooded areas of the floodplain. This species is characteristic of the lowlands and associated with riparian forest and other dense closed canopy forest types. It probably occurs naturally at somewhat lower densities than green pigeons and appears to rarely form very large aggregations, but is more sensitive to hunting than the majority of *Treron* species, given its threatened regional status (especially in Lao PDR). At risk in the study area from hunting and habitat loss.

Masked Finfoot (*Heliopais personata*) (Globally Threatened–Vulnerable)
One adult bird, 24 March 2007, close to the western bank of the main channel *c.*2.5 km downstream of the north end of Koh Enchey Island (MB) (Annex 2 – Map 2). This was the only sighting in the study area and is the only recent record along the Mekong River. In all three surveys, considerable effort was focused on bankside observation, especially July-August, when more survey effort (>50 hours) was devoted to this than any other activity and included observations along the Mekong channel banks, tributaries of various sizes, and floodplain wetlands supporting emergent trees and shrubs. The paucity of records appears to indicate very low numbers of birds in the surveyed area. This is of conservation concern, as most surveyed areas appeared well-suited to the species compared with other sites in Indochina where the species has been found (below).

Despite extensive survey work and opportunistic observations along Cambodian rivers and other wetlands, there are few recent records (Table 6). Indochinese river records cluster in an area encompassed by the Mekong, Se Kong, Se San and Srepok rivers. Relatively frequent observations in the 1990s contrast with relatively few from 2000 onwards (no records in May 2002 by Tordoff et al. 2002; February-May 2003 by Claassen 2003; May 2003 by Timmins unpublished data; March-April 2006 by Timmins 2006). Although most surveyed stretches in the earlier period were in Lao PDR and in the latter period in Cambodia, these data probably reflect a downward trend in status. River stretches where the species was detected were little used by people, with low levels of fishing throughout the year. Many areas surveyed in the latter period have higher human activity, especially in stretches where the species has not been detected (RJT unpublished data).

Table 6. Post-1998 records of Masked Finfoot in Indochina.

Source	Dates	Numbers observed	Location
Round (1998)	6, 10, 17 July	3 singles (probably two birds)	Lamphao River, Lao PDR
Davidson et al. (1997)	19 May	single seen only once	Xe Kaman River, Lao PDR
Thewlis et al. (1998)	10-17 April	3 singles	Xe Pian River, Lao PDR
Thewlis et al. (1998)	5-12 May	5+, including pairs, seen repeatedly	Xe Pian River, Lao PDR
Thewlis et al. (1998)	March	2 singles seen on several occasions	Xe Pian River, Lao PDR
Timmins and Men (1998)	31 May, 3 June	2 singles	Srepok River, Cambodia
Le et al. (1997); BirdLife International (2001)	2-4 June	single female	Dak Ken Stream (Srepok River), Viet Nam
Eames et al. (2004)	25, 27 May	2 singles (male)	Srepok River, Viet Nam
Eames et al. (2004)	May	single	Pool, Srepok River lowlands, Viet Nam
Goes et al. (2004)	19 March	single	Srepok River, Cambodia
Robson et al. (1989)	10-14 May	single female	Kon River, Viet Nam
BirdLife International & FIPI (2001); Tordoff (2002)	March	single	Kon River, Viet Nam
E. Pollard personal communication	12 March-2 June 2006; 25 March 2007	single; observed >10 occasions in 2006, about 80% of visits	Pond, east Mondulkiri Province, Cambodia

This species has been considered enigmatic, although this may reflect low densities and serious declines (BirdLife International 2001; Tordoff et al. 2005). Many recent Indochinese observations (Le et al. 1997; Round 1998; Thewlis et al 1998; Eames et al. 2004; E. Pollard personal communication) were of individuals seen on multiple occasions, suggesting the species may be shy but is not exceptionally difficult to detect, especially by quiet boat-based surveys. Observations of the Mondulkiri bird suggest that birds spend a large majority of their time within vegetation cover (E. Pollard personal communication). If the proportion of birds overlooked is actually not high, then the extensive survey work around the Tonle Sap Lake (which has resulted in few records) and large rivers of the northeast suggest the paucity of records is a reflection of bird density rather than bird behaviour, in which case the species may be very scarce. A large proportion of rivers that might support this species have been surveyed (Tordoff et al. 2005), suggesting it may be unlikely that large breeding populations remain to be found. Similarly, although only local areas in the Tonle Sap Lake floodplain have been surveyed well, there are no indications to suspect that large numbers might remain undetected.

The Tonle Sap records suggest the species may be resident all year, contra earlier thoughts (e.g. BirdLife International 2001) that the species was probably a breeding visitor to mainland Indochina. Survey work on the rivers of Indochina has primarily focused on the dry season. There appears to be proportionally more birds recorded in the late versus early dry season, giving some credence to the view that the species is only a breeding season visitor to these rivers. The earliest river records are from March, with negative evidence from a number of river surveys undertaken during the early part of the dry season (January 1995: van Zalinge 1995; December 1997: W. G. Robichaud personal communication; February-March 1998: Round 1998; February 2000-2002: van Zalinge et al. 2002; January 2003: Seng et al. 2003; November-December 2005: Timmins 2006; January-February 2006: Claassen and Ou 2006; November-December 2006: this project).

Breeding was recently documented in Indochina, with young captive chicks found on 30 September at Prek Toal (Goes & Davidson 2001b) and a fledged young bird found captive in late June at Prek Toal (Goes et al. 2004). The disparity in these dates is remarkable, suggesting perhaps a protracted breeding season, one of the dates is anomalous, or the September chicks being the result of a second nesting attempt due to prior nest/brood failure. The June record could be taken to indicate that breeding on rivers might also occur relatively early in the wet-season and birds might disperse thereafter, but there have been no observations of young birds in the months of May-July on rivers despite this being the period with most river records.

BirdLife International (2001) and Tordoff et al. (2005) discuss ecology and habitat attributes associated with the species in Indochina. The species appears to be primarily associated with wetlands with (seasonally) emergent or bankside dense woody growth in areas with low levels of human activity. Birds use such dense woody

vegetation for breeding. Tordoff et al. (2005) also discussed probable threats to the species. Little can be added here, and with a species so infrequently seen, living at very low density, gathering observational data on threats may not occur quickly. The primary threat would appear to be the loss of trees, shrubs and vines from river banks and other wetlands, augmented by human persecution in the form of deliberate hunting (guns, traps, egg and young collection), probable predation by dogs and incidental capture in fishing gear. Of the latter, the practice of placing gill nets and lines of fishing hooks along the outer edge of river bank vegetation may be highly threatening to this species.

Eurasian Thick-knee (*Burhinus oedicnemus*) (Near Threatened in Thailand; Little Known in Lao PDR)
Two birds on 2 April 2007 in a mosaic of channel habitat along the eastern channels close to Prek Krieng River; two+ birds in similar habitat on 29 November 2006 along the eastern Mekong bank between Prek Preah and Prek Krieng Rivers. This species is difficult to detect and is probably more abundant than records suggest. The significance of the study area population is difficult to assess, but it is possible many more birds were present than detected, given that little time was spent in suitable habitats (see also Timmins 2006). The regional status of this species is enigmatic, due to its cryptic nature and potential paucity of survey work in suitable habitats. It has been proposed that the resident population on the Indian Subcontinent represents a species *B.indicus*, distinct from the Palaearctic *B.oedicnemus* population (Rasmussen & Anderton 2005). Pending investigation the isolated resident Southeast Asian population (which was tentatively assigned to *B.indicus* might best be considered a potential conservation unit of species equivalence and consequently of somewhat higher conservation priority. Indochinese records of the species are from few areas (mainly large rivers and the Tonle Sap floodplain), and where human activities are at low intensity. The South Asian population was described as "common" in open dry habitats (Rasmussen & Anderton 2005).

Great Thick-knee (*Esacus recurvirostris*) (Critical in Thailand; At Risk in Lao PDR)
Recorded widely and frequently within the "central section" during March-April 2007, when it was almost certainly common. Birds were recorded from six out of ten campsites; of the remaining four sites, three sites were quite disturbed and one supported little suitable habitat. No birds were detected in the complex channel area above Kampi, or other river stretches below the "central section", but no crepuscular or night time survey effort was carried out in these areas. Birds were detected as far north as the north end of Koh Preah Island. There were frequent records of the species in the latter part of the November-December 2006 survey, as birds were probably arriving back at the site, but numbers in the channel at that time were not high. The only record from the July-August 2007 survey was of a bird heard on 7 August after dawn in the channel between Koh Enchey and Koh Rongnieu Islands. The "central section" is likely to support several hundred birds and there are probably small numbers sporadically in other sections of the Mekong channel.

This species is cryptic and easily overlooked in the daytime in its primary habitat of well vegetated channel areas with extensive sand formations. The species is most active at night, dawn and dusk, when it is quite vocal. In Indochina and Thailand the species is largely restricted to the Mekong and its largest tributaries. It has probably been extirpated from or severely declined in many river stretches where levels of human use are high, probably mainly from nest predation by dogs and people, hunting/trapping of adults, and all probably exacerbated by clearance of woody channel vegetation.

River Lapwing (*Vanellus duvaucelii*) (Vulnerable in Thailand; At Risk in Lao PDR)
Recorded commonly in the "central section" in appropriate areas of habitat, in the dry season; scarce above the "central section" with the most northerly records at the north end of Koh Preah; none observed in the western main channel below the "central section"; in the eastern channels, the most southerly detected birds were at the downstream end of Koh Preng (Annex 3 – Plate 23). No birds were detected in the complex channel area above Kampi. No birds were recorded in the July-August survey. The "central section" is likely to support several hundred birds.

This species like many other riverine birds has declined substantially, and although still widespread, there remain few contiguous river stretches within Thailand and Indochina that have more than a few tens of birds. Duckworth et al. (1998) found a negative correlation between River Lapwing and village densities, and speculated that incidental disturbance and nest damage by people, livestock and dogs was primarily the cause. Between 1998 and 2003, River Lapwing counts on the Se San River fell by approximately 50% amounting to roughly 100 birds (Timmins & Men 1998; Claassen 2003). Claassen (2003) recorded low breeding success for River Lapwings in 2003, and speculated this may be due to a combination of nest predation from unknown sources and inundation by fluctuating high water releases from an upstream dam.

Population distribution on narrower rivers is essentially linear, due to the territorial behaviour of breeding pairs, and thus population size is greatly influenced by river length. In the study area and similar Mekong sites however, where the exposed dry season channel habitats form a two-dimensional matrix, territories can form side by side across the width of the channel. Thus for instance the roughly 200 birds present along the Se San River in northern Cambodia in 1998 were spread along a roughly 200 km stretch of the river; the Stung Treng Ramsar site, which probably has a similar if not greater number of birds, by comparison is around 40 km long. The population in the "central section" of the study area is larger, covering a greater area, but probably at a similar density to the Ramsar site. These two populations together are the most significant regionally.

River Tern (*Sterna aurantia*) (Critical in Thailand; At Risk in Lao PDR)
The study area appears to support the largest population in Indochina. Few were observed during the November-December survey, but by March-April birds were scattered from the Koh Sampeay area, *c.*10 km below Stung Treng Town south to Koh Plong, with a total estimate of 78-104 birds (Annex 2 – Map 3). Observations suggested most birds were attempting to breed as solitary pairs, although one large colony (30-40 birds) was in an area of sand, shrubs and rock to the west of the north end of Koh Preah, and another group of ~eight adult birds were in the channel east of Koh Enchey. No birds were found in the breeding season in the eastern channels and none were seen between Sambor and Kampi. During the wet season survey there were few records, with the only confirmed records coming from below Kratie Town. Reproductive success appeared to be very low, with fledged juveniles seen in only two areas: three juveniles at the Koh Preah colony and one at the Koh Enchey colony. Local guides used during the survey also reported that adult birds are sometimes hunted with traps / nets and poisoned fish, and this has been reported elsewhere (Timmins 2006). Locals reported that the species had once bred in the eastern channels but it was now only an occasional visitor to the area (one was seen in November-December). The same was probably the case in the area between Sambor and Kampi where birds were seen in February 2000 (C. Poole & J. W. Duckworth personal communication) and April 2000 (RJT unpublished data).

This species has undergone a major decline in Southeast Asia and was once common on many large rivers of Indochina. Currently in Indochina and Thailand, it is largely restricted to the Mekong above Sambor to just north of the Lao PDR border, and the Se San and Se Kong Rivers in Cambodia. The Se San and Se Kong Rivers have *c.*46 and 38 breeding birds respectively (Timmins et al. 2003; Claassen 2003) and the Stung Treng Ramsar site 45-70 (Timmins 2006). Populations in Myanmar may be larger, but there are no specific data. The species remains widespread in South Asia. The regional decline of this species has largely been caused by nest predation by domestic dogs and nest robbery by people, and both were observed in the study area. The same factors are almost certainly the cause of poor reproductive success in the study area. A survey of the Se San river found that a high proportion of River Tern nests had eggs taken by people and breeding success was low (Claassen 2003).

Little Tern (*Sterna albifrons*) (Near-Threatened in Thailand; At Risk in Lao PDR)
Single pair downstream of Kratie Town on 7 April 2007. In the early 1960s, the species was "regular in winter on the Mekong river at Phnom Penh" (Thomas & Poole 2003), but today the species is rarely if ever present during the winter breeding season. The species was recorded regularly in small numbers in the 1990s along the Mekong between Kratie and the Khompong Cham border. Mundkur et al. (1994) noted one between Khompong Cham and Kratie, and Van Zalinge et al. (2002) observed five (two pairs and a single) in the same stretch in February 2000. A similar decline has been documented along the Mekong of Lao PDR (Thewlis et al. 1998). Coastal populations also appear to be in decline. In Thailand, the species is considered "Near-Threatened" (Round 2000). In Viet Nam, the coastal breeding population appears to be localised, uncommon, and presumably in decline, although little information is currently available: most coastal bird surveys have focused on deltas with mudflats (where records are usually of non-breeding birds) and there have been few systematic surveys of sand dunes and beaches away from large deltas (J. Tordoff personal communication; Round 2000).

Brahminy Kite (*Haliastur indus*) (At Risk in Lao PDR)
Common in the "central section" during dry season surveys, with a roost of 40+ birds in the channel above Koh Enchey in late November. Small numbers were recorded between Stung Treng Town and the "central section", and no birds were seen below Sambor Town. Four singles (mainly adults) on the 18, 20 and 21 August 2007 were the only confirmed records during the wet season, all in the upper part of the "central section", indicating the majority of the population moves away from the area during at least part of the wet-season. An unconfirmed single was also seen over a floodplain area close to Sambor on 22 August. This species has declined regionally, probably from a combination of factors, although hunting is likely to be the predominant cause.

White-bellied Sea-eagle (*Haliaeetus leucogaster*) (Near-Threatened in Thailand; At Risk in Lao PDR)
A juvenile bird in the western main channel, Koh Enchey area, 18 November 2006 was the only confirmed sighting during surveys (Annex 2 – Map 5). Another bird seen in the Koh Krabei area on 19 November 2006 may have been a juvenile of this species. This species appears to have been relatively common and widespread along large inland rivers and wetlands of Cambodia (Thomas & Poole 2003) but may now be on the verge of extinction in inland areas. There are few other recent records: a bird in the Stung Treng Ramsar site in 1994 (Mundkur et al. 1995); an immature on 19 February 2004 between Kratie and Stung Treng Towns (Goes et al. 2004); a single along the Se Kong River on 28 January 2003 (Goes & Davidson 2003b); and, a bird reported from the Tonle Sap Lake area (Hong & Goes 2001). In the Ang Tropeang Thmor Sarus Crane Reserve it is listed as an "uncommon resident" (Goes 2004) but the only detailed account from this site is a provisional record in December 1998 (Hong & Goes 2001). A similar decline has been documented in Lao PDR (Thewlis et al. 1998). Nearby coastal populations also appear to be in decline; it is regarded as "Near-Threatened" in Thailand (Robson 2000) and in Viet Nam, appears to be largely extirpated from the mainland, persisting only on some off-shore islands (J. Tordoff personal communication; Buckton & Safford 2004).

Lesser Fish-eagle (*Ichthyophaga humilis*) (Globally Near-Threatened)
Confirmed sightings were made in five locations along the Mekong channel (one location recorded by MB) and one unconfirmed record (Annex 2 – Map 5), all potentially representing separate territories and probably breeding pairs. Birds were also found along the Prek Krieng in August. Regionally, this species is commonly associated with small, usually permanently flowing rivers (commonly in hilly areas), and in Cambodia is particularly localised and scarce. Given the natural scarcity of such rivers within forested landscapes, the species is regionally and globally scarce and the Indochinese population probably numbers in the low hundreds. Data from Lao PDR suggests that even river systems with apparently optimal habitat (Nam Ou, Se Kong) may only support a few dozen pairs each (Tordoff et al. 2005; Fuchs et al. 2007), while in Viet Nam the species is perhaps as rare as it is in Cambodia. Thai populations seem unlikely to exceed those in Lao PDR, although at least one area in Myanmar has a much larger population (Fuchs et al. 2007). A study area breeding population of five or more pairs would therefore be significant regionally, and to some extent globally, given that few areas, especially protected areas, have the capacity to support large numbers.

Grey-headed Fish-eagle (*Ichthyophaga ichthyaetus*) (Globally Near-Threatened)
Largely confined to the "central section" in which it is still common (*c.*150 records of fish-eagles during surveys) (Annex 2 – Map 4; see cover page photo this chapter). Based on the survey records and ecological observations elsewhere, the "central section" may support 40-60 breeding pairs. Outside the "central section" there were only two records: a single heard from seasonally inundated floodplain forest on 1 August 2007 at Boeng Chhrea, and a single in a seasonally inundated floodplain area on 5 August, Contoipreykien area. These records are the most significant, well documented concentration of birds within Indochina and Thailand, although local areas on the Tonle Sap Lake floodplain may hold similar numbers. The Prek Toal core area may hold at least 15 pairs and the lake and floodplain as a whole might support 100 pairs (Goes 2001a, 2001b). The Stung Treng Ramsar site by comparison was estimated to harbour around 6-8 breeding pairs (Timmins 2006), while in Lao PDR, Thailand and Viet Nam the species is on the verge of local extinction with little more than sporadic records and a small handful of remnant pairs. Regionally, this species favours wooded lowland rivers and other wetlands, and is more at risk than Lesser Fish-eagle, although globally, the latter species is more threatened due to a smaller range and reduced populations throughout this range. Grey-headed Fish-eagle is intrinsically vulnerable as a large raptor because of its relatively low population density, exacerbated by the linear constraint of territories along rivers compared with larger territories of forest raptors, magnified further by the rarity of wooded wetlands relative to many other habitats.

White-rumped Vulture (*Gyps bengalensis*), Slender-billed Vulture (*Gyps tenuirostris*), Red-headed Vulture (*Sarcogyps calvus*) (all Globally Threatened-Critically Endangered)
Vultures were seen occasionally in all three surveys, mostly in eastern parts of the "central section". Single Red-headed Vultures were seen on: 29 November 2006, over the eastern mainland south of Koh Somtup; 1 April 2007, flushed from channel trees northeast of Koh Norong; twice on 2 April 2007, between Koh Somtup and Koh Khlap; 11 August 2007, over Koh Rongnieu to the west of Koh Khleng Por; 18 August 2007, over the channel west of Koh Dambong; and, five birds on 15 March 2007 with two White-rumped Vultures, feeding on a carcass close to Koh Somtup (MB). Five birds, supported by photographic evidence, were recorded by the Cambodia Turtle Conservation Team (Sun Yoeung et al.) on 8 February 2007 feeding on a carcass north of Koh Khlap Island. White-rumped Vultures: three on 16 November 2006 circling over Koh Kvien; a single on 1 April 2007 perched in a channel tree northeast of Koh Norong; two with Red-headed Vultures feeding on a carcass (see MB record above). Long-billed Vulture: single bird on 16 November 2007 circling with the above three White-backed. One unidentified vulture was seen on 13 November 2007 flying west over Koh Tnaot.

Southeast Asian populations of these species have declined considerably, with significant remnant populations only persisting in northeast Cambodia and Myanmar (Pain et al. 2003). The Cambodian vulture population, which marginally extends to adjacent areas of Lao PDR and Viet Nam, probably numbers in the low hundreds of both White-rumped and Red-headed, and perhaps not many more than a hundred Slender-billed. Recent data suggests Myanmar populations are no more significant than those in Cambodia. The only other significant populations of all three species are in South Asia, where all have undergone rapid and massive declines due to toxicity of a widely used veterinary drug which birds ingest when eating domestic livestock carcasses (Oaks et al. 2004; Shultz et al. 2004). The cause of decline in Southeast Asia, especially Indochina, appears to be a combination of persecution by humans and declining food availability (J.W. Duckworth, C.M. Poole, P.D. Round, R.J. Timmins & P. Davidson unpublished data).

Darter (*Anhinga melanogaster*) (Globally Near-Threatened)
Observed commonly in much of the "central section" in March-April 2007, with a total of 800+ individuals; common in the channel from below Sambor Town to Kampi, with 200+ birds; elsewhere scarce, none recorded south of Kratie Town. No roost sites were located, although a large roost was suspected along the Prek Preah River and one+ roosts were suspected in the channel below Sambor Town; small roosts were also suspected somewhere above Koh Preah Island. In the wet season, relatively small numbers (low hundreds) were recorded commonly in floodplain areas and in smaller numbers in the Mekong channel between Kampi and Koh Plong Island. Many of the latter were adults. No birds were seen in the eastern channels. The most northerly sightings were in the western main channel in the Koh Enchey Island area. No birds were seen in November-December 2006. Breeding was reported by two independent local sources in two large trees on Koh Preang in March-April 2006; the colony was reportedly a mix of cormorants, Darters and herons, and was completely collected (eggs and chicks) by local people. This site was visited on 18 April 2007 by the author and contained old nests; no birds were present and a local resident stated no birds had returned. The study area supports seasonally a significant concentration of birds which may largely originate from the Tonle Sap area (below).

During the last few decades of the twentieth century, this species declined within Indochina and Thailand to a few scattered remnant groups of at most tens of birds (including along the Mekong), one larger population of hundreds in the Tonle Sap Lake area, and one-two populations of over 100 birds in the Vietnamese Mekong Delta (J. Tordoff personal communication). As a colony nester the species is vulnerable to nest robbery by people, and prior observations from other areas of Cambodia suggest that Darter and cormorant colonies are actually sought by people for egg and chick harvest. This is likely to be the primary cause of the species population collapse over much of the region in prior decades. Following protection of a breeding colony at Prek Toal on the Tonle Sap Lake floodplain, the population there has undergone a rapid recovery from *c.*200 pairs in 2001 to an estimated 4,000 nesting pairs in the 2006-2007 breeding season (now the largest breeding colony in the world) (Goes 2005; O'Kelly et al. in press). The majority of birds in the study area as well as the Stung Treng Ramsar site further north, are non-breeding birds from the Tonle Sap Lake population, which breeds between September and January (O'Kelly et al. in press). Protection efforts at Prek Toal also appear to have resulted in the establishment of new colonies elsewhere including Thailand (Bird Conservation Society of Thailand / P. D. Round unpublished data). With appropriate protection activities (including roost site protection), regular breeding activity might quickly re-establish in the study area.

Little Cormorant (*Phalacrocorax niger*) (At Risk in Lao PDR), Indian Cormorant (*Phalacrocorax fuscicollis*) (Near-Threatened in Thailand; not recorded in Lao PDR), Great Cormorant (*Phalacrocorax carbo*) (Endangered in Thailand; At Risk in Lao PDR)
In March-April 2007 these three species were recorded widely, with Little Cormorant the most abundant (Table 7). Indian and Great Cormorants were scarce in narrow eastern channels of the "central section", while Little Cormorant was more uniformly distributed. Only Little Cormorants were confirmed below Kratie Town from the Mekong channel. All species were seen in July-August 2007 but in lower numbers than March-April. None was seen in November-December 2006. Peak numbers in the study area are difficult to assess and may vary annually. One small roost was located on Koh Sake (Stung Treng section of study area) and two large roosts appeared to occur (but were not confirmed) along the Prek Preah River and Boeng Rhung area respectively. The latter site was used as a roost in July-August 2007, and residents stated it was also used in the dry season. The study area supports a significant seasonal proportion of regional cormorant populations.

Breeding was reported by three independent local sources in two large trees on Koh Preang in March-April 2006; the colony was reportedly a mix of cormorants, Darters and herons, and was completely collected (eggs and chicks) by local people. This site was visited on 18 April 2007 by the author and contained old nests; no birds

Table 7. Counts in 2007 of Darter and cormorants.

Site / roost site	Date	Darter	Little Cormorant	Indian Cormorant	Great Cormorant	cormorant spp.	Total cormorants
Koh Preah (EO)	11 Mar.	28(S)	-	-	-	-	
Koh Sake (R)	14 Mar.	0	200	<20	0	-	200+
Koh Khlee-ay (EO)*	24-27 Mar.	3	600 (SE)	100 (SE)	<50 (SE)	-	750+
Main channel, Koh Enchey to top Koh Plong (DC)	27 Mar.	92	-	-	18	-	-
Main channel, Koh Enchey to top Koh Plong (DC)*	28, 29, 30 Mar.	69+45-26	-	-	7+5-12	-	-
Koh Enchey channel (DC)*	29-30 Mar.	14+37	-	-	3+	-	-
Koh Plong area (DC)	28 Mar.	56+	+	200+	25+	-	250+
Main channel to south of Koh Enchey (E/MO)*	28, 30 Mar.	101(N), 41(S), 10(?)	~70% of cormorants	30% of cormorant	3+	1000+ (S)	1000+
Main channel to south of Koh Enchey (EO)	30 Mar.	214-276 (N, W,S)	-	-	-	-	-
Koh Enchey channel (EO/DC)*	29, 30 Mar.	[c.120] (N, S)	85+% of cormorants	<15% of cormorants	[4]	1400(S)	1400
Prek Preah (EO: observed from Koh Tachan)	1 April	477(N) 23(W)	?	-	?	-	-
Prek Preah (EO: observed from Koh Somtup)	2 April	267(N), 73 (W)	?	[600+] & 780 (N,W)	?	-	1380+
Prek Preah (MO: observed from channel between Koh Tachan and Somtup)	3 April	140 (W)	?	-	?	-	-
Koh Sam Thom (DC)^	6 April	16	-	-	14	-	-
Below Koh Sam Thom to Kratie (MO/DC)	6 April	164 (N)	[1700+] & 2300 (N)	20 (N)	30 (N)	-	4,200+
Boeng Rhung (EO)	7 April	0?	[2850+] & 350	Small numbers?	?	-	3,200+
Study area total estimate[$]		N: 800+, S: 200+	N: 1,200-2,000; S: 4000+	N: 1,500? S: <100?	N: 100+ S: 50+		N: 2,500-4,000 S: 4,000-5,000
Ramsar site estimates for comparison (Timmins 2006)		400+	1000+	3000+	Tens		-

Counts include birds flying to or from roosts, at roosts, or along river stretches.EO/MO = Evening or morning count of birds flying to or from roosts; DC = counts of birds along section of river during the day; R = counts of birds at roost; ^ = count of birds that appeared to have roosted in the Koh Sam Thom area; * = count an aggregate of more than one day's survey; $ = Study area total estimate: North = north of Sambor; South = south of Sambor; Letters in brackets after counts indicates the direction birds were travelling from on their way to roost.

were present and a local resident stated no birds had returned in 2007. Birds may also breed in small numbers in the floodplain below Kratie Town given the presence of adults in breeding plumage during the July-August surveys, but the only reported occurrence was of a small colony found by one resident in the Boeng Thom area some years previously (the report was vague and at times contradictory). Most birds are clearly non-breeding visitors, presumably coming from breeding colonies around the Tonle Sap Lake and / or the Mekong Delta.

The Tonle Sap Lake area probably supports >10,000 cormorants in the dry season (e.g. Goes & Hong 2002), the majority presumed to be breeding at the site in the late wet-/early dry season (Goes 2001b; Goes & Davidson 2001b, 2003a), with single roost/colony counts of 4,600+ birds (Goes & Hong 2002). Actual numbers are difficult to estimate as is the relative population size of the three species, but numbers of Great Cormorant are probably <1,000 (dry season counts suggest 500+ birds, with wet season breeding colony counts >400) (e.g. Goes & Davidson 2001b, 2003a; Goes & Hong 2002). Large dry season counts of both Little (*c*.3,500, Goes & Hong 2002) and Indian (*c*.6000, Goes 2001a) have been made but their relative abundance is hard to estimate with

Indian apparently much commoner (Goes 2001b). Few data have been collected on cormorants in the wet season in the Tonle Sap Lake area. In the Mekong Delta of Viet Nam, surveys suggest there are few if any Great Cormorants but perhaps >5,000 Little Cormorants in several roosts/colonies in July and August (numbers appear lower from February-April), with perhaps only one large colony of Indian Cormorant of *c.*1,000 birds in August (Buckton et al. 1999; Buckton & Safford 2004). Other lower Mekong sites host large numbers of presumed non-breeders, especially Little Cormorants, e.g. Basset Marshes (*c.*1,000 Little Cormorants on 21 April 2002: Goes & Davidson 2002), 1,500 on 27 April 2003 (Goes & Davidson 2003b), 3000+ on 6 July 2003 (Goes & Davidson 2003b) and in the Bassac Marshes 600+ Little Cormorants on 13 January 2002 (Goes & Davidson 2002). Elsewhere in Indochina and Thailand, numbers, especially of Great and Indian, are much lower (Timmins & Men 1998; Duckworth et al. 1999b, 2002; Buckton & Safford 2004).

Grey Heron (*Ardea cinerea*) (Potentially At Risk in Lao PDR)
Recorded in all three survey periods in many parts of the study area, although due to water levels during the July-August survey birds were only found away from the channel. Small breeding colonies were found in March-April 2007 and others were suspected and/or reported (Annex 2 – Map 6). Observed colonies were composed principally of Grey Herons, although in the Koh Kapeung area a pair appeared to be using a tree with an active White-shouldered Ibis nest. Breeding was reported by three independent local sources in two large trees on Koh Preang in March-April 2006; the colony was reportedly a mix of cormorants, Darters and herons, and was completely collected (eggs and chicks) by local people. This site was visited on 18 April 2007 by the author and contained old nests; no birds were present and a local resident stated no birds had returned in 2007. Locals were seen climbing one of two closely spaced nesting trees in the Koh Khe area, reportedly harvesting a wasp nest, in March-April, and in the process a small fire had been made at its base. By the July-August survey, the one tree had been completely destroyed by fire and the other badly damaged.

Elsewhere in Cambodia, this species breeds at Tonle Sap Lake (e.g. 100+ nests estimated in Prek Toal on 8 February 2004, Goes et al. 2004) but otherwise the only previously known colony was one of *c.*155 nests with chicks recorded in a pagoda in Takeo Province on 10 November 2001 (Goes 2001a). Regionally, this species no longer breeds in Lao PDR (its "PARL" status was given to the non-breeding population; there is no unambiguous evidence that it ever did breed, but the historical record is too patchy to conclude that it did not do o; on balance it seems likely that it is a nationally extinct former breeder) and in Thailand the lack of listing reflects the same situation, in that the species no longer breeds there (Round 2000). A similar scenario appears to pertain to Viet Nam, with for instance only small numbers documented for the Mekong Delta (Buckton & Safford 2004).

White-shouldered Ibis (*Pseudibis davisoni*) (Globally Threatened-Critically Endangered)
Locally common throughout the "central section" during dry season surveys (see cover page photo this chapter). The distribution of records and numbers of birds seen suggest the "central section" and some adjacent areas support an estimated 78-125 birds (Annex 2 – Map 2). None were recorded by the author in the wet season survey (July-August) but one was seen by MB on 29 July 2007 along an eastern channel north of Sambor Town. The "central section" of the study area may support the largest global population of this species and is at least one of the three largest global populations. Birds in the study area were using channel areas of extensive, seasonally exposed mosaics of vegetation, which was similar to habitat usage observed in the Stung Treng Ramsar site (Timmins 2006). Surveys confirmed that birds nest within trees in the channel, with one active nest found on 25 March 2007, and nests suspected in channel trees in at least two other locations. Birds with incomplete white napes, possibly sub-adults from the previous year, were seen in at least one area, suggesting there is still successful nesting in the study area. The paucity of wet season records was possibly due to seasonal movement to wetlands and grassy areas in habitats away from the Mekong channel. Local people in several areas repeatedly reported having seen or heard ibises in the week prior to questioning, often on the periphery of rice paddy enclaves and within five kilometres of the river.

The global population is probably <500 birds, with most in Cambodia (the next largest group is in Kalimantan, Indonesian Borneo). In 2006, the Stung Treng Ramsar site supported a minimum of 20-30 birds (Timmins 2006). Reasons for global decline of this species are unclear, but may involve two factors (RJT & T. Clements unpublished data). First, hunting (including nest robbery) has probably been the primary cause in the species's decline, exacerbated by its habitat preferences which leave the species without remote refuges from human persecution. Second, the species appears to prefer channels of large rivers and certain land habitats dominated by short grass. Its preference for the latter appears to correlate with human use of landscapes in which such habitat occurs, probably through traditional forms of livestock management. Birds appear to use fallow areas or "more natural" grass-dominated habitats (both of which tend to be heavily grazed), rather than active

agricultural areas, suggesting agricultural practices are of minor importance. The species is scarce in remote forest areas, where ungulate densities are now very low, but which otherwise appear to have suitable and often extensive areas of short grass habitat. With the drastic reduction in wild ungulate densities even in the remotest of lowland forest areas (Timmins & Ou 2001), subsequent changes in the ecology of grazing areas, thus affecting ibis feeding ecology, may have forced the species out of such remote refuges, which may have existed when wild ungulate densities were high.

This theory is unproven but if correct, management actions in the study area would need to consider current human patterns of use in channel and terrestrial habitats, as well as protection of birds and nests. Until further data are available, it is important that current livestock grazing practices, especially of domestic water buffalo, and low intensity agricultural practices, are maintained in the "central section".

Spot-billed Pelican (*Pelecanus philippensis*) (Globally Near-Threatened)
Recorded in July-August 2007, with two birds in the Prek Bang/Boeng Meier area, 28-33 in the Contoipreykien area, and up to eight in the Mekong channel in the Koh Plong area. The only known breeding site for this species in Indochina and Thailand is at Prek Toal on the floodplain of the Tonle Sap Lake. When not breeding a proportion of birds disperse considerable distances. More non-breeding birds may use the study area in the wet season, with most presumably returning to Prek Toal around October for the breeding season.

Woolly-necked Stork (*Ciconia episcopus*) (Critically Endangered in Thailand; At Risk in Lao PDR)
Recorded in all three surveys; most records were from the "central section", where the species was frequent to common within the channel in the dry-season (Annex 3 – Plate 21). Often seen in groups of 1-5, with the highest count of 14 birds on 2 April 2007. A single record outside the "central section" was a bird perched in channel trees on 6 April 2007 in the complex channel area above Kampi. Concentrations of birds coincided with extensive areas of seasonally exposed well-vegetated channel bed, especially the area between Koh Khlap and Koh Kring Islands and the area north of Koh Ampel and Koh Dambong Islands. Probably tens of birds use the channel of the "central section" on a regular basis in the dry season and may be local breeders. One grown but unfledged chick was seen dead in Satlieu Village in August 2007, and was reportedly collected from a nest with one other chick. These records suggest the "central section" forms a significant component of the range of the largest population remaining in Indochina and Thailand. Unlike most other stork species, there are no concentrations of Woolly-necked Stork around the Tonle Sap Lake; the largest populations in Indochina and Thailand are in the lowland forests of north and east Cambodia. In this landscape, the species is widespread and highly dispersed. Nowhere in this range have high concentrations been documented; records are generally sporadic with occasional concentrations of low tens of birds at the height of the dry season. The wetland diversity in the Mekong channel is probably a significant attribute to the importance of the "central section" for this species.

Black-necked Stork (*Ephippiorhynchus asiaticus*) (Globally Near-Threatened)
None recorded during surveys. A single bird was seen in the Koh Tbal Island area in the "central section" on 12 April 2006 (RJT unpublished data). It is not present in the study area in large numbers, but a pair or two could have been easily overlooked during surveys given the extent and complexity of suitable feeding habitats in the dry season. Regionally, this species is so rare that any indication of presence gives potential significance to a site. This species has a remnant distribution in Indochina similar to that of Woolly-necked Stork (it may now only be a vagrant to Thailand and Viet Nam), except there are no large populations anywhere. No site in Indochina is known or thought to support more than a small number of birds; the northern plains and the Srepok Wilderness Area in Cambodia appear to have the highest potential for conservation of this species.

Lesser Adjutant (*Leptoptilos javanicus*) (Globally Threatened-Vulnerable)
Recorded in all three surveys; most records from the "central section", where the species was probably frequent within the channel in the dry season (Annex 3 – Plate 20). Many adjutant sightings were made during surveys but not confirmed to species, but of confirmed records, Lesser Adjutant was more common and widespread. Adjutants were seen in groups (usually while in flight) of up to seven, although more often as singles or twos. Concentrations occurred in areas similar to those of Woolly-necked Stork (see above). The "central section" could be a very significant area for the species following population recovery.

Regionally, this species has a similar status and distribution as Woolly-necked Stork, although it is more wary of human activity. The largest populations in Indochina and Thailand are around the Tonle Sap Lake and lowland forests of north and east Cambodia (which may functionally constitute two separate breeding populations), and small adjacent areas of Lao PDR and Viet Nam. These populations may constitute as much as

0% of the global population of the species, assuming figures from other range states are correct (BirdLife International 2001, 2007; RJT & T. Clements unpublished data) and are likely to be one of the two most numerous populations remaining globally (the other in Sumatra; BirdLife International 2001). The Indian population, although perhaps equally large, seems to consist of several geographically separate subunits (BirdLife International 2001). This species nests colonially, which increases risk of nest robbery in comparison to solitary nesters such as Woolly-necked Stork and White-shouldered Ibis. This reduces the possibility of nesting colonies in the study area, although the frequency of wet season and November-December observations, including birds that appeared to be adults, suggest there are at least a proportion of relatively local breeding birds.

Greater Adjutant (*Leptoptilos dubius*) (Globally Threatened-Endangered)
At least two birds were regularly observed in well-vegetated channel areas northwest of Koh Dambong Island, March 2007; not recorded in other areas or survey periods. Probably more than two birds were present in the Koh Dambong area given that many adjutants (groups of 1-7, with perhaps low tens present) in this area were not confirmed to species. Greater Adjutant may have been overlooked in other survey areas and periods. A bird observed and photographed while perched appeared to be adult and in breeding appearance, with relatively bright yellow lower portions of the neck and an obvious naked red hind neck protrusion, although greater wing coverts were only partially grey and not strongly contrasting with the rest of the wing. None of the other birds seen had full grey greater covert wing panels. The grey coloration was primarily on the outer fringe of the outer web of each feather, and the proximal feathers had a narrower fringe than the distal feathers. A similar wing pattern has been noted on breeding birds at Prek Toal on the Tonle Sap floodplain. Regionally, this species breeds in only two areas, both in Cambodia, with at most a few hundred birds remaining. In Cambodia, March is close to the height of the breeding season for the colony at Prek Toal (Goes 2005; O'Kelly et al. in press) suggesting that birds in the study area were from a population breeding relatively nearby. A population in the northern plains breeds between approximately October and February (Tan et al. 2005), although those birds appear to be relatively sedentary. The current surveys may indicate the presence of a small, localised breeding colony in or close to the study area. The only other large population (<1,000 birds) globally is in Assam, India (BirdLife International 2001, 2007).

Plain Martin (*Riparia paludicola*) (Vulnerable in Thailand; At Risk in Lao PDR)
Small breeding colonies were located in two sites and a third colony was suspected in the Koh Preal area, March-April 2007; other sites with records probably indicate breeding nearby (Annex 2 - Map 7). Not detected in the other two survey periods. These are the only known breeding sites in Cambodia. This species appears to have been extirpated from the Stung Treng Ramsar site (Timmins 2006) and has not been recorded elsewhere in Cambodia. Historically, the species may have been more widespread, although there are few historical data. In Lao PDR, it appears to have declined substantially along the Mekong downstream of Vientiane, with no confirmed colonies known from this stretch (Thewlis et al. 1998; RJT unpublished data). Reasons for decline are unclear but may involve human disturbance of breeding colonies. North of Vientiane in Lao PDR, along the Mekong, the species remains common (hundreds of birds) but elsewhere is very localised (Duckworth et al. 2002; Fuchs et al. 2007). Rasmussen and Anderton (2005) considered the Plain Martin populations of South and Southeast Asia, which they called Grey-throated Sand Martin (*Riparia chinensis*), as specifically distinct from African populations which they called African Plain Martin (*Riparia paludicola*). Plain Martin remains widespread and common in South Asia (Rasmussen and Anderton 2005).

Wire-tailed Swallow (*Hirundo smithii*) (Near-Threatened in Thailand; Potentially At Risk in Lao PDR)
Small numbers recorded during surveys; perhaps <100 birds in the study area. Largely confined to the "central section". Breeding pairs and occasionally small colonies were observed in sections of Mekong channel with large rock outcrops in the dry season (Annex 2 - Map 8). Birds were observed in all survey periods in such habitats. Breeding success appeared variable, with nest failure suspected to be due to human interference in several areas, although several pairs were seen with fledged young. The localised distribution of this species partly reflects the distribution of suitable nesting habitat (large channel rocks and cliffs with faces of 2+ m height), but numbers appear very low even in suitable habitat within the "central section". Along the western main channel below the "central section", there appears to be suitable, unoccupied rocky stretches. The species is localised in Cambodia; in the Stung Treng Ramsar site, it appears to be extirpated (Timmins 2006). Regionally, this pattern is also evident although larger populations persist, especially on the Mekong above Vientiane, Lao PDR (Thewlis et al. 1998; Duckworth et al. 2002).

Mekong Wagtail (*Motacilla samveasnae*) (Globally Near-Threatened)
Relatively abundant in the dry and wet seasons in river sections with extensive channel trees and shrubs (Annex 3 – Plate 22). None recorded south of Kratie Town in any survey. Few birds were observed away from

the Mekong channel; all such records were in the wet season. At least two birds were seen on 16 August 2007 in the Prek Preah River, six kilometres upstream from the confluence with the Prek Preah/Mekong confluence; one bird was seen on 22 August 2007 at a floodplain wetland 1.5 km inland, east of Sambor Town. This species is endemic to a localised area of the Lower Mekong Basin, and has a strong habitat preference to areas of the channel dominated by shrubs exposed in the dry season, especially shrub areas adjacent to flowing water (sizeable areas of channel with significant shrub cover occur in areas with no or insignificant water flow for much of the dry season).

Streaked Weaver (*Ploceus manyar*) (Near-Threatened in Thailand; not recorded from Lao PDR)
One bird at Boeng Ptoul marsh (others may have been present); at least nine with Asian Golden Weavers (*Ploceus hypoxanthus*) in paddies and scrub along the edge of Boeng Veng lake, 2 August 2007, with all records in the Boeng Chhrea area. Old nests probably of this species were found partially submerged nearby in sedge beds of Boeng Veng. The least common of three weaver species recorded during surveys.

Elsewhere, this species is known from the eastern Tonle Sap Lake floodplain (Goes et al. 2001; Goes & Hong 2002; no records from Prek Toal: Goes 2001c) and at Ang Tropeang Thmor Sarus Crane Reserve ("uncommon resident"; Goes 2004c) but is always less common than Baya Weaver. In north and east Cambodia it is less frequently recorded than other weaver species (Timmins & Men 1998; Timmins & Ou 2001; Timmins et al. 2003), and in the northern plains an approximate ratio of 10 Baya: 2 Streaked: 1 Asian Golden Weaver has been recorded (Goes & Davidson 2001a). Apparently not recorded from wetlands on the Four-Arms Plain [birds recorded by Duckworth & Hedges (1998) were probably merit-release birds]; the other two weavers there are characterised as "uncommon residents" (Goes & Poole 2002). During monitoring of cage-bird sales from 1995-1996, Streaked Weavers (n=77) comprised 0.5% of total bird volume, compared with Baya (21%) and Asian Golden (2.7%) (van Zalinge 1999), suggesting that Streaked Weavers are less numerous and probably more localised than, especially, Baya. Previous authors state the species was most common of the weavers (Engelbach 1948) or "uncommon" and Baya as "fairly common throughout the central plains" for the period 1958-1961 (Thomas and Poole 2003). Its habitat preferences are poorly known, although Thomas and Poole (2003) stated "when breeding, confined to marshes with high grass". Breeding birds were observed in Takeo provincial town on 2 February 2005 and 2 July 2004 (Davidson 2005).

Little attention has been accorded to this species in recent years, an oversight given its apparent decline in Cambodia. The species is not known from Lao PDR, probably indicating an early historical decline in at least the southern provinces (it is known from closely adjacent areas in Cambodia). It is difficult to assess recent Vietnamese records, but during extensive surveys of the Mekong Delta the species was only found at four sites (Buckton & Safford 2004). In Thailand the species is considered an "uncommon resident…much reduced by human persecution" (Sanguansombat 2005).

Asian Golden Weaver (*Ploceus hypoxanthus*) (Globally Near-Threatened)
None recorded from Mekong channel habitats where in contrast, Baya Weaver was locally common to abundant. One breeding colony was located on 2 August 2007 in a tree (atypical breeding habitat; the species usually breeds in graminoids or *Sesbania* shrubs) on a floodplain with *c*.12 active nests, close to Boeng Veng marsh in the Boeng Chhrea area, south of Kratie Town; single birds were observed in the Contoipreykien area on 5 August 2007. In the few terrestrial wetlands visited north of Sambor Town, one suspected large breeding colony was found in a sedge bed at Viel Sraeprey (on the mainland east of the "central section"): 200+ birds observed on 1 December 2006 were provisionally identified as this species, and 10+ males (confirmed identity) were observed on 16 August 2007. Old nests presumed to be of this species were found at Boeng Snit marsh on 13 November 2006, and at Trapeang Bungchow, an old nest of this species was found on 27 November 2006 in a seasonal marsh pond with ~40 birds of either this species or Baya. In Cambodia, this species remains relatively widespread (Timmins & Men 1998). It is associated with wetlands (seasonal and permanent) with tall emergent graminoid vegetation, but also utilises small ponds with tall *Sesbania* shrubs in terrestrial non-floodplain forest areas (Timmins et al. 2003).

Black-headed Munia (*Lonchura malacca*) (Little Known in Lao PDR)
Three groups (total 28+ birds including juveniles) were observed on 4 August 2007 in a section of the Mekong channel with tall grass at the downstream end of Koh Tasuy Island. A single and a group of two munias in channel habitat mosaic above Kampi on 23 April 2000 were probably this species (RJT unpublished data). The apparent absence of this species from other sections of channel in the study area with tall cane grass, marsh and floodplains dominated by tall grass, suggests habitat specificity and a need for extensive areas of suitable habitat, and suggests the species is likely to be vulnerable to habitat changes in addition to trapping.

Elsewhere in Cambodia, there are few recent field records: reported in Ream National Park (coastal south Cambodia) on 1 May 2000 (Goes 2000c) and in January 2001 (Goes & Davidson 2001a); reported from the eastern Tonle Sap floodplain from 15-16 February 2000 (Goes & Hong 2002); and, two birds (perhaps merit-released) observed on 29 October 2005 in the Basset marshes on the outskirts of Phnom Penh (RJT unpublished data). During monitoring of cage-bird trade in Phnom Penh from 1995-1996, Black-headed Munia comprised 13% (n=1,825) of total trade volume, the third most common species on sale (van Zalinge 1999), suggesting the presence of localised large populations (species composition of cage birds suggested trapping at wetland roosts). Although common in the mid-1990s in the cage-bird trade, the same pattern is not apparent in field surveys of wetland and grassland areas, although the other species in the top five of sales (Scaly-breasted Munia, Baya Weaver, Asian Golden Weaver, White-rumped Munia) are routinely found during surveys. Of the 27 species recorded on sale, Black-headed Munia is the rarest of the species recorded during recent field surveys of Cambodia. The species was recorded widely in remnant patches of marsh and habitat dominated by grass in the Mekong Delta of Viet Nam (Buckton & Safford 2004) suggesting Phnom Penh cage-birds originated from the delta of either Cambodia (poorly surveyed) or Viet Nam. In Cambodia it appears to have declined considerably, from a former status of "uncommon", recorded from five provinces in the period 1958-1961 (Thomas & Poole 2003).

4.3.3 Threats and local use

Threats to birds in the study area are in general well known and fit within a widespread regional pattern of predominantly chronic threats. Threats to riverine birds are similar to those documented in the nearby Stung Treng Ramsar site (Timmins 2006); this section does not repeat those findings, but provides an overview [see Table 2 in Timmins (2006) for additional details]. In the study area, actual observations of "threats" to birds were few and primarily involved birds seen captive or dead in the possession of local villagers. The primary evidence for threats is from indirect evidence, especially the perceived population status of this species with respect to geographic location. Inferences are also possible from the growing body of regional information on threats to birds, while other threats were inferred by observed changes in "wildlife habitats" within the study area. Species most clearly threatened in the study area are those for which significant declines are evident or can be confidently inferred. These fall into three broad categories:

- Species which may have already disappeared from the study area (*c.*13 species, Annex 7), including Indian Skimmer, Black-bellied Tern, White-winged Duck and Black Kite (*Milvus migrans*). A few others such as cormorants and Darter may no longer breed in the study area, although non-breeding populations still occur (Annex 6; on-line table).

- Species clearly reduced in numbers and now localised in their distribution, with suitable areas of habitat remaining in which the species are absent e.g. Green Peafowl, River Lapwing, fish-eagles (clear indications of substantial declines), and Pied Kingfisher and Plain Martin (a little more widespread although still evidently reduced from natural levels) (Annex 6; on-line table).

- Species for which evidence of threats is less direct (especially in the study area), although there is certainly cause for concern, primarily based on regional evidence from other locations e.g. Streaked Weaver, Black-headed Munia (Annex 6; on-line table).

The greatest impact to most threatened bird species is hunting, including egg and chick collection or capture of adults. Levels of threat differ between species based on their ecology and vulnerability to different hunting methods.

Bird eggs are collected opportunistically by local people, and some species e.g. River Tern, are predisposed to egg collection because they nest in easily visible sites (sometimes as colonies) in areas frequented by people, and make nests on the ground where they are easily detected. River Terns are highly threatened in the study area, because few nests remain undetected. Cormorants, like terns, are primarily threatened by egg collection because of communal breeding behaviour, which also lends itself to economic gains in the form of egg trading (River Terns are apparently too few in number to create a significant economic incentive, at least at present). Adult cormorants are locally considered "not tasty", yet low levels of hunting do occur, presumably partly due to their communal roosting behaviour, which renders hunting easy.

Hunting of adult birds includes many species (in addition to cormorants a few other species are considered "untasty"). Storks appear to be one of a suite of species impacted by "speculative hunting", especially of live

chicks. It is speculative because there is local anticipation that live birds might have monetary value. In contrast to many other birds, storks are relatively easy to maintain in captivity, and local traders may request storks from local communities, for sale to zoos or private collections (Timmins 2006). Once general awareness of this is raised among local communities, local collection may increase: if birds are not sold they are eaten or kept for amusement, with little effort and cost. Active searching for nests may be rare but eggs or chicks are almost certainly kept when found: infrequent, low-level collection of eggs or chicks may have disproportionately high impacts to the small populations within the study area and region.

Green pigeons (*Treron*) are more threatened by hunting than many other species because of their body size (a bigger meal per unit hunting effort) and the fact that they are congregatory frugivores, flocking at fruiting trees and other essential resources, such as mineral licks. Hunting of green pigeons is less "opportunistic" than for River Terns since a greater degree of planning and effort is involved, but it is easy and anyone chancing upon a flock may attempt to capture birds. Green pigeons have low trade value and are probably largely eaten by local residents, with some income from local sale for meat or cage birds. Hunting intensity is thus moderated by the level of effort needed (small as it may be) and the relatively low economic value of the activity. Green pigeon populations are almost certainly decreasing in the study area, but hunting pressure may be partly offset by large populations in and near the study area and perhaps a relatively high reproductive output.

Hill Mynas amongst birds are relatively exceptional in having an established high trade value due to their demand as cage birds. Birds are collected as nestlings and sold to wildlife dealers. Nests are in tree holes and relatively easy to find and collect (trees are climbed or cut down), however searching for nests may be time-intensive and many nests are probably found incidentally. Nest sites found in this manner may be visited by the same people in subsequent seasons, although this may lead to nest-site abandonment. Nest collection may be leading to local declines but these appear to low, due to the difficulty of finding nests and/or because collection is offset by immigration from large populations in areas with little or no collection.

Threats to Masked Finfoot are less clear. It has perhaps always been a low-density species relying on large rivers and other wetlands, themselves a rather scarce landscape feature, and thus intrinsically more vulnerable as a species than a similar-sized forest bird. Its size and behaviour may have made it more favourable as a quarry than smaller species or those that are more evasive. Its breeding behaviour may place it at risk from nest robbery or young which are easy to catch. It may also be vulnerable to several fishing practices. As a fish-eating diving bird, the species may be at risk of capture in gill nets and on baited hooks, especially when nets and hooks are placed alongside bank-side vegetation (the habitat in which the species most likely breeds). Given the apparently small size of the regional population, any individuals in the study area caught in fishing gear could represent a significant proportion of the regional population.

There are at least three key aspects to consider in the management of hunting. First, "hunting" (i.e. collection of a wide range of animal products) is deeply embedded within local culture. Second, most local people spend large amounts of time in wildlife habitats for a range of resource collection activities, and whether they are "professional" hunters or not, this increases the likelihood of wildlife being detected and collected. Consequently, opportunistic hunting may have high impacts, particularly with species whose ecology predisposes them to easy hunting. In contrast to some mammals however, there are no bird species for which economic incentives to hunt are very high. Third, interrelated to human hunting is predation by domestic dogs. Although commonly used in the human hunting of animals, dogs culturally are allowed to roam freely, and inevitably predate various bird species. This is particularly significant for ground-nesting species, especially species nesting on sedimentary formations in river channels.

After hunting and dogs, a key threat to birds in the study area is habitat loss or alteration. This may often be interrelated with the impacts of hunting, since habitat changes are primarily brought about by people and people are also hunting. In many cases species populations are probably primarily reduced by hunting before habitat changes begin to seriously affect populations. The exceptions are potentially species strongly associated with riparian forest but for which hunting threats are relatively insignificant, of which the most obvious is White-bellied Woodpecker (*Dryocopus javensis*), and potentially species associated with floodplain wildlife habitats dominated by grasses (no substantive evidence for any species).

White-shouldered Ibis although evidently primarily threatened by hunting (taking several forms, but probably predominantly egg and chick collection) is probably also vulnerable to habitat change. Some evidence suggests this species has specialised feeding ecology, linked closely with "micro-habitat" features of feeding sites. The species appears to have two primary feeding environments, river channel sedimentary formations

and, marsh and grass-dominated areas away from channel. It is in feeding environments away from the channel that the species may be most vulnerable to change; it appears that ibis favour landscapes with some low-intensity modification e.g. characteristic of local communities living within a forested landscape. Livestock husbandry by local communities, which alters the way in which livestock use land habitats favoured by ibis, may be an important factor in management for this species.

Other potential threats to birds in the study area are unconfirmed and require further review. Hydrologic changes (especially from dams along the Mekong mainstream) could cause impacts to local bird populations, but would depend on the extent of changes in local hydrologic regimes. Global climate change, and pollution, could also impact local populations, although this is difficult to assess at the current time.

4.4 Discussion

Previous sections have summarised the population status and threats to target species in the study area. Some species have relatively robust, secure, populations in the study area while others appear to be absent or nearly so. This section discusses the relative significance of the study area for bird species and priorities for conservation intervention. Conservation priorities were ranked in a systematic method applied to all vertebrate fauna (Annexes 5,6); here, the rationale for specific species is discussed in greater detail. Two species (River Tern and White-shouldered Ibis) were assessed to be "very high" priorities for conservation intervention in the study area. A further three stork species (Woolly-necked Stork, Greater and Lesser Adjutant) are potentially "very high" priorities dependent on the size of the study area's breeding population. Between 12 and 17 species were assessed to be "high" priorities for conservation intervention in the study area, while up to 16 species were assessed to be (or potentially be) "medium" priorities for conservation intervention in the study area.

White-shouldered Ibis is "Critical" at the global level having once been a relatively common species through a large part of mainland Southeast Asia. Conservation of the study area population in the "central section" is a global priority. Globally, this species persists as five populations (four in Cambodia and one in Indonesia) as well as remnant singles and small groups in north and east Cambodia and closely adjacent Lao PDR and Viet Nam: one population is in the study area; one is along the Mekong above Stung Treng Town (estimated minimum 20-30 birds; Timmins 2006); one is in an area of lowland forest/agricultural land in Siem Pang District, Stung Treng Province (*c.*108 birds; BirdLife International unpublished data); one is in lowland forest/agricultural land in Kulen Promtep Wildlife Sanctuary (15-20+ birds; WCS unpublished data). A fifth population is along the Mahakam River in East Kalimantan (Indonesian Borneo) (estimated population <100 birds; BirdLife International 2001). The study area population is comparable to all, if not larger than any. Of the known Cambodian populations, only one, in Kulen Promtep Wildlife Sanctuary, is currently under active protection. Threats facing each population are likely to be similar in type and severity. Conservation of a "riverine-based" White-shouldered Ibis population may prove easier than for "non-channel-based" populations, because of the potential conflicts between ibis ecological needs in non-channel areas and current trends for agricultural development. Channel habitats in the study area are probably at lower risk of extensive modification in comparison to non-channel feeding habitats.

River Tern populations have been extirpated from the majority of Indochina and Thailand: the study area contains the most important remnant population in Indochina. All populations of significance in Indochina and Thailand are now largely confined to northeast Cambodia, and the Mekong catchment population as a whole may be <250 birds. Populations persist in Myanmar but few quantitative data are available. Although not recognised as a global priority at present because of large numbers in the Indian subcontinent, extinction in Southeast Asia (a significant proportion of historical range) would inevitably increase its global vulnerability. The study area is significant because the numbers of birds (78+ adults), especially at the breeding colony in the upper Koh Preah area, is greater than any known from elsewhere in Indochina or Thailand. All Indochinese populations are similarly threatened and those in Myanmar are unlikely to be significantly more secure. With effective management, the study area could potentially support a much larger population. Unlike most other Indochinese populations, at least one large breeding colony persists, making conservation easier.

The Mekong Wagtail population in the study area represents 30% or more of the global population of this species, with probably 90% or more of the global population restricted to the Mekong channel between Siphandon (Lao PDR) and Kampi. The study area is globally significant for this species. At present there are few threats or conservation needs for this species, except maintenance of the mosaic of channel vegetation.

Regional stork populations have steeply declined. Large populations of Woolly-necked Stork persist only in north and east Cambodia and probably Myanmar; Lesser Adjutant has a similar distribution with large numbers also around the Tonle Sap Lake floodplain; Black-necked Stork has been reduced to little more than remnant pairs with a similar distribution to Lesser Adjutant; Greater Adjutant is now confirmed from only one sizeable colony (Prek Toal, Tonle Sap Lake floodplain) and small colonies in the northern plains (a total of a few hundred birds; WCS Cambodia unpublished data). This species appears to persist in Myanmar but there are few records (BirdLife International 2007).

The Lesser Adjutants in north and east Cambodia form one of the largest remaining global populations of this species, albeit highly threatened and perhaps more dispersed than other populations. Individuals using the study area may account for a small percentage of this population which may number in the thousands (but widely dispersed, breeding in small scattered colonies), but the regular presence of birds, especially during the surveys in November-December and July-August, suggests a sizeable local breeding population and thus a significant contribution to the north and east Cambodian population. Globally, Greater Adjutants also breed in Assam, India, but with perhaps no more birds than in Cambodia. Cambodian Greater Adjutant populations are highly significant globally. It is hard to determine the significance of the study area for this species, because the species's status in northern and eastern Cambodia is less clear than with the other stork species. The birds seen appeared to include adults, and although they may be non-breeding visitors there is almost equal likelihood of there being a local breeding population. If regular presence is confirmed then site significance is probably high and may further indicate local breeding, which if confirmed clearly would give the site high significance for the species.

Black-necked Stork remains more numerous in the Indian subcontinent and Australia than in Southeast Asia, although in India it is undergoing a significant decline. There is only one record from the study area, but no localised area within Indochina and Thailand is known to support more than a few birds. Confirmation of one or two local breeding pairs would give the study area as much regional significance as any other regional conservation area for the species. Woolly-necked Stork is globally the most widespread of the four stork species, still relatively common in Africa and the Indian subcontinent, but as with River Tern its loss from Southeas Asia would have significant global conservation implications. The species status and population significance in the study area is similar to that of Lesser Adjutant; if anything, numbers of Woolly-necked Stork are higher and may amount to a greater proportion of the regional population.

Although large breeding colonies of Greater and Lesser Adjutant are being actively protected at Prek Toal (Tonle Sap floodplain) and smaller colonies are receiving protection in the northern plains, there are no other species-focused interventions ongoing in Indochina. All breeding colonies are threatened and adults are opportunistically killed throughout their Indochinese range. Woolly-necked Stork is not receiving any species-focused conservation efforts in Indochina. A few Black-necked Stork breeding pairs are being actively protected at Prek Toal and in the northern plains. Further species-focused conservation interventions are needed for all four species, especially Black-necked Stork. The "central section" of the study area, with its extensive feeding habitats, could support populations of all four stork species a magnitude or more greater than at present, a potential offered in few sites regionally.

Populations of all three resident vultures in southeast Asia have crashed, leaving only two populations of each species (each of similar size) that have more than a handful of birds, one in Myanmar and one in northeast Cambodia. The numbers of each species in the Cambodian-centred population are thought to be <200, with Slender-billed the most scarce. Globally all three species are faring little better, with South Asian populations having crashed because of the toxic effects of a widely used veterinary drug, ingested as a result of eating domestic livestock carcases. This problem appears not to be the case for declines in Southeast Asia. The "central section" of the study area is on the southwest edge of the Cambodian range. Individual birds probably have home-rangeswithin this overall range, but all three species are capable of flying great distances in search of food, thus the importance of the study area largely depends on the availability of food and the relative level of threat faced by birds while they are present. The study area has a free-ranging domestic buffalo population, which becomes available to vultures when animals die, and theoretically would at one time have supported high densities of ungulates. The ecological interactions of ungulates with the study area vegetation, particularly in the form of domestic buffalo, should be considered an integral aspect of site management and one which should be managed accordingly. Conservation of vultures might thus be considered an extension of natural / traditional forms of livestock management in the study area.

Grey-headed Fish-eagle populations are in severe decline throughout Southeast Asia, and for this species which appears to prefer lowlands with extensive wetlands, large numbers only remain in Cambodia around the Tonle Sap Lake floodplain and the rivers of the northeast, with unknown but probably significant numbers in Myanmar. With probably between 40-60 pairs, the "central section" of the study area may support the highest densities and largest population of this species in Cambodia. Globally the species is still relatively numerous in South Asia. Grey-headed Fish-eagles have always been less numerous than equivalent-sized forest raptors, because of the relative scarcity of permanent wetlands within Southeast Asian landscapes. This intrinsic scarcity is confounded by human populations which are focused on the same wetlands. Birds are threatened by persecution and habitat loss (primarily in the removal of trees), which interact to increase relative threat levels to remaining populations.

The global Red Listing of Masked Finfoot as "Vulnerable" is surely an underestimation of its true status. Globally, there are no known large breeding populations (possibly the only recent confirmation of breeding comes from Cambodia and involves a small number of birds) or large concentrations (BirdLife International 2001). It was long suspected that the floodplain of the Tonle Sap Lake and rivers of northeast Cambodia and adjacent areas of Lao PDR and Viet Nam held a globally significant breeding population, but in no area have records amounted to more than small numbers of individuals. Available data appears to indicate this species is declining even in almost pristine wetland habitats (this contrasts with species such as White-shouldered Ibis, River Tern and Grey-headed Fish-eagle). With little available data on status, it is difficult to review threats. It is possible the species is sensitive to a suite of factors, most unconfirmed, including direct hunting of birds, nest robbery by people and dogs, and vulnerability to capture in various fishing gear. Masked Finfoot is probably "Critically Endangered" globally, yet there are no species-focused conservation interventions anywhere in its global range. Although there is only one record from the study area, there is little to suggest the "central section" is of lesser value to the regional population of this species, than any other river stretch or wetland with confirmed records. Global attention is needed for this species more urgently than any other species recorded during surveys.

Green Peafowl populations have steeply declined regionally. The largest remaining populations are centred on extensive tracts of habitat in Cambodia and Myanmar, with outlying populations in Java. The species retains some large populations (tens of thousands of birds may survive in Cambodia), and it is the extent and speed of decline of the global population that led to its Red List status. Green Peafowl populations will continue to decline significantly under any conservation scenario, because it is unlikely the majority of their current range could be brought under effective conservation management. However, if several sizeable areas in their current range are protected, the long-term survival of this species could be secured. Currently, the study area supports a small proportion of the Cambodian population, but in the "central section" birds are still numerous and at relatively high density. One of the limiting factors in its ecology appears to be accessibility of permanent water sources, critically during the height of the dry-season. The "central section", due to its proximity to water, may offer optimal conditions for this species. Conservation of this species in the "central section" has other potential advantages e.g. using the species for monitoring of hunting trends, and ecotourism.

Within the study area, all of the above species are confined or largely confined to the "central section", except the Mekong Wagtail (although highest numbers are in the "central section"). In the "central section", riparian and channel habitats are still in relatively good condition, clearance of riparian forest is still patchy within a mainly forested landscape, villages and settlements are still localised rather than continuous, the density of people is low, and human use of the channel is much lower than in other sections of the Mekong, which are more populated. One attribute of the "central section" enhances its significance considerably: the two-dimensional complexity of the channel, especially areas covered by shrubs and trees and the extensive areas of channel bed exposed during the dry season (Annex 3 – Plate 25). This complexity increases both the species richness and numbers of birds that are able to use the "central section", and also has a "protective" effect in that it limits frequency and volume of human incursion into wildlife habitats, because most people invariably use the most easily navigable channels.

The "central section" has the least disrupted and most diverse assemblage of riverine birds known in Indochina and Thailand, and its significance extends beyond the target species discussed above. The "central section" also supports a range of other (lower priority) species e.g. Great Thick-knee, River Lapwing and Lesser Fish-eagle. The study area has probably lost several species, but in most cases these are not closely tied to riverine environments (large hornbills) or, they are riverine species that have been lost from most or all of Indochina and Thailand. Conservation interventions in the "central section" are a high priority, and could

not only protect several high priority species but also help maintain a rich assemblage of riverine bird species. The Stung Treng Ramsar site is the most comparable site to the study area in Indochina and Thailand, in terms of habitats and the communities of birds present. Timmins (2006: Section 6.2) assessed the conservation significance of the Ramsar site with other regional wetlands and acknowledged the "central section" was likely to be of higher conservation value than the Ramsar site. This is now confirmed. The "central section" of the study area represents an unparalleled opportunity to conserve a globally significant assemblage of bird species.

In addition to the channel habitats of the "central section", the study area has other geographical areas and landscape types. The well-vegetated, seasonally exposed channel above Kampi is most comparable with the "central section", but has lower conservation value, due to the absence or rarity of some species e.g. fish-eagles (rare/absent), River Tern (no longer breeding) and White-shouldered Ibis (none recorded). This is due to higher numbers of people and levels of habitat degradation. Riparian forest has been completely lost, and relatively few large trees survive within the channel. This section still has significance however, especially for Mekong Wagtail, Plain Martin, Darter, Spot-billed Duck and Pied Kingfisher.

The Mekong below Kampi has a different character, becoming slow and broad with extensive sand formations. Most of the historic wildlife value of this area has been lost, although some moderate regional conservation values remain for birds. This river section has a high density of people and riparian habitats have been highly modified. Little Tern is still present but close to extirpation (as it probably is along the length of the Mekong, although more substantial regional breeding populations occur coastally). The bird community present in the sand formations dominated by tall grasses was notable particularly in the presence of Black-headed Munia, a species which is localised and apparently in significant decline in at least Indochina. Also notable were large numbers of Blossom-headed Parakeets found using these grass formations. Assessing the significance of residual populations of these species is hampered by a paucity of data from comparable areas, and further surveys of tall grass formations and breeding birds of sand formations is a low priority, but one of some immediacy (if any conservation interventions were warranted) as the larger grass formations are probably under considerable pressure for conversion to agricultural land.

Floodplain areas are prevalent only from Sambor Town and downstream, and are also difficult to assess without more comparable data. Surveys have been conducted in two similar areas, the Mekong Delta (Viet Nam and small adjacent areas in Cambodia) and Tonle Sap floodplain (Cambodia) although these areas appear to have differences physically and faunistically. Three types of floodplain wildlife habitats are potential conservation priorities: areas dominated by tall grass, areas dominated by trees and shrubs, and permanent marshes. All are threatened by conversion to agriculture. In the study area, no high-priority bird populations were detected during surveys and indications were disappointing (e.g. low numbers of waterfowl). However, these habitats are relatively rare and very threatened when compared with other major wildlife habitat types. More extensive surveys of the Cambodian Mekong floodplain wetlands are warranted, especially in areas dominated by tall grass, and for Masked Finfoot, Comb Duck (*Sarkidiornis melanotos*), Streaked Weaver, Red Avadavat (*Amandava amandava*), Black-headed Munia and two potential species not known from at least the lower Mekong, Clamorous Reed Warbler (*Acrocephalus stentoreus*) and Rufous-rumped Grassbird (*Graminicola bengalensis*). Other aspects for investigation would be consideration of the recorded numbers of jacanas, Purple Swamphens (*Porphyrio porphyrio*), Watercocks (*Gallicrex cinerea*) and Cotton Pygmy-geese in relation to ecological and human factors in floodplain areas.

Surveys in the study area focused on channel habitats, because pre-survey observations suggested that forests along the mainland and on islands would have lower conservation value compared with channel or floodplain habitats. Brief surveys in such forest habitats confirmed this prediction. Most birds in these areas are widespread and of lower conservation significance than those in the Mekong channel (no indication of Sarus Crane or Giant Ibis). With many frugivorous birds (green and imperial pigeons, hornbills, parakeets, Hill Myna), the loss of nearby terrestrial forest will probably cause population declines in the study area. Conservation of these species within the study area is not considered a high priority, although the remnant terrestrial and riparian forest within the study area, if effectively managed, could still support large populations of all species except perhaps the two large hornbill species (which have already declined in the study area).

At least four channel-associated priority bird groups/species also use areas extending beyond riparian forest: storks, vultures, Green Peafowl and White-shouldered Ibis. The conservation of these species is primarily dependant on changing cultural attitudes toward wildlife. For vultures and Green Peafowl, requirements for habitat management are probably insignificant but for vultures, ensuring adequate food supplies is important.

Green Peafowl (Brickle et al. in press) and White-shouldered Ibis seem likely to use areas within several kilometres of the Mekong channel and their conservation can be site-based. Vultures utilise tens of thousands of square kilometres and their conservation requires a landscape-scale approach. Storks are also wide ranging, particularly Greater Adjutant, but site-based protection of birds and especially nests up to 20 km from the Mekong would likely enable population recovery to occur. In general however, the study area is not an appropriate site for conservation of forest species compared with lowland forest conservation areas in Cambodia.

For areas outside of the channel and away from riparian forest, bird conservation in the study area would be optimised by protection of areas dominated by grass and marshes. Thus new clearance for cultivation and agricultural should avoid the latter wildlife habitats (which are often favoured for conversion) and instead focus on forest areas away from the channel and riparian forest as far as possible. It would also be beneficial to promote continuation of traditional low intensity agriculture (potentially amidst high intensity agriculture), including not using chemical fertilisers, pesticides or herbicides, maintaining small paddy areas with overgrown bunds, scrub patches, trees and patches of fallow, and allowing grazing of fallow, post-harvest and pre-planted paddies. Continuation of traditional livestock grazing practices (allowing "free-ranging" herds to utilise a patchwork of marsh, paddy and other areas dominated by grass) should also be encouraged.

