



KINGDOM OF CAMBODIA
NATION RELIGION KING

National Biodiversity Status Report



February 2016

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PREFACE

The Royal Government of Cambodia under the leadership and wisdom of **Samdech Akka Moha Sena Padei Techo Hun Sen**, Prime Minister, continues to view natural resources, including biodiversity as part of its efforts and commitments to reduce poverty and enhance economic development for Cambodia. In this regard, the Royal Government of Cambodia has ratified regional and international agreements and conventions, including the UN Convention on Biological Diversity (UNCBD), UN Framework Convention on Climate Change (UNFCCC) and UN Convention to Combat Desertification (UNCCD).

In response to commitments under the UNCBD, National Biodiversity Strategy & Action Plan (NBSAP) Updated, this National Biodiversity Status Report (NBSR) is developed to provide a context through stocktaking and assessment of Cambodia's Biodiversity. This report is divided into five chapters: 1. Introduction (Value of Biodiversity, Biodiversity Reporting, Geologic History, Mekong River, Physical Geography and Hydrology); 2. Genetic Diversity (Plant & Animal Genetic Resources); 3. Species Diversity (Plants, Invertebrates, Amphibians & Reptiles, Fish, Birds and Mammals); 4. Ecosystem Diversity (Agricultural, Aquatic, Forest, and Coastal); and 5. Bibliography.

Cambodia's first National Biodiversity Status Report was published in 2001 and provided a context for the 2002 National Biodiversity Strategy and Action Plan. The previous NBSR has also provided a starting point for this report however in 2001 many areas were data deficient so the report served more to provide theories about biodiversity, and included specialist inputs but lacked much hard data for comparison in this report. Information needs for updating the NBSR were through contributions and efforts from the concerned governmental ministries and non-governmental agencies working in the fields of environment and natural resources, in particular biodiversity in the Kingdom of Cambodia. This was coordinated by the International Conventions and Biodiversity Department currently name as Department of Biodiversity.

On behalf of the Ministry of Environment and the National Biodiversity Steering Committee¹, I would like to express my high appreciation to Excellencies, ladies and gentlemen from the line ministries, international organizations, non-governmental organizations, development partners and academia who provided data and information, including supporting references for the successful development of this National Biodiversity Status Report.

I would like to acknowledge the National Biodiversity Steering Committee members for their facilitation and coordination of the remarkable interventions on biodiversity activities and development of this report, with support from the Biodiversity Technical Working Group. My special thanks are due to other relevant stakeholders and the experts for their efforts in contributing to important inputs and comments on the preparation of the report so that it even truly reflects the biodiversity situations in the Kingdom of Cambodia. I would like to express my sincere thanks to USAID funded Harvest program and UNEP/GEF for their important cooperation and financial assistance for this successful report preparation.

Last but not least, this is a living document and like other life it needs resources to live. I would like to take this opportunity to encourage the cooperation and collaboration among all partners and allocation of resources to develop agreed terminology for systematic databases of biodiversity information so as to better facilitate the monitoring and management of biodiversity in the future.

Phnom Penh *February 04, 2016*


Say Samal

Minister of Environment, and
Chairman of National Council for Sustainable Development

¹ National Biodiversity Steering Committee has been invalidated by Subdecree N° 59 dated 18 May 2015 and merged into National Council for Sustainable Development

ACKNOWLEDGEMENT

This, the second National Biodiversity Status Report is to support the National Biodiversity Strategy & Action Plan and is the result of combined efforts and commitments made by the government institutions, stakeholders, biodiversity specialists, and non-governmental agencies.

The National Council for Sustainable Development (NCSD)/Ministry of Environment expresses its most sincere thanks and appreciation to **H.E Say Samal**, the Minister for the Ministry of Environment and Chairman of National Council for Sustainable Development for his brilliant leadership and initiatives on nationwide conservation and protection of natural resources, especially biological diversity, which is part of Royal Government's commitments to the Convention on Biological Diversity, as well as constant encouragement and support for the successful development of this report. Special thanks are conveyed to **H.E. Dr. Mok Mareth**, former Minister of Environment & former Chairman, and to members of National Biodiversity Steering Committee² (NBSC) for their guidance and advice.

We would like to express our deep thanks to **H.E Chay Samith**, Delegate of the Royal Government of Cambodia in charge of the General Directorate of Administration for Nature Conservation and Protection, **H. E. Dr. Tin Ponlok**, Secretary General of National Council for Sustainable Development, **H.E Ouk Seiha**, Chairwoman of the multi-sectorial Technical Working Group on NBSAP Updating (TWG-NBSAP), for their supports and encouragement. We would also acknowledge to the important work and significant support of the members of the TWG-NBSAP.

Importantly, we would like to express our sincere gratitude to the consultants **Mr. Jady Smith** for compiling, drafting and editing the report and **Mrs. Ly Vichuta** for assisting with data collection and validation, and key staffs of the Department of Biodiversity for their commitments and contributions to the whole preparation and development of NBSR process, especially **Mrs Ken Bopreang** for coordinating updating of the species lists. There has also been direct support from biodiversity specialists including: Genetic Diversity (**Mr. Ty Channa**), Plants (**Mr. Khou Eanghourt & Mr. Chhang Phourin**), Invertebrates (**Dr. Ing Try, Dr. Kath Jensen, Mr. Hun Seiha, Mr. Oleg Kosterin and Mr. Stephan De Greef**), Amphibians & Reptiles (**Mr. Neang Thy**), Fish (**Mr. Uy Ching and Mr. You Chanpraseth**), Birds (**Mr. Frederic Goes & Mr. Tan Setha**), and Mammals (**Mr. Meng Monyrak and Mr. Neil Fury**). Without the regular and effective involvement of these people, this report would not be sufficient and produced on time.

We acknowledge with thanks to all contributors and stakeholders from concerned ministries, international organizations, non-governmental organizations, local authorities, communities and Indigenous people for their participation and technical inputs in the formal and informal consultation processes, National Consultation Workshops, meetings toward preparation and consolidation of this National Biodiversity Status Report.

Our great thanks are conveyed to Global Environment Facility (GEF) through United Nations Environment Programme (UNEP), and USAID funded Harvest Program (**Mr. Matt Maltby**) for

² National Biodiversity Steering Committee has been invalidated by Subdecree N° 59 dated 18 May 2015 and merged into National Council for Sustainable Development.

their financial and technical supports to the preparation of this report. Without the substantial supports of many partners it would have been difficult to achieve Cambodia's National Biodiversity Status Report. In this regard we would like to highlight the very significant sharing of biodiversity data from Fauna and Flora International and commend them on their work with the Royal University of Phnom Penh on the Biodiversity Masters program and the Cambodian Journal of Natural History.

I also would like to thank the members of Secretariat of the NBSC and all staffs of Department of Biodiversity for their commitments, hard and active work, and patience for the successful development of this report. Finally, I wish to thank all experts for their valuable time and efforts to provide significant ideas and feedbacks during the preparation and development process of the National Biodiversity Status Report to support Cambodia's commitments to the UN Convention on Biological Diversity.

Phnom Penh, 26 January 2016



H.E Somaly CHAN

Project Director, and

Deputy Secretary General

National Council for Sustainable Development/
Ministry of Environment

NATIONAL BIODIVERSITY STEERING COMMITTEE (NBSC)

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H.E Kim Chhaihieng	Deputy Governor, Siem Reap Province	Member
H.E So Neak	Deputy Governor, Ratanakiri Province	Member

TECHNICAL WORKING GROUP ON NBSAP UPDATING

H.E Ouk Seiha	Assistant to the Minister, Ministry of Environment	Chair
H.E Chan Somaly	Deputy Secretary General, National Council for Sustainable Development (NCSD)	Vice Chair
Mr. Ung Sam Oeun	Deputy Director, Department of Administration, Planning and Finance, General Secretariat of National Council for Sustainable Development	Secretary
Mr. Kim Chantharith	Deputy Director, National Institute of Statistics of the Ministry of Planning	Member
Mr. So Veasna	Deputy Director, Department of New and Renewable Energy, Ministry of Mines and Energy	Member
Mr. Chheang Dany	Deputy Director, Department of Wildlife and Biodiversity, Ministry of Agriculture, Forestry and Fisheries	Member
Mr.Thuch Phanhchaksokhavith	Deputy Chief of Office, Multilateral Cooperation 2, Ministry of Economy and Finance	Member
Mr. Suon Sam Aun	Chief of Administration Office, Department of Water Resource Management and Conservation, Ministry of Water Resources and Meteorology	Member
Mr. Ou Manira	Deputy Director, Department of Planning and Public Relations, Ministry of Rural Development	Member
Mr. Bou Chan Serey	Deputy Director General, Ministry of Tourism	Member
Mr. Choun Vanna	Vice Chief of Science Office, Department of Curriculum Development, Ministry of Education, Youth and Sport	Member

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EXECUTIVE SUMMARY

The Royal Government of Cambodia has made biodiversity a priority: as stated in the constitution:

“The state shall protect the environment and balance of abundant natural resources and establish a precise plan of management of land, water, air, wind geology, ecologic systems, mines, energy, petrol and gas, gems, forests and forest products, wildlife, fish and aquatic resources” article 59 of the Constitution (CDRI 2010).

Despite a growing account of Cambodia’s biodiversity, the full extent of Cambodia’s biodiversity is not yet known. Cambodia is thought to have a rich diversity of species given its tropical location and extensive field surveys continue to find new species, which is also highlighting significant data gaps. Compared with neighbouring countries of Thailand and Vietnam, Cambodia has a low population density and relatively large natural areas that are still intact. Natural resources, agriculture and tourism are mainstays of Cambodia’s economy; but in recent history, many of Cambodia’s natural resources have been heavily exploited and are being rapidly degraded.

The first comprehensive step towards compiling existing information on biodiversity in Cambodia was made in 1997 with the IUCN publication of the National Biodiversity Prospectus by David Ashwell. Since the development of the Prospectus, there has been relative stability in the country and this combined with strong donor support and government willingness to work towards conservation and sustainable development has helped to increase the quality of biodiversity information. In 2001, as part of the GEF/FAO Cambodia Biodiversity Enabling Activity, Cambodia’s Biodiversity Status Report; *Every Living Thing*: sought to provide a more comprehensive assessment of biodiversity than was possible for the Prospectus, but this report was still limited.

The Convention on Biological Diversity’s second meeting of parties called for the preparation of a periodic report on biological diversity: the Global Biodiversity Outlook (GBO). It suggested that the GBO should provide a summary of the status of biological diversity and an analysis of the steps being taken by the global community to ensure that biodiversity is conserved and used sustainably, and that benefits arising from the use of genetic resources are shared equitably. Three editions of the report have been prepared and preparations for the fourth edition are currently underway. The contents of these GBO reports has helped to guide the contents for this Status Report on Cambodia’s biodiversity.

In response to commitments under the UNCBD, National Biodiversity Strategy and Action Plan (NBSAP) Updating, this National Biodiversity Status Report (NBSR) is developed to provide a context through stocktaking and assessment of Cambodia’s Biodiversity. This NBSR for Cambodia is divided into five chapters: 1. Introduction (Value of Biodiversity, Biodiversity Reporting, Geologic History, Mekong River, Physical Geography and Hydrology); 2. Genetic Diversity (Plant & Animal Genetic Resources); 3. Species Diversity (Plants, Invertebrates, Amphibians & Reptiles, Fish, Birds and Mammals); 4. Ecosystem Diversity (Agricultural, Aquatic, Forest, and Coastal); and 5. Bibliography.

GENETIC DIVERSITY: The previous NBSR (RGC 2001) provided a very broad overview of genetic diversity in Cambodia and highlighted the potential significance of genetics in agricultural diversity for domestic plants and animals and also wild relatives of some domesticated plants and animals. There was limited in-situ and ex-situ work on genetic diversity in 2001 and while this is still low there are some areas of improvement. There is a positive trend toward increased understanding of genetic diversity and the importance for conservation but still limited use for domestic and commercial plants and animals.

Plant Genetic Diversity: The previous status was derived from the FAO Status of Plant Genetic Resources (2000). In-situ conservation was considered non-existent and the only known ex-situ resources was 2557 accessions of local rice germplasm held by the International Rice Research Institute in the Phillipines. The current status was drawn from the CARDI report *Conservation and Utilization of Plant Genetic Resources for Food and Agriculture in Cambodia*’ (2011). Significantly, this report showed that there were now ex-situ resources in country including, 3313

accessions (ex-situ at CADRI) and Kbal Koh Vegetable Research Station has some in-situ conservation. There are also plans for herbaria and botanical gardens (links with Kew gardens).

Animal Genetic Diversity: The previous status was derived from the FAO Domestic Animal Diversity Information System (1998) and Domestic Livestock report by Maclean (1998). These highlighted the presence of 4 Cattle species, 3 Pigs, Buffalo, Horse, Goat, Chicken, Duck, Goose, and Turkey. Wild relatives were also identified including: wild cattle, water buffalo, boar and the Red Jungle Fowl, the wild chicken. The '*Environmental Animal Health Monitoring Initiative*' (RUA/FAO 2011), has reinforced some of the previous status information for domestic animals. In regards to conservation, DNA Sampling of 69 crocodiles in captivity to identify the pure Fish-eating Hill Crocodile (*C. siamensis*) crocodiles has had positive results: 34 Siamese, 32 Hybrid with Estuarine, and 3 Hybrid with Cuban. Fecal DNA studies of wild elephants have been used to estimate a population of 400-600 elephants in Cambodia. The most positive trend is the innovative use of DNA for crocodile and elephant research, but need more research on commercial animals and wild relatives.

SPECIES DIVERSITY: The previous NBSR (RGC 2001) provided a very broad overview of species diversity in Cambodia with some chapters directly from relevant specialists. There were few actual species list available so limited status to compare with. Significant increases in species knowledge, with increased capacity and research. The major gaps in invertebrate species knowledge and Endemism in species. While most is known about species, new species are still being found and there are significant gaps in invertebrate and plant species knowledge. Overall, there is a positive trend toward increased species numbers and knowledge but with this knowledge there are also potential extinctions becoming apparent.

Plant Diversity: Dr Philip Rundel provided excerpts from the WWF report "Towards a vision for Biodiversity Conservation in the Forests of the Lower Mekong Ecoregion Complex." (WWF 2001), for the previous NBSR. As the plant species were not well covered, another section was compiled on 'Useful Plant Species in Cambodia'. In regards to the current status, Forestry Administration staff Khou Eanghourt and Chhang Phourin have worked to compile a more thorough list of known plant species for Cambodia. Some data on plants through a Forestry Administration and Korean project is still being processed, but may provide a significant increase in documented plant species for Cambodia. Little is known about the status of plant species but Siamese Rosewood and other luxury timbers have been heavily targeted and are likely to be in decline. There is a positive trend toward increasing the plant knowledge and there are 3113 plant species currently listed for Cambodia.

Invertebrate Diversity: The previous NBSR section on invertebrates was compiled by Ruth O'Connor (RGC 2001) and had focus on aquatic macro-invertebrates. This provided some understanding of some of the major freshwater macro-aquatic invertebrate families but further highlighted the lack of invertebrate data for Cambodia. The current status of invertebrates while still weak is an improvement on the past thanks to the work of a range of specialists including: Dr Ing Try & Dr Kath Jensen (aquatic invertebrates), Hun Seiha (Moths & Butterflies), Oleg Kosterin (Dragonflies) and Stephan De Greef (Ants). The trend is toward an increasing understanding of invertebrate species, however this is the most significant gap area for species. There are 671 invertebrates currently listed for Cambodia.

Amphibian & Reptile Diversity: Dr Bryan Stuart assisted with the previous NBSR (RGC 2001) section and has amphibian and reptile collections from Cambodia at the Chicago Field Museum in America. The research on Amphibians and Reptiles has been ably continued by the Ministry of Environment's Neang Thy, who has also identified several species new to science and/or Cambodia. The status of Amphibians was greatly assisted with Fauna & Flora International publication "A Field Guide to the Amphibians of Cambodia" by Neang Thy and Jeremy Holden. The trend for reptile and amphibian species understanding is positive and has also been assisted by Va Longdy with his work on sea turtles. In regards to amphibians a guide has been developed and a reptile guide is currently underway. Optimistically, there is also a trend toward the release of key reptile species back into the wild. As part of the Cambodia Crocodile Conservation Project, Phnom Tamao Wildlife and Rescue Centre and Fauna Flora International have released Fish-eating Hill Crocodiles (*Crocodylus siamensis*), while the Fisheries Administration have worked with Conservation International to release Cantor's softshell turtle,

(*Pelochelys cantorii*) and with the Wildlife Conservation Society have released the Southern River Terrapin (*Batagur affinis*) back to the wild. There are 72 amphibians and 173 reptiles currently listed for Cambodia.

Fish Diversity: The previous NBSR (RGC 2001) had a non-technical section on fish, written by Jady Smith, Uy Ching and John Valbo-Jorgensen, which sought to give an overview of knowledge on fish species status in Cambodia. There was no delineation made between freshwater and marine species but it was noted that more data was available for freshwater fish species. The Fisheries Administration have worked with World Fish and IFREDI in developing a comprehensive fish species list for Cambodia. There are growing concerns that the trend in reducing fish species diversity is a sign of unsustainable harvest and potentially a tipping point for the fishery. Furthermore, there is a trend toward increased damming of the Mekong and its tributaries, which could further impact fish species diversity as stream flows and migration routes are altered. As highlighted in Cambodia's Fifth National Report to the Convention on Biological Diversity, the Government has taken quite strong action, by removing the previous fishing concessions on the Tonle Sap Lake while also promoting aquaculture and community fisheries. This is a positive trend showing. The Government has acknowledged the significance of the fishery to the people and is acting to better manage the resource. Fish diversity in Cambodia, across both fresh and salt water systems includes 1357 species.

Bird Diversity: The previous NBSR (RGC 2001) section on birds was developed by Colin Poole of the Wildlife Conservation Society. The current NBSR section on birds has been developed by Frederic Goes, with review and feedback from Tan Setha. The bird section is based on and updated from "The Birds of Cambodia: An Annotated Checklist" (Goes 2013), which is a significant biodiversity resource for Cambodia. Protection of breeding colonies and nests has been part of the successful approach to conservation used at Prek Toal and in the northern plains, but has not worked in other sites. The recent decision to abolish all fishing concessions within the Tonle Sap could also undermine over ten years of successful conservation efforts through unrestricted access to flooded forest areas formerly protected for commercial fishing had led to increased disturbance and resurgence of egg and chick collection. In addition to these setbacks, bird conservation actions must increasingly encounter new challenges. Rapid development has shifted threats from local and species-focused issues to those associated with landscape-level changes. The latter come in various forms (e.g., grassland conversion to rice cultivation; the leasing of large forest areas for commercial plantations; and the construction of hydroelectric dams), but invariably create large-scale threats to habitats and the wildlife those habitats support. Birds seem to be the most well researched of the species lists, (including field guides and checklists from 1998, 2003 and 2014) but even recently a new species was identified in Phnom Penh. There are 601 bird species currently listed for Cambodia, with 7 on the new global Evolutionally Distinct and Globally Endangered (EDGE) list.

Mammal Diversity: The previous NBSR (RGC 2001) separated terrestrial (Joe Walston) and marine mammals (Pete Davidson and Isabel Beasley). This section was a mix between providing a basic understanding of mammals, while also providing some information of their status at the time. The previous mammal data, which includes the now questionable K'Ting Vor, place greater importance on setting an agreed national mammal list. New mammal species are still being uncovered in Cambodia, and Neil Fury helped to highlight some of the specialist work on bats, for which 72 species have now been identified, which is more than the total for mammals in 2001. There have been significant mammal finds since 2001, which seem likely to continue, but with fewer new mammal species expected. In 2008, a Wildlife Conservation Society (WCS 2008) survey of the Seima Protected Forest identified previously unknown and internationally significant populations of black-shanked doucs and yellow-cheeked crested gibbons. While there has been important mammal research, it has not been systematically collected and has not been effectively shared among relevant stakeholders. The decline in Dugong and River Dolphins are concerning indicators for marine mammals in Cambodia. There is a need for classification standards and national discussions around the mammal list including potential extinctions such as Kouprey and Rhinoceros. Mammal diversity in Cambodia, across both terrestrial and marine systems includes 162 species.