5. LARGE MAMMALS

Robert Timmins



5. Introduction

The study area has been the focus of prolonged and detailed survey work on the Irrawaddy Dolphin (*Orcaella brevirostris*) and a conservation project is ongoing (MAFF 2005; Dove et al. 2008). For this reason the current surveys did not include this species. Surveys of other mammals in the study area have been minimal, although the discovery in February 2006 of Hog Deer (*Axis porcinus*) in localised areas of the floodplain, resulted in initiation of surveys and conservation activities (Maxwell et al. 2006). Other recent data on mammals in the study area has resulted from incidental observations during other fieldwork (Poole 2003). Previous general wildlife surveys along the Mekong channel (Section 4.1) have generated few data on mammals.

5.2 Methods

5.2.1 Target species

Surveys focused on "large mammals" as collection of data on small mammals is time consuming with little current use in conservation planning, because the context in which to assess new results is so incomplete. In this report, "large mammals" were defined as mammalian families in which the majority of species are readily identifiable in the field (*sensu* Dorst & Dandelot 1970; Duckworth et al. 1999a). A suite of target species (Table 8) were selected following the criteria applied for selection of target bird species (Section 4.2.1).

Table 8. Target mammal species surveyed in the study area.

Group / species	Survey goal / activities	Survey period
Primates (Cercopithecidae)	Survey representative areas of riparian forests and dense tree formations within the river channel	All
Otters (Lutrinae)	Survey representative areas of the channel for otter signs; gather information from local people on reported occurrence	All
Hog Deer	Gather information from local people on reported occurrence of species and the locations of floodplain areas dominated by tall grass; survey reported localities to assess the likely status of the species	All
Ungulates	Assess use of the area by sign based surveys of representative areas	All
Large fruit bats (flying-fox *Pteropus* spp.)	Gather information from local people on reported occurrence; survey reported localities to assess their status	All

Prior to the survey it was predicted that few mammal species of conservation significance would occur in the study area for at least two reasons. First, there are few aquatic mammals in non-marine habitats of Cambodia (only otters and Irrawaddy dolphin). Second, although the terrestrial areas and floodplains of the study area would once have supported an abundant mammalian community, this was presumed to be unlikely at the time of surveys. Many large mammals are now globally or at least regionally threatened and have declined greatly in abundance. The study area has a relatively high human density and associated degradation of terrestrial forest, compared with more remote tracts of similar habitats: it seemed likely that species of concern associated with such terrestrial habitats in the study area would primarily be those which remain widespread through the forested landscapes of Cambodia (i.e. species for which the study area would have minimal conservation value in a national and Indochinese context). Most other large mammals of conservation significance were predicted to be locally extinct or nearly so. For this reason, little survey effort was extended to large mammals away from channel and riparian areas.

Mammal taxonomy follows Corbet and Hill (1992), with English names following Duckworth and Pine (2003). Species records which are provisional or unconfirmed are denoted **[ ]**; species presumed to have been present historically (no records in survey) are denoted †.

Cover: Hog Deer (*Axis porcinus*), adult male ©WWF-GMP/DNCP/FA Cambodia.
1. Otter sp.©WWF-GMP/FA Cambodia.
2: Hog Deer, female with fawn ©WWF-GMP/DNCP/FA Cambodia.
3. Otter (*Lutra*)sp.©WWF-GMP/FA Cambodia.

5.2.2 Survey localities and dates

Mammal surveys focused on the Mekong channel and its remaining riparian forests, with relatively little survey effort in terrestrial habitats away from the channel (Table 9).

Table 9. Timing, effort and localities of surveys for large mammals.

Survey period / location	Dates	Survey focus†	Effort (days)$
November-December 2006			
Eastern Channels	11-16, 17 Nov., 29 Nov.–2 Dec.	All species, habitats	5.5"^
Koh Enchey area	16-20, 24 November	Channel, riparian habitats	2.5
Koh Plong area	18 November, 2 December	Channel, riparian habitats	0.5
Island cluster, ST border to Koh Dambong	19, 20-29 November	All species, habitats	8.5"^
Koh Preah area	21 November	Riparian habitats	<0.5
Contoipreykien floodplain area	3-4 December	Floodplain habitats	1.5
Boeng Thom floodplain south of Kratie	5 December	Floodplain habitats	0.5
March-April 2007			
Stung Treng to Kratie provincial border	11-14 March	Channel, riparian habitats	2.5
Island cluster, ST border to Koh Dambong	14-27, 31 March	Channel, riparian habitats	12.5
Koh Plong area	20, 27-28 March	Channel, riparian habitats	1.5
Koh Enchey area	20, 27, 28-31 March	Channel, riparian habitats	3
Eastern Channels	31 March–5 April	Channel, riparian habitats	5
July-August 2007			
Floodplain wetlands south and west of Kratie	29 July-3 August, 5 August	Floodplain habitats	5
Viel Ma-om near Tchroybantee-ayleur Village	6, 22-23 August	hog deer (*Axis porcinus*)	0.5
Koh Plong area	6, 8 August	Channel, riparian habitats	1"
Koh Enchey area	6-10, 20 August	Channel, riparian habitats	2.5
Eastern Channels	10-17, 21-22 August	All species, habitats	7"^
Island cluster, ST border to Koh Dambong	7, 17-21 August	All species, habitats	4"^
Floodplain wetlands close to Sambor	22 August	fruit bats (*Pteropus*)	<0.5

ST=Stung Treng. † = all observations of significant species were recorded; $ = bird+mammal survey effort, focused mammal effort was significantly less; ^ = ponds visited, and " = tributaries surveyed (effort included in total)

5.2.3 Survey methods

Survey methods for large mammals were largely the same as for birds (Section 4.2.3), and surveys for mammals and birds were usually undertaken simultaneously. No attempt was made to conduct an inventory of the large mammals present at the sites visited. This would have entailed a different survey strategy, and would not have provided much data of significance for wildlife conservation management. Focused mammal observation was primarily restricted to the "central section", although information on otters and large fruit bats was sought throughout the study area, and primates were also sought during surveys of well-wooded floodplains. Given the current conservation initiative for Hog Deer (Maxwell et al. 2006; WWF Cambodia Programme unpublished data), surveys focused on obtaining new information from areas not previously known to support this species.

1. Boat-based observation methods. This method was used for surveying riparian areas for macaques (*Macaca)* and leaf monkeys (*Semnopithecus*). Incidental records of other species were noted as appropriate.

2. Foot-based observation methods. These methods were primarily aimed at birds and diurnally active mammals (primates, squirrels and treeshrews) and mammal signs. Signs of wild ungulates were recorded; some signs were traced and/or photographed. Identification of tracks was based solely on the prior experience of RJT, and in the case of otters and cervid deer, was primarily based upon comparison with track morphology and measurements obtained from prior fieldwork and captive animals in Indochina (see Timmins et al. 2003). Subjective assessments of distribution and abundance of large mammals were made based on the abundance of signs seen. During channel surveys, a representative proportion of sand and silt substrates along water edges was systematically searched for signs of otters (usually by foot, occasionally from the boat), in each channel habitat and in each section of the channel surveyed. A similar method was used for potential otter spraint (= faeces) sites (i.e. logs, trunks, rocks close to or within water). During foot-based surveys in channel habitats, significant effort was engaged in detecting signs along the survey route. Habitat use by target species is given in an on-line table (OLT, www.panda.org/greatermekong/survey) (see also Annex 5).

3. Abundance. Abundance categories were assessed as for birds (Section 5.2.3). Abundance estimates are described in individual species accounts (Section 4.3.2) and the OLT (see also Annex 5).

4. Interviews with local people. Interviews focused on gathering first-hand information of sightings of otters and flying-fox roosts. Information on doucs (*Pygathrix*) and Hog Deer was sought through interviews.

5.2.4 Limitations

Few limitations were encountered for surveys (see Section 4.2.4 for birds).

5.3 Results

5.3.1 Overview

Large mammal communities documented in the study area were much as expected dependent upon the type of habitat found. This section briefly describes some key observations about the relationship between large mammal communities and habitats in the Mekong River channel, and supplements a more detailed discussion in Timmins (2006) for the Stung Treng Ramsar site.

The least disrupted remnant large mammal communities in the study area are within the "central section". This is due to lower human densities and more extensive, less encroached, "natural" habitat than elsewhere in the study area. Some floodplain areas west of the Mekong River also remain well-forested and retain large mammal species (e.g. Long-tailed Macaque, Silvered Leaf Monkey, Sambar) which have probably disappeared from other parts of the study area. The "central section" may have also lost much of its large mammal community, especially large quarry species [wild oxen (*Bos, Bubalus*), elephants (*Elephas maximus*), big cats (*Panthera*); Annex 7; OLT]. Smaller species, including Northern Treeshrew (*Tupaia belangeri*), lorises (*Nycticebus*), Golden Jackal (*Canis aureus*), Yellow-throated Marten (*Martes flavigula*), badgers (*Arctonyx collaris*, *Melogale*), civets (Viverridae), mongooses (*Herpestes*), small cats (Felidae), pigs (*Sus*), Lesser Oriental Chevrotain (*Tragulus javanicus*), deer (Cervidae), squirrels (Sciuridae), flying squirrels (Pteromyidae), porcupines (Hystricidae) and Siamese Hare (*Lepus peguensis*), were confirmed or are predicted to occur (Annex 6). Gibbons (*Hylobates*), if they occurred, have probably disappeared from the study area, and the same appears to be the case for Pig-tailed Macaque (*Macaca nemestrina*). Bears (Ursidae), pangolins (*Manis*) and Dhole (*Cuon alpinus*) are likely in a similar predicament although survey methods did not allow for detailed assessment.

Historically, most mammals were probably widespread in the study area, but a few species show natural patterns of variation in distribution. The Variable Squirrel (*Callosciurus finlaysonii*) is restricted to areas west of the main dry season channel of the Mekong (including islands and areas with extensive trees within the channel), while to the east Pallas's Squirrel (*C. erythraeus*) occurs. The only exception to this pattern observed during the survey was the presence of what appeared to be a variable squirrel taxon (perhaps unnamed) on Koh Chreng, below Kratie Town, which is east of the main dry season channel of the Mekong. Gibbons would once have presumably shown a similar pattern with Pileated Gibbon (*Hylobates pileatus*) in the west and Yellow-cheeked Crested Gibbon (*H. gabriellae*) in the east; another group probably with a similar pattern

is the lorises. It is thought that doucs (*Pygathrix*) are restricted to areas east of the Mekong, but independent information from two local residents who appeared familiar with these primates suggests doucs may occur within dense forest areas west of the Mekong, although they do not occur in riparian forests of the study area. If confirmed this would be a significant extension of the known range.

Hog Deer appears to be naturally restricted in distribution primarily to floodplain areas west and south of Kratie Town. It is possible the species may also have occurred in terrestrial habitats further north where there is little/no floodplain, but it is suspected to be most abundant within floodplain habitats (Maxwell et al. 2006).

Two large mammal species, Long-tailed Macaque (*Macaca fasicularis*) and Silvered Leaf Monkey (*Semnopithecus cristatus*), are associated with riparian vegetation and occur in the study area. Wild Water Buffalo (*Bubalus arnee*) may once have been associated with the channel, riparian and floodplain habitats in the study area, but if so, probably no longer occur.

5.3.2 Species accounts

This section presents accounts of target species for which the study area's population is ranked to be of "high" or "medium" management priority, some species which may have been, or are close to, local extirpation, and some species of presumed ecological significance (species sometimes referred to as "keystone" species) (Annex 6; OLT). Species of lower conservation importance are listed in Annex 6. Forest habitats on the mainland and islands in the channel would once have supported an abundant mammalian community, yet most are now globally or regionally threatened and are extirpated from the study area (Annex 7; OLT). Large mammals which may persist in the study area and require conservation of large forest blocks are better suited to conservation approaches in other regions of Cambodia and these species are not considered further: they include Sunda Pangolin (*Manis javanica*), primates (except those in Annex 6), Dhole, bears, badgers, Binturong (*Arctictis binturong*), Large-spotted Civet (*Viverra megaspila*) and various small cats. Distribution maps for some target species are in Annex 2.

Long-tailed Macaque (*Macaca fascicularis*) (Globally Near-Threatened)
Recorded widely in the "central section"; outside the "central section", recorded only in the Prek Bang / Boeng Meier area (Annex 2–Map 9). This species is probably in rapid decline in the study area, due to targeted hunting of live animals for wildlife trade. Signs of hunting were frequently observed in the "central section". A decade ago this species was probably abundant in the "central section"; it is likely to soon be extirpated in the study area unless hunting is reduced. This trend is occurring throughout Cambodia (Timmins 2006; J. Walston personal communication). In Lao PDR, the species has a naturally small area of distribution and in Viet Nam it is localized; hunting of this species occurs in both countries. Populations in Thailand are still high. This species is facultatively associated with forested areas in or adjacent to wetlands.

Silvered Leaf Monkey (*Semnopithecus cristatus*) (Globally Data Deficient, as *Trachypithecus villosus*)
Recorded widely in the "central section"; outside the "central section", recorded only in the Prek Bang / Boeng Meier area (Annex 2–Map 9). The conservation status of this species is clouded by unresolved taxonomic issues. It has been proposed that one taxon, *Trachypithecus germaini* (*sensu* Groves 2001) restricted to Thailand, Cambodia, Viet Nam, Lao PDR and perhaps Myanmar, is in fact two species (Nadler et al. 2005), possibly separated by the Mekong River. Observations of external morphology made during surveys suggest such a division is not clear. Cambodia supports the largest numbers of the proposed *T. germaini* taxon globally, and it is still widespread and numerous in some areas. Populations in other range countries are generally small and localised (Global Mammal Assessment unpublished data). This mainland Southeast Asian taxon is likely to be considered "Globally Threatened-Endangered" in the future. The species is hunted alongside most large mammals and this, confounded by its association with lowland habitats, especially riparian and other wooded wetland habitats, threatens remaining populations. The trade in primate parts for "traditional Asian medicines" appears to be not yet widespread in Cambodia, but this may in part be due to the massive ongoing trade in macaques. Primate trade is likely to increase in the future, especially as macaque numbers decline, and will increase pressures on Silvered Leaf Monkey.

[Eurasian / Hairy-nosed Otter (*Lutra lutra/L. sumatrana*)] (Globally Near-Threatened/Data Deficient)
Tracks, probably from *Lutra* otters (Annex 3–Plate 29), were found occasionally in the "central section" in the dry season (Annex 2–Map 10). Otter tracks can be difficult to separate from those of civets, but the locations of tracks found during surveys, in addition to their morphology, almost certainly indicate they were from otters. Local residents reported that otters are still present in the eastern channels and Koh Plong Island area of the

western mainstream; no direct evidence was found in these areas, although survey effort was lower than other areas (Table 9). Otters may still be present in some floodplain areas, although few are likely to persist. The ratio of all otter tracks (even confirmed *Lutrogale* tracks) to spraints found during surveys was high. In the author's experience this is unusual, and may be indicative of the very small numbers of otters present (rather than casting doubt on the identification of tracks). In general, the paucity of all otter signs indicates otters are nearly extirpated in the study area.

Smooth-coated Otter (*Lutrogale perspicillata*) (Globally Threatened-Vulnerable)
Tracks of this species were found occasionally in the " central section " (Annex 2–Map 10). Local residents reported that otters are still present in the eastern channels and Koh Plong Island area of the western mainstream; no direct evidence was found in these areas, although survey effort was lower than other areas (Table 9). Otters may still be present in some floodplain areas, although few are likely to persist. The paucity of all signs of this species indicates it is nearly extirpated in the study area.

†[Oriental Small-clawed Otter (*Aonyx cinerea*)] (Globally Near-Threatened)
No evidence of this species was found during surveys. This species was perhaps historically the most wide ranging and numerous of the Southeast Asian otters, and the lack of evidence for this species in the study area is surprising. It probably occurred historically but if so, is either locally extinct or nearly so.

'Wild' pig sp.(p.) (*Sus*) (Little Known in Lao PDR)
Signs of pigs, probably of wild animals, were found throughout the "central section", although numbers are probably depressed from historical levels. The taxon present in the study area, probably Eurasian Wild Pig (*S. scrofa*), is unlikely to be of any conservation concern. Maintenance of the species in the study area would surely be of ecological value in assisting a balanced channel and riparian habitat ecology.

[Eld's Deer (*Cervus eldii*)] (Globally Threatened-Vulnerable)
Old deer tracks, whose size matched either Eld's or Hog Deer, were found on 1 December 2006 at a pond north of the Prek Preah River. The habitat at this site was characteristic of the habitats where Eld's Deer occurs in Cambodia (open forest with high grass content in the understory, Tordoff et al. 2005). Unconfirmed local reports were also obtained of *Romeang*, the usual Khmer word for Eld's Deer, from areas north of Sambor Town. None of the reports suggested anything other than residual animals and any remaining population is likely to be of relatively low conservation significance.

Sambar (*C. unicolor*) (Potentially At Risk in Lao PDR)
Tracks of this species were recorded occasionally or frequently at various sites in or adjacent to the eastern mainstream, and occasionally elsewhere in the "central section". Sambar, though widespread regionally, has undergone a significant decline in Cambodia due to bushmeat trade and a primarily medicinal trade of antlers to East Asia. Maintenance of this species in the study area would surely be of ecological value in assisting a balanced channel and riparian habitat ecology.

Hog Deer (*Axis porcinus*) (Endangered in Thailand; Conditionally At Risk in Lao PDR)
The survey gathered no new data on the local occurrence of this species (Annex 3–Plates 26-28 and cover photos this chapter) outside previously documented sites at floodplains west of Kratie Town. Circumstantial evidence for the species was gathered from areas to the north. Old footprints of this species or more likely Eld's Deer, were found on 1 December 2006 at a pond north of Prek Preah River. Tracks, probably too large for Red Muntjac (*Muntiacus muntjak*) and thus suggesting Hog Deer, were found twice within channel areas, on 23 March 2007 (southwest of Koh Sompong Thom Island) and 4 April 2007 (close to Koh Thnaot Island). Some local residents reported the presence of *Kadan* (the Khmer term for Hog Deer) from the islands and eastern mainland north of Sambor Town, including Boeng Snit marsh and paddy fields on Koh Thnaot (possible tracks found close by), and Koh Tbong Khla, but stated that numbers were low. Other residents were not familiar with the species. Sporadic or localised occurrence in these areas seems possible as the species was probably more abundant historically, but it seems unlikely that even under natural conditions, populations in terrestrial forests away from floodplain areas would be large (see Maxwell et al. 2006). Conservation status of the species is summarized by Maxwell et al. (2006); additional data are being gathered by WWF Cambodia.

†[Wild Water Buffalo (*Bubalus arnee*)] (Globally Threatened-Endangered)
Not recorded during surveys. This species, the wild progenitor of domestic water buffalo (*B. bubalis*), is probably locally extinct, as it is throughout almost all of its former range. It is naturally associated with wetlands. Although lost from most areas, its ecological role has probably been largely replaced by domestic water buffalo, as traditional husbandry methods allow buffalo to wander freely for much of the year.

Large/Lyle's Flying-fox (*Pteropus vampyrus/P. lylei*) (Vulnerable/Near-Threatened in Thailand; Potentially At Risk in Lao PDR)
A large roost of 1,700-3,500 bats, probably of both species, but certainly at least the latter, was located in tall riparian trees in the grounds of a monastery on Koh Chreng Island south of Kratie Town (E614000, N1366300). Roost sharing is common with these species (e.g. Phnom Penh and Siem Reap colonies) and since size is the only distinguishable feature separating their appearances, determining even the relative abundance of either species in a colony is difficult (J. Walston personal communication). This roost is reportedly permanent. Local people reported that bat numbers had decreased, which they attributed to hunting by people. A second, smaller seasonal roost was reported by two residents to occur in a small patch of trees and shrubs on the floodplain east of Sambor Town (E606500, N1411500). In April 2007, one resident reported seeing 100+ bats in August-September 2005 and 2004, and stated that the bats roosted in relatively small trees (*c.*10 m tall) in a patch (<5 ha) of inundated shrubs and trees. In August 2007, another resident reported seeing bats in the same area in May 2006, and *c.*10 bats in mid-July 2007, but not since then. Both residents thought people had disturbed the bats while at roost and possibly hunted them, causing roost abandonment. These species are known to often, though not always, be seasonal migrants in the region, and the dates of these movements are not consistent (J. Walston personal communication). Given the small numbers reported and apparent annual disturbance it seems likely this roost will soon cease to be used.

In Cambodia, as across much of Southeast Asia, flying-foxes are actively hunted and have probably declined greatly from historic levels. Remnant populations in Cambodia and Viet Nam (the genus is probably extinct in Lao PDR) are largely confined to sites where they are somewhat protected from persecution (especially monasteries), and although such populations may be relatively stable, bats are still actively hunted when feeding, or roosting in "non-protected" sites (as reported on several occasions during the survey).

5.3.3 Threats and local use

Current threats to mammals in the study area are similar to threats to birds, including hunting, commercial trade and habitat loss (Section 9). A key difference is that a much larger proportion of large mammals have a high "trade" value than birds (see also Table 2 in Timmins 2006), and this is the primary reason why a larger proportion of large mammals is locally extinct or nearly so in the study area (at least 11 species, Annex 7).

Commercial-scale demand can threaten even resilient species, e.g. Long-tailed Macaque, which appears to tolerate low levels of hunting and is adaptable to habitat degradation. Intensive and uncontrolled capture of macaques is currently occurring throughout Cambodia, largely due to government approval for legal export of live wild animals for "scientific" purposes to East Asian countries. For many rural Cambodians, macaque capture and sale represents a relatively new but lucrative source of cash income. In the study area, macaque capture and trade was observed throughout the "central section". The most obvious capture method observed (always post-capture) was the reported practice of corralling macaque troops in a "roost" tree, felling a ring of trees around this tree, then erecting nets and chasing the monkeys into the nets at night. Over 15 such capture sites, as well as large macaque spring-traps and evidence of other capture methods, were observed. Survey teams also observed captive macaques in villages in the "central section", including the homes of two wildlife traders in Koh Khnhaer and Saitlieu Villages. Sale prices reported to teams were 80,000-200,000 Riel (USD20-50/individual, sold by a local person to a middleman) (M. Bezuijen personal communication) and 400,000 Riel (USD100/individual, sold by a middleman to a wildlife dealer). In contrast, in 1999 in the Tonle Sap Lake region, macaques were sold for 5,000 Riel (USD1.3)/individual (Anon. 1999).

Residents in the "central section" reported that macaque hunting began in 1999, but that intensive capture and trade only began in 2005-2006, when prices increased rapidly (M. Bezuijen personal communication). This was also evident from many new capture "rings", where trees had been recently cut. However, the current intensity of macaque hunting is almost certainly unsustainable, and threatens the species with local extinction, aided by the rapid ongoing loss of riparian forest. In the Tonle Sap Lake region, where intensive capture appears to have been conducted longer (Anon. 1999), hunters now catch Silvered Leaf Monkeys because macaques are so scarce (C. Poole personal communication). This presumably supplies a different but equally insidious wildlife market for East Asian "traditional medicines" derived from primates. Local people in the study area stated that dead macaques and Silvered Leaf Monkeys were not currently sold to middlemen, but it seems likely this will occur. Elsewhere in northeast Cambodia, macaque hunting is also relatively new; during other surveys between 1998 and 2003, the author did not observe any macaque hunting. For other primates (gibbons, doucs), their disappearance from the study area probably reflects differences in species ecology which render them more vulnerable to hunting (e.g. lower fecundity, less wary, lower natural densities) rather than higher trade value.

5.4 Discussion

This section discusses the relative significance of the study area within the context of global, regional and national biodiversity conservation for large mammal species. Mammal priorities for conservation intervention in the study area were in a systematic method applied to all vertebrate fauna (Annexes 5, 6); here, the rationale for specific species is discussed in greater detail. Only one species, Hog Deer, was ranked as a "very high" priority for management action in the study area. Silvered Leaf Monkey was assessed as a "high" priority and otters may also be a "high" priority, although the viability of populations remains in question, because of the very low numbers present and the difficulty of implementing effective measures to protect otters. The priority of Long-tailed Macaque, Eld's Deer and large fruit bats is questionable because of uncertainty over the significance of the study areas populations. As with birds, the most significant part of the study area for general mammal conservation is the "central section", but in addition to the "central section", the floodplain areas west of the Mekong in the southern portion of the study area are of equal if not higher significance, at least for conservation of Hog Deer. While some floodplain areas hold residual significance for Silvered Leaf Monkey and possibly otters, these areas do not appear to coincide well with those for Hog Deer because of the very different habitat preferences of these species.

The Hog Deer population in the study area is critically threatened. Individuals live in a habitat mosaic used daily by a large and growing human population. Animals are hunted, and fawns are easily found by dogs, whether by human-initiated hunting or incidentally. Remnant floodplain habitats are being rapidly converted to agricultural lands. Hog Deer, which may always have been localised in occurrence, has declined regionally from former abundance to its current status of probably extinct in Lao PDR, Thailand and Viet Nam, with only one known population remaining in Cambodia, in the study area (Maxwell et al. 2006). Current "wild" populations in Thailand originate from animals introduced from Myanmar populations and in several instances occur within habitats not usually associated with "natural" populations (Maxwell et al. 2006; RJT unpublished data). Myanmar may have several discrete populations, with larger numbers than Cambodia, but these animals appear to be a different subspecies (Maxwell et al. 2006; Global Mammal Assessment unpublished data). Although still "numerous" in South Asia, remaining populations are localised and in decline (Maxwell et al. 2006; Global Mammal Assessment unpublished data). Conserving the Cambodian population is significant for preserving the global diversity of this species, maintaining part of its global range, and as a means to conserve some of the last vestiges of its natural habitat in Indochina. Active protection is required to conserve this remnant population.

If Hairy-nosed Otter is present in the study area, its population significance is potentially "high". The global status of this species is enigmatic; it appears to be largely restricted to a specific habitat, well-wooded lowland wetlands, and has a relatively small global range. In mainland Southeast Asia it is now known only from Cambodia (a few coastal and Tonle Sap Lake sites), Viet Nam (one site in the Mekong Delta) and Thailand (two sites). Most otter species are declining in Indochina and there are currently few conservation activities to protect otters. Otters, like the wetlands they inhabit, are intrinsically rare compared with other habitat features, and this is confounded by the association of human populations with wetlands. The principle factor in otter declines is the trade of otter pelts to North and East Asia, and traditional medicinal use of otters regionally. In the study area, otters would be difficult to protect given their low numbers and increasing human pressures, but otter conservation should be considered as a longer-term conservation priority. Successful protection of otters (and many other threatened species) in the "central section" will require ranger patrols to halt hunting or incidental capture. If otters disappear from the study area, it is unlikely that natural recolonisation will occur, due to the lack of conservation efforts for otters in Indochina and few plausible source populations. Currently in Indochina, the most protected otter populations are probably in the Srepok Wilderness Area in eastern Cambodia, and in conservation areas in the Cardamom Mountains.

The population significance of flying-foxes in the study area is potentially "high", at least regionally. Little information on the regional conservation status of flying-foxes is available, although some remnant colonies (especially in Indochina) are in the grounds of monasteries, where they receive some degree of protection, and in Thailand many colonies are on offshore islands (Nabhitabhata and Chan-ard 2005). The paucity of colonies outside monasteries or other localities where they might otherwise occur indicates their threatened status. Regionally, flying-foxes are a popular food item, and in Cambodia, there is an active restaurant trade in Phnom Penh (J. Walston personal communication). Growing economic wealth is likely to increase regional demand for wildlife consumption, and cultural taboos of protecting wildlife appear to be declining. Protection of roosting colonies should be relatively easy, but protecting bats while foraging is more difficult. In the study area, roost protection and monitoring is an important first step for flying-fox conservation.

The Silvered Leaf Monkey population in the study area has a "high" conservation priority, and may also be of at least "medium" global conservation priority. Assessing the relative value of the study area's population is marred by taxonomic considerations: if animals in non-Sundaic regions of mainland Southeast Asia are found to be a separate species, then the study area population is probably of "high" global significance. Elsewhere in Cambodia, the species appears relatively widespread in some areas, especially the northeast (Timmins and Ou 2001), but is declining in other areas e.g. the Tonle Sap Lake region (C. Poole personal communication) and Stung Treng Ramsar site (Timmins 2006). In Lao PDR, the species is "At Risk" and is localised and scarce (Duckworth et al. 1999c; RJT unpublished data). In Viet Nam, it is similarly localized, with small populations in the Mekong Delta, Cat Tien and Yok Don National Parks and probably other sites in the south (Nadler et al. 2003). In Thailand, where it is ranked "Near-Threatened", remnant populations occur in a few protected areas (Nabhitabhata & Chan-ard 2005; Global Mammal Assessment/W. Brockleman unpublished data). In Myanmar, presence of a "northern" taxon is uncertain. The association of this species with riparian and floodplain habitats, and absence or scarcity from large blocks of dense forest, increases its vulnerability to hunting and habitat loss, especially land conversion trends. It is likely this species will become localised in Cambodia in the near future and persist only in well-protected areas.

Although numbers of Long-tailed Macaque are rapidly declining in Cambodia, regional populations, especially in Thailand, remain robust. This species is one of few large mammals in the study area with a riverine association and as such it is very appropriate as a site for its conservation, but the study area's significance is at most of national level. Even then, the study area's real significance will depend heavily on how well macaques and riparian forest can be protected, in comparison to other conservation areas in Cambodia.

Eld's Deer have been considered as one of the highest mammalian priorities in Indochina and on the brink of local extinction, but a formerly bleak outlook has become more positive with the discovery of numerous small residual pockets of animals, mainly in Cambodia (Tordoff et al. 2005). It is unlikely the study area supports more significant numbers than those known in other areas of Cambodia, nor does it seem likely that its conservation in the study area could be more effective than at other sites. Conservation of this species in the study area would also require a focus away from the central riverine habitats to non-riverine forest areas.

Few large mammals are not already in decline in the study area, and those that are not are generally common species of little current conservation significance. Most large mammals in the study area are not associated with riverine or floodplain habitats, and their conservation is dependent upon conservation of large tracts of terrestrial forest, which the study area does not possess. Conservation efforts in the study area for large mammals should focus primarily on protecting channel and riparian habitats in the "central section", and areas occupied by Hog Deer and areas dominated by tall grasses on the floodplain.

6. AMPHIBIANS AND REPTILES

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6. Amphibians and reptiles

6.1 Introduction

Amphibians and reptiles are the least studied of Cambodia's vertebrate fauna. Due largely to intensive civil conflict since the 1970s, there has been little contemporary herpetological research and the principle publications on Cambodia's herpetofauna remain a series of classic works for French Indochina (Bourret 1936, 1941, 1942) and a monograph on Cambodian snakes (Saint Girons 1972). With the relaxation of security restrictions in the 1990s there has been a resurgence of national herpetological studies.

In the Cambodian Mekong Plain, previous studies have focused on a small number of taxa under global threat or of economic importance to local communities, including the trade and reproductive biology of watersnakes in the Tonle Sap Lake (Stuart et al. 2000; Murphy et al. 2002), trade and distribution of turtles (Holloway 2000; Touch et al. 2000; Lehr & Holloway 2000, 2002; Stuart et al. 2002; Stuart and Platt 2004) and status, distribution and farming of crocodiles, especially the critically endangered Siamese Crocodile (*Crocodylus siamensis*) (Ratanakorn 1992; Cheang & Ratanakorn 1994; Nao 1998; Platt et al. 2004; Sovannara 2004; Simpson & Han 2004; Jelden et al. 2005; Platt et al. 2006a; Rab et al. 2006). A small collection of amphibians and reptiles was made in lowland forest in Mondulkiri Province, eastern Cambodia (Long et al. 2000), and surveys of some reptiles in trade (principally varanids, turtles and large snakes) have been made in settlements along the Mekong River in Stung Treng Province, northeast Cambodia, as well as urban markets (Baird 1993; Martin & Phipps 1996; Singh et al. 2007; Timmins 2007). Elsewhere in the Mekong Plain, limited taxonomic collections (Davidson et al. 1997; Stuart 1998; Teynie et al. 2004; Teynie & David 2007) and status surveys for *C. siamensis* (Bezuijen et al. 2006) have been conducted in southern Lao PDR. Studies of watersnake assemblages have been conducted in the nearby Khorat Basin in Thailand (Karns et al. 2005).

Most herpetological studies in Cambodia have focused on two mountainous regions outside the Mekong Plain, the Cardamom Mountains in the southwest, and hilly regions in the east. In the Cardamoms, surveys have documented taxonomic diversity (Daltry & Momberg 2000; Daltry & Wüster 2002; Ohler et al. 2002; Chuaynkern et al. 2004; Stuart & Emmett 2006; Grismer et al. 2007), and conservation of *C. siamensis* (Daltry & Chheang 2000; Daltry et al. 2003, 2004; Platt et al. 2006b) and another threatened reptile, River Terrapin (*Batagur baska*) (Holloway et al. 2003; Platt et al. 2003; Holloway & Heng 2004). Efforts to conserve the Cardamom population of *C. siamensis* form the largest conservation activity for any reptile in Cambodia (SCWG 2004). In hilly eastern Cambodia, a collection of amphibians and reptiles was made in Stung Treng, Mondulkiri and Ratanakiri Provinces (Stuart et al. 2006).

This report describes a new collection of amphibians and reptiles in the Mekong Plain and herpetological conservation priorities along the Mekong River in northeast Cambodia.

6.2 Methods

6.2.1 Survey localities and dates

Four surveys for amphibians and reptiles were conducted in the study area between November 2006 and August 2007 (total 58 field days): three surveys sampled all taxa (45 days), and one (13 days) was for turtles (Table 1, Section 2.7). Virtually all fieldwork (*c*.55 days) was conducted in the "central section" of the Mekong River between Kratie and Stung Treng Towns. Two days were spent at floodplains northwest of Kratie town (Figures 1,3). Opportunistic observations were made in other sites along the river between Kratie and Stung Treng Towns, usually during boat journeys to the "central section".

Surveys in the “central section” focused on seasonal habitats within the Mekong River channel. In the dry season, large areas of riverbed were exposed and searches were conducted along sandbars, beaches, rock outcrops, vegetation, fibrous root masses and the margins of rocky rapids, swift-flowing shallow water and deep pools. In the wet season many of these habitats were inundated, and searches were along beaches and vegetation near the high water mark. Away from the river channels, the interiors of islands were visited on foot, and searches included small seasonal streams and ponds, tree hollows and leaf litter. Brief visits were made to two tributaries, Prek Krieng and Prek Preah (Fig. 2). Turtle trapping was conducted in the eastern channels of the “central section”, between Koh Rongnieu and Koh Kring Islands, and between Koh Kring Island and the mainland (Fig. 2).

6.2.2 Sampling

Sampling was conducted over three seasonal periods, the early dry season (receding water levels), dry season (low water levels) and wet season (high water levels) (Table 1, Section 2.7). Four methods were employed to sample the range of seasonal habitats in the study area and maximize species detection. First, timed searches (non-area restricted), on foot or by boat, were conducted in the day and night. Boat-based surveys were conducted from a 8.7x1 m wooden boat with 2.5 m “fish-tail” propeller and 13 HP engine, either moving slowly upstream (engine on) or drifting downstream (engine off). At least two observers were always present, but search effort was recorded as the total minutes of searching by a single observer, to avoid double-counting of fauna. Searches focused on in-channel habitats, riverbanks, islands in the mainstream, and floodplains. Timed searches targeted all species. Second, quadrat sampling (area- and time-restricted) was conducted along riverbanks and the interior of islands. Quadrats were 10x10 m and searched for 10 person-minutes. A maximum search effort of two persons/quadrat (i.e. five minutes/person) was recorded, even when more than two people were present, because search effort by additional helpers (local guides) was not consistent. Quadrats were only conducted in the day and targeted diurnal lizards. Densities of diurnal lizards recorded in quadrat sampling will be described elsewhere.

Third, mesh turtle traps designed by Conservation International-Indoburma Programme were placed along riverbanks in the Mekong mainstream. Traps were small (70x40 cm) or large (180x60 cm), with horizontal openings to enable turtles to enter. Small traps were placed along riverbanks, sandbars and beaches in shallow water, with part of the trap exposed to prevent turtles drowning. Large traps were placed in water 3 m deep and included an extendable 3-m mesh-funnel extending to the surface by buoys, which enables captured turtles to swim to the surface for air. Traps were baited with fruit and meat and checked daily. Trapping was conducted in the early- and mid-dry seasons but not in the wet season, when daily rises in water level increased the risk of trapped turtles drowning. Fourth, informal interviews were conducted with local communities. A series of standardized questions was used in these interviews, which focused on status, use and trade of turtles, *C. siamensis*, other large lizards, and snakes. Brief visits were also made to urban markets in Kratie and Stung Treng Towns. Survey effort was not constant between methods and instead reflected seasonal conditions (Table 10).

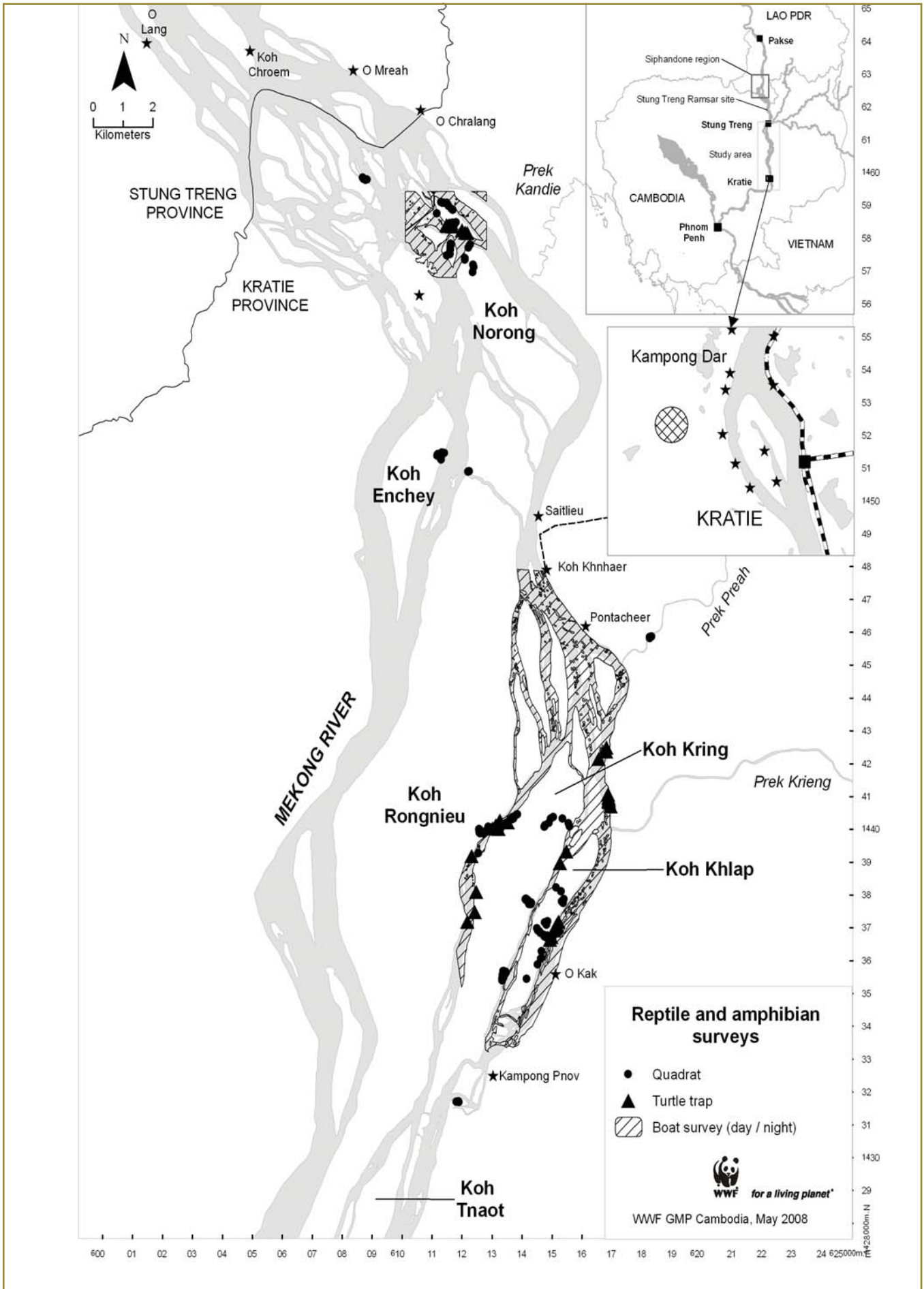

Figure 5. Sampling locations for reptile and amphibian surveys.

Table 10. Sampling effort for amphibians and reptiles.

Method: number (unit of effort)	Early dry season (receding water) (Nov-06)	Dry season (low water) (Mar-07)	Wet season (high water) (Jul-Aug 07)
Timed search (day, walking): n (mins)	1 (95 mins)	0	2 (180 mins)
Timed search (day, boat): n (mins; km)	0	0	13 (840 mins; 94.6 km)
Timed search (night, walking): n (mins)	18 (1140 mins)	7 (390 mins)	11 (860 mins)
Timed search (night, boat): n (mins; km)	2 (210 mins; 3 km)	8 (835 mins; 7.1 km)	4 (390 mins; 5 km)
Turtle trap-days	118	189*	0
Quadrat 10x10 m: n (total mins; ha)	32 (320 mins; 0.32 ha)	70 (700 mins; 0.7 ha)	70 (700 mins; 0.7 ha)
Interviews^	9 (in 7 settlements)	30 (in 23 settlements)*	9 (in 9 settlements)

^All interviewees were residents in the "central section" and were male except one wildlife trader. *Includes 13-day turtle survey (28 January-9 February 2007) by Cambodia Turtle Conservation Team.

Voucher specimens were caught by hand and collected for most species. Specimens were preserved in 10% buffered formalin and later transferred to 70% ethanol. Tissue samples were taken by preserving pieces of liver or muscle in DMSO/EDTA solution before specimens were fixed in formalin. For some snakes, only the tail tip was collected and the snake was released. Voucher specimens were assigned temporary tag numbers supplied by B.L. Stuart and these are used in this report. Specimens were submitted to B.L. Stuart for placement in international institutions and final institution storage numbers will be reported later. Some duplicate specimens were deposited at the Inland Fisheries Research and Development Institute, Cambodia Fisheries Administration.

Measurements were made with dial calipers to the nearest 0.1 mm (for small lizards and all frogs) or with a cloth tape rule to 0.1 cm (for large lizards, turtles and snakes). Measurement abbreviations used are: TL = total length, SVL = snout-vent length, HL = head length (tip of snout to rear of jaws), HW = head width (at the commisure of the jaws), SE = snout-eye length (tip of snout to anterior corner of eye), EYE= diameter of the exposed portion of the eyeball, IO = interorbital width, SCL = maximum straight carapace length including shell projections, SCW = maximum carapace width including shell projections, and PL = plastron length. All specimens were measured within five hours of capture and preserved specimens were measured immediately after euthanasia. Live weight of specimens was measured with a Pesola spring balance to the nearest 0.5 gm (50 gm balance), 1 gm (100 gm balance), 5 gm (500 gm balance) or 10 gm (1,000 gm balance). Large turtles were measured with a 30 kg balance not calibrated for accuracy. Specimens were examined for external parasites, physical abnormalities and injuries. Individuals caught and released were also measured. No turtle species were collected due to their threatened status.

Survey coordinates and capture location of specimens was determined using a handheld Global Positioning System (Garmin *eTrex Vista*) and recorded in Universal Transverse Mercator (easting, northing). Ambient and water temperature (to 0.5°C), %ground- and canopy-cover (in visually-estimated 10% increments), and weather were recorded during surveys. Searches were often made along riverbanks, where the vegetation often formed a distinct belt usually taller and thicker than vegetation further inland. Global threat status is given for species with IUCN listings of "Data Deficient", "Near-threatened", "Vulnerable", "Endangered" or "Critically Endangered" (IUCN 2007).

6.2.3 Limitations

Sampling methods were intended to maximize detection of species rather than enable quantitative comparison of encounter rates per method. Sampling was not stratified by habitat or method but responded to seasonal and local conditions. Night boat surveys were limited in all seasons, in the dry season due to low water levels and rocky rapids, in the wet season due to strong currents and risk of collision with submerged or floating wood. Pitfall trapping, an important method for sampling cryptic and fossorial species, was not utilized due to the short duration spent in sampling sites, but may have resulted in additional species being detected.

6.3 Results

6.3.1 Species accounts

Fifty-six species (40 reptiles and 16 frogs) were recorded during surveys. At least 27 of these species (Table 11) are characteristic of "anthropogenically modified environments" (*sensu* Stuart & Emmett 2006; Stuart et al. 2006) and were observed in waterways, riverbanks, forest or near villages or urban centers. These species have broad geographic ranges in mainland Southeast Asia and are not discussed further here. All specimens were collected within the Mekong River (river channel or islands) in the "central section", Sambor District, Kratie Province, unless stated otherwise.

Table 11. Amphibians and reptiles observed in the study area which occur in "anthropogenically modified environments" (*sensu* Stuart & Emmett 2006; Stuart et al. 2006).

Taxon	Observed	Collected (voucher#)	Tissue voucher	Capture site (UTM coordinate)^
Bufonidae: true toads				
Bufo melanosticus Schneider, 1799	2	none	none	Rongnieu Island (612185, 1437186); Veal Prong lake (603386, 1382524) (Prek Prasap District)
Microhylidae: narrow-mouthed frogs				
Kaloula pulchra Gray, 1831	4	none	none	Khlap (614939, 1436697), Rongnieu (612837, 1440136) Islands
Microhyla butleri Boulenger, 1900	2	11059, 11060	11059, 11060	Enchey Island (611345, 1451433)
Microhyla heymonsi, Vogt, 1911	5	11051	11051	Rongnieu Island (612837, 1440136)
Microhyla ornata (Duméril and Bibron, 1841)	17	11072-11073, 11085, 11086	11072	Kring (612710, 1439326), Norong (612107, 1457350), Rongnieu (612867, 1439931) Islands
Microhyla pulchra (Hallowell, 1861)	7	none	none	Kring, Norong, Rongnieu Islands
Ranidae: typical frogs				
Fejervarya limnocharis (Gravenhorst, 1829)	54*	11074-1075, 11088-11090	11074-1075	Khlap (616165, 1437928; 616165, 1437928), Kring (612710, 1439326), Rongnieu (612028, 1437829) Islands
Hoplobatrachus rugulosa (Wiegmann, 1834)	48	none	none	Enchey, Khlap, Kring, Rongnieu Islands
Occidozyga lima (Gravenhorst, 1829)	1	none	none	Koh Khlap Island (616987, 1440054)
Occidozyga martensii (Peters, 1867)	86	11061-11062, 11076-11079, 11081-11083	11061, 11062	Enchey (611345, 1451433), Khlap (615516, 1437777; 616987, 1440054), Koh Khlee-ay (611490, 1458401) Kring (612437, 1437477; 613952, 1437831), Rongnieu (612028, 1437829; 612837, 1440136; 612867, 1439931) Islands
Rana erythraea (Schlegel, 1837)	15	none	none	Khlap, Khlee-ay, Kring, Norong, Rongnieu Islands
Rhacophoridae: Tree frogs				
Polypedates leucomystax group (Gravenhorst, 1829)	22	11080	none	Rongnieu Island (612028, 1437829)
Agamidae: Agamas				
Calotes versicolor (Daudin, 1802)	8	none	none	Khlap, Khlee-ay, Kring, Rongnieu, Tuk Islands
Scincidae: Skinks				
Eutropis longicaudata (Hallowell, 1857)	3	11055	11055	Kring Island (614146, 1437844)
Eutropis macularia (Blyth, 1853)	84	11054, 11084, 11087	11054, 11087	Kring Island (614146, 1437844; 613685, 1440316), Rongnieu Island (612896, 1440032)
Eutropis multifasciata (Kuhl, 1820)	2	none	none	Neang Hen and Rongnieu Islands
Gekkonidae: Geckos				
Cosymbotus platyurus (Schneider, 1792)	9	11092	11092	Khlee-ay Island (611561, 1458980)
Gekko gecko (Linnaeus, 1758)	16	none	none	Khlap, Khlee-ay, Kring, Norong, Rongnieu Islands
Hemidactylus frenatus (Duméril and Bibron, 1836)	5	none	none	Khlap, Rongnieu Islands
Boidae: Pythons				
Python reticulatus (Schneider, 1801)	3	none	none	1 wild juvenile: Kring Island (613824, 1435637); 2 captive adults (Rongnieu Island, 613861, 1440965; Kampong Dar village 603455, 1382042). Reported by local residents to be 'common'.

Taxon	Observed	Collected (voucher#)	Tissue voucher	Capture site (UTM coordinate)^
Colubridae: Typical snakes				
Dendrelaphis pictus (Gmelin, 1789)	2	none	none	Veal Pong floodplain (603386, 1382524) (Prek Prasap District)
Elaphe radiata (Boie, 1827)	1	none	none	Kratie town (611000, 1381000)
Homalopsis buccata	1*	none	none	Dead juvenile (SVL 29.9 cm) for sale, Kratie Town Market (7 February 2008)
Enhydris enhydris (Schneider, 1799)	0	11069	none	1 captive adult: Veal Pong floodplain (605564, 1382615) (Prek Prasap District); 20 dead adults for sale as food, Kratie Town Market (7 February 2008)
Enhydris plumbea (Boie, 1827)	3	11064	11064	Koh Enchey island (611345, 1451433)
Ptyas mucosus (Linnaeus, 1758)	0	none	none	2 captive adults: Koh Khnhaer village; local residence Koh Rongnieu island (603541, 1413072)
Elapidae: Elapid snakes				
Bungarus fasciatus (Schneider, 1801)	0	none	none	1 captive adult, Prek Krieng river (617456, 1439921)

*Duplicate specimens deposited at Cambodia Fisheries Administration (no voucher numbers): *Fejervarya limnocharis* - 2 specimens; *Occidozyga martensii*- 23 specimens; *Homalopsis buccata* (only 1 specimen collected). ^UTM coordinates (easting, northing) are for voucher specimens (with a tag number) and specimens measured then released (no tag number).

Bufonidae: True toads

***Bufo macrotis* Boulenger, 1887**

Specimen 11056, evergreen forest, E614246, N1438028, 4 August 2007. Specimens 11057-11058, riverbank, E614947, N1438733, 5 August 2007, Koh Kring Island. Specimen 11102, juvenile, riverbank forest, E611417, N1451467, 22 November 2006, Koh Enchey Island. One juvenile (SVL 25 mm) and three adult males (SVL 46.4-50.6 mm, mean±SD 48.3±2.1; HL 10.6-15.0 mm, mean±SD 12.8±2.2; HW 17.4-27.7 mm, mean±SD 20.9±5.9; SE 6.2-6.6 mm, mean±SD 6.3±0.2; EYE 4.2-5.1 mm, mean±SD 4.7±0.5; IO 4.2-4.7 mm, mean±SD 4.5±0.3, mass 10-13 gm, mean±SD 11.2±1.6) agree with the expanded description of Taylor (1962) in lacking cranial crests, having low parotid glands slightly larger than eyelid, large tympanum (equal to or slightly smaller than eye), body covered with tubercles of varying size (those on head smallest), a row of enlarged tarsal tubercles, large, rounded palmar tubercle, and tarsal fold absent (Annex 3–Plate 30). The juvenile was collected at 1010 h among tree roots on a riverbank, 4 m from the river. The adult males were collected at night (2000-2125 h). Specimen 11056 was in leaf litter >50 m from the riverbank. Specimens 11057-11058 were in a large (250+) single-species aggregation of *B. macrotis* in riverbank forest along a small tributary, 70 m from the mainstream. This aggregation occurred on a moonless evening with full cloud cover and moderate rain (ambient and water temperatures 25°C / 28.5°C respectively). On 6 August 2007, two other aggregations were heard at 2000 h along small forest tributaries. *B. macrotis* was observed in all seasonal periods, the early dry-, dry- and wet-seasons, along riverbanks and in logged forest >50 m from the river. Reported from lowland forest in eastern Cambodia (Long et al. 2000) and the Cardamom Mountains (Swan & Daltry 2000; Ohler et al. 2002; Daltry & Traeholt 2003; Grismer et al. 2007).

Microhylidae: Narrow-mouthed frogs

***Glyphoglossus molossus* Günther, 1869 (Globally Near-Threatened)**

Two adults (sex undetermined), riverbank forest, E615709, N1440071, 8 August 2007, Koh Kring Island (Annex 3–Plate 32). Released. Both were caught at 0900 h: one was in leaf litter among tree roots at the water's edge and the other was observed floating in the mainstream next to the bank. On 25 March 2007, 40 pickled specimens were observed for sale as food in Kratie Town market. Reported from Cambodia by Bourret (1942), van Djik (unpublished data cited in Ohler et al. 2002) and in the Cardamom Mountains (Daltry & Traeholt 2003).

***Microhyla berdmorei* (Blyth, 1856)**

Specimen 11099, river channel, E612028, N1437829, 13 November 2006. Specimens 11096-11097, river channel, E616609, N1442726, 16 November 2006. Three adult males (SVL 26, 29, 34 mm) agree with Stuart and Emmett's (2006) expanded description by having an obtusely pointed snout, toes fully webbed (reaching the base of expanded discs on toes), third and fifth toes equal in length, inner and outer metatarsal

tubercle, dark throat, and a distinctive yellow venter (Annex 3–Plate 34). Fourteen *M. berdmorei* were observed including voucher specimens. Specimens 11096-11097 were in a chorus of seven calling males in a small pool on a sandbar recently exposed by receding waters; the others were in riverbank vegetation or evergreen forest >50 m from the riverbank, on Koh Rongnieu, Koh Khlap and Koh Kring Islands, in the early dry-, dry- and wet-seasons. Twelve individuals were recorded at night (2030-2100 h) and two were recorded in the day (1154 and 1218 h). Reported from lowlands and hills in Cambodia (Bourret 1942; Swan & Daltry 2000; Ohler et al. 2002; Daltry & Traeholt 2003; Stuart & Emmett 2006; Stuart et al. 2006).

***Microhyla* sp.**
Specimens 11065-11067, E611308, N1451339, 10 August 2007, Koh Enchey Island. Three individuals (SVL 15.7-18.6 mm, mean±SD 17.2±1.5; HL 4.2-5.4 mm, mean±SD 4.6±0.7; HW 5.2-7.9 mm, mean ±SD 6.7±1.4; SE 2.8-2.9 mm, mean±SD 2.8±0.1; EYE 1.7-2.0 mm, mean±SD 1.9±0.2; IO 2.0-2.7 mm, mean±SD 2.4±0.4, mass 0.4-0.7 gm, mean±SD 0.6±0.2, sex not determined) possess one inner metatarsal tubercle, toes without webs, an outer and inner metacarpal tubercle (approximately the same size), tips of digits not widened into discs and no notch and cleft above. These features agree with *Microhyla ornata* (Taylor 1962) but in contrast, specimens possess a broad, rounded snout, wide head and short, bulky torso. In life the dorsum was a dark grey-brown with an irregular orange stripe extending from behind the eye to hind legs. Legs were barred orange and brown. The throat was yellow-orange and belly was grey, both finely speckled with black. Specimens were caught in the day (1530-1630 h) in leaf litter, within logged evergreen forest 5-70 m from the Mekong River and 30 m from a seasonal pond.

Emydidae: Typical turtles
***Heosemys grandis* (Gray, 1860) (Globally Threatened-Vulnerable; Potentially At Risk in Lao PDR)**
Nine records (one wild individual and eight captive individuals or remains). Wild individual, river channel, E612431, N1437386, 12 November 2006 (n=1). Captive individuals in Kampong Pnov Village, E612887, N1432565, visited 11 November 2006 (n=1) and in Koh Khnhaer Village, E614566, N1449544, visited 17 November 2006 (n=4), 1 February 2007 (n=1) and 9 August 2007 (n=1). Fresh remains (plastron) in a local house, E614394, N1456752, visited 15 November 2006 (n=1). Specimens were of undetermined sex. Seven intact specimens (SCL 18.6-28.2 cm, mean±SD 24.8±3.6; SCW 15.3-22.8 cm, mean±SD 19.7±2.7; PL 17.0-28.0 cm, mean±SD 23.3±3.5; mass 0.89-3.3 kg, mean±SD 2.2±1.0) conformed to the description of Stuart et al. (2001) in having spikes along the posterior margin of the carapace, a pale vertebral keel along the carapace midline, yellow plastron with black lines radiating from a black blotch on each scute, straight seam between femoral and anal scutes, and lack of a plastron hinge (Annex 3–Plates 42,43).

The wild specimen was found in a fishtrap among submerged tree roots along a sandy riverbank, Koh Kring Island, and was released. The Kampong Pnov Village specimen had been caught a few days previously along a grassy sandbar (reported capture site E611583, N1432332, visited with the original hunter). The five Koh Khnhaer Village specimens were in the house of a wildlife trader. A fresh plastron (PL 13.2 cm) was in a house on Koh Kring Island; the turtle had been consumed by residents. All captive specimens were said to have been caught within the previous week. Historically reported from Cambodia (Bourret 1942); recent records are from the Cardamom Mountains (Daltry & Traeholt 2003) and southeast Cambodia (Stuart & Platt 2004).

***Heosemys annandalii* (Boulenger, 1903) (Globally Threatened-Endangered; At Risk in Lao PDR)**
Fresh carapace and plastron of a juvenile in a local house, 30 July 2007, Koh Kring Island. The reported capture site (E612598, N1436784, visited with the hunter) was in evergreen forest 300 m from the riverbank and next to a seasonal stream. The carapace and plastron of this specimen (SCL 13.0 cm, SCW 11.8 cm, PL 12.0 cm) partly agreed with Stuart et al. (2001) and Stuart and Platt (2004) in having a raised elongate carapace, no pale stripe on the vertebral keel, and lack of radiating lines on the plastron, but varied from their descriptions in having a notably raised vertebral keel (of uniform colour with the dark carapace) and yellow plastron with a black blotch in the lower left corner of each scute. The specimen was caught two days previously by the resident's hunting dog. Historically reported from Cambodia (Bourret 1942); recent records are from central Cambodia (Stuart & Platt 2004). The IUCN status of this species will probably be upgraded to "Critically Endangered" (D. Emmett personal communication).

***Malayemys subtrijuga* (Schlegel and Müller, 1844) (Globally Threatened-Vulnerable; Potentially At Risk in Lao PDR)**

Four records, all captive individuals or remains (three in Mekong River, one on floodplain). Mekong River: one captive adult and one carapace+skull, Koh Khnhaer Village, E614566, N1449544, 17 November 2006 and 1 February 2007 respectively. One intact head (no other remains) in a local house, E611392, N1434812, 3 August 2007, Koh Rongnieu Island. Floodplain: one captive juvenile, Kampong Dar village, E603455, N1382042, 11 August 2007, west of Mekong River, Prek Prasap District. Both intact specimens agreed with Stuart et al. (2001), having a brown carapace with three distinct keels, smooth margin and cream-yellow border, and a yellow plastron with black blotches (Annex 3–Plate 44). The third specimen (an intact head), identified by the pattern of broad yellow-white stripes extending along the head, was stated by the owner to come from a specimen caught in a fishtrap along the riverbank in July 2007. The captive adult (SCL 18.7 cm, SCW 14.2, PL 17.1 cm, mass 1 kg) was in the house of a wildlife trader who had purchased it two days previously from a local fisherman. The captive juvenile (SCL 13.7 cm, SCW 10.0, PL 11.5, mass 303 g) was in the house of a local resident who caught it the same day in a fishnet one kilometer west of the Mekong River. Historically reported from Cambodia (Bourret 1942); recent records are mostly captive specimens from central-west Cambodia (Stuart & Platt 2004).

Testudinidae: Tortoises

***Indotestudo elongata* (Blyth, 1853) (Globally Threatened-Endangered; At Risk in Lao PDR)**

Eight records, all captive individuals or remains. Captive adult, Koh Khnhaer Village, E614566, N1449544, 17 November 2006 (n=1). Fresh remains (plastron) in a local house, confluence of Mekong/Prek Kandie Rivers, E614394, N1456752, 15 November 2006 (n=1). Captive adults, O Kak Village, E616463, N1441389, 1-4 February 2007 (n=5). Old remains (plastron) in a local house, E611577, N1435284, 3 August 2007, Koh Rongnieu Island (n=1). All specimens (sex undetermined) agreed with Stuart et al. (2001) in having an unhinged, elongate yellow plastron with black splotches in the center of each scute and (for the captive individual) rounded legs with large scales, a single large supracaudal scute over the tail and a brown carapace with black splotches. The Koh Khnhaer Village specimen (SCL 20.3 cm, SCW 12.5 cm, PL 18.3 cm, mass 1.1 kg) was in the house of a wildlife trader, who purchased it from a local fisherman in the previous two weeks. The Prek Kandie plastron (PL 17.5 cm) was stated by the owner to be from a specimen he caught in October 2006 near the riverbank while clearing land. The five O Kak Village individuals (SCL 16.2-20.0 cm, mean$\pm$SD 18.2$\pm$1.7; SCW 12.1-15 cm, mean$\pm$SD 13.8$\pm$1.2) were in the homes of local residents. The Koh Rongnieu plastron (not measured) was stated by the owner to be from a specimen caught in forest >50 m from the riverbank. Historically reported from Cambodia (Bourret 1942); recent records are from captive specimens in the Mekong Plain of east and southwest Cambodia (Long et al. 2000; Stuart & Platt 2004) and Cardamom Mountains (Daltry & Chheang 2000; Daltry & Traeholt 2003).

Trionychidae: Softshell turtles

***Amyda cartilaginea* (Boddaert, 1770) (Globally Threatened-Vulnerable; Potentially At Risk in Lao PDR)**

Six records, all captive individuals or remains. Juvenile, E617359, N1444994, 18 November 2006, Prek Preah River (n=1). Adult (E616610, N1442726, 21 November 2006) (n=1) and juvenile (E615659, N1437140, 18 March 2007) (n=1) in river channel between Koh Khlap Island/mainland. Juvenile, river channel between Koh Rongnieu/Koh Kring Islands, E612185, N1437186, 30 July 2007 (n=1). Fresh remains (plastron) and captive juvenile, Koh Khnhaer Village, E614566, N1449544, 17 and 18 November 2006 (n=2). All specimens [SCL 13.1-37.5 cm, mean$\pm$SD 24.1$\pm$8.9 (n=6); SCW 11.7-30.1 cm, mean$\pm$SD 19.5$\pm$7.1 (n=5); PL 11.9-29.1 cm, mean$\pm$SD 19.9$\pm$8.1 (n=5); mass 0.24-6.1 kg, mean$\pm$SD 2.5$\pm$2.7 (n=6)] agree with Cox et al. (1998) and Stuart et al. (2001) in possessing a row of prominent bumps along the anterior margin of the carapace and a slender snout (Annex 3–Plate 38). Specimens were of undetermined sex. Three specimens (Prek Preah, Koh Rongnieu/Koh Kring, Koh Khlap/mainland) were observed soon after residents had removed them from fishtraps among submerged tree roots along riverbanks. The Koh Khlap/mainland specimen observed on 18 March was caught the previous day by fishing line. The Koh Khnhaer Village specimens were in the house of a wildlife trader who had purchased them from local fishermen.

Historically reported from Cambodia (Bourret 1942); recent records are mainly captive specimens in the Stung Treng Ramsar site, Mekong River (Timmins 2006), Stung Treng Town market (Singh et al. 2006), the Cardamom Mountains (Daltry & Chheang 2000; Daltry & Traeholt 2003) and the lowlands in southwest Cambodia (Stuart & Platt 2004).

***Pelochelys cantorii* (Gray, 1864) (Globally Threatened-Endangered; At Risk in Lao PDR)**
Six records: one wild individual caught during surveys and five captive records (Table 12). A subadult female (SCL 55 cm, SCW 47.5 cm, mass 11.6 kg) was caught on 3 February 2007 in a turtle trap at 3 m depth, in a deep pool locally named *Kain Svay* in the Mekong channel between Koh Kring Island and the mainland. The pool was surrounded by seasonally exposed sandbars with trees, shrubs and grasses. The turtle was released at the capture site. Of the five captive records, two were the fresh remains of individuals caught and consumed locally: an intact head with skin (11.5x9.5 cm) in Sambor Town, and a carapace (SCL 28.5 cm, SCW 32 cm) in Koh Dambong Village. In addition to these records, an old nest site of a softshell turtle which contained eggshell fragments was examined on 15 March 2007. This site was visited with a local resident who stated he had found the nest "one month earlier", when it apparently contained eggs, which he collected for personal consumption. It seems likely this nest belonged to a *P. cantorii* as other nests of this species discovered recently were on sandbars in similar habitat (D. Emmett personal communication). Local communities state that the similar *A. cartilaginea* does not nest on sandbars (Table 14). A map of the locations of confirmed and unconfirmed records is in Annex 2 (Map 11).

The other three records are of two captive individuals and a clutch of eggs observed after completion of surveys. On 8 March 2007, one adult was observed and photographed in Sambor Town market and reported to weigh 17 kg; the trader stated it was caught in the Mekong channel between Koh Kring Island and the mainland (WWF staff personal communication). It had a fishing hook in the front left limb. On 28 March and 5 April respectively, a fisherman brought a live, subadult male (SCL 35.3 cm, SCW 30.8 cm, mass 3 kg) and a clutch of 34 eggs to staff at the WWF Kratie office, which he stated were collected several kilometers north of Sambor Town. This individual and eggs were maintained in captivity by D. Emmett (CI-IP) and on 8 May 2007, both the male and 12 hatchlings were released in the Mekong River north of Sambor Town. All live individuals and remains agreed with the description by Stuart et al. (2001) of a broad head with eyes close to tip of snout and short tube-nose (Annex 3 – Plates 39,40, and see cover photo this chapter). Additional distinctive features were an ovoid carapace and lack of prominent bumps along the anterior margin of the carapace. Incubation data and an expanded morphological description will be described elsewhere (D. Emmett unpublished data).

Table 12. Confirmed records of *Pelochelys cantorii* in 2007 in the "central section".

Date	Record	Coordinate	Location	Notes
30 January	Captive - fresh remains	E605200, N1412000*	Sambor town	Intact head with skin only
3 February	Wild - live individual	E616413, N1442818	Eastern channel	Caught by survey team
5 February	Captive - fresh remains	E610000, N1457000*	Koh Dambong village	Carapace only
8 March	Captive - live individual	E605200, N1412000*	Sambor town market	Sold for food (WWF staff pers. obs.)
28 March	Captive - live individual	Unknown	"5 km north of Sambor"	Found near "Natamak village". Brought to WWF Kratie office
5 April	Captive – eggs	Unknown	As above	As above

*Location of captive specimen (capture location unknown).

These records confirm the persistence of a breeding population of *P. cantorii* in the Mekong River in northeast Cambodia. Previous confirmed Cambodian records are a captive subadult in Kratie Town in 2000 (Stuart & Platt 2004) and a wild hatchling in April 2003 in the Mekong River, 15 km north of Kratie Town at "Chroy Bantley" pool (I. Beasely unpublished data). Unconfirmed local reports of *P. cantorii* are from Stung Treng Province, in the Mekong Ramsar site (Timmins 2006) and Se San River (D. Emmett personal communication). Reports of captive specimens or remains in the Cardamom Mountains (Daltry & Chheang 2000) appear to be invalidated and there is no evidence the species occurs there (D. Emmett personal communication). In August 2007, an adult *P. cantorii* was caught and photographed in the Se Kong River in Attapu Province, Lao PDR, <20 km from the Lao-Cambodia border (WWF unpublished data). Collectively, these records emphasise the regional importance of the Mekong River in northeast Cambodia and southern Lao PDR for *P. cantorii*.

Ecological notes

One confirmed and three reported *P. cantorii* nest sites were visited by the authors with residents who claimed they had located these nests (Table 13). Eggshell fragments in one nest were confirmed with molecular analysis to be *P. cantorii* (B.L. Stuart personal communication). Residents stated all nests were located in February or March (the mid-dry season) and contained eggs. The confirmed nest was located on a seasonally-exposed sandbar 100 x 15 x 4 m in the middle of a remote, eastern section of the Mekong channel (Annex 3 – Plate 41). The nest was 3.5 m from, and 1.2 m above, the current water level, on an exposed bank of 45° incline oriented southwest, with no vegetation cover. Eggshell fragments were at 50 cm depth. Three reported nest sites (with no eggs or shell fragments) were respectively located on a small, seasonal sandbar opposite the nest with shell fragments (n=1), a seasonally flooded beach along a large island (n=1), and a permanently exposed beach along a small island (n=1). These sites were 2-15 m from, and 0.4-3 m above, the current water level, located on exposed, steep banks (30-40^0), oriented east. Three of four sites, including the confirmed nest, were fully exposed to direct sunlight with no shade; one site was partly shaded but received >50% direct sunlight throughout the day. In all sites, surface sand was fine or coarse, dry, and contained little organic matter, but at 50 cm the sand was notably more coarse and humid with small amounts of organic matter. A fifth reported nest site was not visited (Table 13).

Table 13. Measurements of reported *Pelochelys cantorii* nest sites.

Location	Site	Coordinates	Date*	ST (°C)	AT (°C)	DFW (m)	HAW (m)	6-900 h (%)^	9-1200 h (%)^	12-1500 h (%)^	15-1800 h (%)^
Waterway between Koh Khlap Island and mainland[1]	Seasonal sandbar	E616863, N1442281	Mar-2007	33.5	34	3.5	1.2	0	0	0	0
As above	Seasonal sandbar	E616832, N1442380	Jan-2007	32	34.1	2	0.4	20	20	10	0
Koh Rongnieu Island	Seasonal beach	E612989, N1440024	Feb-2007	37	37.5	5	3	0	0	0	0
Koh Sam Toch Island	Permanent beach	E607000, N1409000	2005	--	--	20	2	0	0	10	20
Channel Koh Khlap Island-mainland[2]	Seasonal sandbar	E616000, N1438000	2003	--	--	--	--	--	--	--	--

[1]Confirmed nest site. *Date nest contained eggs, residents pers. comm. ST-sand temperature (50 cm depth), AT-ambient temperature, DFW-distance from water, HAW-height above water. ^%shade over nest site in 3-hour increments i.e. 0 = no shade, 100% = fully shaded, no direct exposure to sunlight. [2]Not visited by authors (data from resident, personal communication).

Table 13. continued.

Location	Length (m)*	Width (m)*	Height (m)*	Nest orientation	Slope (°incline)	%ground cover^	%canopy cover^
Channel Koh Khlap island-mainland	100	15	4	Southwest	45	0	0
Channel Koh Khlap island-mainland	20	15	1.2	East	35-40	60	<10
Koh Rongnieu island	250	70	5	East	40	0	0
Koh Sam Toch island	1000	200	>10	East	30	10	10
Channel Koh Khlap island-mainland[1]	--	--	--	--	--	--	--

*Dimensions of sandbar or beach. ^10 m radius around nest.

At one reported nest site (Koh Rongnieu Island, Table 13), ambient and sand temperatures at 2-, 10- and 60-cm depth were measured over four consecutive days in a period of constant weather conditions (dry, no rain or cloud cover, 11-14 March 2007). At 60 cm, mean sand temperature was 36.8±SD 0.5°C (13 readings) with little daily fluctuation (35.5-37.2°C). In contrast, ambient (23.2-38.7°C, mean±SD 31.7±5.9, n=13) and surface sand (23.5-65°C, mean±SD 43.3 ±15.8, n=11) temperatures were subject to high daily fluctuations. Maximum sand temperatures occurred at 2-cm (65°C, at noon) which was 27.8°C greater than the maximum temperature recorded at 60-cm (37.2°C, at 1500 h). This limited data suggests a relatively constant thermal environment for egg incubation compared with ambient temperatures (Fig. 6).

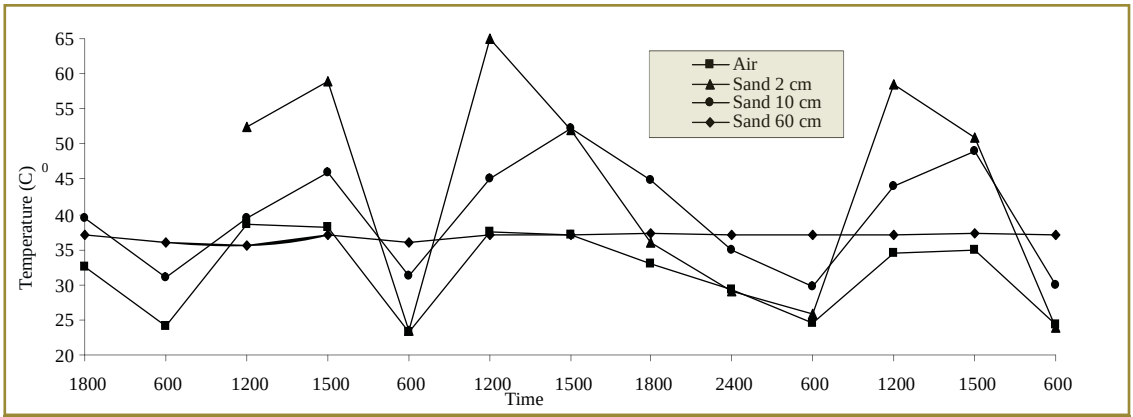

Figure 6. Temperatures at a reported nest site of *Pelochelys cantorii*, Kratie Province, March 2007

Local knowledge

Fifteen of 19 local residents in the "central section" questioned about turtles were clearly familiar with *P. cantorii* (termed *Ro-mik* in Khmer), and reported at least six sightings between 2003 and 2007, including capture of adult *P. cantorii* by fishing line (n=2) and egg collection from nests (n=4). Caution is required in interpreting local knowledge of turtles, as local names for turtles may refer to more than one species or form (Timmins 2006). During interviews, residents cited consistent and correct external differences between *P. cantorii* and the similar *A. cartilaginea* (termed *Khon-teay* in Khmer), specifically the shape of snout and carapace, and captive softshell turtles observed in local homes were always correctly referred to using the Khmer names for *P. cantorii* or *A. cartilaginea*. Residents stated *P. cantorii* is widely distributed along the Mekong River between Kratie and Stung Treng Towns, and was historically "common" in the study area, but that the number of nests collected each year, as well as trapped individuals, has decreased. All residents stated that nests are sought opportunisitically during fishing or hunting and are for personal, not commercial, consumption (Section 7.3.2).

Six interviewees claimed to have encountered *P. cantorii* nests and eggs. All stated that *P. cantorii* nesting occurs between January and March, the dry season (low water levels), with hatchlings present in April-May, the early wet season. This is largely consistent with available dates for confirmed nests and hatchlings (see previous sections). Interviewees stated that *P. cantorii* only nests on beaches and sandbars of the mainstream or large tributaries; no nest sites were reported from muddy riverbanks or streams and lakes away from the Mekong River. Clutch sizes of 43 and *c*.40 eggs were independently reported by two residents who had collected eggs from nests. Residents who collected softshell turtle eggs stated they were *P. cantorii* because the embryos "had no snout" compared with *A. cartilaginea*, which has a "pointed snout". Two residents stated that *P. cantorii* sometimes makes trial nest scrapes in addition to the actual nest. Consistent differences in the nesting ecology of *P. cantorii* and *A. cartilaginea* were cited by these six interviewees, including nest location and nest site fidelity (Table 14).

Table 14. Local knowledge of softshell turtle breeding ecology, Sambor District, Kratie Province

Species	Khmer name	Nesting season	Nest location	Site fidelity	Clutch size	Eggs
Pelochelys cantorii	*Ro-mik*	October-March (older females nest from October-February)	Seasonal sandbars, beaches. Eggs deposited relatively deep under surface. Nest easy to locate by turtle tracks	Yes (return to same site)	30-40 (older females lay larger clutches)	Cream white, relatively soft
Amyda cartilaginea	*Khon-teay*	Not asked	On riverbank near water, among vegetation. Eggs deposited near surface. Nest difficult to locate	No (nest in different locations)	25-55 (older females lay larger clutches)	Cream white, relatively firm

Nests of *P. cantorii* are apparently collected each year along sandbars and beaches in the mainstream from Kampi pool (E610500, N1394000) in the south to at least the Kratie/Stung Treng provincial border in the north, and two residents stated they collected "1-2 nests/year" between Kampi and Sambor Town. Nests of *P. cantorii* are apparently easy to detect due to the tracks of nesting females and are found more frequently than nests of *A. cartilaginea.* Some residents attributed nest declines to increased hunting and egg collection.

Gekkonidae: Geckos

***Dixonius siamensis* (Boulenger, 1899)**

Specimen 11101, E612185, N1437186, 11 November 2006 and specimen 11098, E612896, N1440032, 13 November 2006, Koh Rongnieu Island. Specimen 11107, E613300, N1440022, 13 March 2007, and specimen 11110, E614836, N1437088, 16 March 2007, Koh Kring Island. Specimen 11094, E616241, N1442192, 18 November 2006, and specimen 11116, E614662, N1436282, 18 March 2007, Koh Khlap Island. Two males (TL 85.0-88.4 mm, SVL 48.0-48.6 mm, HL 14.0-14.4 mm, HW 1.0-1.9 mm, SE 0.5 mm) and three females [TL 85.9-111.4 mm, SVL 38.1-49.7, HL 1.0-1.4 mm, HW 0.9 (n=1), SE 0.4 (n=1)] mostly agree with Taylor (1963) in having a vertebral series of fine body scales flanked by 5-7 rows of enlarged, keeled scales that blend ventrally into large, imbricate, cycloid scales, ventral scales with minute posterior serrations, expanded subdigital lamellae at the tip of the digit only, subcaudals transversely widened, preanal pores in a curving or broadly angular series, numerous large black spots on the dorsum (rarely diffuse), tail banded dark and light, no black stripe from snout tip through eye to tail, lips strongly barred with cream and black. Number of preanal pores ("usually 6", Taylor 1963: 750) was six (n=3 females), seven (n=2, one female, one male) and eight (n=1 male). Two colour morphs were observed as reported by Smith (1935) and Taylor (1963), a dark morph, and a pale morph with little or no patterning on the dorsum except a dark canthal stripe extending from behind the eye to the back of the head.

Thirty-six individuals were observed including these voucher specimens (30 dark morph, six pale morph). All were among leaf litter or wood debris on the ground, within seasonally exposed portions of the Mekong channel (n=3), in riverbank forest on islands (n=12), and in mixed evergreen/deciduous forest >50 m away from water on islands (n=21). Individuals observed at night (1930-2200 h) were actively foraging while individuals detected in the day (0855-1553 h) were under wood debris. Two gravid females, each with two eggs, were found on 11 November 2006 and 16 March 2007 respectively. Adults and smaller individuals were observed in all seasons but only two hatchlings were recorded, on 20 March (dry season) and 29 July 2007 (wet season). Previous records are from the Cardamom Mountains (Daltry & Chheang 2000; Daltry & Traeholt 2003; Grismer et al. 2007). *D. siamensis* is widespread in Thailand (Taylor 1963). The similar *D. vietnamensis* was reported from hilly eastern Cambodia (Stuart et al. 2006).

***Hemiphyllodactylus yunnanensis* (Boulenger, 1903)**

Specimen 11117, in channel vegetation, E612028, N1437829, 13 November 2006, Koh Rongnieu Island. Specimens 11105-11106, riverbank vegetation, E611494, N1459075, 20 March 2007, Koh Khlee-ay Island. One adult male (SVL 51.0 mm, HL 12.0 mm, HW 9.5 mm, SE 6 mm, IO 1.9 mm) (see cover photo this chapter), one unmeasured adult male (both with incomplete tails) and one adult female (TL 107.1 mm, SVL 52.3 mm, HL 11.9, HW 9.2 mm, SE 5.6 mm, IO 2 mm) agree with Taylor (1963) and Zhao and Adler (1993) in having four outer digits clawed and well developed, a vestigial (not expanded) inner digit of the hand, small granular dorsal scales lacking enlarged tubercles, ventral scales cycloid, vertical pupil, hind limbs that reach more than halfway between axilla and groin, a pair of enlarged postmentals, rostral nearly rectangular, with an entrant notch in its upper edge, subcaudals not strongly widened, and males possessing

a distinct singles series of preanofemoral pores, transversely widened. Specimen 11117 was foraging on a branch at 2130 h in a tree within the river channel recently exposed by receding waters, several meters from the riverbank. Specimens 11105-11106 were in a tree hollow 2.5 m above ground in riverbank vegetation (1025 h). The female was gravid with two eggs.

This is the first record of *H. yunnanensis* from Cambodia. Elsewhere in Indochina, *H. yunnanensis* is known in Lao PDR from a single specimen in the mountainous north (Stuart 1999). In Thailand, there are three specimens from Phu (=mountain) Kading in Loei Province (Taylor 1963). Taylor (1963) reported this species also occurs in upper Myanmar and Yunnan, China.

Agamidae: Agamas

***Calotes mystaceus* (Duméril and Bibron, 1837)**

Individuals caught and released (no vouchers) in forest on Koh Khlap Island (E615383, N1437753, 20 November 2006), Koh Kring Island (E614777, N1440096, 8 August 2007), and riverbank vegetation on Koh Khlee-ay Island (E611707, N1458863, 20 March 2007). One adult male (TL 238 mm, SVL 74 mm, mass 11 gm) and 10 other individuals agreed with Stuart et al. (2006) in having one or two spines above the tympanum, no spine at the posterior end of the supraciliary edge, and a deep oblique skin fold in front of the shoulder containing small, granular darkly pigmented scales (Annex 3–Plate 50). All individuals were observed in the day (0830-1314 h) in riverbank vegetation, or mixed evergreen/deciduous forest with bamboo thickets, >50 m from water. Adults exhibiting courtship / territoriality behaviour were observed on 20 November 2006 and 22 March 2007. Three hatchlings (TL <11 cm) were observed on 6-8 August 2007. Previous records are from lowland forest in eastern Cambodia (Long et al. 2000), hilly eastern Cambodia (Stuart et al. 2006) and the Cardamom Mountains (Daltry & Chheang 2000; Daltry & Traeholt 2003; Stuart & Emmett 2006).

***Physignathus cocincinus* Cuvier, 1829**

Ten individuals observed but not caught (no vouchers). Adult, E615565, N1437625, 20 November 2006, Koh Khlap Island (n=1). Two adults, E611172, N1458757, 20 March 2007 (n=1) and E611196, N1458620, 22 March 2007 (n=1), Koh Khlee-ay Island. Juvenile, E614231, N1437873, 4 August 2007, Koh Kring Island (n=1). Adult, E612251, N1450909, 22 November 2006, Koh Rongnieu Island (n=1). Adult, Koh Sompong Thom island, E608594, N1460775, 22 March 2007 (n=1). Two adults, E614750, N1435863, 16 March 2007, channel between Koh Khlap Island and mainland (n=2). Adult, E614527, N1441747, 30 July 2007, channel between Koh Rongnieu and Koh Kring Islands (n=1). Juvenile, E613814, N1443632, 9 August 2007, channel between Koh Rongnieu and Koh Neang Hen Islands (n=1). All individuals were observed at close proximity and had compressed bodies and tails, nuchal, dorsal and caudal crests (well developed in adults and weakly developed in juveniles), enlarged, white scales on the lower jaw, a nuchal fold and green colouration with banding on the tail. Five individuals were observed at night (1900-2030 h), sleeping on branches 0.3-4 m above water along forested riverbanks of islands (one juvenile was sleeping along a seasonal stream 200 m from the mainstream), and five were observed in the day (0845-1210 h) basking in riverbank vegetation. Adults were observed in all seasons. The two juveniles (TL *c.*40-55 cm) were observed in the wet season. Previous records are from hilly eastern Cambodia (Stuart et al. 2006) and the Cardamom Mountains (Daltry & Chheang 2000; Daltry & Traeholt 2003; Stuart & Emmett 2006; Grismer et al. 2007).

Varanidae: Monitors

***Varanus bengalensis* Daudin, 1802**

Four individuals observed but not caught (no vouchers). Three individuals seen over one kilometre of river in riverbank vegetation, E616137, N1441374, 7 August 2007, and one other individual seen, E614801, N1438207, 8 August 2007, channel between Koh Khlap and Koh Kring Islands. This was the only site where *V. bengalensis* was recorded. All individuals were observed at close proximity, had nostrils close to snout tip, and a uniform brown body with numerous small yellow spots which did not form any well-defined crossbars. These individuals were of four size classes (estimated in 2-foot increments then converted to meters): TL 0.3-0.6 m (1-2 ft), 0.6-0.9 m (2-3 ft), 0.9-1.2 m (3-4 ft) and 1.5-1.8 m (5-6 ft). All were observed in the day (0710-1235 h), basking on tree branches 2-15 m above the river, on trees along the riverbank or partly submerged within the channel. Previous records are from lowland forest in eastern Cambodia (Long et al. 2000) and the Cardamom Mountains (Daltry & Traeholt 2003; Grismer et al. 2007).

***Varanus salvator* Laurenti, 1786**

Four individuals observed but not caught (no vouchers). Mekong River: fresh remains (feet, tail, stomach) of an individual caught by residents, E615069, N1438667, 3 August 2007, and one live individual, riverbank

vegetation, E615551, N1439833, 6 August 2007, channel between Koh Khlap and Koh Kring Islands. One individual in riverbank vegetation, E614968, N1443001, 10 August 2007, channel between Koh Khleng Por and Koh Tachan Islands. Floodplain: one individual, E603386, N1382524, 11 August 2007, Veal Prong Lake, west of Mekong River, Prek Prasap District. All individuals were observed at close proximity and had relatively long, depressed snouts and clearly demarcated yellow transverse bands across a dark brown-black dorsum. These individuals were of three size classes (estimated in 2-foot increments then converted to meters): TL 0.3-0.6 m (1-2 ft), 0.6-0.9 m (2-3 ft) and 1.2-1.5 m (4-5 ft). Two were basking in trees along the riverbank 0.5 and 6 m above the river and one was basking in a tree 0.5 m above the water in a partly-submerged tree in a floodplain lake. All were observed in the day (0945-1355 h). The stomach contents of a large hunted specimen included snake scales, fish scales, bones and fins, and prawns. Two sets of varanid tracks were observed on beaches and sandbars in the Mekong River on 13 November 2006 (E612028, N1437829, Koh Rongnieu island) and 20 March 2007 (E611728, N1458369, Koh Khlee-ay island). Previous records are from lowland forest in eastern Cambodia (Long et al. 2000) and the Cardamom Mountains (Daltry & Chheang 2000; Daltry & Traeholt 2003).

Lacertidae: Old-world lizards

***Takydromus sexlineatus* Daudin, 1802**

Specimen 11108, riverbank forest, E613666, N1440303, 13 March 2007, Koh Kring Island. Specimen 11114, dry bamboo thickets, E613387, N1435689, Koh Kring Island. Two individuals (SVL 52.0-63.6 mm, HL 11.8-15.8 mm, HW 5.7-6.6, SE 5.1-6.9, IO 1.9-2.0, mass 3 gm each) have tail length 2.8-4.7 times the SVL (tail tip missing in smaller individual), single femoral pore, smooth (not keeled) head shields, four strongly keeled dorsal plates across the middle of the back, which form continuous lines, and one with ocellate spots on flanks and one without. Specimen 11108 was collected at 1005 h among dry grass and shrubs in riverbank vegetation 20 m from the mainstream. Specimen 11114 was collected at 1133 h in dry bamboo thickets with thick leaf litter 300 m from the river. Another five individuals were observed (but not caught), also on islands in the mainstream. All were in mixed evergreen or deciduous forest and bamboo thickets >50 m from water and were seen in the day (0844-1145 h). Adults were seen in all seasons (early dry, mid-dry, wet) and two hatchlings (TL 80-150.4 mm) were observed on 4 and 8 August 2007 (wet season). Previously reported from hilly eastern Cambodia (Stuart et al. 2006) and the Cardamom Mountains (Stuart & Emmett 2006).

Scincidae: Skinks

***Lipinia vittigera* Boulenger, 1894**

Specimen 11113, riverbank forest, E613481, N1435634, 17 March 2007, Koh Kring Island. One adult (TL 94.6 mm, SVL 37.3 mm, HL 7.3 mm, HW 6.0 mm, SE 3.1 mm, IO 1.5 mm) agrees with descriptions by Stuart et al. (2006) and Taylor (1963) in having an acutely pointed snout nearly twice the diameter of the eye, prefrontals in contact, two large preanals, three distinct light-coloured (gold in life) longitudinal stripes across the back consisting of a vertebral stripe from snout tip to tail, a dorsolateral stripe from above the eye to tail, a black stripe flanking each light-coloured stripe, and a bright red-orange tail. This individual was seen at 1047 h, foraging 2 m above ground on the stem of a large *Ficus* tree, in mixed evergreen/deciduous riverbank forest 50 m from the river. Another four individuals were observed (but not caught) on islands in the mainstream, foraging in the day (1155-1400 h) on tree branches 1-5 m above the ground in riverbank forest, 12 and 14 November 2006. Previously reported from hilly eastern Cambodia (Stuart et al. 2006) and the Cardamom Mountains (Daltry & Traeholt 2003; Stuart & Emmett 2006; Grismer et al. 2007).

***Lygosoma bowringi* Günther, 1864**

Specimen 11095, riverbank forest, E615516, N1437777, 20 November 2006, Koh Khlap Island. Specimen 11111, E613702, N1440313, 13 March 2007, and specimen 11115, E613481, N1435634, 17 March 2007, riverbank forest, Koh Kring Island. Two adults (TL 90.2-110.8 mm, SVL 75.0-50.1 mm, HL 7.6-8.8 mm, HW 5.9-6.8, SE 2.9-3.5, IO 1.1-1.6 mm) and one juvenile (TL 66.0 mm, SVL 38.0 mm) match Taylor's (1963) description, with the distance between snout and arm-insertion contained 1.5 times in axilla-to-groin distance, adpressed limbs not touching, a pair of nuchals, lower eyelid scaly, 28-30 scales around body, paired frontoparietals, supranasals in contact, dorsal scales smooth, and a blackish dorsolateral line. Specimens were collected in thick leaf litter in logged, mature secondary evergreen/deciduous forest on the riverbank 20-30 m from the mainstream. Specimens 11111-11115 were foraging in the day (0846-1047 h) and specimen 11095 was collected at night (2000 h). Thirty-nine other individuals (not collected) were observed, on eight islands in the Mekong River: all were foraging in leaf litter in the day (0844-1629 h), in riverbank vegetation (n=15) or in evergreen/deciduous forest >50 m from the river (n=24). Previously recorded from the Cardamom Mountains (Daltry & Chheang 2000; Daltry & Traeholt 2003; Stuart & Emmett 2006; Grismer et al. 2007).

***Sphenomorphus maculatus* Blyth, 1853**
Specimen 11093, E611676, N1458444, 22 November 2006, and specimens 11103-11104, E611494, N1459075, 20 March 2007, riverbank forest, Koh Khlee-ay Island. Specimen 11109, riverbank forest, E613683, N1440350, 13 March 2007, Koh Kring Island. These specimens (SVL 36.0-56.9 mm mean± SD 50.2±0.5, n=3) agree with Taylor (1963) and Stuart and Emmett (2006) in having a concave or flattened rostral, touching frontonasal, no nuchals, ear opening about size of eye, a pair of large preanals, limbs well developed, and pentadactyle, adpressed limbs overlapping (Annex 3 – Plate 51). These specimens and 22 other individuals observed (not collected) were on six islands in the mainstream, foraging in the day (0918-1500 h) in leaf litter on sandy soils in riverbank vegetation. Adults were observed in all seasons but hatchlings (TL<60 mm) were only seen in the wet season (July-August). Widely reported in Cambodia, from semi-evergreen forest in eastern Cambodia (Long et al. 2000), hilly eastern Cambodia (Stuart et al. 2006) and the Cardamom Mountains (Daltry & Chheang 2000; Stuart & Emmett 2006).

Colubridae: Typical snakes
***Boiga cyanea* (Duméril, Bibron & Duméril, 1854)**
Single specimen measured and released, riverbank forest, E616065, N1442047, 17 November 2006, Koh Khlap Island. This adult male (TL 125 cm, mass 303 gm) agreed with Taylor (1965) and Stuart et al. (2006) in having enlarged vertebral scales, eight supralabials, one preocular, two postoculars, 21 longitudinal scale rows at midbody, and green upperparts. The chin was white with pale blue infralabials. This individual was caught at night (2215 h) in a tree 3 m above ground on the riverbank, in mature secondary evergreen forest. The tail tip was missing and old scars were present on the belly. Previously recorded from central Cambodia (Saint Girons 1972), hilly eastern Cambodia (Stuart et al. 2006) and the Cardamom Mountains (Saint Girons 1972; Stuart & Emmett 2006).

***Chrysopelea ornata* (Shaw, 1802)**
Specimen 11068 (tail tip collected only, specimen released), riverbank forest, E611381, N1451383, 10 August 2007, Koh Enchey Island. This juvenile male (TL 81.0 cm, SVL 60.7 cm, HW 1.0 cm, mass 41.5 gm) agreed with Stuart and Emmett (2006) in having a bell-shaped frontal, one preocular, two postoculars, nine supralabials, fifth and sixth touching the orbit, last ventral and anal scale divided, and the top of head black with yellowish-green crossbars and spots and body scales green with a black margin and median line. This individual was caught at 1200 h on the riverbank, in logged forest 3 m from the mainstream. Two other *Chrysopelea* were observed with 10x40 binoculars in good light: one basking at 1047 h in a tree 10 m above the ground, in logged forest, Koh Norong island (E612372, N1457197, 20 March 2007); and, one basking at 1210 h in a tree within the river channel between Koh Khlap and Koh Kring Islands, 1 m above water and 10 m from the riverbank, E613824, N1435637, 7 August 2007. Previously recorded from central Cambodia (Saint Girons 1972), in dry deciduous forest in eastern Cambodia (Long et al. 2000) and in the Cardamom Mountains (Saint Girons 1972; Daltry & Chheang 2000; Stuart & Emmett 2006).

***Erpeton tentaculum* Lacépède, 1800**
One individual measured and released, E603386, N1382524, 11 August 2007, floodplain west of Mekong River. Two freshly dead specimens, E611000, N1381000, 23 November 2006, Kratie Town market (collected by C. Vidthayanon and deposited at Thailand Department of Fisheries; Annex 3 – Plate 45). These three specimens (TL 62.9-87.3 cm mean±SD 73.1±12.7, SVL 49.5-58.2 cm mean±SD 53.8±4.4) possessed the two tentacle-like appendages extending from the rostrals unique to this species (Saint Giron 1972). The wild individual, a female (TL 69.0 cm, SVL 49.5 cm, HW 1.1 cm, mass 90 gm) was caught at 1540 h in water among the branches of a partly submerged tree in a large, seasonal lake. The market specimens were said by the vendor to have been caught "close to Kratie Town". At Tonle Sap Lake in central Cambodia, fishermen believe *E. tentaculum* is venomous and often discard live or dead individuals caught in fishnets (Stuart et al. 2000). Previously recorded in the Tonle Sap Lake and floodplains around Phnom Penh, central Cambodia (Saint Girons 1972; Stuart et al. 2000). This species is largely confined to the Mekong Plain and does not occur in the Khorat Basin northwest of the study area (Karns et al. 2005).

***Homalopsis nigroventralis* Deuve, 1970**
Three records. Specimen 11112 (tail tip collected only, specimen released), rock pool on riverbank, E611440, N1458235, 21 March 2007, Koh Kapeung Island; one adult measured and released, river channel, E616998, N1439761, 19 November 2006, between Koh Khlap Island and mainland; juvenile (collected by C. Vidthayanon and deposited at Thailand Department of Fisheries), riverbank, E611900, N1459400,7 August 2007, Koh Tongdaeng Island (Annex 3 – Plates 46,47). Two adults (Koh Kapeung specimen TL 98 cm, SVL 84 cm, HW 2.3 cm, mass not measured; Koh Khlap/mainland river channel individual TL 104 cm, SVL 98 cm, mass 596 gm) and one juvenile female (TL 61.5 cm, SVL 46 cm, HW 1.8 cm, measured after one week

in 10% formalin) mostly agree with Deuve (1970) (who described *H. nigroventralis* as a subspecies of *H. buccata*, Linnaeus) and Stuart et al. (2006) in having 11-13 supralabials and 15-16 infralabials (one adult had 10 supralabials and 14 infralabials), 35-38 longitudinal scale rows at midbody, 157-165 ventrals (160, 161 and 162 in these three specimens) and a dark venter with light spots. In life, colour and patterns of the two adults and juvenile closely matched the description by Stuart et al. (2006), except that the adults had a light or dark olive venter, and in one adult, the white chin marking was shaped as an incomplete rectangle extending to the first ventral.

The Koh Kapeung adult was caught at 2115 h under 30 cm of water in a rock pool on the riverbank, within a thick algae mass. The Koh Khlap/mainland adult was caught at 1945 h among low shrubs in the water along a muddy riverbank, and was observed catching and killing a fish *Channa striata* TL 16 cm (see cover photo this chapter). The Koh Tongdaeng juvenile was caught in early evening on an exposed, muddy riverbank (C. Vidthayanon personal communication). These records comprise the second report in Cambodia of this species. Stuart et al. (2006) first recorded *H. nigroventralis* in rocky hill streams in eastern Cambodia, and treated *nigroventralis* as a separate species from *H. buccata* on the basis of colour, morphology and habitat.

***Enhydris longicauda* Bourret, 1934**
Specimen 11070, captive, E605564, N1382615, 5 August 2007, Kampong Dar Village (west bank of Mekong River) (collector R.J. Timmins; Annex 3–Plate 49). This adult male (TL 49.3 cm, SVL 34.9 cm, HW 1.4 cm, measured after one week in 70% ethanol) with 21 midbody dorsal rows, 133 ventrals and 70 subcaudals agrees with reported scale counts for *Enhydris longicauda* by Murphy (2007) (ventrals 122-136, subcaudals 52-76) and Saint Girons (1972, for *E. innominata longicauda*) (ventrals 124-134, subcaudals 53-74). The dorsal scale row formula of this specimen is: 30 at first widened ventral, 25 at 10th ventral, 21 at midbody, and 19 before vent. In most other aspects of scalation and colour this specimen closely agrees with descriptions of *E.i. longicauda* (Saint Girons 1972) and *E. jagorii* (Taylor 1965, see descriptions for *E. smithi* and *E. jagori*) in having nasals large and broadly in contact behind the rostral, rostral more than twice as wide as high, ventrals wider than lateral keels, dorsal scales smooth and distinctly larger posteriorly than anteriorly, parietals whole and touching, two or three postoculars one of which is the subocular, loreal touching internasal, eight supralabials, the fourth touching the eye and fifth and sixth touching the subocular, 10 or 11 infralabials (11 in this specimen), five touching the first pair of chinshields, which are nearly three times the size of the second pair, small head, distinct vertebral ridge, and possessing a mental groove. Colour after one week of preservation is a grey dorsum with 64 blackish, rather pointed lateral bands extending from behind the head to tail tip, each 2-5 scales in width, with a dark grey belly scattered with pale spots.

This specimen was purchased from a local resident who stated she caught it in fishing gear on a nearby floodplain west of the Mekong. This floodplain supports a mosaic of seasonally flooded, degraded forest, grasses and rice fields. The resident had a second specimen but this was not purchased (R.J. Timmins personal communication).

Three closely related and cryptic taxa, *E. longicauda*, *E. innominata* and *E. jagorii*, are reported from Cambodia, central Thailand and Viet Nam, and are distinguished principally on ventral scale counts and pattern (Murphy 2007). *E. longicauda* is known only from Cambodia and was considered by Saint Girons (1972) to be a race of *E. innominata*. Cambodian specimens were collected by Saint Girons (1972) at the Tonle Sap Lake and confluence of the Mekong/Tonle Rivers, who noted “it would be interesting to know if the species occurs in the lower Mekong from Kratie to the delta” (p.118). This appears to be the first record of the species outside the Tonle Sap Lake region of Cambodia.

***Lycodon capucinus* (Boie, 1827)**
Specimen 11053, mixed deciduous/evergreen forest, E614146, N1437844, 4 August 2007, Koh Kring Island (Annex 3–Plate 48). This juvenile female (TL 29.6 cm, SVL 27.9 cm, mass 7 gm) conforms to descriptions by Taylor (1965) and Lanza (1999) in having the following combination of features: 19 midbody dorsal rows, paired subcaudals, smooth scales, nasals subequal, loreal in contact with internasal and not touching eye, flattened snout and head (snout projecting beyond lower jaw), rostral bent back over tip of snout, internasals much smaller than prefrontals, loreal more than twice as long as high, two postoculars and each in contact with a temporal, a white or yellow nuchal band, and purplish-brown above, with more or less distinct fine white or yellow reticulations. This specimen was found at 1145 h under bark 1.5 m above ground, on a dead standing tree, 10 m from a sandy seasonal stream and 200 m from the Mekong mainstream. Taylor (1965) and Saint Girons (1972) treated *L.capucinus* as a full species while Lanza

(1999) considered *capucinus* a subspecies of *L.aulicus* (Linnaeus 1758). *L.capucinus* was previously reported by a single specimen from central Cambodia (Saint Girons 1972) and *L.aulicus* is listed in early herpetological collections from Cambodia in the 1800s (summarized in Bourret 1936).

***Oligodon taeniatus* Günther, 1861**
Single individual measured and released, riverbank forest, E611417, N1451467, 22 November 2006, Koh Enchey Island. This individual (TL 37.5 cm, SVL 33.1 cm, mass 17 gm) had a gray-brown dorsum with two narrow blackish longitudinal lines flanking a prominent vertebral ridge with small yellow spots, two blackish longitudinal dorsolateral lines, two broad, dark brown bands on the head, one extending from the prefrontals through the eyes to the supralabials and one from the crown to the base of the jaw but not reaching the ventrals, small mental groove, coral-red ventrals with irregular, black quadrangular markings and 28 divided subcaudals (not 30-47 as stated by Taylor 1965). This specimen was caught in the day (1000 h) among treeroots and leaf litter on a muddy riverbank, in logged, mixed evergreen/deciduous forest, 3 m from the mainstream. Upon capture the snake curled its tail tip, flashing the red ventrals. Saint Girons (1972) reported the species from central and southwest Cambodia.

***Xenochrophis piscator* (Schneider, 1799)**
Two records. Specimen 11091, river channel between Koh Khlap Island and mainland, E615542, N1437666, 19 November 2006; and, dead specimen (decomposed, not collected), E611371, N1456440, 22 March 2007, Koh Dambong Island. A juvenile (TL 57.5 cm, SVL 39 cm, mass 41 gm) and a dead adult female (TL 90.2 cm, SVL 83.8) conform with descriptions by Taylor (1965) and Saint Girons (1972) in having 22-28 maxillary teeth, with maxillary teeth gradually increasing in size posteriorly, upwardly directed nostrils, internasals narrowed anteriorly to about one-third width of the scale, one large preocular reaching surface of head, outer posterior edge of ventrals grayish or blackish, diagonal lines from eye absent or very dim, and no black diagonal lateral stripe on neck tending to meet its fellow at nape. The number of ventrals and divided subcaudals in the juvenile and adult female were 132/85 and 143/21 respectively. The ventrals of both specimens lack the black posterior border which is distinctive of *X. flavipunctus* (Zug et al. 2006; G. Zug personal communication). The juvenile was caught at night (2015 h) in emergent shrubs along a muddy riverbank. The adult female was drowned in a gillnet in the river channel next to Koh Dambong Island. Saint Girons (1972) recorded this species in central and southwest Cambodia.

Viperidae: Vipers
***Calloselasma rhodostoma* (Boie, 1827)**
Single individual photographed (not caught) by P. Palee and J.F. Maxwell and identified by the authors, deciduous dipterocarp forest, E612185, N1437186, 12 November 2006, Koh Rongnieu Island. This individual mostly agreed with Taylor (1965) and Cox et al. (1998) in having a prominent ridge from the eye to snout, an upturned and pointed snout, head gray-brown with a light, dark-bordered stripe on each side, dark, purplish-brown dorsum with paired, dark triangular markings (36 markings compared with 19-31 stated by Cox et al. 1998). Observed in leaf litter on sandy soil at 1000 h, 200 m from the Mekong River. Previously recorded throughout Cambodia (Saint Girons 1972), hilly eastern Cambodia (Stuart et al. 2006) and the Cardamom Mountains (Stuart & Emmett 2006).

Crocodylidae: Crocodiles (local information only)
Siamese Crocodile *Crocodylus siamensis* Schneider, 1801 (Globally Threatened-Critically Endangered; At Risk in Lao PDR)
No crocodiles were observed during surveys. Some local residents reported the historic or continued presence of crocodiles, which probably refer to *Crocodylus siamensis*, the only crocodilian confirmed to occur in the Mekong River north of Tonle Sap Lake. Local reports were obtained during interviews and were considered potentially valid if they were firsthand (described by the resident to the authors or R.J. Timmins), the resident could correctly distinguish between a crocodile and varanid, and a year and location were provided. Sixteen sightings meeting these criteria were obtained, from the Mekong River in the "central section": 12 wild crocodiles, one captive crocodile, and three nests (Table 15; Annex 2–Map 12). Reported dates of sightings were the 1950s (n=3), 1960s (n=1), 1980s (n=3), 2003 (n=1), 2004 (n=1), 2005 (n=4) and 2006 (n=1). In general, most local residents had little awareness of the potential occurrence of crocodiles; of 23 interviewees questioned by the authors about crocodiles (19 fishermen, three wildlife traders, one village head) only seven (five fishermen, one trader, one village head) claimed to have seen a crocodile, despite all interviewees living in the "central section" for at least three years (mean 32±24.1SD, range 3-84 years) (mean age of interviewees was 48±14.9SD years, range 32-84).

Table 15. Local reports of crocodile sightings, Sambor District, Kratie Province.

Sighting	Year	UTM coordinates*	Local report
Crocodile	1950s	618000, 1446000	Prek Preah River. Shot 2 crocodiles 1 km upstream from confluence of Prek Preah/Mekong Rivers
Crocodile	1950s	609299, 1427785	'Many' crocodiles in Mekong River but hunted out due to for skin trade
Nest	1950s	? (near above site)	'Large mound' on 'Koh Gau On-Tee' island (said to be near Bung Rum Lik lake E609299, N1427785)
Crocodile	1960s	614000, 1434000	1 crocodile, in deep pool in mainstream
Crocodile	1980	614566, 1449544	2 'small' crocodiles, caught in fishnet
Crocodile	1984	616000, 1438000	2 'small' crocodiles, caught in fishnet
Crocodile	1980s	616986, 1440054	Caught 5 'small' crocodiles in deep pool; saw a nest on riverbank nearby
Nest	1980s	616986, 1440054	Mound nest with 44 eggs on riverbank near above site
Crocodile	1990s	none	Saw 1 'small' crocodile for sale in Pontacheer village
Nest	2003	613800, 1445500	1+ crocodiles and 1 nest observed between Koh Rongnieu and Koh Khleng Por Islands[1]
Crocodile	2004	609300, 1428000	1 'large' crocodile and tracks[1]
Crocodile	2005	610600, 1455000	1 crocodile near Koh Amp Island[1]
Crocodile	2005	612000, 1452000	2+ crocodiles between Koh Enchey/Koh Chroem Islands[1]
Crocodile	2005	616400, 1453500	1 crocodile near Koh Norong Island[1]
Crocodile	2005	609000, 1456600	1 crocodile[1]
Crocodile	2006	612500, 1459500	1 'large' crocodile, seen in dry and wet seasons[1]

*Derived from descriptions by interviewees and plotted on 1:50,000 topographic maps. [1]Personal communication from local residents to R.J. Timmins.

These reports suggest three conditions: first, that a small number of crocodiles persist in the study area; second, that any recruitment (nesting, immigration) occurring in the study area is infrequent and probably insufficient to maintain local populations, which may be aging and in decline; third, human disturbance may be the principle factor suppressing current recruitment, because the "central section" retains extensive and apparently suitable nesting and foraging habitat for crocodiles. Although commercial hunting of crocodiles may no longer occur, it is likely that any eggs or crocodiles encountered by local communities are kept, either for local consumption, commercial sale or as "curios". *C. siamensis* forms large, obvious nest mounds and most waterways in the "central section" are visited by local communities, increasing the likelihood nests are detected. In one unconfirmed report, a crocodile nest with eggs was apparently found near Koh Khnhaer Village in the 1990s and the eggs were sold to a trader from Thailand (I. Saksang WCS Cambodia personal communication). Elsewhere in Cambodia, wild crocodile eggs and hatchlings are purchased from local communities by national and foreign crocodile farms (SCWG 2004; Jelden et al. 2005). The removal of eggs or individuals may cause disproportionately high impacts to small and isolated remnant populations.

Small, fragmented populations of *C. siamensis* persist in similar or more degraded and populated riverine habitats within 60 km of the study area, including 1+crocodiles in O Kandel River (*c.*50 km northwest), 10+ crocodiles in Se Kong River (*c.*60 km northeast) (Simpson & Han 2004) and an unknown number of crocodiles in the Stung Treng Ramsar site (Timmins 2006). Infrequent migration between sites may occur.

Other local knowledge

Three interviewees aged 84, 50+ and 66 years respectively claimed crocodiles were frequently hunted for the skin trade from the 1950s-60s, and were "common" in the study area until at least the 1950s. Skins were sold to "chinese traders" from Cambodia or Lao PDR and the meat was eaten locally. Sale of crocodile skins was apparently an important cash source in the 1950s. Skins were dried or salted, then priced in 10 cm increments: in the 1950s, skin price was 5 Riel (USD0.001)/10 cm. Interviewees who had seen crocodiles stated only one form occurs (in contrast to Lao PDR, where some communities recognize different "forms" of crocodiles based on colour or size, Bezuijen et al. 2006). No interviewee was aware of any cultural or medicinal practices involving crocodiles or their derivatives, and had never heard of any attacks on humans. Most interviewees were familiar with the national Khmer term for crocodile *Kro-pu*. The ethnic name for "crocodile" for two local ethnic groups, P'nong and Khouey, is *Ra-pu* and *Pleo* respectively.

6.3.2 Threats and local use

Unregulated harvesting for commercial trade is the greatest local threat to most turtles, large lizards and snakes in the study area. In the "central section", most wildlife trade is conducted by at least two traders in Koh Khnhaer and Saitlieu Villages (Fig. 2), who purchase turtles, lizards, snakes, macaques and other animals and are widely known among residents. At least three restaurants in Kratie Province (Mlup Doung, Chhne Tonle, Consul) apparently purchase softshell turtles directly from these traders. These traders also employ "buyers" who visit seasonal fishing camps and villages to purchase fauna. Fauna is stockpiled and then transported to Stung Treng, Kratie or Sambor Towns for sale to other traders. The authors visited both traders twice in their homes and on one occasion (22 November) encountered one of the traders in Stung Treng Town, where they were selling their current stockpile of fauna. Most villages also have at least one "middleman", who purchases fauna from residents then transports them to these two traders or nearby towns.

Turtles are the most commercially valued reptiles. Five turtle species were observed in trade (*M. subtrijuga*, *H. grandis*, *I. elongata*, *A. cartilaginea*, *P. cantorii*). *H. grandis* and *A. cartilaginea* were the most frequently observed species in trade; residents stated this is because they are easily caught in fishtraps. Turtles are caught in fishing gear or with hunting dogs. In 2006-2007, sale prices between residents and village traders for live turtles ranged from 8,000-20,000 Riel (USD2-5)/kg, with *H. grandis* the most expensive. Prices between village- and town-traders was reported to be 10,000-40,000 Riel (USD2.5-10)/kg for live turtles and 15,000-40,000 Riel (USD3.8-10)/kg for turtle carapaces or plastrons. For two species *A. cartilaginea* and *P. cantorii*, small individuals are most valued (up to 40,000 Riel/kg), apparently due to better taste. Most fishermen stated they caught "1-2 turtles/year". A trader in Saitlieu Village stated he purchased 20-40 *A. cartilaginea* and 4-5 *P. cantorii* per year; a trader in Koh Khnhaer Village in November 2006 had seven live turtles, which she claimed had taken her one month to stockpile.

In contrast to live turtles, the eggs of *P. cantorii* are reported to be consumed locally. Beaches and sandbars throughout the study area are searched each dry season for *P. cantorii* nests, which are detected by tracks of nesting females. Eggs provide an opportunistic food source for residents and seasonal fishermen. Egg removal appears to be the greatest threat to *P. cantorii* in the study area; the sustainability of current harvest rates is unknown but local residents reported that fewer nests and adults are caught compared with 10 years previously. Five residents who claimed to have located *P. cantorii* nests stated they had removed all eggs from the nests.

Three large lizards, *V. bengalensis*, *V. salvator* and *P. cocincinnus* are hunted by residents for sale or local consumption. Residents reported that in 2006-2007, sale prices for varanids between residents and village traders was 6,000-8,000 Riel (USD1.5-2)/kg (smaller individuals fetch higher prices). Varanids are caught with hunting dogs or a bamboo-pole trap (one end is split open, baited, and sprung when the bait is removed). One resident stated that 1-2 varanids/month are caught. *P. cocincinnus* is sometimes caught using a catapult. Three large snake species, *P. mucosus*, *P. korros* and *P. reticulatus* were observed in local homes or in trade. Snakes are hunted opportunistically and sold to local traders for 10,000 Riel (USD2.5)/kg. Residents and traders stated fewer large lizards and snakes are caught compared with 10 years previously and attributed this to increased hunting pressure. Few varanids were seen during surveys despite extensive searches (Section 7.3.1) and this may be due to intensive harvesting or increased wariness of individuals.

At least two common frog species, *H. rugulosa* and *F. limnocharis*, are harvested for food and sale. The optimal time for frog harvesting is apparently the onset of the wet season (May). Frogs are caught at night by hand. In 2006-07, frog prices in Sambor Town market were 3,000-5,000 (USD0.8-1.3) Riel/kg. One Sambor resident stated that 10 years ago, up to "two large sacks of frogs could be collected in one evening" (one sack apparently holds >20 kg of live frogs), but in 2006 "only half a bag was collected".

Historic commercial hunting already appears to have caused the near local-extinction of at least one species, Siamese Crocodile, and any current recruitment is probably suppressed by the incidental capture of individuals or egg collection from any nests which are found. Commercial trade is the greatest threat to at least four turtle species confirmed to occur in the area, and residents report that numbers of turtles caught are declining. For a fifth turtle species, *P. cantorii*, the principle threats are the local consumption of eggs and infrequent capture of nesting adults. Varanid lizards are also targeted for local consumption and commercial trade; only eight individuals and two sets of tracks were seen in 55 days in

the field, in habitats suitable for these species. This low incidence of sightings suggests extreme wariness and/or low densities. Without management, populations of most turtles and large lizards in the study area will probably continue to decline.

6.4 Discussion

Sixteen frog and 40 reptile species (17 snakes, 17 lizards, six turtles) were documented in the current surveys. Species incidence curves suggest that surveys detected most frog species but did not detect all reptiles (Fig. 7), and additional species will probably be recorded in future surveys. Of significance is the occurrence of six globally threatened turtle species, including potentially the largest breeding population in the Mekong River Basin of *P. cantorii*, a new country record for a gecko (*H. yunnanensis*), a second country record for a snake (*H. nigroventralis*), a range extension for a snake (*E. longicauda*, *c*.300 km north from the Tonle Sap Lake region), and the possible extirpation of a crocodilian, probably *C. siamensis*. The persistence of intact riverine habitats suggests the "central section" plays an important role in the maintenance of regional populations of these species, especially turtles.

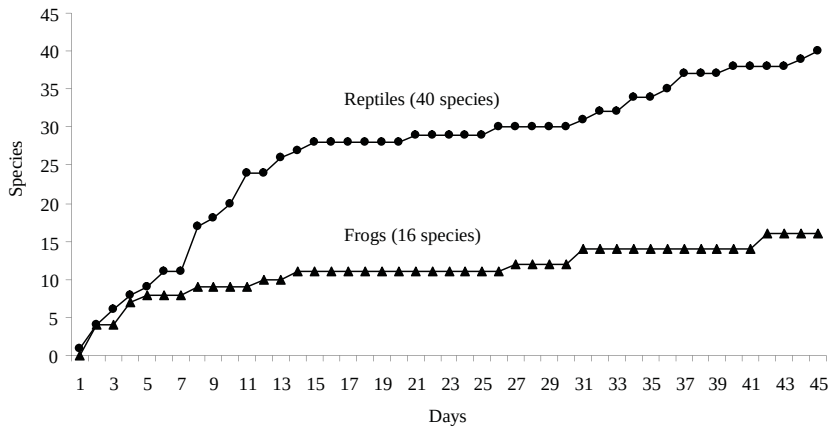

Figure 7. Species incidence curves for frogs and reptiles over 45 survey-days (excluding turtle field survey), Mekong River, Kratie Province.

Three local residents independently reported the occurrence of another turtle species, *Chitra*, which they referred to as *So-sai* and described as "very large with patterns on the back". They stated this species is different from *A. cartilaginea* and *P. cantorii* and without prompting, recognized photographs of *Chitra* in Stuart et al. (2000). This form of turtle is apparently now "very rare". In contrast, one 84-year resident had never seen or heard of this species. The genus *Chitra* is currently known from the Mae Klong and Chao Phraya rivers in Thailand (>600 km northwest of the study area), Peninsular Malaysia, and Java (Indonesia) (Thirakhupt & Djik 1994; Kitimasak et al. 2005). If confirmed, the presence of *Chitra* in the Mekong River would represent a significant extension to the global range of this genus.

Seasonal differences in detection, standardized for survey effort, were apparent between the three surveys: highest encounter rates were in the wet season (2.9 species/day; total 44 species) followed by the early dry season (2.7 species/day; 38 species) and mid-dry season (1.9 species/day; 30 species). Fifteen species were only recorded in the wet season and six species were only recorded in the early dry season; all species recorded in the mid-dry season were recorded in other seasons. This suggests that surveys in riverine habitats of the Mekong Plain which aim to document richness need not include mid-dry season surveys, although this would exclude the nesting season of some species e.g. *P. cantorii*.

Hourly species encounter rates between five quantified search methods were similar: quadrats (0.9 species/hour), day- and night-searches by walking (0.7/0.6), and day- and night-searches by boat (0.6/0.5). More species were recorded in quadrats (27) and night searches by walking (24), yet all species recorded in quadrats were also recorded with other methods. Twelve species were only observed from captive specimens/remains (9) or by incidental encounters (3). In 307 turtle trap-days one turtle (*P. cantorii*) was caught. All search methods except quadrats and day searches by walking, detected at least one species not found by

other methods, despite initial detection rates being highest in quadrats. These results indicate the importance of utilizing a range of survey methods, and incidental encounters, in maximizing detection of amphibians and reptiles.

Comparison of species richness and composition with other sites is limited due to differences in sampling methods, intensity and timing, but available data indicate the following. First, many species (47%) in the study area are characteristic of anthropogenically modified environments (*sensu* Stuart & Emmett 2006; Stuart et al. 2006) and occur elsewhere in Cambodia or Indochina. Second, the riverine habitats of the Mekong Plain support a lower richness than mountainous or hilly regions of Cambodia (Table 16). The Cardamom Mountains and surrounding lowlands support most frogs (87.5%), lizards (82.4%) and turtles (83.3%) recorded in the study area (see checklist in Grismer et al. 2007); a smaller overlap occurs with hilly eastern Cambodia and the lowland forests of the eastern plain (respectively, 62.5% and 68.8% for frogs, 52.9% and 64.7% for lizards, and 16.7% for turtles in the lowland forests, Long et al. 2000; Stuart et al. 2006).

Table 16. Comparison of herpetofauna richness in four locations in Cambodia.

Location and habitat	Amphibians	Reptiles	Effort (days)*	Daily encounter rate (total spp./days)*	Source
Cardamom mountains: mountain ranges 0-600 m asl, some lowland forest, wetlands	38	84	?^	?	Grismer et al. 2007 and references therein
Cardamom mountains (as above)	28	50	90	0.9	Stuart & Emmett (2006)
Eastern Cambodia: forested hills, 109-800 m asl, streams, some agricultural habitats	30	42	23	3.1	Stuart et al. (2006)
Eastern Cambodia, Mekong Plain: dry dipterocarp forest, 140-400 m asl, seasonal wetlands, some agricultural habitats	14	24	21	1.8	Long et al. (2000)
Northeast Cambodia, Mekong Plain: Mekong River and floodplain, 20-50 m asl	16	40	45	1.2	Current survey

*Derived from survey effort cited in references. ^Cumulative result of several surveys.

Third, the principle conservation priorities for amphibians and reptiles of the Mekong River in northeast Cambodia involve a relatively small subset of lowland species (six turtles, two snakes *H. nigroventralis* and *E. longicauda*, and Siamese Crocodile) not restricted to the Mekong Plain (except perhaps *E. longicauda*), but for which the plain supports important regional populations. In a systematic ranking of vertebrate fauna recorded in the study area, all six turtle species recorded in the study area were ranked as a "high" priority for management and at least one watersnake *E. longicauda* is considered a "medium" priority (Section 10.1).

For most species, especially in the "central section" of Kratie and Stung Treng Provinces, the principle threat to remnant populations is unregulated harvesting of adults or eggs. The study area lies within a region of well organized wildlife trade, where locally-caught fauna is sold elsewhere in Cambodia, Lao PDR, Viet Nam and possibly China (Singh et al. 2006a,b). For turtles, large snakes and lizards, management requires control of commercial hunting. For *P. cantorii*, community-supported protection schemes are required to control and monitor unregulated egg collection, and for release of juveniles and adults caught in fishnets and traps. For *C. siamensis*, identification and management is needed of factors (presumably human) suppressing recruitment in apparently suitable nesting habitat. Management opportunities exist for most of these species, especially in the "central section", where extensive and intact natural habitats persist. Site-based management actions for taxa ranked as "high" or "medium" priority are discussed in Section 10.

7. FISH

Chavalit Vidthayanon, Chall Phalla,
Tum Nyro and Seng Lieng


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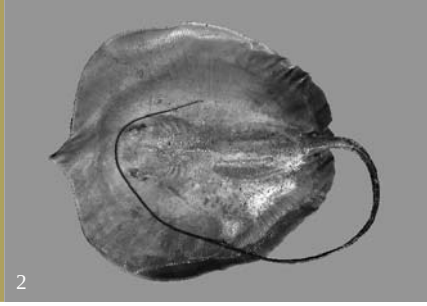
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7. Fish

7.1 Introduction

Fish and shellfish are critical components of the freshwater biodiversity of the Mekong Basin. Yet in many parts of the basin, the richness and composition of freshwater fish assemblages is poorly known, and information on aquatic invertebrates is absent. Approximately 700 fish species have been documented in the Lower Mekong Basin (Kottelat 2001a); other estimates range up to 1,700 species, but these are largely speculative. Many fish in the Lower Mekong Basin are migratory, and the diet and income of most lowland communities is closely linked with the river's annual "flood pulse" and migration cycles of these species.

At least three fish migration systems are present in the Lower Mekong Basin (Poulsen et al. 2000). The "Lower Migration System" links the Mekong Delta, the Tonle Sap, the "3S" Rivers (Se Kong, Se San, Srepok), and the Mekong mainstream as far as Siphandon in southern Lao PDR. The "Middle Migration System" extends along the Mekong from Siphandon to Loei Province in Thailand and the floodplains of large tributaries in southern Lao PDR and northeast Thailand. The "Upper Migration System" extends from Loei to the Lao-China border and is mostly confined to the mainstream with very small flood plains and relatively few major tributaries (Poulsen et al. 2000).

Fish and aquatic invertebrates contribute significantly to the economy of the nations of the Lower Mekong Basin, and are essential for the food security and livelihoods of thousands of local communities. Preliminary estimates indicate that at least 2.5 million tonnes of wild fish are consumed annually in the Lower Mekong Basin, with an estimated value of over USD2.5 billion, and support over 55 million people in the nations of Cambodia, Lao PDR, Thailand and Viet Nam (Baran et al. 2007). In Cambodia, over 120 fishing methods have been documented, reflecting the importance of fish to local livelihoods (Deap et al. 2003). Some fish taxa also serve as "bio-indicators" of the general "health" of the river, especially water quality.

Few surveys of fish diversity and richness have been conducted in the section of Mekong River between Kratie and Stung Treng Towns, northeast Cambodia. The study area is located in the "Lower Migration System", and is characterized by large floodplains extending from Cambodia to the Mekong Delta, and deep pools along the mainstream, which are critical dry-season habitats for many migratory fish species. The study area contains the majority of deep pools in this system (58), including 39 in Kratie Province and 19 in Stung Treng Province (Poulsen et al. 2002; Chan et al. 2005). Deep pools in Kratie Province are 10-60 m deep, 100-300 m long and 50-600 m wide (Hill 1995).

Roberts and Warren (1994) surveyed fish in the markets of Stung Treng Town between October 1993 and February 1994, and recorded 144 species and 13 types of fishing gear. Along the Mekong River between Kratie Town and Pakse Town (Lao PDR), including the Siphandon region located 45 km north of the study area, a range of market surveys and field sampling have documented over 310 species (Roberts 1993; Baird et al. 1999; Baird 2001; Singh et al. 2006b). In the nearby Srepok and Se San River catchments, at least 200 fish species (MRRF 2005) and 150 species (Mai 2008) respectively have been recorded. At the Khone Falls (Siphandon region), at least 47 fish species are migratory, and migration cues appear to include water level, discharge volume, changes in turbidity or food supply (Baran 2006).

Fishing is a critical source of protein and income for many communities in the study area. In Stung Treng Province, up to 5,000 tonnes/year of fish and other aquatic fauna are consumed locally (Hortle 2007).

This report describes a new survey of fish, as well as opportunistic observations of edible shellfish and fishing methods, from the Mekong River in northeast Cambodia.

7.2 Methods

The objectives of the fish survey were to: (a) document fish assemblages and habitats in the study area, especially habitats for migration, breeding and foraging; (b) identify the conservation significance of the

1: *Tenualosa thibaudeaui*, globally "Endangered". 2: Giant Freshwater Stingray (*Himantura chaophraya*), globally "Vulnerable". 3: Catfish *Hemibagrus* sp., little-known undescribed species. 4: *Toxabramis* sp., a new record for Cambodia. 5: Long-nosed spiny eel *Macrognathus* sp., little-known and undescribed species which appears to be restricted to northeast Cambodia and southern Lao PDR. All photos ©Chavalit Vidthayanon/WWF.

study area for fish assemblages and individual fish taxa; (c) when possible, document the occurrence of aquatic bivalves and molluscs in the study area.

7.2.1 Survey localities and dates

Three surveys for fish were conducted in the study area between November 2006 and August 2007 (total 58 field days) (Table 1, Section 2.7). Sampling was conducted over three seasonal periods, the early dry season (receding water levels), dry season (low water levels) and wet season (high water levels). Approximately half of all fieldwork (29 days) was conducted in the "central section" of the Mekong River between Kratie and Stung Treng Towns. Within the "central section", field sampling was conducted around six islands (Koh Norong, Koh Tuk, Koh Tongdaeng, Koh Dambong, Koh Chbarr, Koh Baichor) and the entrances of three tributaries (Prek Krieng, Prek Preah, Prek Kandie) (Table 17; Fig. 8). Field camps were made for 2-4 days duration at field sites.

Table 17. Fish survey localities and sampling effort.

Survey location*	Early dry season (receding water) (Nov-06)	Dry season (low water) (Mar-07)	Wet season (high water) (Jul-Aug 07)
"Central section", Mekong River (habitat sampling; market surveys in local villages)	10	9	10
Mekong River near Kratie and Stung Treng Towns (habitat sampling)	2	3	3
Kratie Town market	2	4	4
Stung Treng Town market	4	3	3
Sambor Town market	>2	>1	>1
Total	20	19	20

*See Table 1 (Section 2.7) for coordinates of survey localities.

Another 20 days were spent visiting large urban markets in Kratie and Stung Treng Towns (Table 17). The remaining days were spent conducting opportunistic observations along the Mekong River between Kratie and Stung Treng Towns, and for survey preparation.

7.2.2 Sampling

Surveys focused on the inventory of all fish taxa encountered within the study area. Two approaches were used to sample fish richness: field sampling (direct capture of wild fish) and, observations of fish catches at markets within the study area. Fish capture in the "central section" was conducted in a range of habitats in the Mekong River, including the mid-stream, channel banks, margins of deep pools, sandbars, beaches and rock outcrops, semi-submerged vegetation, rocky rapids, the entrances of tributaries, and small, seasonal forested streams on islands. Daily sampling generally comprised visits to settlements in the mornings, to record species being sold, followed by capture of wild fish in the afternoons and evenings. Sampling was not stratified by habitat or location but aimed to record the maximum number of species possible. Fish were caught using hand-held small- and large-mesh dipnets and a small purse-sein net. Limited electro-fishing was conducted during the first survey in some small streams and tributary entrances, but was not permitted by the Fisheries Administration for the second and third surveys. General observations on fishing activity and fishing methods were recorded. Shellfish encountered during fieldwork were collected; the most optimal time for sampling shellfish appeared to be in the dry season (low water levels).

Observations at markets comprised regular visits to the large urban markets of Kratie and Stung Treng Towns, as well as opportunistic visits to Sambor Town market and fish traders in villages within the "central section", especially Koh Khnhaer and Saitlieu Villages. Checklists of all species observed were recorded

for each visit. Voucher specimens were obtained for most species encountered. Globally threatened species were photographed but not purchased.

Additional information was collected during community interviews. Local fishermen encountered during field surveys along the Mekong River, and market stall owners, were questioned about fishing methods and locations, and sale price, catch volume and status of threatened and/or economically-targeted species, using pictures in Rainboth (1996) to assist discussions.

Voucher specimens collected in the field and from markets were photographed then preserved in 90% ethanol or 10% buffered formalin and later transferred to 75% ethanol. Some specimens were deposited with WWF Cambodia with the aim that these are eventually transferred to a national museum facility when this becomes available. Most specimens were deposited at the Thailand National Inland Fisheries Institute (Thailand Department of Fisheries) and will be assigned unique catalogue numbers. Tissue samples of the families Cyprinidae, Cobitidae and Balitoridae (Order Cypriniformes) were submitted to the "Cypriniform Tree of Life Project", University of Missouri (USA), which is researching the phylogenetic relationships of cyprinids in Southeast Asia.

7.2.3 Limitations

Deep pools are critical habitats for many fish species but due to their depth require specialised survey techniques (e.g. sonar) and were not sampled in the current surveys. Electro-fishing, an effective method for sampling fish in small, clear streams was only conducted in the first survey. Survey timing, despite including three seasonal periods, may not have encompassed the full seasonal occurrence of all fish species in the study area, which may also be influenced by variations in water level and lunar cycle. These limitations may have precluded the detection of some species during surveys.

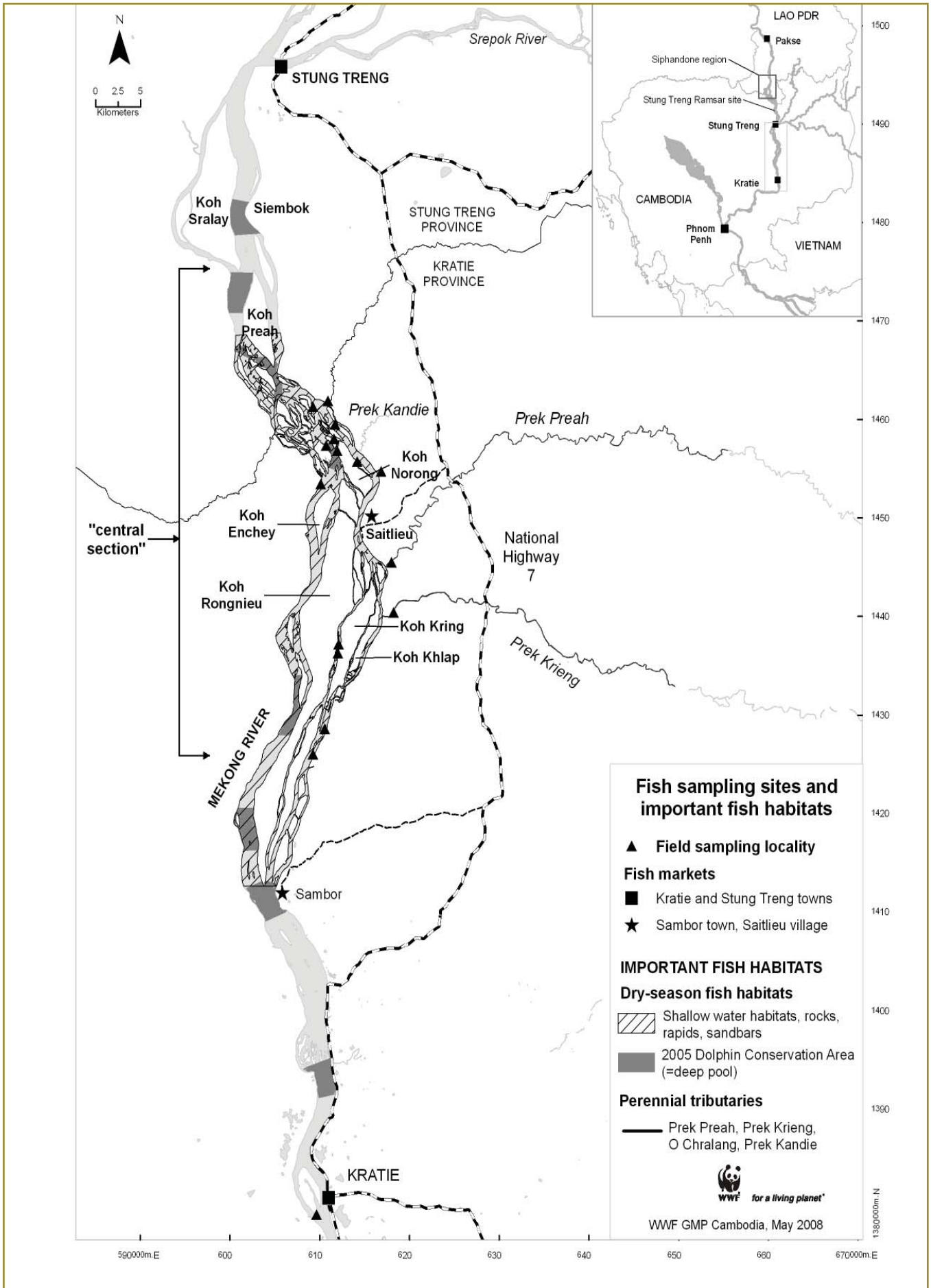

Figure 8. Fish sampling locations and fish habitats in the study area.

7.3 Results

7.3.1 Species richness and assemblages

A total of 223 indigenous (native) fish species, 17 native edible mollusc species and six native crustaceans were recorded during surveys (Annex 6; see also on-line table "OLT"). In addition, nine exotic fish species were recorded in Kratie and Stung Treng Town markets (no exotic species were observed in the wild during field sampling) (see OLT). The native fish comprised 37 families and 115 genera (Table 18):

- one elasmobranch (a stingray);
- cypriniforms (106 species of four families, including 91 carp, barbs, minnows and 14 loaches);
- catfishes (55 species of seven families);
- percomopha (47 species, including 26 perch-like taxa from 10 families, seven spiny/swamp eels, one pipefish, seven flatfishes, and six puffer species);
- 14 other bonyfish species [six clupeoids (sardines and anchovies), four featherbacks (Notopteridae), three belonids (needlefishes), and 1 true eel (Anguillidae).

Table 18. Taxonomic diversity of native fish taxa recorded in the study area during surveys.

Orders	Families		Genera		Species	
	No.	% of total	No.	% of total	No.	% of total
Elasmobranches: sharks and rays	1	3	1	1	1	0
Osteoglossiformes: featherbacks	1	3	2	2	4	2
Anguilliformes: true eels	1	3	1	1	1	0
Clupeiformes: sardines and allies	2	5	6	5	6	3
Cypriniformes: carp, barbs and loaches	4	11	53	46	106	48
Siluriformes: catfishes	8	22	22	19	55	25
Beloniformes: needlefishes and allies	3	8	3	3	3	1
Gasterosteiformes: pipefishes	1	3	1	1	1	0
Synbranchiformes: swamp and spiny eels	2	5	3	3	7	3
Perciformes: perches and allies	11	30	16	14	26	12
Pleuronectiformes: flatfishes	2	4	5	4	7	3
Tetraodontiformes:puffers	1	3	2	2	6	3
Total	37	100	115	100	223	100

The composition of native fish families was dominated by the Siluriformes (catfishes) and Perciformes (perches and their allies), although the highest number of species was from the family Cypriniformes (Fig. 9).

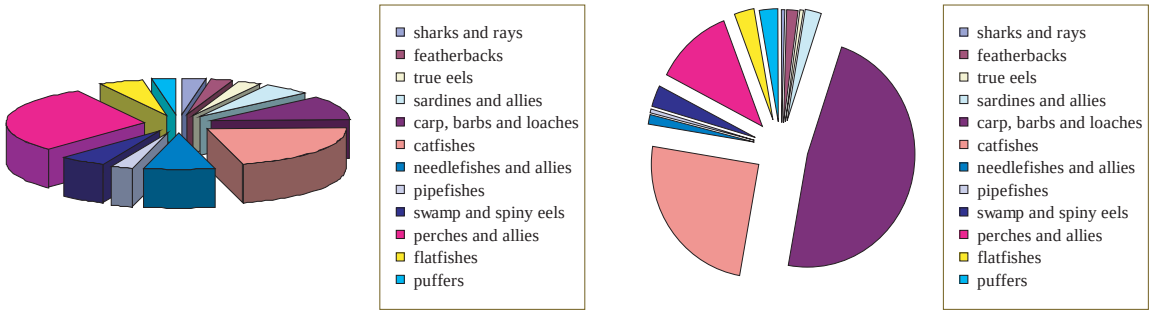

Figure 9. Composition of native fish assemblages recorded in surveys expressed as #families per order (on left) and #species per family (on right).

The highest number of native fish species recorded was in the dry season (second survey, March 2007) (195 species), followed by the the wet season (third survey, August 2007) (182 species). The lowest number of species recorded was in the early dry season (receding water levels, first survey, November 2006) (181 species). In the "central section", where most field sampling was conducted, 158 species of fish were recorded (Table 19).

Table 19. Fish species richness in survey sites along the Mekong River.

Survey results	Kratie Town market	Stung Treng Town market	Field sampling ("central section"+near Kratie Town)	Total richness (all sites)
Survey 1 (early dry season, receding water levels, Nov-2006)	153	166	103	181
Survey 2 (dry season, low water levels, Mar-2007)	161	175	119	195
Survey 3 (wet season, high water levels, Jul-Aug 2007)	152	167	82	182
Total	172	190	158	**223**
Additional data				
1. Elasmobranchs	1	1	1	1
2. Bony fishes	171	189	157	222
3. Species conducting longitudinal migration ("white fish")	79	90	73	98
4. Species conducting lateral migration (to floodplains)	8	8	3	9
6. "Black fish" species	72	73	40	77
7. Species which spawn on rocky rapids	37	44	44	48
8. Species which utilise deep pools (based on ecological data in Poulsen et al., 2002)	50	46	39	53

An additional three species, *Amphothistes laosensis*, Giant Salmon-carp (*Aaptosyax grypus*) and *Catlocarpio siamensis*, were reported by previous researchers to occur in or near the study area (Roberts & Warren 1994; Baird et al. 1999; Baird 2001; Mai 2008) but were not recorded during the current surveys.

7.3.2 New national record and undescribed taxa

One new fish record for Cambodia was discovered during surveys, an abramine cyprinid *Toxabramis* sp. (see cover photo this chapter). A single specimen was recorded in the wet season (August 2007) in Stung Treng Town market, but could not be identified to taxon-level due to the paucity of taxonomic information for this genus. Few other confirmed records of this genus exist for the Mekong Basin. Specimens of this genus were collected in April 2008 in upper tributaries of the Srepok River in Viet Nam, where it appeared to be "common" (C. Vidthayanon unpublished data) and was also reported from the Mekong Basin in 2005 (MRRF 2005). It is possible the specimen collected in Stung Treng market originated from the Srepok River, outside the study area; available data indicates this genus may inhabit small, upper tributaries away from large rivers. The genus may also be under-reported in market surveys of fish in the Mekong Basin, due to its superficial similarity with a common and frequently harvested species *Paralaubuca typus* (often observed at markets in the study area). Elsewhere, the genus is known only from the Red River Basin (Viet Nam) and China (W.J. Rainboth personal communication 2003). The single specimen from Stung Treng market may represent a downstream range extension of over 100 km, but the status of the genus in and near the study area requires further review.

One fish species recorded during surveys, *Minyclupeoides dentibranchialus* (Annex 3 – Plate 57), was previously only reported from the lower reaches of the Cambodian Mekong River (Roberts 2008). Less than 10 specimens were recorded in the current survey, from Kratie Town market and the "central section". These records represent a range extension of at least 100 km upstream from the type locality.

Two undescribed fish taxa were recorded during surveys, a bagrid catfish *Hemibagrus* sp. (Bagridae) and a long-nosed spiny eel *Macrognathus* sp. (Mastacembelidae) (see cover photos this chapter). Single specimens of both taxa were previously discovered by Rainboth (1996) and Baird et al. (1999) in Stung Treng Province and the Siphandon region (Lao PDR) (W.J. Rainboth personal communication 2005), and were considered by those authors to potentially represent new taxa. In the current surveys, 12 specimens (total length 10-25 cm) of the catfish were collected during field sampling along the Mekong River and in Kratie and Stung Treng Town markets. This catfish appears to be locally common in the Lower Mekong Basin and is recorded in markets from northern Thailand to Cambodia (C. Vidthayanon personal observation; P. Saenjundaeng unpublished thesis Kasetsart University). For the spiny eel, five juveniles were collected along the banks of Koh Rongnieu Island during field sampling in the dry season, and 13 adults were collected in Kratie and Stung Treng Town markets. This eel was previously known only from rocky habitats in the Mekong River in southern Lao PDR (Baird et al. 1999), and the current records represent a downstream range extension of approximately 180 km. Both species await scientific description.

7.3.3 Fish habitats

In general, the most intact and diverse natural fish habitats remaining in the study area are within the "central section", mid-way along the Mekong River between Kratie and Stung Treng Towns. At least three general fish habitats are situated in the "central section": deep pools, rocky rapids and shallows, and sandbars and sandy shallows. Deep pools in the study area were not sampled due to their depth, and sonar-based studies were beyond the scope of surveys. Little local fishing activity was observed at deep pools in the "central section", and few direct observations of fish caught in deep pools were made. Other studies in Cambodia and Lao PDR indicate that deep pools between Kratie Town and Siphandon, Lao PDR, provide critical resting and feeding sites for at least 20 species of migratory fish (Poulsen et al. 2002).

Rocky rapids and shallows in the "central section" provide dry-season habitats for over 90 fish species for migration passage and/or spawning, including seven threatened species, Giant Freshwater Stingray (*Himantura chaophraya*), Mekong Featherback (*Chitala blanci*), a clupeid *Tenualosa thibaudeaui*, Leaping Barb (*Chela caeruleostigmata*), Jullien's Golden Carp (*Probarbus jullieni*), another barb *Probarbus labeaminor*, and Chao Phraya Giant Catfish (*Pangasius sanitwongsei*) (see cover photos this chapter and Annex 3 – Plates 52-56). At least 48 species recorded in the study area are dependent on rocky rapids for spawning (Table 19 and see also OLT; Roberts 1993; Roberts and Warren 1994). In the dry (low water) season, sandbars and sandy shallows in the "central section" and elsewhere in the study area provide nursing grounds for juveniles of the cyprinids *Henicorhynchus* spp. and possibly also for Giant Freshwater Stingray. Important fish habitats in the "central section" and the locations of known deep pools in the study area are shown in Figure 8.