No.	Species	Data Collected	General %
1	Plants	3113	50.5%
2	Invertebrates	671	11%
3	Amphibians	72	1%
4	Reptiles	173	3%
5	Fishes	1357	22%
6	Birds	601	10%
7	Mammals	162	2.5%
Total species collection		6149	100%

ECOSYSTEM DIVERSITY: The 2001 NBSR (RGC 2001) provided a broad overview of ecosystem diversity, with more emphasis on the theory than actual status of agricultural, wetland, forest, and coastal ecosystems. In the absence of hard data, the previous status report developed the initial concepts of ecosystem services. The improving national land use mapping greatly assists an overview of ecosystems but this is limited due to the lack of agreed definitions, and limited research. The Ministry of Environment has started to highlight ecosystems and their services, but this is still as a major gap area. Furthermore, within the ecosystems there are smaller habitats such as Karst areas of high biodiversity potential, but these are vulnerable to disturbance. As a generalized statement, the overall trend in ecosystems has seen a shift toward more human use of ecosystems: increasing agricultural, commercial and extractive use.

The National Biodiversity Status report has sought to identify the status and current trends for Cambodia's Biodiversity. With the time and resources available, we are only able to provide an overview but from the data collected it is clear that there is now greater understanding of Cambodia's biodiversity, but still significant gaps in data and coordination. There are some individuals that mostly through their own passion have greatly helped to provide a clearer picture of Cambodia's diversity. New programs such as the RUPP Masters in Conservation, Centre for Biodiversity Conservation and the Cambodian Journal of Natural History are very positive developments. This data needs to be better consolidated and shared within Government in support of biodiversity management, the Clearing House Mechanism and National Biodiversity Status Report Update should help with this.

1. INTRODUCTION

BIODIVERSITY = EVERY LIVING THING

The terms biological diversity or biodiversity have the same meaning, and are defined in many ways by many different authors. The broad definition of biodiversity allows for near limitless scope. Following are just a few of the many definitions for biodiversity;

"Biological diversity means the variability among living organisms from all sources including, (inter alia,) terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." (Convention on Biological Diversity)

"Biodiversity is defined as all hereditarily based variation at all levels of organization, from the genes within a single local population or species, to the species composing all or part of a local community, and finally to the communities themselves that compose the living parts of the multifarious (*diverse*) ecosystems of the world." Reaka-Kudla et al p1 1997.

The Royal Government of Cambodia has made biodiversity a priority: as stated in the constitution: "The state shall protect the environment and balance of abundant natural resources and establish a precise plan of management of land, water, air, wind geology, ecologic systems, mines, energy, petrol and gas, gems, forests and forest products, wild life, fish and aquatic resources" (article 59 of the Constitution) (CDRI 2010).

Despite a growing account of Cambodia's biodiversity over the past 13 years, the full extent of Cambodia's biodiversity is not yet known. Cambodia is thought to have a rich diversity of species given its tropical location and extensive field surveys continue to find new species highlighting significant data gaps. Compared with neighbouring countries of Thailand and Vietnam, Cambodia has a low population density and relatively large natural areas that are still intact. Natural resources, agriculture and tourism are mainstays of Cambodia's economy; but in recent history, many of Cambodia's natural resources have been heavily exploited and are being rapidly degraded.

The cultural significance of biodiversity, and historical importance of natural resources in Cambodia is represented in the many detailed stone carvings in the bas-relief's of Angkor. Other historical records would also be expected in Khmer and may date back much earlier than what is represented in this report, however this report has been limited to modern historical scientific literature related to the Biodiversity of Cambodia.

The historical information of a scientific nature that does exist is not comprehensive, however; scientific research on plants, birds and mammals was undertaken during French colonization, and more importantly it is currently being undertaken. Over the past few years several international organizations have been active in assisting the Royal Government of Cambodia to better understand and sustainably utilize its rich biodiversity. While the knowledge of biodiversity in Cambodia is growing some data gaps still remain.

Value of Biodiversity

Biodiversity supports human societies from ecological, economical, cultural and spiritual perspectives. Despite their importance, however, ecosystems are being degraded and species and genetic diversity reduced at an alarming rate due to the impact of our growing human population and increasing resource consumption rates. The global decline of biodiversity is now recognized as one of the most serious environmental issues facing humanity.

Every ecosystem provides habitat for plants, animals and microorganisms which we can use or which perform useful functions. The World Resources Institute calls ecosystems "the productive engines of the planet, providing us with everything from the water we drink to the food we eat and the fiber we use for clothing, paper, or wood for construction (WRI 2000).

Biodiversity is used in many ways and as such there are numerous ways to value biological diversity. While it is not difficult to assign a value to biological resources that are available on markets, such as rice, wood, medicines, etc., there are many functions that cannot be so easily measured in monetary terms, (for example, ecosystem services or social benefits). For many

people who rely on the benefits provided by ecosystems for their daily subsistence, placing a realistic monetary value on these goods and services would prove very difficult.

Reporting on Biodiversity Status

The Convention on Biological Diversity's second meeting of parties called for the preparation of a periodic report on biological diversity: the Global Biodiversity Outlook (GBO). It suggested that the GBO should provide a summary of the status of biological diversity and an analysis of the steps being taken by the global community to ensure that biodiversity is conserved and used sustainably, and that benefits arising from the use of genetic resources are shared equitably. Three editions of the report have been prepared and preparations for the fourth edition are currently underway. The contents of these documents helped guide the contents for this Status Report on Cambodia's biodiversity.

The area best known is Species Diversity, but an exact figure for species is still some way off. There is estimated to be 10 million species, but scientists estimate that there could be anything from 5 to 30 million species. Many species are tiny, and inconspicuous such as bacteria, and invertebrates, but their significance in terms of life can not be underestimated with invertebrates thought to make up 90% of species diversity. Indeed, Cambodia may contain many species that are not known to science, but most of these would likely be very small, but still larger species including mammals and reptiles are regularly being recorded and a new species of bird was just confirmed in the capital city. The more people look the more biodiversity they find, but we also won't know how much is lost as we may be losing species faster than they are being identified.

The first comprehensive step towards compiling existing information on biodiversity in Cambodia was made in 1997 with the IUCN publication of the National Biodiversity Prospectus by David Ashwell. Since the development of the Prospectus, there has been relative stability in the country and this combined with strong donor support and government willingness to work towards conservation and sustainable development has helped to increase the quality of biodiversity information. In 2001 as part of the GEF funded Cambodia Biodiversity Enabling Activity, Cambodia's Biodiversity Status Report; Every Living Thing: sought to provide a more comprehensive assessment of biodiversity than was possible for the Prospectus, but this was still limited.

With the assistance and support of a variety of organizations and projects, this report seeks to give up to date information on biodiversity status in Cambodia. The rate at which knowledge is increasing, the limitations of budget and human resource and the sheer magnitude of the topic have reduced our ability to provide an all-inclusive Biodiversity Status Report, however it is hoped that what information is provided will give a representative indication of what is and isn't known about biodiversity in Cambodia.

This National Biodiversity Status Report is broken into the following major sections on Biodiversity; Introduction, Trends in Genetic Resources, Trends in Species Diversity, and Trends in Ecosystem Diversity. It is hoped that the information in this report helps to increase knowledge of biodiversity and assists in promoting the use protection and management of biodiversity for sustainable development in Cambodia. It should be noted that as scientific knowledge advances the terminology used is often changing as well, this may see some variation in the nomenclature and terminology summarized from the previous Status Report (2001) to the current use in this document.

As a Status Report this document seeks to compile available existing work on Cambodia's biodiversity. The document is therefore a representation of the existing knowledge and strengths and weaknesses of that knowledge in relation to biodiversity. Wherever possible the status report is based on the most currently available information, but as biodiversity knowledge is increasing rapidly this information should only be seen as a guide. It is intended to provide a "snapshot" of the current state of knowledge, to provide a framework for the future filling in of information gaps, and to highlight major management and conservation priorities.

It should be noted that this is a rapid revision of Cambodia's National Biodiversity Status Report (NBSR) that draws significantly on the previous NBSR 2001. A lack of consolidated species lists for Cambodia has meant much of the energy in conducting the status review was based on

developing updated species list, which has been quite successful as shown in the table below. This report is more of a supporting document to those lists.

No.	Species	Data Collected	General %
1	Plants	3113	50.5%
2	Invertebrates	671	11%
3	Amphibians	72	1%
4	Reptiles	173	3%
5	Fishes	1357	22%
6	Birds	601	10%
7	Mammals	162	2.5%
Total species collection		6149	100%

This snapshot of biodiversity status in Cambodia is designed to support the current review process of Cambodia's National Biodiversity Strategy and Action Plan (NBSAP). Furthermore, this process highlighted the fragmented and ad-hoc approach to biodiversity data collection and reporting and it is hoped lessons from this will be reflected in the NBSAP.

In many ways this document serves as a testimony to the positive work that many International and Non Government Organizations have been conducting with the Royal Government of Cambodia. The document would not be possible without the support, assistance and information sharing of these organizations, and especially the cooperation and commitment of the Government.

In the future more resources are needed so as to better link with new opportunities to better understand, manage and sustainably use Cambodia's biodiversity. The Cambodian Journal of Natural History is Cambodia's first peer-reviewed scientific journal, launched in 2008 as a partnership between the Royal University of Phnom Penh and Fauna & Flora International, as part of a University Capacity Building Project. This journal reflects the trend toward the development of a more effective platform for sharing species information across institutions and organizations. There is also an active facebook page Natural Cambodia. These and many other biodiversity related activities all have the potential to help develop a more comprehensive understanding of Cambodia's biodiversity. The Ministry of Environment also recently outlined an updated Clearing House Mechanism, which will better be able to collect and share species information.

Southeast Asia & Cambodia

Philip W. Rundel, PhD

Excerpts from: Baltzer, M.C., Nguyen Thi Dao and Shore R.G. (Eds.) 2001. *Towards a vision for Biodiversity Conservation in the Forests of the Lower Mekong Ecoregion Complex*. WWF Indochina Programme, Hanoi, Vietnam.

Geologic History

Mainland Southeast Asia forms a primary geomorphological unit underlain by a nucleus of Pre-Cambrian crystalline rock that consolidated to form a stable core area in Late Triassic times. This unit, variously designated as the Southeast Asian or Sundaland prong of the Eurasian Plate, extends from the Andaman Islands to the west across Burma, Thailand, Cambodia and Lao to northern Vietnam... The oldest rocks of Indochina are the metamorphic crystalline complexes formed in Pre-Cambrian and early Paleozoic periods of geologic activity. Basement

crystalline rock is also exposed today near Pailin in western Cambodia... Shallow seas covered much of central and northern Indochina during the late Paleozoic, leading to the formation of extensive deposits of limestone. Spectacular karst topography developed today across eastern Lao and northern and central Vietnam is formed of limestone from the Permian. Marine transgressions continued into the Triassic, with seas covering eastern Cambodia and parts of southern Vietnam. Continental formations characterized as red beds (terrain rouge) were also deposited over widespread areas at this time in Cambodia and southern Vietnam (Fontaine and Workman 1978).

Core highland areas of Indosinia experienced steady erosion from the late Triassic through the Jurassic and Cretaceous into the early Tertiary, with an inland sea covering much of northeastern Thailand and portions of Lao and Cambodia. Similar marine basins formed in northern and southern Vietnam. Local volcanic activity was also present over this period. The deposition of terrestrial sediments into these inland seas produced extensive sandstones that are exposed today in the Khorat Plateau of northeastern Thailand and the Cardamom Mountains of Cambodia. Other important basins of such sediments include the Lomphat Basin of eastern Cambodia and the Tu Le and Au Chau Basins of northern Vietnam... The lake basin of Tonle Sap in Cambodia was formed in the Pleistocene by subsidence along a northeast-southwest trending fault line. Holocene deposits of continental origin cover an extensive area of the Tonle Sap basin in central Cambodia. Holocene alluvium of increasing amounts extends down the Mekong River from Cambodia, reaching up to about 100 m depth at the delta.

Mekong River System

The Mekong ranks as one of the great rivers in Asia, and indeed of the world. From its origins in the Himalayas of southern China, it flows southward through six countries in its 4,200 km course to the South China Sea. In terms of its length, the Mekong rates as the twelfth longest river in the world. It ranks even higher in terms of its mean annual discharge (about $475 \times 10^9 \text{ m}^3 \text{ yr}^{-1}$) where it is sixth in the world (Pantulu 1986). The hydrology of the Mekong provides an interesting pattern of flow that separates this river from smaller Southeast Asian Rivers that lack the Himalayan source of its drainage. Although the upper Mekong basin above the Burma-Lao-Thailand border provides only 20% of the annual flow (in 26% of the total drainage basin), the snowmelt source of this flow provides a fairly steady discharge throughout the year. The lower Mekong basin has inputs solely from rainfall, and thus exhibits far sharper seasonal changes in water supply.

Physical Geography

Cambodia is positioned between Thailand and Vietnam in Southeast Asia, straddling a length of the Mekong River. The northeast margin of Cambodia abuts Laos, and the southern margin lies along the Gulf of Thailand. The total area of Cambodia is 181,035 km², just over half the size of Vietnam. The coastline of Vietnam along the Gulf of Thailand extends for 443 km.

The largest areas of lowlands are the extensive flat sandstone plains and rolling terrain that covers much of northern and northeastern Cambodia. These plains are composed of continental and marine sediments of Upper Mesozoic age. This terrain is broken by scattered flat-topped sandstone hills and rounded hills formed of andesite or basalt. A large area of alluvial plains surrounding Tonle Sap and the Mekong River form a second physiographic unit, with these low-lying wetlands at 5-30 m elevation receiving annual flooding and associated deposition of silt. The final two lowland areas are the Battambang plain of western Cambodia, with its fertile soils, and the basaltic areas near Kompong Cham in eastern Cambodia. Together, these five lowland regions cover more than 75% of Cambodia.

The coastal ranges of southwestern Cambodia comprises the largest and highest upland unit of the country. The Cardamom Mountains (Chhor Phnom Krâvanh) and Elephant Mountains (Chhor Phnom Damrei) form these coastal mountains, reaching to 1,150 m elevation in the latter. The orientation of their topography along the Gulf of Thailand produces unusually wet conditions on the southwestern slopes of these ranges. Also included to the northeastern part of this mountain unit are granite ridges that reach a maximum elevation of 1,813 m at Phnom Aural, the highest point in Cambodia. The fourth upland unit of Cambodia comprises the northeastern mountains that represent a westward extension of the granitic and sedimentary

rocks of the Kontum Plateau of southern Vietnam. Thus, this area forms a small part of the Annamite Ranges. Although higher peaks occur just across the border into Laos and Vietnam from this northeastern area, the highest hills here in Cambodia reach only 700- 800 m in elevation. The final physiographic unit of Cambodia is made up of basalts of the Rattanakiri and Chhlong Plateaus that lie along the northeastern border of Cambodia with Vietnam and form a transition to the Annamite Range.

Hydrology

The Mekong River flows from north to south through Cambodia, bisecting the eastern half of the country. Entering northeastern Cambodia, the Mekong flows southward until its course is deflected sharply westward by basalt formations near Kompang Cham. One quarter of the Mekong's flow is derived from the mountains of China and Tibet, while about half comes from adjacent parts of Laos, Thailand, and Vietnam (Pantulu 1986). Three tributaries of the Mekong - the Sekong, Sesan and Srepok Rivers - drain northeastern Cambodia and adjacent areas of Laos and Vietnam. The Stung Sen and Stung Chinit that flow into Tonle Sap drain much of northern Cambodia. The overall drainage basin of Tonle Sap is 67,600 km² (Pantulu 1986). Short rivers with steep gradients drain the south slope of the Cardamom and Elephant Mountains flow directly into the Gulf of Thailand. Tonle Sap covers about 2,580 square kilometers (about 1,000 square miles) in the dry season, but as much as 10,400 square kilometers (4,015 square miles) in the rainy season. It is Southeast Asia's largest lake. Despite its large size, the depth of Tonle Sap is only 1-2 m in the dry season and 8-10 m in the wet season. Its volume changes from about 1.3 x 10⁹ m³ in the dry season to 72 x 10⁹ m³ in the wet season (ORSTOM and BCEOM 1993).



2. TRENDS IN GENETIC DIVERSITY

GENETIC DIVERSITY

The more genetic variety there is in a species or a population, the better it can adapt to a range of environmental conditions. A decrease or loss of genetic diversity results in a reduction of the ability of a species to cope with the demands of its environment, (Global Biodiversity Strategy, 1992).

The genetic diversity among Cambodia's more than 2000 varieties of rice allows farmers to select strains that are adapted to a wide range of environmental conditions. Studies in Ratanakiri have shown that the ethnic minorities in the area use an amazing array of agricultural species and varieties in their fields. This is an excellent example of the importance of genetic diversity for food security.

Loss of genetic diversity can have many different causes. Here are two examples:

If a population of animals reaches very low numbers, more and more individuals will be related to each other. The genetic variation between individuals will decrease. Weak characteristics may become more apparent when there is no new input of genes from unrelated strong animals. The loss of genetic diversity and can lead to the extinction of a species. The Kouprey is a good example for this: even if there are still kouprey in the forests somewhere, it is likely that the population is not large enough to survive in the long term.

Breeding or selection of agricultural crops, including rice, often focuses on a small number of features such as high yields and pest resistance. If we continually select for these characteristics we will produce rice plants strong in these characteristics, but with less genetic variation. How will these plants be able to cope with a change in the environment, for example the outbreak of a new disease?. Because all the plants are genetically very similar this could have devastating effects. In a more genetically diverse crop there may be plants that could cope better with a new disease so the damage to the crop would be less. It is important to ensure that wild strains are maintained in order to preserve the gene pool.

PLANT GENETIC DIVERSITY IN CAMBODIA

1. Previous Status in Genetic Diversity

The 2001 NBSR data (RGC 2001) on Plant Genetic Resources for Cambodia was based on a summary and excerpts from: K.P.S Chandel and R.S. Paroda. 2000. *STATUS OF PLANT GENETIC RESOURCES CONSERVATION AND UTILIZATION IN ASIA-PACIFIC REGION, REGIONAL SYNTHESIS REPORT*, Asia-Pacific Association Of Agricultural Research Institutions, FAO Bangkok.

This document is further summarized highlighting the following:

Plant genetic resources are essential to the establishment of sustainable agriculture and food security. The world has been largely demarcated into gene rich and gene poor regions depending on the available diversity of different crop plant species and their wild relatives. The Asia-Pacific region is generally gene rich, although there are important challenges to sustainability as the result of, especially, population growth, poverty, hunger, deprivation and degradation of the natural resource base. It is well recognised that conservation and effective management of genetic resources contributes to economic growth and development.

Crop cultivation in Cambodia is primarily dependent on traditional cultivars, old primitive varieties and land races. Almost 80% of its agricultural area is cultivated with local, unimproved varieties of rice, maize, sesame, vegetables and sweet potato etc. Traditionally, farmers have been using their own produce as seeds for their next crops without changes. New pests and pathogens have contributed significantly to the loss of land race diversity. Rice is the most predominant staple food crop and it is estimated that for every 400 ha of rice planted, there existed a traditional cultivar in the past. Rich diversity has also built up in crops such as maize, soybean, sesame, sweet potato, peanuts and vegetables. Home gardens and backyards possess a very rich diversity in diverse species.