Floodplains near Kratie Town support over 68 species of fish, based mainly on specimens recorded in Kratie Town market. These floodplains are important habitat for species which undertake lateral migrations between the mainstream and floodplains and/or which are sedentary and reside on the floodplain (sometimes loosely termed "black fish" species).

7.3.4 Threats and local use

At least 131 fish species and 18 shellfish species were observed for sale at markets in the study area (see OLT). Fish are the most important source of protein and cash income for many communities in the study area. Virtually all communities along the Mekong River in the study area conduct subsistence fishing, and many conduct "commercial" fishing (i.e. for sale in local markets). Fourteen fishing methods were observed, including gill nets, cast nets, *dai* nets (bagnets), sein nets, various types of fish traps, and speargun, and three methods were observed for shellfish collection, including clam dredges and collection by hand (Table 20; Annex 3 – Plate 59). Gillnet-fishing was the most frequently observed method along the river. At floodplains near Kratie Town, bagnets, dipnets and lift nets were observed. Commercial-scale fishing, including groups of people and boats with large gillnets working cooperatively, was observed in the "central section". Some of these communities were from Sambor Town or nearby villages and stated they conduct fishing in remote waterways of the "central section" each year. In the "central section", most commercial trade of fish (as well as wildlife) appears to be dominated by a relatively small number of traders in two villages, Koh Khnhaer and Saitlieu, which purchase fish from many surrounding villages (see also Section 8).

Table 20. Fishing equipment observed in the study area.

Fishing equipment	Cambodian name (Deap et al. 2003)	Habitat
Long-handled scoop net	*Thnorng Chhrung*	River (rocky rapids, tributaries)
Cross-bow	*Snaa Ban Trey*	Opportunistic (river, floodplain)
Hook set pole and line	*Santouch Bongkai*	Floodplain (ponds, lake margins)
Long-line with hooks	*Santouch Ronong*	River (slow-flowing sections)
Large bamboo vertical trap	*Saiyoeun*	River (slow-flowing sections), ponds
Horizantal cylinder trap	*Lop Prueh Saiyoeun*	Riverbanks, streams, shallow ponds
Horizantal cylinder trap for catfishes	*Lop Trey Kanchos*	Riverbanks, streams, shallow ponds
Large cylinder traps (several varieties)	*Lop Prueh Duen*	Riverbanks, deeper ponds
Trap door traps	*Chann*	Along riverbanks
River barrage	*Thnous, Dai*	River (mainstream, large tributaries)
Giant lift net	*Chhnuok*	River (mainstream, large tributaries)
Gill nets	*Mong Kang*	River (deep pools, tributaries), deeper areas of floodplains
Cast nets	*Samnanh*	Shallow waterbodies
Sein net	*Oun Hum*	Riverbanks, deeper ponds

Over-fishing is the greatest potential threat to most fish taxa of economic importance in the study area. Human populations and fishing pressure for commercial sale and local subsistence, especially in the "central section", are rapidly increasing. During surveys, intensive use of gillnets was observed along waterways between Koh Rongnieu and Koh Kring Islands, among islands at the Kratie/Stung Treng provincial border, and at the entrances of tributaries. At Prek Krieng and Prek Kandie Rivers, large bagnets were observed blocking the entire entrance of both rivers. Local fishermen reported that catches of some "large fish species" are declining in the "central section" and elsewhere in the study area. Over-fishing appears to have resulted in the loss of at least one species, Largetooth Sawfish (*Pristis microdon*) (IUCN "Critically Endangered"). Local communities reported this species previously occurred and was harvested, but has not been seen for many years. At least two other species appear not to have been caught for some years, Large-band Tiger Perch (*Datnioides pulcher*) and Giant Salmon-carp (both "critically endangered" in Thailand, Vidthayanon 2006).

In the "central section", fish habitats remain relatively intact and for many non-economic species, their populations may be relatively secure. The principle threat to economically-targeted fish taxa in the "central section" is over-fishing. Elsewhere in the study area, habitat loss and degradation are a greater threat to fish populations, including sedentary species and species which undertake lateral migration between the Mekong channel and floodplains. Floodplains in the study area have largely been converted to agricultural lands and support human populations, while most riverbanks along the Mekong have been cleared of native vegetation. This has reduced the extent and quality of breeding and foraging habitats for fish.

7.4 Discussion

Surveys confirmed that the "central section" supports some of the most intact fish habitats remaining in the Lower Mekong River: this site is the highest priority in the study area for fish conservation. It is particularly important in contributing to the integrity of migration habitats for fish species of the "lower" and "middle" Mekong migration systems (Poulsen et al. 2000). Other important locations in the study area are deep pools (some are designated as "dolphin conservation zones", Fig. 8; Section 2.6) and floodplains near Kratie Town.

Fish richness and diversity recorded during surveys was consistent with data for similar nearby habitats, especially the Siphandon region (Lao PDR). The study area is part of a distinct hydrological unit of the Mekong River extending from Kratie Town north to Pakse Town (Lao PDR), which includes the Stung Treng Ramsar site and Siphandon region (Section 2.2). In the Siphandon region, over 300 fish and 30 shellfish species were recorded during 6+ years of collection by a number of agencies and projects (Baird 2001; Baird et al. 1999 and references therein). The current surveys documented 223 native fish species in six weeks of

survey work, approximately 43% of the total richness documented in Cambodia (Table 21). This richness reflects the high diversity of aquatic habitats along this section of the Mekong, and the central location of the study area along the migration route of species traveling between the Mekong Delta, Tonle Sap Lake and "upper" Mekong in northern Lao PDR and Thailand. Future surveys will probably detect additional fish taxa.

Table 21. Fish richness along the Mekong River and tributaries between Kratie (Cambodia) and Siphandon (Lao PDR).

Source	Study area (total)	"Central section"	Stung Treng market	Kratie market	Siphandon (Lao PDR)	Srepok-Se San	Cambodia Total
This study	223	158	190	172			
Roberts and Warren (1994)			144				
Baird et al. (1999)					310		
Baird (2001)					201		
MFD (2003)							521
MRRF (2005)						200	
Virawong et al. (2006)					178 (in deep pools)		
Mai (2008)						150	

The most frequently encountered fish species in all surveys were *Rasbora aurotaeniata* and *Mystacoleucus marginatus*. An additional three species, *Amphothistius laosensis*, Giant Carp (*Catlocarpio siamensis*), and Giant Salmon-carp, were reported by previous researchers to occur in or near the study area (Roberts & Warren 1994; Baird et al. 1999; Baird 2001; Mai 2008) but were not recorded during the current surveys. The study area may also be within the global range of a newly described barb, Siamese Bala Shark (*Balantiocheilos ambusticauda*), although this may already be extinct in the wild in Thailand and elsewhere (Vidthayanon 2006; Ng & Kottelat 2007).

The study area lies within a region of the Mekong River that supports a high diversity and endemism of inland freshwater molluscs. Seventeen species of edible molluscs were recorded during surveys (e.g. Annex 3–Plate 58), but at least 121 gastropods (of which 111 are endemic to the Mekong River) and 39 bivalves (five endemic) have been recorded in the Lower Mekong (Groombridge & Jenkins 2002).

Differences are apparent in the composition of fish species and total richness recorded in each survey period (dry season, late dry season, wet season) (see OLT). For example, the highest numbers of fish/shellfish species recorded in Stung Treng and Kratie Town markets were 190/8 and 172/17 respectively (Table 19; OLT), while a maximum of 58 fish species were recorded in Sambor Town market. These differences reflect the timing of surveys, the seasonal migration of fish along the Mekong River and between the Mekong and adjacent floodplains (in response to exposure/inundation of habitats within the Mekong channel) and possibly, varying detectability / catchability of fish between seasons and water levels. At Sambor Town, low species totals probably reflect the small amount of time spent there (four days, Table 17) and because more fish are transported to the larger markets of Kratie and Stung Treng.

In the dry season, the margins of seasonally exposed sandbars around islands form important nursing grounds for several economically-targeted species, including barbs *Hypsibarbus* spp., Mekong Giant Gourami (*Osphronemus exodon*) and subadults of *Henicorhynchus lobatus* ("trey riel"). In the wet season, species recorded in the study area included species migrating northward from south of the study area ("lower Mekong species" e.g. *Thryssocypris tonlesapensis*) and species migrating south, from north of the study area ("upper Mekong species" e.g. *Anguilla marmorata, Hemiculterella microlepis*). Inundated channel habitats and tributaries provide wet season refugia and spawning sites for several carps and barbs e.g. *Henicorhynchus lobatus* (Baran 2006).

At least eight species listed by IUCN as globally threatened, 36 species listed as threatened in Thailand, and 2+ species listed as protected in Cambodia, were recorded in the study area (Annex 6). Some species e.g. a clupeid *Tenualosa thibaudeaui*, Mekong Featherback, a cyprinid *Osteochilus schlegeli*, Mekong Tiger Perch (*Datnioides undecimradiatus*) and Jullien's Golden Carp, are listed as "endangered" or "vulnerable" in Thailand but are still recorded relatively frequently in markets in Cambodia and Lao PDR, including the study area. Many fish species considered rare or threatened elsewhere in Cambodia or the Lower Mekong

Basin remain relatively abundant in the study area, particularly the “central section”. The intact riverine habitats of the “central section” also form the basis for the continued availability of critical food resources and cash income for local communities (see also Section 8). Fishing pressures in the “central section” are increasing rapidly and management strategies will be essential to secure fish and shellfish populations and their habitats for the food security of local communities.

In a systematic ranking of vertebrate fauna (Annexes 5,6), five fish species were ranked as a “high priority” for management in the study area (Giant Freshwater Stingray, Mekong Giant Catfish, Chao Phraya Giant Catfish, Shovelnose Sea Catfish, Giant Carp) and eight species were ranked as a “medium priority” for management (Mekong Featherback, another featherback *Chitala lopis*, a cyprinid *Macrochirichthys macrochirus*, Thinlip Barb, an undescribed, long-nosed spiny eel, Mekong Tiger Perch, Leaping Barb, and a barb *Probarbus labeamajor*). Management actions for these taxa are described in Section 10.1.2.

Based on survey findings, the following recommendations are considered priorities for fish conservation and management: (1) implement conservation actions for 13 fish species ranked as “high” or “medium” management priority in the study area (Section 10.1.2); (2) assess the importance of fisheries and habitats in the study area, especially the “central section”, to (a) local livelihoods and food security and (b) downstream fisheries, including the Tonle Sap Lake; (3) implement market monitoring to record the catch volume and frequency of selected fish species, including rare, threatened and large species; (4) implement immediate management of the remaining riverine habitats in the “central section”, including vegetation within the river channel and along the river banks, to reduce loss and damage to fish breeding and foraging resources; (5) strengthen community management of local fisheries in the “central section”; (6) strengthen the capacity of provincial fisheries staff in Kratie and Stung Treng Provinces to manage local fisheries and fish habitats along the Mekong River, especially: identification skills to recognize key species (e.g. rare, threatened, economically targeted), market monitoring, data collection (including photographing fish specimens) and fish preservation.

8. SETTLEMENT AND RESOURCE USE IN THE "CENTRAL SECTION"

Mark R. Bezuijen and Vinn Bunna



8. Settlement and resource use in the “central section”

8.1 Introduction

This section describes observations of natural resource use in the “central section” recorded during biological surveys between November 2006 and August 2007. The “central section” may support some of the most intact forest and wetland resources remaining along the Mekong River in Cambodia, including timber stocks, populations of fish taxa of economic importance, intact fish breeding and nursery habitats, and large areas of unclaimed land. These resources, especially fish, contribute significantly to the food security and income of many communities in Kratie and Stung Treng Provinces. Communities over 30 km away visit the “central section” to access natural resources and locally-caught fish are sold in provincial towns. The economic value of the natural resources of the “central section” is unknown but presumably considerable for its contribution to local diets and income. Due to its intact riverine habitats, the “central section” may represent an important “source” area for the maintenance and recruitment of regional fish populations. Pressure on these natural resources, especially fish and riverbank vegetation, is increasing due to rapid human population growth. The data presented here are preliminary observations only; collection of human socio-economic data was beyond the scope of surveys.

8.2 Methods

Observations of human settlement and natural resource use in the “central section” were collected on an opportunistic basis and supplemented with community interviews. When time permitted, settlements were visited and the following data collected: GPS location, number of houses/ camps, number of residents, number of years residence or duration of visit, source village of migrants and seasonal visitors, reasons for moving to the “central section”, and principle activity (fishing, cultivation etc). Settlements that were newly established over the duration of surveys were documented. The distance that migrants or seasonal visitors had moved from their source villages to the “central section” was estimated from 1:50,000 topographic maps. Settlements were classified in three categories: “villages” (well-established permanent settlements $\geq$10 years old), “new settlements” (permanent and <10 years old) and “camps” (seasonal settlements used for less than one dry- or wet-season). Fishing or logging activities were defined as “commercial” if the resource was being collected for sale in urban markets and was clearly at a larger scale than subsistence activities. Data collection was largely limited to the remote waterways in the eastern portion of the “central section”, and not all settlements were visited.

8.3 Results

8.3.1 Villages in the eastern waterways

Only six villages are located in the waterways of the “central section” between Koh Rongnieu Island and the east bank of the Mekong River: Kampong Pnov, O Kak, Pontacheer, Koh Khnhaer, Satlieu and Koh Dambong (Fig. 2). These waterways support the lowest human populations in the entire study area. These villages retain traditional land ownership and are critical for the management of natural resources of this area. Residents stated that Kampong Pnov, O Kak, Koh Khnhaer and Pontacheer Villages are 50-100+ years old. Satlieu Village is adjacent to Koh Khnhaer Village and was apparently created in 1970 by an administrative division of the latter. In all villages, the principle subsistence activity is rain-fed rice cultivation (no rice irrigation was observed). All communities supplement cultivation with fishing and hunting. Some preliminary data on village boundaries was obtained (Table 22) but specific land boundaries and their legal status, and traditional regulations for natural resource use, settlement of new lands and resource sharing with other communities, is unknown. Government mapping of village lands was observed in Koh Khnhaer and Satlieu villages in March 2007.

Cover: Subsistence fishing is practiced by all communities in the study area ©Trudy Chatwin.
1: Sambor town. 2-4: Residents and local resource use. Photos 1-4 ©Mark Bezuijen/WWF.

Table 22. Local information on land ownership in the eastern waterways of the "central section".

Village	Islands	Extent of village lands
Koh Khnhaer / Saitleu	Koh Rongnieu, Koh Chreum, Koh Norong	Northeast and northcentral portions of Koh Rongnieu and surrounding islands
Pontacheer	Koh Kring, Koh Khlap	From river and islands between Koh Khnhaer and Pontacheer Villages in the north, to the entrance of Prek Krieng River in the south, and the central and north section of river channel between Koh Kring and Koh Khlap Islands in the west
O Kak	Koh Khlap, Koh Kring, east bank of Mekong River	From the village to Prek Krieng River in the north, the centre of Koh Kring Island (including most of Koh Khlap Island) in the west, and to O Panah River in the south
Kampong Pnov	Koh Kring, Koh Khlap, east bank of Mekong River	From the village to the southern region of Koh Kring Island, and the central and west regions of Koh Khlap Island

Population expansion was observed in two villages, Koh Dambong and Pontacheer. At Pontacheer Village, new houses and land clearance along the riverbank south of the village were observed between November 2006 and August 2007. On Koh Norong and Koh Kring Islands, residents in three new settlements (2007) stated they were from Koh Dambong Island and had moved due to a shortage of land on that island (Fig. 2): these residents had migrated 2-15 km to form these new settlements.

8.3.2 New settlements in the eastern waterways

Thirty-one new settlements (i.e. <10 years old) were documented in the eastern waterways of the "central section" between Koh Rongnieu Island and the east bank of the Mekong River (Table 23; Fig. 2). This is almost certainly an underestimate of the true extent of new settlement in the "central section", because not all waterways in the "central section" were visited and some areas were only visited once.

Table 23. New settlements observed in the eastern waterways of the "central section".

Waterway	Settle-ments	Density (per km surveyed)	Houses per set-tlement: mean (range, n)	Years of residence: mean (range, n=interviewees)	Visual estimate cleared land (ha) per settlement: mean (range, n)	Total cleared land (ha)	New settlements (%of total settlements)[3]
Between Koh Rongnieu and Koh Kring Islands	8	0.7	2 (1-4, n=8)	5.5 (0.5-10, n=5)	7 (1-16, n=8)	57	2 (25%)
Between Koh Kring and Koh Khlap Islands	1	0.1	3	?	6	6	0
Between Koh Khlap Island and east bank of Mekong[1]	13	0.5	2.8 (1-13, n=13)	0.8 (0.5-1, n=3)	2.5 (1-8, n=13)	33	4 (31%)
Between Koh Rongnieu and Koh Chdong Islands	4	1.1	1 (n=4)	?	5.3 (1-8, n=4)	21	? (visited once Aug-07)
Between Koh Rongnieu and Koh Kleinpor Islands	2	0.8	2 (1-3, n=2)	?	3 (1-5, n=2)	6	? (visited once Aug-07)
Kratie-Stung Treng border area (many small islands)[2]	3	not re-corded	1.3 (1-2, n=3)	1.7 (1-3, n=3)	3 (1-6, n=3)	9	2 (67%)

[1]Includes waterway extending north to Koh Norong and Koh Khleeay Islands. [2]Many islands in this area were not visited. [3]New settlements in waterways visited at least twice between November 2006 and August 2007.

These limited data, and discussions with residents of these new settlements, revealed the following.

- Current in-migration and creation of new settlements is uncontrolled and unregulated. There appear to be few regulations (national, provincial or traditional) to manage migration and settlement along the Mekong River, although three migrants stated they had applied for permission from the head of their village to migrate to the "central section".

- Migrants stated they moved to the "central section" due to the relative abundance of land for farming and other natural resources, compared with their native village lands. The residents of the 31 settlements visited were from at least six villages: four outside the "central section" (Sambor Town and Wattana, Koh Tnao and Koh Ksang Villages: migration distance 20-30 km) and two within the "central section" (Kampong Pnov and Koh Dambong Villages: migration distance 2-5 km).

- The mean length of residence in these 31 settlements was 3.2 years (range 0.5-10 years, n=31). Most settlements in the eastern waterways were "new" and migrants had only moved to the "central section" within the last three years. All settlements were small: the mean number of houses per settlement in all waterways visited was two (range 1-13).

- Most settlements are located on riverbanks for close proximity to water. Settlements generally comprised small houses of timber with thatched roofs, cultivated land and some domestic animals (usually dogs and chickens). Some settlements were located up to 100 m inland from the riverbank. All settlements were associated with plots of cleared and cultivated land at least 100 x 100 m (1 ha) (visual estimate), usually along the riverbanks. The 31 settlements visited had resulted in loss of >142 ha of riverbank forest, which had been logged, burnt and cultivated. New settlement is resulting in rapid loss and degradation of remaining sections of riverbank vegetation, a critical habitat for some vertebrate fauna (Sections 4, 5).

- In 2007, most new settlement had been in two waterways: between Koh Rongnieu and Koh Kring Islands, and between Koh Khlap Island and the east bank of the Mekong, extending north to Koh Norong Island (Table 23). The waterways with the lowest densities of settlement appear to be between Koh Kring and Koh Khlap Islands, and the region of small islands in the Kratie-Stung Treng border area.

- Settlement in the "central section" is occurring rapidly. Between November 2006 and August 2007, the number of settlements established in the "central section" increased by at least 35% (eight of the 31 settlements recorded were established during the survey period). This equates to an increase of 0.8 settlements/month or 9.6 settlements/year. Assuming each settlement results in a minimum loss of one hectare of riverbank forest, the current rate of forest loss is 9-10 ha/year. This is almost certainly a significant underestimate of forest loss because: (a) not all parts of the "central section" were visited; (b) forest loss around established villages was not recorded; (c) direct forest loss does not account for the impact of edge effects and forest fragmentation caused by new settlement.

8.3.3 Seasonal camps in the eastern waterways

Thirteen seasonal camps were recorded in the eastern waterways of the "central section" between Koh Rongnieu Island and the east bank of the Mekong River (Table 24). The number of camps documented is almost certainly a significant underestimate of the total number of seasonal visitors to the "central section", because not all waterways in the "central section" were visited.

These limited data, and discussions with seasonal visitors, indicate the following.

- The highest rates of seasonal visitation to the "central section" are in the dry season. Fishing is the principle dry-season activity of most visitors. Commercial fishing was only observed in the dry season; subsistence fishing is conducted in all months by all communities (seasonal visitors and permanent residents) but appears to be highest in the dry season.

- The highest levels of dry-season fishing activity observed were in two areas: the waterway between Koh Rongnieu and Koh Kring Islands, and the region of small islands in the Kratie-Stung Treng border area.

- Dry-season fishing in the "central section" is a dynamic activity, with people moving between islands and waterways depending on seasonal water levels and fish movements. Some camps are temporary and located on sandbars, and may be moved after several days to a new location. Other camps are semi-permanent,

Table 24. Resource use by seasonal visitors to the "central section".

Variable	Dry season (observations in November 2006 and March 2007)	Wet season (observations in July-August 2007)
Total camps	10	3
Camps for commercial fishing	5	0
Camps for subsistence fishing	3	0
Camps for cultivation	2	2
Camps for charcoal production	0	1
Duration of visit	1 week-2 months	wet season*
People per camp: mean (range, n)	8 (1-28, n=8)	3 (1-6, n=3)
Motorised boats per camp: mean (range, n)	3.6 (1-16, n=8)	1.3 (1-2, n=3)
Distance from source village: mean (range, n)	16.5 km (5-25 km, n=8)	7.5 (3-12, n=2)

*Some visitors stated they alternate between their village and seasonal camps throughout the year.

and are located on riverbanks, where small areas of forest are cleared and crops are cultivated. These semi-permanent camps are made by non-residents and also by residents from villages elsewhere in the "central section". Most fishermen conducting dry season fishing stated they would return to their villages at the end of the dry season. The reported duration of fishing trips by visitors in the "central section" was from three days to three months.

- In the wet season, the principle activity of seasonal visitors is crop cultivation (mainly rice and corn). At two camps with wet-season cultivation, the visitors stated they would return to their villages at the "end of the wet season". Visitors undertaking wet-season cultivation were distinguished from permanent residents through discussion and because seasonal huts were generally simple, sparse and with little equipment, compared with permanent homes.

- Visitors had come from 10+ villages located along the Mekong River up to 30 km north or south of the "central section" in Kratie and Stung Treng Provinces. Most seasonal fishermen were from Sambor District, including Sambor town and nearby villages, 15 km south of the "central section". This is probably an underestimate of the total number of communities and distance some visitors travel to access the "central section".

8.3.4 Natural resource use

Nine human activities involving natural resources were observed in the "central section" (Table 25): logging (subsistence and commercial), burning of forest and wetland vegetation, cultivation (subsistence), fishing (subsistence and commercial), wildlife hunting (subsistence and commercial wildlife trade), livestock grazing, charcoal production, driftwood collection (subsistence and commercial) and collection of non-timber forest products. These activities are conducted by a wide range of residents and visitors. Fishing, wildlife hunting and logging appear to be the greatest sources of financial income for residents and visitors.

Table 25. Observations of natural resource use in the "central section" between November 2006 and August 2007.

Resource use	Observations
Timber extraction (logging)	• Uncontrolled and unregulated; driven by short-term cash income. Conducted by local and non-local communities (timber traders reported to be from Kampong Cham Province). • Extensive logging on riverbanks and large areas of many islands; remnant forests on large islands (Koh Rongnieu, Koh Kring, Koh Khlap, Koh Norong) are being degraded rapidly. • Commercial timber use is for boat / house construction. Logging is conducted with chainsaws and logs are floated out in the wet season (May-November). • Long-term negative impacts: loss / reduced timber supplies for house/boat construction.
Burning	• Extensive burning of forests on riverbanks and islands in dry season (in March 2007, large areas of forest were entirely burnt on Koh Rongnieu, Koh Kring and Koh Khlap Islands). • Burning of driftwood within the river channel. • Some burning is deliberate (to clear forest for hunting, or for no clear purpose); some burning is accidental (poor management of camp fires, cigarettes etc). • Long-term negative impacts: loss of mature trees and seed store prevents natural recruitment of economically and locally important species.
Cultivation	• Principle crops are rice and corn. Riverbank forest targeted for cultivation due to proximity to water. Conducted by permanent residents, new settlers, and some seasonal visitors. • High impacts: clearance (burning, logging) of riverbank forest, and increasing demands caused by rapid population growth along riverbanks to grow crops.
Commercial fishing	• Uncontrolled and unregulated. Mainly occurs in dry season (December-April) • Key commercial method is gillnet fishing, observed across river channels and around deep pools, especially in river channel between Koh Rongnieu and Koh Kring Islands. Two gillnets each >100 m long observed in March 2007 blocking river entrances at Prek Krieng, Prek Kandie. • Usually conducted by non-local communities from outside the "central section" especially Sambor Town and nearby villages e.g. Svay Chek. • Well-organised fish trade system in "central section", dominated by 2+ traders in Koh Khnhaer and Saitleu Villages, who purchase most local fish and wildlife. Fish is sold to these 2+ traders as follows: (1) fishermen sell fish directly to these traders; (2) fishermen sell fish to "middlemen" based in local villages or who visit fishing camps each day to purchase fish then resell to the traders. • "Middlemen" are residents of local villages in the "central section" or seasonal visitors to the "central section" from Sambor Town or other villages. • Non-local fishermen utilize local fish resources with little benefit for local communities. It is unclear if non-local fishermen obtain permission from local communities to fish in village lands. • Unsustainable fishing practices and overfishing may lead to fish declines which will impact food security of local communities. Local residents identified the following methods as a high threat: blocking of river entrances and deep pools with gillnets, electro-fishing, explosives, poisons (including a chemical called T'moh so'ey in Khmer, apparently used to flush fish from deep pools into nets).
Subsistence fishing	• Conducted by local communities and many non-local communities 30+ km from the "central section". • Mainly occurs in dry season (December-April) (fishermen return home in wet season). Duration of seasonal fishing trips by non-local fishermen may be 3 days to 3 months. • Fishing methods include gillnets, traps, hook/line, explosives, poisons, electricity. • Fishermen stay in small camps on sandbars / riverbanks. • Construction of seasonal fishing camps increases likelihood of new, permanent settlements. • Fishermen also conduct opportunistic hunting e.g. collection of turtle eggs, capture of macaques.
Wildlife hunting and trade	• Extensive hunting on all islands by local+non-local people. Wildlife is caught as a supplement for diet and income. Hunting methods include: locally-made "cross-bows" (with thick elastic bands and wood arrows with metal tips), traps, snares, hunting dogs. All fishermen encountered had 1-4 hunting dogs. • Species targeted for commercial sale are monkeys, turtles, large lizards and snakes. • A large, well-organised system of wildlife trade occurs within the study area and is linked to national and international trade. Wildlife trade is conducted by the same fish traders in Koh Khnhaer and Saitleu villages. Wildlife is transported in similar fashion as fish. Traders sell wildlife to 'dealers' in Sambor,

Resource use	Observations
Livestock grazing	• Domestic buffalo are the most abundant livestock (few cattle observed). • In the early dry- and late wet seasons, buffalo are unattended and range widely from source villages (10+ km) – animals, tracks and dung were observed on most large islands. • Buffalo are collected by villagers in late dry season for rice farming. • Current livestock densities appear to be low and may imitate the ecological role of large native ungulates formerly present in the study area. In the future, increasing livestock densities may result in significant loss or damage to remnant vegetation, especially along riverbanks and riverine flora.
Charcoal production	• Observed at one site in "central section" on Koh Khlap Island (west bank). Conducted by residents of Kampong Pnov Village (3 km away) who camp on Koh Khlap, harvest timber to produce charcoal and sell charcoal at Sambor Town. Charcoal production is conducted throughout the year at this site.
Driftwood collection	• Wet season activity: logs and wood debris floating downstream are collected by residents and visitors. Local communities collect floating wood debris for fuelwood • In August 2007, visitors from Kampong Cham Province were observed collecting large, old logs floating downstream the Prek Krieng River. Specialised boats were being used to collect logs as they
Non-timber forest products	• Bamboo harvesting occurs on many islands. Snails, molluscs and honey are also collected, generally for subsistence consumption. Little collection of aquatic plants (e.g. for food or medicinal purposes) currently occurs. Current harvest levels of most NTFPs are unclear but appear to be low.

These observations indicate the following.

- Natural resources in the "central section" are utilized by a range of communities including established villages, new settlements and seasonal visitors. Virtually all islands in the "central section" are visited for natural resource extraction: signs of logging, burning, hunting or fishing were observed on all islands visited by survey teams, including uninhabited areas in the centre of Koh Rongnieu and Koh Kring Islands.

- Most residents and visitors to the "central section" harvest a range of natural resources which collectively contribute to their livelihood, including seasonal subsistence activities (fishing, wildlife hunting, NTFP collection) and commercial activities (e.g. organized fishing activities, opportunistic sale of fish, wildlife, timber, labour employment in timber operations, hire of buffalo for timber stockpiling, charcoal production). Residents of established villages and new settlements conduct wet-season rice cultivation and subsistence timber logging for house and boat construction.

- Many human activities in the "central section" are seasonal. Dry season activities include fishing, burning/clearance (for cultivation, firewood), hunting and some timber logging. Wet season activities include crop cultivation, timber extraction and driftwood collection.

- Fishing, wildlife hunting and logging appear to be the greatest sources of financial income for residents and visitors. Residents and visitors engaged in farming and/or fishing conduct frequent, short hunting excursions on islands, using hunting dogs, traps, snares and locally-made crossbows. Turtles and monkeys are highly targeted and most are sold, not eaten. The extent of involvement of local communities in commercial timber logging is unclear. At one small logging camp (between Koh Kring and Koh Khlap Islands), residents of Kampong Pnov Village had been employed by non-residents reported to be from Kampong Cham Province, to utilise their buffalo to stockpile logs for river transport.

- The impact of cultivation by residents or visitors is largely the same: burning, clearance and permanent loss of natural forest, and increased wildlife hunting and fishing.

- Koh Khnhaer and Satlieu villages appear to be the most important villages for commercial fish and wildlife trade in the entire "central section". Most residents and visitors sell fish and wildlife to 2+ traders in these villages. This trade is unregulated and uncontrolled. These villages are a high priority for management of natural resources and law enforcement.

9. THREATS TO BIODIVERSITY

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9. Threats to biodiversity

Threats to biodiversity in the study area include "current" and "potential" threats. "Current" threats were documented by survey teams during fieldwork and focus on the "central section", which supports at least 62 taxa ranked "medium" or higher management priority (Section 10.1). Threats observed in the "central section" are symptomatic of the human activities which have led to the decline or extirpation of many taxa and natural habitats elsewhere in the study area. "Potential" threats were identified by desktop review and discussions with a range of government and non-government agencies.

Two principle causal factors are responsible for most threats to biodiversity in the study area:

- increasing population growth and settlement, especially within the "central section", and,
- provincial and regional economic development.

An overview of key threats is given below. Threats to individual taxa are described in Sections 3-7 and were considered on an individual basis for all taxa to derive rankings of conservation priority (Annex 6). For the Irrawaddy Dolphin, threats are described by MAFF (2005) and Beasely et al. (2007).

9.1 Current Threats

Within the "central section", increasing human population is the greatest causal factor for most threats to biodiversity. Human population growth is resulting from three sources:

- Expanding populations of established villages, particularly within six villages located in the eastern waterways of the "central section" (Kampong Pnov, O Kak, Pontacheer, Koh Khnhaer, Satlieu and Koh Dambong Villages, Fig. 2).
- Immigration and settlement by new residents who are moving to the "central section"
- Increasing volume of seasonal visitors to the "central section", who stay for weeks or months to access natural resources and then return to villages outside the "central section".

Population growth is causing a rapid increase in settlement and the extraction of natural resources, particularly the clearance of riverbank forest, timber logging, wildlife hunting and fishing. Six human activities (of nine activities involving natural resource recorded in the "central section", Section 8.3.4) appear to be causing the highest impacts to biodiversity: clearance for new settlement, unregulated timber extraction, burning, cultivation, fishing, and wildlife hunting and trade (Annex 3 – Plates 60-63). A further threat is the spread of an invasive weed (Table 26).

Unless management actions are undertaken immediately, current threats in the "central section" and other important sites will result in further declines, and potentially the loss, of up to 44 taxa in this site ranked "high" or "very high" management priority, including riverine vegetation, birds, large mammals and turtles (Section 10.1). For many of these taxa, there is no evidence they persist elsewhere in the study area, while at least 26 other species of vertebrate fauna may have already been lost (Annex 7), almost certainly due to similar threatening processes. The loss of the remaining populations of priority taxa in the study area could significantly impact the integrity of populations throughout the Mekong Basin or Southeast Asia.

Cover and photos 1-4: Fishing and hunting are causing declines in some threatened species such as the Giant Freshwater Stingray; logging and burning is causing rapid loss of riverbank forest, critical for the survival of many fauna. All photos ©Mark Bezuijen/WWF.

Table 26. Current threats to biodiversity in the "central section".

Threat	Impacts	Factors
Clearance for new settlement	• Virtually all new settlement restricted to riverbanks along mainstream and islands (human need for proximity to water; interior of most islands remain uninhabited). • Settlement resulting in rapid fragmentation and loss of remnant riverbank vegetation. • Loss of riverbank forest results in loss of critical nesting and/or foraging habitat for 7+ threatened bird species (White-shouldered Ibis, storks, herons, Green Peafowl, fish-eagles) and 2+ mammals (Silvered Leaf Monkey, Long-tailed Macaque). • Loss of riverbank forest increases exposure of Riverine Vegetation Zones 5, 6 (near high-water mark) and interior forests to edge effects (altered microclimate, increased vulnerability to fire). The net area of impacted habitat is greater than only the area cleared.	(a) Residents of established villages are moving due to land shortages and colonizing new sections of riverbank; (b) Arrival of new migrants; (c) Seasonal visitors clear land for a home and crops during their visit
Unregulated timber extraction	• Loss of forest along riverbanks and island interiors. • Loss and damage of Riverine Vegetation Zone 6 ("Strand") (logging, branch removal, seasonal firewood collection). • Increased fuel-loads from discarded wood causes increased risk of dry-season fires.	Subsistence timber use; commercial timber demands outside study area
Burning	• As above for forest along riverbanks and island interiors. • Deliberate or accidental (e.g. campfires) burning of Riverine Vegetation Zone 6. • Fire in channel woodlands, bushlands and accumulations of floatsam. • Frequent burning suppresses seasonal recruitment of non fire-tolerant flora and increases likelihood of invasive species colonizing and/or loss of native species.	Subsistence land use; new settlement
Cultivation	• Loss of riverbank forest for crop conversion (usually after logging, burning) and construction of seasonal camps or permanent settlements.	Increasing food needs of human population
Fishing	• Population declines of commercially valued species reported by residents. • Unsustainable methods (intensive gillnet fishing, poison, explosives) target all size classes and impact breeding females. • All fishermen conduct opportunistic hunting of other fauna, including large mammals (especially Long-tailed Macaque), birds, turtles, and collection of eggs of Cantor's Giant Softshell Turtle. • Accidental drowning of Irrawaddy Dolphins in gill nets (MAFF 2005). • Loss and damage of riverbank forest and Riverine Vegetation Zone 6 ("Strand") due to associated activities (camp construction, camp fires, firewood collection). • Seasonal fishing camps develop into permanent settlements.	Subsistence fish use; commercial demands in Kratie, Stung Treng Provinces and elsewhere
Wildlife hunting and trade	• High risk of local extirpation for most remaining large mammal species (8+, Section 5), especially Long-tailed Macaque and Hog Deer. • Population declines of 23+ bird species, 6 turtle species, large lizards and snakes due to commercial and subsistence hunting of adults and/or egg collection. • Population decline of Cantor's Giant Softshell Turtle due to egg collection (subsistence use) and incidental capture of breeding adults.	National and international commercial demand for wildlife consumption and/or medicinal use
Weed invasion	• *Mimosa pigra*, an invasive species from South America, is spreading within the "central section" and will increase as more sections of riverbank forest are cleared. • May outcompete native flora; difficult to remove once established.	Infestation will increase as natural vegetation is cleared

9.2 Potential threats

Potential threats to biodiversity in the study area arise from development projects, especially hydropower, land concessions or roads, which are proposed or under construction along the Mekong River and tributaries in northeast Cambodia, Lao PDR and Viet Nam. Without sufficient review or mitigation measures these developments may cause severe and cumulative impacts to biodiversity when added to existing threats.

1. Hydropower development in the study area. The Cambodian Government has for decades proposed the construction of a dam across the Mekong mainstream north of Sambor Town. Although few details are available, in 2007 a Chinese company apparently conducted a feasibility study for two dam options: a) a 10 km long, 54 meter-high barrage which would block the entire river, creating a reservoir of 880 km^2 which could generate 3,300 MW of electricity, and b) a smaller scheme resulting in a 6 km^2 reservoir generating 465 MW of electricity (JICA 2007; Lawrence & Middleton 2007). Such a dam, especially the larger scheme, would have immense and potentially irreversible impacts to many freshwater biota of the Mekong (Table 27) and could impact the food security of thousands of local people dependent upon fish and other freshwater resources.

Table 27. Potential threats to biodiversity in the study area.

Potential threat	Potential impacts	Factors
Hydropower development (1): Sambor dam in study area	• Many high and potentially irreversible impacts, particularly to water quality, migratory fish and Irrawaddy Dolphin. Sambor rapids and associated deep pools "are important fish habitats, particularly for spawning and refuge purposes"; 75% of total catch in *Dai* fisheries in Tonle Sap Lake depend on availability of deep pool habitats in northeast Cambodia, including Mekong mainstream from Kratie – Khone falls (Poulsen et al. 2002b). • Downstream impacts: large-reservoir option could alter river morphodynamics, including river bank stability, bed incision, delta stability, loss of deep pools between Kratie and Stung Treng (filling up with sediment) and loss of other critical channel habitats used by aquatic invertebrates, fish, turtles and other fauna. • Upstream impacts: large-reservoir option would probably inundate a large portion of the riverine habitats in the "central section" confirmed in the current surveys to support high conservation values, and cause the loss of many species and habitats • Dam construction could cut or impede fish migration corridors between floodplain habitats in the south and refuge habitats in the north, and interfere with fish larval drift systems (Poulsen et al. 2002b). • Probable extirpation of the entire Mekong River population (Cambodia, Lao PDR) of the Irrawaddy Dolphin, due to isolation of dolphin groups above and below dam, and loss or alteration of critical deep pool habitats (4 of 9 deep pools utilized by dolphins are within 15 km of the proposed dam site).	National economic development
Hydropower development (2): proposed or under construction nearby the study area	• Review by Oxfam America (2005) indicates dam developments are planned or under construction along the Se Kong, Se San and Srepok Rivers in Cambodia (21), Lao PDR (17) and Viet Nam (15), located 30-400 km upstream of the study area. • At least one other dam is proposed, Don Sahong (Lao PDR), which if built would be the first dam on the mainstream of the Lower Mekong River. • Close upstream proximity to the study area and/or cumulative impacts of these dams would potentially cause a wide range of biological impacts. Dams along the Se Kong, Se San and Srepok Rivers could significantly impact mainstream hydrology because most are annual storage schemes with large reservoirs. • Don Sahong dam could result in severe impacts to fish migration (Baran & Ratner 2007), including the study area, and decline or local extinction of Irrawaddy Dolphin in the Mekong River Basin (Bezuijen et al. 2007).	Regional economic development in Cambodia, Lao PDR, Viet Nam
Land concessions	• Concessions in the study area, especially the "central section", would probably cause loss of riverine habitats and threatened taxa. • Concessions elsewhere in Kratie and Stung Treng Provinces may displace communities and cause increased migration to the "central section" – further pressures on limited resources and high biodiversity values.	Provincial economic development

Potential threat	Potential impacts	Factors
Expanding road network	• Improved transport routes for transfer of wildlife, fish and other natural resources from study area to urban centres. Road from Koh Khnhaer Village (in "central section") to National Highway 7 was sealed in 2007. • Further roads will be built as land concessions are developed and communities expand.	rovincial economic development

2. Hydropower development nearby the study area. A review by Oxfam America (2005) indicates that at least 53 dams and 11 irrigation schemes are planned or under construction within the Se Kong, Se San and Srepok Rivers, which drain into the Mekong River immediately north of Stung Treng Town. The projected or installed capacity of these dams are 1-10 MW (11 dams), 10-50 MW (10), 50-200 MW (14), 200-400 MW (12) and 400-1,000 MW (seven) (Oxfam America 2005). Two proposed dams are located within 30 km of the study area and have a projected capacity of 400-1,000 MW ("Stung Treng dam", "Lower Se San 1"). The other 51 dams are located 30-400 km upstream from the study area along these three rivers, with current or projected capacities of 1-400 MW. The proposed dams are in Stung Treng Province, Cambodia (21), Lao PDR (17) and Viet Nam (15). Since the completion of Oxfam America's review, another dam, Don Sahong, has been proposed in Lao PDR near the Lao-Cambodia border. This dam is within 50 km of the study area and may have an installed capacity of 240 MW (Bezuijen et al. 2007 and references therein).

The cumulative impact of these water development projects to the hydrology of the Mekong River south of Stung Treng Town, should they all be constructed, is largely unknown. The Se Kong, Se San and Srepok Rivers contribute over 25% annual flow volume at Kratie Town (MRC 2005), yet relatively few environmental impact assessments have been conducted for these schemes. In general, there is controversy over the perceived and documented impacts of dam construction in the Mekong Basin, especially to changes in basin hydrology (Baran et al. 2007 and references therein). In the nearby Se San River, the construction of the Yali Falls hydropower dam in Viet Nam has been directly linked with a wide range of severe biological and social impacts in the downstream Cambodian section, including declines in fish populations, increased mortality of sandbar-nesting birds, changes in river hydrology and water quality, reduced food security and new health issues for local communities (Baird et al. 2002; Claassen 2003; SWECO Grøner 2006; Wyatt & Baird 2007; Trandem 2008). For the Don Sahong dam, preliminary reviews indicate the dam could cause severe impacts to the Mekong population of the Irrawaddy Dolphin (Bezuijen et al. 2007) and fish migration between Cambodia and Lao PDR (Baran & Ratner 2007). Water development projects in the basin are often characterized by the absence of transparent and detailed environmental and social impact assessments, and there is little current indication that a well-mediated review process will be conducted to assess or mitigate the potential cumulative impacts of these developments.

3. Commercial land concessions. Few public sources of information on land planning are available for Kratie and Stung Treng Provinces, yet it appears the large majority of land in both provinces has been earmarked for allocation for commercial land concessions. In Stung Treng Province, a preliminary map of land concessions released by the provincial government indicates that since 1999, at least 68% (*c.*911,482 ha) of the total land area of the province (1,201,654 ha) has been allocated to 13+ companies for development. Areas of land excluded from concession include Virak Chey National Park (in the northeast corner of the province) and a narrow strip of land on each side of the Mekong River, extending from the border with Kratie Province north to the border with Lao PDR. The unallocated land along the Mekong River appears to be less than 20 km wide on each bank. In Kratie Province, unconfirmed data indicate that at least 56,813 ha of land in Sambor District may have been allocated for land concessions, although the specific location of these concessions and proximity to the Mekong River is unclear. Most concessions appear to be intended for forestry plantations (teak, fruit trees, rubber) and sugarcane.

The paucity of reliable information limits review of the potential impacts of concessions to biodiversity of the study area, yet some key points are evident. First, commercial land allocation is occurring rapidly in both provinces, yet it is unlikely that environmental or social impacts of concessions have been fully assessed and the extent to which provincial agencies would monitor and regulate such impacts is unknown. Second, concessions in or near the study area may involve clearance of natural vegetation, the construction of access roads, labour camps, machinery storage sites and other infrastructure, and increased numbers of personnel. This may result in direct loss of habitats in the "central section" and increased demand for wildlife, fish and other natural resources to supply workers. Third, concessions in Kratie and Stung Treng Provinces may displace communities in those areas and result in further migration to available lands along the Mekong River,

including the “central section”, placing further pressures on natural resources. Elsewhere in Cambodia, commercial concessions have caused loss of traditional land tenure, the influx of non-ethnic migrants, and immediate social impacts to local communities (Cornford & Matthews 2007).

4. Expanding road network. National Highway “7” between Kratie and Stung Treng Towns is currently being sealed and upgraded, and in 2007 a road from this highway to Koh Khnhaer Village, in the centre of the “central section”, was upgraded (Figures 1, 2). Commercial concessions and other development will probably result in the construction of further access roads into the “central section”. This expanding road network may facilitate increased access and transport of natural resources from the “central section”, especially wildlife and fish.

10. MANAGEMENT

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10. Management

This section identifies biological conservation priorities for the study area and recommendations for management. Recommendations were developed based on the ranking of taxa to identify those of highest management priority, their threat status, distribution and ecology in the study area, and identification of key sites and habitats. Management approaches were refined in a workshop with provincial and national government agencies (Annex 8). Recommendations are described for:

- "priority taxa" – actions to conserve the taxa of highest conservation priority in the study area (Section 10.1);
- "priority sites" – actions to maintain specific sites which support priority taxa and their habitats (Section 10.2);
- the entire study area – actions which reflect the connectivity of aquatic habitats in the study area with other sections of the Mekong River (Section 10.3). This section also addresses key information gaps.

The recommendations described here are intended to prioritise and initiate activities for biodiversity conservation in the study area. It is beyond the scope of this report to develop management plans for individual taxa or sites. Recommendations do not address the population of Irrawaddy Dolphin in the study area, which is already subject to an ongoing conservation programme (MAFF 2005; WWF 2006a).

10.1 Priority taxa for management interventions

10.1.1 Ranking

A ranking of "very high", "high", "medium", "low" or "0" (negligible) management priority was derived for vegetation and vertebrate taxa recorded in the study area. Rankings indicate the relative importance of a taxon's population in the study area, based on size and threat status, compared with national and global populations (Annex 5). Ranking was undertaken for all bird (281), large mammal (31), amphibian (16), reptile (40) and fish (223) taxa recorded during surveys or considered to have previously occurred in the study area. For flora, due to the large number of taxa recorded (689) and paucity of data for most of these, ranking was limited to the 11 "communities" recorded (six riverine zones and five terrestrial facies), 12 riverine taxa (considered to be the dominant taxa of the riverine zones) and one new taxon *Amorphophallus* sp. nov. Ranking results are in Annex 6; taxa ranked as "0" priority are not considered further here. Further data on ranking is available in the on-line table ("OLT", www.panda.org/greatermekong/survey).

A total of 108 taxa were ranked as "low" management priority or higher (Table 28). Eighty-four taxa were ranked as "very high" (6), "high" (38) or "medium" (40) priority, including riverine flora, birds, large mammals, reptiles and fish. These are the highest priorities for biodiversity conservation in the study area. Six taxa ranked as "very high" priority are all vertebrate fauna: River Tern, White-shouldered Ibis, Woolly-necked Stork, Lesser Adjutant, Greater Adjutant and Hog Deer. No amphibians were ranked as "low" priority or higher (all taxa recorded within the study area are relatively common and widespread).

Table 28. Results of ranking to identify "priority" taxa for management in the study area.

Taxa	VHP[1]	HP[1]	MP[1]	LP[1]	Total	Total ranked	%[2]
Vegetation Zone		3	3		6	11	55
Flora			12		12	13*	n/a*
Birds	5	17	16	7	45	281	16
Mammals	1	6	1		8	31	26
Reptiles		6	1		7	41	17
Fish		5	8	12	25	223	11
Total	6	38	40	24	108	598	

[1]VHP-very high priority; HP-high priority; MP-medium priority; LP-low priority. [2]Proportion of all taxa ranked which are "low" priority or higher. *Includes one new taxon of unknown rank; n/a-not applicable (only a subset of taxa were ranked).

Cover: Community-based dolphin conservation in the study area ©WWF Cambodia. 1: Workshop of survey results ©Mark Bezuijen/WWF. 2:Monks supporting Mekong conservation ©WWF Cambodia. 3: Identifing conservation priorites in the study area ©Mark Bezuijen/WWF. 4: Community fisheries by Oxfam Australia in the study area ©Mark Bezuijen/WWF.

For one new flora taxon, four birds (Tawny Fish Owl, Buffy Fish Owl, Brown-streaked Flycatcher, Black-browed/Manchurian Reed Warbler) and two fish (Giant Salmon-carp and a cyprinid *Onychostoma meridionale*), a priority ranking could not be assigned due to insufficient field data. The new flora taxon appeared to be rare and localized in the study area and is possibly a "high" or "very high" management priority. Ranking of fish included four species not confirmed during surveys but which may occur or previously occurred [Giant Carp ("high" priority"), a cyprinid *Probarbus labeamajor* ("medium?" priority), Giant Salmon-carp "status unknown" and Largetooth Sawfish ("extinct in study area")] (Annex 6).

10.1.2 Recommendations for priority taxa

Management actions are identified for taxa of "very high", "high" and "medium" priority (Table 29) and are based on threat status, distribution and ecology in the study area. One species of unknown priority, a new flora taxon, is included. Recommendations for taxa ranked as "very high" and "high" priority require immediate implementation if populations in the study area are to be maintained. In general, the management actions developed for these taxa comprise seven approaches.

- **Nest protection schemes.** Protection of nesting colonies and / or individual nests will be critical to maintain the populations of most priority storks, herons, terns, fish-eagles, vultures, weaver birds, Plain Martin, Wire-tailed Swallow and Cantor's Giant Softshell Turtle in the study area. Nest protection schemes for waterbirds have been trialed in northern Cambodia by the Wildlife Conservation Society (Clements 2007; Clements et al. 2007) and provide a model which may be adapted to the study area.

- **Development of "protection zones" in the "central section" for riverbank forest and riverine vegetation.** These habitats provide critical breeding, foraging and/or migratory resources for storks, herons, terns, thick-knees, fish-eagles, hornbills, pigeons, Darter, cormorants, turtles and most priority fish. The exclusion of settlement, clearance, burning, hunting and domestic dogs along selected sections of channel and riverbank is critical for a wide range of priority species.

- **Protection of discrete sites outside the "central section".** Conservation of Hog Deer, flying-foxes, some ducks, and weaver birds, will require protection of discrete sites, including roosting or nesting colonies, located outside the "central section".

- **Reducing illegal commercial wildlife trade.** For most large birds, mammals, lizards, snakes, and all turtles, hunting to supply wildlife trade is the greatest current threat to remnant populations. Reducing wildlife trade will require enforcement of national laws in the study area, particularly with established dealers in Kratie, Sambor and Stung Treng Towns, and in Saitlieu and Koh Khnhaer Villages in the "central section".

- **Status surveys.** For at least three birds (Masked Finfoot, Black-headed Munia, Streaked Weaver), one plant (*Amorphophallus* sp. nov.) and one water snake (*Enhydris longicauda*), further information on status and distribution in the study area is required to develop management actions.

- **Monitoring.** Monitoring will be necessary to assess the population status of priority taxa and impacts of management. Species under nest protection schemes will receive relatively rigorous population monitoring (seasonal counts of nests, eggs, nesting adults, and for waterbirds, rates of hatching and fledging). For taxa with low densities, including most large mammals, some birds, and turtles, monitoring may be more subjective and comprise periodic expert review based on systematic collection of sighting records (e.g. from ranger patrols) and assessments of the status of key habitats.

- **Regional initiatives.** For many fish taxa, especially migratory species, effective conservation will require maintenance of breeding, foraging, nursery or migration habitats in sites both within the study area (e.g. the "central section", deep pools) and outside the study area. Initiatives involving the entire study area and nearby regions are in Section 10.1.3.

Table 29. Results of ranking to identify "priority" taxa for management in the study area.

Priority[1]	Category	English name	Scientific name	Key site[2]	Recommendations
VHP	Bird	River Tern	*Sterna aurantia*	1	• Implement NPS at colonies on Koh Preah, Koh Enchey islands, and protect any single nests located in "central section"; implement a database of nest and sighting records
VHP	Bird	White-shouldered Ibis	*Pseudibis davisoni*	1	• Implement NPS at all nests found (*c.*40-60 nests in study area); implement a database of nest and sighting records; clarify seasonal movements & habitat requirements
VHP?	Bird	Woolly-necked Stork	*Ciconia episcopus*	1	• No nests reported but in future protect any which are found; nest searches and protection could extend up to 1 km from river
VHP?	Bird	Lesser Adjutant	*Leptoptilos javanicus*	1	• No nests reported but in future protect any which are found • Nest searches and protection could extend up to 20 km from river
VHP?	Bird	Greater Adjutant	*Leptoptilos dubius*	1	• As for Lesser Adjutant
VHP	Mammal	Hog Deer	*Axis porcinus*	2	• See site recommendations (Table 30, "proposed Hog Deer protected area"); conduct DNA analysis of dung/hair to clarify taxonomic status of Cambodia population
HP	VEG	Zone 4 (Acacia-Anogeissus)		1	• Implement protection zones+ regulations to control burning, camps, campfires and timber collection; monitor and if necessary control spread of the weed *Mimosa pigra* • Protection will benefit at least 2 taxa ranked "HP" located in this zone: *Acacia harmandiana*, *Anogeissus rivularis*
HP	VEG	Zone 5 (Beach)		1	• As for Vegetation Zone 4, and, regulate livestock density & grazing (dry-season grazing, registration, etc) • Protection will benefit at least 2 taxa ranked as "MP" located in this zone: *Polyalthia modesta*, *Combretum trifoliatum*
HP	VEG	Zone 6 (Strand)		1	• As for Vegetation Zones 4 and 5, and, implement protection zones to prohibit all clearance and settlement
HP	Bird	Green Peafowl	*Pavo muticus*	1	• Enforce national laws and conduct patrols to reduce hunting
HP	Bird	Great Thick-knee	*Esacus recurvirostris*	1	• As for Green Peafowl, and, implement protection zones for riverbank forest and beaches, and exclude hunting and dogs
HP	Bird	River Lapwing	*Vanellus duvaucelii*	1	• As for Great Thick-knee
HP	Bird	Lesser Fish Eagle	*Ichthyophaga humilis*	1	• No nests located but in future protect any which are found • Implement a database of nest and sighting records
HP	Bird	Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*	1	• As for Lesser Fish Eagle
HP	Bird	White-rumped Vulture	*Gyps bengalensis*	1	• Protect any nests which are found
HP	Bird	Slender-billed Vulture	*Gyps tenuirostris*	1	• Protect any nests which are found
HP	Bird	Red-headed Vulture	*Sarcogyps calvus*	1	• Protect any nests which are found

Priority[1]	Category	English name	Scientific name	Key site[2]	Recommendations
HP	Bird	Plain Martin	*Riparia paludicola*	1,4	• Implement NPS at colonies at Kampi and "central section" • Implement a database of nest and sighting records
HP	Bird	Wire-tailed Swallow	*Hirundo smithii*	1	• Implement NPS at the two known colonies • Implement a database of nest and sighting records
HP	Bird	Black-headed Munia	*Lonchura malacca*	2,8	• Status survey to clarify distribution and threats in study area
HP (br)	Bird	Grey Heron	*Ardea cinerea*	1	• Implement NPS in at least 3 of the 4-6 confirmed nest colonies
HP?	Bird	Masked Finfoot	*Heliopais personata*	1	• Raise agency awareness of this species; conduct survey in late May – July to clarify local status; ensure any regional surveys in northeast Cambodia include the study area
HP?	Bird	Black-necked Stork	*Ephippiorhynchus asiaticus*	1	• No nests reported but in future protect any which are found; nest searches, protection could extend up to 1 km from river
HP?	Bird	Streaked Weaver	*Ploceus manyar*	8	• Status surveys to clarify distribution and threats in study area
HP	Mammal	Silvered Leaf Monkey	*Semnopithecus cristatus*	1	• Immediately halt hunting • Implement a database of sightings
HP?	Mammal	Long-tailed Macaque	*Macaca fascicularis*	1	• Immediately halt hunting • Implement a database of sightings
HP?	Mammal	Eld's Deer	*Cervus eldii*	1	• Clarify status; implement site-based protection; in long-term, assess efficacy for re-establishment if necessary
HP?	Mammal	Large / Lyle's Flying-fox	*Pteropus vampyrus / P. lylei*	3,7	• Raise support from monks at monastery to protect roost; collect dead specimens to confirm taxa; initiate regular roost counts; assess potential for eco-tourism
HP-0	Mammal	Smooth-coated Otter	*Lutrogale perspicillata*	1	• Implement protection zones for riverbank forest and ranger patrols to reduce hunting
HP	Reptile	Giant Asian Pond Turtle	*Heosemys grandis*	1	• Implement riverbank protection zones to protect nest habitat; regulate susbsistence harvests of adults; halt commercial trade (Sambor Town, Saitlieu, Koh Khnhaer Villages)
HP?	Reptile	Yellow-headed Temple Turtle	*Hieremys annandalii*	1	• As for Giant Asian Pond Turtle
HP	Reptile	Asiatic Softshell Turtle	*Amyda cartilaginea*	1	• As for Giant Asian Pond Turtle
HP	Reptile	Cantor's Giant Softshell Turtle	*Pelochelys cantorii*	1,5	• Implement scheme for release of juveniles/adults caught in fishnets/traps, and NPS, with Pontacheer, O Kak Villages at "Kain Svay" pool and channel between Koh Khlap Island/mainland; expand NPS to other sites including channel between Sambor and Kampi; utilise national expertise for scheme e.g. CTCT • Halt any commercial trade by wildlife dealers in Sambor Town, Saitlieu and Koh Khnhaer Villages, and three Kratie restaurants (Mlup Doung, Chhne Tonle, Consul)
HP?	Reptile	Malayan Snail-eating Turtle	*Malayemys subtrijuga*		• As for Giant Asian Pond Turtle, but focus on floodplains as well as "central section" (combine with Hog Deer activities)

Priority[1]	Category	English name	Scientific name	Key site[2]	Recommendations
HP?	Reptile	Elongated Tortoise	*Indotestudo elongata*	1	• As for Giant Asian Pond Turtle
HP	Fish	Giant Freshwater Stingray	*Himantura chaophraya*	1,6	• Monitor market catch (Kratie, Sambor, Stung Treng Towns; Saitlieu, Koh Khnhaer Villages); initiate research to identify spawning sites and local population status • Develop a "species management plan" for the study area to regulate fishing and protect spawning sites
HP	Fish	Mekong Giant Catfish	*Pangasianodon gigas*	1,6	• Support relevant actions of "MGC Regional Action Plan" • Monitor market catch (as for Giant Freshwater Stingray)
HP	Fish	Chao Phraya Giant Catfish	*Pangasius sanitwongsei*	1,6	• As for Giant Freshwater Stingray
HP	Fish	Shovelnose Sea Catfish	*Hemiarius verrucosus*	1,6	• As for Giant Freshwater Stingray
HP	Fish	Giant Carp	*Catlocarpio siamensis*	1,6	• Clarify status in study area (not recorded in surveys); other actions as for Giant Freshwater Stingray
MP	VEG	Zone 1 (Aquatic)		1	• Maintain extent and quality of zone (no specific interventions currently necessary)
MP	VEG	Zone 2 (Rapids)		1	• Maintain extent+quality of zone; monitor livestock density to avoid overgrazing/trampling damage. Protection will benefit at least 4 taxa ranked "MP" in this zone: *Cryptocoryne crispatula*, *Telectadium edule*, *Phyllanthus jullienii*, *Dalzellia carinata*
MP	VEG	Zone 3 (Kai Kum)		1	• As for Vegetation Zone 2. Protection will benefit at least 5 taxa ranked "MP" in this zone: *Phyllanthus jullienii*, *Morinda pandurifolia* var. *oblonga*, *Xantonnea parviflora* var. *salicifolia*, *Blachia cotoneaster*, *Eugenia mekongensis*
?	Flora	New taxon	*Amorphophallus* sp. nov.	1	• Clarify status, distribution and threats in study area • Raise national awareness of this new taxon
MP	Bird	Cotton Pygmy-goose	*Nettapus coromandelianus*	8?	• Initiate community protection of any nests found and raise local support to regulate any hunting at sustainable levels
MP	Bird	Spot-billed Duck	*Anas poecilorhyncha*	1, 4	• As for Cotton Pygmy-goose and, exclude dogs from key roost and nest sites
MP	Bird	Oriental Pied Hornbill	*Anthracoceros albirostris*	1	• Develop protection zones for riverbank forest • Protect any nests found
MP	Bird	Pied Kingfisher	*Ceryle rudis*	1,6	• Implement a database of nest and sighting records, with periodic status review
MP	Bird	Yellow-footed Green Pigeon	*Treron phoenicoptera*	1	• Develop protection zones for riverbank forest • Raise local support to regulate hunting at sustainable levels
MP	Bird	Green Imperial Pigeon	*Ducula aenea*	1	• As for Yellow-footed Green Pigeon
MP	Bird	Brahminy Kite	*Haliastur indus*	1	• As for Oriental Pied Hornbill
MP	Bird	Mekong Wagtail	*Motacilla samveasnae*	1,5	• Implement population monitoring (currently no key threats)

Priority[1]	Category	English name	Scientific name	Key site[2]	Recommendations
MP (nbr); HP? (br)	Bird	Darter	*Anhinga melanogaster*	1,5	• Protect the roost colony at Prek Preah River from January-May; this may also assist establishment of a nesting colony; implement NPS for any colonies located in future
MP (nbr); HP? (br)	Bird	Great Cormorant	*Phalacrocorax carbo*	6	• As for Darter
MP?	Bird	Great Hornbill	*Buceros bicornis*	1	• As for Oriental Pied Hornbill
MP?	Bird	Spotted Wood Owl	*Strix seloputo*	1	• Develop protection zones for riverbank forest and wooded channel habitats in Riverine Zones 4,5,6
MP?	Bird	Eurasian Thick-knee	*Burhinus oedicnemus*	1	• As for Great Thick-knee
MP?	Bird	Little Tern	*Sterna albifrons*	8	• Protect any nests found and exclude dogs from nest sites
MP?	Bird	Asian Golden Weaver	*Ploceus hypoxanthus*	1,8	• Wetlands north of Sambor town: implement NPS for nest+roost colonies (regulate clearance, burning at key sites)
MP-0	Bird	White-bellied Sea-eagle	*Haliaeetus leucogaster*	6	• Protect any nests found; enforce national laws by halting any trade of this species by wildlife traders in Kratie, Stung Treng and Sambor Towns, and Saitlieu and Koh Khnhaer Villages
MP? (br)	Bird	Indian Cormorant	*Phalacrocorax fuscicollis*	6	• As for Darter
MP? (br)	Bird	Little Cormorant	*Phalacrocorax niger*	6	• As for Darter
MP?	Mammal	Eurasian / Hairy-nosed Otter	*Lutra lutra / L. sumatrana*	1	• As for Smooth-coated Otter
MP	Mammal	Sambar	*Cervus unicolor*	1	• Raise local support to regulate hunting at sustainable levels
MP?	Reptile	water snake	*Enhydris longicauda*	2,3	• Clarify status, distribution and extent of harvesting: focus on floodplains west of Kratie Town
MP	Fish	Mekong Featherback	*Chitala blanci*	1	• Undertakes lateral migrations (mainstream-floodplain): site-based approach in "central section" is appropriate • Protect tributaries (key migration corridors) between channel & floodplains during migration periods: maintain habitats+prevent blocking of tributary entrances by fishing
MP	Fish	Featherback sp.	*Chitala lopis*	1	• As for Mekong Featherback
MP	Fish		*Macrochirichthys macrochirus*	1	• As for Mekong Featherback
MP	Fish	Thinlip Barb	*Probarbus labeaminor*	6	• As for Chao Phraya Giant Catfish
MP	Fish	Long-nosed Spiny Eel (undescribed taxon)	*Macrognathus* sp.	1	• Maintain habitats and monitor extent of bycatch in local markets (no site-specific interventions currently required)
MP	Fish	Mekong Tiger Perch	*Datnioides undecimradiatus*	1	• As for Chao Phraya Giant Catfish

Priority[1]	Category	English name	Scientific name	Key site[2]	Recommendations
MP?	Fish	Leaping Barb	*Chela caeruleostigmata*	1	• Maintain habitat (rocky rapids) and monitor extent of catch in local markets (no specific interventions currently required)
MP?	Fish	Barb species	*Probarbus labeamajor*		• Most vulnerable lifecycle phase is spawning (congregates on rocky rapids). Identify large rapids confirmed to be spawning sites and initiate community management to prevent over-harvesting and protect habitat

[1] VHP-very high priority; HP-high priority; MP-medium priority; br – breeding; nbr- non-breeding. [2] Sites: 1–"central section"; 2–floodplains west of Kratie Town; 3–floodplains east of Sambor Town; 4–Kampi pool and the 3 km of exposed channel mosaic upstream of the pool; 5–Mekong channel from "central section" to Kampi pool; 6–habitats along entire Mekong channel between Kratie and Stung Treng Towns (no specific sites known); 7–Koh Chreng monastery; 8-Floodplains and/or Koh Tasuy Island south of Kratie Town. For further details of taxa in this table, refer to species accounts (Sections 3-7) and maps (Annex 2). NPS–nest protection scheme.

10.2 Priority sites for management

"Priority sites" were defined as localities which support the largest remnant populations and habitats for taxa of "medium" or higher management priority in the study area. Priority sites comprise:

(1) the "central section";
(2) the floodplain west of Kratie Town ("Hog Deer protected area");
(3) a range of smaller sites.

In general, site-based approaches are appropriate to address current threats to most priority flora, birds, mammals and reptiles in the study area, because the remnant populations of these taxa are largely restricted to a small number of sites, where they are threatened by similar factors (e.g. habitat loss or hunting). For some aquatic taxa, especially migratory fish, site-based management will be insufficient to maintain local populations, because these taxa require the collective maintenance of aquatic habitats throughout their seasonal range within and outside the study area, and/or because threats originate from sources outside the study area e.g. upstream dam construction. For these taxa, the site-based actions described in this section should be complemented by landscape-level initiatives (see Section 10.3). Management recommendations for priority sites are in Table 30; the locations of priority sites are in Figure 10.

10.2.1 "Central section"

The "central section" supports the highest biological values of the study area and warrants immediate management. At least 62 taxa of "medium" or higher management priority (Table 29) are partly or entirely reduced to remnant habitats in the "central section", including taxa which are extirpated elsewhere in the study area. At a workshop in February 2008, national and provincial agencies agreed the "central section" should be designated as a "special management site". Key recommendations:

- The boundaries of the special management site should encompass all lands and water within a 56-km section of the Mekong channel, from 49 km north of Kratie Town to 14 km north of the Kratie-Stung Treng provincial border (42 km of river-distance in Kratie Province and 14 km in Stung Treng Province): a total area of *c.*33,808 ha (*c.*20,230 ha "protection zone" and 13,578 ha "multiple-use zone", see below). This includes the Mekong mainstream, islands, riverbanks, and tributary entrances.

- All lands and water in the site should be zoned, to conserve priority taxa and regulate spatial and seasonal resource use by communities. Workshop participants agreed that two zones are appropriate: a "multiple-use" zone, where settlement, in-migration, and agriculture are permitted, and where efforts to support livelihoods should be focused; and a "protection zone", focusing on protection of remaining sections of intact riverbank forest and riverine habitats.

Recommended site boundaries and zonation are in Figure 11. These are based upon the distributions of priority taxa, remnant riverbank forest, and preliminary mapping of settlements (Sections 3-8).

10.2.2 Floodplains west of Kratie Town ("Hog Deer protected area")

A floodplain west of Kratie Town supports the last known population of Hog Deer ("very high" management priority) in Indochina. Since its discovery in 2006, this population has received preliminary management including ranger patrols, raising community awareness, and identification of proposed boundaries for a "Hog Deer protected area" (Maxwell et al. 2006). This would potentially encompass 51,848 ha: a dry-season zone (12,826 ha), wet-season zone (14,777 ha) and buffer zone (24,245 ha) (A. Maxwell personal communication) (Fig. 10). This proposed protected area has been nominated by the Kratie Forestry Administration. The management of this floodplain would also benefit other priority taxa, including Malayan Snail-eating Turtle and a watersnake *Enhydris longicauda* (both confirmed to occur), fish which migrate between the mainstream and floodplains, and potentially, otters. Recommendations for this site (Table 30) are based on previous studies of this Hog Deer population (Maxwell et al. 2006) and findings from the current surveys.

Table 30. Results of ranking to identify "priority" taxa for management in the study area.

Recommendations (urgency*)	Justification
"CENTRAL SECTION" Action 1: Gazette "Provincial Special Management Site" **(very high)** • Obtain a provincial regulation (*Deka*) for official declaration of the site. Recommended site boundaries are in Fig. 11 • Identify key management agencies in Kratie and Stung Treng Provinces; nominate a lead agency in each province	• Site supports highest biological values in study area and is threatened by rapidly increasing pressures on natural resources • Provincial, rather than national, gazettement was recommended by government agencies as faster and to strengthen provincial ownership
Action 2: Conduct preliminary zonation of the site **(very high)** • Designate all lands and water in site under 2 zones, "multiple-use" (MUZ) or "protection" (PZ). Recommended zone boundaries are in Fig. 11. MUZ: locations where settlement & resource use is permitted. PZ: locations where settlement is prohibited and resource use is strictly controlled. • PZ should include: riverbank forest (up to 100 m wide), riverine habitats (Riverine Zones 1-6) and entrances of two tributaries, Prek Krieng and Prek Preah. • Obtain provincial approval for preliminary zone boundaries as soon as possible	• Official approval for preliminary zonation is urgently needed to secure remaining natural resources in the short-term, due to high rates of habitat loss. If zonation is first subject to extensive community consultation the raised awareness of pending zonation will almost certainly cause increased settlement, logging and hunting • Once natural resources are secured, final mapping of zones can be achieved in a participatory process with stakeholders (below)
Action 3: Raise local awareness of new site status and zones **(very high)** • Provincial government should officially notify district centers and all villages within 30 km of new site status and zones as soon as possible. A government field team could travel to district centres and villages to instruct village heads to prohibit immigration to Protection Zones, distribute a map of site boundaries, and ensure all communities are aware of the new regulations • For migrants clearing land but have not yet established homes, assist them to re-locate to lands in MUZ alongside established villages	• A halt or at least reduction in current rate of clearance of natural habitats along riverbanks is urgently needed;
Action 4: Obtain baseline socio-economic data **(very high)** • Conduct rapid assessment of current human population, location of villages and new settlements, land ownership, and in-migration	• Assist development of zones and regulations in site
Action 5: Protect "priority" taxa **(very high)** • Implement actions to protect priority taxa listed in Table 29	• Conservation of priority taxa will contribute to national biodiversity commitments
Action 6: Conduct final zonation of the site **(high)** • Finalise zone boundaries and develop zone regulations with stakeholders to address specific threats in different locations/zones • Conduct cadastral mapping of village land boundaries • Prepare and distribute a map of final zones, regulations and village boundaries to district centres and all settlements within 30 km	• Stakeholder support critical for zonation to succeed • Zonation provides a framework to focus management resources, clarify roles, jurisdiction of management agencies

Recommendations (urgency*)	Justification
Action 7: Strengthen provincial capacity for site management **(medium)** • Review and identify actions to strengthen capacity of the site management agencies • Integrate capacity building with the Wetlands Alliance Programme	• Capacity of some agencies insufficient to address site management needs; strengthening capacity may include resources and technical skills
Action 8: Implement field ranger teams **(high)** • Train and implement ranger patrols to: monitor compliance of all stakeholders with site regulations and zonation, liaise with local communities, and assist in site monitoring • Patrols could comprise government and community representatives	• Ranger teams should form the core support for implementation of management actions and safeguarding sites of highest biological value • Teams comprising government and community members could strengthen links and mutual understanding for management
Action 9: Strengthen community management of natural resources **(med)** • Livelihood projects should focus on timber and fisheries in at least 6 target villages: Kampong Pnov, O Kak, Pontacheer, Koh Khnhaer, Satlieu, Koh Dambong. Community regulations for natural resource use which are developed should be aligned with zone regulations. • Focus livelihood projects within the Multiple-Use Zones. • Integrate livelihood projects with existing government & NGO rural development programmes. • Enforce national laws to: reduce illegal wildlife trade; relocate settlements to MUZs; reforest riverbanks.	• Strong community ownership & management will contribute to sustainable, long-term use of natural resources • Regulate extraction of resources by non-local communities (e.g. dry-seasons commercial fishing), which is currently unregulated & provides little benefit to communities in the site • Enforce national laws, especially for wildlife trade in Koh Khnhaer and Saitlieu villages
Action 10: Conduct SEIAs for concessions **(medium)** • Conduct "Social and Environmental Impact Assessments" for proposed commercial development within / near the site e.g. Sambor dam, commercial land concessions	• Current extent and impact of concessions is unclear, but may result in increased migration to site; integrated planning of provincial and regional development will strengthen site management
Action 11: Develop and implement a site management plan **(medium)** • Consolidate Actions 1-10 in a site management plan, with measurable targets and timelines, which addresses local livelihoods, biodiversity conservation and economic development • Promote and strengthen links between government agencies, aid agencies and NGOs to support and implement the plan	• Management plan will help balance priorities for livelihoods, conservation and development, and clarify the jurisdiction and roles of provincial agencies responsible for site management
FLOODPLAIN WEST OF KRATIE TOWN ("HOG DEER PROTECTED AREA") Action 1: Complete gazettement for "Hog Deer protected area" **(high)** • Kratie Forestry Administration (FA) should complete gazettement of protected area. Proposed zone boundaries previously developed by FA and WWF are in Fig. 10	• Site supports last known population of Hog Deer in Indochina • Proposed site boundaries were identified by FA, WWF based on surveys since 2006. Recommendations are from Maxwell et al. (2006) and current survey data
Action 2: Maintain ranger patrols and strengthen capacity of patrol members **(high)** • Secure funding to maintain current patrol teams • Strengthen capacity with training in patrol planning, data collection and monitoring	• Patrols were implemented in 2006 and include community members • Teams are familiar with the Hog Deer and local communities, and are critical to Hog Deer conservation
Action 3: Monitor and control new cultivation in proposed Hog Deer protected area **(high)** • Work with local communities to minimize new land clearance in site, increase output from existing agricultural land, and utilise lands outside the proposed protected area	• Habitat loss is a critical threat to Hog Deer (site already degraded); need to address food requirements of the 15 villages in the proposed protected area
Action 4: Conduct SEIA in proposed Hog Deer protected area **(high)** • Conduct a "Social & Environmental Impact Assessment" for local livelihoods that creation of a protection zone may cause for the 15 villages located in the proposed protected area	• Site protection may impact local communities; the SEIA would complement a preliminary SEIA planned by Kratie Forestry Administration

Recommendations (urgency*)	Justification
Action 5: Reduce crop predation by wild pigs in proposed Hog Deer protected area **(very high)** • Work with local communities to implement methods to reduce crop predation by wild pigs, which do not kill Hog Deer	• Villagers use traps to remove wild pigs from crops but Hog Deer are sometimes caught; rangers remove traps, leading to local tensions • Quick action needed to address this problem and ensure continued community support for Hog Deer conservation
Action 6: Assess taxonomic status of Cambodian population of Hog Deer **(medium / low)** • Conduct DNA analysis of Hog Deer dung/hair to clarify whether the Cambodia population is a separate subspecies from Indian populations	• Assist in clarifying global conservation priorities for Hog Deer • DNA sampling may assist in estimating size of Hog Deer population
Action 7: Develop actions for other priority taxa in this floodplain **(medium)** • Implement recommendations for 3+ other priority taxa which occur in this floodplain (Malayan Snail-eating Turtle, a watersnake *Enhydris longicauda* and possibly otters, Table 29)	• Protection of floodplain habitats for Hog Deer may benefit 3+ other priority taxa
Action 8: Develop and implement a site management plan **(medium)** • Consolidate Actions 1-7 in a site management plan, with measurable targets and timelines, which addresses local livelihoods and biodiversity conservation	• Management plan will help balance priorities for livelihoods and conservation, and clarify the jurisdiction and roles of provincial agencies responsible for site management
OTHER SITES (1): KOH CHRENG MONASTERY Action 1: Protect a roost of Large / Lyle's Flying-fox located in this monastery **(medium)** • Establish a roost protection programme: work with monks to raise local awareness, reduce hunting, and initiate roost counts to monitor population status (see also Table 29)	• Largest roost of Large / Lyle's Flying-fox documented in study area
OTHER SITES (2): FLOODPLAINS SOUTH OF KRATIE TOWN Action 1: Protect nesting or roosting colonies of priority taxa **(medium / low)** • Clarify and confirm status of Asian Golden Weaver and flying-fox roost colonies, and initiate community protection schemes for these	• Few records of flying foxes elsewhere in study area • The extent these taxa utilize floodplains in the study area (especially those south of Kratie and near Sambor Town) is unclear
OTHER SITES (3): KAMPI POOL AND the seasonally exposed channel mosaic extending 3 km upstream of this pool Action 1: Protect riverine habitats and implement protection for priority taxa **(medium)** 1. For Plain Martin, implement nest protection scheme at the documented nesting colony 2. For Spot-billed Duck, identify key roosting/nesting sites and exclude dogs 3. Maintain quality and extent of riverine habitats at this pool	• Site supports 1 of 2 Plain Martin nest colonies recorded in study area, and nesting and roosting habitat of Spot-billed Duck • After the "central section", this site retains among the most intact mosaic of riverine habitats in the study area
OTHER SITES (4): MEKONG CHANNEL FROM "CENTRAL SECTION" TO KAMPI Action 1: Protect riverine habitats and implement protection for priority taxa **(medium)** 1. As far as possible maintain the remnant riverine habitats (vegetation, sandbars) in the river channel between "central section" and Kampi pool 2. Identify specific sites along this section utilized by priority taxa (e.g. turtle nest sites, cormorant roosts), and implement community protection schemes 3. Where appropriate, include this river section in conservation plans for individual fish taxa	• A range of priority taxa, especially fish, some birds and Cantor's Giant Softshell Turtle, utilize this river section in conjunction with the "central section" and other river sections • Maintaining aquatic habitats in this river section will contribute to maintenance of local populations of some priority taxa

*Urgency for the action (very high, high, medium, low) is not based on a quantitative ranking but reflects the rankings of priority taxa which occur in each site.

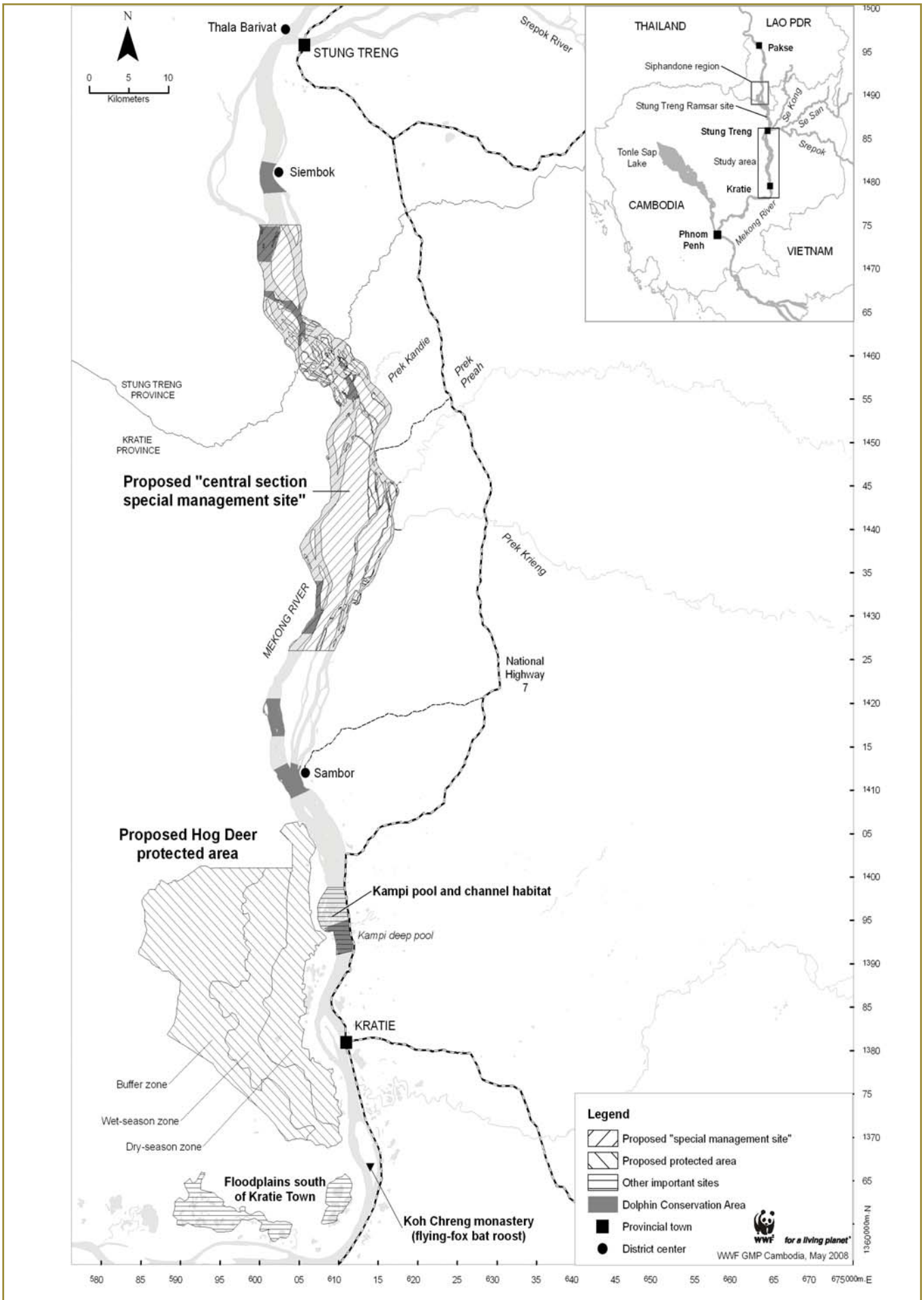

Figure 10. Priority sites for biodiversity conservation in the study area.

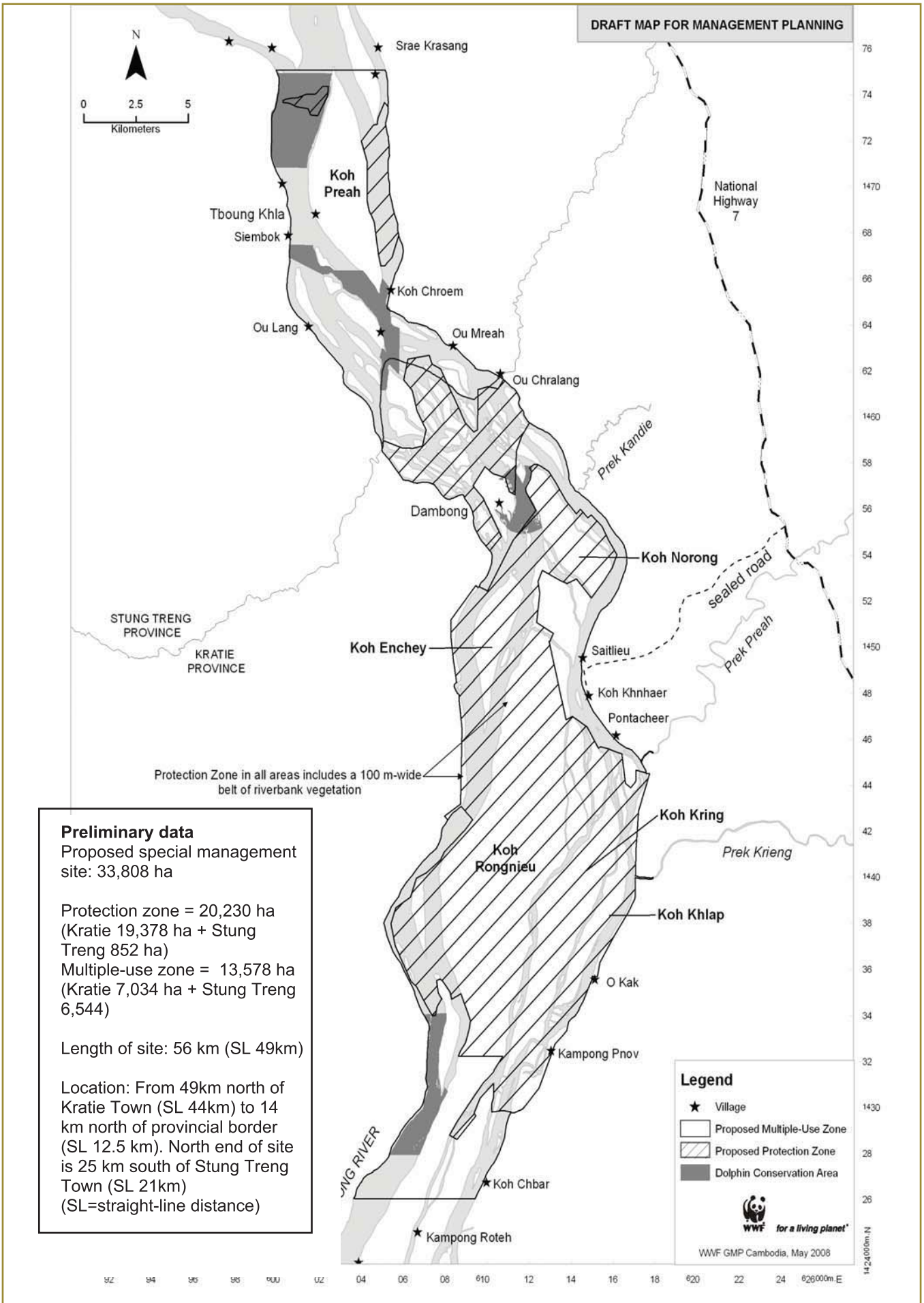

Figure 11. Proposed zonation of the "central section".

10.2.3 Other sites

At least four other locations in the study area support priority taxa (Fig. 10):

- a monastery on Koh Chreng Island (roosting colony of Large/Lyle's Flying-fox);
- floodplains south of Kratie Town (nesting and/or roosting colonies of Asian Golden Weaver, Black-headed Munia, and potentially Large/Lyle's Flying-fox);
- Kampi pool (nesting colony of Plain Martin, and roosting/foraging habitat of Spot-billed Duck); and,
- the Mekong River mainstream, from at least the "central section" south to Kampi pool (a range of taxa).

The monastery on Koh Chreng Island, and floodplains south of Kratie Town, are relatively small, discrete sites with a low number of priority taxa. Recommendations for these species and sites include status surveys and protection of nesting or roosting colonies (Tables 29, 30).

The remaining two sites are part of a continuous section of the Mekong River from the "central section" south to Kampi pool. Here the channel exhibits a higher diversity of habitats (including riverine vegetation, sandbars, and deep pools) than sections near Kratie and Stung Treng Towns, yet is less intact than the "central section". Priority taxa in this river section include Irrawaddy Dolphin, Mekong Wagtail, Darter, cormorants, Cantor's Giant Softshell Turtle, and a wide range of threatened and/or economically-targeted fish e.g. Giant Goonch (*Bagarius yarelli*), Giant Carp, and possibly Mekong Giant Catfish. In general, management here requires the maintenance of current extent and quality of habitats, particularly of riverine vegetation, rather than site- or species-focused actions (Table 30). This will contribute to the maintenance of habitats in the "central section" and sites outside the study area e.g. the Stung Treng Ramsar site.

10.3 Information gaps and landscape-level actions

For many aquatic taxa recorded in the study area, especially migratory fish, site-based interventions will be insufficient to maintain local populations unless they are complemented by larger-scale initiatives encompassing the full extent of migration ranges within and outside the study area. The seasonal distributions of some migratory fish extend hundreds of kilometers along the Mekong River, and their conservation requires management at the catchment level. The management of freshwater biodiversity in the Mekong River is also hindered by a paucity of data on the status, distribution and ecology of most aquatic taxa. Scientific data gained from further research in the study area would benefit conservation and management of freshwater taxa throughout the Lower Mekong Basin. This section identifies management actions within and outside the study area which are intended to complement the site-based actions described in Section 10.2.

Information gaps (short-term)

1. Conduct a survey of aquatic invertebrates to establish a baseline inventory for the study area and if possible, establish priorities and sites for conservation action. Previous studies indicate the Mekong Basin is a center of endemism for freshwater gastropods and other invertebrates (Dudgeon 2000a), and the lack of surveys for aquatic invertebrates is a key limitation of the current project.

2. Review the national legal status of priority taxa listed in Table 29 and assess whether the management of these species is sufficiently represented under provincial and/or national regulations. For example, Plain Martin is currently listed as "Common" under the national *Law on Classification and List of Wildlife Species*, yet two breeding colonies recorded in the study area are the only known sites in Cambodia and there are few other national records; for this species, an upgrade in protection status is probably required.

3. Assess the economic value of fisheries: (a) within the study area; (b) contribution of the habitats within the study area to maintaining fisheries downstream, especially in the Tonle Sap Lake. This study should include the catch volume and revenue gained from fisheries in the study area and the contribution of fisheries to the total annual revenue for Kratie and Stung Treng Provinces. This study will assist in identifying the potential economic impacts of regional development to fisheries and fish habitats in the study area and connected regions (below) and provide a stronger case for management of fish populations and their habitats.

4. Develop a strategy to review and address the potential impacts of regional development on the ecological and hydrological values of the study area, especially dam construction and commercial land concessions. The urgency for such a study is high given the pending status of some developments. The strategy would enable government agencies to consider environmental and economic criteria which may not have been previously considered in the planning of these developments. Key recommended actions are:

    - Economic valuation of the fishery in the study area (see point 3).
    - Identification of potential "impact scenarios", which would indicate the ecological and economic impacts to the natural resources of the study area over time and if some or all proposed regional developments are implemented.
    - Distribute the results of the study to key development stakeholders (governments, international aid agencies etc) to strengthen regional coordination for water and land planning.
    - Promote the application of "environmental criteria for hydropower development" (King et al. 2007) for regional water development projects.

New research (longer-term)

5. Develop an international field research station in the study area. The study area is well-suited for a research station given its location in an ecologically unique section of the Mekong River, the intactness of aquatic habitats in the "central section", and proximity to a range of different aquatic habitats (river, tributaries, floodplains) and other sites (e.g. Tonle Sap Lake, Stung Treng Ramsar site and Siphandon in Lao PDR).

6. Develop linkages between national and international institutions (including academic, research and government agencies) to establish and implement joint research projects at this station, and to support Cambodian students to implement research in the study area.

7. Research priorities should include:
    - Status, ecology and habitat requirements of freshwater fish, especially non-economic species (to date most research in the Mekong Basin has focused on fish taxa of economic importance). This would extend the inventory obtained in the current survey.
    - Status, ecology and habitat requirements of aquatic invertebrates.
    - Mapping of deep pools in the study area and surveys of these pools, to assess whether specialist or undescribed biota are present, and to supplement the limited available data on the ecological use of these pools by aquatic taxa.
    - Botanical research, to increase knowledge of the occurrence, distribution and status of taxa in the study area, particularly the new taxon *Amorphophallus* sp. nov. identified in the current project.
    - Identification of the potential impacts of dam construction within and upstream of the study area, especially in the Se Kong, Se San and Srepok Rivers. This could include modeling of the impacts of dam construction on hydrology, sedimentation, groundwater flows, soil, aquatic biodiversity, and the economic impacts to plantations or crops. This research would contribute to efforts to achieve appropriate environmental management for development planning (see point 4).

Strengthen provincial capacity to manage aquatic resources in the study area

8. Establish or strengthen links with other agencies in Kratie and Stung Treng Provinces to coordinate and leverage greater support for wetland management and improving local livelihoods, including:
    - Coordinate with the Wetlands Alliance Programme (WAP) to strengthen provincial capacity to manage wetland vegetation, conduct socio-economic assessments, and undertake environmental impact assessments (e.g. Yasuda et al. 2008).
    - Coordinate with non-government organizations focused on livelihoods to strengthen community management of wetland resources, especially in the "central section" e.g. Oxfam, Community Rural Development Team, Community Economic Development.
    - Coordinate with ecotourism planning by the World Tourism Organisation, Asian Development Bank and other agencies, to identify opportunities for ecotourism in the study area which focus on benefits for biodiversity and local communities (e.g. MoT 2008).
    - Strengthen capacity of provincial fisheries staff to interpret and apply the 2007 Law on Fisheries, especially during field patrols and liaison with local communities.

Transboundary fisheries management

9. Promote the development of transboundary strategies for the management of migratory fish species, and ensure the study area is included within these strategies. These could include the following.

    - Create transboundary agreements between provinces within Cambodia to collectively manage habitats along the Mekong River for migratory fish.
    - Develop national and international conservation plans between Cambodia, Lao PDR, Thailand and Viet Nam for migratory taxa and assemblages, which consider the full migration range and ecology of these taxa. Between Cambodia and Lao PDR, the existing "Transboundary Wetland Agreement" between Stung Treng Province and Champassak Province (Lao PDR), signed in 2006, provides a platform for wetland management.
    - Coordinate site management and promotion of information exchange between the study area with the Stung Treng Ramsar site (Cambodia) and Siphandon region (Lao PDR), especially for migratory fish, but also other taxa which occur in some or all of these sites e.g. White-shouldered Ibis. These three sites provide critical habitats for many threatened taxa, including fish which migrate from the Tonle Sap Lake to Siphandon or further north.

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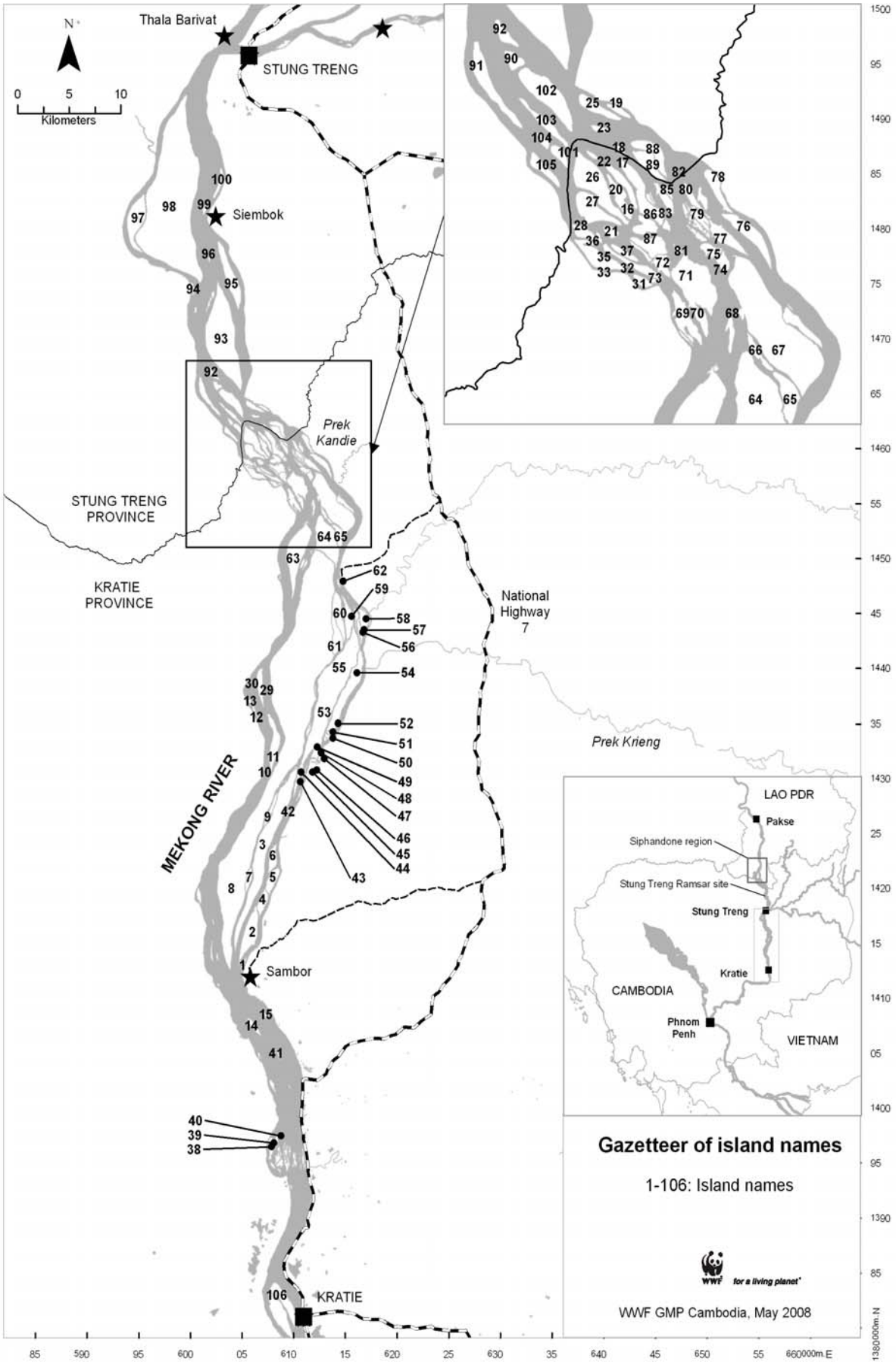
ANNEX 1. GAZETTEER OF ISLAND AND VILLAGE NAMES IN THE "CENTRAL SECTION"

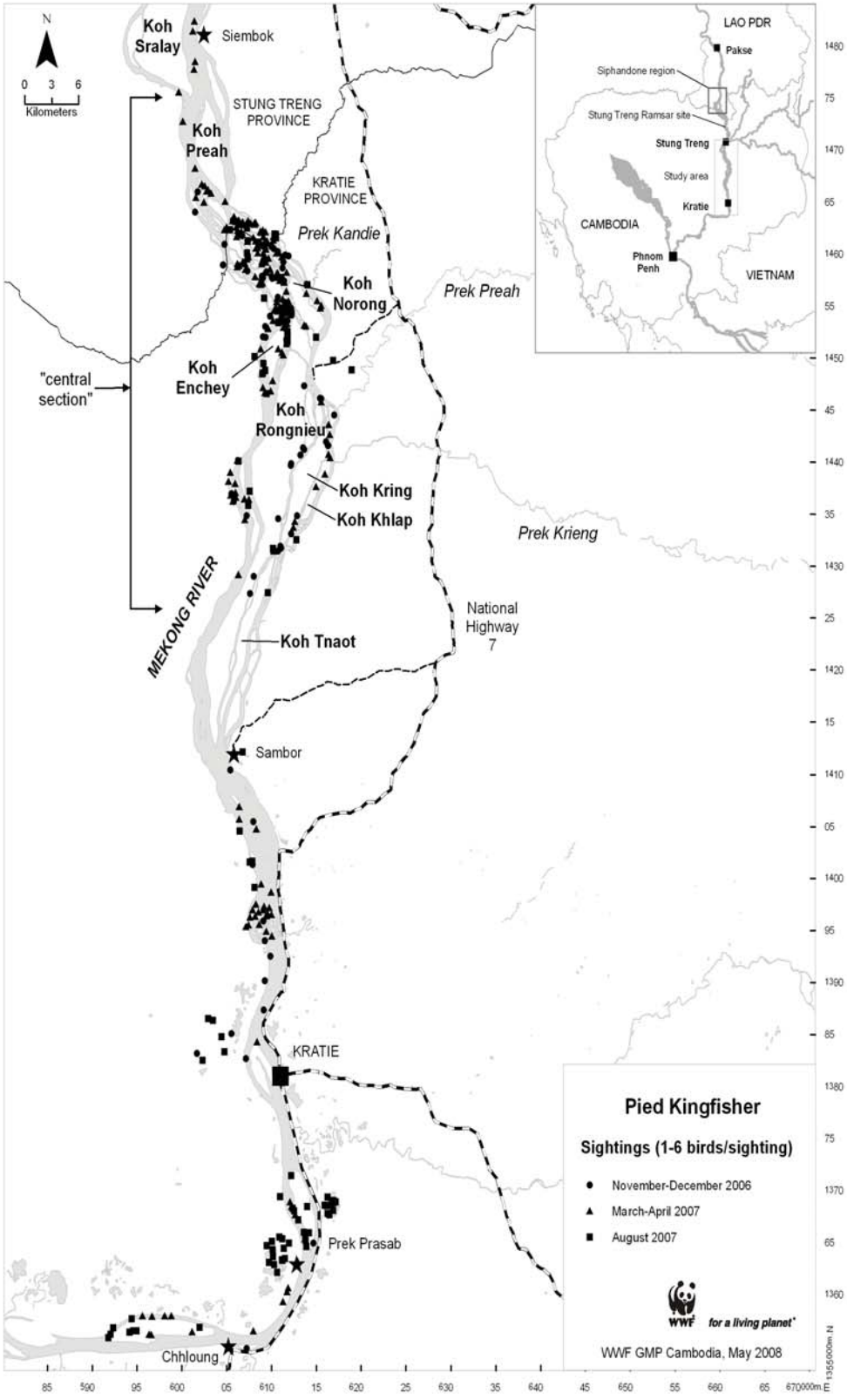
ID	Province	District	Easting	Northing	1:50,000 map sheet	Feature	Name on map sheet	Name used in report
1	Kratie	Prek Prasap	610848	1380256	6234-III	Town	Kracheh	Kratie
2	Kratie	Sambor	605500	1412500	6134-I	Town	Sambor	Sambor
3	Kratie	Sambor	605000	1413000	6134-I	Island	Kaoh Preal	Koh Preal
4	Kratie	Sambor	606000	1416000	6134-I	Island	Kaoh Real	Koh Real
5	Kratie	Sambor	607000	1424000	6134-I	Island	Kaoh Tnaot	Koh Tnaot
6	Kratie	Sambor	607000	1419000	6134-I	Island	Kaoh Kombor	Koh Dohphor
7	Kratie	Sambor	608000	1421000	6134-I	Island	no name	Koh Poat
8	Kratie	Sambor	608000	1423000	6134-I	Island	Kaoh Preng	Koh Preng
9	Kratie	Sambor	605700	1421000	6134-I	Island	Kaoh Takor	Koh Takor
10	Kratie	Sambor	604000	1420000	6134-I	Island	Kaoh Rogniev	Koh Rongnieu
11	Kratie	Sambor	607500	1426500	6134-I	Island	Kaoh Vang	Koh Krauwbang
12	Kratie	Sambor	607200	1431000	6134-I	Island	no name	Koh Somp-han
13	Kratie	Sambor	608000	1432000	6134-I	Island	Kaoh Preang	Koh Preang
14	Kratie	Sambor	606400	1436000	6134-I	Island	no name	Koh Preh
15	Kratie	Sambor	605800	1437000	6134-I	Island	no name	Koh Takang
16	Kratie	Sambor	606000	1407500	6134-II	Island	Kaoh Sam Thom	Koh Sam Thom
17	Kratie	Sambor	607300	1408500	6134-II	Island	Kaoh Sam Toch	Koh Som Toch
18	Kratie	Sambor	607500	1459700	6135-II	Island	no name	Koh Preah Phnom
19	Kratie	Sambor	607300	1461800	6135-II	Island	no name	Koh Klong
20	Kratie	Sambor	607100	1462200	6135-II	Island	no name	Koh Thmar Kiep
21	Kratie	Sambor	607000	1464000	6135-II	Island	Kaoh Chvea Mala	Koh Marash
22	Kratie	Sambor	607000	1460500	6135-II	Island	no name	Koh Tbal
23	Kratie	Sambor	606800	1458800	6135-II	Island	no name	Koh Preah Trapeang
24	Kratie	Sambor	606500	1461500	6135-II	Island	no name	Koh Mattee
25	Kratie	Sambor	606500	1463000	6135-II	Island	no name	Koh Domlorng
26	Kratie	Sambor	606300	1458700	6135-II	Island	no name	Koh Deisanar
27	Kratie	Sambor	606000	1464000	6135-II	Island	Kaoh Tbong Khla	Koh Tbong Khla
28	Kratie	Sambor	606000	1461000	6135-II	Island	Kaoh Toan Han	Koh Toan Han
29	Kratie	Sambor	606000	1460000	6135-II	Island	no name	Koh Pnear
30	Kratie	Sambor	605500	1459000	6135-II	Island	no name	Koh Moul
31	Kratie	Sambor	607000	1438000	6135-II	Island	no name	Koh Plong
32	Kratie	Sambor	606000	1438600	6135-II	Island	no name	Koh Tbal
33	Kratie	Sambor	608000	1456900	6135-III	Island	no name	Koh Damreay
34	Kratie	Sambor	607500	1457300	6135-III	Island	no name	Koh Chkrua
35	Kratie	Sambor	606500	1457300	6135-III	Island	no name	Koh Peamkrak
36	Kratie	Sambor	606000	1458000	6135-III	Island	Kaoh Mul	Koh Veng Thom
37	Kratie	Sambor	606500	1457800	6135-III	Island	no name	Koh Veng Toch
38	Kratie	Sambor	606000	1458400	6135-III	Island	no name	Koh Khombauw
39	Kratie	Sambor	607500	1458000	6135-III	Island	no name	Koh Ontauwk
40	Kratie	Sambor	608200	1396500	6234-III	Island	no name	Koh Khor
41	Kratie	Sambor	608400	1396800	6234-III	Island	no name	Koh Sake
42	Kratie	Sambor	609100	1397400	6234-III	Island	no name	Koh Reangauwn
43	Kratie	Sambor	608300	1405000	6234-III	Island	no name	Koh Preal
44	Kratie	Sambor	609500	1427000	6234-IV	Island	Kaoh Chbar	Koh Chbar
45	Kratie	Sambor	610000	1426500	6234-IV	Village	Kaoh Chbarr	Koh Chbarr
46	Kratie	Sambor	610500	1430000	6234-IV	Island	Kaoh Veng	Koh Umpel
47	Kratie	Sambor	610500	1430800	6234-IV	Island	no name	Koh Krabei
48	Kratie	Sambor	611600	1430800	6234-IV	Island	no name	Koh Rusai
49	Kratie	Sambor	612000	1431000	6234-IV	Island	Kaoh Svan	Koh Svan
50	Kratie	Sambor	612700	1432000	6234-IV	Island	no name	Koh Smout
51	Kratie	Sambor	612400	1432500	6234-IV	Island	Kaoh Sambor	Koh Rokha
52	Kratie	Sambor	612886	1432565	6234-IV	Village	Kampong Pnov	Kampong Pnov
53	Kratie	Sambor	612000	1433000	6234-IV	Island	no name	Koh Chate
54	Kratie	Sambor	613500	1433800	6234-IV	Island	Kaoh Kor	Koh Prolaikor
55	Kratie	Sambor	613500	1434300	6234-IV	Island	no name	Koh Rut

ID	Province	District	Easting	Northing	1:50,000 map sheet	Feature	Name on map sheet	Name used in report
56	Kratie	Sambor	615300	1435700	6234-IV	Village	O Kak	O Kak
57	Kratie	Sambor	614000	1435000	6234-IV	Island	Kaoh Khlap	Koh Khlap
58	Kratie	Sambor	613000	1436000	6234-IV	Island	Kaoh Krang	Koh Kring
59	Kratie	Sambor	615800	1439600	6235-III	Island	no name	Koh Kesh
60	Kratie	Sambor	616000	1442000	6235-III	Island	Kaoh Chhoang	Koh Auw
61	Kratie	Sambor	616400	1443400	6235-III	Island	no name	Koh Araq
62	Kratie	Sambor	616500	1443500	6235-III	Island	no name	Koh Ruesai
63	Kratie	Sambor	616700	1444500	6235-III	Island	no name	Koh Somtup
64	Kratie	Sambor	615400	1444500	6235-III	Island	Kaoh Chan	Koh Tachan
65	Kratie	Sambor	614500	1445000	6235-III	Island	Kaoh Khleng Por	Koh Khleng Por
66	Kratie	Sambor	614000	1442000	6235-III	Island	Kaoh Neang Hen	Koh Neang Hen/Chdong
67	Kratie	Sambor	616143	1446066	6235-III	Village	Cheang Kachea	Pontacheer
68	Kratie	Sambor	615000	1447500	6235-III	Village	Kaoh Khnhaer	Kaoh Khnhaer
69	Kratie	Sambor	614500	1447800	6235-III	Island	Kaoh Kvien	Koh Kvien
70	Kratie	Sambor	614566	1449544	6235-III	Village	no village denoted	Satlieu village
71	Kratie	Sambor	610000	1450000	6235-III	Island	Kaoh Enchey	Koh Enchey
72	Kratie	Sambor	616986	1440054	6235-III	River	Prek Krieng	Prek Krieng
73	Kratie	Sambor	617359	1444994	6235-III	River	Prek Preah	Prek Preah
74	Kratie	Sambor	613000	1452000	6235-III	Island	Kaoh Chroem	Koh Chroem
75	Kratie	Sambor	614500	1452000	6235-III	Island	Kaoh Amdeng	Koh Amdeng
76	Kratie	Sambor	613000	1454000	6235-III	Island	no name	Koh Rohaing
77	Kratie	Sambor	614000	1454000	6235-III	Island	Kaoh Norong	Koh Norong
78	Kratie	Sambor	614394	1456752	6235-III	River	Prek Kandie	Prek Kondeea
79	Kratie	Sambor	612000	1455500	6235-III	Island	no name	Koh Khe
80	Kratie	Sambor	610000	1455500	6235-III	Island	no name	Koh Ampel Toch
81	Kratie	Sambor	610500	1455500	6235-III	Island	Kaoh Ampel	Koh Ampel Thom
82	Kratie	Sambor	610000	1457000	6235-III	Island	Kaoh Dambang	Koh Dambong
83	Kratie	Sambor	610000	1457000	6235-III	Village	no name	Koh Dambong
84	Kratie	Sambor	609000	1457400	6235-III	Island	no name	Koh Sombua
85	Kratie	Sambor	608700	1456900	6235-III	Island	no name	Koh Chheuteal
86	Kratie	Sambor	611500	1457500	6235-III	Island	Kaoh Toak	Koh Tuk
87	Kratie	Sambor	611200	1458000	6235-III	Island	no name	Koh Kapeung
88	Kratie	Sambor	612500	1459000	6235-III	Island	Kaoh Amdong	Koh Tongdaeng
89	Kratie	Sambor	611500	1458500	6235-III	Island	Kaoh Roang Khla	Koh Khlee-ay
90	Kratie	Sambor	611400	1461000	6235-III	Island	Kaoh Boeng Kev	Koh Bongkhow
91	Kratie	Sambor	610500	1459500	6235-III	Island	no name	Koh Kondul
92	Kratie	Sambor	610000	1460500	6235-III	Island	no name	Koh Krabei
93	Kratie	Sambor	609800	1458000	6235-III	Island	no name	Koh Preal
94	Kratie	Sambor	609700	1461200	6235-III	Island	no name	Koh Kaing Thama
95	Kratie	Sambor	609500	1462300	6235-III	Village	no village denoted	O Marash
96	Kratie	Sambor	609120	1459524	6235-III	Island	no name	Koh Preah-trabeik
97	Kratie	Sambor	609000	1460000	6235-III	Island	Kaoh Russei	Koh Dongnea
98	Kratie	Sambor	609200	1460500	6235-III	Island	no name	Koh Reusai
99	Kratie	Sambor	608500	1459500	6235-III	Island	no name	Koh Sompong Thom
100	Kratie	Sambor	608500	1458500	6235-III	Island	no name	Koh Sompong Toch
101	Kratie	Sambor	608600	1462000	6235-III	Island	Kaoh O Kev	Koh Baichor
102	Kratie	Sambor	608600	1461500	6235-III	Island	Kaoh Ta Ke	Koh Ta Ke
103	Stung Treng	Siembok	602500	1465800	6135-I	Island	no name	Koh Domnam
104	Stung Treng	Siembok	601000	1465500	6135-I	Island	Kaoh Preal	Koh Preal Thom
105	Stung Treng	Siembok	602000	1467000	6135-I	Island	no name	Koh Preal Toch
106	Stung Treng	Siembok	603000	1470000	6135-I	Island	Kaoh Preah	Koh Preah
107	Stung Treng	Siembok	600300	1474500	6135-I	Island	no name	Koh Treyang
108	Stung Treng	Siembok	604000	1475000	6135-I	Island	Kaoh Kroch	Koh Kroch
109	Stung Treng	Siembok	601800	1477700	6135-I	Island	no name	Koh Sake
110	Stung Treng	Siembok	595000	1481000	6135-I	Island	Kaoh Pring	Koh Pring
111	Stung Treng	Siembok	598000	1482000	6135-I	Island	Kaoh Sralay	Koh Sralay
112	Stung Treng	Siembok	601500	1481500	6135-I	Island	no name	Koh Tova
113	Stung Treng	Siembok	603000	1484500	6135-I	Island	Kaoh Sampeay	Koh Sampeay
114	Stung Treng	Siembok	604500	1462000	6135-II	Island	no name	Koh P-auw
115	Stung Treng	Siembok	604000	1464500	6135-II	Island	Kaoh Chroem	Koh Chroem
116	Stung Treng	Siembok	604000	1463300	6135-II	Island	no name	Koh Chraey
117	Stung Treng	Siembok	603800	1462600	6135-II	Island	no name	Koh Preang
118	Stung Treng	Siembok	604000	1461500	6135-II	Island	Kaoh Phaav	Koh Baisomnom

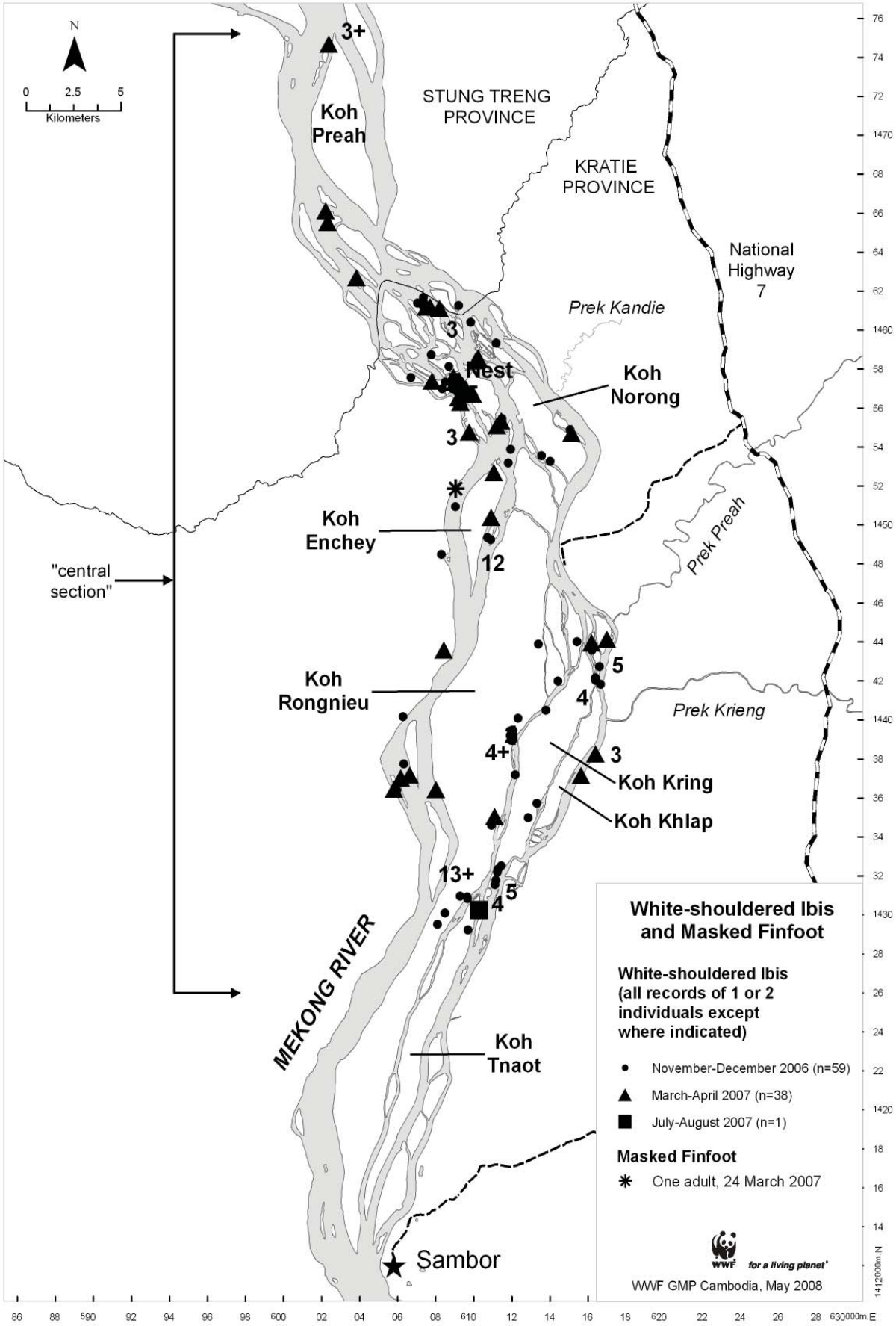


Map of island locations and names (refer to above table for numbering index).

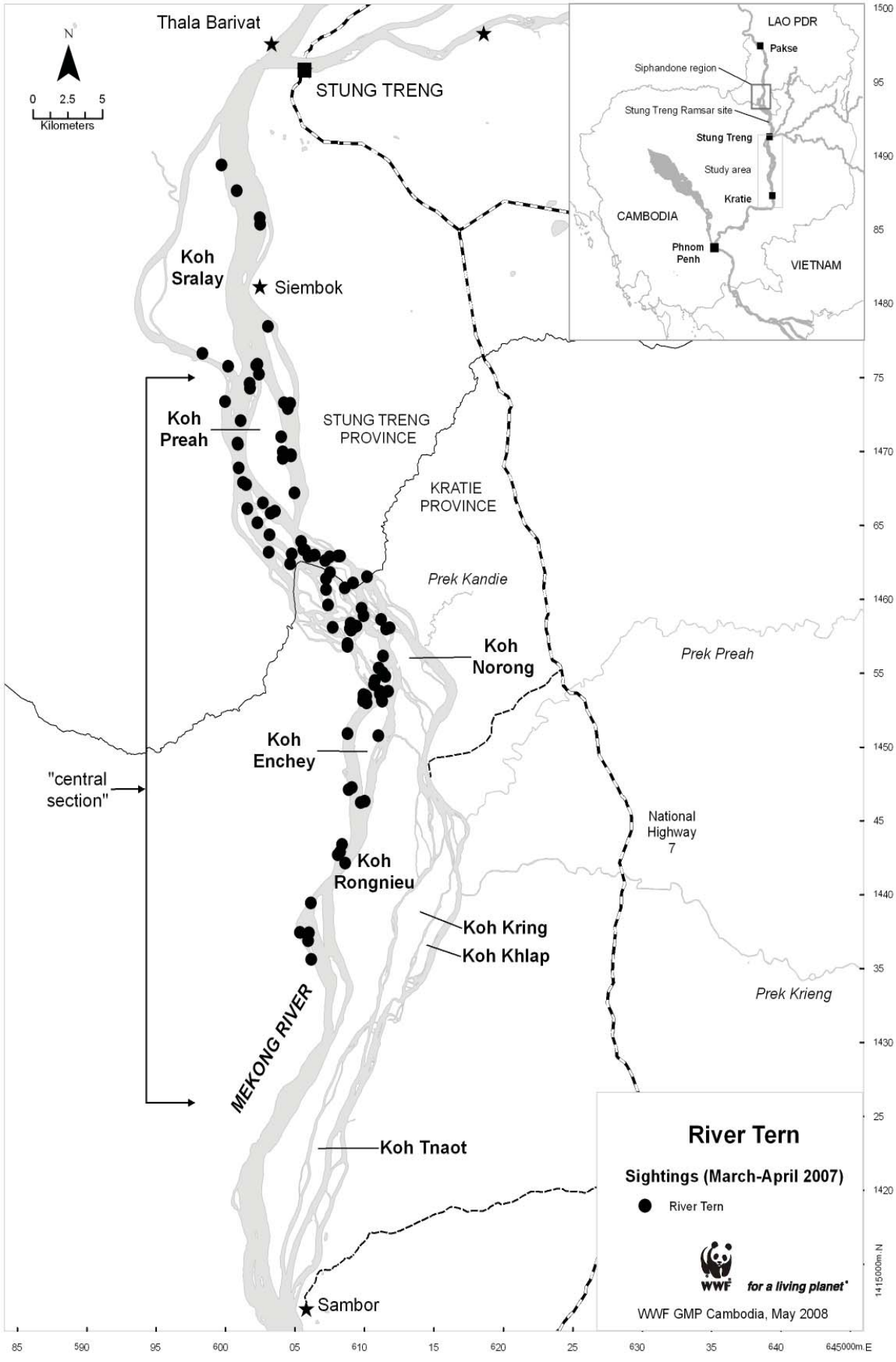
ANNEX 2. MAPS OF SELECTED TARGET SPECIES



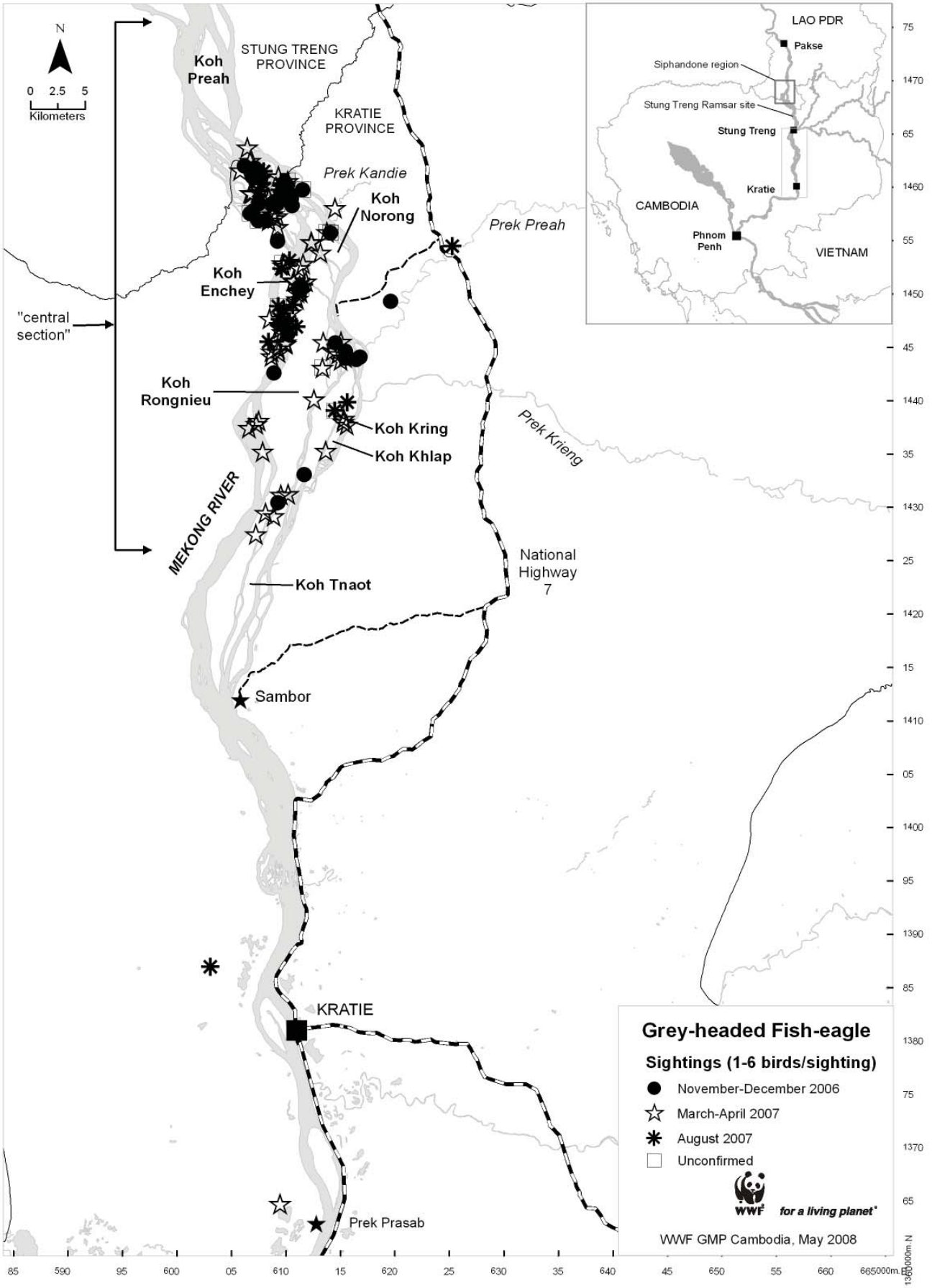
Map 1. Pied Kingfisher.



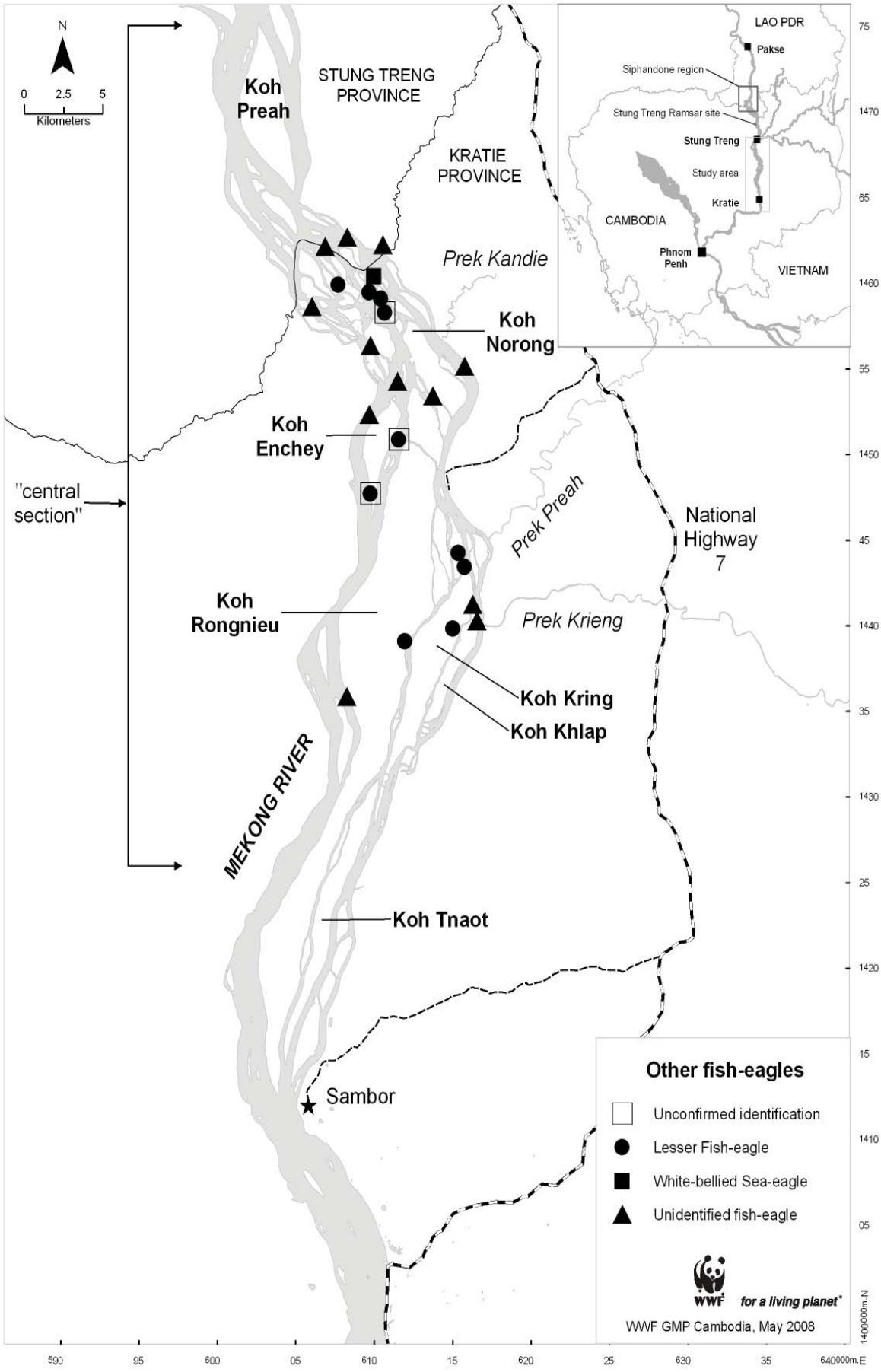
Map 2. White-shouldered Ibis and Masked Finfoot.



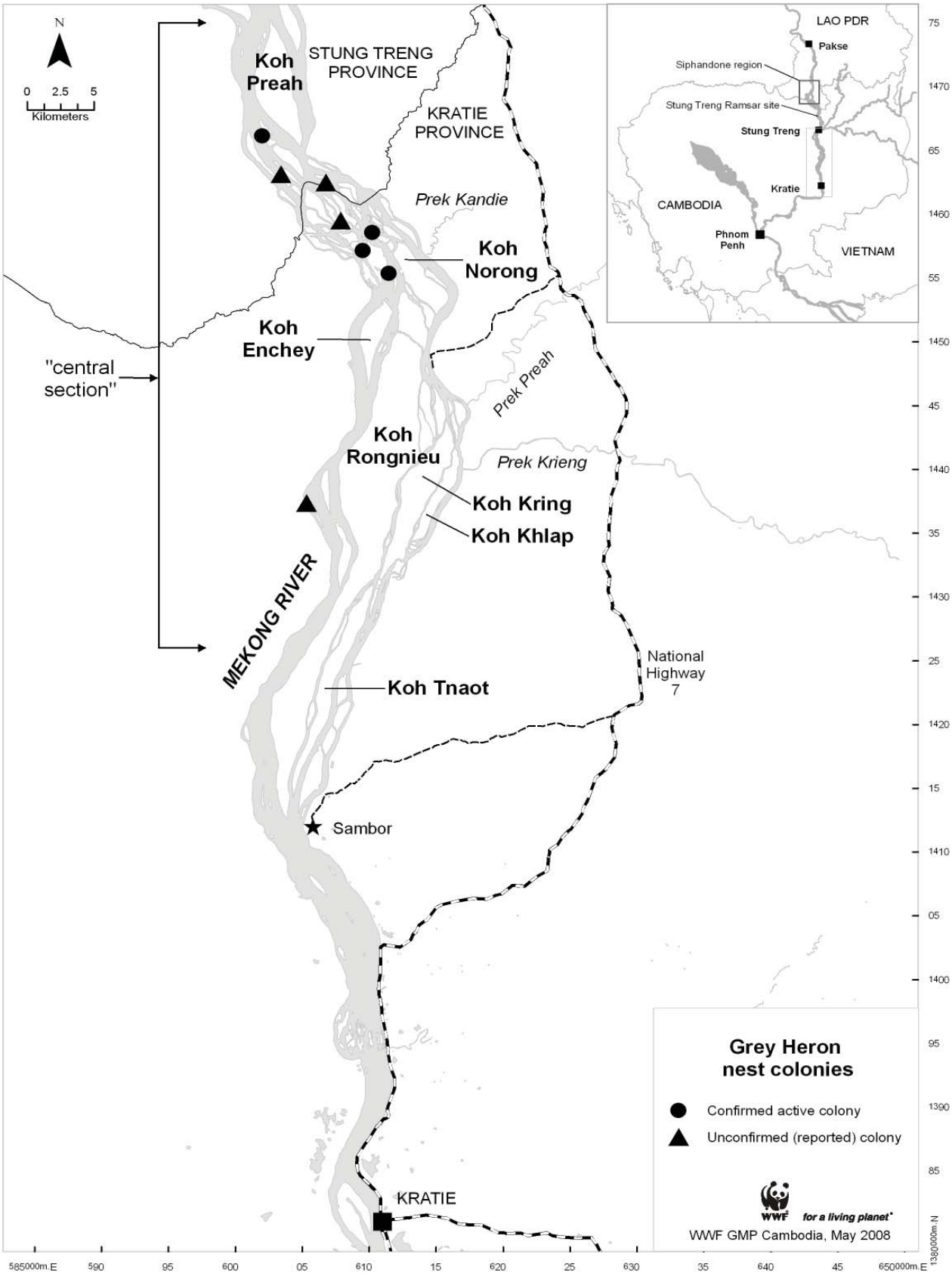
Map 3. River Tern.



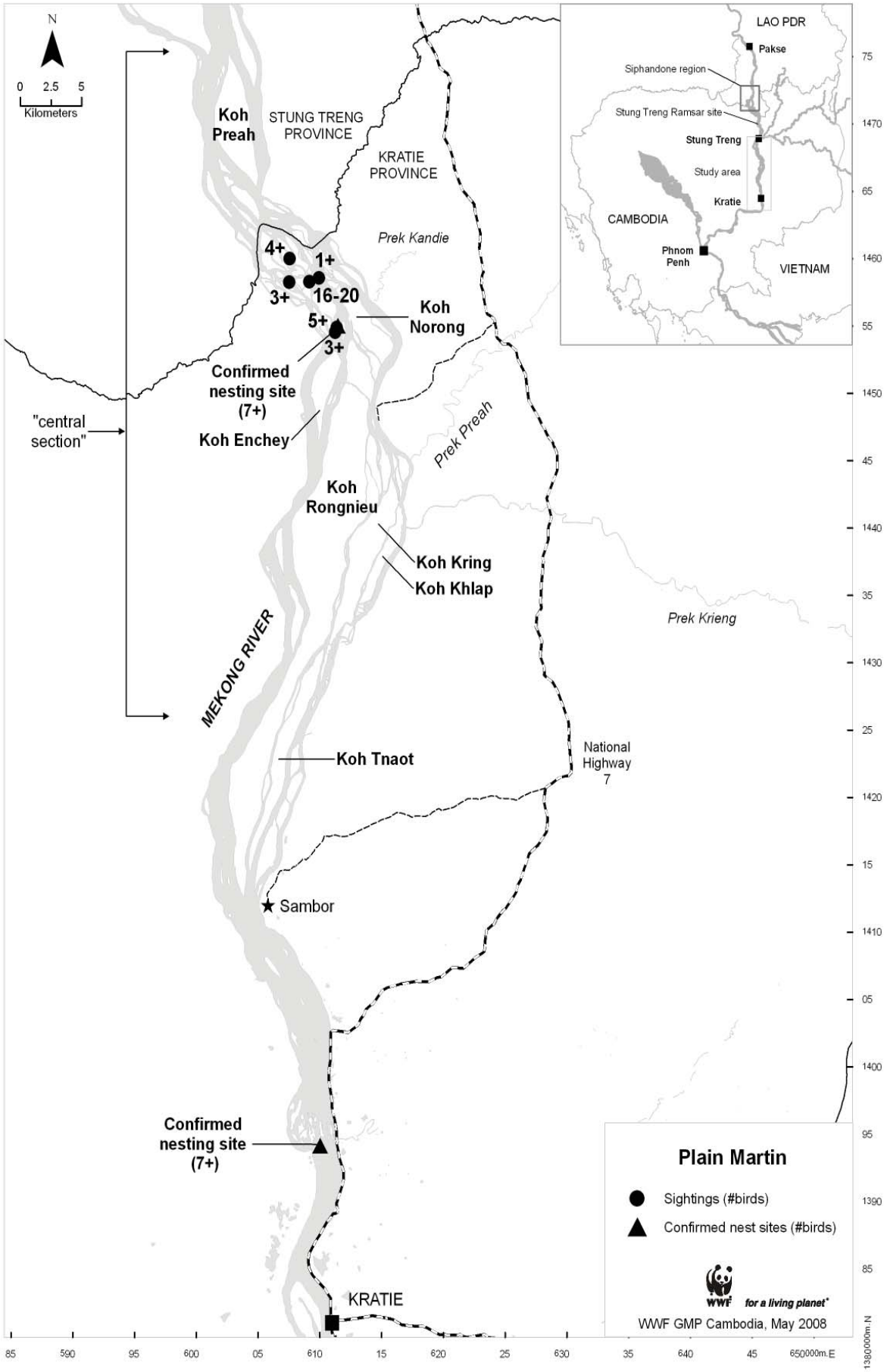
Map 4. Grey-headed Fish-eagle.



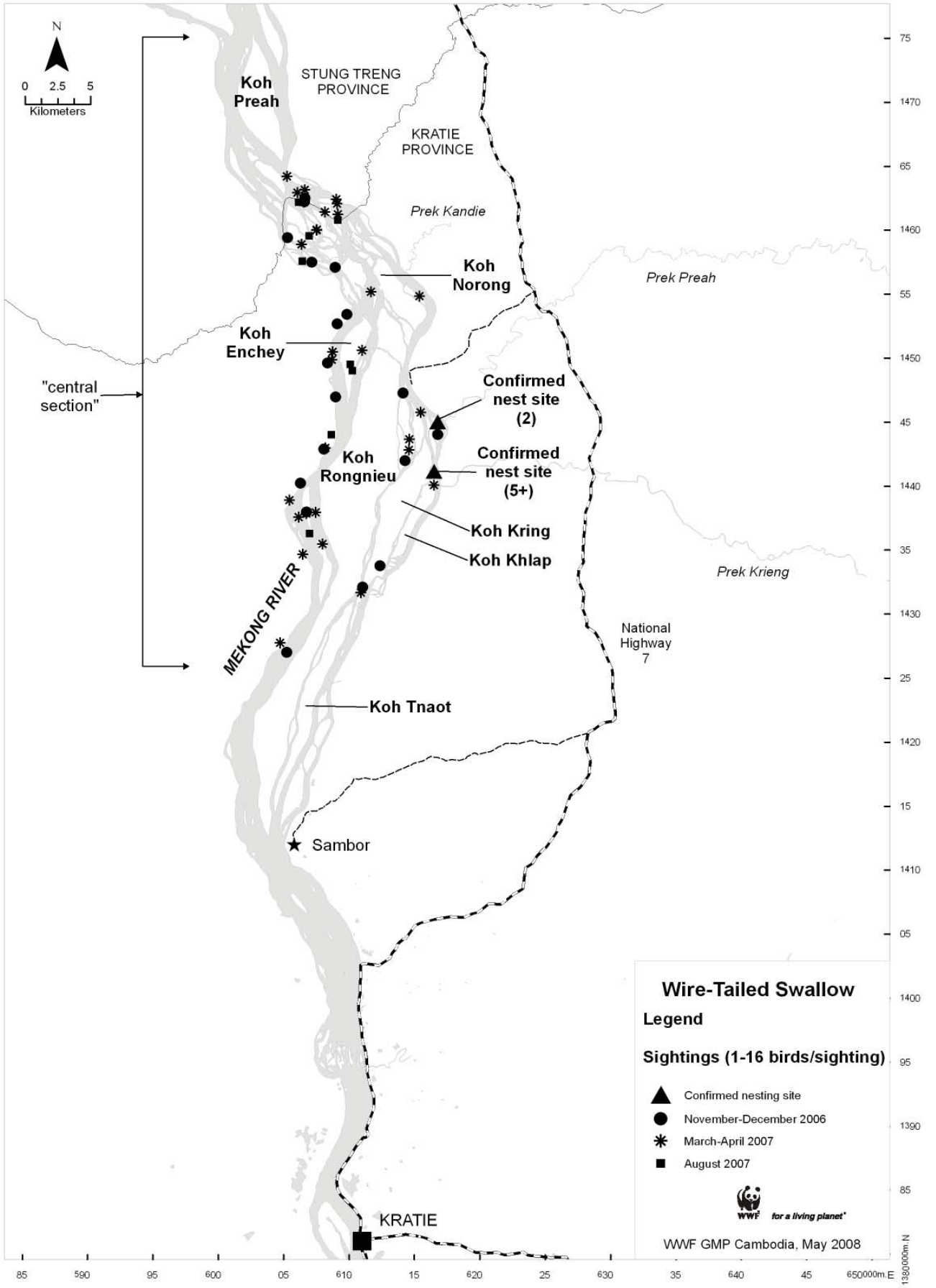
Map 5. White-bellied Sea-eagle and Lesser Fish-eagle.



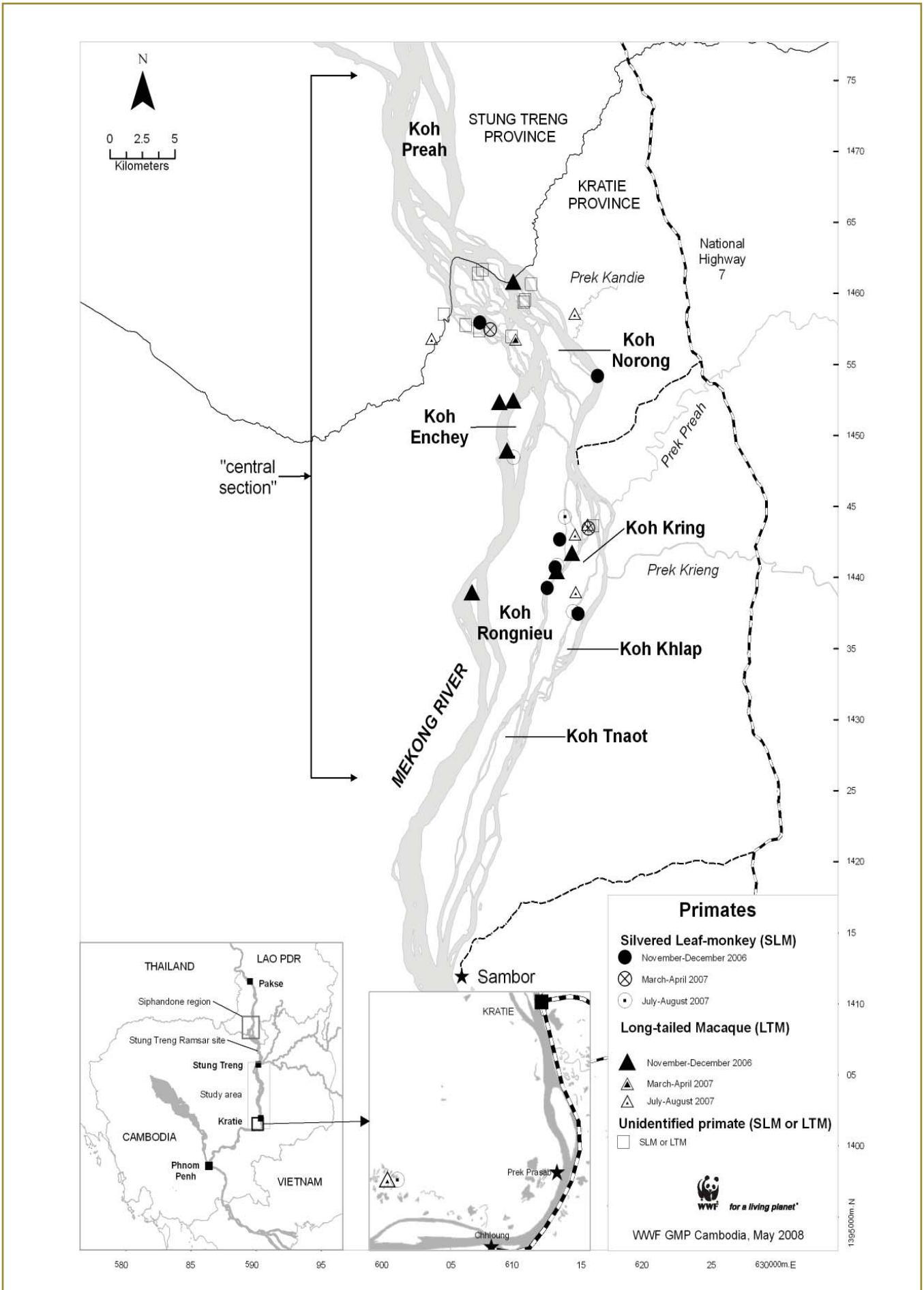
Map 6. Grey Heron (nest colonies).