Nevertheless, there are serious gaps in the information pertaining to the distribution and occurrence of wild species and wild relatives of crops in Cambodia. These are primarily results of the lack of systematic scientific studies of their taxonomic description and delineation. In a joint expedition conducted in four provinces with IRRI, wild *Oryza* species such as *O. nivara*, *O. rufipogon* and introgressed forms between *O. nivara* x *O. rufipogon* were collected. Samples were maintained at the IRRI gene bank. As the new varieties, hybrids and improved varieties are introduced into traditional farming systems, the old varieties in farmers' fields are gradually, or, in some instances, very rapidly, replaced. The old varieties have different gene complexes and are generally adapted to local environmental and edaphic conditions, while newer varieties have a different genetic base which is sometimes very narrow.

Cambodia does not have proper *ex situ* conservation facilities such as a national genebank for long-term conservation of germplasm and a botanical garden, herbaria herbarium and available seed. The gene bank constructed by the Cambodia-IRRI-Australia Project (CIAP) and CARDI has 2557 accessions of local rice germplasm that are maintained under medium term conservation conditions.

Cambodia also does not have an *in vitro* repository, or a cryobank. Most of its germplasm collections are maintained under field conditions and subjected to field rejuvenation too frequently. A productive and stable agricultural system requires conservation of genetic diversity on farms. In Cambodia, the programme related to *in situ* conservation of genetic resources, or on-farm conservation of native land race diversity, are almost non-existent.

Cambodia requires a holistic approach linking both *in situ* and *ex situ* conservation strategies and adopting need-based approaches. Considerable gains would be accomplished in the region, if plant genetic resource policies were streamlined along with regulations on their introduction, exchange and quarantine procedures. A regional information network and database system to share available information is specifically warranted, relating to germplasm collection, evaluation, characterization and utilization.

2. Current Status of Plant Genetic Diversity

While there is still a lack of information on plant genetic resources in Cambodia, the Cambodian Agricultural Research and Development Institute (CARDI) report on *'The Establishment of the National Information Sharing Mechanism (NISM) on the Implementation of the Global Plan of Action (GPA) for the Conservation and Utilization of Plant Genetic Resources for Food and Agriculture in Cambodia'* (CARDI 2011) shows an important move toward better understanding of the importance of plant genetic resources and highlights some current trends. Table 1 lists the registered institutions that are currently providing data to the National Information Sharing Mechanism on the implementation of the Global Plan of Action.

Plant genetic resources are considered to be an important part of cultural heritages, national identities and resources. They are the basis for food security and safety, as well. The International Treaty on Plant Genetic Resources for Food and Agriculture is crucial for the sustainable conservation of plant genetic resources and food security.

The Royal Government of Cambodia is committed to participating in international processes with the aim of sustainable development, germplasm conservation and sustainable use of genetic resources. To this end, Cambodia is a Contracting Country to the "International Treaty on Plant Genetic Resources for Food and Agriculture" since this is also closely related to the fulfillment of the UN Millennium Development Goals.

Table 1: List of registered institutions providing data to the Cambodia National Information Sharing Mechanism on the Implementation of the Global Plan of Action.

No.	Registered Institutions
1	Plant Breeding Division of CARDI
2	Department of Rice Crops (MAFF)
3	Department of Horticulture and Crops (MAFF)
4	Department of Crop Industry (MAFF)
5	Agricultural Information and Documentation Center (MAFF)
6	General Directorate of Administration for Natural Conservation and Protection (MoE)
7	Former Department of Natural Resources Assessment and Environmental Data Management (MoE)
8	Graduate School of the Royal University of Agriculture
9	Department of Biology (Royal University of Phnom Penh)

As well as the National Information Sharing Mechanism on the implementation of the Global Plan of Action, other important projects have been initiated in support of plant genetic resources in Cambodia. These have included: *Capacity Building and Enhanced Regional Collaboration for the Conservation and Sustainable Use of Plant Genetic Resources in Asia*; *"In situ Conservation of Plant Genetic Resources for Development Value in Northeast Provinces of Cambodia,"* and *the Cambodia Tree Seed Project*.

Plant genetic resources in Cambodia are poorly documented both as the result of limited human resources and insufficient funding, and ex situ collection has been limited to rice genetic resources. Sahai et al describe that in the early 1970s, 756 traditional cultivars were collected and stored at the IRRI genebank ... the succeeding effort to collect rice germplasm was between 1989 and 1990 at which time there were 1270 accessions (Sahai et al, 1992a). The third collection was carried out from 1990 to 1991 when 348 accessions were collected from 13 provinces (Sahai et al, 1992b). A fourth collection period was from 1992 to 1997 when 939 rice germplasms were collected in 13 provinces (Javier et al, 1999). There are currently 3313 accessions conserved at CARDI that are safe duplicated at IRRI, as well, for long-term conservation (Makara and Sophany, 2009).

The collection of indigenous vegetable germplasm was conducted from 20 January to 2

February, 2005 as part of a collaborative effort between the Kbal Koh Vegetable Research Station and the Asian Vegetable Research and Development Center. The provinces that were targeted included Battambang, Banteay Meanchey and Siem Reap. There were 212 accessions of 39 species, subspecies or cultivar groups collected, with the most accessions being of *Solanum melongena* (22), *Luffa aegyptiaca* (20) and *Cucumis sativus* (18) (Altoveros, 2005).

Table 2: Accessions conserved in CARDI's gene bank

Crop	Accessions/Samples	Crop	Accessions/Samples
Rice	2595	Maize	20
Banana	150	Mungbean	12
Chili	35	Soybean	18
Sugarcane	22	Sesame	10
Cassava	23	Sweet potato	9
Peanut	15	Tomato	30
Watermelon	2	Mango	2

3. Current Trends in Plant Genetic Diversity

Cambodia has now obtained an in-country ex-situ collection of plant genetic resource accessions within CARDI. This collection is indicative of trends toward more extensive collection and more effective management of plant genetic resources. CARDI reporting has underscored the primary constraints that impact plant genetic resources management in the country, especially those associated with stakeholder understanding of value and incentives and standards for directing the collection of data.

There are herbaria and botanical gardens which are planned to be developed through collaborative programs between ministries, academic institutions and development partners. These will increase the interest on collecting and storing plant genetic resources that encompass accessions and samples of representative Cambodian crops. Ultimately, the establishment of a national organization will be required to further research, identify and collate traditional terminologies, as well as advance the understanding of the commercial values of species and the potential impacts on those species of diseases and climate change.

The previous status was derived from the FAO Status of Plant Genetic Resources (2000). In-situ conservation was considered non-existent and the only known ex-situ resources was 2557 accessions of local rice germplasm held by the International Rice Research Institute in the Philippines. The current status was drawn from the report 'Conservation and Utilization of Plant Genetic Resources for Food and Agriculture in Cambodia' (CARDI 2011). Significantly this report showed that there were now ex-sit resources in country including, 3313 accessions (ex-situ at CADRI) and Kbal Koh Vegetable Research Station has some in-situ conservation. There are also plans for herbaria and botanical gardens (links with Kew gardens).

ANIMAL GENETIC DIVERSITY IN CAMBODIA

1. Previous Status in Animal Genetic Diversity

The 2001 Status Report (RGC 2001) on Plant Genetic Resources for Cambodia was based on a variety of sources including Domestic Animal Diversity Information System (1998), which is an FAO initiative for Animal Genetic Diversity, and the report by Maclean (1998) on Livestock in Cambodia. The report is further summarized highlighting the following information.

Over time many animals have been domesticated locally or introduced from other countries for their usefulness. These animals have adapted to their agro-ecological conditions and have lost many of their wild traits. Access to new genetic materials, in the form of live animals, embryos and semen has led to widespread crossbreeding throughout Asia, which may have reduced unique animal genetic resources and sustainability, (FAO, 1998). Cambodia has not experienced the same scale of change in the past but is currently experiencing very rapid change.

The genetic diversity found in domestic animal breeds allows farmers to select stock or develop new characteristics or breeds in response to changes in the environment, threats of disease, market conditions and societal needs, all of which are largely unpredictable. Breeds, which are rare today, may carry traits of commercial importance in the future...Indigenous livestock breeds often possess valuable traits such as disease resistance, high fertility, good maternal qualities, longevity, and adaptability to harsh conditions and poor quality feeds, all the qualities that form the basis for low-input sustainable agriculture, (RAFI 1997).

Cattle & Water Buffalo

"The cattle and buffalo production system in Cambodia is primarily a draft power production system, with meat production a secondary consideration. The primary need is for draft power, the most important being soil preparation for rice growing, and this is consistent with the knowledge skills and customs of the farmer." Maclean 1998. The official government statistics for Cattle and Buffalo numbers are commonly inaccurate due to language and communication problems, but they have definitely fluctuated greatly, due to war and anarchy, since a pre-war peak of 3,298,000, (Maclean 1998).

Cattle - There are five types of wild bovine in the world – "Gaur, Banteng, Kouprey, Yak and Auroch, and four of these are found in Cambodia. Most modern domesticated cattle are of the Auroch type, and are divided into two general types, *Bos taurus* (non-humped cattle) and *Bos indicus* (humped cattle).

Water Buffalo - "Buffaloes of the world are divided generally into two groups, the Asian Buffalo and the African Buffalo. In turn Asian Buffaloes are divided into Swamp Buffalo and the River Buffalo. All Cambodian Buffaloes are of the Swamp Buffalo type," (Maclean 1998).

Poultry

Most of the world's poultry are believed to have come from wild species in South East Asia. There are expected to be other newer varieties being introduced to Cambodia however there is little documentation on these breeds. Monn Khmer chicken is a strain of domestic chicken that is considered indigenous to Cambodia and used for meat and eggs. Tea Ankam duck is a variety of domestic duck that can be classified as indigenous to Cambodia. It is used for meat and eggs. Kangan goose is a strain of domestic goose used in Cambodia for meat and hobby. Monn Barain turkey is a fancy breed of domestic turkey used in Cambodia for hobby.

Other Groups

Cambodian horse is a breed of domestic horse used in Cambodia for pulling carts. It is very similar to Thai and Vietnamese horses and all come from the South-East Asia pony group. Indo-Chinese goat is a breed of domestic goat used in Cambodia for meat. Preap pigeon is a variety of domestic pigeon that is used in Cambodia for meat and hobby. All pig production systems in Cambodia are focused on meat production, but can be divided based on the intensity of the farming – from traditional through to intensive, or least to most management.

- Gondol pig is a local breed of small early maturing pig, which is still found as a pure bred in Ratanakiri and Mondulakiri.
- Other pig breeds include; Hainam from China, and Yorkshire, Berkshire and Large White from Europe. There have also been recent introductions of further improved Large White and Duroc types imported from Thailand and Vietnam.
- Asian elephant - There are estimated to be 400 –600 wild and approximately 90 Domesticated Elephants (*Elephas maximus*) in Cambodia.

Wild Relatives

Domesticated animals can be prone to many diseases or afflictions that their wild relatives may be less affected by. Some of the domesticated animals with wild ancestors still in Cambodia deserve special attention for biodiversity management and include;

- Wild Cattle - There are two species of wild cattle recorded for Cambodia including; Banteng (*Bos javanicus*), and Kouprey (*Bos sauveli*). There have been no recent sightings of the Kouprey, and it is feared that it may be extinct. Banteng or Tsine Cattle (*Bos javanicus*) is a wild species of cattle found in cold hilly jungle regions of Cambodia.
- Wild Water Buffalo (*Bubalus arnee*) are recorded to occur in Cambodia. The Red - - Jungle Fowl (*Gallus gallus*) is considered to be the ancestor of the domestic chicken. - Asian Elephant (*Elephas maximus*) is known to occur in more remote parts of Cambodia. The wild pig (*Sus scrofa*) is most noticeably different from domestic pigs due to the teeth that protrude as tusks.

2. Current Status in Animal Genetic Diversity

While the raising of domestic animals is increasing in Cambodia there is still limited consideration placed on the management of Animal Genetic Resources and their wild relatives. In 2011, the Royal University of Agriculture (RUA) completed a field study of breed distribution, population composition and disease symptoms/syndromes in cattle, buffaloes, horses, swine, goat and sheep in Cambodia. This report was, commissioned by the Environmental Animal Health Monitoring Initiative (EAHMI) Cambodia, with the Food and Agriculture Organization (FAO) of the United Nations. The Department of Animal Production and Health (DAPH), Provincial Animal Production and Health Offices and Village Animal Health workers helped in the collection of data. Selections from that report have been adapted and summarized to provide an update on Animal Genetic Resources as below.

Cattle: With regard to the distribution of cattle breed types, most provinces are dominated by white cross bred and local cattle breed types, except in more mountainous provinces in north-eastern Cambodia, where local and mountain breed types predominate.

Buffalo: Buffalo are relatively uniform with no obviously distinctive breed types and are most commonly found in lowland provinces. Buffalo herd size and structure for was comparable with that of cattle.

Pig: The dominant types in these areas are local/indigenous and various crosses with imported exotic breeds, in more or less equal proportions.

Goat: Very little is known or documented about goat breeds in Cambodia. In comparison with phenotypes found in neighbouring countries and elsewhere in Asia, the main goat types in Cambodia are: Kakang, cross bred Etawa, Alpine and Anglo Nubian, with various crossbreeds.

Wild Relatives and Wild Animal Genetics

With growing questions around the classification of species and increases in technology there is a trend to start looking at the genetics of wild animals. One of the pioneers looking at wild animal genetics in Cambodia was Bryan Stuart and his: *“research has shown that many geographically widespread ‘species’ actually contain multiple, divergent, and sometimes sympatric evolutionary lineages that I hypothesize to be distinct species.”* His work in Cambodia started in 1999 and focused on reptiles, but he has continued to work across the region on

reptiles and amphibians with specialists such as Neang Thy, who is also working with Lee Grismer, a specialist in Island Biogeography, on the taxonomy of reptiles.

The domestic chickens relative the Red Jungle Fowl is as noted by (Goes 2014) “a common and widespread resident likely to cross-breed with domestic chickens in all but the remotest locations”. As such genetic assessment may be necessary to identify the sub-species of domestic chickens so as to clarify wild and semi-wild strains (such as Monn Khmer), which may be of genetic importance. There is no current information on the status of other poultry such as ducks and the turkey that was noted as rare in 2001.

In 2009, the Phnom Tamao zoo conducted DNA sampling of their crocodiles in captivity, and found that “of 69 crocodile samples of Phnom Tamao Rescue Centre, 34 samples are Siamese crocodile’s DNA, 32 samples are hybrid DNA of Siamese crocodile x Salt water crocodile or backcross progenies (where the mother is Siamese) and 3 samples are hybrid’ DNA of Siamese crocodile x Cuban crocodile (not Siamese crocodile nor Salt water crocodile) or backcross progenies in which the mother is Siamese.” Such information is imperative for ex-situ breeding programs for conservation of critically endangered species, such as the Siamese crocodile. This also raises issues around the species lists, as the reptile lists do not show the introduced Cuban crocodile (with which Siamese crocodile is commonly hybridized with in crocodile farms), which may account for some unknown crocodile DNA.

The Royal Government of Cambodia is working with WWF and note that “diseases and parasites from domestic and feral livestock pose further serious threats to banteng survival. As a result, WWF is (providing support for) enforcing a ban of all domestic cattle in the strict protection zones of Mondulkiri Protected Forest and Phnom Prich Wildlife Sanctuary.” Biodiversity assessments have been conducted across the potential range of the Kouprey and there continue to be no confirmed recordings. Likewise, there have been no confirmations of wild water buffalo, with the previous record in 2001 based on camera traps, which without DNA support is difficult to confirm.

Wild Asian Elephant - The Asian Elephant (*Elephas maximus*) is known to occur in more remote parts of Cambodia, in Koh Kong, Pursat, Battambang, Kratie, Preah Vihear, Mondulkiri and Ratanakiri provinces in particular. Their existence is confirmed from signs such as; prints, trails and droppings, but they are rarely seen in the wild, so population estimates are difficult. However a number of fecal DNA studies (by FFI, WCS, WWF) have revealed that Cambodia’s total wild Asian elephant population is likely to be between 400-600 animals, with the two largest populations in the Cardamom Mountains and Eastern Plains landscapes. Encouragingly, reports of illegal elephant killings in Cambodia are among the lowest in the region, but the threats of habitat loss, degradation and fragmentation remain the largest threat to Cambodia’s wild Asian elephants.

3. Trends in Animal Genetic Diversity

Research on Animal Genetic Diversity is still very limited in Cambodia. It is positive to note the Environmental Animal Health Monitoring Initiative (EAHMI) activities, however a noted constraint is the lack of resources for ongoing research. This may also link to limited understanding on the significance of Animal Genetic Resources, even though they make up 5% of the countries Gross Domestic Product.

There has been a significant trend in utilizing genetics in research related to wild animals, including: snakes, crocodiles and elephants. In regards to crocodiles this has major significance for breeding programs and the potential release of wild siamese crocodiles (*C. siamensis*) back into the wild. It is a very positive trend that such efforts are being made. An important activity in relation to the release of siamese crocodiles is the ‘Cambodia Crocodile Conservation Project’. Since 2011, the CCCP has released 55 crocodiles back into the wild; 35 of them were crocodiles we received as donations or were confiscated, while 20 were head-started juveniles (eggs removed from the wild and reared for two to three years) that were recently released back into the wild.

Innovative DNA research may also be the only way to confirm the presence of Wild Water Buffalo. In regard to mammal surveys, there is the potential to collect leaches and take DNA

samples from the blood they have fed on, however such an approach has not been trialled in Cambodia yet.

Future genetic research is required and may be linked to the Convention on Biological Diversities, Access & Benefit Sharing. As Cambodia does not currently have the technology to assess animal DNA, such support may come from other countries to support animal genetic diversity research for domestic and wild animal management.

There is limited research and data available on animal genetic resources and as such impacts the ability to assess trends is also limited. More research is required in this field so as to better understand and manage animal genetic resources. The high commercial values of some species and unknown impacts from disease or climate change should be better understood.

The previous status was derived from the FAO Domestic Animal Diversity Information System (1998) and Domestic Livestock report by Maclean (1998). These highlighted the presence of 4 Cattle species, 3 Pigs, Buffalo, Horse, Goat, Chicken, Duck, Goose, and Turkey. Wild relatives were also identified including: wild cattle, water buffalo, boar and the Red Jungle Fowl, the wild chicken. The 'Environmental Animal Health Monitoring Initiative' (RUA/FAO 2011), has reinforced some of the previous status information for domestic animals. In regards to conservation, DNA Sampling of 69 crocodiles in captivity to identify the pure Fish-eating Hill Crocodile (*C. siamensis*) has had positive results: 34 Siamese, 32 Hybrid with Estuarine, & 3 Hybrid with Cuban. Fecal DNA studies of wild elephants, have been used to estimate a population 400-600 elephants in Cambodia. The most positive trend is the innovative use of DNA for crocodile and elephant research, but need more research on commercial animals and wild relatives.



3. TRENDS IN SPECIES DIVERSITY

SPECIES DIVERSITY

Species = a group of organisms that can breed to produce fertile offspring

- ⇒ A dog and a cat cannot produce offspring.
- ⇒ A flower on a Barringtonia tree cannot be fertilized with the pollen from water hyacinth.
- ⇒ The Anopheles mosquito that carries the malaria parasite and the Aedes mosquito that carries the dengue fever virus cannot interbreed.

Species diversity refers to the variety of species. This can be measured by determining **species richness** = the number of species in a defined area and/or **species abundance** = the relative numbers among the species.

Example: Counting the number of species occurring in a particular area gives us the species richness. We are able to compare species richness between different ecosystems (eg a mountainous area like Bokor and a coastal ecosystem). In addition to the species richness we can look at the relative numbers of each species: Let's say the total number of species is 50, we can then determine how many of these 50 species are common or are rare.