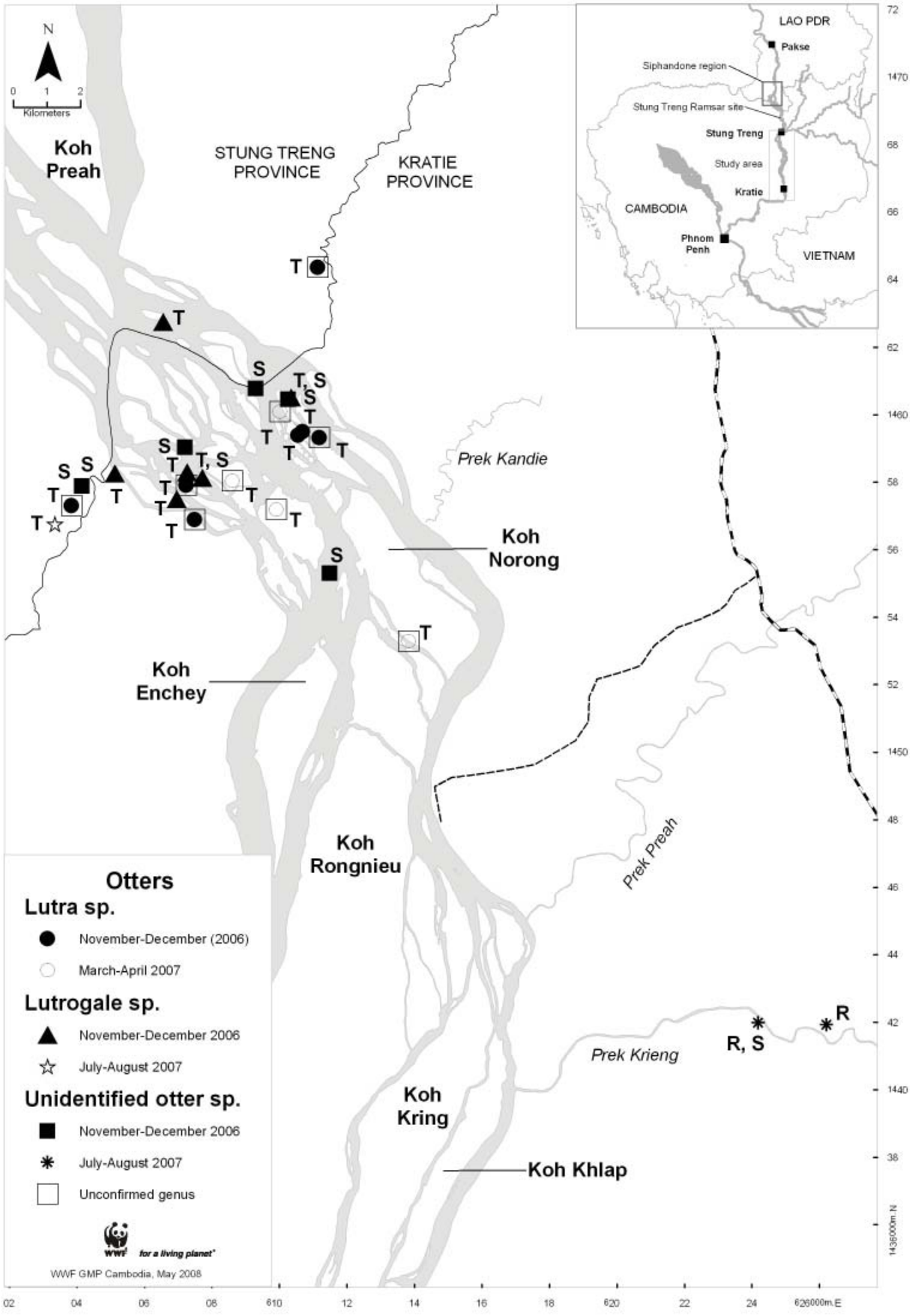
Map 7. Plain Martin.



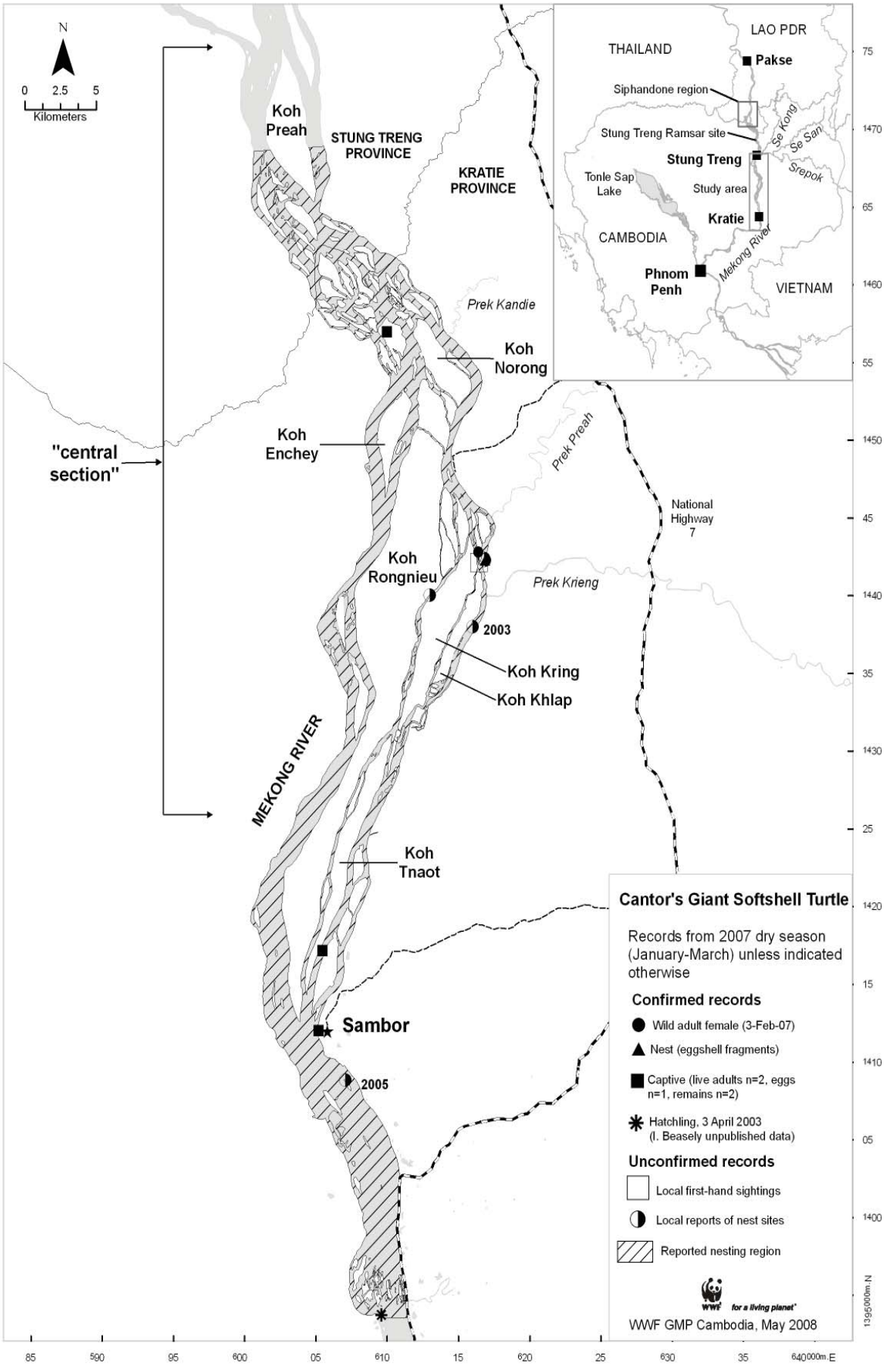
Map 8. Wire-tailed Swallow.



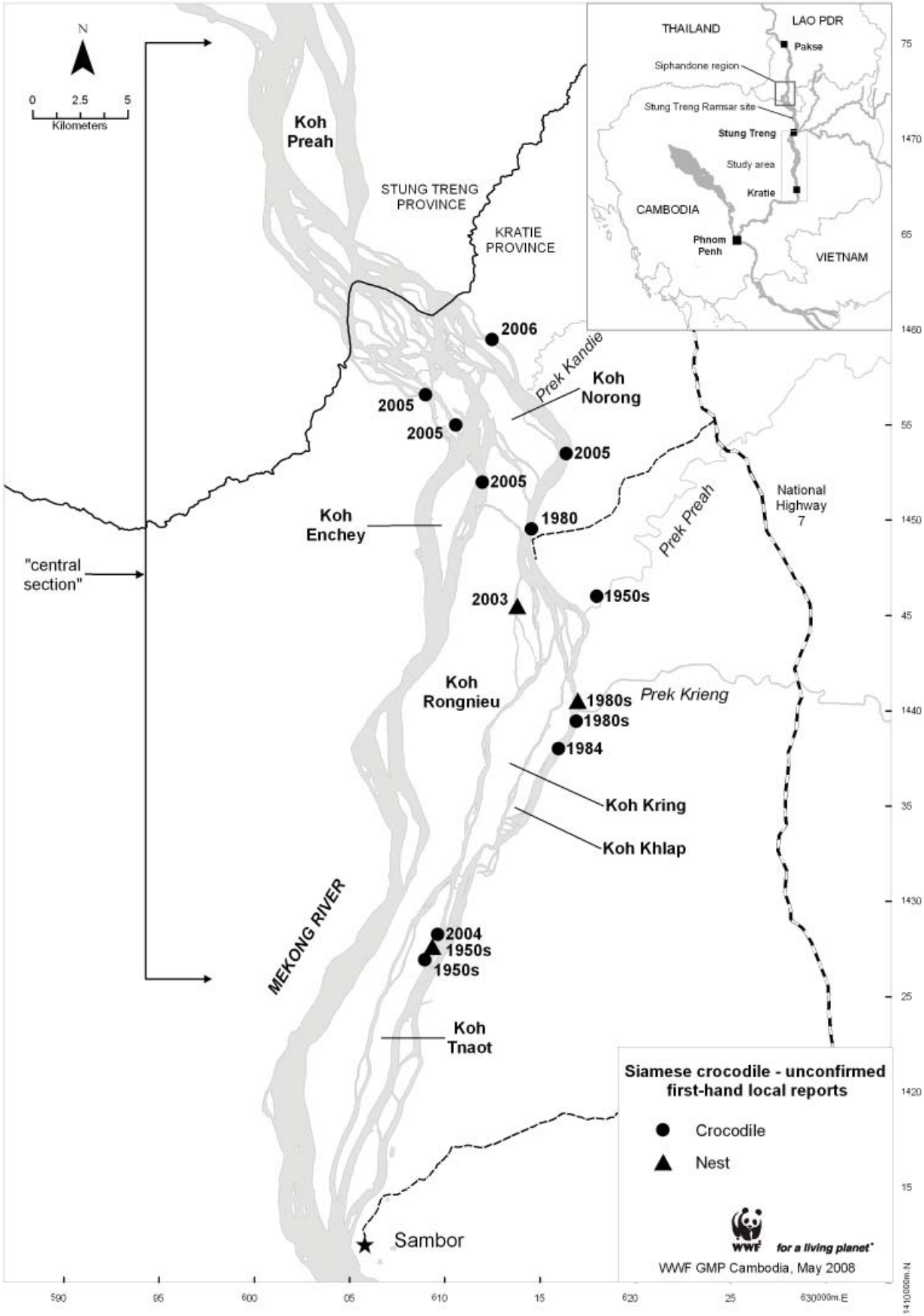
Map 9. Long-tailed Macaque and Silvered Leaf Monkey.



Map 10. Otters.



Map 11. Cantor's Giant Softshell Turtle.



Map 12. Siamese Crocodile.

ANNEX 3. PLATES

Photos within the "central section" and taken by M. Bezuijen unless indicated otherwise

VEGETATION – RIVERINE ZONES AND TERRESTRIAL FACIES

Plate 1. Riverine Zones 1 and 2 ("Aquatic", "Rapids"),dry season

Plate 2. Riverine Zone 2 showing *Telectadium edule*

Plate 3. Riverine Zone 3 ("Kai Kum")

Plate 4. Riverine Zone 4 ("Acacia-Anogeissus"), dry season

Plates 5,6. Zone 4 showing *Acacia harmandiana* with dense, fibrous, adventitious roots which are submerged in the wet season

Plate 7. Zone 4 showing *Anogeissus rivularis* and *Acacia harmandiana* with canopies bent by river currents and trapping debris (wet season)

Plate 8. Zone 5 ("Beach")

Plate 9. Zone 6 ("Strand")

Plate 10. Bamboo+Deciduous Seasonal Hardwood Forest (BB/DF)-remnant and degraded, with 2 *Lagerstroemia cochinchinensis*, wet season (Photo: Khou Eanghourt)

Plate 11. Mixed Evergreen+Deciduous, Seasonal Hardwood Forest (MXF)

Plate 12. Deciduous, Dipterocarp, Seasonal Hardwood Forest (DDF): open, single-story, dense 1-1.5 m tall herbaceous ground flora (wet season). Annual fire damage in the dry season prevents woody species from regenerating

Plate 13. Seasonal ponds, common in DDF; typically shallow, of varying size, mud substrate, with water from *c*.June-October (Photo: M. v.d. Bult)

Plate 14. *Cryptocoryne crispatula*, deciduous herb: new record for Cambodia. Commonly found in Riverine Zones 2-3. (Photo: P. Palee/J.F. Maxwell)

FLORA

Plate 15. *Amorphophallus* sp. nov. (proposed name *hemicryptus* Hett., in prep.). New species to science. Deciduous ground herb in BB/DF (Photo: P. Palee/J.F. Maxwell)

Plate 16. *Amorphophallus koratensis*, uncommon deciduous ground herb: new record for Cambodia, BB/DF (Photo: M. v.d. Bult/J.F. Maxwell)

Plate 17. *Desmodium flexuosum*, rare deciduous species in DDF and BB/DF: new record for Cambodia (Photo: P. Palee/J.F. Maxwell)

Plate 18. *Ardisia attenuata*, evergreen treelet in MXF and DA: new record for Cambodia (Photo: P. Palee)

BIRDS

Plates 19-21. Plate 19 (above left): Painted Stork (*Mycteria leucocephala*), globally "Near-Threatened". Plate 20 (above center): Lesser Adjutant (*Leptoptilos javanicus*), globally "Vulnerable". Plate 21 (above right): Woolly-necked Stork (*Ciconia episcopus*) (all photos ©Chamnan Kim/Cambodian Turtle Conservation Team)

Plate 22. Plover (*Charadrius*) sp. (left) and White Wagtail (*Motacilla alba*) (Photo: ©Trudy Chatwin)

Plate 23 (right). River Lapwing (*Vanellus duvaucelii*) (Photo: ©Chamnan Kim/Cambodian Turtle Conservation Team)

Plate 24 (left). Green Peafowl (*Pavo muticus*) (globally "Vulnerable"); common in the "central section" (Photo: ©WWF-GMP/DNCP/FA Cambodia; taken in Phnom Prich Wildlife Sanctuary)

Plate 25 (below). The importance of the study area for many bird species is due to the diverse mosaic of seasonal and permanent habitats within the river and riverbanks, including sandbars, rocky rapids, and seasonally exposed vegetation

MAMMALS

Plates 26-28. Hog Deer (*Axis porcinus*): last-known population in Indochina, near Kratie Town. Plate 26 (top left)- adult female. Plate 27 (left)- adult female and fawn (Photos taken by camera-trap & first appeared in Maxwell et al. (2006) (Photos: ©WWF-GMP/DNCP/FA Cambodia). Plate 28 (above)- antlers of male Hog Deer with local ranger patrol

Plate 29. Otter (*Lutra*) sp. (Photo: ©WWF-GMP/FA Cambodia)

AMPHIBIANS

Plate 30. B*ufo macrotis*

Plate 31. *Kaloula pulchra*

Plate 32. *Glyphoglossus molossus*, globally "Near-Threatened"

Plate 33. *Occidozyga martensii*

Plate 34. *Microhyla berdmorei*

Plate 37. *Polypedates leucomystax*

Plate 35. *Microhyla heymonsi*

Plate 36. *Rana erythraea*

REPTILES

Plate 38. *Amyda cartilaginea*, globally "Vulnerable"

Plates 39-41. *Pelochelys cantorii*, globally "Endangered". Largest known breeding population in Mekong Basin. Plate 39 (above left): adult (Photo: ©Chris Greenwood/WWF Cambodia). Plate 40 (above center): adult (Photo:©Trudy Chatwin). Plate 41 (above right): reported nest site with eggshell fragments

Plate 42. *Heosemys grandis*, globally "Vulnerable" (dorsal surface)

Plate 43. *Heosemys grandis* (ventral surface)

Plate 44. *Malayemys subtrijuga*, globally "Vulnerable"

Plate 45. *Erpeton tentaculum*

Plate 46. *Homalopsis nigroventralis*, adult (second Cambodia record)

Plate 47. *Homalopsis nigroventralis*, juvenile (Photo: Chavalit Vidthayanon)

Plate 48. *Lycodon capucinus*

Plate 49. *Enhydris longicauda* (first record outside Tonle Sap Lake region)

Plate 50. *Calotes mystaceus*

Plate 51. *Sphenomorphus maculatus*

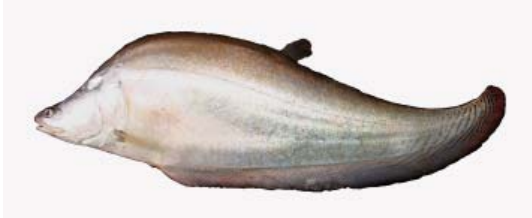


Plate 52. Mekong Featherback (*Chitala blanci*), globally "Near-Threatened" (Photo: C. Vidthayanon)

Plate 53. *Chela caeruleostigmata*, globally "Critically Endangered" (Photo: C. Vidthayanon)

Plate 54. Chao Phraya Giant Catfish (*Pangasius sanitwongsei*), globally "Endangered" (Photo: C. Vidthayanon)

Plate 55. *Probarbus labeamajor*, globally "Data Deficient" (Photo: C. Vidthayanon)

Plate 56. Jullien's Golden Carp (*Probarbus jullieni*), globally "Endangered" (Photo: C. Vidthayanon)

Plate 57. *Minyclupeoides dentibranchialus*, 100 km upstream range extension (Photo: C. Vidthayanon)

Plate 58. Edible shellfish and other aquatic invertebrates observed in local markets. Species are currently being identified; the prawn is *Macrobrachium rosenburgi* (Photos: C. Vidthayanon)

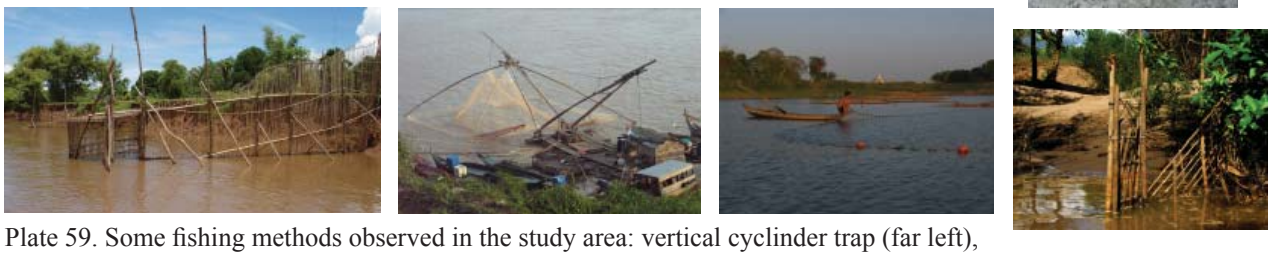


Plate 59. Some fishing methods observed in the study area: vertical cyclinder trap (far left), giant lift net (middle left), sein net (middle right), trapdoor (right) (Photos: C. Vidthayanon)

CURRENT THREATS TO BIODIVERSITY

Plate 60. Wildlife hunting and trade: the greatest threat to many large bird, mammal and reptile species in the study area: local crossbow (far left), wild pig *Sus* sp. (middle left), mesh trap (middle right), turtles in trade (right)

Plate 61. Increasing fishing pressure: nets across entire tributaries (left); extensive gill-net fishing (right)

Plate 62. Uncontrolled timber logging is rapidly removing natural forest in the "central section"

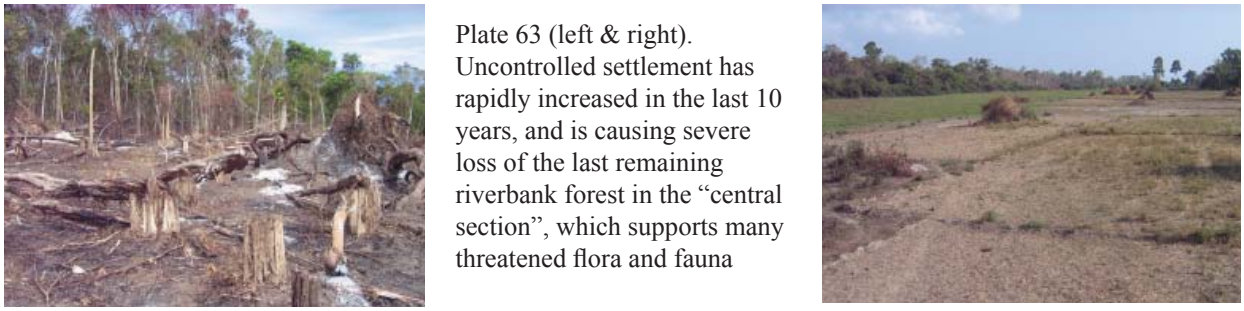


Plate 63 (left & right). Uncontrolled settlement has rapidly increased in the last 10 years, and is causing severe loss of the last remaining riverbank forest in the "central section", which supports many threatened flora and fauna

ANNEX 4. VASCULAR PLANTS RECORDED IN THE STUDY AREA

KEY
Habit: cr - creeper; **h** - herb; **l** - treelet; **s** - shrub; **sc** - scandent; **t** - tree; **v** - vine; **wc** - woody climber.
Month: ja - January; **fb** – February; **mr** – March; **ap** – April; **my** – May; **jn** – June; **jl** – July; **ag** – August; **sp** – September; **oc** – October; **nv** – November; **dc** - December
Phenology: a – annual; **pe** - perennial evergreen; **pd** - perennial deciduous
Lifemode: aqu – aquatic; **car** – carnivorous; **cul** – cultivated; **epi** – epiphyte; **epl** – epilithic; **gro** – ground; **hyp** – hyperparasite; **int** - introduced, not native; **nat** – naturalized; **par –** parasite; **rhe-** rheophyte; **sap** – saprophyte; **str** - "strangler"; **wee** – weed
Bedrock: ms - metamorphic sandstone; **sh** - shale
Abundance ("AB"): 0 = probably extirpated; **1** = down to a few individuals, in danger of extirpation; **2** = rare; **3** = medium abundance; **4** = common, but not dominant; **5** = abundant.
***** new record
Habitat: mxf - mixed evergreen + deciduous forest; **bb/df** - deciduous forest with bamboo; **ddf** - deciduous dipterocarp forest; **sg** - secondary growth; **da** - degraded areas; **rv 1** - riverine zone 1, aquatic; **rv 2** - riverine zone 2, rapids ("boong"); **rv 3** - riverine zone 3, "kai kum"; **rv 4** - riverine zone 4, *Acacia-Anogeissus*; **rv 5** - riverine zone 5, beach; **rv 6** - riverine zone 6, strand.
LE- Lower Elevation (m); **UE**-Upper Elevation (m). **Flower Month**-Flowering Month.

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Angiospermae, Dicotyledoneae													
Naravellia laurifolia Wall. *ex* Hk f. & Th.	Ranunculaceae	v	a	gro	2	bb/df	ms	25	30		oc-nv	my-dc	fruits
Dillenia ovata Wall. *ex* Hk. f. & Th.	Dilleniaceae	t	pd	gro	3	bb/df	ms	25	30	ja-fb	mr-ap	my-dc	
Dillenia parviflora Griff. var. *kerrii* (Criab) Hoogl.	Dilleniaceae	t	pd	gro	3	bb/df	ms	25	30	mr	ap	my-ja	flowers
Dillenia pentagyna Roxb.	Dilleniaceae	t	pd	gro	3	ddf	ms	25	30	fb-mr	mr-ap	my-nv	flowers
Dillenia suffruticosa (Griff.) Mart.	Dilleniaceae	s	pd	gro	3	ddf	ms	30	30	jl-ag		my-nv	flowers
Tetracera loureiri (Fin. & Gagnep.) Pierre *ex* Craib	Dilleniaceae	v	pe	gro	2	bb/df,rv 6	ms	25	30	ag-oc	ag-dc	ja-dc	fruits
Anomianthus dulcis (Dun.) Sincl.	Annonaceae	wc	pd	gro	3	bb/df,mxf,rv 6	ms	25	30	ap-my	jl-ag	ap-nv	fruits
Artabotrys hexapetalus (L.f.) Bhar.	Annonaceae	wc	pe	gro	3	mxf,ddf,sg	ms	25	30	fb-mr	mr-my	ja-dc	flowers,fruits
Desmos chinensis Lour.	Annonaceae	l	pe	gro	2	mxf	ms	25	30	ag-oc	nv-fb	ja-dc	fruits
Desmos velutinus (Hance) Ast	Annonaceae	l	pd	gro	2	bb/df,mxf	ms	25	30	ap-my	nv-dc	my-dc	fruits
Ellipelopsis cherrevensis (Pierre *ex* Fin. & Gagnep.)	Annonaceae	s	pd	gro	3	ddf	ms	30	30	jn-jl	ag-sp	my-nv	fruits
Goniothalamus marcanii Craib	Annonaceae	l	pe	gro	2	bb/df,mxf	ms	30	30	jl-ag	ag-sp	ja-dc	flowers
Melodorum fruticosum Lour.	Annonaceae	t	pe	gro	2	mxf	ms	25	30	mr-ap		ja-dc	flowers
Miliusa velutina (Dun.) Hk. f. & Th.	Annonaceae	t	pd	gro	3	ddf	ms	25	30	ap	jl	my-dc	
Polyalthia cerasoides (Roxb.) Bth. *ex* Bedd.	Annonaceae	t	pd	gro	3	ddf,bb/df	ms	25	30	ja-mr	mr-ap	mr-nv	flowers, fruits
Polyalthia evecta (Pierre) Fin. & Gagnep.	Annonaceae	t,l	pe	gro	3	mxf, rv 6	ms	25	30	oc-dc(mr)	oc-nv	ja-dc	flowers, fruits
Polyalthia modesta (Pierre) Fin. & Gagnep.	Annonaceae	s	pd	gro	3	rv 5-6	ms	20	25	dc	mr-ap	nv-jn	fruits
Polyalthia simiarum (Ham. *ex* Hk. f. & Th.) Bth. *ex* Hk. f. & Th.	Annonaceae	t	pe	gro	2	mxf	ms	25	30	fb-mr	jl	ja-dc	flowers
Polyalthia suberosa (Roxb.)	Annonaceae	t,l	pe	gro	2	mxf, rv 6	ms	25	30	oc-	oc-nv	ja-dc	flowers, fruits
Uvaria cordata (Dun.) Alst.	Annonaceae	wc	pe	gro	2	bb/df,da	ms	25	30	ag-oc	nv-fb	ja-dc	fruits
Uvaria hahnii (Fin. &	Annonaceae	wc	pd	gro	3	bb/df	ms	30	30	mr-ap	jl-ag	my-nv	fruits
Xylopia pierrei Hance	Annonaceae	t	pe	gro	2	bb/df, mxf	ms	25	30	mr-ap	ag	ja-dc	flowers, fruits
Cyclea barbata Miers	Menispermaceae	v	pe	gro	2	bb/df,da	ms	25	30	ap-sp	ag-nv	ja-dc	fruits
Tiliacora triandra (Colebr.)	Menispermaceae	v	pd	gro	3	da, sg	ms	25	30	jn-jl	ag-sp	my-ja	

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Tinospora crispa (L.) Hk. f. & Th.	Menispermaceae	v	pd	gro	2	da	ms	25	30	fb-mr	my-jn	jn-ja	
Ceratophyllum demersum L.	Ceratophyllaceae	h	a	aqu	3	rv 1	ms	20	20	mr-my	ap-jn	nv-jn	
Rorippa indica (L.) Hiern	Cruciferae	h	a	gro	3	rv 5	ms	20	25	fb-mr	mr-ap	nv-jn	flowers
Capparis flavicans Kurz	Capparaceae	l,wc	pd	gro	2	bb/df	ms	30	30		ag-sp	my-dc	fruits
Capparis micracantha DC. ssp. *micracantha*	Capparaceae	wc	pd	gro	3	bb/df	sh, ms	25	30	sp-mr	ap-jn	my-fb	flowers
Cleome viscosa L.	Capparaceae	h	a	gro,wee	3	da, rv 5	ms	20	30	fb-ag	ap-ag	oc-sp	flowers, fruits
Crateva magna (Lour) DC.	Capparaceae	t,l	pd	gro	4	rv 2-6	ms	20	25	ag-nv(mr)	jl-ag	nv-oc	flowers
Stixis obtusifolia (Hk. f. & Th.) Pierre	Capparaceae	wc	pd	gro	2	da	ms	25	30	nv-mr	ja-ap	mr-ja	flowers
Scyphellandra pierrei Boiss.	Violaceae	s,l	pe	gro	2	bb/df	ms	25	30	oc-ja	dc-mr	ja-dc	flowers
Polygala chinensis L.	Polygalaceae	h	a	gro	2	ddf	ms	25	30	jl-sp	ag-oc	my-dc	flowers, fruits
Salomonoia cantoniensis Lour.	Polygalaceae	h	a	gro	3	ddf	ms	30	30	jn-sp	jl-oc	my-dc	flowers, fruits
Xanthophyllum lanceatum (Miq.) J. J. Sm.	Polygalaceae	t	pe	gro	2	rv 6	ms	20	25	fb-mr		ja-dc	flowers
Polycarpaea corymbosa (L.) Lmk.	Caryophyllaceae	h	a	gro	3	ddf	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Portulaca oleracea L.	Portulacaceae	h	pe	gro,wee	3	da, rv 5	ms	25	30	oc-ja	ag-ja	ja-dc	flowers
Calophyllum sp.	Guttiferae	t	pe	gro	2	bb/df,mxf	ms	30	30			ja-dc	
Cratoxylum cochinchinense (Lour.) Bl.	Guttiferae	t	pd	gro	3	bb/df	ms	25	30	dc-ja	jl-ag	my-ja	fruits
Garcinia cowa Roxb.	Guttiferae	t	pe	gro	3	bb/df, mxf	ms	25	30	fb-ap (ag)	mr-my	ja-dc	♂
Garcinia sp.	Guttiferae	t	pe	gro	2	mxf	ms	25	30			ja-dc	
Mammea siamensis (Miq.) T. And.	Guttiferae	t	pe	gro	2	bb/df, mxf	ms	25	30	oc-dc	mr-ap	ja-dc	flowers, fruits
Casearia grewiifolia Vent. var. *grewiifolia*	Flacourtiaceae	l,t	pd	gro	3	bb/df,mxf,sg	ms	25	30	fb-mr	jl-ag	my-ja	flowers, fruits
Flacourtia indica (Burm. f.) Merr.	Flacourtiaceae	t	pd	gro	2	da,sg	ms	30	30	fb-ap	jl-sp	my-dc	
Homalium brevidens Gagnep.	Flacourtiaceae	t	pe	gro	3	rv 6	ms	25	30	jn-jl	sp-oc	ja-dc	flowers
Homalium caryophyllaceum (Zoll. & Mor.) Bth.	Flacourtiaceae	t	pe	gro	3	rv 6	ms	25	30	jl		ja-dc	flowers
Hydnocarpus anthelminthica Pierre *ex* Lanes.	Flacourtiaceae	t	pe	gro	3	rv 6, mxf	ms	25	30	nv-dc	ap-my	ja-dc	♀♂
Dipterocarpus alatus Roxb. *ex* G. Don	Dipterocarpaceae	t	pd	gro	2	bb/df	ms	25	30	ja-fb	mr-ap	my-fb	
Dipterocarpus intricatus Dyer	Dipterocarpaceae	t	pd	gro	3	ddf	ms	25	30	fr-mr	ap	my-fb	flowers, imm. fruits
Dipterocarpus tuberculatus Roxb. var. *tuberculatus*	Dipterocarpaceae	t	pd	gro	3	ddf	ms	30	30	mr-ap	ap-my	ap-dc	
Hopea odorata Roxb.	Dipterocarpaceae	t	pd	gro	1	bb/df	ms	25	30	mr		my-fb	flowers
Shorea obtusa Wall. *ex* Bl.	Dipterocarpaceae	t	pd	gro	3	ddf	ms	25	30	mr-my	ap-jn	ap-fb	
Shorea roxburghii G. Don	Dipterocarpaceae	t	pd	gro	3	ddf	ms	25	30	ja-fb	mr-ap	mr-dc	fruits
Shorea siamensis Miq. var. *siamensis*	Dipterocarpaceae	t	pd	gro	3	ddf	ms	25	30	fb-mr	mr-ap	ap-dc	fruits
Ancistrocladus wallichii Pl.	Ancistrocladaceae	sc	pe	gro	2	streams,mxf	sh,ms	25	30	mr-my	jn-jl	ja-dc	flowers
Sida rhombifolia L. ssp. *rhombifolia*	Malvaceae	h	pe	gro,wee	3	da,sg	sh,ms	25	30	sp-mr	nv-ap	ja-dc	
Thespesia lampas (Cav.) Dalz. & Gibs. ssp. *lampas* var. *lampas*	Malvaceae	h	pd	gro	2	mxf,da	ms	25	30	sp-nv	nv-ja	my-dc	fruits
Urena lobata L. ssp. *lobata* var. *lobata*	Malvaceae	h	pe	gro, wee	3	da,rv 5	ms	25	30	sp-ja	oc-fb	ja-dc	
Bombax anceps Pierre var. *anceps*	Bombacaceae	t	pd	gro	3	ddf,bb/df	ms	25	30	ja-fb	mr	jn-dc	flowers,fruits
Ceiba pentandra (L.) Gaertn.	Bombacaceae	t	pd	gro,int, cul,nat	3	da	ms	30	30	ja-ap	my-jl	my-dc	
Byttneria echinata Wall. *ex* Kurz	Sterculiaceae	wc	pd	gro	3	wet areas in sg	ms	25	30	jn-jl	oc-dc	my-dc	fruits
Helicteres angustifolia L.	Sterculiaceae	s	pd	gro	3	ddf,bb/df	ms	25	30	jl-ag	nv-dc	my-dc	flowers
Helicteres elongata Wall. *ex* Boj.	Sterculiaceae	h	pd	gro	3	bb/df,da	ms	25	30	jl-dc	nv-dc	my-dc	flowers
Helicteres hirsuta Lour.	Sterculiaceae	s	pd	gro	3	bb/df,sg	ms	25	30	jl-dc	nv-fb	my-dc	flowers,fruits
Pterospermum cinnamomum Kurz	Sterculiaceae	t	pe	gro	3	mxf	ms	25	30	oc-ap	my-jn	ja-dc	
Pterospermum diversifolium Bl.	Sterculiaceae	t	pe	gro	3	rv 6,bb/df,mxf	ms	25	30	mr-ap (ag)	sp-nv	ja-dc	fruits
Sterculia balanghas L.	Sterculiaceae	t	pd	gro	3	ddf,bb/df	ms	25	30	mr-ap	oc-nv	ap-ja	
Sterculia foetida L.	Sterculiaceae	t	pd	gro	2	bb/df,mxf	ms	25	30		nv-dc	ap-dc	

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Sterculia urena Roxb. var. *thorelii* (Pierre) Pheng.	Sterculiaceae	t	pd	gro	2	bb/df,ddf	ms	25	30	nv-dc	ja-mr	my-nv	flowers
Berrya mollis Wall. *ex* Kurz	Tiliaceae	t	pd	gro	3	ddf	ms	25	30	jn-jl	ag-nv	my-dc	fruits
Colona auriculata (Desf.) Craib	Tiliaceae	s	pd	gro	3	bb/df,da	ms	25	30	ag-nv	nv-ja	my-dc	flowers, fruits
Corchorus aestuans L.	Tiliaceae	h	a	gro	2	mxf,da	ms	25	30	ag-oc	nv-fb	my-dc	fruits
Grewia eriocarpa Juss.	Tiliaceae	t	pd	gro	3	bb/df,da,sg	ms	25	30	mr-ap	jl-sp	mr-nv	flowers
Grewia hirsuta Vahl	Tiliaceae	s	pd	gro	4	wet areas in sg	ms	25	30	jl-sp	oc-dc	my-fb	fruits
Microcos paniculata L.	Tiliaceae	t	pe	gro	4	bb/df,da/sg	ms	25	30	oc-nv	nv-ja	ja-dc	flowers,fruits
Microcos sinuata (Wall. *ex* Mast.) Burr.	Tiliaceae	l	pd	gro	2	rv 4	ms	20	25	mr-ap		nv-jn	flowers
Muntingia calabura L.	Tiliaceae	l	pe	gro,int, nat	2	da,sg	sh,ms	25	30	ja-dc	ja-dc	ja-dc	
Schoutenia ovata Korth.	Tiliaceae	t	pd	gro	3	rv 6, ddf	ms	25	30	jl	sp-nv	my-dc	flowers, fruits
Elaeocarpus sphaericus (Gaertn.) K. Sch.	Elaeocarpaceae	t	pd	gro	2	bb/df	ms	25	30	oc-nv	oc-nv	my-fb	flowers
Hiptage triacantha Pierre	Malpighiaceae	wc	pd	gro	2	rv 3-4	ms	20	25	jl-ag	oc-nv	my-nv	flowers
Biophytum reinwardtii (Zucc.) Klot.	Oxalidaceae	h	a	gro	2	ddf	ms	30	30	jl-sp	ag-oc	my-nv	
Biophytum sensitivum (L.) DC.	Oxalidaceae	h	a	gro	2	bb/df	ms	25	30	ag-oc	nv-ja	my-ja	flowers, fruits
Oxalis barrellieri L.	Oxalidaceae	h	a	gro,int, nat	2	bb/df,da	ms	30	30	jl-ag	ag-sp	my-nv	flowers, fruits
Acronychia pedunculata (L.) Miq.	Rutaceae	t	pe	gro	3	mxf	ms	25	30	jl-sp	nv-dc	ja-dc	flowers
Atalantia monophylla (L.) DC.	Rutaceae	l	pe	gro	2	mxf	sh,ms	25	30	oc-dc	my-jl	ja-dc	
Clausena excavata Burm. f. var. *excavata*	Rutaceae	l	pd	gro	3	ddf,bb/df,mxf	ms	25	30	fb-mr	jl-ag	fb-nv	flowers, fruits
Clausena wallichii Oliv. var. *wallichii*	Rutaceae	t	pd	gro	2	bb/df	ms	30	30		jl-ag	my-dc	fruits
Glycosmis pentaphylla (Retz.) DC. var. *pentaphylla*	Rutaceae	l,s	pe	gro	3	bb/df,mxf	ms	25	30	nv-dc	mr-ap	ja-dc	flowers,fruits
Murraya paniculata (L.) Jack	Rutaceae	l	pe	gro	2	mxf	ms	25	30	ap-my	sp-oc	ja-dc	
Paramignya scandens (Griff.) Craib var. *scandens*	Rutaceae	wc	pe	gro	2	mxf	ms	25	30	fb-mr	ag-nv	ja-dc	
Zanthoxylum rhetsa (Roxb.) DC.	Rutaceae	t	pd	gro	3	bb/df	ms	25	30	my-jn	sp-oc	my-dc	
Harrisonia perforata (Blanco) Merr.	Simaroubaceae	wc	pd	gro	3	bb/df,da,sg	ms	25	30	my-jn	jl-ag	my-fb	fruits
Quassia harmandiana (Pierre) Noot.	Simaroubaceae	t,l	pe	gro	3	rv 6, mxf	ms	25	30	ap-my	jn-ag	ja-dc	fruits
Irvingia malayana Oliv. *ex* Benn.	Irvingiaceae	t	pe	gro	2	bb/df,mxf	sh,ms	25	30	mr-my	jl	ja-dc	
Gomphia serrata (Gaertn.) Kanis	Ochnaceae	l	pe	gro	2	mxf	sh,ms	25	30	ja-mr	fb-mr	my-mr	flowers,fruits
Canarium subulatum Guill.	Burseraceae	t	pd	gro	3	bb/df	ms	30	30	mr-ap	jl-ag	my-dc	fruits
Aglaia odorata Lour.	Meliaceae	l	pe	gro	2	bb/df,mxf	ms	25	30	sp-nv	dc-fb	ja-dc	flowers
Azadiracta indica A. Juss.	Meliaceae	t	pd	gro	2	bb/df	ms	25	30	ja-fb	ap-my	mr-dc	imm. fruits
Chukrasia tabularis A. Juss.	Meliaceae	t	pd	gro	3	bb/df	ms	30	30	jl-ag	dc-ja	my-dc	
Walsura pinnata Hassk.	Meliaceae	l	pe	gro	2	bb/df,mxf	ms	25	30	nv-ja	nv-fb	ja-dc	flowers
Olax psittacorum (Willd.) Vahl	Olacaceae	wc	pe	gro	3	ddf	ms	30	30	ap-my	jl-ag	ja-dc	fruits
Celastrus paniculatus Willd.	Celastraceae	wc	pd	gro	3	ddf,bb/df	ms	30	30	mr-my	ag-sp	my-dc	fruits
Maytenus sp.	Celastraceae	l	pe	gro	2	bb/df,mxf		25	30		oc-nv	ja-dc	fruits
Salacia macrophylla Bl.	Celastraceae	wc	pe	gro	3	mxf	ms	25	30	ja-ap	ap-my	ja-dc	flowers, imm. fruits
Siphonodon celastrineus Griff.	Celastraceae	t	pd	gro	2	bb/df	ms	30	30	ja-fb	dc-fb	ap-dc	
Colubrina pubescens Kurz	Rhamnaceae	s	pe	gro	3	bb/df,da	ms	25	30	sp-nv	nv-dc	ja-dc	flowers,fruits
Ventilago harmandiana Pierre	Rhamnaceae	wc	pd	gro	3	rv 6,mxf,bb/df	ms	25	30		jl-ag	my-mr	fruits
Ziziphus cambodiana Pierre var. *cambodiana*	Rhamnaceae	wc	pd	gro	3	bb/df	ms	25	30	ap-my	oc-dc	my-dc	fruits
Ziziphus oenoplia (L.) Mill. var. *oenoplia*	Rhamnaceae	sc	pd	gro	3	da,sg,ddf, bb/df	ms	25	30	mr-ap	oc-dc	my-dc	flowers,fruits
Ampelocissus martinii Pl.	Vitaceae	wc	pd	gro	3	bb/df,da	ms	25	30	jl-ag	sp-oc	my-nv	flowers, fruits
Cayratia trifolia (L.) Dom. var. *trifolia*	Vitaceae	v	pe	gro	3	rv 6, bb/df,da	ms	25	30	ag-dc	jl-ja	ja-dc	flowers
Cissus modeccoides Pl. var. *modeccoides*	Vitaceae	v	a	gro	3	bb/df,da	ms	25	30	sp-oc	nv-dc	my-dc	fruits
Cissus quadrangularis L.	Vitaceae	v	pe	gro	2	bb/df,da	ms	25	30	nv-fb	dc-mr	ja-dc	flowers
Tetrastigma harmandii Pl.	Vitaceae	wc	pe	gro	3	mxf	ms	25	30	dc-mr	nv-ja	ja-dc	♀, fruits
Leea aequata L.	Leeaceae	h	pd	gro	3	ddf	ms	30	30	jl-ag	oc-nv	my-nv	flowers

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Leea indica (Burm. f.) Merr.	Leeaceae	h/s	pe	gro	3	da,sg	ms	25	30	jl-oc	sp-nv	ja-dc	
Leea rubra Bl. *ex* Spreng.	Leeaceae	l	pd	gro	3	da,sg	ms	25	30	jl-ag	ag-oc	my-nv	flowers, fruits
Allophyllus cobbe (L.) Raeus.	Sapindaceae	t	pe	gro	3	da, sg	ms	25	30	jn-jl	jl-ag	ja-nv	fruits
Cardiospermum halicacabum L. var. *halicacabum*	Sapindaceae	v	a	gro,wee	3	rv 5, da	ms	20	25	fb-ag		ag-jn	flowers,fruits
Dimocarpus longan Lour. ssp. *longan* var. *longan*	Sapindaceae	t	pe	gro	3	bb/df	ms	25	30	mr-ap	ag-sp	ja-dc	fruits
Lepisanthes rubiginosa (Roxb.) Leenh.	Sapindaceae	l,t	ped	gro	3	bb/df,mxf	ms	25	30	fb-mr	mr-ap	mr-ja(dc)	flowers,fruits
Lepisanthes senegalensis (Poir.) Leenh.	Sapindaceae	l	ped	gro	3	bb/df,rv	ms	25	30	nv-mr	fb-ap	ja-dc	flowers,fruits
Lepisanthes tetraphylla (Vahl) Radlk.	Sapindaceae	t	pe	gro	3	mxf	ms	25	30	ja-mr	fb-mr	ja-dc	flowers,fruits
Schleichera oleosa (Lour.) Oken	Sapindaceae	t	pd	gro	3	bb/df	ms	25	30	fb-ap	jl	mr-dc	flowers, fruits
Buchanania glabra Wall. *ex* Hk f.	Anacardiaceae	l,t	pe	gro	3	ddf	ms	25	30	oc-ja	mr-ap	ja-dc	flowers,fruits
Buchanania lanzan Spreng.	Anacardiaceae	t	pd	gro	3	ddf	ms	25	30	ja-fb	mr-ap	mr-nv	fruits
**Buchanania reticulata* Hance	Anacardiaceae	t	pe	gro	3	bb/df	ms	25	30	oc-nv	mr-ap	ja-dc	flowers,fruits
Lannea coromandelica (Houtt.) Merr.	Anacardiaceae	t	pd	gro	3	ddf	ms	30	30	ja-mr	ap-my	ap-dc	
Mangifera camptosperea Pierre	Anacardiaceae	t	pe	gro	2	mxf	ms	25	30	ap-my	mr-ap	ja-dc	fruits
Semecarpus cochinchinensis Engl.	Anacardiaceae	t	pe	gro	2	mxf,bb/df	ms	25	30	dc-mr	mr-my	ja-dc	
Spondias pinnata (L. f.) Kurz	Anacardiaceae	t	pd	gro	3	bb/df	ms	25	30	ja-fb	dc-mr	my-ja	
Connarus cochinchinensis (Baill.) Pierre	Connaraceae	wc	pe	gro	2	mxf,da	ms	25	30	nv-mr	sp-oc	ja-dc	flowers,fruits
Acacia harmandiana (Pierre) Gagnep.	Leguminosae, Mimosoideae	t	pd	gro,epl	5	rv 4	ms	20	25	nv-dc	mr	oc-ag	flowers,fruits
**Acacia leucopholea* (Roxb.) Willd.	As above	t	pd	gro	2	bb/df	ms	25	30	ag-sp	ap-my	mr-nv	
Acacia pennata (L.) Willd. ssp. *kerrii* I. Niels.	As above	wc	pd	gro	3	da,sg	ms	25	30	fb-ag	sp-oc	mr-nv	flowers
Albizia lebbeckoides (DC.) Bth.	As above	t	pd	gro	3	streams,rv 6	ms	25	30	nv-dc	mr	my-dc	flowers,fruits
Entada rheedei Spreng.	As above	wc	pd	gro	3	bb/df,mxf	ms	25	30	mr-ap	oc-mr	mr-nv	flowers
Mimosa diplotricha C. Wright *ex* Sauv. var. *diplotricha*	As above	v	a	gro,int, nat,wee	3	da	ms	30	30	sp-nv	nv-ja	my-ja	
Mimosa pigra L.	As above	h	pe	gro,int, nat,wee	3	rv 5-6,da,sg	sh,ms	20	30	fb-ag	ja-sp	ja-dc	
Mimosa pudica L.	As above	h	a	gro,int, nat,wee	3	da,sg	sh,ms	25	30	ag-mr	dc-ap	jl-ap	
Xylia xylocarpa (Roxb.) Taub. var. *kerrii* (Craib & Hutch.) I. Niels.	As above	t	pd	gro	1	bb/df	ms	25	30	ja-fb	oc-nv	my-dc	
*Bauhinia bracteata (*Grah. *ex* Bth.) Baker ssp. *bracteata*	Leguminosae, Caesalpinioideae	sc, wc	pe	gro	3	rv 5-6, bb/df, mxf	ms	25	30	ag-nv	jl-ag	ja-dc	flowers
Bauhinia championii (Bth.) Bth. var. *championii*	As above	wc	pd	gro	2	bb/df,mxf	ms	25	30	oc-nv		my-fb	flowers
Bauhinia racemosa Lmk.	As above	t	pd	gro	3	bb/df	ms	25	30	ag-oc	fb-mr	my-ja	fruits
Cassia fistula L.	As above	t	pd	gro	2	ddf,bb/df	sh,ms	25	30	fb-mr	nv-ja	my-ja	
Caesalpinia digyna Rottl.	As above	wc	pe	gro	3	bb/df	ms	25	30	jl-ag	fb-mr	ja-dc	flowers
*Caesalpinia mimosoides*Lmk.	As above	wc	pd	gro	3	da,sg	ms	25	30	oc-nv	fb-ap	my-dc	flowers
Crudia chrysantha (Pierre)	As above	t	pe	gro	3	rv 6	ms	25	30		jl-sp	ja-dc	fruits
Cynometra dongnaiensis	As above	t	pd	gro	1	bb/df	ms	25	30			my-dc	
Peltophorum pterocarpum (DC.) Back. *ex* K. Heyne	As above	t	pd	gro	2	mxf,ddf	ms	25	30	fb-mr	jn-jl	mr-dc	flowers
Senna tora (L.) Roxb.	As above	h	a	gro	2	ddf,bb/df,da	ms	25	30	sp-nv	nv-fb	my-dc	flowers,fruits
Sindora siamensis Teysm. *ex* Miq. var. *siamensis*	As above	t	pd	gro	2	bb/df,ddf	ms	25	30	ap-jn	ag-oc	mr-dc	
Aeschynomene americana L.	Leguminosae, Papilionoideae	h	a	gro,int, nat,wee	3	da	ms	25	30	sp-nv	dc-ja	jn-ja	flowers
Aganope thyrsiflora (Bth.) Polh.	As above	wc	pe	gro	3	bb/df	ms	30	30	jl-ag		ja-dc	flowers
Butea monosperma (Lmk.) Taub.	As above	t	pd	gro	3	da,sg,bb/df	ms	25	30	ja-fb	jn-jl	my-fb	
Canavalia ensiformis (L.) A. DC.	As above	v	pd	gro	2	bb/df,da	ms	25	30	nv-dc	ja-mr	jn-mr	flowers
Centrosema pubescens Bth.	As above	v	a	gro	3	da,sg	ms	25	30	nv-ja	nv-ja	my-ja	flowers
Clitoria mariana L.	As above	v	pd	gro	3	ddf	ms	30	30	jl-ag	sp-oc	my-nv	flowers
Crotolaria acicularis Ham. *ex* Bth.	As above	h	a	gro	3	bb/df,da	ms	25	30	nv-fb	nv-fb	my-ja	flowers

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Crotalaria bracteata Roxb. *ex* DC.	As above	h	a	gro	4	ddf,da	ms	25	30	oc-dc	oc-ja	my-ja	flowers
Crotalaria montana Hey. *ex* Roth	As above	h	a	gro	2	ddf	ms	30	30	jl-ag		my-nv	flowers
Crotalaria verrucosa L.	As above	h	a	gro	3	bb/df,da	ms	25	30	sp-nv	nv-ja	my-dc	flowers
Dalbergia cultrata Grah. *ex* Bth.	As above	t	pd	gro	3	ddf	ms	30	30	fb-mr	jn-jl	my-nv	
Dalbergia entadoides Pierre *ex* Gagnep.	As above	wc	pe	gro	3	mxf	ms	25	30	mr-ap		ja-dc	flowers
Dalbergia oliveri Gamb. *ex* Prain	As above	t	pd	gro	2	ddf	ms	25	30	jn-fb	fb-jn	my-dc	fruits
Dalbergia volubilis Roxb.	As above	wc	pd	gro	3	rv 4, 6	ms	20	25	mr-ap	jl-ag	mr-nv	flowers
Derris scandens (Roxb.) Bth.	As above	wc	pd	gro	3	rv 4, 6	ms	25	30	jl-sp	nv-dc	my-fb	flowers, fruits
Desmodium baccatum Schindl.	As above	l,s	pd	gro	3	bb/df,mxf	ms	25	30	oc-nv	dc-ja	ja-dc	flowers,fruits
**Desmodium flexuosum* Wall. *ex* Bth.	As above	v	pd	gro	2	ddf,bb/df	ms	25	30	sp-oc	nv-dc	ap-dc	fruits
Desmodium heterocarpon (L.) DC. ssp. *angustifolium* Oha.	As above	h	pd	gro	3	mxf,da	ms	25	30	nv-fb	nv-fb	jn-fb	flowers,fruits
Desmodium pulchelum (L.) Bth.	As above	s	pd	gro	3	ddf,bb/df	ms	25	30	ag-sp	nv-dc	my-dc	fruits
Desmodium triangulare (Retz.) Merr. ssp. *triangulare*	As above	h	pd	gro	3	bb/df	sh,ms	25	30	jl-nv	nv-ja	my-dc	flowers
Desmodium triflorum (L.) DC.	As above	h,cr	pe	gro,wee	3	ddf,da	ms	30	30	oc-ja	nv-fb	ja-dc	
Desmodium velutinum (Willd.) DC. ssp. *velutinum* var. *velutinum*	As above	h	pd	gro	3	mxf,da,sg	ms	25	30	oc-dc	nv-fb	my-dc	flowers
Eriosema chinense Vogel	As above	h	pd	gro	3	ddf	ms	30	30	jl-ag	sp-oc	my-nv	flowers, fruits
Flemingia strobilifera (L.) R.	As above	l,s	pd	gro	2	da,sg	ms	25	30	oc-nv	ja-fb	my-fb	
Indigofera cassioides Rottl.	Leguminosae,	s	pd	gro	3	ddf	ms	30	30	jl-ag	nv-dc	my-nv	flowers
Indigofera galegoides DC.	As above	s	pd	gro	2	bb/df	ms	25	30	sp-oc	nv-ja	my-dc	fruits
**Indigofera zollingeriana*	As above	t	pd	gro	2	da,sg	ms	25	30		ja-mr	mr-nv	fruits
Lespedeza henryi Schindl.	As above	l,s	pd	gro	3	ddf, bb/df	ms	25	30	ag-nv	nv-dc	my-dc	flowers
Mecopus nidulans Benn.	As above	h	a	gro	3	bb/df,da	ms	25	30	sp-nv	nv-dc	my-dc	flowers,
Mucuna pruriens (L.) DC. var.	As above	v	a	gro	2	bb/df,da	ms	25	30	oc-nv	fb-mr	my-dc	flowers
Paraderris elliptica (Wall.)	As above	wc	pd	gro	3	rv 4, 6	ms	25	30	mr		mr-nv	flowers
Pterocarpus macrocarpus	As above	t	pd	gro	2	ddf,da	ms	25	30	jn-ag	sp-dc	my-dc	fruits
Rhynchosia bracteata Bth. *ex*	As above	v	a	gro	3	da,sg	ms	25	30	nv-mr	dc-ap	nv-my	flowers,fruits
Spatholobus parviflorus (Roxb.) O.K.	As above	wc	pd	gro	3	ddf, bb/df	ms	25	30	jl-ag	nv-dc	my-ja	flowers
Teramnus labialis (L.f.) Spreng.	As above	v	a	gro	3	bb/df,da	ms	25	30	oc-nv	dc-ja	jn-ja	flowers
Uraria campanulata (Wall. *ex* DC.) Gagnep.	As above	h	pd	gro	3	bb/df,da	ms	25	30	sp-nv	nv-dc	my-dc	flowers,fruits
Uraria cordifolia Wall.	As above	h	pd	gro	2	ddf,bb/df	ms	25	30	oc-nv	nv-dc	my-dc	flowers,fruits
Uraria lagopodioides (L.) Desv. *ex* DC.	As above	h	pd	gro	3	ddf, bb/df	ms	25	30	ag-nv	nv-dc	my-dc	flowers,fruits
Uraria pierrei Schindl.	As above	h	pd	gro	3	ddf	ms	30	30	jn-ag	ag-oc	my-dc	flowers,fruits
Parinari anamensis Hance	Rosaceae	t	pe	gro	3	ddf,bb/df	ms	25	30	mr-ap	mr-my	ja-dc	flowers
Drosera burmannii Vahl	Droseraceae	h	a	gro	2	ddf	ms	30	30	ap-my	my-jn	jn-nv	
Drosera indica L.	Droseraceae	h	a	gro	2	ddf	ms	30	30	jn-ag	ag-oc	my-nv	flowers
Carallia brachiata (Lour.) Merr.	Rhizophoraceae	t	pe	gro	2	mxf	ms	25	30	dc-ja	my-jn	ja-dc	flowers
Anogeissus acuminata (Roxb. *ex* DC.) Guill. & Perr.	Combretaceae	t	pd	gro	3	bb/df	ms	25	30	oc-nv	nv-dc	my-dc	flowers,fruits
Anogeissus rivularis (Gagnep.) Lec.	Combretaceae	t	pd	gro,rhe	4	rv 4	sh,ms	20	25	jl-ag	sp	ag-jl	flowers
Calycopteris floribunda(Roxb.) Lmk.	Combretaceae	wc	pd	gro	4	bb/df	ms	25	30	ja-fb	mr-ap	mr-nv	fruits
Combretum latifolium Bl.	Combretaceae	wc	pd	gro	4	bb/df,mxf	sh,ms	25	30	dc-ja	mr	ap-dc	
Combretum quadrangulare Kurz	Combretaceae	t	pe	gro,rhe	2	wet areas in da, rv 6	ms	25	30	mr-my	oc-dc	ja-dc	flowers,fruits
Combretum trifoliatum Vent.	Combretaceae	sc	pd	gro,rhe	3	rv 5-6	ms	20	30	nv-mr	mr-ag	oc-jl	flowers,fruits
Terminalia alata Hey. *ex* Roth	Combretaceae	t	pd	gro	3	ddf	ms	25	30	my-jn	mr	my-dc	
Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	t	pd	gro	2	ddf,bb/df	ms	25	30	jl-ag	oc-dc	mr-dc	flowers
Terminalia chebula Retz. var. *chebula*	Combretaceae	t	pd	gro	3	ddf,bb/df	ms	25	30	mr-ap	nv-fb	mr-dc	
Terminalia mucronata Craib & Hutch.	Combretaceae	t	pd	gro	3	ddf	ms	30	30	ap	jl-sp	my-dc	
Terminalia triptera Stapf	Combretaceae	t	pd	gro	2	bb/df	ms	25	30	sp-oc	dc-ja	my-dc	flowers

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Eugenia cumini (L.) Druce	Myrtaceae	t	pd	gro	3	ddf	ms	30	30	mr-ap	jl-ag	ap-dc	
Eugenia fruticosa (DC.) Roxb.	Myrtaceae	t	pe	gro	3	mxf	ms	25	30	mr-ap	jn	ja-dc	flowers
Eugenia grandis Wight var. *grandis*	Myrtaceae	t	pe	gro	2	mxf	ms	25	30	nv-mr	jl-ag	ja-dc	flowers
Eugenia grata Wight	Myrtaceae	t	pe	gro	2	mxf	sh,ms	25	30	ap-my	jl-ag	ja-dc	
Eugenia mekongensis Gagnep.	Myrtaceae	t	pd	gro,rhe	3	rv 3-6	ms	20	25	mr-ap	ap-my	nv-jn	flowers, imm. fruits
**Rhodamnia cinerea* Jack var. *cinerea*	Myrtaceae	l	pe	gro	2	bb/df, mxf	ms	25	30	my-jn	sp-oc	ja-dc	imm.fruits
Barringtonia acutangula (L.) Gaertn.	Lecythidaceae	t	pd	gro,rhe	3	rv 4-6	ms	20	25	ag-mr	oc-my	nv-jl	flowers,fruits
Careya arborea Roxb.	Lecythidaceae	t	pd	gro	3	ddf	ms	25	30	mr-ap	my-jn	my-fb	flowers
Memecylon caeruleum Jack	Melastomataceae	t,l	pe	gro	3	rv 6,bb/df,mxf	ms,sh	25	30	fb-mr	oc-dc	ja-dc	fruits
Memecylon lilacinum Zoll. & Mor.	Melastomataceae	t	pe	gro	3	mxf	ms	25	30	jl	oc-my	ja-dc	fruits
Memecylon scutellatum (Lour.) Naud.	Melastomataceae	l	pe	gro	3	ddf, streams in mxf	ms	25	30	ap-my	mr-ap	ja-dc	fruits
Memecylon umbellatum Burm. f.	Melastomataceae	t,l	pe	gro	3	rv 6,bb/df,mxf	ms	25	30	ja-fb	nv-dc	ja-dc	fruits
Osbeckia setoso-annulata Gedd.	Melastomataceae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Ammannia baccifera L.	Lythraceae	h	a	gro	3	wet areas in bb/df	ms	25	30	jl-sp	oc-nv	my-nv	fruits
Lagerstroemia cochinchinensis Pierre var. *ovalifolia* Furt. & Mont.	Lythraceae	t	pd	gro	4	bb/df	ms	25	30	jl-sp	fb-ap	my-dc	flowers
Lagerstroemia floribunda Jack var. *sublaevis* Craib	Lythraceae	t	pd	gro	3	bb/df	ms	25	30	sp-oc	oc-dc	my-dc	fruits
Lagerstroemia lecomtei Gagnep.	Lythraceae	t,l	pd	gro	4	bb/dfd, wet areas in sg	ms	25	30	jl-ag	nv-dc	my-ja	flowers, fruits
Lagerstroemia macrocarpa Kurz var. *macrocarpa*	Lythraceae	t	pd	gro	3	ddf,bb/df	ms	25	30	ap-my	jl-ag	my-dc	fruits
Lagerstroemia tomentosa Presl	Lythraceae	t	pd	gro	3	bb/df	ms	25	30	ap-my	ag-oc	my-nv	
Lagerstroemia villosa Wall. *ex* Kurz	Lythraceae	t	pd	gro	3	bb/df	ms	25	30	mr-my	ag-oc	my-nv	
Rotala indica (Willd.) Koeh.	Lythraceae	h	a	gro	3	wet areas in ddf	ms	25	30	jl-ag	oc-nv	my-dc	fruits
Duabanga grandiflora (Roxb. *ex* DC.) Walp.	Sonneratiaceae	t	pe	gro	1	mxf,da,sg	ms	30	30	ja-fb	ap-my	ja-dc	
Ludwigia hyssopifolia (G. Don) Exell	Onagraceae	h	a	gro,wee	3	rv 5, da	ms	20	25	ja-dc	ja-dc	ja-dc	flowers
Passiflora foetida L.	Passifloraceae	v	a	gro,int, nat,wee	3	da,sg	sh,ms	25	30	jl-mr	ag-ap	jl-my	
Coccinia grandis (L.) Voigt	Cucurbitaceae	v	a	gro	3	da,sg	ms	20	30	jl-mr	nv-mr	jl-ap	
Gymnopetalum integrifolium (Roxb.) Kurz var. *integrifolium*	Cucurbitaceae	v	a	gro	3	rv 5, da	ms	25	30	mr-ag	jn-oc	ja-oc	♂, fruits
Luffa cylindrica (L.) M. J. Roem.	Cucurbitaceae	v	a	gro	3	bb/df,da	ms	25	30	nv-mr	nv-ap	my-ap	flowers,fruits
Momordica charantina L.	Cucurbitaceae	v	a	gro,wee	3	da	ms	25	30	jn-oc	ag-nv	my-dc	
Mukia maderaspatana (L.) M. J. Roem.	Cucurbitaceae	v	a	gro	2	bb/df,da	ms	25	30	oc-dc	oc-ja	my-dc	flowers,fruits
Scopella marginata (Bl.) Wilde & Duy. var. *marginata*	Cucurbitaceae	v	a	gro	2	bb/df,da	ms	30	30	jl-ag	ag-sp	my-nv	flowers, fruits
Solena heterophylla Lour. ssp. *heterophylla*	Cucurbitaceae	v	pd	gro	2	ddf	ms	30	30	jl-sp	sp-oc	my-dc	♂
Trichosanthes kirilowii Maxim.	Cucurbitaceae	v	a	gro	3	rv 5	ms	20	25			ja-jn	
Trichosanthes pubera Bl. ssp. *rubriflos* (Thor. *ex* Cay.) Duf. & Prue.	Cucurbitaceae	v	a	gro	3	rv 6, da, sg	ms	25	30	jn-ag	jl-oc	my-dc	fruits
Zehneria marginata (Bl.) Kera.	Cucurbitaceae	v	a	gro	3	ddf,da	ms	25	30	ag-oc	nv-dc	my-dc	fruits
Tetrameles nudiflora R. Br. *ex* Benn.	Datiscaceae	t	pd	gro	3	bb/df	ms	25	30	mr-ap	ap-my	my-dc	
Glinus lotoides L.	Aizoaceae	h	a	gro	3	bb/df,da	ms	25	30	fb-ap	mr-my	nv-jn	flowers
Mollugo pentaphylla L.	Aizoaceae	h	a	gro,wee	3	bb/df,da	ms	25	30	nv-ag	ja-ag	sp-ap	flowers,fruits
Oenanthe javanica (Bl.) DC.	Umbelliferae	h	a	gro	3	rv 5	ms	20	25	mr-my	my-jn	nv-jn	flowers
Alangium salvifolium (L. f.) Wang. ssp. *hexapetalum* (Lmk.) Wang.	Alangiaceae	t	pd	gro	3	bb/df,da,sg	ms	25	30	ja-mr	ap-jn	ap-dc	fruits
Aphaenandra uniflora (Wall. *ex* G. Don) Brem.	Rubiaceae	h,cr	pd	gro	3	bb/df	ms	25	30	jl-ag	sp-oc	my-nv	flowers, imm. fruits

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Borreria brachystema (R. Br. *ex* Bth.) Val.	Rubiaceae	h	a	gro	3	bb/df	ms	25	30	jl-ag	oc-nv	my-dc	fruits
Canthium berberidifolium Gedd.	Rubiaceae	l	pd	gro	2	ddf	ms	30	30		oc-nv	my-dc	
Catunaregam spathulifolia Tirv.	Rubiaceae	l	pd	gro	3	ddf,bb/df	ms	30	30	my-jn	sp-oc	my-dc	
Catunaregam tomentosum (Bl. *ex* DC.) Tirv.	Rubiaceae	l	pd	gro	3	ddf	ms	25	30	my-jn	jl-sp	my-dc	fruits
Dentella repens (L.) J. R. & G. Forst.	Rubiaceae	h	a	gro	3	rv 5	ms	20	25	ja-my	fb-jn	ja-jn	flowers
Fagerlindia (*Randia griffithii* Hk. f.)	Rubiaceae	sc	pe	gro	3	mxf,bb/df	ms	25	30		nv-dc	ja-dc	fruits
Gardenia cambodiana Pit.	Rubiaceae	l	pd	gro	2	bb/df	ms	30	30	my-jn	ag-sp	my-dc	imm. fruits
Haldina cordifolia (Roxb.) Rids.	Rubiaceae	t	pd	gro	3	bb/df	ms	25	30	ap-my	dc-df	my-dc	
Hedyotis chereevensis (Pierre *ex* Pit.) Fuku.	Rubiaceae	h	a	gro	3	rv 5-6	ms	25	30	jl-ag	ag-sp	ja-ag	flowers
Hedyotis kerwanhensis (Pierre *ex* Pit.) Maxw.	Rubiaceae	h	a	gro	3	bb/df,sg	ms	25	30	jl-ag	ag-nv	my-dc	flowers, fruits
Hedyotis nodiflora Wall. *ex* G. Don	Rubiaceae	t	pd	gro	2	ddf, bb/df	ms	25	30	jl-ag	oc-nv	my-dc	fruits
Hedyotis ovatifolia Cav.	Rubiaceae	h	a	gro	3	rv 5-6,	ms	25	30	jn-sp	ag-oc	ja-sp	flowers,fruits
Hedyotis pinifolia Wall. *ex* G. Don	Rubiaceae	h	a	gro	3	rv 5	ms	20	25	ja-mr	mr-ap	nv-jn	flowers
Hedyotis verticillata (L.) Lmk.	Rubiaceae	h	a	gro	3	wet areas	ms	25	30	jl-ag	oc-nv	my-dc	flowers, fruits
Hymenodictyon orixense	Rubiaceae	t	pd	gro	3	bb/df	ms	25	30	jl-ag	oc-fb	my-dc	flowers
Ixora cibdela Craib	Rubiaceae	l	pe	gro	3	bb/df,mxf	sh,ms	25	30	ja-mr	mr-ap	ja-dc	fruits
Ixora finlaysoniana Wall. *ex* G. Don	Rubiaceae	l,s	pe	gro	3	bb/df,mxf	ms	25	30	mr-my	nv-dc	ja-dc	flowers,fruits
Ixora nigricans R. Br. *ex* Wight & Arn.	Rubiaceae	l	pe	gro	3	mxf	ms	25	30	fb-mr		ja-dc	flowers
Ixora sp.	Rubiaceae	l,s	pe	gro	3	bb/df,mxf	ms	25	30	ag-oc	nv-fb	ja-dc	fruits
Knoxia brachycarpa R. Br. *ex* Hk. f.	Rubiaceae	h	pd	gro	3	ddf	ms	25	30	jn-ag	jl-sp	my-nv	flowers,fruits
Mitragyna hirsuta Hav.	Rubiaceae	t	pd	gro	3	ddf	ms	30	30	jl-ag	fb-mr	my-fb	flowers
Mitragyna rotundifolia (Roxb.) O.K.	Rubiaceae	t	pd	gro	4	ddf,sg	ms	25	30	ap-my	sp-nv	my-ja	flowers, fruits
Morinda pandurifolia O. K. var. *oblonga* (Pit.) Craib	Rubiaceae	s,l	pd	gro,rhe	3	rv 3-5	sh,ms	20	30	nv-mr (my)	mr-ag	oc-my	flowers,fruits
Morinda tomentosa Hey. *ex* Roth	Rubiaceae	t	pd	gro	3	ddf	ms	25	30	mr-ap	jl-sp	mr-oc	flowers, fruits
Nauclea orientalis (L.) L.	Rubiaceae	t	pe	gro	3	rv 6	ms	25	30	mr-ap	jl-dc	ja-dc	fruits
Ophiorrhiza trichocarpon Bl. var. *trichocarpon*	Rubiaceae	h	pd	gro	3	bb/df	ms	30	30	jl-sp	sp-oc	my-nv	flowers
Oxyceros horrida Lour.	Rubiaceae	wc	pe	gro	3	bb/df	ms	25	30	ap-my	ag-sp	ja-dc	fruits
Psychotria montana Bl.	Rubiaceae	l	pe	gro	2	mxf	ms	25	30	ag-nv	nv-fb	ja-dc	fruits
Tamilnadia uliginosa (Retz.) Tirv. & Sastre	Rubiaceae	l	pd	gro	2	bb/df	ms	30	30	mr	jl-ag	my-dc	fruits
Xantonnea parviflora (O. K.) Craib var. *salicifolia* (Pierre *ex* Pit.) Craib	Rubiaceae	s	pd	gro,rhe	4	rv 2-5	ms	20	25	ja-my	ag	nv-jn	flowers, fruits
Ageratum conyzoides L.	Compositae	h	a	gro,nat, wee	4	rv 5, da,sg	sh,ms	20	30	jn-mr	ag-ap	oc-jn	
Blumea glandulosa DC.	Compositae	h	a	gro,wee	3	da,sg	ms	25	30	ja-mr	mr-ap	nv-jn	flowers
Blumea napifolia DC.	Compositae	h	a	gro,wee	3	da	sh,ms	25	30	ja-mr	mr-ap	nv-jn	flowers
Eclipta prostrata (L.) L.	Compositae	h	a	gro,wee	3	rv 5,da,sg	sh,ms	20	30	dc-mr	ja-ap	nv-jn	
Elephantopus scaber L. ssp. *scaber* var. *scaber*	Compositae	h	pe	gro	3	bb/df,da	ms	25	30	oc-fb	oc-fb	ja-dc	flowers,fruits
Eupatorium odoratum L.	Compositae	h	pe	nat,wee	4	da,sg	sh,ms	25	30	ja-mr	mr-ap	ja-dc	
Grangea maderaspatana (L.) Poir.	Compositae	h	a	gro,wee	3	rv 5	ms	20	30	fb-ap	mr-my	nv-jn	flowers
Spilanthes paniculata Wall. *ex* DC.	Compositae	h	a	gro,wee	3	rv 5,da	ms	25	30	jn-sp	jl-oc	my-nv	flowers
Lobelia alsinoides Lmk.	Campanulaceae	h	a	gro	3	wet areas in ddf	ms	30	30	jn-ag	ag-sp	my-nv	flowers, fruits
Plumbago indica L.	Plumbaginaceae	h	pd	gro	2	bb/df	ms	25	30	oc-nv	ja-dc	my-dc	flowers
**Ardisia attenuata* Wall. *ex* DC.	Myrsinaceae	l	pe	gro	3	mxf,sg	ms	25	30	nv-ja	nv-fb	ja-dc	flowers,fruits
Ardisia villosa Roxb.	Myrsinaceae	l	pe	gro	2	mxf	ms	30	30	ap-jn	sp-nv	ja-dc	
Pouteria obovata (R. Br.) Baeh.	Sapotaceae	t	pd	gro	2	mxf	ms	25	30	mr-ap		mr-dc	
Diospyros bejaudii Lec.	Ebenaceae	t	pe	gro	3	bb/df	ms	30	30	jl-ag	jl-sp	ja-dc	fruits
Diospyros castanea (Craib) Flet.	Ebenaceae	t	pe	gro	2	ddf,sg	ms	30	30	mr-ap	jl-ag	ja-dc	fruits