The species level is usually regarded to be the most appropriate to consider the diversity between organisms. While this report summarizes the status, significant effort has been expended in collating up to date species lists for Cambodian: Plants, Invertebrates, Amphibians & Reptiles, Fish, Birds and Mammals, to assist in future biodiversity management.

PLANT SPECIES OF CAMBODIA

1. Previous Status of Plant Species in Cambodia

In the 2001 Biodiversity Status report (RGC 2001) Philip W. Rundel, PhD provided excerpts from: Baltzer, M.C., Nguyen Thi Dao and Shore R.G. (Eds.) 2001. *Towards a vision for Biodiversity Conservation in the Forests of the Lower Mekong Ecoregion Complex*. WWF Indochina Programme, Hanoi, Vietnam, from, which to provide an overview of the Flora of Cambodia. As the plant species were not well covered, another section was compiled for the NBSR on 'Useful Plant Species in Cambodia' These two sections still provide a good base from which to consider Cambodia's Plant Species and as such that information has been reviewed and summarized below.

Flora of Cambodia

No accurate assessment of the size of the Cambodian flora is available. Dy Phon (1982) suggested a known flora of 2308 species of seed plants, but this total seems far too small given more reasonable estimates of about 12,000-15,000 species for Laos, Cambodia and Vietnam combined (Schmid 1989). Considering the absence of strong biogeographic barriers of topography or habitat between Cambodia and neighboring countries, one would not expect to find a high level of endemism in Cambodia. Areas that might be expected to harbor locally distributed species would include the wet forests of the Cardamom and Elephant Mountains and swamp forests of the Tonle Sap floodplain. Adequate field studies have not been made, however, to determine what level of endemism might be present. The flora existing on the slopes of the Phnom Dangrek Mountains has not been studied, but the semi-evergreen forests of that region would not be expected to harbor large numbers of endemic species because it occurs so broadly.

Based on those species that were included, Dy Phon (1982) estimated that 10% of the Cambodian flora was endemic within the national political borders. This figure seems higher than what might be expected. Although the flora of the Cambodian lowlands exhibits Indomalaysian affinities, as indicated in part by the lack of endemic genera (Dy Phon 1982), the floodplains of the Tonle Sap exhibit a flora rich in species unique to the Indochinese floristic region. These species include many that are shared more broadly throughout the Mekong basin, as well as others entirely restricted in distribution to the Tonle Sap floodplain. The endemic flora of the Elephant Mountains has been discussed by Dy Phon (1970). She listed 36 species as endemic to these mountains, amounting to about 9% of the recognized flora. Several of these species have since been collected out of this region, lowering the rate of endemism, but limited botanical collecting suggests that both the total number and the number of endemic species will rise as the flora becomes better known. McDonald et al. (1997) pointed out that many of the broadly distributed endemics of the Mekong basin appeared to be restricted around the Tonle Sap to the Steung Sen catchment at the mouth of the lake where they occur as secondary or upper floodplain species. Their field studies suggest that the swamp forest communities of the Tonle Sap floodplain are unique both in structure and floristic composition and contain a number of narrow endemic species. While the Tonle Sap is a freshwater lake, some elements of its floodplain flora are indicative of relationships with coastal mangrove habitats.

USEFUL PLANT SPECIES IN CAMBODIA

There is a modern history of scientific information on plant diversity in the Indochina region (Cambodia, Laos & Vietnam), including the recording of 8,000 species in the *Flore Général de l'Indochine* that was published by the Museum of Natural History in Paris. This and other more recent studies were compiled to assist the IUCN (1995) to estimate 12,000-15,000 plant species in Cambodia, Laos and Vietnam. Literature specific to Cambodian plant diversity has been more ad-hoc. In fact, Fauna and Flora International considered Cambodia to be "the only nation in Southeast Asia never to have undertaken comprehensive biological investigations, particularly in regard to flora" (Daltry & Momberg 2000).

An unpublished report prepared for the IUCN by Derleth (1996) on Useful Plants in Cambodia was used by Ashwell (1997) to develop a section on useful plant species in the Cambodia Biodiversity Prospectus. Derleth specifically reviewed literature published prior to the civil war

and subsequent period of social dislocations, which indicated many of the uses for plants in Cambodia. That information, which has not been updated by other sources, states that:

Cambodians habitually utilized at least 931 species of Cambodia's 2,304 plant species. Of the 849 species for which life forms are described 34.8% are trees of various sizes, followed by 21.7% herbs (including bamboo and bananas) and 15.1% shrubs. The remaining 28.4% include shrubs, palm trees, lianas and ferns. Habitats are known for 62.7% of these species. The main class are the cultivated plants (23.6%), then species coming from primary evergreen (dense) forests (14.3%) and secondary formations (7.2%). 29.4% of all species are known only from natural and semi-natural habitats. Thus wild plants appear to be at least as important as cultivated plants, (Derleth in Ashwell, 1997).

There is much overlap in the use of species as the same species may be used for multiple purposes. It should be noted also that there are serious gaps in the information pertaining to the distribution/occurrence of wild species and wild relatives of crops in Cambodia. This is primarily due to a lack of systematic studies of their taxonomical description and delineation.

Endangered Species

Endangered species of plants are important to consider, since the current limited understanding of specific ecosystems functions in Cambodia means that the loss of any species may result in dramatic alterations to the ecosystem. Several plant species or varieties occurring in Cambodia may currently be at risk because of their high demand. These include valuable tree species, such as Chankreussna (*Aquilaria crassna*), Cheuteal (*Dipterocarpus sp.*) and Koki (*Hopea sp.*), rare endemics that are not found elsewhere, such as *Fokeinia hodgsonii*, which is a highly valued coniferous tree, and several species of orchids.

There are still many threats to the terrestrial flora, including encroachment caused by human settlements, deforestation, cultivation, landscape gardening and livestock grazing, as well as illegal collecting for local or international markets. The primary threat to tree species continues to be legal and illegal logging. There are also potential threats from alien invasive species of plants and animals.

2. Current Status of Plant Species in Cambodia

While the Indochine region may be considered to have 8,000-15,000 plant species, Cambodia's plant species are still poorly documented and there has only recently been a significant effort to strengthen that documentation. Since the previous status report, there have been additional plant species studies, but those have been focused on species lists from protected areas and useful plant species efforts have been conducted on specific groups, such as rattan, but such reports rarely have been incorporated into national lists unless those lists had been compiled by the same researchers.

Internationally, orchids are a specialty plant group that attracts significant attention and Orchid Cambodia collaborates in its efforts with RUPP and experts from the National Museum of Natural History of Paris and Kew Botanical Garden, including leading orchid research experts and local orchid activists. In 2008, a list of over 80 species was compiled and there have been several more discoveries since that time. The group is in the process of reviewing the current list, which is expected to include at least 250 species. Kew Gardens has also recently made orchid collections and is producing a new orchid list for Cambodia, which will include at least one new species of the *Porpax* genus.

In the "Ferns of Thailand, Laos and Cambodia" (Lindsay and Middleton, 2012), the authors noted that regarding ferns in Cambodia: "There are approximately 130 species of ferns in Cambodia although this is almost certainly an underestimate of the actual number of species due to the extremely low plant collection density for the country. Of the countries Thailand, Laos and Cambodia, the number of species recorded for Cambodia is by far the lowest, but even taking into account the relative collection densities of the three countries it is likely that Cambodia really does have the lowest fern diversity of these countries as it also has the least variation in topography and range of habitats." The number of ferns in Cambodia as reported by Sun Byung-Yun, et al (2014) has recently been increased to 288 as the result of the research conducted with the support of the Korean National Institute of Biological Resources.

3. Trends for Plant Species in Cambodia

The Forestry Administration, in collaboration with Korean technical support and expertise, has been conducting some of the most significant botanical surveys of Cambodia to date. At the time of updating Cambodia's Biodiversity Status, their report had not yet been published, but there are promising signs that a more significant plant species list will be forthcoming that is potentially composed of 4500 species.

With significant changes in natural landscapes, there are likely to be some negative impacts on plant species of Cambodia, but with limited knowledge of the existing species, it is difficult to determine the overall trends and areas of critical concern. Based on regional concerns and local market prices, there is a trend that some high value 'luxury woods' are being unsustainably extracted. This is exemplified by the Siamese rosewood (*Dalbergia cochinchinensis*), which is now considered to be an endangered species and illegal loggers are literally willing to risk their lives to collect this wood in the border areas of Cambodia and Thailand.

Dr Philip Rundel provided excerpts from the WWF report "Towards a vision for Biodiversity Conservation in the Forests of the Lower Mekong Ecoregion Complex." (WWF 2001), for the previous NBSR. As the plant species were not well covered, another section was compiled on 'Useful Plant Species in Cambodia'. In regards to the current status Forestry Administration staff Chhang Phourin and Khou Eanghourt have worked to compile a more thorough list of known plant species for Cambodia. Some data on plants through a Forestry Administration and Korean project is still being processed, but may provide a significant increase in documented plant species for Cambodia. Little is known about the status of plant species but Siamese Rosewood and other luxury timbers have been heavily targeted and are likely to be in decline. There is a positive trend toward increasing the plant knowledge and there are 3113 plant species currently listed for Cambodia.

INVERTEBRATE SPECIES OF CAMBODIA

1. Previous Invertebrate Status in Cambodia

Considering the significance of invertebrates this group was poorly covered in the 2001 Biodiversity Status Report. The exception was a short section about Aquatic Macroinvertebrates, by Ruth O'Connor (RGC 2001), which is summarized below to provide some context from the Previous Status Report Findings, however this is very biased toward only aquatic macroinvertebrates.

Macroinvertebrates are small animals without backbones such as shrimps, worms, snails and insects including dragonflies, beetles and flies. Some of these animals, like shrimps, live their whole life in the water. Others, like the dragonflies spend only the early part of their life in the water. Macroinvertebrates are found in most places where there is fresh water. There are many more species of macroinvertebrates than vertebrate groups such as fish or frogs but they are of interest and importance for other reasons also: food for people and other animals; role in aquatic ecosystems; and useful as biological indicators.

Little information is currently available about the aquatic macroinvertebrates of Cambodia. One of the difficulties in documenting macroinvertebrate biodiversity is in identifying and naming the species. A lot of taxonomic work is required to describe and classify species and this requires specialist skills and resources. It is likely that many of the species found in Cambodia will also be found in neighboring countries with similar environments such as Thailand and Vietnam. However, until the taxonomic work is done, we won't have a comprehensive list of species or be able to assess which groups are unique to Cambodia. The macroinvertebrate families commonly recorded in Siem Reap and Banteay Meanchey (Table 3) are typical of tropical waters... Limited species-level information at this stage means that the degree of endemism in Cambodia cannot be assessed.

Table 3: Summary of freshwater macroinvertebrates identified in Siem Reap and Banteay Meanchey, 2001

Order	Number of families	Number of identifiable groups (species)	Species identification attempted?
Coleoptera (beetles)	10	48	yes
Diptera (true flies)	7	11	only for 1 family
Ephemeroptera (mayflies)	4	5	only for 2 families*
Hemiptera (true bugs)	10	14	only for 1 family
Lepidoptera (moths)	1	4	yes
Odonata (damselfly & dragonflies)	6	16	yes
Lecoptera (stoneflies)	1	1	yes
Trichoptera (caddis flies)	4	6	only for 2 families
Non-insects	11	19	only for 9 families
Total diversity recorded		124	
Total number of animals collected & identified		1397	

*many mayfly specimens were damaged so species identification was often impossible

Few aquatic macroinvertebrate groups worldwide have been assigned a conservation status because many species are undescribed and those that are described have limited information available about their distribution. If any aquatic macroinvertebrate species in Cambodia are formally designated as significant it is most likely to be larger more well known groups such as the decapods or gastropods.

2. Current Invertebrate Status in Cambodia

Invertebrates account for up to 90% of animal diversity, and should therefore have systematic consideration in any biodiversity assessment, but continue to be poorly considered, and this is also the case in Cambodia. This is in part because invertebrates are such a complex group and as such there is significant difficulty in not only making a list for one order or family but to coordinate across many specialty areas for an entire invertebrate species list would take a major investment in time and resources. Sustainable use of some invertebrate species in Cambodia is significant and gaining more support. There is demand for marine resources such as crustacea, cephalopods and molluscs. Through FAO's work on insect protein, there is an

increased interest in the sustainable use of other invertebrates for food security in Cambodia. There is even now a specialty 'Bug' café in Siem Reap, and beekeeping for natural honey from point sources is now being promoted and marketed in Cambodia. In regards to Odonata (Dragonflies) Olg Kosterin has a tentative list of 153 species confirmed for Cambodia.

Butterflies and moths have had more research than many invertebrates, due in part to their economic potential but typically due to specialist interest. Several focused research activities have focused on butterflies and a list of 345 species has been compiled by Mr. Hun Seiha at the Royal University of Phnom Penh. The silk industry, with its reliance on silk worms (*Bombyx mori*) has had something of resurgence in Cambodia, and is acclaimed for its 'Golden Silk'. Some small moth and butterfly enterprises have tapped into the tourism and collector market. These trends in the sustainable use of invertebrates can be quite positive in raising the profile of invertebrates but more research is needed to ensure utilization of these resources is sustainable.

A leader in the field of aquatic invertebrate research in Cambodia since the previous Status Report in 2001 especially in the coastal zone is ING Try from the Fisheries Administration. Through his work and publications there is a base of invertebrate data including a photographic collection represented in four posters. The 'Field Guide to Marine Living Resources in Cambodia' 2008 by ING Try, Dr. Kathe JENSEN and VA Longdy contains coastal invertebrates such as: Marine bivalves, Marine gastropods, Cephalopods, Stomatopods and shrimps, and Marine crabs and horseshoe crabs.

With experience participating in several expeditions and collecting for several organisations in Virachey, Cardamoms and around Siem Reap, and with his own records collected samples, Mr. Stéphane De Greef is an example of individuals that are providing some perspective on the current status of invertebrates in Cambodia. From hundreds of specimens many were never identified to the species level and most were sent abroad, studied and identified by other scientists. There is full data on only 20 ant specimens from the AntWeb site by the California Academy of Science. The most complete (but still incomplete) list of ant species present in Cambodia can be found on AntWiki.org, which shows 67 species of ants, with 16 endemic species (23.9%).

3. Current Trends for Invertebrate in Cambodia

While not working alone it does highlight the significance of individuals who actively go into the field to fill these gaps in data, and as mentioned previously the gaps in invertebrate data for Cambodia are significant. The trend in invertebrate species data collection is that it has been driven by individuals with a personal interest and this seems likely to continue. A recent find of a species of ant displaying a previously un-recorded socially cooperative hunting has drawn some more interest in Cambodia's invertebrates and may hopefully inspire some others to collect invertebrate data. A new Internet site 'Natural Cambodia' is also encouraging more amateur field biologists through a supportive network seeking to identify existing and sometimes new species many of which have been invertebrates.

The previous NBSR section on invertebrates was compiled by Ruth O'Connor and had focus on aquatic macro-invertebrates. This provided some understanding of some of the major freshwater macro-aquatic invertebrate families but further highlighted the lack of invertebrate data for Cambodia. The current status of invertebrates while still weak is an improvement on the past thanks to the work of a range of specialists including: Dr Ing Try & Dr Kath Jensen (aquatic invertebrates), Seiha (Moths & Butterflies), Oleg Kosterin (Dragon Flies) and Stephan De Greef (Ants). The trend is toward an increasing understanding of invertebrate species, however this is the most significant gap area for species. There are 671 invertebrates currently listed for Cambodia.

AMPHIBIAN AND REPTILE SPECIES OF CAMBODIA

1. Previous Status of Reptiles and Amphibian Species (HERPS) in Cambodia

The previous biodiversity status report (RGC 2001) had a non-technical section on Reptiles and Amphibians, written by Bryan Stuart, which sought to give an overview of knowledge on reptile and amphibian species status in Cambodia. Key excerpts from that text are summarized below.

Although amphibians and reptiles are unrelated, they are grouped by the colloquial term “herps” and tend to be studied by the same biologists, called herpetologists, owing to all being ectothermic tetrapods (meaning four-limbed, or originally four-limbed, animals that cannot generate their own body heat). Amphibians are cold-blooded animals with a backbone (vertebrates) and scaleless skin. In Cambodia, the Class Amphibia is represented by two of the world’s three Orders: the Anura (frogs and toads) and the Gymnophiona (caecilians). Within the Order Anura, at least five families occur in Cambodia: Bufonidae, Megophryidae, Rhacophoridae, Ranidae, and Microhylidae. Caecilians are limbless, burrowing amphibians, which are unfamiliar even to many biologists. Within the Order Gymnophiona, only one family occurs in Cambodia, the Ichthyophiidae.

Reptiles are cold-blooded animals with a backbone (vertebrates) that breathe with lungs and have dry, scaly skin. In Cambodia, the Class Reptilia is represented by three of the world’s four Orders: the Chelonia (turtles), Crocodylia (crocodiles), and Squamata (snakes and lizards). Chelonia or turtles are the only reptiles with a shell, and they can use the shell as protection from predators by pulling their head and legs into the shell. Within the Order Chelonia, three families are known to occur in Cambodia: Bataguridae, Testudinidae, and Trionychidae. Crocodylia or crocodiles are some of the largest living reptiles. Lizards and snakes are closely related and both part of the Order Squamata. Within the Order Squamata, at least 12 families occur in Cambodia: Gekkonidae, Agamidae, Varanidae, Lacertidae, Scincidae, Typhlopidae, Xenopeltidae, Uropeltidae, Boidae, Colubridae, Elapidae, and Viperidae.

The occurrence and distribution of amphibians and reptiles in Cambodia have long been poorly known. Today herpetologists must still rely on the historical literature for studying these species. However, the taxonomy of many species has been dramatically revised owing to work in other areas in Southeast Asia in the last fifty years. Recently, some reptile distributions have become available in a regional field guide that includes color photographs and fairly simple diagnostic characters for identification (Cox et al. 1998). A photographic guide to the turtles of Indochina, which will be produced in four bilingual versions including Khmer-English, is expected for release in 2001. At present, two species are considered endemic to Cambodia: the Tonle Sap Watersnake *Enhydryis longicauda*, which is known only from the Tonle Sap Great Lake and River (Saint Girons 1972), and Toumanoff’s Frog *Rana toumanoffi*, which is known only from Mondolkiri Province (Bourret 1942).

Records from 2001 on Reptiles and Amphibians are either historical or relatively recent and had not been rigorously taxonomically studied or effectively peer reviewed, as such an estimate of overall species numbers was not made. More thorough reptile and amphibian species identification has been undertaken since 2001 and we would ask that organisation species records be provided to develop a country list.

2. Current Status of Amphibians and Reptiles in Cambodia

With specific assistance from Neang Thy a total of 245 species (72 amphibians and 173 reptiles) have been recorded for this status report. Among these species the IUCN classification shows that 4 Reptiles are endangered (the Fish-eating Hill Crocodile (*C. siamensis*) is critically endangered) and 82 are threatened, no of amphibians are noted of conservation significance. The 2008 Fauna Flora International publication of “A Field Guide to the Amphibians of Cambodia” by Neang Thy and Jeremy Holden provided an important status of amphibians, which highlighted the growing understanding of amphibian diversity in Cambodia. Furthermore the ongoing research of Neang Thy and other herpetologists have continued to identify new species, such as: a skink (*Lygosoma veunsaiensis*), a legless lizard (*Dibamus dalaiensis*), the Cambodian Kukri snake (*Oligodon kampucheaensis*), a black caecilian (*Ichthyophis cardamomensis*) and most recently a new ‘wolf snake’ (*Lycodon zoosvictoriae*).

In 2002 VA Longdy identified marine turtle distribution and nesting grounds in Cambodia, and this work has been continued into the 'Field Guide to Marine Living Resources in Cambodia' 2008 by ING Try, Dr. Kathe JENSEN and VA Longdy. Five species of marine turtle have been recorded in Cambodia; olive ridley turtle (*Lepidochelys olivacea*), loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*) and Leatherback turtle (*Dermochelys coriacea*).

Amphibians in Cambodia

The following excerpt is taken directly from the 2008 Fauna Flora International publication of "A Field Guide to the Amphibians of Cambodia" by Neang Thy and Jeremy Holden.

Currently at least six species are known to occur nowhere else, and most of these were discovered recently, from 2000 onwards. Other species are 'regional endemics' found only in Cambodia and adjacent areas of Vietnam or Thailand. In 2000-2001, Fauna & Flora International, the Ministry of Environment and the former Department of Forestry and Wildlife, began a series of biodiversity surveys in the remote and little-studied Cardamom Mountains and Mondulhiri province. The surveys resulted in the first recent checklist of Cambodian amphibians, and the discovery of three species new to science.

*Amphibian research is still in its infancy, with many areas yet to be explored. For the amphibians of Cambodia, as for those across the world, there is a growing sense of urgency to both study and protect them. In 2006 a field survey around Samkos Mountain, in the Cardamom Mountains range, discovered a new species of tree frog, *Chiromantis samkosensis*, that is unique among Cambodian amphibians in having turquoise-coloured bones and green blood. Only two individuals were found, perched above a small pool along a forest track. Before this species was scientifically described, or any further research could be made, a road expansion scheme destroyed the pool in which these frogs bred - the only known site. It is clear from such cases that amphibians need to be the subject of our conservation efforts.*

3. Trends for Amphibian and Reptile Species in Cambodia

Through increased local capacity and in particular a skilled individual such as Neang Thy with international support, the trend for amphibian and reptile species research is very positive. In regards to amphibians a guide has been developed and a reptile guide is currently underway. Optimistically, there is also a trend toward the release of key reptile species back into the wild. As part of the Cambodia Crocodile Conservation Project, Phnom Tamao Wildlife and Rescue Centre and Fauna Flora International have released Fish-eating Hill Crocodiles (*Crocodylus siamensis*), while the Fisheries Administration have worked with Conservation International to release Cantor's softshell turtle, (*Pelochelys cantorii*) and with the Wildlife Conservation Society have released the Southern River Terrapin (*Batagur affinis*) back to the wild.

Dr Bryan Stuart assisted with the previous NBSR section and has amphibian and reptile collections from Cambodia at the Chicago Field Museum in America. The research on Amphibians and Reptiles has been ably continued by the Ministry of Environment's Neang Thy, who has also identified several species new to science and/or Cambodia. The status of Amphibians was greatly assisted with Fauna & Flora International publication "A Field Guide to the Amphibians of Cambodia" by Neang Thy and Jeremy Holden. The trend for reptile and amphibian species understanding is positive and has also been assisted by Va Longdy with his work on sea turtles. In regards to amphibians a guide has been developed and a reptile guide is currently underway. Optimistically, there is also a trend toward the release of key reptile species back into the wild. As part of the Cambodia Crocodile Conservation Project, Phnom Tamao Wildlife and Rescue Centre and Fauna Flora International have released Fish-eating Hill Crocodiles (*Crocodylus siamensis*), while the Fisheries Administration have worked with Conservation International to release Cantor's softshell turtle, (*Pelochelys cantorii*) and with the Wildlife Conservation Society have released the Southern River Terrapin (*Batagur affinis*) back to the wild. There are 72 amphibians and 173 reptiles currently listed for Cambodia.

RELATED ARTICLE: Second group of endangered Siamese crocodiles released in southern Cambodia. Feb 18, 2014 by Jeremy Holden.

After an idle lifetime in the soupy water of a concrete pond, a young Siamese crocodile tests out a new element – the clear flowing water of a jungle river. One of eight individuals, this crocodile is part of a test case release project that plans to rewild Cambodia's rivers with this Critically Endangered species.

Fauna & Flora International (FFI) has been working to conserve Siamese crocodiles in Cambodia since rediscovering a remnant population during a survey of the Cardamom Mountains in 2000. Now numbering fewer than an estimated 300 individuals, the wild population crashed after facing multiple threats. Crocodiles were hunted for their skins, and driven out of former habitats by human encroachment; while young crocs were easily tangled and drowned in fishing nets. But for FFI's and the Forestry Administration's intervention, this species was doomed to slip into extinction.

In January this year, the Cambodian Crocodile Conservation Project (CCCP) released the second batch of crocodiles into a secret site in southern Cambodia. The first release in December 2012 saw 18 individuals released, including crocodiles bred in a specialised facility in Phnom Tamao Wildlife Rescue Centre. The site was specially chosen: a remote forested stretch of prime habitat – somewhere that crocodiles used to live before they were extirpated by hunters and fishermen.

A number of the release crocodiles were fitted with radio tracking devices, enabling the CCCP team to monitor their movements. "Tracking the crocs after release is an essential part of the work, allowing us to see how they are faring, whether they stay in this location, or move on," said Sarah Brook, FFI Cambodia's Species Programme Manager. "Five of the original ten transmitters we placed on the crocodiles have now outlived their battery life," says Sam Han, CCCP Manager, who leads the team that monitor the radio tagged animals. "We are still picking up signals from three of the remaining transmitters, and regularly see other crocs that weren't tagged. They have moved up and down stream, but return to the original release site and seem to be doing well."

Community wardens now visit the location each month to ensure that hunting or fishing doesn't threaten these new colonists. So far there have been no recorded casualties. "This project is really a test case to see if the release initiative works," said Sarah. If it does, we eventually plan to release crocodiles into suitable, well-protected river systems across Cambodia, and truly bring this species back from the brink. "This will be a long-term prospect, and will require cooperation from zoos and breeders around the world. But if we are successful, we could see the return of one of Cambodia's most charismatic species – an important part of both Cambodia's ecosystems and its culture."

FISH SPECIES OF CAMBODIA

1. Previous Status of Fish in Cambodia

The previous biodiversity status report (2001) had a non-technical section on fish, written by Jady Smith, Uy Ching and John Valbo-Jorgensen, which sought to give an overview of knowledge on fish species status in Cambodia. There was no delineation made between freshwater and marine species but it was noted that more data was available for freshwater fish species. Key excerpts from that text are summarized below.

Cambodian Fish Species Literature

The historical importance of fish is represented in the many detailed stone carvings in the bas-relief's of Angkor. Other historical records would also be expected in Khmer and may date back much earlier than what is represented in this report, however this report has been limited to modern historical literature of the fish of Cambodia.

Cambodia has a particularly rich fishery literature, dating back to the early part of this century (LeClere, 1901; Caillard, 1905; Durand, 1915), no doubt due to the extraordinary importance of fish and fisheries to the Cambodian people, their culture and the economy. Nearly all of the fisheries literature relates to the Great Lake and floodplain of the lower Mekong. The most important of these were produced by Chevey and Le Poulain (1940), Blache and Goossens (1954), Bardach (1959), Fily and Aubenton (1964), Lloze (1964), Shiraishi (1969) Lagler (1976), the Mekong Secretariat (1992), Csavas et al. (1994). This fishery information can provide a great deal about the fishes, but relatively few fishery publications will actually help someone identify anything other than the largest and most valuable species, (Rainboth, 1996).

Cambodian Fish Diversity

Freshwater fish species in Cambodia are very diverse because the variety of river, lake and high estuary ecosystems supports a rich diversity, the true scope of which has only recently begun to be understood, furthermore geological changes in the ways the rivers drain in Cambodia has helped to increase fish diversity by isolating and rejoining fish species, (Rainboth 1996). Most Cambodians live near freshwater and as such the freshwater fishery of Cambodia has traditionally been the most important source of protein, and more is known about freshwater than marine fish.

Over 850 species of fish have been recorded in the lower Mekong river and the Great lake... A range of other adaptations are also evident and enable the recognition of two ecologically complementary groups – 'white fish' and 'black fish'. The white fish require water of higher oxygen and lower pH fluctuations than the black fish. White fish migrate annually to the Great lake and floodplain areas from the mainstream and tributaries with the rise of the Mekong floodwaters...The black fish are the permanent residents of the lake, (Ashwell, 1997).

Cambodia's marine and coastal species have not been extensively researched, however surveys of the Gulf of Thailand and the South China Sea identified coastal waters off Cambodia as being zones of high biological productivity and important nurseries for fish breeding in the Gulf, (Scripps Institution, 1962). Estimates for freshwater fish alone in Cambodia range from 850 – 1200. A more understated but highly cross referenced estimate of Cambodian fish species is made by the Fishbase Internet site, showing fish species list for Freshwater (486) and Marine/Brackish (357), and totaling 843 fish species for Cambodia.

2. Current Status of Fish In Cambodia

The Royal Government of Cambodia's Fifth National Report to the Convention on Biological Diversity (2014) states that:

"Cambodia's fisheries are some of the world's most productive and they play a significant role in the development of the country. In regards to the fishery sector there have been increasing yields in inland and marine capture fisheries and aquaculture is also increasing. There are some concerns that the effort per catch is increasing and the fish diversity and size is decreasing, and this may show stress on the systems that may be exacerbated by potential impacts from upstream dams on the Mekong."

In 2001 estimates for freshwater fish in Cambodia range from 850 – 1200, however a more conservative but highly cross-referenced estimate of overall Cambodian fish species is made by in Fishbase and from more recent IFREDI research, showing a fish species list for freshwater (486) and marine/brackish (357), totalling 843 fish species for Cambodia while a more up to date data from Mr. Uy Ching, a staff from Fisheries Administration listed a total 1357 fish species for Cambodia including freshwater (775) and marine/brackish (582). As FishBase continues to be updated the species list is growing. There are concerns about the status of Cambodia's fisheries as noted in the Stockholm Environment Institute report on the Tonle Sap in 2010:

Reduced catches can be caused by diminishing stocks, but also by more people fishing the same stocks. However, from a livelihood perspective, the important aspect is the catch per fisherman and the time and resources he has to spend to catch each kilo of fish. The clear message from the studied villages is that the important fish catches were going down, and that some people even chose to leave fishing to search for other livelihood options because of the decline in the resource. (SEI 2010)

The Tonle Sap is known as the major fishery and upper parts of the Mekong in Cambodia are significant for Spawning. In a 2012 presentation Dr So Nam from IFReDI noted the following key fisheries issues for Cambodia:

- Max. yield, i.e. approx. 400,000 tons/y achieved, although there is no significant decrease in total fish catch.
- > 80% of total inland catch are small-sized fish.
- Fish catch rate (kg/fisher) significantly decreased, e.g. in Tonle Sap region from 347 tons/fish in 1940 to 196 tons/fisher in 1995 (44%) and 116 tons/fisher in 2008 (67%).
- Cambodia's fisheries overfished, alarming stage!- Population increased, and no. fishers increased, e.g. in Tonle Sap region from 0.36 million in 1940 to 1.2 million in 1995 and 1.5 million in 2008 leading to an increase in no. of fishing gears, more effective and efficient ones.
- Use of illegal or destructive fishing gears, i.e. electro- shockers and fine-meshed size nets.
- Loss of healthy fish habitats due to flooded forests/wetland converted to crop fields leading to an increase in use of pesticide, e.g. 1.3 million liters of pesticide used in TS in 2000; and erosion/siltation, and due to water management projects increased and planned.

Dr. So Nam's presentation raises some concern around current practices and the potential impact this may have on the status of fish species in Cambodia.

3. Trends for Fish Species in Cambodia

There are growing concerns that the trend in fish species diversity is a sign of unsustainable harvest and potentially a tipping point for the fishery. Furthermore, there is a trend toward increased damming of the Mekong and its tributaries, which could further impact fish species diversity as stream flows and migration routes are altered.

As highlighted in Cambodia's Fifth National Report to the Convention on Biological Diversity, the Government has taken quite strong action, by removing the previous fishing concessions on the Tonle Sap Lake while also promoting aquaculture and community fisheries. This is a positive trend showing. The Government has acknowledged the significance of the fishery to the people and is acting to better manage the resource.

The previous NBSR (RGC 2001) had a non-technical section on fish, written by Jady Smith, Uy Ching and John Valbo-Jorgensen, which sought to give an overview of knowledge on fish species status in Cambodia. There was no delineation made between freshwater and marine species but it was noted that more data was available for freshwater fish species. The Fisheries Administration have worked with World Fish and IFReDI in developing a comprehensive fish species list for Cambodia. There are growing concerns that the trend in reducing fish species diversity is a sign of unsustainable harvest and potentially a tipping point for the fishery.

Furthermore, there is a trend toward increased damming of the Mekong and its tributaries, which could further impact fish species diversity as stream flows and migration routes are altered. As highlighted in Cambodia's Fifth National Report to the Convention on Biological Diversity, the Government has taken quite strong action, by removing the previous fishing concessions on the Tonle Sap Lake while also promoting aquaculture and community fisheries. This is a positive trend showing the Government has acknowledged the significance of the fishery to the people and is acting to better manage the resource. Fish diversity in Cambodia, across both fresh and salt water systems includes 1357 species.

BIRD SPECIES OF CAMBODIA

1. Previous Bird Species Status in Cambodia

The previous biodiversity status report (RGC 2001) had a non-technical section on birds, written by Colin Poole, which was a mix between providing a basic understanding of birds, while also providing some information of bird status at the time. Key excerpts from that text are summarized below.

Over 500 species of birds were recorded from Cambodia, but based on data from neighbouring countries (Thailand, Laos and Vietnam) more than 600 species are likely to occur. Almost two-thirds of these are resident and a quarter are winter visitors. This is a remarkably high diversity for a moderately-sized country whose topography consists mostly of lowlands and little in the way of high mountain ranges. It is comparable to the whole of Western Europe, which supports about 650 bird species in an area 20 times larger, albeit in the temperate zone.

Most areas of the country have received at least some preliminary fieldwork with the most notable exception being the upland areas of Virachey National Park in Ratanakiri Province. The first ornithological survey of that area will add much to the preliminary knowledge of occurrence and distribution of Cambodian birds. The bird fauna of Cambodia and the major families occurring may be divided into **six distinct geographical areas**: the Tonle Sap floodplain, the Mekong River channel, the Coastal wetlands, the Cardamom Mountains, the South Annamite forests and the Northern Plains' deciduous dipterocarp forest.

In 2000, **39 species** of birds known to occur in Cambodia were listed as globally threatened or near-threatened by BirdLife International. Of these, 25 are species that are primarily reliant on wetlands, the majority of which are large waterbirds. The only species suspected to have gone extinct in Cambodia is the Indian Skimmer (*Rynchops albicollis*), a species confined to the Mekong River channel. If Cambodia's globally threatened species are applied to the above six geographical areas, the Tonle Sap floodplain and the northern deciduous dipterocarp forest plains stand out as the most significant areas for bird conservation.

The greatest **threat** to bird species in Cambodia is from hunting, including the collection of eggs and young birds, as well as the direct persecution (hunting) of adults. Food is the single most important driving factor in bird hunting in Cambodia, although bird merit release at Buddhist temples affects ricefield passerines caught with mistnets. A number of species are also hunted to supply the pet trade, such as parakeets and Hill Mynas, for ornamentation (Green Peafowl feathers, Great Hornbill casques) and/or sold to zoos.

Habitat loss has had a less profound effect on most bird communities in Cambodia, but several key issues do emerge. Conversion of grasslands for agriculture is reducing important habitats for globally significant species such as the Bengal Florican and White-shouldered Ibis and potentially small passerines such as the Red Avadavat and Asian Golden Weaver. Large nesting trees are under increasing threat from collection for fuelwood and building materials. Loss of these will impact colonial large waterbirds, vultures and large hole nesting species such as hornbills. The Mekong River and its tributaries are under increasing threat, as well, from flow manipulation due to the construction of large hydroelectric dams.

2. Current Bird Species Status in Cambodia

A comprehensive documentation of the avifauna of Cambodia has recently been published in the form of an annotated checklist (Goes 2014). This is the first such publication for any Southeast Asian country. Dates intervened since that publication are included in this report regarding species recorded after mid-2013 and latest global conservation status.

Diversity and distinctiveness

The national bird list has increased steadily since ornithological studies resumed in the mid-1990's. Survey efforts throughout the country, as well as field research, conservation programs and birdwatching tourism, have contributed to greatly enhance the knowledge of Cambodia's avifauna. Between 1992 and 2013, the number of birds recorded in Cambodia increased by 50%, reaching the long-predicted estimate of 600 species. Since the previous status report,

nearly 100 additional species have been documented and the recently-published checklist documents 599 confirmed species. 2 further species have been reported since that documentation, as well, bringing the current total of bird species known from Cambodia to 601. This represents a remarkable diversity for a predominantly lowland and small land-area country.

In contrast to its high diversity, the originality of the Cambodian avifauna is relatively low. The country hosts two strictly endemic species – the Cambodian Laughingthrush and the Cambodian Tailorbird - and two near-endemic species -- the Chestnut-headed Partridge and the Mekong Wagtail – whose ranges marginally extend into adjacent countries. The Cardamom Mountains support two restricted-range species and form an important part of the “Thailand-Cambodia mountains” Endemic Bird Area (*sensu* BirdLife International). Thirteen highly distinctive subspecies are also endemic to this area, some regarded as deserving proper species status.

Conservation significance

Cambodia has unparalleled regional significance and high global importance for bird conservation. In contrast to Thailand and Vietnam, large tracts of untouched natural habitat remain in the country. As a result, many of the species lost or close to extinction in the region have persisted in relatively healthy populations in Cambodia, making the country a regional refuge for large waterbirds, vultures, grasslands and riverine birds, as well as threatened lowland forest species.

No less than 67 bird species occurring in Cambodia – including 48 resident - are listed by BirdLife International under a Globally Threatened or Globally Near-Threatened category plus one as a Data Deficient species. Of the 30 Globally Threatened species, 8 are classified as Critically Endangered and 12 as Endangered. There are only eight countries in the world, none in mainland Southeast Asia, that support more than 8 Critically Endangered bird species. Furthermore, Cambodia holds globally highly significant populations of 10 Globally Threatened or Globally Near-Threatened species, as well as 3 Globally Near-Threatened endemic and near-endemic species.

Bird conservation

Conservation legislation

Wildlife in Cambodia is granted protection under several decrees and sub-decrees issued by the Ministry of Environment and the Forestry Administration. The national Forestry Law of 2002 states that “all wildlife belongs to the state” and defines penalties for offenses. A decree on the legal classification of wildlife in January 2007 identifies various species as “endangered,” “rare” or “common.” The legal status of species, however, does not always correspond to their true conservation status and is currently under revision.

A special mobile intervention unit of the Forestry Administration conducts investigations and operations against wildlife crimes. In general, however, wildlife offenses are rarely reported or conducted in collusion with enforcement officials and, as such, the law is unevenly enforced, even in protected areas. Separation of responsibilities between the Fisheries Administration (for aquatic breeding wildlife) and the Forestry Administration (for terrestrial wildlife), and between the different line management authorities responsible for protected areas, further compounds the difficulties of ensuring effective enforcement.

Conservation actions and results

In the early 2000's, several conservation programs were initiated that , focused on addressing the most prevailing threat, which is that of bird hunting and 'persecution.' At Prek Toal, local ranger teams were established set up to monitor the colonies throughout the breeding season and undertake patrols and interventions to stop poachers. The program, which was initiated began in 2001, and achieved a remarkable success: egg and chick collection were curtailed by 2005 and waterbird populations of seven globally significant species recovered at various rates. The intervention project has often been cited labelled as one of the most successful conservation stories in Asia.

In the northern plains, opportunistic 'persecution' of often solitary nesting species across a vast landscape have required a different approach. There, Here payments are directly provided to villagers for reporting and protecting nests. Piloted in Preah Vihear province from 2003 to 2012, the program ensured protection of no less than 2,700 nests of nine bird species of global conservation concern across 2,000km² and totaled \$20,000 in annual payments to villagers. Using fledging success as its primary main indicator, the approach was proved very effective for the Sarus Crane, Lesser Adjutant and the Oriental Darter. This model has since been replicated with varying success at other important sites in the country for bird conservation.

Since 2004, the *Cambodian Vulture Conservation Program* has addressed the perilous status of vultures in Cambodia through a network of feeding stations, better known as 'vulture restaurants.' Six sites across the north and northeast regions are supplied monthly with dead cattle to supplement scarce natural food resources in efforts to increase breeding success and population recovery. Annual census figures indicate that the populations of the three species have remained stable since the program's occurrence.

Aside from these prominent initiatives, a series of local committees and site support groups have been established at critical sites through *BirdLife International* that conduct patrols and enforcement and provide habitat protection and monitoring.

3. Trends for Cambodia Bird Species in Cambodia

Knowledge

Diversity

The species discovery curve does not yet seem to have reached a plateau, with at least five species added every year since 2004 with the exception of one year during that period. No less than 70 species may still occur in Cambodia based on their ranges and distribution in neighbouring countries. Most of the resident species among the potential additions are found in the higher hills of the northeast, especially in Virachey National Park. In terms of species diversity, this area still represents a significant gap in knowledge. Scarce regional migrants and hitherto overlooked species regularly visiting Cambodia will probably also contribute to additional new records so that by the time of the next status report, Cambodia may have 650 species on which to report.

Colonists and new taxa

With the return to 'normalcy' of the country in the late 1990's, two species primarily associated with human settlements – the House Sparrow and the Zebra Dove – have expanded their range from Thailand into Cambodia and quickly spread throughout the country. Rare and localized in the early 2000's, they are now widespread and common in suitable habitat.

More significantly, two new species have been uncovered in Cambodia. In 2001, the Mekong Wagtail was described from the riverine channel of the Mekong River and its tributaries above Kratie. It is the river's only endemic bird. In 2013, the shrublands on the outskirts of Phnom Penh revealed a hitherto undiscovered species, the Cambodian Tailorbird. This restricted-range species is endemic to the lower Mekong - Tonle Sap floodplain and currently only known from Cambodia. In both instances, the distinctive taxon had been observed or even photographed by ornithologists quite some time before they were considered to be unknown species. Their 'discovery' is more the result of sharp mind-opening processes than expeditions in remote and unexplored parts of the country.

Ornithology

Since the previous status report, the knowledge of Cambodian avifauna has progressed in various aspects, including with regard to distribution, populations, breeding and ecology. Dedicated research by graduate students on globally threatened species has yielded extensive and invaluable scientific information on the Bengal Florican, Giant and White-shouldered Ibises and riverine-nesting birds. Some ad hoc research, or theses by Biodiversity Conservation students at the Royal University of Phnom Penh, have also contributed to the country's expanding ornithological knowledge.

Conservation status

Global threat status

One might attribute the increase in the number of species of global conservation concern present in Cambodia from 39 in 2000 to 67 in 2015 as a reflection of the worsening state of the world's biodiversity. Taxonomic revisions or newly-recorded or described species account for 15 additional Globally Threatened/Globally Near-Threatened species.

Characterising the status trends of globally threatened bird species present in Cambodia requires differentiating between multiple factors and different avifaunal groups. On the basis of the global status evolution presented, these important trends are highlighted:

- Galliformes, with the notable exception of the Green Peafowl, are considered less threatened, primarily because of their noted resilience to snaring and forest logging.
- All three resident Vulture species and the Bengal Florican have become Critically Endangered, the latter following a documented steep decline from Cambodia's grasslands.
- There is a fairly stable conservation status for large waterbirds, aside from actual improvement for the Spot-billed Pelican, partly following the halt of the decline in Cambodia as a result of the Prek Toal program and the worsening status for the Milky Stork, whose primary population decline is in Indonesia.
- There is a clearly worsening status for riverine species, with three species (Great Thick-knee, River Lapwing and River Tern) recently listed as Globally Near-Threatened and the Black-bellied Tern becoming Endangered, its extinction from Cambodia and, therefore, the Mekong region part of the rationale for this status change.
- There is increasing conservation concern for forest birds, with five species having recently been 'uplisted,' including the Great Slaty Woodpecker and four parakeets, as the result of expected habitat loss.
- Higher conservation concerns are emerging in recent years regarding three migrant passerines, the Silver Oriole, Rufous-headed Robin and Yellow-breasted Bunting, as the result of threats both at breeding and wintering grounds; only the latter species, however, winters in significant numbers in Cambodia.

It should also be recognized that none of the Critically Endangered resident species have had their status improved despite dedicated conservation efforts and research. This is illustrated in the case of the White-shouldered Ibis, a species that is now practically confined to Cambodia, apart from a tiny outlying population in Borneo. The species was extremely poorly known and considered to number less than 250 individuals in 2001. Its distribution, ecology, breeding and threats are now much better understood and conservation actions have been implemented to address nest harvesting and its current population is estimated to be about 1,000 birds. Nevertheless, it is still considered to be highly threatened.

Even the considerable achievements of the Prek Toal efforts, with significant and consistent increases of several species, including the Greater and Lesser Adjutants, Oriental Darter and Painted Stork, have not resulted in improved global status. These large waterbirds, as with most colonial breeders, remain at very high risk of population decline should the conservation programs cease.

Overall, it may be stated that the global conservation status of wetlands birds has not significantly worsened or improved, while it has clearly worsened for riverine species in recent years and is expected to do so for forest species in the near term. These trends are likely to continue or even become exacerbated with regard to riverine and forest birds, while the status of wetlands birds remains fragile and largely dependent on dedicated conservation efforts.

National conservation priorities

A national threat status has recently been proposed, adapting the application of IUCN criteria at the country level. This process has identified 99 species, or 17% of the country's avifauna, of definite or potential national conservation concern, plus 30 species that have a restricted range and are vulnerable to local threats or land use changes.

Of the 14 species assessed as Critical in Cambodia, 10 are Globally Threatened. These should be regarded as of the highest priority for national bird conservation. These include, in decreasing order of global importance:

- The Giant Ibis: 500-1,000 birds, Cambodia's national bird and the flagship species of the dry deciduous forest; recently listed no.1 of "the 100 highly distinctive and most endangered bird species in the world"; threatened by disturbance and habitat loss.
- The White-shouldered Ibis: 1,000 birds in three main populations in the north-northeast, each severely threatened by economic land concessions, nest harvesting and hydroelectric dams.
- The Bengal Florican: 300-500 birds heading toward extinction as the result of the reclamation of grasslands for agriculture.
- Three resident Vulture species: 100 to 250 birds each, suffering from chronic lack of food since the depletion of the mammal megafauna of the open forests, as well as victims of poisoning.
- The Greater Adjutant: 500 birds with a major colony in Prek Toal, increasing from 30 pair to 200 pair, which is, now the world's largest colony; threatened by nest harvesting, hunting at feeding grounds and poisoning.
- The White-winged Duck: 100-200 birds in very small, fragmented populations; threatened by hunting, capture, and habitat loss from the construction of hydroelectric dams and logging.
- The Masked Finfoot: very small population of poorly known species; threatened by disturbances, capture, fishing gear and hydroelectric dams.
- The Milky Stork: 30-50 birds with 10-15 pairs at Prek Toal, plus a possible coastal population; threatened by genetic dilution through hybridization with the Painted Stork.

Extinction pressure

Four species are considered extinct in Cambodia (see Table 4), three during the past century and one during the first decade of this century. As widespread and dramatic land use changes accelerate, the extinction rate is expected to increase. Three species are currently confronting a very high and imminent risk of extinction and are likely to become extinct in the next ten years (see Table 4), while all other nationally critical species may be extirpated by 2050. Often, extinction in Cambodia means that the species becomes regionally extinct, as well.

Table 4: Species extinct or heading toward extinction

Species	Habitat	Last record/projected extinction	Significance
Greater Flamingo	Wetlands	1935, shot on Tonle Sap shore	Regional
Indian Skimmer	Rivers	Early 1960's, Mekong River	Regional
Great White Pelican	Wetlands	Unknown prior to 1975	Regional
Black-bellied Tern	Rivers	2003, Sesan River	Regional
Nicobar Pigeon	Offshore islands	2015-2020 (not recorded since 2001)	National
River Tern	Rivers	2020-2025	Regional
Bengal Florican	Grasslands	2025	Major global population

			loss; extinction of Indochinese species
Milky Stork	Wetlands	2030-2035	Regional

Bird in Table 4 also indicates those habitats that are falling through some conservation gaps, either receiving no attention, such as offshore islands, or characterized by inadequate or unsuccessful efforts, such as rivers and grasslands. As such, the Nicobar Pigeon, River Tern and Bengal Florican “extinction candidates” represent flagship species since saving them would also secure populations of a suite of other species associated with these habitats.

Introduced species

There is one case in which the introduction of a non-native species is suspected to pose a threat to the native bird fauna. Since the boom of swiftlet farms in Cambodia, concerns have been raised about the import of edible-nest swiftlet eggs to be artificially cross-fostered by local parents. Such a practice, which is common across Asia, may result in progressively outcompeting the native species.

Conservation challenges

Protection of breeding colonies and nests has been part of the successful approach to conservation used at Prek Toal and in the northern plains, halting the decline, or even ensuring recovery, of many globally threatened species. The same strategy has, however, not had a significant impact at other sites, in particular in the Mekong River region for various reasons, including a more complex pattern of threats. The status of the River Tern remains desperate and Cambodia might soon lose its third riverine-nesting bird species, which is experiencing a population collapse as the result of the combined effects of very low breeding success and high adult mortality, possibly as a result of ageing birds.

At Prek Toal, the recent decision to abolish all fishing concessions within the Tonle Sap could undermine over ten years of successful conservation efforts. Unrestricted access to flooded forest areas formerly protected for commercial fishing had led to increased disturbance and resurgence of egg and chick collection. While some recognizable results have been achieved in addressing hunting and ‘persecution’ of birds, this demonstrates that no conservation success may be assumed to be permanent and the impacts of some even well-intentioned political decisions are not always carefully evaluated.

In addition to these setbacks, bird conservation actions must increasingly encounter new challenges. Rapid development has shifted threats from local and species-focused issues to those associated with landscape-level changes. The latter come in various forms (e.g., grassland conversion to rice cultivation; the leasing of large forest areas for commercial plantations; and the construction of hydroelectric dams), but invariably create large-scale threats to habitats and the wildlife those habitats support.

The previous NBSR section on birds was developed by Colin Poole of the Wildlife Conservation Society. The current NBSR section on birds has been developed by Frederic Goes, with review and feedback from Tan Seta. The bird section is based on and updated from “The Birds of Cambodia: An Annotated Checklist” (Goes 2013), which is a significant biodiversity resource for Cambodia. Protection of breeding colonies and nests has been part of the successful approach to conservation used at Prek Toal and in the northern plains, but has not worked in other sites. The recent decision to abolish all fishing concessions within the Tonle Sap could also undermine over ten years of successful conservation efforts through unrestricted access to flooded forest areas formerly protected for commercial fishing had led to increased disturbance and resurgence of egg and chick collection. In addition to these setbacks, bird conservation actions must increasingly encounter new challenges. Rapid development has shifted threats from local and species-focused issues to those associated with landscape-level changes. The latter come in various forms (e.g., grassland conversion to rice cultivation; the leasing of large forest areas for commercial plantations; and the construction of hydroelectric dams), but

invariably create large-scale threats to habitats and the wildlife those habitats support. Birds seem to be the most well researched of the species lists, (including field guides and checklists from 1998, 2003 and 2014) but even recently a new species was identified in Phnom Penh. There are 601 bird species currently listed for Cambodia, with 7 on the new global Evolutionarily Distinct and Globally Endangered (EDGE) list.

MAMMAL SPECIES OF CAMBODIA

1. Previous Status for Mammals in Cambodia

The previous biodiversity status report (RGC 2001) had a non-technical section on mammals, written by Joe Walston from the Wildlife Conservation Society, which was a mix between providing a basic understanding of mammals were separated, while also providing some information of their status at the time. Terrestrial and marine mammals were separated, with a non-technical section on marine mammals, written by Pete Davidson and Isabel Beasley. This was a mix between providing a basic understanding of marine mammals, while also providing some information of their status at the time. Key excerpts from that text are summarized below.

There are approximately 100 species of terrestrial mammals that have been recorded from Cambodia. There were 49 mammal taxa listed by the IUCN (2000) as Globally Threatened, Near-threatened or Data Deficient (see the attached Key Species Accounts) and present in Cambodia. Of those, however, 17 have not been recorded from the country, with some species, such as the Chinese Pangolin (*Manis pentadactyla*) and Asian Tapir (*Tapirus indicus*) unlikely to occur. Recent IUCN listings have added 3 more species, the Hairy-faced Myotis (*Myotis annectans*) and Hairy-winged Bat (*Harpiocephalus mordax*), which are near-threatened, and the Wroughton's Free-tailed Bat (*Otomops wroughtoni*), which is critical.

There are 35 IUCN-listed terrestrial species of mammals known from Cambodia. Of those, the Kouprey (*Bos sauveli*) and Javan Rhinoceros (*Rhinoceros sondaicus*) are potentially extinct (globally and nationally, respectively). Moreover, since it is still unclear whether the Khting Vor (*Pseudonovibos spiralis*) should be recognized as a genuine species, its presence in Cambodia is included as provisional and, thus, is not included in the analysis of the faunal areas. *Rattus sikkimensis* is also included by the IUCN (2000), although such confusion surrounds the taxonomy of this group that its inclusion would be difficult to support. Similarly, since the Red-shanked Douc Langur (*Pygathrix nemaeus*), Malayan Tapir (*Tapirus indicus*) and the Particoloured Flying Squirrel (*Hylopetes alboniger*) have not been recorded from Cambodia and their presence is doubtful, they, too, have been omitted from the report.

Six of the seven Critical or Endangered species listed are recorded for the Eastern or Northern Plains, four for the Southern Annamites and three for the Cardamoms. While the Cardamoms have a high number of less endangered species, for Globally Threatened species it is depauperate, while the reverse is the case for the Southern Annamites. The Northern Plains and Southern Annamites together represent habitats for 31 (89%) of the IUCN-listed mammal species, suggesting that conservation efforts across these areas would represent the most efficient use of conservation resources in meeting the mammal conservation priorities of the country.

Five of the seven most threatened mammals in Cambodia are very large-bodied species requiring sizeable expanses of habitat and known to favour open or edge forest (with the exception of the Javan Rhinoceros), all natural features of the Northern and Eastern Plains. Furthermore, of the remaining two species, one is known only from the Northern Plains and the other is restricted to the Eastern Plains and the Southern Annamites.

Threats

The most immediate and severe threat to mammal species of global significance is hunting. Each of the large-bodied mammals listed in the tables has both a commercial and a subsistence value to local communities and professional hunters, which combine to exert intense pressure on remaining mammal populations. It is likely that all large ungulates have declined over recent years due to hunting, with some taxa now close to global extinction, such as the Kouprey, Indochinese Hog Deer (*A. porcinus annamiticus*) and Indochinese Eld's Deer (*C. e. siamensis*). The near, or total, extirpation of populations in neighbouring countries has only increased the pressure on some species, especially the Tiger, Asian Elephant and wild cattle.

While other anthropogenic activities such as selective logging, shifting agriculture, burning, and non-timber forest products (NTFP) collection have their own complex effects, hunting supersedes each of these in posing the most intense and immediate threat to mammals. There are a number of factors that have brought about this state; increased access to rural areas, the subsequent spread of wildlife trade networks from the local to the international level, increased

access of local populations to weapons (though this trend now appears to be reversing), the lessening of security threats and the increase in financial rewards for wildlife products.

The former widespread actions of unregulated logging concessions throughout the country undoubtedly had some serious negative effects on mammal species, though these varied greatly in their intensity between different species groups. An indirect, but nonetheless potentially serious impact of large-scale logging operations is the building of logging tracks and roads. Not only do these open access to larger areas, they also allow the transport of a larger mass of wildlife, thus facilitating more intensive hunting regimes. Such access also encourages others to take up opportunistic or professional hunting, especially among those who have recently moved into the area. For a significant proportion of Cambodia's mammal megafauna, the possibility of curbing poaching and opportunistic hunting offers the greatest opportunity for ensuring their survival.

Marine Mammals

Eight marine mammal species were identified from 42 encounters during surveys that were conducted by Beasley et al., 2001. Six constituted new country-records, including the False Killer Whale (*Pseudorca crassidens*), a long-beaked form of the Common Dolphin (*Delphinus capensis* (cf. *tropicalis*), the Pantropical Spotted Dolphin (*Stenella attenuata*), the Dwarf Spinner Dolphin (*Stenella longirostris roseiventris*), the Bottlenose Dolphin (*Tursiops sp?*) and the Indo-Pacific Hump-backed Dolphin. The Finless Porpoise and the Irrawaddy Dolphin were also recorded during the surveys.

Cetacean stranding reports during the period were investigated and necropsies performed when possible as a first step towards establishing a national strandings network. This included the first country record of Short-finned Pilot Whale (*Globicephala macrorhynchus*). Marine mammal skeletal material was also collected, thoroughly examined, labelled and deposited with the Department of Fisheries in Phnom Penh. Two species were recorded based on skeletal specimens collected prior to the surveys' inception: the Dugong (*Dugong dugon*) and a large rorqual whale (either the Fin Whale (*Balaenoptera physalus*) or the Bryde's Whale (*B. edeni*). This brought the number of marine mammals recorded in Cambodian waters to eleven.

The initial results indicated the current status of marine mammals in coastal waters of Cambodia to be encouraging, both in terms of species diversity (particularly among the typically more oceanic species, for which the waters of the Koh Tang and Koh Polou Wai archipelagoes seem to be a key area) and abundance (especially the three inshore water specialists, the Irrawaddy Dolphin, Indo-Pacific Hump-backed Dolphin and Finless Porpoise, for which Koh Kong Bay and adjacent waters, Kompong Som Bay and Ream National Park appear to be of critical importance) (Beasley et al. 2001). Cambodian waters appear to support regionally, if not globally, significant populations of several of these species.

2. Current Status of Mammals in Cambodia

In 2001, approximately 70 species of terrestrial mammals were recorded for Cambodia. In 2014 mammal species list includes 162 species. The comparison of the IUCN and national categories for some of these mammal species are summarized in table 5.

Table 5: Species Categories

IUCN		National (MAFF)	
LC – Least Concern	33		
EN - Endangered	9	Endangered	27
VU - Vulnerable	12		
NT – Near Threatened	6	Threatened	46
CR – Critically Endangered	1	Critically Endangered	10
DD – Data Deficiency	1		
N/A – Not Applicable	20		

It is a very encouraging sign that the Ministry of Agriculture, Forestry and Fisheries has developed Cambodian Categories for some mammal species, but there is some difficulty in the translation of categories for listing.

The following excerpt is from Cambodia's Fifth National Biodiversity Report:

There are no confirmed extinctions for the period since the 4th National Report, however ongoing habitat loss is placing significant pressure on many species. With increased research more species have been identified and confirmed for Cambodia. Mammals are often the best known and researched species and since the last report more bat species have been confirmed for Cambodia bringing the total from 53 to 61 and then to 66 bat species recorded for Cambodia in 2012.

Relatively little is known about endangered marine species nationally. The first boat-based marine mammal surveys in 2001 (Beasley & Davidson, 2007) suggested that Cambodian waters at the time supported regionally, if not globally, significant populations and confirmed the presence of ten marine mammal species. Surveys specifically for marine mammals have been conducted in the Koh Rong Archipelago, but coverage of the area, particularly in the last ten years, has been essentially non-existent. The few marine mammal records available are from incidental encounters. The Fisheries Administration developed sub-decree (Anukret) 123, which was approved by the Prime Minister on 12 August 2009, that identifies three marine mammals of importance (see Table 6).

Table 6: Endangered aquatic species or genera listed on sub-decree 123 recorded within the boundaries of the proposed Marine Fisheries Management Area.

Sub-decree 123 Categorization	IUCN category	Year of last sp. record	Source
Dugong <i>Dugong dugon</i>	VU	2005	Nhem V., <i>in litt.</i>
False killer whale <i>Pseudorca crassidens</i>	DD	2001	Beasley & Davidson, 2007
Irrawady dolphin <i>Orcaella brevirostris</i>	VU	2009 (skeleton)	FFI, 2009

The Royal Government of Cambodia (Sub-decree 123) lists 10 cetaceans and the dugong, which appears to represent all marine mammal species that have been recorded in Cambodian waters. On the basis of studies from neighboring countries, Beasley & Davidson (2007) suggested that it is highly likely that further cetacean species remain unrecorded for Cambodian coastal waters. Cambodia's shallow seas and gentle seabed gradient, which lacks marked "shelving" or other prominent underwater features, may constitute a limiting factor to marine mammal species diversity (Beasley & Davidson, 2007). With the exception of the Irrawaddy dolphin, which has received recent 2014 survey efforts in near shore and estuarine habitats in Koh Kong Province (Kong S., *pers. comm.*), the national status of the remaining species remains unknown and the significance of the water of the proposed Marine Fisheries Management Area for cetacean populations in the Gulf of Thailand remains uncertain and merits further research. It is also important to highlight that ongoing degradation of the marine environment and escalating threats to marine mammals since the 2001 surveys has probably had a negative impact on populations of those species that frequent or frequented Cambodian waters.

3. Trends for Mammal Species in Cambodia

New mammal species are still being uncovered in Cambodia, especially through specialist work on bats, for which 72 species have now been identified, which is more than the total for mammals in 2001. The high bat diversity also draws attention to small karst ecosystems around the country as potentially significant biodiversity hot spots. Habitat fragmentation blocking wildlife corridors threatens large mammal migration, isolating them in smaller areas, which makes them more vulnerable and promotes inbreeding depression that could lead to extinction in the longer term.

There have been significant mammal finds since 2001, which seem likely to continue, but with fewer new mammal species expected. In 2008, a Wildlife Conservation Society survey of the Seima Protected Forest identified previously unknown and internationally significant populations of black-shanked doucs and yellow-cheeked crested gibbons.

The current emphasis is to identify new mammal species, but there is also the need to verify the Royal Government of Cambodia's existing mammal list since some mammals may now be considered locally extinct and one is considered to have never existed (Khting Vor). In terms of national biodiversity management, it may be useful for the Government to have one agreed mammal species list for Cambodia. Interestingly, at the time of the last Biodiversity Status Report (2001), there was also a lively debate about the K'Ting Vor, which is now considered by many to be a hoax, but is still found on some Cambodian species lists.

The Fisheries Administration has been conducting research related to a proposed Marine Fisheries Management Area. There is limited data on marine mammal trends, but that related to the decline in Dugong highlights some of the concerns regarding potential trends for other marine mammals, as well. Dugongs (*Dugong dugon*) were reportedly abundant on parts of the Cambodian coast until 1975 (Nelson, 1999).

The previous NBSR (2001) separated terrestrial (Joe Walston) and marine mammals (Pete Davidson and Isabel Beasley). This section was a mix between providing a basic understanding of mammals, while also providing some information of their status at the time. The previous mammal data, which includes the now questionable K'Ting Vor, place greater importance on setting an agreed national mammal list. New mammal species are still being uncovered in Cambodia, and Neil Fury helped to highlight some of the specialist work on bats, for which 72 species have now been identified, which is more than the total for mammals in 2001. There have been significant mammal finds since 2001, which seem likely to continue, but with fewer new mammal species expected. In 2008, a Wildlife Conservation Society survey of the Seima Protected Forest identified previously unknown and internationally significant populations of black-shanked doucs and yellow-cheeked crested gibbons. While there has been important mammal research it has not been systematically collected and has not been effectively shared among relevant stakeholders. The decline in Dugong and River Dolphins are concerning indicators for marine mammals in Cambodia. There is a need for classification standards and national discussions around the mammal list including potential extinctions such as Kouprey and Rhinoceros. Mammal diversity in Cambodia, across both terrestrial and marine systems includes 162 species.



4. CAMBODIA'S ECOSYSTEM DIVERSITY

FUNCTION OF ECOSYSTEM SERVICES

An ecosystem is a dynamic complex of plants, animals, and micro-organisms communities and the non-living environment interacting as a functional unit. According to the Millennium Ecosystem Assessment³ ecosystem services have been defined as the benefits that people obtain from the ecosystems. In the original definition of the Millennium Ecosystem Assessment the concept of “ecosystem goods and services” is synonymous with ecosystem services. Other approaches distinguish “final ecosystem services” that directly deliver welfare gains and/or losses to people through goods from this general term that includes the whole pathway from.

The services include the following:

- ⇒ Provisioning: goods produced or provided by ecosystems such as food, fresh water, fuel wood, and genetics resources, timber and fibre;
- ⇒ Regulating: benefits obtained from regulation of ecosystem such as climate regulation, disease regulation, floods regulation, wastes and water quality;
- ⇒ Cultural: non-material benefits from ecosystems such as spiritual, recreational, aesthetic, inspirational, and educational;
- ⇒ Supporting: services necessary for production of other ecosystem services such as soil forming, nutrient cycling, primary production.

ECOSYSTEM DIVERSITY

Ecosystems are communities of interacting organisms and the physical environment in which they live:

- ⇒ Ecosystem diversity relates to broad differences between ecosystem types and the diversity of habitats and ecological processes within ecosystems;
- ⇒ **Habitat** is the place where an organism lives: tiger habitat provides for the tiger what it needs to live;
- ⇒ An **ecosystem** can contain many habitats. Tiger habitat is part of the forest ecosystem. Without a forest ecosystem there would be no tigers, but it is possible to have a forest ecosystem without tigers. The ecosystem is like a complex web and depending on which link is broken, the system can collapse.

It is more difficult to define ecosystem diversity than species or genetic diversity because the ‘boundaries’ of communities and ecosystems are not always very clear. The ecosystem concept can be applied at different scales from very broad to very specific. For management purposes, a broad ecosystem concept is usually used. There are a number of ways to classify ecosystem and the choice often depends on the purpose of the classification. There is no right or wrong way to classify Cambodia’s ecosystems. The World Resources Institute (2000) has undertaken a global assessment of ecosystems. They have chosen five major ecosystem categories: **agro-ecosystems, forest ecosystems, grassland ecosystems, freshwater ecosystems and coastal ecosystems**. Cambodia has all of these systems, with the exception of extensive grassland ecosystems.

Ecosystems are very complex and it is not yet understood all the relationships within an ecosystem. Therefore we cannot always predict the effect that the removal or disturbance of one part of the ecosystem may have on the functioning of many other components of the ecosystem. Maintaining natural habitats will help ecosystem functions over a wider area. It is also important to maintain the healthy ecosystems in combatting climate change by applying Ecosystem based adaptation. Every ecosystem provides habitat for plants, animals and microorganisms which we can use or which perform useful functions. The World Resources Institute call ecosystems “the productive engines of the planet, providing us with everything from

³ Millennium Ecosystem Assessment, Ecosystems and human well-being: biodiversity synthesis (Washington, D.C., World Resources Institute, 2005)

the water we drink to the food we eat and the fiber we use for clothing, paper, or wood for construction (WRI 2000).

Table 7 gives examples of the many goods and services provided by four broad ecosystem categories found in Cambodia.

Table 7: Ecosystem Services

Ecosystem	Goods provided	Services provided
Agroecosystems	<ul style="list-style-type: none"> ⇒ Food crops ⇒ Additional food items (eg rice field fisheries) ⇒ Fiber crops ⇒ Crop genetic resources 	<ul style="list-style-type: none"> ⇒ Maintain limited watershed functions (infiltration, flow) ⇒ Control, partial soil protection) ⇒ Provide habitat for birds, pollinators, soil organisms important to agriculture ⇒ Build soil organic matter ⇒ Bind atmospheric carbon ⇒ Provide employment
Forest Ecosystems	<ul style="list-style-type: none"> ⇒ Timber ⇒ Fuelwood ⇒ Drinking and irrigation water ⇒ Fodder ⇒ Non-timber products; vines, bamboo, leaves, etc. ⇒ Food (honey, mushrooms, fruit, and other edible plants; game) ⇒ Genetic resources 	<ul style="list-style-type: none"> ⇒ Remove air pollutants, emit oxygen ⇒ Cycle nutrients ⇒ Protect water resources (infiltration, purification, flow control, soil stabilization) ⇒ Maintain biodiversity ⇒ Bind atmospheric carbon ⇒ Moderate weather extremes and impacts ⇒ Generate soil ⇒ Provide employment ⇒ Contribute aesthetic beauty and provide recreation
Freshwater Systems	<ul style="list-style-type: none"> ⇒ Drinking and irrigation water ⇒ Fish and other aquatic organisms ⇒ Hydroelectricity ⇒ Housing materials ⇒ Medicines ⇒ Genetic resources 	<ul style="list-style-type: none"> ⇒ Lessen or prevent the impact of flooding ⇒ Dilute and carry away wastes ⇒ Cycle nutrients ⇒ Maintain biodiversity ⇒ Provide transport corridor ⇒ Provide employment ⇒ Contribute aesthetic beauty and provide recreation
Coastal Ecosystems	<ul style="list-style-type: none"> ⇒ Fish and shellfish ⇒ Seaweeds (for food and industrial use) ⇒ Salt ⇒ Genetic resources 	<ul style="list-style-type: none"> ⇒ Moderate storm impacts (mangroves; barrier islands) ⇒ Provide wildlife (marine and terrestrial) habitat ⇒ Maintain biodiversity ⇒ Dilute and treat wastes ⇒ Provide harbors and transport routes ⇒ Provide employment ⇒ Contribute aesthetic beauty and provide recreation

Source: adapted from WRI 2000. Global ecosystem assessment

This Biodiversity Status review seeks to describe the major Agricultural, Forest, Inland Water and Coastal Ecosystems, however within these major ecosystems there are other significant smaller ecosystems. Karst is an example of a specific ecosystem of high biodiversity value that

is found within larger ecosystems but which may require specific biodiversity management due to its potentially high endemism.

CAMBODIAN AGRICULTURAL ECOSYSTEMS

1. Previous Status of Cambodian Agricultural Ecosystems

The 2001 Status Report on Cambodia's Ecosystem Diversity was based on a summary of available data on Cambodian Agricultural Ecosystems. This document is further summarized highlighting the following information below.

Throughout the world human communities have played a central role in shaping nature's diversity and its associated functions. Biological diversity has contributed in many ways to the development of human culture, and humankind has in turn influenced biological diversity...

Sustainable practices see conservation and agricultural use together in a larger context: it is within this context that it is understood that the boundaries between natural and agricultural ecosystems are very narrow. Agroecosystems are not only influenced by agronomic and ecological demands per se, but also by household and market demands for various crops as well as culture, beliefs, customs, and economic and political systems. All of these components need to be considered together.

One of the main characteristics distinguishing agricultural ecosystems from natural ecosystems is the primary role that human activities have in shaping the structure and function of agroecosystems. More specifically, agricultural ecosystems differ from natural ecosystems in that they have a specific human-determined function, namely the production of harvestable yield. Farmers structure their agroecosystems to provide desired goods and services. Within each agricultural ecosystem there are other significant species and genetic agricultural biodiversity components.

Agricultural Land Use In Cambodia

Chandel & Paroda (2000) have given the following description of agricultural land use in Cambodia, as part of their report on the Status of Plant Genetic Resources in the Asia Pacific Region.

"Agriculture has traditionally been the most dominant sector in the economy of South-East Asia until very recently. About 90% of the population still thrive on agriculture in Cambodia... The Cambodian national economy is (also) largely agriculture based, mostly rainfed, mono-cropped and mainly under rice based farming system... over 95% area of the country is situated below elevation of 1000 metres above average sea level. Rice constitutes the predominant crop followed by maize. Among legumes, soybean is important followed by mungbean. The oilseed crops include groundnut and sesame. Further, among commercial crops, sugarcane followed by jute and tobacco is commonly grown. Vegetables occupy very large area under cultivation; sweet potato is more common whereas cassava is also sparsely cultivated."

Agricultural Ecosystems In Cambodia

Rice based agriculture

Rice is Cambodia's major agricultural crop and traditional source of carbohydrate. The cultural significance of rice is emphasized by the inclusion of the word for cooked rice as a way of describing all meals. Of the total rice cropping area in Cambodia, 86% is rainfed lowland rice, 8% is Dry season rice, 4% is floating rice and 2% is upland rice (O'Brien 1999). Rainfed lowland rice represents the most abundant rice crop and is characterized by flat banded rice fields that are almost entirely dependant on rainfall and surface runoff for water supply. Dry Season rice production is limited to areas close to major rivers and floodplains. Floating rice is undertaken in low-lying depressions that accumulate floodwater, and is further divided based on depth and duration of the water (Nesbitt, 1996). Upland rain fed rice cultivation is characterized by unbanded fields and is associated primarily with shifting agriculture.

Shifting cultivation

Olofson has emphasized that shifting cultivation, also called swidden agriculture, is a common form of agriculture for crops other than rice in Southeast Asia, particularly in upland areas but

also lowland areas where there is a low human population and tropical forest still remains, (Olofson in Marten, 1986). Typical shifting cultivation in Cambodia is the practice of clearing and utilizing a plot of land for 1 – 5 years and then clearing another plot of land. The plots are rain-fed and usually 1 –3 ha large but often include another 5 – 6 ha of fallow land. Plots are typically cleared in the dry season by drying and burning the timber and underbrush; this is often termed as "slash & burn". The plots chosen are typically secondary growth forest 8 – 20 years old, and old growth forest is typically only used if suitable secondary growth forest is lacking (Colm, 1997). Shifting cultivation in the upland areas of Cambodia can have very rich agricultural biodiversity. As such shifting cultivation agriculture may serve as important collections of agricultural biodiversity.

Homegardens

Home gardens in Cambodia; typically represent the area directly surrounding the house. The plants in homegardens throughout Southeast Asia represent a rich species diversity, and often have a variety of uses including food, fuel, construction materials, herbal medicine, ornamentation and shade, (Marten 1986). All the plants in homegardens are used in the home. Moreover, there is active seed collection and swapping of desired homegarden plants.

Commercial field crops

Throughout Southeast Asia commercial field crops have increased, including; vegetable gardening in response to increasing urban markets, and annual plantation crops such as tobacco, cotton, sugarcane, indigo, pineapple and bananas for export or local processing (Marten 1986) In Cambodia rice is the predominant crop followed by maize, and other crops include; legumes such as soybean and mungbean; oilseeds including groundnut and sesame; commercial crops of sugarcane, jute and tobacco; vegetables also occupy a large area under cultivation; and sweet potato is more common whereas cassava is also sparsely cultivated, (Chandel & Paroda, 2000).

Perennial crops in agroecosystems

High value perennial crops such as coconuts, rubber, sugar palms, oil palms, tea, citrus and other fruit trees are grown at varying scales throughout settled parts of Cambodia. Most of the perennial crops are parts of other crops systems - large-scale plantations of perennials such as rubber and oil palm, are typically undertaken as monocultures, and are more likely to use increased inputs of agro-chemicals.

2. Current Status of Cambodia's Agricultural Ecosystems

The Royal Government of Cambodia's Fifth National Report to the Convention on Biological Diversity 2014, places significant emphasis on agricultural production and that may be seen as an indicator for agricultural ecosystems.

The Government's agricultural strategy promotes diversified farming systems, agro-forestry and protection, and the management of critical watersheds. Those strategies and their link to the maintenance of protected areas and biodiversity are critical to maintaining stability in agricultural systems and ensuring food security. The significant contribution of protected areas to the supply and regulation of water for agriculture is recognized. Populations are expanding and bringing agricultural activities to the edge of protected areas, including subsistence plots, market gardens and commercial operations.

Rice production has steadily increased, not only as the result of an expansion of the area cultivated, but also the growth in yield in response to the Government's promotion of more effective management and cropping techniques, including the development and use of higher quality seed varieties. This is reflected, especially, in the development of several different early, medium, and late-season rice seed varieties to take advantage of diverse ecological requirements. The recognition of the importance of promoting diversity into agriculture has also extended into Government initiatives to expand crop diversity, which has led to increases in cultivated areas, as well as production, of other agricultural crops including: corn, cassava, soybean, and mung-bean.

While there is significant investment to expand the agricultural sector there is limited investment in land use planning and as such urban expansion can be taking more fertile lands leaving less

fertile lands for agriculture. More information on agriculture is available in the Royal Government of Cambodia's Fifth National Report to the CBD.

3. Trends in Cambodia's Agricultural Ecosystems

The Royal Government of Cambodia includes agriculture as a key component of its rectangular strategy for development. Ministry of Agriculture Forestry and Fisheries records shows a steady increase in the area of agricultural land cultivated for rice from 2008 (2,615,741 Ha) to 2012 (3,007,454 Ha), which is a 15% in land area used for rice over 5 years. There was also a corresponding increase in rice production from 7,175,000 tonnes in 2008 to 9,290,000 tonnes in 2012, which has helped Cambodia to become a rice exporting nation.

The Cambodian Organic Agriculture Association, produced a report on "Organic Agriculture and Food Processing in Cambodia: Status and Potentials" in 2011. The report highlighted opportunities for Cambodia as farming has traditionally been less intensive. The report notes that there has been some small export of organic rice and CEDAC shops have sold about 1,000 tonnes, which is a small part of the overall rice market but organic rice cultivation was growing. The communal nature of rice paddy's means that 'parallel production' where neighbours are using chemicals can impact organic farming efforts. Palm Sugar and Pepper seem to have been some of the new success stories for organic agriculture in Cambodia and show a trend for the promotion of existing agricultural products to an international market through quality controls.

There are no specific agricultural biodiversity projects at present but there are increasing processes in place to assist in better planning for effective agricultural ecosystem use. The Ministry of Agriculture Forestry and Fisheries with support from CGIAR have developed a guidance manual in 2012 on Commune Agroecosystem Analysis "to identify and prioritize agricultural development needs at the commune level". This was further supported by the ADB commissioned 2006 Tonle Sap Agro Ecosystem Study, and the MAFF, EU and IFAD project in 2010 to promote water allocation and fisheries considerations as part of the Commune Agroecosystem Analysis (CAEA) process undertaken in Cambodia.

FOREST ECOSYSTEMS IN CAMBODIA

1. Previous Status of Forest Ecosystems In Cambodia

In the 2001 Status Report Philip W. Rundel, PhD took excerpts from: Baltzer, M.C., Nguyen Thi Dao and Shore R.G. (Eds.) 2001. “Towards a vision for Biodiversity Conservation in the Forests of the Lower Mekong Ecoregion Complex. WWF Indochina Programme, Hanoi, Vietnam”, to provide an overview of Forest habitats in Cambodia. This work is further summarized to provide the previous status of forest ecosystems in Cambodia.

Forest habitats in Cambodia may be divided into three broad groups: lowland forest habitats, montane forest habitat, and azonal forest habitats where factors other than the regional climatic regime are the primary determinants of community structure.

LOWLAND FOREST HABITATS

Evergreen Forests. These are usually multi-storied forests in which trees maintain their leaves throughout the entire year. These forests occur on hills and along the courses of streams and rivers. They are comprised of lowland tropical rain forests, hill evergreen forests and dry evergreen forests. Some percentage of deciduous trees is also present in these forests. Evergreen forests formerly covered much of western and northern Cambodia, the northern and eastern slopes of the Cardamom and Elephant Mountains and the lowlands east of the Mekong River. Logging, shifting agriculture, fire and other disturbances have heavily degraded large parts of this area into open savanna and savanna woodland.

Wet Evergreen Forests. Wet evergreen forests in Cambodia are found principally on the south-facing slopes of the Cardamom and Elephant Mountains, particularly in the area around Kompong Som Bay, where the southwestern monsoon produces unusually heavy rainfall.

Dwarf Evergreen Forests in the Cardamom and Elephant Mountains. In addition to typical wet evergreen forests, scattered areas in the Cardamom and Elephant Mountains from near sea level to moderate elevations support an unusual dwarf rainforest community reaching no more than 12-15 m in height in areas of poorly-drained depressions.

Submontane Wet Evergreen Forests. A distinctive wet evergreen forest community occurs at elevations of about 500-800 m in the Elephant, and probably in the Cardamom Mountains, as well, forming a transitional association between lowland wet evergreen forest and montane forest.

Semi-Evergreen Forests. The wide distribution and rich diversity of tree species in semi-evergreen forests makes it impossible to characterize these communities by a single suite of dominant species. Semi-evergreen forests have a characteristic tall and multi-layered forest structure similar to those of lowland evergreen rainforest, but grow in areas of lower and more seasonal rainfall regimes. With the broad distribution of these types of communities across Thailand and Laos, however, there are few Cambodian endemics.

Mixed Deciduous Forests. These are diverse forest communities with complex canopy structures, high biomass and multiple species dominance. In Cambodia, there is a murky transition between mixed deciduous forest and forms of semi-evergreen forest in which deciduous species exhibit a strong co-dominance with evergreen species.

Deciduous Dipterocarp Forests and Woodlands. The name of this community comes from its deciduous character during the dry season and the dominance by a small number of species of Dipterocarpaceae. Ground fires burning through the herbaceous understory are a regular aspect of the environment of deciduous dipterocarp forests and, thus, this community has sometimes been termed a fire climax community.

Lowland Pine Forests. The Cambodian pine flora includes only a single species, *Pinus merkusii*. Pines may constitute as much as 50% of the trees present in lowland pine forests.

Savannas and Savanna Woodlands. Open savannas and savanna woodlands with a scattered distribution of low woody species cover extensive areas of the central Cambodian lowlands and areas of young basalt substrate to the east of the Mekong River. These habitats are almost certainly of anthropogenic origin.

MONTANE FOREST HABITATS

Forest structure and composition undergo sharp changes from lowland forests to montane communities above about 800 m in Cambodia. Trees above 1500 m are densely packed, have small crowns and may appear stunted, gnarled and short (less than 15 m). Their trunks and branches are coated in moss and other epiphytes. The higher elevations comprise a complex mosaic of grassland, pine forest and evergreen forest formations, depending on local variations in altitude, aspect, geology and soils. Small stands of *Pinus merkusii*, which grow to heights of 25 m, mixed with *Dipterocarpus obtusifolius*, occur especially on thin soils at high elevation and may be maintained by fire. Understories are dominated by grasses, cycads and pitcher plants.

AZONAL FOREST FORMATIONS

Swamp Forests and Shrublands. Swamp forests typically occur in areas permanently inundated with shallow freshwater. The French literature has referred to the swamp forest association in Cambodia as *forêt inondée* (Rollet 1972, Legris and Blasco 1972, Dy Phon 1970). Care must be exercised, however, in separating the seasonal swamp forests that characterize extensive areas of the Tonle Sap basin and low lying floodplains of major Cambodian rivers from these classic swamp forests of Southeast Asia with permanent flooding.

Hydromorphic Savannas. Areas of poor drainage around the margins of many forest communities and rivers often support hydromorphic savannas dominated by graminoids. This community is referred to as a *veal* in Khmer, a term that is also now present in the French literature.

Riverine Forests. Riverine, or evergreen gallery, forests occur in a scattered distribution along the channel of the Mekong River and other major rivers. These flooded forests, often form open and discontinuous belts along river banks and are best known from scattered areas along the Mekong River in Stung Treng and Kratie provinces.

Mangroves. Mangroves once formed extensive stands along several areas of the short coastal areas of Cambodia (Dy Phon 1970, Rollet 1972). The absence of more extensive mangrove stands along the Gulf of Thailand is strongly related to the rocky Cambodian coastline and relative lack of major estuaries or river deltas.

“Rear Mangrove” Paperbark Swamps. Brackish wetlands behind mangrove areas in southern Cambodia are typically dominated by dense stands of shrubby *Meleuca leucadendron* (Myrtaceae) and termed rear mangrove communities (Dy Phon 1970, Rollet 1972, Legris and Blasco 1972).

Coastal Strand Vegetation. The coast of Cambodia includes alternating areas of sandy beach, silty mud flats and rocky shores. An open cover of woody vegetation, or thicket growth, is often present along a coastal belt between the beach and the first dunes.

2. Current Status of Forest Ecosystems in Cambodia

The Royal Government of Cambodia’s Fifth National Report to the Convention on Biological Diversity 2014 recognized that:

Cambodian forests are variously dominated by Dipterocarpaceae, Leguminosae, Lythraceae, or Fagaceae families and, in some places, Pinaceae or, Podocarpaceae families, or bamboo. The flora of lower altitudes is typical of the Indochinese floristic province and, as such, contrasts with that of the Chinese, Indo-Burma and Indo-Malayan provinces, while the higher altitudes share an affinity with those of the Indo-Malayan region.

The report indicated, as well, that in order to monitor the country’s various forests a *periodic series of forest cover assessments had been conducted in 1993, 1997, 2002, 2006, and 2010 by the Forestry Administration, which divided forests into categories of Evergreen, Semi-Evergreen, Deciduous and other forest.*

Those assessments resulted in an estimate for the area of forests in 2010 of 10,363,789 ha, or 57.07% of the total area of the country. That area is comprised of deciduous forest, which accounts for 24.68% of the country’s land area; evergreen forest, which accounts for 19.27% of its land area; and semi-evergreen forest, which accounts for 7.02% of land area. The 2010

forest cover assessment also revealed that forest cover had been lost at an average annual rate of 0.5% of land area between 2002 and 2010. In response, the Government has established 60% of the country's area as forests as a Millennium Development Goal and a priority of the National Forest Programme.

The Eastern and Northern Plains and the Cardamom Mountains are considered to be particularly important forest ecosystems that have considerable biodiversity significance.

The watershed, at the heart of the Cardamoms mountain range, in the Central Cardamoms Protected Forest, is a protected area of 400,000 ha that is of especially critical importance. Mountain rivers provide drinking water for more than 30,000 people and support rice and fish production in the lowland agricultural plains. The natural resources of the region - including endemic species such as the Siamese crocodile, dragon fish, gibbon and pangolin - were protected for centuries due to the region's isolation, but as Cambodia has modernized, the Cardamom Mountains have become increasingly vulnerable to illegal logging, hunting, forest clearing and land encroachment.

The current severity and continued threat of the land encroachment threat is underscored by the recognition that in the 1960s and early 1970s at the time that forest cover was about 73% of the country's total area, the Cambodian population was only about 9 million people, but by 2010, as forest cover had declined to about 57%, population has increased to more than 14 million people, increasing the disproportionate decline in the ratio of forest cover to the country's population.

The Northern Plains of Cambodia, meanwhile, constitute the largest remaining intact block of a unique landscape that once covered much of Indochina. The landscape is one of the most spectacular and important areas of Southeast Asia for biodiversity, with over 260 bird species and large mammals, including the Asian elephant, gaur and banteng. Local communities, who depend on rain-fed paddy or upland rice fields for their livelihoods, supplement these activities with small-scale animal raising and collection of non-timber forest products. The continued integrity of these ecosystems, however, is confronted with a number of growing threats, ranging from small-scale incidences of hunting or land clearance by local people to large-scale commercial pressures, such as mineral exploitation.

Ongoing field research continues to identify new forest habitats within the ecosystems. Neang Thy for example describes small patch of short (wind stunted) three needle pine (*Pinus kesyia*) on 1,100 m asl. at Tumpor Mountain in Samkos, which was previously undescribed. As more is being understood about Cambodia's Forest types it may be necessary to review the classifications. As an example Cambodian Montane forest may now better be described as: short, stunted trees, of which branches and tree trunks are covered by mosses and locate on top at 1,700 m at Samkos or at least 1,500 on some Mts tops where climate is cold with mist most of the time.

3. Trends for Forest Ecosystems in Cambodia

The Royal Government of Cambodia continues to strengthen its collaboration with its international and national development partners and conservation organizations and demonstrate its commitment to sustainable forest management and biodiversity conservation through various programs, including the National Forest Programme implemented by the Forestry Administration, and other guidelines, regulations, and laws. Those achievements and a Case Study on Protected Areas & Economic Land Concessions, are highlighted in the Fifth National Report to the Convention on Biological Diversity.

CAMBODIA'S INLAND WATER ECOSYSTEMS

1. Previous Status Of Cambodian Inland Water Ecosystems

The previous biodiversity status report had a non-technical section on Cambodian Wetlands and Biodiversity, written by Isabell von Oertzen (RGC 2001), which provided a context for the significance of wetlands in Cambodia. Key excerpts from that text are summarized below to provide a context for this update on the Status of Cambodia's.

Wetlands are the most important ecosystems in Cambodia: they cover 30% of the country and a large proportion the Cambodian population relies on them for food security. Cambodia's extensive freshwater wetlands support the fourth largest annual catch in the world (230,000 – 400,000t). That means that the Cambodian freshwater capture fisheries may contribute more to national food security and the economy than is the case in most other countries. (Nao Thuok & So Nam, 2000).

More than 85% of Cambodia belongs to the catchment of the Mekong River. A large proportion of the population in Cambodia lives in wetland areas and their well-being depends on the productivity of wetlands. The fisheries sector is one of Cambodia's most productive sectors and provides employment for a significant number of people..

The most comprehensive surveys have been carried out on freshwater fisheries as part of the Mekong River Commission's (MRC) fisheries programme. The MRC's Environment Programme, with funding from Danida, implemented a project for the Inventory and Management of Cambodian wetlands. The sectoral approach to wetland management can be detrimental because wetlands function as a system and it is often not totally predictable what the consequences are when one part of the system is changed. The water regime drives wetland functions. Therefore the hydrology of wetland systems and its influence on system components, eg fish, needs to be understood very clearly before decisions about possible changes are made.

The main reasons for wetland loss and degradation are changes in wetland area, changes in the water regime, changes in the water quality, unsustainable exploitation of wetland products, and the introduction of alien species. These causes are mostly addressed on a sectoral basis. If the extent of wetland degradation in Cambodia is to be halted we will need to address urgently the social, economic and political underlying reasons and not just the apparent expressions of the reasons for such degradation. Globally, the underlying reasons include population pressure, lack of public and political awareness of wetland values, lack of political will for wetland conservation, over-centralised planning procedures, financial policies and illegal activities. This applies in Cambodia as well. The more immediate causes of wetland loss and degradation relate to weak conservation institutions, sectoral organisation of decision making, deficiencies in the application of environmental impact and cost-benefit analysis, the passing of good legislation without subsequent enforcement, a lack of trained personnel, limited international pressure, and alliances which promote studies rather than action.

2. Current Status of Cambodia's Inland Water Ecosystems

The Royal Government of Cambodia recognizes the Tonle Sap and Mekong rivers as priority inland water ecosystems for management due to their significant role in food security and agricultural productivity. While there are no specific reports on the current status of the inland water ecosystems. Cambodia's Fifth national Report to the CBD provides further descriptions about the ecosystem status related to water resources and freshwater fisheries.

Fish is an important food for Cambodian people since the ancient time. Cambodia is known as one of the four largest fish producers in South-East Asia, especially with regard to fresh water fish grown in rivers, ponds and lakes. Today, the size of fish production has declined due to the increasing number of fishermen in recent years. Many larger fish species have declined while at the same time the smaller fish species dominate the catch. It is the objective of setting up aquaculture systems in Cambodia to refill this gap to have a sustainable fish supply. Fish farm owners have formed a fish farmer community in order to facilitate the support from developing partners. Fish from natural fresh water (natural rivers and lakes) provides a high content of protein substance, good flavor and gives fishermen a higher price than aquaculture fish. The Fisheries Administration of the MAFF, has

demarcated boundaries for fisheries conservation areas, reviewing and removing all fishing lots to enhance community-based fisheries management. (5NR 2014)

The International Rivers organisation has been researching the Mekong and states that:

The Lower Mekong River is a major source of food security in mainland Southeast Asia. Of the 60 million people who live in the river basin, an estimated 80% rely directly on the river for their food and livelihoods. It is the world's largest and most productive inland fishery. Scientists have identified around 850 fish species, but estimate that over 1,000 fish species exist. Over one-third of these species migrate more than 1,000 kilometers along the river to feed and breed. In some areas, peak migrations can reach up to three million fish per hour, making the Mekong home to one of the world's largest migrations.

Conservation International describes the Tonle Sap ecosystem as follows:

Southeast Asia's largest lake, Cambodia's Tonle Sap more than quadruples in size during monsoon season, flushing the region with water and life. Many residents of the Tonle Sap floodplain live in floating villages on the lake, and more than 90% directly rely on the seasonally flooded forests for fresh water, food, fuelwood and other essential resources. Tonle Sap and the inland waters system in Cambodia support some 500,000 tons of fish each year, and the flooded forests purify water and buffer communities from storms — an increasingly important benefit as climate change makes extreme weather more frequent.

But they also note concern around unsustainable human activities, especially the destruction of flooded forests. This important ecosystem and key threats are further described by the Wildlife Conservation Society:

The Tonle Sap ecosystem now faces unprecedented threats. As Cambodia's population increases, so does the pressure on the country's natural resources. Fish stocks are now threatened by over-exploitation and illegal fishing methods. Commercial farmers and developers are seizing land in the flooded forest and grasslands in wider floodplain, destroying key wildlife habitats in the process. Deforestation poses a continued threat to the flooded forest, the key breeding ground for fish and the endangered water birds, as local people continue to fell trees for firewood and agriculture.

The Ministry of Environment is also working with partners to reduce the impact of invasive alien species in and around the Tonle Sap. Specific efforts are being made to reduce the spread of *Mimosa pigra*, which is considered to negatively impact the waterways, fish habitats and agricultural lands.

3. Trends for Cambodia's Inland Water Ecosystems

The major trend for Cambodia's Inland Water Ecosystems is that they are in a period of change. There are multiple factors impacting inland water ecosystems, including changing land uses, damming or filling of water ecosystems and climate change, which is directly attributed to increased flooding and droughts in Cambodia. The sections in relation to Hydrological Regime and Climate Change in the Royal Government of Cambodia's Fifth National Report to the Convention on Biological Diversity 2014, provides a context for the livelihood significance of Cambodia's Inland Water Ecosystems.

The centrepiece of Cambodia's Inland Water Ecosystems, is the Tonle Sap lake, which is the largest lake in South East Asia. As part of the Consultative Group on International Agricultural Research (CGIAR) – Agriculture & Ecosystems blog raised concerns about the Tonle Sap in an article "Preventing Cardiac Arrest for Cambodia's Heart". The following excerpt from that article is of relevance to the future of Cambodia's Tonle Sap Lake (Basin), and indeed all inland water ecosystems in Cambodia.

It is tempting to think that development solutions in this basin would involve increasing irrigation infrastructure, giving farmers more control over when and how much water is available. Intensifying agricultural development by increasing farm size, and diversifying income strategies presents an important solution for many families with the growth of the garment industry in Phnom Penh and neighboring countries. The rapid development of hydroelectric projects on the Mekong River promises to provide electricity for the growing electricity demand of the region. Elements of these approaches, while providing important opportunities, may have hidden consequences however. Unsustainable agricultural development within the larger basin threatens to increase sedimentation and siltation within the shallow lake reducing its capacity to store monsoon waters and threatening the lake's fisheries.

CAMBODIA'S MARINE & COASTAL ECO-SYSTEMS

1. Previous Status of Marine & Coastal Ecosystems

In the 2001 Status Report (RGC 2001) Marschke provided an overview of Coastal Ecosystems in Cambodia. This work is further summarized below to provide the previous status of Coastal Ecosystems in Cambodia.

Cambodia's Coastal Ecosystem

"This complex of coastal and marine ecosystems combines to maintain a diversity of biota which is significant not only in terms of biological diversity but also is of direct economic significance to Cambodia and, indeed, for all other countries situated around the Gulf of Thailand. Having remained relatively isolated from core areas of human activity, the level of exploitation of the coastal resources is much less than in neighbouring Thailand or Vietnam, and in Malaysia, across the Gulf (Ashwell, 1997)."

The seaward boundary of the coastal zone has been delineated as the outer limit of the EEZ, which is an area of 55 600 km² (Nelson, 1999). According to Nelson (1999), the landward boundary has not been adequately defined, although for working purposes it is assumed to be 5 km from the shoreline. The coastal ecosystem can be further classified into mangrove forest ecosystem, coral reef ecosystem, seagrass bed ecosystem, islands and beaches. Ecosystems are linked; for example, shrimp species spawn in the mangrove roots, and their larvae settle in seagrass beds to grow into adults before migrating back to the mangroves areas to spawn (O'Brien, 1999).

Gum (2001) notes that estimated catches for coastal marine fisheries appear to be stagnant at approximately 30,000 to 40,000 tonnes / year. These numbers exist because official DoF catch numbers are based on estimated catches by fishing gear, which are determined by tax paid by fishers or – more importantly – tax collected by locally based fisheries staff. These catch trends therefore reflect trends in 'effort' for taxable fishing gears and also 'effort' in tax revenue collection (Gum, 2001). There are no other catch statistics available.

2. Current Status of Cambodia's Marine & Coastal Ecosystems

Knowledge about Cambodia's Coastal Ecosystems has been increasing with research toward a Marine Fisheries Management Area (MFMA). This has identified some considerations for Cambodia's Coastal Ecosystems, which ultimately place emphasis on the need to manage many of the identified species at ecosystem level. The research has re informed the lack of information available on the status of the coastal ecosystems or species found within this system. Some species are collected commercially Some commercially valuable species are better known but the collection and trade with limited understanding of wider impacts is of concern.

Mangrove horseshoe crabs (Carcinoscorpius rotundicauda) have been observed near fringing mangroves close to the village of Prek Svay, but almost nothing is known about local distribution, threats and population trends. Collection and trade might be assumed to be a significant threat given that horseshoe crab species are openly sold and consumed in restaurants in nearby Sihanoukville (B, Mulligan, Pers. obs.), but further research is urgently required to understand their status in the area.

As identified by the Koh Rong Important Bird Area (IBA) (BirdLife International, 2014) Cambodia's Coastal Ecosystems may also be critical for some bird species, such as the globally Near Threatened Malaysian plover (*Charadrius peronei*), which was the and a rare coastal resident restricted to undisturbed sandy beaches.

The MFMA report notes that species focused management practices factoring in specific life histories and behavior will be necessary to ensure endangered species persist within and around the MFMA. Seahorses, for example, change depths with the seasons, which is important to understand when protecting them as the full picture of any seasonal variations and changes in behavior is required (N. Garrick-Maidment, pers. comm.).

3. Trends for Cambodia's Marine & Coastal Ecosystems

As with other ecosystems the major trend is a transformation due to direct human impacts, often for the utilization of natural resources but also tourism. On a positive note there are moves toward more protection of Cambodia's Coastal Ecosystems. Recent high-end coastal tourism has helped to highlight the longer term values associated with management of coastal ecosystems. There are also significant moves toward Marine Protected Areas and specifically Cambodia's first a Marine Fisheries Management Area.



5. BIBLIOGRAPHIC REFERENCES

The combination of text and data coming from multiple sources and limited time and resources to capture all of that information has led to an alternate approach to referencing, rather than lose valuable information this referencing approach is more bibliographic. This section seeks to summarize all of the key references that have supported this review. Websites have also been used as a source of already summarized relevant reports.

Most of the information for this review has been drawn from Cambodia's previous National Biodiversity Status Report (RGC 2001) and the most recent Fifth National Report to the Convention on Biological Diversity. These two documents contain more traditional referencing, which can be found as following.

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