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Diospyros ehretoides Wall. *ex* G. Don	Ebenaceae	t	pd	gro	3	ddf	ms	25	30	mr-ap	oc-dc	my-dc	♂,fruits
**Diospyros filipendula* Pierre *ex* Pit.	Ebenaceae	t	pe	gro	2	ddf	ms	25	30		fb-ap	ja-dc	fruits
Diospyros malabarica (Desr.) Kostel. var. *siamensis* (Hochr.) Pheng.	Ebenaceae	t	pe	gro	3	rv 6, mxf	ms	25	30	mr-ap	oc-dc	ja-dc	♂,♀,fruits
Diospyros mollis Griff.	Ebenaceae	t	pd	gro	3	bb/df	ms	25	30	mr-ap	oc-dc	my-dc	♂,fruits
Diospyros montana Roxb.	Ebenaceae	t	pe	gro	3	rv 6	ms	25	30	mr-ap	jl-sp	ja-dc	fruits
**Diospyros oblonga* Wall. *ex* G. Don	Ebenaceae	t	pe	gro	2	bb/df	ms	30	30		jl-sp	ja-dc	fruits
Diospyros scalariformis Flet.	Ebenaceae	t	pe	gro	3	mxf	ms	25	30	mr-ap		ja-dc	♂
Diospyros venosa Wall. *ex* A. DC. var. *venosa*	Ebenaceae	t	pe	gro	3	bb/df,mxf	ms	25	30	fb-mr		ja-dc	♂
Jasminum siamensis Craib	Oleaceae	s	pd	gro	2	bb/df	ms	25	30	sp-nv	nv-ja	my-ja	fruits
Jasminum sp.	Oleaceae	wc	pd	gro	2	bb/df	ms	30	30	jl-ag		my-dc	
Myxopyrum smilacifolium (Wall.) Bl. ssp. *smilacifolium*	Oleaceae	wc	pe	gro	2	mxf	ms	30	30	fb-mr		ja-dc	flowers
Aganoneiron polymorphum Pierre *ex* Spire	Apocynaceae	v	pd	gro	2	da,sg	ms	25	30	jl-ag		my-nv	flowers
Aganosma marginata (Roxb.) DC.	Apocynaceae	wc	pd	gro	3	bb/df	ms	25	30	ap-my	dc-mr	my-fb	
Holarrhena curtisii King & Gamb.	Apocynaceae	s	pd	gro	3	ddf	ms	30	30	my-ag	ag-oc	my-dc	flowers, fruits
Holarrhena pubescens Wall. *ex* G. Don	Apocynaceae	t	pd	gro	3	bb/df	ms	25	30	mr-my	ag-dc	mr-dc	flowers,fruits
Ichnocarpus frutescens (L.) W. T. Ait.	Apocynaceae	wc,v	pe	gro	2	mxf,da,sg	ms	25	30	nv-ja	dc-fb	ja-dc	flowers
Parameria laevigata (Juss.) Mold.	Apocynaceae	wc	pe	gro	3	bb/df,mxf	ms	25	30	oc-nv	fb-mr	ja-dc	flowers
Rauvolfia micrantha Hk. f.	Apocynaceae	h	pd	gro	2	bb/df	ms	30	30		jl-ag	my-dc	fruits
Wrightia arborea (Denn.) Mabb.	Apocynaceae	t	pd	gro	3	bb/df	ms	25	30	my-jn	jl-sp	my-dc	
**Brachystelma kerrii* Craib	Asclepiadaceae	h	pd	gro	2	ddf	ms	30	30	jl-ag		my-nv	flowers
Ceropegia thorelii Craib	Asclepiadaceae	v	pd	gro	2	bb/df	ms	30	30	jl-ag		my-nv	flowers
Hoya diversifolia Bl.	Asclepiadaceae	v	pe	epi	3	dof,bb/df	ms	25	30	mr-ap		ja-dc	flowers
Hoya kerrii Craib	Asclepiadaceae	v	pe	epi	2	ddf	ms	25	30	my-jl	jl-sp	ja-dc	
Hoya verticillata (Vahl) G. Don var. *verticillata*	Asclepiadaceae	v	pe	epi	2	ddf	ms	25	30	fb-mr	jn-ag	ja-dc	
Oxystelma esculentum (L. f.) R. Br.	Asclepiadaceae	v	pe	gro,rhe	3	rv 2-6	ms	20	30	ag-nv(mr)	ja-fb	ja-dc	flowers
Streptocaulon juventas (Lour.) Merr.	Asclepiadaceae	v	pe	gro	2	ddf, mxf,da	ms	25	30	ag-dc	sp-fb	ja-dc	flowers,fruits
Telectadium edule H. Baill.	Asclepiadaceae	sh	pd	epl	5	rv 2-3	ms	20	25	nv-dc(mr)	fb-mr	oc-ap	fruits
Toxocarpus villous (Bl.) Dcne.	Asclepiadaceae	v	pe	gro	2	mxf,da	ms	25	30	oc-dc	dc-fb	ja-dc	flowers
Tylophora harmandii Cost.	Asclepiadaceae	v	a	gro	2	bb/df,da	ms	25	30	sp-nv	nv-dc	my-dc	fruits
Zygostelma benthamii Baill.	Asclepiadaceae	v	pe	gro	2	bb/df	ms	30	30	oc-nv		ja-dc	
Mirteola petiolata (Gmel.) Torr. & A. Gray	Loganiaceae	h	a	gro	2	bb/df,da	ms	25	30	oc-dc	nv-ja	my-ja	flowers,fruits
Mitrasacme pygmaea R. Br. var. *pygmaea*	Loganiaceae	h	a	gro	3	ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Strychnos nux-vomica L.	Loganiaceae	t	pd	gro	3	ddf,bb/df	ms	25	30	mr-ap	dc-my	mr-ja	flowers
Strychnos rupicula Pierre *ex* Dop	Loganiaceae	wc	pe	gro	2	bb/df	ms	30	30		jl-ag	ja-dc	fruits
Canscora decussata (Roxb.) Schult.	Gentianaceae	h	a	gro	2	wet areas in ddf	ms	30	30	jn-ag	ag-sp	my-nv	flowers,fruits
Nymphoides (Limnanthemum tonkinense Dop)	Gentianaceae	h	a	aqu, gro	3	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers
Hydrolea zeylanica (L.) Vahl	Hydrophyllaceae	h	a	gro	3	ddf,bb/df	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Cordia dichotoma Forst. f.	Boraginaceae	t	pe	gro	3	rv 6	sh,ms	25	30	nv-dc(mr)	jl-nv	ja-dc	flowers,fruits
Heliotropium indicum L.	Boraginaceae	h	a	gro,wee	3	rv 5,da	ms	20	25	ja-dc	ja-dc	ja-dc	flowers
Heliotropium strigosum Willd.	Boraginaceae	h	a	gro	3	ddf	ms	30	30	jn-ag	jl-sp	my-dc	flowers, fruits
Rotula aquatica Lour.	Boraginaceae	s	pd	gro	3	rv 2-4	ms	25	30	fb-mr	mr-ap	nv-jl	flowers
Argyreia sp.	Convolvulaceae	v	pd	gro	2	ddf	ms	30	30	jn		my-dc	
Erycibe subspicata Wall. *ex* G. Don	Convolvulaceae	wc	pe	gro	3	rv 6	ms	25	30	ag-oc	nv-fb	ja-dc	fruits
Ipomoea mauritiana Jacq.	Convolvulaceae	v	a	gro	3	bb/df,da	ms	25	30	ag-sp	oc-nv	ja-dc	fruits
Jacquemontia paniculata (Burm. f.) Hall. f. var. *paniculata*	Convolvulaceae	v	a	gro	2	ddf,da	ms	25	30	nv-dc	ja-ap	jn-mr	flowers

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Merremia hederacea (Burm. f.) Hall. f.	Convolvulaceae	v	a	gro	4	mxf.,sg	ms	25	30	oc-dc	oc-fb	jn-fb	flowers
Merremia hirta (L.) Merr. var. *hirta*	Convolvulaceae	v	a	gro	3	bb/df,da	ms	25	30	oc-dc	nv-fb	my-fb	flowers
Merremia vitifolia (Burm. f.) Hall. f.	Convolvulaceae	v	a	gro	3	da/sg	ms	25	30	ja-fb	mr-my	jn-dc	
Operculina turpethum (L.) S. Manso	Convolvulaceae	v	a	gro	3	rv 5,da,sg	ms	25	30	nv-dc	fb-mr	nv-jn	fruits
Capsicum annuum L.	Solanaceae	h	a	gro,int, nat,wee	3	da,sg	sh,ms	25	30	ja-dc	ja-dc	ja-dc	
Physalis angulata L.	Solanaceae	h	a	gro	3	rv 5, da	ms	20	25	ja-sp	ap-oc	nv-jn	flowers
Solanum nigrum L.	Solanaceae	h	a	gro,wee	3	rv 5, da	ms	20	30	nv-mr	dc-mr	oc-my	flowers,fruits
Solanum torvum Sw.	Solanaceae	h	a	gro,cul, int, nat	3	da, sg	ms	25	30	ag-ja	sp-mr	jn-ap	
Adenosma bracteosa Bon.	Scrophulariaceae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Dopatrium acutifolium Bon.	Scrophulariaceae	h	a	aqu, gro	2	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-dc	flowers
Limnophila laxa Bth.	Scrophulariaceae	h	a	gro	3	ddf	ms	25	30	oc-nv	dc-ja	my-dc	flowers
Limnophila micrantha (Bth.) Bth.	Scrophulariaceae	h	a	aqu, gro	3	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-dc	flowers
Limnophila repens (Bth.) Bth.	Scrophulariaceae	h	a	gro	3	wet areas in ddf	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Lindenbergia muraria (Roxb. *ex* D. Don) R. Br.	Scrophulariaceae	h	a	gro	3	rv 5,da	ms	20	25	fb-mr	mr-ap	oc-jn	flowers
Lindenbergia philippensis (Cham.) Bth.	Scrophulariaceae	h	a	gro	3	rv 5,da	ms	20	25	mr-ag	mr-ag	oc-jn	flowers
Lindernia antipoda (L.) Alst.	Scrophulariaceae	h	a	gro,wee	3	rv 5,da	ms	20	30	ja-sp	mr-oc	nv-jn	flowers
Lindernia cambodgiana (Bon.) Phil.	Scrophulariaceae	h	a	aqu, gro	3	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, imm. fruits
Lindernia ciliata (Colsm.) Penn.	Scrophulariaceae	h	a	gro	3	ddf	ms	30	30	jl-ag	ag-oc	my-nv	flowers, fruits
Lindernia crustacea (L.) F. Muell. var. *crustacea*	Scrophulariaceae	h	a	gro,wee	3	rv 5, da	ms	20	30	ja-sp	mr-oc	nv-jn	flowers
Lindernia spathacea (Bon.) Bon.	Scrophulariaceae	h	a	gro	3	ddf	ms	25	30	oc-nv	dc-ja	my-dc	flowers
Lindernia viatica (Kerr *ex* Barn.) Phil.	Scrophulariaceae	h	a	aqu, gro	3	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers
Lindernia viscosa (Horn.) Bold.	Scrophulariaceae	h	a	gro	3	wet areas in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers
Pierranthus capitatus (Bon.) Bon.	Scrophulariaceae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	jn-dc	flowers
Pseudostriga cambodiana Bon.	Scrophulariaceae	h	a	gro	3	ddf	ms	30	30	jl-ag	sp-oc	my-nv	flowers
Scoparia dulcis L.	Scrophulariaceae	h	a	gro,nat,	3	rv 5, da	ms	25	30	mr-ag	ap-sp	oc-jn	flowers
Striga asiatica Lour.	Scrophulariaceae	h	a	gro	2	ddf	ms	25	30	jn-ag	ag-sp	my-nv	flowers, fruits
Torenia flava B.-H. *ex* Bth.	Scrophulariaceae	h	a	gro	3	bb/df	ms	30	30	jl-sp	ag-oc	my-dc	flowers, fruits
Torenia laotica Bon.	Scrophulariaceae	h	a	gro	3	bb/df	ms	30	30	jn-ag	jl-sp	my-nv	flowers
Torenia thorelii Bon.	Scrophulariaceae	h	a	gro	3	bb/df,da	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Torenia violacea (Aza. *ex* Blanco) Penn.	Scrophulariaceae	h	a	gro	3	bb/df,da	ms	25	30	jl-mr	nv-fb	my-mr	flowers,fruits
Verbascum chinense (L.) Sant.	Scrophulariaceae	h	a	gro	3	rv 5	ms	20	25	fb-mr	mr-ap	nv-jn	flowers,fruits
Aeginetia acaulis (Roxb.) Walp.	Orobanchaeae	h	pd	gro,par	2	ddf	ms	30	30	jl-ag		leafless	flowers
Aeginetia indica Roxb.	Orobanchaeae	h	pd	gro,par	2	bb/df	ms	25	30	jl-sp	sp-oc	leafless	flowers
Utricularia bifida L.	Lentibulariaceae	h	a	aqu, gro	2	ponds in ddf	ms	30	30	jl-sp	ag-oc	jl-nv	
Utricularia pierrei Pell.	Lentibulariaceae	h	a	gro	2	wet areas in ddf	ms	30	30	jl-ag		my-oc	flowers
Utricularia striatula Sm.	Lentibulariaceae	h	a	gro	2	wet areas in ddf	ms	25	30	ag-nv	nv-dc	jl-dc	flowers
**Calcareoboea bonii* (Pell.) Burtt	Gesneriaceae	h	pd	gro	3	bb/df, mxf	ms	30	30	jl-ag	sp-oc	my-nv	flowers, imm. fruits
Markhamia stipulata (Wall.) Seem. *ex* K. Sch. var. *stipulata*	Bignoniaceae	t	pd	gro	3	da,sg	ms	25	30	nv-ag	sp-ap	my-ja	
Millingtonia hortensis L. f.	Bignoniaceae	t	pd	gro	3	bb/df	ms	25	30	ap-sp	oc-nv	my-oc	
Oroxylum indicum (L.) Kurz	Bignoniaceae	t	pd	gro	2	da, sg	ms	25	30	jn-jl	jl-ag	my-dc	
Stereospermum cylindricum Pierre *ex* Dop	Bignoniaceae	t	pd	gro	3	bb/df	ms	30	30	jl-ag	sp-oc	my-dc	flowers, imm. fruits
Barleria strigosa Willd.	Acanthaceae	h	pd	gro	3	ddf,da	ms	25	30	jl-oc	nv-fb	jn-ja	flowers, fruits
Dipteracanthus repens (L.) Hassk.	Acanthaceae	h	a	gro	3	bb/df	ms	25	30	jl-nv	fb	my-fb	flowers,fruits
Dyschoriste depressa Nees	Acanthaceae	h	a	gro	3	bb/df	ms	25	30	nv-dc	nv-fb	my-fb	flowers
Hemigraphis modesta R. Ben.	Acanthaceae	h	pd	gro	2	rv 4,6	ms	20	25	fb-mr	ap-my	nv-jn	flowers
Hydrophila phlomoides Nees	Acanthaceae	h	a	gro	3	wet areas in ddf,bb/df	ms	25	30	oc-nv	dc-mr	my-mr	flowers,fruits
Justicia ventricosa Wall.	Acanthaceae	h	pe	gro	3	bb/df,mxf	ms	25	30	nv-dc		ja-dc	flowers
Justicia sp.	Acanthaceae	h	a	gro	2	wet areas in ddf	ms	30	30	jl-ag		my-nv	flowers

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Lepidagathis incurva Ham. *ex* D. Don	Acanthaceae	h	pe	gro	3	bb/df	sh,ms	25	30	oc-mr	dc-ap	ja-dc	flowers
Nelsonia canescens (Lmk.) Spreng.	Acanthaceae	h	pe	gro	3	bb/df,da	ms	25	30	ja-mr	mr-ap	ja-dc	flowers
Neuracanthus tetragonostachyus Nees ssp. *tetragonostachyus*	Acanthaceae	a	a	gro	3	bb/df	ms	25	30	oc-nv	dc-ja	jn-ja	flowers
Peristrophe acuminata Nees	Acanthaceae	h	pe	gro	3	bb/df	ms	25	30	oc-nv(mr)	dc-ja	ja-dc	flowers
Pseuderanthemum poilanei R. Ben.	Acanthaceae	h	pe	gro	3	bb/df,mxf	ms	25	30	oc-nv	dc-ja	ja-dc	flowers
Ptyssiglotis kunthiana (Nees) B. Han.	Acanthaceae	h	a	gro	3	bb/df	ms	25	30	oc-dc	fb-mr	my-mr	flowers,fruits
Rungia parviflora (Retz.) Nees var. *parviflora*	Acanthaceae	h	a	gro	3	bb/df	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Sericocalyx schomburgkii (Craib) Brem.	Acanthaceae	h	a	gro	3	bb/df	ms	30	30	ja		jn-fb	
Thunbergia similis Craib	Acanthaceae	v	pd	gro	3	ddf	ms	25	30	jl-sp	oc-nv	my-nv	flowers
Clerodendrum godefroyi O. K.	Verbenaceae	l	pe	gro	2	bb/df,mxf	ms	25	30	oc-nv	dc-ja	ja-dc	flowers
Clerodendrum paniculatum L.	Verbenaceae	l,h	pd	gro	2	bb/df	ms	30	30	ag-oc	nv-dc	my-dc	
Clerodendrum serratum (L.) Moon var. *wallichii* Cl.	Verbenaceae	h	pd	gro	2	ddf	ms	30	30	jl-sp	sp-oc	my-dc	flowers, imm. fruits
Congea tomentosa Roxb. var. *tomentosa*	Verbenaceae	wc	pd	gro	3	bb/df	ms	25	30	fb-ap	ap-jn	ap-fb	
Glossocarya siamensis Craib	Verbenaceae	wc	pe	gro	3	rv 6	ms	25	30	jl-ag	oc-nv	ja-dc	flowers
Gmelina philippensis Cham.	Verbenaceae	sc	pd	gro	2	bb/df, da	ms	25	30	ag-fb	nv-fb	my-fb	flowers,fruits
Paravitex sp.	Verbenaceae	s	pd	gro,rhe	3	rv 3-5	ms	20	25	mr-ap(ag)	ap-jl	oc-jn	flowers,fruits
Phyla nodiflora (L.) Greene	Verbenaceae	h	a	gro	3	rv 5	ms	20	25	mr-ag	ap-sp	oc-jl	flowers
Premna coriacea Cl. var. *coriacea*	Verbenaceae	wc	pe	gro	2	Rv 6	ms	25	30	jl-ag	sp	ja-dc	
Premna nana Coll. & Hemsl.	Verbenaceae	l,h	pd	gro	2	ddf	ms	30	30	ap-my	jl-ag	my-dc	fruits
Vitex limoniifolia Wall. *ex* Kurz	Verbenaceae	t	pd	gro	3	ddf,bb/df	ms	25	30	jl-sp	oc-dc	my-dc	
Vitex peduncularis Wall. *ex* Schauer	Verbenaceae	t	pd	gro	3	ddf,bb/df	ms	25	30	jl-ag	my-jl	ap-dc	flowers
Hyptis brevipes Poir.	Labiatae	h	a	gro	3	rv 5,da,sg	ms	25	30	jl-sp	sp-oc	my-nv	flowers, fruits
Leonotis nepetaefolia (L.) R. Br.	Labiatae	h	a	gro,wee, nat	3	rv 5, da	ms	25	30	ja-mr	mr-ap	nv-jn	flowers,fruits
Leucas decemdentata (Willd.) J. Sm.	Labiatae	h	a	gro,wee	3	bb/df,da	ms	25	30	sp-mr	nv-ap	my-ap	flowers
Orthosiphon spiralis (Lour.) Merr.	Labiatae	h	a	gro	2	bb/df	ms	30	30	jl-ag	ag-sp	my-dc	flowers,fruits
Platostoma hispidum (L.) Pat.	Labiatae	h	a	gro	2	ddf,bb/df	ms	25	30	oc-nv	dc-ja	my-dc	flowers
Chenopodium ficifolium Sm.	Chenopodiaceae	h	a	gro,wee	3	rv 5	ms	20	25	mr-my	ap-jn	nv-jn	
Alternanthera sessilis (L.) DC. var. *sessilis*	Amaranthaceae	h	a	gro,wee	2	bb/df,da	ms	25	30	jl-dc	ag-fb	jn-fb	flowers
Amaranthus spinosus L.	Amaranthaceae	h	a	gro,wee	3	rv 5, da	ms	25	30	my-nv	jn-dc	my-dc	
Celosia argentea L.	Amaranthaceae	h	a	gro,wee	3	rv 5, da	ms	25	30	jn-sp	jl-oc	my-nv	flowers, fruits
Psilotrichum ferrugineum (Roxb.) Moq.-Tand.	Amaranthaceae	h	a	Gro	3	rv 5,ddf,bb/df	ms	25	30	jl-nv	sp-dc	my-dc	flowers
Polygonum plebium R. Br.	Polygonaceae	h	a	gro,wee	3	rv 5, da	ms	20	30	dc-ap	ja-my	nv-jn	flowers
Polygonum pubescens Bl.	Polygonaceae	h	a	gro	3	rv 3-5, streams, wet areas	ms	20	25	dc-mr	ja-ap	nv-jn	
Dalzellia carinata (Lec.) C. Cuss.	Tristichaceae	h	pd	aqu,epl, rhe	3	rv 2	ms	20	20	fb-mr	mr	mr-my	flowers
Piper retrofractum Vahl	Piperaceae	v	pe	gro	2	bb/df	ms	25	30	my-jn	nv-dc	ja-dc	fruits
Beilschmiedia aff. glomerata Elm.	Lauraceae	t	pe	gro	3	rv 6	ms	25	30		jl-ag	ja-dc	fruits
Cryptocarya oblongifolia Bl.	Lauraceae	t	pe	gro	3	bb/df,mxf	ms	25	30	jn	nv-mr	ja-dc	fruits
Litsea glutinosa (Lour.) C.B.	Lauraceae	t	pd	gro	3	bb/df	ms	25	30	ag-sp	jl-ag	my-ja	fruits
Illigera thorelii Gagnep.	Hernandiaceae	wc	pd	gro	3	bb/df,da	ms	25	30	sp-oc	ja-fb	my-fb	imm. fruits
Dendrophthoe curvata (Bl.) Miq.	Loranthaceae	s	pe	epi,par	3	ddf,mxf	ms	25	30	jl-ap	oc-my	ja-dc	flowers
Dendrophthoe pentandra (L.) Miq.	Loranthaceae	s	pe	epi,par	3	ddf	ms	25	30	mr-ap	mr-my	ja-dc	flowers
Macrosolen cochinchinensis (Lour.) Tiegh.	Loranthaceae	s	pe	epi,par	4	rv 4	ms	20	30	mr-ap	my	ja-dc	flowers
Viscum articulatum Burm. f.	Viscaceae	h	pe	hyp,epi	3	rv 4	ms	20	30	nv-ap	ja-ap	leafless	flowers
Scleropyrum pentandrum (Denn.) Mabb.	Santalaceae	t,l	pe	gro	2	mxf	sh,ms	25	30	fb-mr	jl-sp	ja-dc	
Acalypha brachystachya Horn.	Euphorbiaceae	h	a	gro	2	ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Acalypha indica L.	Euphorbiaceae	h	a	gro,wee	3	rv 5, da	ms	20	30	fb-sp	ap-oc	nv-oc	flowers
Alchornia tiliifolia (Bth.) M.-A.	Euphorbiaceae	l	pe	gro	3	da, sg	ms	30	30	jn-jl	oc-nv	ja-dc	
Antidesma acidum Retz.	Euphorbiaceae	l	pd	gro	3	ddf,bb/df	ms	30	30	ap-jn	jl-sp	my-dc	fruits
Antidesma ghaesembilla Gaertn.	Euphorbiaceae	t,l	pd	gro	3	bb/df	ms	30	30	my-jn	jl-ag	my-ja	fruits
Antidesma japonicum Sieb. & Zucc. var. *japonicum*	Euphorbiaceae	l,s	pd	gro	3	rv 6	ms	30	30	jl-ag		nv-ag	♂
Antidesma montanum Bl. var. *montanum*	Euphorbiaceae	l,s	pe	gro	3	bb/df,mxf	ms	30	30	ap-my	jl-ag	ja-dc	fruits
Aporosa ficifolia Baill.	Euphorbiaceae	l	pe	gro	2	mxf	ms	25	30	sp-oc	ap-my	ja-dc	
Aporosa octandra (B. -H. *ex* D. Don) Vick. var. *yunnanensis* (Pax & Hoffm.) Schot	Euphorbiaceae	t	pd	gro	3	ddf,da,sg	ms	25	30	ja-fb	ap-my	fb-nv	fruits
Aporosa villosa (Lindl.) Baill.	Euphorbiaceae	t,l	pd	gro	3	ddf	ms	30	30	ja-mr	my-jn	ap-dc	
Baliospermum solanifolium (Burm.f.) Sur.	Euphorbiaceae	s,h	pd	gro	2	da, sg	ms	30	30	jn-nv	ag-dc	jn-dc	
Blachia andamanica (Kurz) Hk. f.	Euphorbiaceae	s	pe	gro	3	mxf,da	ms	25	30	nv-dc	dc-fb	ja-dc	flowers
Blachia siamensis Gagnep.	Euphorbiaceae	s	pd	gro,rhe	3	rv 3-6	ms	20	25	jl-nv	fb-mr	nv-ag	♀,♂, fruits
Breynia vitis-ideae (Burm. f.) C.E.C. Fisch.	Euphorbiaceae	s	pd	gro	3	ddf	ms	25	30	jl-ag	oc-nv	my-nv	flowers
Bridelia harmandii Gagnep.	Euphorbiaceae	s	pd	gro	3	ddf	ms	30	30	jn-ag	ag-sp	my-nv	♂ flowers, fruits
Bridelia stipularis Bl.	Euphorbiaceae	wc,sc	pd	gro	3	bb/df,sg	ms	25	30	sp-nv	dc-fb	my-fb	
Bridelia tomentosa Bl.	Euphorbiaceae	wc	pd	gro	3	da,sg	ms	25	30	ag-nv	fb-mr	my-ja	fruits
Chaetocarpus castanocarpus (Roxb.) Thw.	Euphorbiaceae	t	pe	gro	3	mxf	ms	25	30	dc-ja	mr-ap	ja-dc	fruits
Dalechampia falcata Gagnep.	Euphorbiaceae	v	pd	gro	3	ddf	ms	30	30	jn-ag	ag-sp	my-nv	flowers, fruits
Drypetes assamica (Hk. f.) Pax & Hoffm.	Euphorbiaceae	t	pe	gro	3	bb/df,mxf	ms	25	30	nv-dc	ja-dc	ja-dc	♀,♂
Drypetes roxburghii (Wall.) Huru.	Euphorbiaceae	t	pe	gro	3	bb/df,mxf	ms	25	30	fb-mr	oc-dc	ja-dc	♂,fruits
Drypetes thorelii Gagnep.	Euphorbiaceae	t	pe	gro	3	rv 6	ms	25	30		jl-sp	ja-ag	fruits
Euphorbia parviflora L.	Euphorbiaceae	h	a	gro	3	rv 5,ddf	ms	20	30	jl-mr	ag-ap	jn-dc	flowers,fruits
Euphorbia thymifolia L.	Euphorbiaceae	h	pe	gro,wee	2	da	ms	25	30	ja-dc	ja-dc	ja-dc	flowers,fruits
Fluggea virosa (Roxb. *ex* Willd.) Voigt	Euphorbiaceae	l,s	pd	gro	3	rv 5-6, bb/df, da, sg	ms	25	30	mr-ag	jn-sp	my-fb	♀,♂, fruits
Homonoia riparia Lour.	Euphorbiaceae	s	pd	gro,rhe	5	rv 2-5	ms	20	25	mr-ap	jl-dc	ja-jn	♀,♂, fruits
Hymenocardia punctata Wall. *ex* Lindl.	Euphorbiaceae	l,s	pd	gro	3	bb/df,mxf,sg	ms	25	30	mr-my	ag-sp	my-fb	♂,♀
Mallotus cuneatus Ridl.	Euphorbiaceae	l	pe	gro	3	bb/df,mxf	ms,ry	25	30	mr-my	jl-nv	ja-dc	♂,fruits
Mallotus philippensis (Lmk.) M.-A.	Euphorbiaceae	t	pd	gro	2	bb/df	ms	30	30	nv-dc	ja-mr	my-mr	
Mallotus repandus (Willd.) M.-A.	Euphorbiaceae	wc	pe	gro	3	da,sg,bb/df	ms	25	30	ja-fb	ap-my	ja-dc	
Pantadenia adenanthera Gagnep.	Euphorbiaceae	s	pd	gro	3	bb/df,da	ms	25	30	jl-ja	nv-mr	my-ap	♂,fruits
Phyllanthus amarus Schum. & Thonn.	Euphorbiaceae	h	a	gro,wee	3	da	sh,ms	25	30	ja-dc	ja-dc	ja-dc	flowers,fruits
Phyllanthus emblica L.	Euphorbiaceae	t	pd	gro	3	ddf,bb/df	sh,ms	25	30	fb-mr	sp-dc	mr-dc	
Phyllanthus jullienii Beille	Euphorbiaceae	s	pd	gro,rhe	4	rv 2-4	ms	20	25	nv-dc	mr-my	oc-ap	flowers
Phyllanthus pulcher Wall. *ex* M.-A.	Euphorbiaceae	l	pd	gro	2	bb/df,mxf	ms	25	30	sp-nv	nv-dc	nv-ja	♂,fruits
Phyllanthus reticulatus Poit.	Euphorbiaceae	sc,wc	pd	gro	3	rv 5,da,sg	ms	20	30	jl-ag	sp-nv	my-dc	
Phyllanthus urinaria L.	Euphorbiaceae	h	a	gro,wee	3	bb/df,da	ms	25	30	jl-ja	ag-ja	jn-ja	flowers
Riccinus communis L.	Euphorbiaceae	h	a	gro,int, nat	3	da	ms	25	30	jn-sp	jl-oc	my-dc	
Sauropus androgynus (L.) Merr.	Euphorbiaceae	l	pd	gro	2	bb/df,da	ms	25	30	ag-sp	oc-dc	my-dc	fruits
Suregada multiflora (A. Juss.) Baill. var. *multiflora*	Euphorbiaceae	t	pe	gro	2	mxf	ms	25	30	mr-my	ap-jn	ja-dc	♂,♀
Thyrsanthera suborbicularis Pierre *ex* Gagnep.	Euphorbiaceae	h	pd	gro	3	ddf	ms	25	30	mr-ap	ap-jn	my-dc	♂,♀
Trewia nudiflora L.	Euphorbiaceae	t	pd	gro	3	rv 6	ms	25	30	fb-ap	sp-oc	my-nv	
Trema orientalis (L.) Bl.	Ulmaceae	t	pe	gro	3	da,sg	sh,ms	25	30	mr-ap	my-jl	ja-dc	flowers
Artocarpus ?lakoocha Roxb.	Moraceae	t	pe	gro	2	bb/df, mxf	ms	30	30			ja-dc	
Ficus alongensis Gagnep.	Moraceae	t	pe	gro,epi, str	3	rv 6, mxf	ms	20	30	ap-ag	my-sp	ja-dc	figs
Ficus benjamina L.	Moraceae	t	pe	gro,epi, str	3	rv 4, 6, mxf	ms	25	30	fb-mr	mr-ap	ja-dc	figs

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Ficus fistulosa Reinw. *ex* Bl. var. *fistulosa*	Moraceae	t	pd	gro	3	da,sg	sh,ms	25	30	ja-dc	ja-dc	my-fb	
Ficus heterophylla L. f. var. *heterophylla*	Moraceae	cr,wc	pe	gro	3	rv 5-6,mxf,da	ms	25	30	ja-dc	ja-dc	ja-dc	figs
Ficus hispida L. f. var. *hispida*	Moraceae	l,t	pe	gro	3	da,sg	ms	25	30	ja-dc	ja-dc	ja-dc	figs
Ficus kurzii King	Moraceae	t	pe	gro,epi, str	3	rv 6, mxf	ms	25	30	ja-ap	ja-ap	ja-dc	figs
Ficus racemosa L. var. *racemosa*	Moraceae	t	pd	gro	3	da,sg	ms	25	30	ja-dc	ja-dc	oc-ag	figs
Ficus rumphii Bl.	Moraceae	t	pd	gro,epi, str	3	rv 4, 6	ms	20	25	mr-ap(ag)	ap-my	mr-dc	figs
Ficus subpisocarpa Gagnep.	Moraceae	t	pd	gro,epi, str	3	ddf	ms	25	30	fb-mr	mr-ap	my-nv	figs
Ficus virens Ait var. *sublanceolata* (Miq.) Corn.	Moraceae	t	pe	epi,str	3	rv 4,6,streams	sh,ms	25	30	sp-mr	sp-ap	ja-dc	figs
Strepblus asper Lour. var. *asper*	Moraceae	l,t	pe	gro	3	rv 6, mxf	ms	25	30	ja-mr	de-mr	ja-dc	flowers,fruits
Laportea interrupta (L.) Chew	Urticaceae	h	a	gro,wee	3	bb/df,da	ms	25	30	jn-nv	ag-dc	my-dc	fruits
Pouzoulzia zeylanica (L.) Benn.	Urticaceae	h	a	gro	2	rv 4-6	ms	25	30	jl-ag	sp-oc	ja-ag	flowers
Salix tetrasperma Roxb.	Salicaceae	t	pd	gro,rhe	2	rv 6	ms	20	25	nv-dc	dc-ja	nv-ag	
Angiospermae, Monocotyledoneae													
Hydrilla verticillata (L. f.) Roy.	Hydrocharitaceae	h	a	aqu	2	ponds in ddf	ms	30	30			jn-nv	
Lagarosiphon roxburghii Bth.	Hydrocharitaceae	h	a	aqu,gro	2	ponds in bb/df	ms	20	25	fb-mr	mr-ap	jl-ap	flowers,fruits
Ottellia lanceolata (Gagnep.) Dandy	Hydrocharitaceae	h	a	aqu,gro	2	ponds in bb/df	ms	25	30	ag-oc	dc-nv	my-dc	flowers,fruits
Vallisneria gigantea Greab.	Hydrocharitaceae	h	a	aqu	3	rv 1	ms	20	20	mr-my	ap-jn	nv-jn	
Sagittaria guayanensis Humb. ssp. *lappula* (D. Don) Bogin	Alismataceae	h	a	aqu,gro	3	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Sagittaria trifolia L.	Alismataceae	h	a	aqu,gro	2	ponds in bb/df, rv 5	ms	20	25	fb-mr	mr-ap	ja-dc	flowers,fruits
Potamogeton crispus L.	Potamogetonaceae	h	a	aqu	3	rv 1	ms	20	20	dc-ja	mr	ja-dc	fruits
Najas indica (Willd.) Cham.	Najadaceae	h	pe	aqu	3	rv 1	ms	20	20	ja-fb	mr-ap	ja-dc	fruits
Belosynapsis ciliata (Bl.) R. Rao	Commelinaceae	h	a	gro	2	bb/df,da	ms	25	30	ag-nv	nv-ja	my-ja	flowers
Commelina diffusa Burm. f.	Commelinaceae	h	a	gro	3	bb/df,da	ms	25	30	jn-ag	ag-oc	ja-dc	flowers
Cyanotis axillaris (L.) D. Don	Commelinaceae	h	a	gro	2	bb/df,da	ms	25	30	jl-oc	ag-nv	my-dc	flowers
**Murdannia discreta* (Craib) Thit. & Faden	Commelinaceae	h	pd	gro	3	ddf	ms	30	30	jl-ag	ag-sp	my-dc	fruits
Murdannia edulis (Stokes) Faden	Commelinaceae	h	pd	gro	3	ddf, bb/df	ms	30	30	jl-ag	ag-sp	my-nv	flowers, fruits
Murdannia gigantea (Vahl) Bruck.	Commelinaceae	h	pd	gro	3	ddf	ms	30	30	jn-ag	jl-sp	my-nv	flowers, fruits
Murdannia nudiflora (L.) Bren.	Commelinaceae	h	pd	gro	3	ddf	ms	30	30	jn-ag	ag-sp	my-nv	flowers, fruits
Eriocaulon sexangulare L.	Eriocaulaceae	h	a	gro	3	ddf,bb/df	ms	25	30	sp-nv	oc-dc	my-dc	flowers
Eriocaulon sieboldianum Sieb. & Zucc. *ex* Steud.	Eriocaulaceae	h	a	gro	3	ddf,bb/df	ms	25	30	sp-nv	oc-dc	my-dc	flowers
Alpinia malaccensis (Burm. f.) Rosc.	Zingiberaceae	h	pe	gro	2	da, sg	ms	30	30	mr-my	sp-oc	ja-dc	
Costus speciosus (Koen.) J. E. Sm.	Zingiberaceae	h	pd	gro	3	ddf,bb/df	ms	25	30	jl-sp	oc-nv	my-dc	flowers, fruits
Curcuma aurantiaca van Zijp	Zingiberaceae	h	pd	gro	3	bb/df	ms	25	30	jl-ag		my-nv	flowers
Curcuma gracillima Gagnep.	Zingiberaceae	h	pd	gro	3	ddf	ms	30	30	jl-ag		my-nv	flowers
Curcuma zedoaria (Berg.) Rosc.	Zingiberaceae	h	pd	gro	3	ddf	ms	30	30	ap-my	jl-ag	my-nv	
Curcuma (07-431)	Zingiberaceae	h	pd	gro	3	ddf,bb/df	ms	30	30	jl-ag	sp-oc	my-nv	flowers
Curcuma (07-443)	Zingiberaceae	h	pd	gro	2	bb/df	ms	30	30	jl-ag		my-nv	flowers
Globba schomburgkii Hk. f. var. *schomburgkii*	Zingiberaceae	h	pd	gro	3	ddf,bb/df	ms	25	30	jl-dc	oc-nv	my-dc	flowers
Kaempferia angustifolia Rosc.	Zingiberaceae	h	pd	gro	3	ddf,bb/df	ms	30	30	jl-ag	oc-nv	my-nv	flowers
Kaempferia siamensis Siri.	Zingiberaceae	h	pd	gro	3	ddf	ms	30	30	jl-ag	sp-oc	my-nv	flowers
Stahlianthus thorelii Gagnep.	Zingiberaceae	h	pd	gro	2	ddf	ms	30	30	ap-my	jl-ag	my-nv	fruits
Zingiber montanum (Koen.) Link *ex* Dietr.	Zingiberaceae	h	pd	gro,cul, int	2	bb/df	ms	30	30	ag-sp		my-dc	
Zingiber pellitum Gagnep.	Zingiberaceae	h	pd	gro	2	bb/df	ms	30	30	jl-ag		my-nv	flowers
Zingiber zerumbet (L.) Sm. var. *zerumbet*	Zingiberaceae	h	pd	gro	3	ddf,bb/df	ms	30	30	jl-ag	sp-oc	my-nv	flowers
Halopegia brachystachys Craib	Marantaceae	h	pd	gro	4	ddf,bb/df	ms	30	30	jl-ag	sp-oc	my-nv	flowers

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Chloropytum intermedium Craib var. *intermedium*	Liliaceae	h	pd	gro	3	ddf	ms	30	30	jl-sp	oc-nv	my-nv	
Gloriosa superba L.	Liliaceae	v	pd	gro,int, nat	2	bb/df	ms	30	30	jl-ag		my-dc	flowers
Liriope spicata Lour.	Liliaceae	h	pd	gro	3	bb/df	ms	30	30	jl-ag	ag-sp	my-nv	flowers, fruits
Hypoxis aurea Lour.	Amaryllidaceae	h	pd, ped	gro	2	ddf,bb/df	ms	30	30	jn-ag	jl-sp	my-nv	flowers
Monochoria vaginalis (Burm. f.) Presl	Pontederiaceae	h	a	aqu,gro	3	ponds,wet areas	ms	20	25	ja-ag	mr-sp	nv-oc	flowers,fruits
Smilax cambodiana Gagnep.	Smilacaceae	v	pe	gro	3	da	ms	30	30		jl-ag	ja-dc	fruits
Smilax verticalis Gagnep.	Smilacaceae	v	pd	gro	3	ddf	ms	30	30	ap-my	jl-ag	my-nv	fruits
Alocasia odora C. Koch	Araceae	h	pd	gro	2	bb/df	ms	25	30	ag-sp	nv-dc	my-dc	fruits
Amorphophallus coudercii (Bogn.) Bogn.	Araceae	h	pd	gro	1	bb/df	ms	25	30	mr		my-nv	flowers
Amorphophallus harmandii Engl. & Gehrm.	Araceae	h	pd	gro	3	bb/df	ms	30	30	jl		jn-oc	leaves
Amorphophallus koratensis Gagnep.	Araceae	h	pd	gro	2	bb/df	ms	25	30	mr-ap		my-oc	flowers, leaves
Amorphophallus hemicryptus Hett.	Araceae	h	pd	gro	2	bb/df	sh,ms	25	30	nv		jn-oc	flowers, leaves
Cryptocoryne crispatula Engl.	Araceae	h	pd	gro,rhe, reply	4	rv 2-3	ms	20	25	nv		sp-ap	flowers
Pothos scandens L.	Araceae	v,cr	pe	gro	2	mxf	ms	25	30	oc-dc	ja-fb	ja-dc	flowers
Rhaphidophora peepla (Roxb.) Schott	Araceae	v,cr	pe	epi	3	bb/df	ms	25	30	jl-sp	oc-mr	ja-dc	fruits
Typhonium flagelliforme (Lodd.) Bl.	Araceae	h	pd	aqu,gro	2	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers
**Typhonium laoticum* Gagnep.	Araceae	h	pd	gro	2	bb/df	ms	30	30	jl-ag	ag-sp	my-nv	flowers, fruits
Lemna aequinoctalis Welw.	Lemnaceae	h	a	aqu	3	ponds	ms	25	30			sp-mr	
Stemona tuberosa Lour. var. *tuberosa*	Stemonaceae	v	pd	gro	3	ddf, bb/df	ms	25	30	ap-jl	jn-sp	my-dc	flowers
Dioscorea alata L.	Dioscoreaceae	v	pd	gro	3	da,sg	ms	25	30	sp-nv	nv-fb	my-dc	flowers,fruits
Dioscorea glabra L. var. *glabra*	Dioscoreaceae	v	pd	gro	3	bb/df,da,sg	ms	25	30	sp-dc	nv-dc	my-dc	fruits
Dioscorea hispida Denn. var. *hispida*	Dioscoreaceae	v	pd	gro	3	bb/df	ms	25	30	mr-ap	oc-nv	my-dc	fruits
Calamus rudentum Lour.	Palmae	wc	pe	gro	3	bb/df,mxf	ms	25	30	sp-oc	mr-ap	ja-dc	fruits
Calamus siamensis Becc. var. *siamensis*	Palmae	wc	pe	gro	4	mxf	sh,ms	25	30			ja-dc	
Calamus viminalis Willd.	Palmae	wc	pe	gro	2	bb/df,mxf	ms	25	30	sp-oc	nv-dc	ja-dc	
Caryota maxima Bl.	Palmae	t	pe	gro	1	da	ms	30	30	ja-dc	ja-dc	ja-dc	
Caryota mitis Lour.	Palmae	t	pe	gro	2	mxf	ms	25	30	ja-dc	ja-dc	ja-dc	
Licuala spinosa Thunb.	Palmae	l	pe	gro	2	mxf	ms	25	30	ja-fb	my-jn	ja-dc	imm. fruits
Burmannia coelestis D. Don	Burmanniaceae	h	a	gro	3	wet areas in ddf	ms	25	30	sp-nv	nv-dc	jl-dc	flowers
Burmannia wallichii (Miers) Hk. f.	Burmanniaceae	h	a	gro,sap	2	bb/df	ms	25	30	oc-nv	nv-dc	leafless	flowers
Apostasia wallichii R. Br.	Orchidaceae	h	pe	gro	2	bb/df	ms	25	30	jl-ag	nv-dc	ja-dc	fruits
**Brachycorythis helferi* (Rchb. f.) Summ.	Orchidaceae	h	pd	gro	3	ddf,bb/df	ms	30	30	jl-ag		my-nv	flowers
Brachycorythis laotica (Gagnep.) Summ.	Orchidaceae	h	pd	gro	3	ddf,bb/df	ms	30	30	jl-ag		my-nv	flowers
Bulbophyllum	Orchidaceae	h	pe	epi	3	mxf	ms	25	30			ja-dc	
Cleisomeria pilosulum (Gagnep.) Seid. & Garay	Orchidaceae	h	pe	epi	3	ddf	ms	30	30	jl-ag		ja-dc	flowers
Dendrobium venustum Teijs. & Binn.	Orchidaceae	h	pd	epi	2	bb/df	ms	25	30	oc-dc	nv-fb	my-fb	flowers
Habenaria rumphii Wall. *ex* Lindl.	Orchidaceae	h	pd	gro	3	ddf	ms	30	30	jl-ag		my-nv	flowers
Habenaria dentate (Sw.) Schltr.	Orchidaceae	h	pd	gro	2	mxf,da	ms	25	30	oc-dc	jn-dc	my-dc	flowers
Habenaria khasiana Hk. f.	Orchidaceae	h	pd	gro	3	ddf	ms	30	30	jn-ag		my-nv	flowers
Habenaria lucida Wall. *ex* Lindl.	Orchidaceae	h	pd	gro	3	ddf,bb/df	ms	30	30	jl-ag		my-nv	flowers
Habenaria mandersii Coll. & Hemsl.	Orchidaceae	h	pd	gro	3	ddf	ms	30	30	jl-ag		my-nv	flowers
Habenaria rostellifera (Brogn.) Lindl.	Orchidaceae	h	pd	gro	3	ddf	ms	30	30	jl-ag		my-nv	flowers
**Habenaria viridiflora* (Rottl. *ex* Sw.) R. Br.	Orchidaceae	h	pd	gro	3	ddf	ms	30	30	jl-ag		my-nv	flowers
Liparis campylostalix Rchb. f.	Orchidaceae	h	pd	gro	2	bb/df	ms	25	30	ag-oc	nv-fb	my-dc	fruits
**Liparis rheedii* (Bl.) Lindl.	Orchidaceae	h	pd	gro	3	bb/df	ms	30	30	jl-ag		my-nv	flowers
**Liparis siamensis* Rol. *ex* Dow.	Orchidaceae	h	pd	gro	3	mxf	ms	30	30	jl-ag		my-nv	flowers

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Luisia thailandica Seid.	Orchidaceae	h	pe	epi	2	bb/df	ms	25	30	mr-ap	my-jl	ja-dc	flowers
Nervilia aragoana Gaud.	Orchidaceae	h	pd	gro	2	ddf, bb/df	ms	25	30	ar-my		my-dc	
**Nervilia calcicola* Kerr	Orchidaceae	h	pd	gro	2	bb/df	ms	30	30			my-nv	
Nervilia punctata (Bl.) Schltr.	Orchidaceae	h	pd	gro	2	bb/df	ms	30	30	ap-my		my-nv	leaves
Peristylus constrictus (Lindl.) Lindl.	Orchidaceae	h	pd	gro	2	bb/df	ms	25	30	jl-ag	oc-nv	my-nv	flowers
**Vandopsis gigantea* (Lindl.) Pfitz.	Orchidaceae	h	pe	epi	2	mxf	ms	25	30	mr-ap		ja-dc	flowers
Carex indica L. var. *indica*	Cyperaceae	h	pd	gro	3	mxf	ms	25	30	mr-ap	jn-sp	mr-dc	flowers
Carex tricephala Boeck.	Cyperaceae	h	pd	gro	3	ddf,bb/df	ms	30	30	jl-ag	ag-sp	my-nv	flowers, fruits
Cyperus brevifolius (Rottb.) Hassk.	Cyperaceae	h	pd	gro	3	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Cyperus castaneus Willd.	Cyperaceae	h	a	gro	3	wet areas in ddf	ms	30	30	jn-ag	jl-sp	my-nv	flowers, fruits
Cyperus compactus Retz.	Cyperaceae	h	a	aqu,gro	3	ponds in ddf	ms	30	30	jn-sp	jl-oc	my-nv	flowers, fruits
Cyperus cuspidatus Kunth.	Cyperaceae	h	a	gro	3	rv 5	ms	20	25	jn-ag	jl-sp	ja-ag	flowers, fruits
Cyperus iria L.	Cyperaceae	h	a	aqu,gro, wee	3	rv 5, ponds in ddf, da	ms	25	30	jl-oc	ag-nv	jn-nv	
Cyperus kyllingia Endl.	Cyperaceae	h	pe	gro,wee	3	da, sg	ms	25	30	my-dc	jn-ja	ja-dc	
Cyperus laxus Lmk. var. *laxus*	Cyperaceae	h	pe	gro	3	bb/df,da	ms	25	30	jl-dc	sp-dc	ja-dc	flowers
Cyperus leucocephalus Retz.	Cyperaceae	h	pd	gro	3	ddf	ms	30	30	jl-sp	ag-oc	my-dc	flowers, fruits
Cyperus pilosus Vahl	Cyperaceae	h	a	aqu,gro	3	ponds in ddf	ms	30	30	jn-sp	jl-oc	my-nv	flowers, fruits
Cyperus pygmaeus Rottb.	Cyperaceae	h	a	gro	2	ddf,da	ms	25	30	oc-dc	nv-dc	ja-dc	flowers
Cyperus tenuispica Steud.	Cyperaceae	h	a	gro	3	bb/df	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Cyperus triceps (Rottb.) Engl.	Cyperaceae	h	pd	gro	3	wet areas in ddf	ms	30	30	jn-ag	jl-sp	my-nv	flowers, fruits
Diplacrum caricinum R. Br.	Cyperaceae	h	a	gro	3	wet areas in ddf	ms	30	30	jn-sp	jn-sp	my-nv	flowers, fruits
Eleocharis acutangula (Roxb.) Schult.	Cyperaceae	h	a	aqu,gro	3	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Eleocharis dulcis (Burm. f.) Hensch. var. *dulcis*	Cyperaceae	h	a	aqu,gro	2	ponds in ddf	ms	30	30			my-nv	
Fimbristylis adenolepis Kern	Cyperaceae	h	a	gro	3	ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Fimbristylis aestivalis (Retz.) Vahl var. *aestivalis*	Cyperaceae	h	a	gro	3	rv 5	ms	20	25	ja-my	fb-jn	ja-jn	flowers
Fimbristylis bisumbellata (Forssk.) Bub.	Cyperaceae	h	a	gro	3	bb/df	ms	30	30	jn-ag	jl-sp	my-nv	flowers, fruits
**Fimbristylis brunneoides* Kern	Cyperaceae	h	a	gro	3	rv 4-5	ms	20	30	ja-ap	fb-my	nv-jn	flowers
Fimbristylis cymosa R. Br.	Cyperaceae	h	pd	gro,rhe	3	rv 2-3	ms	20	25	fb-ap	oc-nv	nv-jn	flowers,fruits
Fimbristylis dichotoma (L.) Vahl ssp. *dichotoma*	Cyperaceae	h	pd	gro	3	ddf,bb/df	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Fimbristylis dipascea (Rottb.) Cl.	Cyperaceae	h	a	gro	3	rv 5	ms	20	25	ja-my	fb-jn	ja-jn	flowers
Fimbristylis gracilenta Hance	Cyperaceae	h	a	gro	3	bb/df	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
**Fimbristylis jucunda* (Cl.) Kern	Cyperaceae	h	a	gro	3	rv 2-4	ms	20	25	ja-mr	fb-ap	nv-jn	flowers
Fimbristylis miliacea (L.) Vahl	Cyperaceae	h	a	aqu,gro	3	ponds in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Fimbristylis schoenoides (Retz.) Vahl	Cyperaceae	h	pd	gro	3	wet areas in ddf	ms	30	30	jn-sp	jl-oc	my-nv	flowers, fruits
Fimbristylis tetragona R. Br.	Cyperaceae	h	a	aqu,gro	3	ponds in ddf	ms	30	30	jn-sp	jl-oc	my-nv	flowers, fruits
Liphocarpa hemisphaerica (Roth) Goet.	Cyperaceae	h	a	gro	3	wet areas in ddf	ms	30	30	jn-sp	jl-oc	my-nv	flowers, fruits
Liphocarpa microcephala (R. Br.) Kunth	Cyperaceae	h	a	gro	3	wet areas in ddf	ms	30	30	jn-ag	jl-sp	my-nv	flowers, fruits
Rhynchospora longisetis R. Br.	Cyperaceae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers,fruits
Rhynchospora rubra (Lour.) Mak.	Cyperaceae	h	pd	gro	3	wet areas in ddf	ms	30	30	jn-sp	jl-oc	my-dc	flowers, fruits
Scleria levis Retz.	Cyperaceae	h	pd	gro	3	ddf,bb/ df,mxf,da	ms	25	30	jn-oc	jl-nv	my-nv	flowers, fruits
Scleria lithosperma (L.) Sw. var. *lithosperma*	Cyperaceae	h	pe	gro	2	bb/df	ms	25	30	sp-nv	nv-ja	ja-dc	fruits
Scleria neesii Kunth	Cyperaceae	h	a	gro	3	wet areas in ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Scleria psilorrhiza Cl.	Cyperaceae	h	pd	gro		wet areas in ddf	ms	30	30	jn-sp	ag-oc	my-nv	flowers, fruits
Alloteropsis cimicina (L.) Stapf	Gramineae	h	a	gro	3	ddf, da	ms	30	30	jn-ag	jl-sp	my-nv	flowers, fruits
Andropogon chinensis (Nees) Merr.	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Apocopsis cochinchinensis A. Camus	Gramineae	h	a	gro	3	wet areas in ddf	ms	30	30	jn-sp	jl-oc	my-nv	flowers
Aristida chinensis Munro	Gramineae	h	pd	gro	3	ddf	ms	25	30	oc-nv	dc-ja	my-dc	flowers
Aristida setacea Retz.	Gramineae	h	pd	gro	3	bb/df	ms	25	30	oc-nv	nv-dc	my-dc	flowers

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Arundinella setosa Trin. var. *setosa*	Gramineae	h	pd	gro	3	ddf	ms	30	30	jn-ag	ag-sp	my-nv	flowers, fruits
Capillipedium annamense A. Camus	Gramineae	h	pd	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Capillipedium assimile (Steud.) A. Camus	Gramineae	h	pd	gro	3	ddf	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Capillipedium cinctum (Steud.) A. Camus	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Chrysopogon nemoralis (Balan.) Holtt.	Gramineae	h	pd	gro	4	ddf, bb/df	ms	25	30	jl-sp	sp-oc	jn-fb	flowers
Cyrtococcum accrescens (Trin.) Stapf	Gramineae	h	a	gro	3	bb/df,da	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Dactyloctenium aegyptium (L.) P. Beauv.	Gramineae	h	a	gro,wee	3	rv 5, da	ms	25	30	jn-oc	jl-nv	my-nv	flowers
Dichanthium caricosum (L.) A. Camus	Gramineae	h	a	gro	3	rv 5	ms	20	25	ja-fb	fb-mr	nv-jn	flowers
Digitaria bicornis (Lmk.) Roem. & Schult.	Gramineae	h	a	gro	3	rv 5	ms	20	25	ja-ag	ja-ag	ja-ag	flowers
Digitaria radicosa (Presl) Miq.	Gramineae	h	a	gro	3	rv 5, ddf, da	ms	20	30	ja-ag	fb-sp	nv-ag	flowers
Digitaria violascens Link	Gramineae	h	a	gro	2	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Echinochloa colona (L.) Link	Gramineae	h	a	aqu,gro	3	rv 5, ponds in ddf	ms	25	30	jn-ag	jl-sp	ja-sp	flowers, fruits
Eleusine indica (L.) Gaertn.	Gramineae	h	a	gro,wee	3	rv 5, da	ms	20	30	nv-ap	dc-my	nv-jn	
Enteropogon dolichostachya (Lag.) Keng *ex* Laza.	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Eragrostis bipinnata (L.) Musc.	Gramineae	h	a	gro	3	wet areas in ddf	ms	30	30	jn-sp	jl-oc	my-nv	flowers, fruits
Eragrostis pilosa (L.) P. Beauv.	Gramineae	h	a	gro	3	ddf, bb/df,da	ms	25	30	jl-nv	ag-nv	my-dc	flowers
Eragrostis unioloides (Retz.) Nees *ex* Steud.	Gramineae	h	a	gro	3	ddf	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Eremochloa ciliaris (L.) Merr.	Gramineae	h	pd	gro	3	ddf	ms	30	30	jl-sp	ag-oc	my-nv	flowers
Eulalia velutina (Munro) O.K.	Gramineae	h	pd	gro	3	ddf	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Eulaliopsis binata (Retz.) C. E. Hubb.	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Gymnopogon delicatulus (Cl.) Bor	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Heteropogon contortus (L.) P. Beauv. *ex* Roem. & Schult.	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Hyparrhena hirta (L.) Stapf	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	dc	my-dc	flowers
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C. E. Hubb. *ex* Hubb. & Vaugh.	Gramineae	h	pd	gro	3	da, sg	ms	30	30	jl-oc	ag-nv	my-dc	
Ischaemum indicum (Houtt.) Merr.	Gramineae	h	pd	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Leptochloa chinensis (L.) Nees	Gramineae	h	a	gro	3	rv 5, bb/df	ms	20	30	ja-dc	ja-dc	ja-dc	flowers
Lophaterum gracile Brongn. var. *gracile*	Gramineae	h	a	gro	3	bb/df,mxf	ms	25	30	sp-nv	nv-dc	my-dc	flowers
Microchloa indica (L. f.) P. Beauv.	Gramineae	h	a	gro	3	ddf	ms	30	30	jl-ag	ag-sp	my-nv	flowers
Mnestithea laevis (Retz.) Kunth var. *cochinchinensis* (Lour.) Kon. & Sos.	Gramineae	h	pd	gro	3	ddf	ms	30	30	jn-ag	jl-sp	my-nv	flowers, fruits
Mnesithea striata (Nees *ex* Steud.) Kon. & Sos.	Gramineae	h	pd	gro	3	bb/df,da	ms	25	30	jl-nv	ag-dc	my-dc	flowers
Oplismenus compositus (L.) P. Beauv.	Gramineae	h	a	gro	3	bb/df,da	ms	25	30	sp-nv	oc-dc	my-dc	flowers
Oryza sativa L.	Gramineae	h	a	aqu,gro	3	wet areas in ddf	ms	30	30	jl-ag	ag-sp	my-nv	flowers, fruits
Panicum luzonense Presl	Gramineae	h	a	gro	3	bb/df	ms	30	30	jl-sp	ag-oc	my-nv	flowers, fruits
Panicum notatum Retz.	Gramineae	h	pd	gro	3	bb/df,da	ms	25	30	sp-nv	oc-dc	my-dc	flowers
Panicum trachyrhachis Bth.	Gramineae	h	a	gro	3	ddf	ms	25	30	sp-nv	nv-dc	mydc	flowers
Paspalum scrobiculatum L.	Gramineae	h	a	gro	3	bb/df,da	ms	25	30	jl-nv	ag-dc	my-dc	flowers
Phragmites vallatoria (Pluk. *ex* L.) Veldk.	Gramineae	h	pe	gro,wee	3	da,sg	sh,ms	25	30	nv-fb	dc-mr	ja-dc	
Polytoca digitata (L. f.) Druce	Gramineae	h	pd	gro	3	ddf	ms	25	30	oc-nv	dc	my-dc	flowers
Rottboellia exalata L. f.	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Saccharum arundinaceum Retz.	Gramineae	h	pe	gro	4	streams, wet areas, rv 5, da	ms	25	30	sp-nv	nv-dc	ja-dc	flowers
Saccharum spontaneum L.	Gramineae	h	pd	gro	3	streams, wet areas, rv 5, da	ms	20	30	dc-mr	fb-ap	nv-jn	flowers
Sacciolepis indica (L.) A. Chase	Gramineae	h	a	gro	3	ddf	ms	30	30	jn-sp	jl-oc	my-dc	flowers, fruits

Species	Family	Habit	Aped	Life-mode	AB	Habitat	Bed-rock	LE (m)	UE (m)	Flower Month	Fruiting Month	Leafing Month	Collected
Schizachyrium brevifolium (Sw.) Nees	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Sclerostachya fusca (Roxb.) A. Camus	Gramineae	h	pd	gro	4	wet areas,sg	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Setaria parviflora (Poir.) Kerg.	Gramineae	h	a	gro	4	ddf, bb/df	ms	25	30	jl-nv	ag-dc	my-dc	flowers
Sorghum mekongense (A. Camus) A. Camus	Gramineae	h	a	gro	3	rv 5	ms	25	30	jl-ag	ag-sp	ja-ag	flowers
Sorghum propinquum (Kunth) Hitch.	Gramineae	h	a	gro	3	wet areas,sg	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Themeda arundinacea (Roxb.) Ridl.	Gramineae	h	a	gro	3	ddf	ms	25	30	oc-nv	nv-dc	my-dc	flowers
Thysanolaena latifolia (Roxb. *ex* Horn.) Honda	Gramineae	h	pe	gro,wee	4	da,sg	ms	25	30	ag-oc	sp-nv	ja-dc	
Bambusa bambos (L.) Voss. *ex* Vilm.	Gramineae, Bambusoideae	h	pe	gro	5	bb/df,da	ms	25	30	fb-mr	mr-ap	ja-dc	
Dendrocalamus sp.	Gramineae, Bambusoideae	h	pe	gro	2	bb/df	ms	25	30			my-dc	
Thyrsostachys siamensis (Kurz *ex* Munro) Gamb.	Gramineae, Bambusoideae	h	pd	gro	3	bb/df	ms	30	30	mr-ap		my-dc	
Vietnamosasa ciliata (A. Camus) Nguyen	Gramineae, Bambusoideae	h	pd	gro	4	ddf	ms	25	30	sp-oc		my-dc	
Pteridophyta													
Selaginella roxburghii (Hk. & Grev.) Spring var. *roxburghii*	Selaginellaceae	h	a	gro	2	bb/df, mxf,sg	ms	25	30	ag-nv	ag-nv	my-dc	sporangia
Helminthostachys zeylanica (L.) Hk.	Ophioglossaceae	h	pd	gro	2	bb/df	ms	30	30	jl-ag	jl-ag	my-nv	sori
Ophioglossum gramineum Willd. var. *gramineum*	Ophioglossaceae	h	pd	gro	2	ddf	ms	30	30	jl-sp	jl-sp	jn-sp	
Ophioglossum petiolatum Hk.	Ophioglossaceae	h	pd	gro	2	bb/df,da	ms	25	30	jl-dc	jl-nv	jn-dc	sori
Lygodium flexuosum (L.) Sw.	Schizaeaceae	v	pd	gro	3	ddf, bb/df	ms	25	30	jl-nv	jl-nv	my-dc	sori
Adiantum philippense L.	Parkeriaceae	h	pd	gro	3	bb/df,ddf	ms	25	30	ag-nv	ag-nv	my-dc	sori
Adiantum zollingeri Mett. *ex* Kuhn	Parkeriaceae	h	pd	gro	3	bb/df,ddf	sh,ms	25	30	sp-dc	sp-dc	my-dc	sori
Ceratopteris thalictroides (L.) Brongn.	Parkeriaceae	h	pd	aqu,gro	3	ponds in bb/df	ms	25	30	sp-nv	sp-nv	jn-dc	sori
Cheilanthes belangeri (Bory) C. Chr.	Parkeriaceae	h	pd	gro	3	bb/df	ms	25	30	ag-nv	ag-nv	my-dc	sori
Hemionitis arifolia (Burm. f.) Moore	Parkeriaceae	h	pd	gro	2	bb/df,mxf	ms	25	30	sp-nv	sp-nv	my-dc	sori
Pteris heteromorpha Fee	Pteridaceae	h	pe	gro	3	bb/df	ms	25	30	sp-nv	sp-nv	ja-dc	sori
Diplazium esculentum (Retz.) Sw.	Athyriaceae	h	pd	gro	4	rv 2-3	ms	20	25	ap-my	ap-my	nv-jn	sori
Drynaria bonii Christ	Polypodiaceae	h	pd	gro,epi, epl	2	rocks in bb/df	ms	25	30	sp-nv	sp-nv	my-dc	sori
Drynaria quercifolia (L.) J. Sm.	Polypodiaceae	h	pd	epi	3	rv 6,bb/df,mxf	ms	25	30	ag-oc	ag-oc	my-ja	
Platycerium wallichii Hk.	Polypodiaceae	h	pe	epi	1	mxf	ms	30	30	oc-ap	oc-ap	ja-dc	
Pyrrosia lanceolata (L.) Farw.	Polypodiaceae	h,cr	pe	epi	3	bb/df, mxf	sh,ms	25	30	jl-dc	jl-dc	ja-dc	sori
Pyrrosia stigmosa (Sw.) Ching	Polypodiaceae	h	pe	epi	3	rv 6, mxf	ms	25	30	mr-nv	mr-nv	ja-dc	sori
Bryophyta													
Bryum coronatum Schwaegr.	Bryaceae	h	pe	epi	3	bb/df	ms	25	30	ag-nv	ag-nv	ja-dc	capsules
Fisssidens zollingeri Mont.	Fissidentaceae	h	pe	gro	2	wet areas in bb/df	ms	25	30	sp-nv	sp-nv	ja-dc	capsules
Ochrobryum sp.	Leucobryaceae	h	pe	epi	3	bb/df	ms	25	30	nv-mr	nv-mr	ja-dc	capsules
Octoblepharum albidum Hedw.	Octoblepharaceae	h	pe	epi	3	bb/df	ms	30	30	jn-sp	jn-sp	ja-dc	capsules
Macromitrum zollingeri Mitt. *ex* Dozy & Molk.	Orthotrichaceae	h	pe	epi	3	streams in bb/df,mxf	ms	25	30	sp-nv	sp-nv	ja-dc	capsules
Riccia sp.	Ricciaceae	h	a	gro	2	rv 6,streams, wet areas	ms	20	25	nv-dc	jn-mr	nv-jn	capsules
Taxithelium nepalense (Schwaegr.) Broth.	Sematophyllaceae	h	pe	epi	3	bb/df	ms	25	30	ag-nv	ag-nv	ja-dc	capsules

ANNEX 5. RANKING CRITERIA

This section describes the ranking process developed to identify the conservation management priorities of taxa in the study area. Ranking was partly conducted in a five-day workshop with project consultants and WWF Cambodia (R. Timmins, M. Bezuijen, J. Maxwell, C. Vidthayanon, R. Zanre; 24-28 July 2007, Kratie Town). The aim of ranking was to list the taxa of highest management priority within the study area based on objective and consistent criteria. Ranking was conducted for selected flora and all vegetation communities and vertebrate taxa recorded, or reported to occur, within the study area, in a two-step process:

Step 1: Preliminary ranking of the *relative* conservation value of the study area for a taxon based on two criteria: (1) global conservation status; (2) relative size of populations in the study area and their potential for recovery. In this step, threats were not considered.

Step 2: Final ranking of management priority for a taxon within the study area, based on two criteria: (1) the relative conservation value of the study area (derived from Step 1); (2) threats.

STEP 1. Preliminary ranking.

Two criteria were applied to rank the relative conservation value of the study area for a taxon: (1) global conservation status; (2) relative importance of populations in the study area (i.e. contribution to regional and/or global status) and potential for recovery of reduced populations. Each criterion was assigned a category of "high", "medium", "low" or "negligible" (see definitions below). The relative conservation value of the study area was derived by combining both criteria in a matrix as follows:

Criterion 1: global conservation status	**Criterion 2: relative importance of population in study area and/or potential for recovery with management**			
	High	**Medium**	**Low**	**Negligible**
High	Very High	High	Medium	Low
Medium	High	Medium	Low	0
Low	Medium	Low	0	0
Negligible	Low	0	0	0

Taxa ranked in this step: all bird, large mammal, amphibian, reptile and fish species recorded or reported to occur in the study area; all vegetation communities; and, selected flora species. For flora, the high number of taxa recorded in the study area and lack of ecological data for most taxa precluded an exhaustive ranking, and instead a limited number of riverine taxa and one undescribed taxon were ranked.

Definitions for criteria in this step:

Criterion 1: Global conservation status.

"High" conservation value: defined as taxa listed under IUCN Red Lists as "Vulnerable", "Endangered" or "Critically Endangered" (IUCN 2007); and/or, species with greatly reduced populations (only a few remnant populations remaining) in Southeast Asia (based on consultant expertise and available data); and/or, species with restricted ranges (for birds, following BirdLife International 2003b).

"Medium": defined as species listed as "Near-Threatened" or "Data Deficient" under IUCN Red Lists; and/or, species threatened regionally with evidence of widespread significant decline in many areas, but still with relatively large populations (based on consultant expertise and available data); and/or, species endemic to the mainstream of the Mekong River.

"Low": defined as species considered to be threatened at national level in Cambodia with evidence of a significant decline at a national level; and/or species with evidence of localized significant declines in the region (based on consultant expertise and available data).

"Negligible": taxa in Table 1 not assessed as "High", "Medium" or "Low".

Criterion 2: Relative size of populations in the study area and potential for recovery.
"High conservation value": population in study area is one of the largest (within top 5?) in mainland Southeast Asia; and/or, for migratory species, the study area supports the seasonal occurrence of ≥50% of the total migratory population within the Mekong Basin of any life history phase (adults, juveniles etc).

"Medium": population relatively large and regionally significant in study area; and/or, for migratory fish species, the study area supports the seasonal occurrence of <50% of the total migratory population within the Mekong Basin of any life history phase (adults, juveniles etc).

"Low": population of a 'high conservation value' species in study area is much reduced but potentially still recoverable. Or for widespread nationally/regionally/globally threatened species with "healthy" populations in many areas of Cambodia, the population in study area may be large and viable but not significant at a national or regional or even global level.

"Negligible": population of a nationally/regionally/globally threatened species is close to extinction in the study area with little potential for recovery. Or for widespread non-threatened species with healthy populations in many areas of Cambodia, population in study area may be large and viable but not significant at a national or regional or even global level.

Note: for some mobile species that ulitise large areas, but have regionally restricted 'functional' populations (i.e. vultures and large waterbirds), the study area 'population' is assessed in relation to its likely contribution to the status of the larger functional population. For example the regional vulture population has a globally irreplaceable significance, but the study are probably has only moderate importance to that population.

STEP 2. Final ranking.
In this step, two criteria were applied, to produce a final ranking of "**management priority**" for all taxa included in Step 1: (1) the relative conservation value of the study area (from Step 1); (2) threats. These criteria were combined in the matrix below:

Relative conservation value of site	**Threat**			
	Irreversible	**High**	**Medium**	**Low**
High (Very High)	Low priority	Very high priority	High priority	Mid priority
High	Low priority	High priority	High priority	Mid priority
Medium	0	High priority	Mid priority	Low priority
Low	0	Mid priority	Low priority	0
0	0	0	0	0

In this table, the criterion "Threat" was accorded a higher ranking than "Relative conservation value of site" because the level of threat would affect the urgency of need for management actions.

Definitions for criteria in this step:
Criterion 1: the preliminary ranking identified in Step 1.

Criterion 2: threats.
This ranking included current threats, and potential threats within the next 10 years, based on team observations in the study area. Three variables were considered for threats following TNC (2007) and WWF (2006b): "severity" (the level of damage to the value that can reasonably be expected under current circumstances given continuation of the existing situation); "scope" (the proportion of the overall area of the study area or value likely to be affected by a threat under current circumstances, given continuation of the existing situation); "irreversibility" (the degree to which the impacts of a threat can be restored or recovered). TNC (2007) and WWF (2006b) recommend a point-based scoring system to rank these variables but this was not used in the current project, due to the large number of taxa to be ranked. Instead, these variables were applied qualitatively, to derive a threat ranking of "irreversible", "high", "medium" or "low" for each taxon, based on the team's predictions of status within the study area pending management actions:

"Irreversible" threat:	Not reversible, for all intents and purposes at the current time [this does not take into account possibility of future reintroductions/re-establishment].
"High" threat:	We predict the taxon or community will become locally extinct or nearly so in the study area, within the next 10 years, unless immediate management actions are implemented.

"Medium" threat: We predict the taxon or community will decline substantially in the next 10 years unless immediate management actions are implemented.

"Low" threat: We predict the taxon or community is relatively secure and will not decline substantially as a result of in situ threats in the next ten years; little management is currently required.

RESULTS OF RANKING

The complete results of the ranking process are presented in a table available on-line at: www.panda.org/greatermekong/survey. An abridged version of this table, which shows the results of ranking, is in Annex 6. In the complete on-line table, the following is presented:

- All taxa and communities included in the ranking exercise.
- Results of ranking for each criterion and a brief justification for each ranking.
- A **final ranking**, of the urgency for management (column "**Final Ranking**").
- Preliminary recommendations for the conservation objective, and management actions, for each taxa or community with a final ranking of "Low", "Mid-", "High" or "Very High" management priority. (For this exercise, taxa with a priority ranking of "0" were not considered further).
- For birds and mammals, two additional columns are included, "Habitat" and "Status" (see below).

COLUMN CODES FOR THE RANKING TABLE AVAILABLE ON-LINE

Threat status

Global (IUCN 2007): DD - Data Deficient; NT - Near-threatened; CR - Critically Endangered; EN – Endangered; VU – Vulnerable.

Thailand (information from Round 2000; Nabhitabhata & Chan-ard 2005; Vidthayanon 2005): CR - Critical in Thailand; DD - Data Deficient in Thailand; EN - Endangered in Thailand; EW - Extinct in (the wild in) Thailand; NT - Near-Threatened in Thailand; VU - Vulnerable in Thailand.

Lao PDR (information from Duckworth et al. 1999): ARL - At Risk in Laos; CARL - Conditionally At Risk in Laos; LKL - Little Known in Laos; PARL - Potentially At Risk in Laos.

Probable study area "habitat" association (labeled "**Habitat**" in table) (for birds and large mammals only)
Considers habitats in which the taxon was detected during surveys and, regional data on species habitat preferences. **[ ]** = habitats from which a species may be extirpated. **?** = denotes uncertainty whether the taxon would use a particular habitat on a regular basis. For this column, incidental use of a habitat was not considered an "association with a habitat". Some species, especially swifts (aerial feeders) are not given a habitat association, because they feed over all habitats in a manner unrelated to the habitat below. Codes used are as follows: **F/f** = floodplain (one or more floodplain wildlife habitat associations). **C/c** = Mekong channel (one or more channel wildlife habitat associations). **G/g** = other small terrestrial wetlands/areas dominated by grass. **R/r** = riparian forest. Capital letters denote a major habitat of the species; small letters denote use, but not a major habitat, for the species.

"Status" (for birds and large mammals only)
For birds, recorded status in study area primarily relates to the region and habitat in which the species is most numerous; in most cases this is the "central section". For large mammals, recorded status in study area is split between status in "central section" and status elsewhere in study area. For large mammals and birds, species only recorded in terrestrial wildlife habitats and/or riparian forests are generally excluded from the table. Status codes primarily relating to other parts of the study area are denoted by "*****".

Status assessments are included for some species not detected during surveys, but for which survey methods and effort were sufficient to determine likely status (primarily species likely to now be locally extinct). Species for which survey method and effort was insufficient to determine presence and likely status (i.e. civets) are not included in the table. Codes are as follows:

a = abundant; **c** = common; **f** = frequent; **o** = occasional; **p** = present (abundance not assessed); **v** = recorded previously in study area prior to survey; **r** = recorded elsewhere in adjacent stretches of the Mekong (primarily the Ramsar site above Stung Treng); **hp** = historically likely to have been present and may still persist; **hu** = historically likely to have been present but likely to have been extirpated; **[ ]** = record provisional or unconfirmed; **?** = not recorded during the survey in designated region but probably/possibly present. **(br)** = status only refers to local breeding population (birds only); **(nbr)** = status only refers to local non-breeding population (birds only). Excludes species characteristic of terrestrial habitats if they have not been found associated with Mekong channel habitats (excluding riparian forest), floodplain

areas, or other wetland types. Abundance is given for the species primary wildlife habitat (excluding terrestrial forests other than riparian).

Criterion 1 ("C1"): Global status
0 = Negligible; **L**= Low; **M** = Moderate; **H** = high. For birds only: **(br)** = assessment applies only to breeding population; **(nbr)** = assessment applies only to non-breeding population.

Criterion 2 ("C2"): Relative importance of population in study area and potential for recovery with management
0 = Negligible; **L**= Low; **M** = Moderate; **H** = High; **x** = considered locally extinct. For birds only: **(br)** = assessment applies only to local breeding population; **(nbr)** = assessment applies only to local non-breeding population.

First ranking: Relative conservation value of site (outcome of Criteria 1 and 2)
0 = Negligible; **L** = Low; **M** = Medium; **H** = High; **VH** = Very High; **x** = locally extinct.

Criterion 3 ("C3"): Threat level
L = Low; **M** = Moderate; **H** = High; **I** = Irreversible. For birds only: **(br)** = assessment applies only to local breeding population; **(nbr)** = assessment applies only to local non-breeding population.

Final ranking ("FINAL RANK") (urgency for management actions)
LP = Low Priority; **MP** = Mid-Priority; **HP** = High Priority; **VHP** = Very High Priority.

ANNEX 6. RESULTS OF RANKING

The results of ranking of all vertebrate taxa and selected flora recorded or reported to occur in the study area are presented here. This is an abridged version of a larger table which includes notes on the justifications for each ranking, threats, management actions, and habitat and status in study area (for birds and mammals) and is available in an on-line table at www.panda.org/greatermekong/survey. For definitions of "global", "Cambodia", "Thai" and "Lao" status, see "Conventions" at the beginning of this report. [1,2]Listings under Cambodian legislation: [1] = "forest species" listed under *Prakas* [law] *on Classification and List of Wildlife Species* (No. 020, MAFF, 25 January 2007); [2] = "aquatic" species listed under draft *Prakas on Endangered species for Cambodia*; x = listed under previous draft of legislation but not under current draft. Definitions of ranking criteria and a key for the rankings (Criteria 1,2,3) are in Annex 5. C = Criterion. For the column "Final Rank": VHP-very high priority for conservation action in study area; HP-high priority; MP-medium priority; LP-low priority; 0-negligible priority; x = extirpated in study area; br = breeding; nbr = non-breeding.

English Name	Scientific Name	Global Status	Cam status	Thai Status	Lao Status	C1:Global status	C2:Relative importance	First ranking	C3: Threat	Final rank
FLORA AND VEGETATION COMMUNITIES										
Riverine Zone 1 (Aquatic)						M	H	H	L	**MP**
Riverine Zone 2 (Rapids)						H	H	VH	L	**MP**
Riverine Zone 3 (Kai Kum)						H	H	VH	L	**MP**
Riverine Zone 4 (Acacia-Anogeissus)						H	H	VH	M	**HP**
Riverine Zone 5 (Beach)						M	H	H	M	**HP**
Riverine Zone 6 (Strand)						M	H	H	M	**HP**
Mixed evergreen+Deciduous Seasonal Hardwood Forest						M	L	L	M	**LP**
Bamboo+Deciduous, Seasonal, Hardwood Forest						M	L	L	M	**LP**
Deciduous, Dipterocarp, Seasonal Hardwood Forest						M	L	L	M	**LP**
Ponds						M	L	L	M	**LP**
Secondary Growth & Disturbed Areas						M	L	L	M	**LP**
Flora	*Cryptocoryne crispatula*					H	H	VH	L	**MP**
Flora	*Telectadium edule*					H	H	VH	L	**MP**
Flora	*Phyllanthus jullienii*					H	H	VH	L	**MP**
Flora	*Dalzellia carinata*					H	H	VH	L	**MP**
Flora	*Morinda pandurifolia* var. *oblonga*					H	H	VH	L	**MP**
Flora	*Xantonnea parviflora* var. *salicifolia*					H	H	VH	L	**MP**
Flora	*Blachia cotoneaster*					H	H	VH	L	**MP**
Flora	*Eugenia mekongensis*					H	H	VH	L	**MP**
Flora	*Acacia harmandiana*					H	H	VH	M	**HP**
Flora	*Anogeissus rivularis*					H	H	VH	M	**HP**
Flora	*Polyalthia modesta*					H	H	VH	L	**MP**
Flora	*Combretum trifoliatum*					H	H	VH	L	**MP**
Flora	*Amorphophallus* sp. nov.					?	?	?	?	**?**
BIRDS										
Francolins, Partridges, Quails and Pheasants (Phasianidae)										
Chinese Francolin	*Francolinus pintadeanus*					0	0	0	L	**0**
[Blue-breasted Quail	*Coturnix chinensis]*			NT	LKL	M?	L?	L	M	**LP?**
Red Junglefowl	*Gallus gallus*					0	0	0	L	**0**
Green Peafowl	*Pavo muticus*	VU	RAR[1]	EN	ARL	H	M	H	H	**HP**
Whistling-ducks (Dendrocygnidae)										
Lesser Whistling-duck	*Dendrocygna javanica*					0?	0?	0	L?	**0**
Ducks and Pygmy-geese (Anatidae)										
White-winged Duck	*Cairina scutulata*	EN		CR	ARL	H	x	x	x	**x**
Comb Duck	*Sarkidiornis melanotos*			CR	ARL	H	x?	x	x?	**x**
Cotton Pygmy-goose	*Nettapus coromandelianus*		COM[1]		ARL	M	L	L	H	**MP**
Spot-billed Duck	*Anas poecilorhyncha*		COM[1]			m?	M	M	M	**MP**
Buttonquails (Turnicidae)										
Barred Buttonquail	*Turnix suscitator*									
Buttonquail sp.	*Turnix*					0	0	0	L?	**0**
Piculets and Woodpeckers (Picidae)										
Grey-capped Woodpecker	*Dendrocopos canicapillus*					0	0	0	L	**0**
Rufous Woodpecker	*Celeus brachyurus*					0	0	0	L	**0**
White-bellied Woodpecker	*Dryocopus javensis*			NT	PARL	M?	L?	L?	M	**LP**

English Name	Scientific Name	Global Status	Cam status	Thai Status	Lao Status	C1:Global status	C2:Relative importance	First ranking	C3: Threat	Final rank
Lesser Yellownape	*Picus chlorolophus*					0	0	0	L	**0**
Greater Yellownape	*Picus flavinucha*					0	0	0	L	**0**
Laced Woodpecker	*Picus vittatus*					0	0	0	L	**0**
Black-headed Woodpecker	*Picus erythropygius*					0	0	0	L	**0**
Grey-headed Woodpecker	*Picus canus*					0	0	0	L	**0**
Common Flameback	*Dinopium javanense*					0	0	0	L	**0**
Greater Flameback	*Chrysocolaptes lucidus*					0	0	0	L	**0**
Heart-spotted Woodpecker	*Hemicircus canente*					0	0	0	L	**0**
Great Slaty Woodpecker	*Mulleripicus pulverulentus*			NT		0?	0	0	L	**0**
Barbets (Megalaimidae)										
Lineated Barbet	*Megalaima lineata*					0	0	0	L	**0**
Blue-eared Barbet	*Megalaima australis*					0	0	0	L	**0**
Coppersmith Barbet	*Megalaima haemacephala*					0	0	0	L	**0**
Hornbills (Bucerotidae)										
Oriental Pied Hornbill	*Anthracoceros albirostris*		COM[1]			M?	M?	M?	M	**MP**
Great Hornbill	*Buceros bicornis*	NT	RAR[1]	NT	ARL	M-H	L?	L	H	**MP?**
Wreathed Hornbill	*Aceros undulatus*			NT	ARL	M-H	x?	x	x?	**x**
Hoopoes (Upupidae)										
Common Hoopoe	*Upupa epops*					0	0	0	L	**0**
Rollers (Coraciidae)										
Indian Roller	*Coracias benghalensis*					0	0	0	L	**0**
Dollarbird	*Eurystomus orientalis*					0	0	0	L	**0**
Kingfishers (Alcedinidae, Halcyonidae, Cerylidae)										
Common Kingfisher	*Alcedo atthis*					0	0	0	L	**0**
Stork-billed Kingfisher	*Halcyon capensis*					L?	M	L	L?	**0**
White-throated Kingfisher	*Halcyon smyrnensis*					0	0	0	L	**0**
Black-capped Kingfisher	*Halcyon pileata*					0	0	0	L	**0**
Collared Kingfisher	*Todiramphus chloris*				LKL	L?	x	x	x	**x**
Pied Kingfisher	*Ceryle rudis*		COM[1]		ARL	M?	M	M	M	**MP**
Bee-eaters (Meropidae)										
Blue-bearded Bee-eater	*Nyctyornis athertoni*					0	0	0	L	**0**
Green Bee-eater	*Merops orientalis*					0	0	0	L	**0**
Blue-throated Bee-eater	*Merops viridis*					M-H? (br);0 (nbr)	x	x	x	**x**
Blue-tailed Bee-eater	*Merops philippinus*				PARL	L?	M?	L?	L?	**0**
Chestnut-headed Bee-eater	*Merops leschenaulti*					0	0	0	L	**0**
Cuckoos (Cuculidae)										
Chestnut-winged Cuckoo	*Clamator coromandus*					0	0	0	L	**0**
Indian Cuckoo	*Cuculus micropterus*					0	0	0	L	**0**
Banded Bay Cuckoo	*Cacomantis sonneratii*					0	0	0	L	**0**
Plaintive Cuckoo	*Cacomantis merulinus*					0	0	0	L	**0**
Drongo Cuckoo	*Surniculus lugubris*					0	0	0	L	**0**
Asian Koel	*Eudynamys scolopacea*					0	0	0	L?	**0**
Green-billed Malkoha	*Phaenicophaeus tristis*					0	0	0	L	**0**
Coucals (Centropodidae)										
Greater Coucal	*Centropus sinensis*					0	0	0	L	**0**
Lesser Coucal	*Centropus bengalensis*					0	0	0	L	**0**
Parrots and Parakeets (Psittacidae)										
Vernal Hanging Parrot	*Loriculus vernalis*					0	0	0	L	**0**
Alexandrine Parakeet	*Psittacula eupatria*			EN	ARL	M?	L?	L?	M	**LP**
Grey-headed Parakeet	*Psittacula finschii*					0	0	0	L?	**0**
Blossom-headed Parakeet	*Psittacula roseata*			NT	PARL	L?	M?	L?	L-M	**LP?**
Red-breasted Parakeet	*Psittacula alexandri*					L?	L?	0	L?	**0**
Swifts and Treeswifts (Apodidae, Hemiprocnidae)										
Silver-backed Needletail	*Hirundapus cochinchinensis*					0?	0	0	?	**0**
Brown-backed Needletail	*Hirundapus giganteus*					0?	0	0	?	**0**
Asian Palm Swift	*Cypsiurus balasiensis*					0	0	0	L	**0**
Fork-tailed Swift	*Apus pacificus*					0	0	0	L	**0**
Crested Treeswift	*Hemiprocne coronata*					0	0	0	L	**0**
Owls (Tytonidae, Strigidae)										
Barn Owl	*Tyto alba*			NT	LKL	L?	?	0?	?	**0**
Collared Scops Owl	*Otus bakkamoena*					0	0	0	L	**0**
Brown Fish Owl	*Ketupa zeylonensis*			NT	PARL	L?	M?	L?	M?	**LP?**
Tawny Fish Owl	*Ketupa flavipes*			NA	LKL	?	?	?	M?	**?**
Buffy Fish Owl	*Ketupa ketupu*			NT	LKL	?	?	?	M?	**?**
Spotted Wood Owl	*Strix seloputo*		COM[1]	VU	LKL	M?	M?	M?	M?	**MP?**
Asian Barred Owlet	*Glaucidium cuculoides*					0	0	0	L	**0**
Brown Hawk Owl	*Ninox scutulata*					0	0	0	L	**0**
Nightjars (Eurostopodidae, Caprimulgidae)										
Great Eared Nightjar	*Eurostopodus macrotis*					0	0	0	L	**0**
[Grey Nightjar	*Caprimulgus indicus]*					0	0	0	L	**0**
Large-tailed Nightjar	*Caprimulgus macrurus*					0	0	0	L	**0**
Pigeons and Doves (Columbidae)										
Pale-capped Pigeon	*Columba punicea*	VU		VU	LKL	H	x?	x	x	**x**
Spotted Dove	*Streptopelia chinensis*					0	0	0	L	**0**
Red Collared Dove	*Streptopelia tranquebarica*					L?	0?	0	L?	**0**

English Name	Scientific Name	Global Status	Cam status	Thai Status	Lao Status	C1:Global status	C2:Relative importance	First ranking	C3: Threat	Final rank
Pink-necked Green Pigeon	*Treron vernans*				NA	0?	0?	0	M?	**0**
Orange-breasted Green Pigeon	*Treron bicincta*			NT	PARL	M?	L?	L?	M?	**LP?**
Pompadour Green Pigeon	*Treron pompadora*			NT	ARL	M	x?	x	x	**x**
Thick-billed Green Pigeon	*Treron curvirostra*					0	0	0	L?	**0**
Yellow-footed Green Pigeon	*Treron phoenicoptera*		COM[1]	VU	ARL	M	M?	M	M	**MP**
Green Imperial Pigeon	*Ducula aenea*		COM[1]	NT	ARL	M	M?	M	M	**MP**
Finfoots (Heliornithidae)										
Masked Finfoot	*Heliopais personata*	VU	RAR[1]	CR	ARL	H	M?	H?	H	**HP?**
Rails, Crakes and Coots (Rallidae)										
White-breasted Waterhen	*Amaurornis phoenicurus*					0	0	0	L	**0**
Watercock	*Gallicrex cinerea*			NT	ARL	M?	0?	0	M?	**0**
Purple Swamphen	*Porphyrio porphyrio*				ARL	L?	0?	0	L?	**0**
Common Moorhen	*Gallinula chloropus*					0	0	0	L	**0**
Snipes, Godwits, Curlews, Sandpipers and Dowitchers (Scolopacidae)										
Snipe sp.	*Gallinago*					0	0	0	L	**0**
Spotted Redshank	*Tringa erythropus*					0	0	0	L	**0**
Marsh Sandpiper	*Tringa stagnatilis*					0	0	0	L	**0**
Common Greenshank	*Tringa nebularia*					0	0	0	L	**0**
Green Sandpiper	*Tringa ochropus*					0	0	0	L	**0**
Wood Sandpiper	*Tringa glareola*					0	0	0	L	**0**
Common Sandpiper	*Actitis hypoleucos*					0	0	0	L	**0**
Red-necked Stint	*Calidris ruficollis*					0	0	0	L	**0**
Temminck's Stint	*Calidris temminckii*					0	0	0	L	**0**
Curlew Sandpiper	*Calidris ferruginea*					0	0	0	L	**0**
Red-necked Phalarope	*Phalaropus lobatus*					0	0	0	L	**0**
Painted-snipes (Rostratulidae)										
Greater Painted-snipe	*Rostratula benghalensis*					0	0	0	L	**0**
Jacanas (Jacanidae)										
Pheasant-tailed Jacana	*Hydrophasianus chirurgus*					L? (br)	0?	0	?	**0**
Bronze-winged Jacana	*Metopidius indicus*					L?	0?	0	L?	**0**
Thick-knees (Burhinidae)										
Eurasian Thick-knee	*Burhinus oedicnemus*		RAR[1]	NT	LKL	M?	M?	M?	M?	**MP?**
Great Thick-knee	*Esacus recurvirostris*		RAR[1]	CR	ARL	M	H?	h	M	**HP**
Stilts, Plovers and Lapwings (Charadriidae)										
Black-winged Stilt	*Himantopus himantopus*					0(nbr); L?(br)	0 (nbr)	0	L (nbr)	**0**
Pacific Golden Plover	*Pluvialis fulva*					0	0	0	L	**0**
Grey Plover	*Pluvialis squatarola*					0	0	0	L	**0**
Little Ringed Plover	*Charadrius dubius*					0	0	0	L	**0**
Kentish Plover	*Charadrius alexandrinus*					0	0	0	L	**0**
Greater Sand Plover	*Charadrius leschenaultii*					0	0	0	L	**0**
Oriental Plover	*Charadrius veredus*			NT	NA	0	0	0	L	**0**
River Lapwing	*Vanellus duvaucelii*		COM[1]	VU	ARL	M	H	H	H	**HP**
Red-wattled Lapwing	*Vanellus indicus*					0	0	0	L?	**0**
Pratincoles (Glareolidae)										
[Oriental Pratincole	*Glareola maldivarum]*					L? (br)	0	0	I? (br)	**0**
Small Pratincole	*Glareola lactea*			NT	PARL	L?	M?	l?	L?	**0**
Gulls, Terns, Skimmers and Skuas (Laridae)										
Indian Skimmer	*Rynchops albicollis*	VU		VU	ARL	H	x	x	x	**x**
Brown-headed Gull	*Larus brunnicephalus*					0	0	0	L	**0**
Caspian Tern	*Sterna caspia*					0	0	0	L	**0**
River Tern	*Sterna aurantia*		COM[1]	CR	ARL	H	H	VH	H	**VHP**
Little Tern	*Sterna albifrons*		COM[1]	NT (br)?	ARL	M?	L?	L?	H	**MP?**
Black-bellied Tern	*Sterna acuticauda*	NT		CR	ARL	H	x	x	x	**x**
Whiskered Tern	*Chlidonias hybridus*					0	0	0	L	**0**
White-winged Tern	*Chlidonias leucopterus*					0	0	0	L	**0**
Hawks, Eagles and Vultures (Accipitridae)										
Osprey	*Pandion haliaetus*					0	0	0	L	**0**
Black Baza	*Aviceda leuphotes*					0	0	0	L?	**0**
Oriental Honey-buzzard	*Pernis ptilorhyncus*					0	0	0	L	**0**
Black-shouldered Kite	*Elanus caeruleus*					0	0	0	L?	**0**
Black Kite	*Milvus migrans*			EN (br)	ARL	H (br); 0 (nbr)	x	x	x	**x**
Brahminy Kite	*Haliastur indus*		COM[1]		ARL	M	M	M	M	**MP**
White-bellied Sea Eagle	*Haliaeetus leucogaster*		RAR[1]	NT	ARL	M?	L?	L?	H-L	**MP-0**
Lesser Fish Eagle	*Ichthyophaga humilis*	GNT	COM[1]	VU	ARL	M-H	M?	M+	H	**HP**
Grey-headed Fish Eagle	*Ichthyophaga ichthyaetus*	GNT	COM[1]	CR	ARL	M-H	H?	H	H	**HP**
White-rumped Vulture	*Gyps bengalensis*	CR	RAR[1]	CR	ARL	H	M	H	H	**HP**
Slender-billed Vulture	*Gyps tenuirostris*	CR		CR	ARL	H	M	H	H	**HP**
Red-headed Vulture	*Sarcogyps calvus*	CR	RAR[1]	CR	ARL	H	M	H	H	**HP**
Short-toed Snake Eagle	*Circaetus gallicus*					0	0	0	L	**0**
Crested Serpent Eagle	*Spilornis cheela*					0	0	0	L	**0**
Eastern Marsh Harrier	*Circus spilonotus*					0	0	0	L	**0**
Pied Harrier	*Circus melanoleucos*					0	0	0	L	**0**
Crested Goshawk	*Accipiter trivirgatus*					0	0	0	L	**0**
Shikra	*Accipiter badius*					0	0	0	L	**0**
Rufous-winged Buzzard	*Butastur liventer*			NT		0	0	0	L	**0**

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Grey-faced Buzzard	*Butastur indicus*					0	0	0	L	**0**
Rufous-bellied Eagle	*Hieraaetus kienerii*			NT		0	0	0	L	**0**
Changeable Hawk Eagle	*Spizaetus cirrhatus*					0	0	0	L	**0**
Falcons (Falconidae)										
Collared Falconet	*Microhierax caerulescens*					0	0	0	L?	**0**
[Eurasian Hobby	*Falco subbuteo]*					0	0	0	L	**0**
Peregrine Falcon	*Falco peregrinus*			VU (br)?		0	0	0	L	**0**
Darters and Cormorants (Anhingidae, Phalacrocoracidae)										
Darter	*Anhinga melanogaster*	NT	COM[1]	EN	ARL	M	H (nbr)	H	H (br); L? (nbr)	**MP (nbr); HP? (br)**
Little Cormorant	*Phalacrocorax niger*		COM[1]		ARL	L	M? (nbr)	L	H (br); L? (nbr)	**0 (nbr); MP? (br)**
Indian Cormorant	*Phalacrocorax fuscicollis*		COM[1]	NT	NA	M?	M? (nbr)	M?	H (br); L? (nbr)	**LP (nbr); MP? (br)**
Great Cormorant	*Phalacrocorax carbo*		COM[1]	EN	ARL	M	H (nbr)	H	H (br); L? (nbr)	**MP (nbr); HP? (br)**
Herons, Egrets and Bitterns (Ardeidae)										
Little Egret	*Egretta garzetta*					0	0	0	L	**0**
Grey Heron	*Ardea cinerea*		COM[1]		PARL (nbr)	M(br); 0 (nbr)	M	M	H (br); L (nbr)	**HP (br)**
Purple Heron	*Ardea purpurea*			VU (br)?	PARL (nbr)	M(br); 0 (nbr)	0?	0?	x? (br); L (nbr)	**0**
Great Egret	*Casmerodius albus*					0	0	0	L	**0**
Intermediate Egret	*Mesophoyx intermedia*					0	0	0	L	**0**
Cattle Egret	*Bubulcus ibis*					0	0	0	L	**0**
Chinese Pond Heron	*Ardeola bacchus*					0	0	0	L	**0**
Little Heron	*Butorides striatus*					0	0	0	L	**0**
Black-crowned Night Heron	*Nycticorax nycticorax*				PARL (nbr)	L? (br); 0 (nbr)	0?	0	x? (br); L (nbr)	**0**
Yellow Bittern	*Ixobrychus sinensis*					0	0	0	L	**0**
Cinnamon Bittern	*Ixobrychus cinnamomeus*					0	0	0	L	**0**
Black Bittern	*Dupetor flavicollis*					0	0	0	L	**0**
Ibises and Spoonbills (Threskiornithidae)										
White-shouldered Ibis	*Pseudibis davisoni*	CR	EN[1]	EW	ARL	H	H	VH	H	**VHP**
Giant Ibis	*Pseudibis gigantea*	CR		EX	ARL	H	x	x	x	**x**
Pelicans (Pelecanidae)										
Spot-billed Pelican	*Pelecanus philippensis*	NT		EN	ARL	H	L	M	L?	**LP**
Storks (Ciconiidae)										
Painted Stork	*Mycteria leucocephala*	NT		VU	ARL	M	L	L	L	**0**
Asian Openbill	*Anastomus oscitans*				ARL	L?	L	0	L	**0**
Woolly-necked Stork	*Ciconia episcopus*		COM[1]	CR	ARL	H	H?	VH?	H	**VHP?**
Black-necked Stork	*Ephippiorhynchus asiaticus*	NT	EN[1]	CR	ARL	H	M?	H?	H?	**HP?**
Lesser Adjutant	*Leptoptilos javanicus*	VU	RAR[1]	CR	ARL	H	H?	VH?	H	**VHP?**
Greater Adjutant	*Leptoptilos dubius*	EN	EN[1]	CR	ARL	H	H?	VH?	H	**VHP?**
Pittas (Pittidae)										
Blue-winged Pitta	*Pitta moluccensis*					0	0	0	L	**0**
Fairy Bluebirds and Leafbirds (Irenidae)										
Asian Fairy Bluebird	*Irena puella*					0	0	0	L	**0**
Golden-fronted Leafbird	*Chloropsis aurifrons*					0	0	0	L	**0**
Shrikes (Laniidae)										
Brown Shrike	*Lanius cristatus*					0	0	0	L	**0**
Jays, Magpies, Treepies and Crows (Corvidae: Corvinae)										
Eurasian Jay	*Garrulus glandarius*					0	0	0	L	**0**
Red-billed Blue Magpie	*Urocissa erythrorhyncha*					0	0	0	L?	**0**
Racket-tailed Treepie	*Crypsirina temia*					0	0	0	L	**0**
Large-billed Crow	*Corvus macrorhynchos*					0?	0	0	L?	**0**
Woodswallows (Corvidae: Artamini)										
Ashy Woodswallow	*Artamus fuscus*					?	0	0	L?	**0**
Orioles, Cuckooshrikes, Minivets and Flycatcher-shrikes (Corvidae: Oriolini)										
[Black-naped Oriole	*Oriolus chinensis]*					0	0	0	L	**0**
Black-hooded Oriole	*Oriolus xanthornus*					0	0	0	L	**0**
Large Cuckooshrike	*Coracina macei*					0	0	0	L	**0**
Indochinese / Black-winged Cuckooshrike	*Coracina polioptera / C. melaschistos*					0	0	0	L	**0**
Swinhoe's Minivet	*Pericrocotus cantonensis*					0	0	0	L	**0**
Ashy Minivet	*Pericrocotus divaricatus*					0	0	0	L	**0**
Small Minivet	*Pericrocotus cinnamomeus*					0	0	0	L	**0**
Scarlet Minivet	*Pericrocotus flammeus*					0	0	0	L	**0**
Bar-winged Flycatcher-shrike	*Hemipus picatus*					0	0	0	L	**0**
Fantails, Drongos, Monarchs and Paradise-flycatchers (Corvidae: Dicrurinae)										
Pied Fantail	*Rhipidura javanica*					0	0	0	L	**0**
Black Drongo	*Dicrurus macrocercus*					0	0	0	L	**0**
Ashy Drongo	*Dicrurus leucophaeus*					0	0	0	L	**0**
Bronzed Drongo	*Dicrurus aeneus*					0	0	0	L	**0**
Spangled Drongo	*Dicrurus hottentottus*					0	0	0	L	**0**

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Greater Racket-tailed Drongo	*Dicrurus paradiseus*					0	0	0	L	**0**
Black-naped Monarch	*Hypothymis azurea*					0	0	0	L	**0**
[Japanese Paradise-flycatcher	*Terpsiphone atrocaudata]*	NT		NT		0	0	0	L	**0**
Ioras (Corvidae: Aegithininae)										
Common Iora	*Aegithina tiphia*					0	0	0	L	**0**
Woodshrikes (Corvidae: Aegithininae)										
Large Woodshrike	*Tephrodornis gularis*					0	0	0	L	**0**
Thrushes and Shortwings (Muscicapidae: Turdinae)										
White-throated Rock Thrush	*Monticola gularis*					0	0	0	L	**0**
Blue Rock Thrush	*Monticola solitarius*					0	0	0	L	**0**
Flycatchers (Muscicapidae: Muscicapinae)										
Dark-sided Flycatcher	*Muscicapa sibirica*					0	0	0	L	**0**
Asian Brown Flycatcher	*Muscicapa dauurica*					0	0	0	L	**0**
[Brown-streaked Flycatcher	*Muscicapa williamsoni]*			NT	NA	?	?	?	L?	**?**
Red-throated Flycatcher	*Ficedula parva*					0	0	0	L	**0**
Verditer Flycatcher	*Eumyias thalassina*					0	0	0	L	**0**
Hill / Tickell's Blue Flycatcher	*Cyornis banyumas / tickelliae*					0	0	0	L	**0**
Robins and Chats (Muscicapidae: Muscicapinae: Saxicolini)										
Siberian Rubythroat	*Luscinia calliope*					0	0	0	L	**0**
Oriental Magpie Robin	*Copsychus saularis*					0	0	0	L	**0**
White-rumped Shama	*Copsychus malabaricus*					0	0	0	L	**0**
Common Stonechat	*Saxicola torquata*					0	0	0	L	**0**
Pied Bushchat	*Saxicola caprata*					0	0	0	L	**0**
Starlings and Mynas (Sturnidae)										
Chestnut-tailed Starling	*Sturnus malabaricus*					0	0	0	L?	**0**
White-shouldered Starling	*Sturnus sinensis*					0	0	0	L?	**0**
Asian Pied Starling	*Sturnus contra*				LKL	L?	x	x	x	**x**
Black-collared Starling	*Sturnus nigricollis*					0	0	0	L	**0**
Vinous-breasted Starling	*Sturnus burmannicus*					0	0	0	L?	**0**
Common Myna	*Acridotheres tristis*					0	0	0	L	**0**
White-vented Myna	*Acridotheres grandis*					0	0	0	L	**0**
[Golden-crested Myna	*Ampeliceps coronatus]*				PARL	L?	L?	0	M?	**0**
Hill Myna	*Gracula religiosa*			NT		L	L?	0	M	**0**
Nuthatches (Sittidae)										
Velvet-fronted Nuthatch	*Sitta frontalis*					0	0	0	L	**0**
Tits (Paridae)										
Great Tit	*Parus major*					0	0	0	L	**0**
Swallows and Martins (Hirundinidae)										
Plain Martin	*Riparia paludicola*		COM[1]	VU	ARL	M	M	M	H	**HP**
Barn Swallow	*Hirundo rustica*					0	0	0	L	**0**
Wire-tailed Swallow	*Hirundo smithii*		COM[1]	NT	PARL	M	M	M	H	**HP**
Red-rumped Swallow	*Hirundo daurica*					0	0	0	L	**0**
Striated Swallow	*Hirundo striolata*					0	0	0	L	**0**
Bulbuls (Pycnonotidae)										
Black-headed Bulbul	*Pycnonotus atriceps*					0	0	0	L	**0**
Black-crested Bulbul	*Pycnonotus melanicterus*					0	0	0	L	**0**
Sooty-headed Bulbul	*Pycnonotus aurigaster*					0	0	0	L	**0**
Stripe-throated Bulbul	*Pycnonotus finlaysoni*					0	0	0	L	**0**
Yellow-vented Bulbul	*Pycnonotus goiavier*					0	0	0	L	**0**
Streak-eared Bulbul	*Pycnonotus blanfordi*					0	0	0	L	**0**
Cisticolas and Prinias (Cisticolidae)										
Zitting Cisticola	*Cisticola juncidis*					0	0	0	L	**0**
Bright-headed Cisticola	*Cisticola exilis*					0	0	0	L	**0**
Brown Prinia	*Prinia polychroa*					0	0	0	L	**0**
Rufescent Prinia	*Prinia rufescens*					0	0	0	L	**0**
[Grey-breasted Prinia	*Prinia hodgsonii]*					0	0	0	L	**0**
Yellow-bellied Prinia	*Prinia flaviventris*					0	0	0	L	**0**
Plain Prinia	*Prinia inornata*					0	0	0	L	**0**
Warblers and Tailorbirds (Sylviidae: Acrocephalinae)										
Lanceolated Warbler	*Locustella lanceolata*					0	0	0	L	**0**
Rusty-rumped Warbler	*Locustella certhiola*					0	0	0	L	**0**
Black-browed / Manchurian Reed Warbler	*Acrocephalus bistrigiceps / A. tangorum*	0 / VU		0 / EN	0 / LKL	0 / H	0 / ?	0 / ?	L / ?	**0 / ?**
[Blunt-winged Warbler	*Acrocephalus concinens]*					0	0	0	L	**0**
Oriental / Clamorous Reed Warbler	*Acrocephalus orientalis / stentoreus*			0 / DD		0	0	0	L	**0**
Thick-billed Warbler	*Acrocephalus aedon*					0	0	0	L	**0**
Common Tailorbird	*Orthotomus sutorius*					0	0	0	L	**0**
Dark-necked Tailorbird	*Orthotomus atrogularis*					0	0	0	L	**0**
Dusky Warbler	*Phylloscopus fuscatus*					0	0	0	L	**0**
Radde's Warbler	*Phylloscopus schwarzi*					0	0	0	L	**0**
Yellow-browed Warbler	*Phylloscopus inornatus*					0	0	0	L	**0**
Grassbirds (Sylviidae: Megalurinae)										
Striated Grassbird	*Megalurus palustris*					L?	0?	0	H?	**0**

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Laughingthrushes (Sylviidae: Garrulacinae)										
White-crested Laughingthrush	*Garrulax leucolophus*					0	0	0	L	**0**
Lesser Necklaced Laughingthrush	*Garrulax monileger*					0	0	0	L	**0**
Babblers (Sylviidae: Sylviinae: Timaliini)										
Striped Tit Babbler	*Macronous gularis*					0	0	0	L	**0**
Chestnut-capped Babbler	*Timalia pileata*					0	0	0	L	**0**
Larks (Alaudidae)										
Indochinese Bushlark	*Mirafra marionae*					0	0	0	L	**0**
Flowerpeckers, Sunbirds and Spiderhunters (Nectariniidae)										
Thick-billed Flowerpecker	*Dicaeum agile*					0	0	0	L	**0**
Scarlet-backed Flowerpecker	*Dicaeum cruentatum*					0	0	0	L	**0**
Purple-throated Sunbird	*Nectarinia sperata*					0	0	0	L	**0**
Olive-backed Sunbird	*Nectarinia jugularis*					0	0	0	L	**0**
Purple Sunbird	*Nectarinia asiatica*					0	0	0	L	**0**
Sparrows (Passeridae: Passerinae)										
Plain-backed Sparrow	*Passer flaveolus*					0	0	0	L	**0**
Eurasian Tree Sparrow	*Passer montanus*					0	0	0	L	**0**
Wagtails and Pipits (Passeridae: Motacillinae)										
Forest Wagtail	*Dendronanthus indicus*					0	0	0	L	**0**
White Wagtail	*Motacilla alba*					0	0	0	L	**0**
Yellow Wagtail	*Motacilla flava*					0	0	0	L	**0**
Grey Wagtail	*Motacilla cinerea*					0	0	0	L	**0**
Mekong Wagtail	*Motacilla samveasnae*	NT	RAR[1]	DD	NA	H	H	VH	L	**MP**
Richard's / Paddyfield Pipit	*Anthus richardi / A. rufulus*					0	0	0	L	**0**
Olive-backed Pipit	*Anthus hodgsoni*					0	0	0	L	**0**
Red-throated Pipit	*Anthus cervinus*					0	0	0	L	**0**
Weavers (Passeridae: Ploceinae)										
Streaked Weaver	*Ploceus manyar*		COM[1]	NT	NA	M	M?	M?	H?	**HP?**
Baya Weaver	*Ploceus philippinus*			NT	PARL	L	M	L	L?	**0**
Asian Golden Weaver	*Ploceus hypoxanthus*	NT	RAR[1]	NT	ARL	M?	M?	M?	M?	**MP?**
Avadavat, Parrotfinches and Munias (Passeridae: Estrildinae)										
Red Avadavat	*Amandava amandava*			NT	NA	M	x	x	x?	**x**
White-rumped Munia	*Lonchura striata*					0	0	0	L	**0**
Scaly-breasted Munia	*Lonchura punctulata*					0	0	0	L	**0**
Black-headed Munia	*Lonchura malacca*		COM[1]		LKL	M	M	M	H	**HP**
MAMMALS										
Northern Treeshrew (1)	*Tupaia belangeri*					0	0	0	L	**0**
Pig-tailed Macaque	*Macaca nemestrina*	VU		NT	PARL	H	x?	x	x?	**x**
Long-tailed Macaque	*Macaca fascicularis*	NT	COM[1]		PARL	M	M?	M?	H	**HP?**
Silvered Leaf Monkey	*Semnopithecus cristatus*	DD	COM[1]	NT	ARL	M-H	H?	H	H	**HP**
Douc	*Pygathrix nemaeus*	EN		NA	ARL	H	x	x	x	**x**
Piliated Gibbon	*Hylobates pileatus*	VU		EN	ARL	H	x	x	x	**x**
Yellow-cheeked Crested Gibbon	*Hylobates gabriellae*	VU		NA	LKL	H	x	x	x	**x**
Eurasian Otter / Hairy-nosed Otter	*Lutra lutra / L. sumatrana*	NT / DD	RAR[1]	EN / CR	CARL	M?/H?	L? / M?	L? / H?	H-I	**MP-0? / HP-0?**
Smooth-coated Otter	*Lutrogale perspicillata*	VU	x[1]	VU	ARL	H	L?	M	H-I	**HP-0**
Oriental Small-clawed Otter	*Aonyx cinerea*	GNT			ARL	M?	x?	x	x?	**x**
Small Asian Mongoose	*Herpestes javanicus*					0	0	0	L	**0**
Leopard Cat	*Prionailurus bengalensis*					0	0	0	L	**0**
Leopard	*Panthera pardus*			VU	ARL	M-H	x?	x	x?	**x**
Tiger	*Panthera tigris*	EN		EN	ARL	H	x	x	x	**x**
Asian Elephant	*Elephas maximus*	EN		EN	ARL	H	x	x	x	**x**
Wild' Pig sp.(p).	*Sus*				LKL	0?	0	0	L?	**0**
Eld's Deer	*Cervus eldii*	VU	EN[1]	EW	ARL	H	L?	M?	H	**HP?**
Sambar	*C. unicolor*		COM[1]		PARL	M	L?	L	H	**MP**
Hog Deer	*Axis porcinus*		EN[1]	EN	CARL	H	H	VH	H	**VHP**
Red Muntjac	*Muntiacus muntjak*					0	0	0	L?	**0**
Gaur	*Bos gaurus*	VU		VU	ARL	H	x	x	x	**x**
Banteng	*Bos javanicus*	EN		CR	ARL	H	x	x	x	**x**
Wild Water Buffalo	*Bubalus arnee*	EN		EN	CARL	H	x	x	x	**x**
Black Giant Squirrel	*Ratufa bicolor*				PARL	L	L	0	H	**0**
Pallas's Squirrel	*Callosciurus erythraeus*					0	0	0	L	**0**
Variable Squirrel (2)	*Callosciurus finlaysonii*					0	0	0	L	**0**
Cambodian Striped Squirrel	*Tamiops rodolphii*					0	0	0	L	**0**
Berdmore's Squirrel	*Menetes berdmorei*					0	0	0	L	**0**
Giant Flying Squirrel	*Petaurista*						0	0	L	**0**
Siamese Hare (1)	*Lepus peguensis*					0	0	0	L?	**0**
Large / Lyle's Flying-fox	*Pteropus vampyrus / P. lylei*		COM[1]	VU / NT	PARL	H?	M-H?	H?	M?	**HP?**
AMPHIBIANS										
Bufonidae: true toads										
	Bufo macrotis					0	0	0	L	**0**
	Bufo melanosticus					0	0	0	L	**0**

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Ranidae: typical frogs										
	Hoplobatrachus rugulosa					0	0	0	L	**0**
	Fejervarya limnocharis					0	0	0	L	**0**
	Occidozyga lima					0	0	0	L	**0**
	Occidozyga martensii					0	0	0	L	**0**
	Rana erythraea					0	0	0	L	**0**
Rhacophoridae: Tree frogs										
	Polypedates leucomystax group					0	0	0	L	**0**
Microhylidae: Narrow-mouthed frogs										
	Glyphoglossus molossus	NT				M	0?	0	L	**0**
	Kaloula pulchra					0	0	0	L	**0**
	Microhyla berdmorei					0	0	0	L	**0**
	Microhyla butleri					0	0	0	L	**0**
	Microhyla heymonsi					0	0	0	L	**0**
	Microhyla ornata					0	0	0	L	**0**
	Microhyla pulchra					0	0	0	L	**0**
	Microhyla sp. (pending ID)	?		?	?	?	?	?	?	**?**
REPTILES										
Siamese Crocodile	*Crocodylus siamensis*	CR		CR	AR	H	x?	x?	x?	**x?**
Giant Asian Pond Turtle	*Heosemys grandis*	VU	VU[2]		PARL	H	H	VH	M	**HP**
Yellow-headed Temple Turtle	*Hieremys annandalii*	EN	EN[2]		AR	H	M?	H?	M	**HP**
Malayan Snail-eating Turtle	*Malayemys subtrijuga*	VU	VU[2]		PARL	H	M?	H?	M	**HP?**
Elongated Tortoise	*Indotestudo elongata*	EN	RAR[2]		AR	H	M?	H?	M	**HP?**
Trionychidae: Softshell turtles										
Asiatic Softshell Turtle	*Amyda cartilaginea*	VU	VU[2]		PARL	H	H	VH	M	**HP**
Cantor's Giant Softshell Turtle	*Pelochelys cantorii*	EN	VU[2]		AR	H	H	VH	M	**HP**
Flat-tailed Gecko	*Cosymbotus platyurus*					0	0	0	L	**0**
	Dixonius siamensis					0	0	0	L	**0**
Tokay	*Gekko gecko*					0	0	0	L	**0**
Spiny-tailed House Gecko	*Hemidactylus frenatus*					0	0	0	L	**0**
	Hemiphyllodactylus yunnanensis					L?	L?	0	L	**0**
Agamidae: Agamas										
Moustached Lizard	*Calotes mystaceus*					0	0	0	L	**0**
Garden Fence Lizard	*Calotes versicolor*					0	0	0	L	**0**
Indochinese Water Dragon	*Physignathus cocincinus*				PARL	L	L?	0	L	**0**
Varanidae: Monitors										
Bengal Monitor	*Varanus bengalensis*				PARL	L	L?	0	H	**0**
Water Monitor	*Varanus salvator*				PARL	L	L?	0	H	**0**
Lacertidae: Old-world lizards										
Long-tailed Lizard	*Takydromus sexlineatus*					0	0	0	0	**0**
Scincidae: Skinks										
Striped Tree Skink	*Lipinia vittigera*					0	0	0	0	**0**
Bowring's Supple Skink	*Lygosoma bowringi*					0	0	0	0	**0**
Long-tailed Sun Skink	*Mabuya longicaudata*					0	0	0	0	**0**
Speckled Forest Skink	*Mabuya macularia*					0	0	0	0	**0**
Many-lined Sun Skink	*Mabuya multifasciata*					0	0	0	0	**0**
Streamside Skink	*Sphenomorphus maculatus*					0	0	0	0	**0**
Boidae: Pythons										
Reticulated Python	*Python reticulatus*				PARL	L	L?	0	M	**0**
Colubridae: Typical snakes										
Green Cat Snake	*Boiga cyanea*					L?	L?	0	L?	**0**
Ornate Flying Snake	*Chrysopelea ornata*					0	0	0	0	**0**
Common Bronzeback	*Dendrelaphis pictus*					0	0	0	0	**0**
Radiated Ratsnake	*Elaphe radiata*					0	0	0	0	**0**
Rainbow Water Snake	*Enhydris enhydris*					0	0	0	0	**0**
	Enhydris longicauda					M?	M?	M	M?	**MP?**
Plumbeous Water Snake	*Enhydris plumbea*					0	0	0	0	**0**
Tentacled Snake	*Erpeton tentaculum*					0	0	0	M?	**0**
	Homalopsis nigroventralis					M?	L?	L?	L	**0**
Puff-faced Water Snake	*Homalopsis buccata*					0	0	0	0	**0**
Common Wolf Snake	*Lycodon capucinus*					L?	L?	0	M?	**0**
Striped Kukri Snake	*Oligodon taeniatus*					0	0	0	0	**0**
Common Rat Snake	*Ptyas mucosus*					0	0	0	0	**0**
Chequered Keelback	*Xenochrophis piscator*					0	0	0	0	**0**
Elapidae: Elapid snakes										
Banded Krait	*Bungarus fasciatus*					0	0	0	0	**0**
Viperidae: Vipers										
Malayan Pit Viper	*Calloselasma rhodostoma*					0	0	0	0	**0**
FISH										
Dasyatidae										
Giant Freshwater Stingray	*Himantura chaophraya*	VU		EN		H	H	VH	M	**HP**

English Name	Scientific Name	Global Status	Cam status	Thai Status	Lao Status	C1:Global status	C2:Relative importance	First ranking	C3: Threat	Final rank
Notopteridae										
Mekong featherback	*Chitala blanci*	NT		EN		M	H	H	L	**MP**
	Chitala ornata					0	0	0	L	**0**
	Chitala lopis			EN		M	M	m	M	**MP**
	Notopterus notopterus					0	0	0	L	**0**
Anguillidae										
	Anguilla marmorata					L	M	L	L	**0**
Clupeidae										
	Clupeichthys aesarnensis					0	N	0	L	**0**
	Corica laciniata					0	N	0	L	**0**
	Minyclupeoides					0	0	0	0	**0**
	Tenualosa thibaudeaui	EN		EN		M	M	M	L	**L**
Engraulidae										
	Lycothrissa crocodilus			VU		0	N	0	L	**0**
	Setipinna melanochir			VU		0	N	0	L	**0**
Cyprinidae										
	Paralaubuca riveroi					0	N	0	0	**0**
	Paralaubuca typus					0	0	0	0	**0**
	Paralaubuca barroni					0	0	0	0	**0**
	Macrochirichthys macrochirus			EN		M	M	M	M	**M**
	Parachela maculicauda					0	0	0	0	**0**
	Parachela siamensis					0	0	0	0	**0**
	Parachela williamainae					0	0	0	0	**0**
	Parachela sp.					0	0	0	0	**0**
	Toxabramis sp.					0	0	0	L	**0**
	Thryssocypris tonlesapensis					0	0	0	0	**0**
	Raiamas guttatus					0	0	0	0	**0**
	Opsarius pulchellus					0	0	0	0	**0**
	Amblypharyngodon chulabhornae			DD		0	0	0	0	**0**
	Chela caeruleostigmata	CR		CR		H	M?	H?	L	**MP?**
	Esomus longimana					0	0	0	0	**0**
	Leptobarbus hoevenii			VU		L	N	0	L	**0**
	Luciosoma bleekeri					0	N	0	0	**0**
	Rasbora aurotaenia					0	0	0	0	**0**
	Rasbora palustris					0	0	0	0	**0**
	Rasbora paviei					0	0	0	0	**0**
	Rasbora tornieri					0	0	0	0	**0**
	Rasbora sp.					0		0	0	**0**
	Cyprinus rubrofuscus					0	0	0	0	**0**
	Probarbus jullieni	EN		VU		M	L	L	L	**0**
Thinlip Barb	*Probarbus labeaminor*	DD	VU[2]	EN		M	H	H	L	**MP**
	Amblyrhynchichthys micracanthus					0	0	0	0	**0**
	Cosmochilus harmandi					0	L	0	L	**0**
	Cyclocheilichthys apogon					0	0	0	0	**0**
	Cyclocheilichthys armatus					0	0	L	0	**0**
	Cyclocheilichthys lagleri					0	0	0	L	**0**
	Cyclocheilichthys mekongensis					0	0	0	0	**0**
	Cyclocheilichthys enoplos					0	L	0	L	**0**
	Cyclocheilichthys furcatus					0	L	0	L	**0**
	Cyclocheilichthys repasson					0	0	0	0	**0**
	Cyclocheilichthys heteronema			VU		L	0	0	L	**0**
	Discherodontus ashmeadi			VU		L	L	0	L	**0**
	Mystacoleucus chilopterus					0	0	0	0	**0**
	Mystacoleucus marginatus					0	0	0	0	**0**
	Puntioplites falcifer					0	0	0	0	**0**
	Puntioplites proctozysron					0	0	0	0	**0**
	Sikukia gudgeri					0	0	0	0	**0**
	Sikukia stejnegeri					0	0	0	0	**0**
	Barbonymus altus					0	0	0	0	**0**
	Barbonymus gonionotus					0	0	0	0	**0**
	Barbonymus schwanenfeldi					0	0	0	0	**0**
	Hypsibarbus lagleri					0	L	0	L	**0**
	Hypsibarbus malcolmi					0	L	0	L	**0**
	Hypsibarbus pierrei					0	L	0	L	**0**
	Hypsibarbus wetmorei					0	0	0	0	**0**
	Hypsibarbus vernayi					0	0	0	0	**0**
	Onychostoma meridionale					0	?	?	?	**?**
	Poropuntius laoensis					0	0	0	0	**0**
	Scaphognathops bandanensis					0	0	0	0	**0**
	Scaphognathops stejnegeri					0	0	0	0	**0**
	Scaphognathops theunensis					0	0	0	0	**0**
	Hampala dispar					0	0	0	0	**0**

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	Hampala macrolepidota					0	0	0	0	**0**
	Puntius brevis					0	0	0	0	**0**
	Systomus aurotaeniatus					0	0	0	0	**0**
	Systomus orphroides					0	0	0	0	**0**
	Systomus partipentazona					0	0	0	0	**0**
	Thynnichthys thynnoides					0	0	0	0	**0**
	Bangana behri			VU		L	L	0	M	**0**
	Labeo pierrei			VU		L	L	0	M	**0**
	Barbichthys nitidus					0	0	0	0	**0**
	Cirrhinus jullieni					0	0	0	0	**0**
	Cirrhinus microlepis			VU		0	L	0	M	**L**
	Cirrhinus molitorella					0	0	0	0	**0**
	Labiobarbus siamensis					0	0	0	0	**0**
	Labiobarbus sp. 1					0	0	0	0	**0**
	Labiobarbus sp.2					0	0	0	0	**0**
	Labiobarbus spilopleura					0	0	0	0	**0**
	Henicorhynchus siamensis					0	0	0	0	**0**
	Henicorhynchus lobatus					0	0	0	0	**0**
	Henicorhynchus lineatus					0	0	0	0	**0**
	Henicorhynchus caudimaculatus					0	0	0	0	**0**
	Lobocheilos davisi					0	0	0	0	**0**
	Lobocheilos melanotaenia					0	0	0	0	**0**
	Morulius chrysophekadion					0	0	0	L	**0**
	Osteochilus hasseltii					0	0	0	0	**0**
	Osteochilus lini					0	0	0	0	**0**
	Osteochilus melanopleura					0	0	0	0	**0**
	Osteochilus microcephalus					0	0	0	0	**0**
	Osteochilus schlegeli			CR		L	M	L	l/m	**0/L**
	Osteochilus waandersii					0	0	0	0	**0**
	Crossocheilus reticulatus					0	0	0	0	**0**
	Crossocheilus atrilimes					0	0	0	0	**0**
	Crossocheilus sp.					0	0	0	0	**0**
	Epalzeorhynchos frenatum					0	0	0	0	**0**
	Epalzeorhynchos munense					0	0	0	0	**0**
	Mekongina erythrospila			VU		0	L	0	M	**L**
Gyrinocheilidae										
	Gyrinocheilus pennocki			VU		0	H	L	M	**L**
Balitoridae										
	Nemacheilus lateristriata					0	L	0	L	**0**
	Schistura cf. *khamtanhi*					0	L	0	L	**0**
Cobitidae										
	Syncrossus beauforti					0	N	0	L	**0**
	Syncrossus helodes					0	N	0	L	**0**
	Yasuhikotakia eos			VU		0	N	0	L	**0**
	Yasuhikotakia lecontei					0	L	0	L	**0**
	Yasuhikotakia modesta					0	L	0	L	**0**
	Acantopsis sp.1					0	L	0	L	**0**
	Acantopsis sp2					0	L	0	L	**0**
	Acantopsis sp. 3					0	L	0	L	**0**
	Acanthopsoides molobrium					0	L	0	L	**0**
	Lepidocephalichthys hasselti					0	0	0	0	**0**
	Pangio anguillaris					0	0	0	0	**0**
Bagrichthidae										
	Bagrichthys obscurus					0	0	0	0	**0**
	Bagrichthys majusculus					0	0	0	0	**0**
Bagridae										
	Hemibagrus filamentus					0	0	0	L	**0**
	Hemibagrus nemurus					0	0	0	0	**0**
	Hemibagrus spilopterus					0	0	0	0	**0**
	Hemibagrus wycki					0	L	0	L	**0**
	Hemibagrus wyckioides					0	L		L	**0**
	Hemibagrus sp.1					0	L	0	0	**0**
	Heterobagrus bocourti					0	0	0	0	**0**
	Mystus atrifasciatus					0	0	0	0	**0**
	Mystus albolineatus					0	0	0	0	**0**
	Mystus multiradiatus					0	0	0	0	**0**
	Mystus mysticetus					0	0	0	0	**0**
	Mystus singaringan					0	0	0	0	**0**
	Mystus rhegma					0	0	0	L	**0**
	Pseudomystus siamensis					0	0	0	0	**0**
	Pseudomystus bomboides					0	L	0	L	**0**
Siluridae										
	Belodontichthys truncatus					L	L	0	L	**0**
	Hemisilurus mekongensis					M	L	L	L	**0**

English Name	Scientific Name	Global Status	Cam status	Thai Status	Lao Status	C1:Global status	C2:Relative importance	First ranking	C3: Threat	Final rank
	Kryptopterus cheveyi					0	0	0	0	**0**
	Kryptopterus dissitus			EN		L	M	L	L/M	**0/L**
	Kryptopterus geminus					0	N	0	L	**0**
	Kryptopterus paraschilbeides			VU		0	L	0	L	**0**
	Micronema apogon					L	L	0	M	**L**
	Micronema bleekeri					L	L	0	L	**0**
	Micronema micronemus					L	L	0	L	**0**
	Ompok krattensis					0	0	0	0	**0**
	Ompok urbaini					L	L	0	L	**0**
	Ompok pinnatus			EN		M	M	M	L	**L**
	Wallago attu					L	0	0	L	**0**
	Wallagonia micropogon			VU		M	L	L	M	**L**
Schilbeidae										
	Laides longibarbis					0	0	0	0	**0**
Pangasiidae										
	Pangasianodon hypophthalmus			NT		0	M	L	L	**0**
Mekong Giant Catfish	*Pangasianodon gigas*	CR	RAR[2]	CR		H	M	H	H	**HP**
	Pangasius bocourti					0	0	0	L	**0**
	Pangasius conchophilus					0	0	0	L	**0**
	Pangasius mekongensis					M	L	L	L	**0**
	Pangasius krempfi					M	M	M	L	**L**
	Pangasius larnaudii			NT		0	0	0	0	**0**
Chao Phraya Giant Catfish	*Pangasius sanitwongsei*	EN		EN		H	H	VH	M	**HP**
	Pangasius macronema					0	0	0	0	**0**
	Pangasius elongatus			VU		L	L	0	L	**0**
	Pteropangasius micronemus			VU		M	M	M	L	**0**
	Pteropangasius pleurotaenia					0	0	0	0	**0**
	Helicophagus leptorhynchus					0	0	0	L	**0**
Sisoridae										
	Bagarius bagarius					0	L	0	L	**0**
	Bagarius yarrelli					0	0	0	L	**0**
	Glyptothorax lampris					0	0	0	0	**0**
Clariidae										
	Clarias batrachus			VU		0	0	0	0	**0**
	Clarias macrocephalus			VU		0	0	0	0	**0**
	Clarias meladerma					0	0	0	0	**0**
	Clarias sp.1					0	?	?	L	**0**
	Clarias sp.2					0	?	?	L	**0**
Ariidae										
Shovelnose Sea Catfish	*Hemiarius verrucosus*			EN/CR		M	H	H	M	**HP**
	Hemipimelodus borneensis					0	0	0	0	**0**
Belonidae										
	Xenentodon canciloides					0	0	0	0	**0**
Hemiramphidae										
	Hyporhamphus limbatus					0	0	0	0	**0**
Zenachopteridae										
	Dermogenys siamensis					0	0	0	0	**0**
Syngnathidae										
	Doryichthys boaja					0	0	0	0	**0**
Synbranchidae										
	Monopterus albus					0	0	0	0	**0**
Mastacembelidae										
	Macrognathus semiocellatus					0	0	0	0	**0**
	Macrognathus siamensis					0	0	0	0	**0**
	Macrognathus sp.					M	H	H	L	**MP**
	Mastacembelus armatus					0	0	0	0	**0**
	Mastacembelus cf. *armatus*					0				
	Mastacembelus favus					0	0	0	0	**0**
Ambassidae										
	Parambassis siamensis					0	0	0	0	**0**
	Parambassis wolffii					0	0	0	0	**0**
	Parambassis apogonoides					0	0	0	0	**0**
Datnioidae										
Mekong Tiger Perch	*Datnioides undecimradiatus*			EN		M	H	H	L	**MP**
Polynemidae										
	Polynemus aguilonaris			VU		0	0	0	0	**0**
	Polynemus melanochir					0	0	0	0	**0**
Scianidae										
	Boesemania microlepis					L	0	0	L	**0**
Toxotidae										
	Toxotes chatareus					0	0	0	0	**0**
Pristolepidae										
	Pristolepis fasciata					0	0	0	0	**0**

English Name	Scientific Name	Global Status	Cam status	Thai Status	Lao Status	C1:Global status	C2:Relative importance	First ranking	C3: Threat	Final rank
Gobiidae										
	Glossogobius aureus					0	0	0	0	**0**
	Papuligobius ocellatus					0	0	0	0	**0**
	Rhinogobius sp.					0				
	Oxyeleotris marmoratus					0	0	0	0	**0**
Anabantidae										
	Anabas testudineus					0	0	0	0	**0**
Helostomidae										
	Helostoma temminckii					0	0	0	0	**0**
Osphronemidae										
	Trichogaster microlepis					0	0	0	0	**0**
	Trichogaster pectoralis					0	0	0	0	**0**
	Trichogaster trichopterus					0	0	0	0	**0**
	Trichopsis vittatus					0	0	0	0	**0**
	Trichopsis schalleri					0	0	0	0	**0**
	Osphronemus exodon					L	H	M	L	**L**
Channidae										
	Channa limbata					0	0	0	0	**0**
	Channa lucius					0	0	0	0	**0**
	Channa cf. *aurolineata*					L	H	M	L	**L**
	Channa micropeltes					0	0	0	0	**0**
	Channa striata					0	0	0	0	**0**
Soleidae										
	Achiroides melanorhynchus					0	0	0	L	**0**
	Brachirus harmandi					0	0	0	0	**0**
	Brachirus aenea					0	0	0	0	**0**
	Euryglossa orientalis					0	0	0	0	**0**
	Synaptera panoides					0	0	0	0	**0**
Cynoglossidae										
	Cynoglossus microlepis					0	0	0	0	**0**
	Cynoglossus feldmani					0	0	0	0	**0**
Tetraodontidae										
	Monotrete fangi					0	0	0	0	**0**
	Monotrete turgidus					0	0	0	0	**0**
	Monotrete cambodgiensis					0	0	0	0	**0**
	Monotrete abei					0	0	0	0	**0**
	Chornerhinus nefestus					0	0	0	0	**0**
	Chornerhinus modestus					0	0	0	0	**0**
Fish species reported (but unconfirmed) in study area										
Giant Carp	*Catlocarpio siamensis*	EN	RAR[2]	EN		H	H?	VH?	M	**HP**
Largetooth Sawfish	*Pristis microdon*	CR		CR-PE		H	x	x	x	**x**
Giant Salmon-carp	*Aaptosyax grypus*	DD		CR		M	?	?	?	**?**
	Probarbus labeamajor	DD	VU[2]	VU		M	?	?	M	**M?**

ANNEX 7. VERTEBRATE TAXA WHICH MAY NO LONGER OCCUR IN THE STUDY AREA

This annex lists vertebrate taxa which may no longer occur within the study area. The historic or probable occurrence of these taxa was identified from their known distribution in Cambodia and Indochina, the presence of suitable but unoccupied habitat in the study area, and information provided by local communities. At least 26 taxa appear to have been lost from the study area: 13 birds, 11 mammals, 1 reptile and 1 fish. For most species, especially large mammals and birds, the principle causal factors for this presumed loss are probably over-hunting and habitat loss.

English Name	Scientific Name	Notes on threat level / former status	Potential conservation objective
BIRDS			
White-winged Duck	*Cairina scutulata*	Probably no longer occurs	Re-establish population
Comb Duck	*Sarkidiornis melanotos*	Probably once occurred in floodplain, may persist in small numbers	Re-establish population
Wreathed Hornbill	*Aceros undulatus*	Probably no longer occurs	Re-establish breeding population (study area too small to function alone)
Collared Kingfisher	*Todiramphus chloris*	Probably no longer occurs	Re-establish passively breeding population
Blue-throated Bee-eater	*Merops viridis*	Probably occurred as a breeding resident. Birds may occur on passage	Re-establishment of breeding population
Pale-capped Pigeon	*Columba punicea*	Enigmatic, status unknown; possibly nomadic; probably in severe global decline	Uncertain without further study, habitats may not be suitable
Pompadour Green Pigeon	*Treron pompadora*	Probably no longer occurs	Uncertain without further study
Indian Skimmer	*Rynchops albicollis*	Probably a former breeding resident; now probably locally extinct	Re-establish a breeding population
Black-bellied Tern	*Sterna acuticauda*	Probably a former breeding resident; now probably locally extinct	Nest protection on Se San & Se Kong Rivers is necessary to help re-establish breeding populations in study area
Black Kite	*Milvus migrans*	Probably a former breeding resident; small numbers may occur on passage / wintering	Re-establish a breeding population
Giant Ibis	*Pseudibis gigantea*	Historical records from Sambor; now probably locally extinct	Uncertain
Asian Pied Starling	*Sturnus contra*	Possibly once present, if so now probably locally extinct	Uncertain without further study
Red Avadavat	*Amandava amandava*	Former presence seems likely, probably much reduced in numbers if still present	Uncertain, potentially increase population levels in the study area
MAMMALS			
Pig-tailed macaque	*Macaca nemestrina*	Historically occurred; if still present likely to be extirpated given hunting trends	none
Douc	*Pygathrix nemaeus*	May have occurred, if so probably lost	Re-establish population in long-term?
Piliated gibbon	*Hylobates pileatus*	May have occurred, if so probably lost	Re-establish population in long-term?
Yellow-cheeked crested gibbon	*Hylobates gabriellae*	May have occurred, if so probably lost	Re-establish population in long-term?
Oriental small-clawed otter	*Aonyx cinerea*	Seems likely to have once occurred, may still do so but only in very small numbers	Prevent extirpation / re-establish population in long-term
Leopard	*Panthera pardus*	May have once occurred; if it persists would be in low numbers	none
Tiger	*Panthera tigris*	May have occurred, if so probably lost	none
Asian elephant	*Elephas maximus*	May have occurred, if so probably lost	none
Gaur	*Bos gaurus*	May have occurred, if so probably lost	none
Banteng	*Bos javanicus*	May have occurred, if so probably lost or in very low numbers	none
Wild water buffalo	*Bubalus arnee*	May have occurred, if so probably lost	Manage domestic buffalo to mimic habitat interactions of wild animals
REPTILES			
Siamese crocodile	*Crocodylus siamensis*	Locally reported to be “common” in 1950s. No confirmed records but recent unconfirmed reports; small numbers may persist	Re-establish in study area
FISH			
Largetooth sawfish	*Pristis microdon*	Reported to have occurred but now absent or very rare	Restore breeding populations?

ANNEX 8. PROVINCIAL WORKSHOP

From 12-13 February 2008 a workshop was held in Kratie Province, Cambodia, to present the results of the biodiversity surveys to national and provincial agencies. The workshop was convened by the Governor of Kratie Province. The specific objectives of the workshop were to:

- Present the results of the biodiversity surveys, including: survey methods and results; threats to biodiversity; the results of the ranking of "priority species"; and, team recommendations, especially in relation to the "central section".
- Enable workshop participants to discuss the results and refine the recommendations.

Agenda:
Day 1: Presentations of survey results.
Day 2: Workshop discussions on key threats and management approaches.

Thirty-five people from 17 agencies (13 government agencies and four non-government organizations) attended the workshop:

- National Fisheries Administration: Six participants, including the Inland Fisheries Research and Development Institute.
- National Forestry Administration: Three participants.
- Kratie Provincial Government: Provincial authority (3 participants, including the Kratie Governor), Provincial Rural Development Committee (2 people), Provincial Fisheries Administration (1 person), Provincial Forestry Administration (1 person), Provincial Department of Land Management, Urban Planning, Construction and Cadastral Mapping (1 person), Provincial Department of Environment (1 person), and Provincial Department of Tourism (1 person).
- Stung Treng Provincial Government: Provincial Fisheries Administration (1 person), Provincial Forestry Administration (1 person), Provincial Department of Land Management, Urban Planning, Construction and Cadastral Mapping (1 person), Provincial Department of Environment (1 person), and Provincial Department of Tourism (1 person).
- World Wide Fund for Nature: WWF Cambodia (9 people) and Mekong River Ecoregion Programme (1 person).
- Cambodia Rural Development Team: 1 person.
- Community Economic Development: 1 person.
- Mekong Discovery Trail Project: 1 person.

Key outputs:
- Awareness of the survey results and high biological values of the study area, especially the "central section", raised among national and provincial agencies.
- Collective agreement on recommendations and key next steps for conservation, especially: designation of the "central section" as a "Special Management Site" and for official declaration of the site under a *Deka* (provincial regulation); and, the need to designate a "Hog Deer protected area" as soon as possible.
- Clarification and agreement on the need for an integrated approach for management in the study area involving a range of provincial government agencies, to be led by the Fisheries Administration.
- Agreement on the need for a follow-up workshop with all participants, to develop a management strategy for the "central section", following the release of IFREDI socio-economic survey results for this area.

On 13 February 2008, after completion of the workshop, a meeting was held with the Governor of Kratie to inform him of the outcomes of the workshop. The Governor supported the outcomes and suggested that a provincial *Deka* be drafted as soon as possible for designation of the "central section" as a "Special Management Site".

WWF is one of the world's largest and most experienced independent conservation organizations, with almost 5 million supporters and a global network active in over 96 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption.