

Ross, J., Hearn, A. J., Bernard, H., Secoy, K., and Macdonald, D. W. 2010 The Bornean wild cats - A framework for a Wild Cat Action Plan for Sabah. Report: 1-49.. Oxford. Report to the Sabah Wildlife Department.

Keywords: 4MY/bay cat/behaviour/capacity building/density/description/distribution/estimation /flat-headed cat/habitat/habitat loss/hunting/leopard cat/marbled cat/Neofelis diardi/Pardofelis badia/Pardofelis marmorata/population status/Prionailurus bengalensis/Prionailurus planiceps/protection status/research needs/Sabah/Sunda clouded leopard/threats/trade

**Abstract:** The Bornean Wild Cats and Clouded Leopard Project was a three year multi-disciplinary project aimed at addressing the conservation needs of Borneo's wild cats through the merging of pioneering ecological research, conservation awareness and training. This report details the project's preliminary findings and presents a synthesis of the current knowledge regarding the five species of Bornean wild cat, with a particular focus on Sabah populations. The report provides a basic framework for the future development of a wild cat action plan for Sabah. A unique guild of five wild cat species (Sunda clouded leopard, marbled cat, bay cat, flat-headed cat, and leopard cat) inhabit the rainforests of Borneo. Two are considered by the IUCN as Endangered (Bay Cat and Flat Headed Cat), two as Vulnerable (Marbled cat and Sunda Clouded Leopard), yet they remain some of the world's least known wild cats. The Malaysian state of Sabah, in the north of Borneo, holds globally important populations of all four of these threatened felids. Thought to be forest dependant, the presumed primary habitat of Borneo's wild felids is rapidly being lost and/or altered in the region. Whilst direct hunting of these felids and hunting of their prey likely pose an important threat to the continued survival of these wild cats across their range, in Sabah the main threats to wild cats are believed to stem from habitat degradation and fragmentation as a result of previous widespread timber harvesting and conversion for agriculture. The project principal investigators, Andrew Hearn and Joanna Ross, Research Associates of the Global Canopy Programme, in collaboration with Dr. Henry Bernard and Daniel Pamin at the Universiti Malaysia Sabah, conducted wild cat targeted camera trap surveys in five study areas in Sabah, each exposed to different land management practices. These extensive surveys, the most intensive of their kind to date, provide support for the hypothesis that all four threatened species of Bornean wild cat exist at low densities and are in need of immediate conservation attention. Our surveys also support the hypothesis that selectively logged forest can support populations of all four threatened Bornean felid, and thus selectively logged forest is an important resource for these felids in the human modified landscape of contemporary Borneo. In over three years of camera trapping in eastern Sabah the flat-headed cat was only photo captured on a single occasion, highlighting the critical status of this endangered felid in Sabah. A preliminary, yet intensive camera trap survey of an adjacent oil palm plantation provided evidence that of the five Bornean felid species only the leopard cat is able to utilise this highly modified and increasingly widespread environment. Thus, these data provide further, albeit tentative, evidence that forest loss is the principal threat to the continued survival of threatened wild cats in Sabah, and indeed across Borneo.

Our research provides the first robust density estimates for any Sunda clouded leopard population. Although preliminary, this research provides the first evidence that recent logging and elevated hunting levels may have a detrimental effect on clouded leopard abundance. Further studies are needed across the Sunda clouded leopard's range, but our initial surveys suggest that no single Conservation Area, Wildlife Reserve or Forest Reserve in Sabah is sufficiently large to support a sustainable and genetically viable clouded leopard population of 500 individuals over the long term. To put this into perspective, we estimate that the extensive forests of the Yayasan Sabah Forest Management Area, one of the largest remaining contiguous areas of lowland Dipterocarp forest in Southeast Asia, at approximately 8,000 km<sup>2</sup>, may hold around 400 individual clouded leopards. Thus this is the spatial scale at which we will need to act to improve the probability of this species persisting in Sabah. It is therefore imperative that corridors of suitable habitat are maintained between protected areas and commercial forest reserves, and that connectivity is restored between isolated forest blocks to allow gene flow between sub-populations.



# The Bornean Wild Cats

A framework for a Wild Cat Action Plan for Sabah.

Report to the Sabah Wildlife Department.  
June 2010.



By:

Joanna Ross, Andrew J Hearn  
Henry Bernard, Katherine Secoy  
and David W Macdonald



## A Framework for a Wild Cat Action plan for Sabah

Cover photo: A male Sunda clouded leopard, *Neofelis diardi*, photo-captured in the Tabin Wildlife Reserve. ©J Ross and A J Hearn.

# The Bornean Wild Cats

## A framework for a Wild Cat Action Plan for Sabah.

Report to the Sabah Wildlife Department. June 2010.

### Authors

#### Joanna Ross

Global Canopy Programme, John Krebs Field Station, Wytham, Oxford, OX2 8QJ UK.

Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, The Recanati-Kaplan Centre, Tubney House, Abingdon Road, Tubney, Abingdon OX13 5QL, UK

#### Andrew James Hearn

Global Canopy Programme, John Krebs Field Station, Wytham, Oxford, OX2 8QJ UK.

Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, The Recanati-Kaplan Centre, Tubney House, Abingdon Road, Tubney, Abingdon OX13 5QL, UK

#### Henry Bernard

Institute of Tropical Biology and Conservation, Universiti Malaysia Sabah, Locked Bag No. 2073, 88999 Kota Kinabalu, Sabah, Malaysia

#### Katherine Secoy

Global Canopy Programme, John Krebs Field Station, Wytham, Oxford, OX2 8QJ, UK.

#### David W Macdonald

Wildlife Conservation Research Unit, Department of Zoology, University of Oxford, The Recanati-Kaplan Centre, Tubney House, Abingdon Road, Tubney, Abingdon OX13 5QL, UK

To be cited as: Ross, J.; Hearn, A. J.; Bernard, H.; Secoy, K. and Macdonald, D. (2010): A framework for a Wild Cat Action Plan for Sabah, Global Canopy Programme, Oxford, UK.

**Copyright:** Bornean Wild Cat and Clouded Leopard Project, Global Canopy Programme



## CONTENTS

<b>Preamble and intended audience .....</b>	<b>VIII</b>
<b>Acknowledgments .....</b>	<b>IX</b>
<b>Executive summary .....</b>	<b>X</b>
<b>Part I. Introduction and project overview</b>	
1.1 Introduction .....	1
1.2 Project overview .....	2
<b>Part IIa. Technical and scientific findings</b>	
2.1 General study design .....	4
2.2 Project study sites in Sabah .....	4
2.3 Estimation of Bornean felid density .....	5
2.3.1 Methodology .....	5
2.3.2 Results and discussion .....	5
2.3.2.1 Sunda clouded leopard density .....	6
2.3.2.2 Marbled cat density .....	7
2.4 Bornean felid relative abundance and habitat use .....	8
2.4.1 Methodology .....	8
2.4.2 Results and discussion .....	8
2.5 Bornean felid activity patterns .....	10
2.5.1 Methodology .....	10
2.5.2 Results and discussion .....	10
2.6 Bornean felid spatial ecology .....	11
2.6.1 Methodology .....	11
2.6.2 Results and discussion .....	11
2.6.2.1 Sunda clouded leopard .....	11
2.6.2.2 Leopard cat .....	13
2.7 Key conclusions .....	14
<b>Part IIb. Assessing the anthropogenic threats to Bornean wild cats: conservation awareness questionnaire</b>	
2.8 Conservation awareness survey .....	15
2.8.1 Methodology .....	15
2.8.2 Results .....	15
2.8.2.1 Local awareness of Bornean felids .....	15
2.8.2.2 Local perceptions of danger and problems from wild animals .....	16

2.8.2.3 Hunting of wild animals .....	16
2.8.2.4 Level of education .....	17
2.8.2.5 Awareness and interest in local wildlife conservation .....	17
2.8.2.6 Local use of forest resources .....	17
2.9 Conclusions .....	17
<b>Part III. Species Summaries</b>	
3.1 Leopard cat, <i>Prionailurus bengalensis</i> .....	19
3.1.1 Population Status .....	19
3.1.2 Protection Status .....	19
3.1.3 Principal Threats .....	19
3.1.4 Description and Behaviour.....	19
3.1.5 Habitat and Distribution .....	19
3.1.5.1 Sabah .....	19
3.2 Flat-headed cat, <i>Prionailurus planiceps</i> .....	20
3.2.1 Population Status .....	20
3.2.2 Protection Status .....	20
3.2.3 Principal Threats .....	20
3.2.4 Description and Behaviour.....	20
3.2.2 Habitat and Distribution .....	20
3.2.2.1 Sabah .....	20
3.3 Bay cat, <i>Pardofelis badia</i> .....	21
3.3.1 Population Status .....	21
3.3.2 Protection Status .....	21
3.3.3 Principal Threats .....	21
3.3.4 Description and Behaviour.....	21
3.3.5 Habitat and Distribution .....	21
3.3.5.1 Sabah .....	21
3.4 Marbled cat, <i>Pardofelis marmorata</i> .....	22
3.4.1 Population Status .....	22
3.4.2 Protection Status .....	22
3.4.3 Principal Threats .....	22
3.4.4 Description and Behaviour .....	22
3.4.5 Habitat and Distribution .....	22
3.4.5.1 Sabah .....	22
3.5 Sunda clouded leopard, <i>Neofelis diardi</i> .....	23
3.5.1 Population Status .....	23

3.5.2 Protection Status .....	23
3.5.3 Principal Threats .....	23
3.5.4 Description and Behaviour .....	23
3.5.5 Habitat and Distribution .....	23
3.5.1.1 Sabah .....	23
<b>Part IV. Challenges to Wild Cat Conservation in Sabah</b>	
4.1 Habitat loss .....	24
4.2 Hunting and trade .....	26
4.3 Key conclusions .....	27
4.3.1 Habitat loss .....	27
4.3.2 Hunting and trade .....	28
<b>Part V. Future directions</b>	
5.1 Recommended actions .....	29
5.2 Priority research needs .....	30
5.2.1 Species specific research needs .....	30
5.2.1.1 Sunda clouded leopard .....	30
5.2.1.2 Marbled cat .....	30
5.2.1.3 Flat-headed cat .....	30
5.2.1.4 Bay cat .....	31
5.2.1.5 Leopard cat .....	31
5.2.2 General research topics .....	31
5.3 Capacity building .....	31
<b>References</b> .....	32
<b>Appendices: Full species Accounts</b>	
Appendix I: Leopard cat, <i>Prionailurus bengalensis</i> .....	38
Appendix II: Flat-headed cat, <i>Prionailurus planiceps</i> .....	41
Appendix III: Bay cat, <i>Pardofelis badia</i> .....	43
Appendix IV: Marbled cat, <i>Pardofelis marmorata</i> .....	45
Appendix V: Sunda clouded leopard, <i>Neofelis diardi</i> .....	47
<b>Figures</b>	
Figure 1. The four threatened Bornean felids .....	1
Figure 2. A male Sunda clouded leopard photo-captured in the Ulu Segama Forest Reserve .....	2
Figure 3. A bay cat, photo-captured in the Malua Forest Reserve .....	4
Figure 4. Map of the five study sites within Sabah, Malaysia .....	5
Figure 5. A rarely photographed Sunda clouded leopard cub, photographed in the Danum Valley Conservation Area .....	6

## A Framework for a Wild Cat Action plan for Sabah

Figure 6. A marbled cat from Tabin Wildlife Reserve .....	7
Figure 7. A typical camera trap set-up .....	8
Figure 8. Camera trap image of a flat-headed cat, near the Danum Valley Field Centre .....	8
Figure 9. Bornean felid photo capture rates in four study areas .....	9
Figure 10. Photographic evidence of felids utilising disturbed habitats .....	9
Figure 11. Temporal segregation within the Bornean felid guild.....	10
Figure 12. The first Sunda clouded leopard to be radio-collared .....	11
Figure 13. Sunda clouded leopard home-ranges derived from radio telemetry and camera trapping in the Ulu Segama Forest Reserve and Danum Valley Conservation Area .....	12
Figure 14. A collared leopard cat photographed by a camera trap in the oil palm plantation .....	13
Figure 15. The predominantly selectively logged, but extensive forests of the Yayasan Sabah Forest Management Area .....	14
Figure 16. The percentage of people able to name the species of Borneo's wild cats	16
Figure 17. The percentage of people who had seen each species of Borneo's wild cats .....	16
Figure 18. The species identified as causing problems in the village environment .....	16
Figure 19. The awareness of illegal hunting activities .....	16
Figure 20. Reasons for villagers wishing to use the forest close to their village .....	17
Figure 21. The leopard cat .....	19
Figure 22. The distribution of the leopard cat .....	19
Figure 23. The flat-headed cat .....	20
Figure 24. The distribution of the flat-headed cat .....	20
Figure 25. The Bay cat .....	21
Figure 26. The distribution of the bay cat .....	21
Figure 27. The marbled cat .....	22
Figure 28. The distribution of the marbled cat .....	22
Figure 29. The Sunda clouded leopard .....	23
Figure 30. The distribution of the Sunda clouded leopard .....	23
Figure 31. The predominantly selectively logged, but extensive forests of the Yayasan Sabah Forest Management Area .....	24
Figure 32. Poachers photographed by camera trap .....	26

### Tables

Table 1. Study areas .....	4
Table 2. The estimated population densities of Sunda clouded leopard in the four forest areas .....	6
Table 3. The estimated population density of marbled cat in Tabin Wildlife Reserve	7



## A Framework for a Wild Cat Action plan for Sabah

Table 4. Morphometric measurements for two Sunda clouded leopards from the Ulu Segama Forest Reserve, Sabah .....	11
Table 5. Mean Sunda clouded leopard home ranges derived from both radio-telemetry and camera trapping surveys in eastern Sabah, Malaysia .....	13
Table 6. Summary of threats and recommended mitigating actions .....	29

## **PREAMBLE AND INTENDED AUDIENCE**

This report presents a synthesis of the current knowledge regarding the five species of Bornean wild cat. The first section of the report provides an overview, and details the core technical and scientific findings of the recently completed *Bornean Wild Cats and Clouded Leopard Project*, managed and funded through the Global Canopy Programme in collaboration with the Universiti of Malaysia Sabah. This report is a core output. Subsequent sections present detailed species accounts for each of the five Bornean wild cats, highlight the challenges to the continued conservation of these felids, and suggest a series of recommended actions and research priorities, as developed during the Bornean felid workshop, in 2009. Throughout the report particular emphasis is placed on wild cat populations in Sabah. Thus, this report can provide a basic framework for the future development of a wild cat action plan for Sabah. As such, the principal target audience for this report is the Sabah Wildlife Department, but it is intended and hoped that this report will also be of interest and value to land managers and wildlife researchers in Sabah and across Borneo.

## ACKNOWLEDGEMENTS

This report is the culmination of the recently completed *Bornean Wild Cats and Clouded Leopard Project*, and we owe a debt of gratitude to the numerous individuals and organisations who have supported this project over the last three years. We are grateful to the Economic Planning Unit for permission to conduct research in Sabah. We thank our local collaborators at the Universiti Malaysia Sabah, Professor Datin Dr. Maryati Mohammed and Associate Professor Dr. Abdul Hamid Ahmad. We thank our collaborators at the Sabah Wildlife Department, especially Laurentius Ambu, Augustine Tuuga and Dr. Sen Nathan, for their continued support, their permission to study this unique felid guild and their permission to work in the Tabin Wildlife Reserve. We are grateful to the Yayasan Sabah/Danum Valley Management Committee and the Sabah Forestry Department for permitting us to work in the Danum Valley Conservation Area and the Ulu Segama/Malua Forest Reserves, respectively. Logistical support has kindly been provided by the Royal Society South East Asia Rainforest Research Project (SEARRP), Yayasan Sabah, and the Sabah Wildlife Department. We are particularly indebted to Dr. Glen Reynolds in this respect. We would like to thank our counterpart Daniel Pamin, and field assistants Sajaril Utung, Remmy Murus, Affandey Awang, Steven Hughes, Saul Cowen, Todd James Preston, Krystle Kaufman and Gilmoore Bolongon for their hard work. We also thank Dr. Sen Nathan, Kathy Murphy, Dr. Rosa Sipangkui, Rosalie Dench, Paloma Alcázar and Fernando Nájera Muñoz, for providing veterinary expertise. We are deeply indebted to our scientific advisor, Professor David Macdonald. JR, AJH and KS would like to specifically acknowledge the role of Dr. Henry Bernard for his continued support since the project's inception.

This research was primarily managed and funded through the Global Canopy Programme with the financial assistance of the Darwin Initiative, U.K. Department for Environment Food and Rural Affairs. Additional funding has kindly been provided by the Clouded Leopard project/ Point Defiance Zoo and Aquarium, Felidae Conservation Fund, HDH Wills 1965 Charitable Trust, International Trust for Nature Conservation and Wild About Cats, together with funds from WildCRU generously devoted to the project by Dr. Tom Kaplan and his family.

The Bornean Wild Cat and Clouded Leopard Project is indebted to the Global Canopy Programme for providing encouragement, support and funding over the three years of the project.



## EXECUTIVE SUMMARY

The *Bornean Wild Cats and Clouded Leopard Project* was a three year multi-disciplinary project aimed at addressing the conservation needs of Borneo's wild cats through the merging of pioneering ecological research, conservation awareness and training. This report details the project's preliminary findings and presents a synthesis of the current knowledge regarding the five species of Bornean wild cat, with a particular focus on Sabah populations. The report provides a basic framework for the future development of a wild cat action plan for Sabah.

A unique guild of five wild cat species (Sunda clouded leopard, marbled cat, bay cat, flat-headed cat, and leopard cat) inhabit the rainforests of Borneo. Two are considered by the IUCN as Endangered (Bay Cat and Flat Headed Cat), two as Vulnerable (Marbled cat and Sunda Clouded Leopard), yet they remain some of the world's least known wild cats. The Malaysian state of Sabah, in the north of Borneo, holds globally important populations of all four of these threatened felids. Thought to be forest dependant, the presumed primary habitat of Borneo's wild felids is rapidly being lost and/or altered in the region. Whilst direct hunting of these felids and hunting of their prey likely pose an important threat to the continued survival of these wild cats across their range, in Sabah the main threats to wild cats are believed to stem from habitat degradation and fragmentation as a result of previous widespread timber harvesting and conversion for agriculture.

The project principal investigators, Andrew Hearn and Joanna Ross, Research Associates of the Global Canopy Programme, in collaboration with Dr. Henry Bernard and Daniel Pamin at the Universiti Malaysia Sabah, conducted wild cat targeted camera trap surveys in five study areas in Sabah, each exposed to different land management practices. These extensive surveys, the most intensive of their kind to date, provide support for the hypothesis that all four threatened species of Bornean wild cat exist at low densities and are in need of immediate conservation attention. Our surveys also support the hypothesis that selectively logged forest can support populations of all four threatened Bornean felid, and thus selectively logged forest is an important resource for these felids in the human modified landscape of contemporary Borneo. In over three years of camera trapping in eastern Sabah the flat-headed cat was only photo captured on a single occasion, highlighting the critical status of this endangered felid in Sabah. A preliminary, yet intensive camera trap survey of an adjacent oil palm plantation provided evidence that of the five Bornean felid species only the leopard cat is able to utilise this highly modified and increasingly widespread environment. Thus, these data provide further, albeit tentative, evidence that forest loss is the principal threat to the continued survival of threatened wild cats in Sabah, and indeed across Borneo.

Our research provides the first robust density estimates for any Sunda clouded leopard population. Although preliminary, this research provides the first evidence that recent logging and elevated hunting levels may have a detrimental effect on clouded leopard abundance. Further studies are needed across the Sunda clouded leopard's range, but our initial surveys suggest that no single Conservation Area, Wildlife Reserve or Forest Reserve in Sabah is sufficiently large to support a sustainable and genetically viable clouded leopard population of 500 individuals over the long term. To put this into perspective, we estimate that the extensive forests of the Yayasan Sabah Forest Management Area, one of the largest remaining contiguous areas of lowland Dipterocarp forest in Southeast Asia, at approximately 8,000 km<sup>2</sup>, may hold around 400 individual clouded leopards. Thus this is the spatial scale at which we will need to act to improve the probability of this species persisting in Sabah. It is therefore imperative that corridors of suitable habitat are maintained between protected areas and commercial forest reserves, and that connectivity is restored between isolated forest blocks to allow gene flow between sub-populations.

## PART I

### INTRODUCTION AND PROJECT OVERVIEW

#### 1.1 Introduction

A unique guild of five wild cat species inhabit the rainforests of Borneo: Sunda clouded leopard *Neofelis diardi*, marbled cat *Pardofelis marmorata*, bay cat *Pardofelis badia*, flat-headed cat *Prionailurus planiceps*, and leopard cat *Prionailurus bengalensis*. Two are considered by the International Union for Conservation of Nature (IUCN) as Endangered (*bay cat and flat-headed cat*), two as Vulnerable (*marbled cat and Sunda clouded leopard*) (IUCN 2009) (Figure 1), and their presumed primary habitat is rapidly being lost and/or altered in the region. The main threats to the Bornean wild cats are believed to stem from habitat loss, degradation and fragmentation as a result of widespread timber harvesting and conversion for agriculture (Nowell and Jackson, 1996). As a consequence Borneo's forests are under increasing pressure; while in the mid 1980s forests still covered nearly three quarters of the island, today only 52% of Borneo remains forested (Rautner *et al.*, 2005). Hunting of wild cats and their prey may also pose a potential threat. These threats are exacerbated by the lack of knowledge regarding the status and ecology of these felids, which is needed to facilitate the development of effective management and conservation measures. Indeed, the flat-headed cat and endemic bay cat are arguably two of the world's least known felids (Sunquist and Sunquist, 2002; Wilting *et al.*, 2010).

In recent years several independent Bornean wild cat focused conservation initiatives have taken place in the Malaysian state of Sabah. These conservation and research programmes have brought Sabah to the forefront of the challenge to understand this little known felid guild. This report presents a synthesis of the current knowledge regarding the five species of Bornean wild cat based on the work of the recently completed Bornean Wild Cat and Clouded Leopard Project.

The first section of the report provides an overview, and details the core technical and scientific findings of this project. Subsequent sections present detailed species accounts for each of the five Bornean wild cats, highlight the challenges to the continued conservation of these felids, and suggest a series of recommended actions and research priorities, as developed during the Bornean felid workshop, 'First Steps Towards the Conservation of Wild Cats in Sabah', in 2009 (copies of the report – Hearn *et al.*, 2010b – are available on request to the authors). Throughout the report particular emphasis is placed on wild cat populations in Sabah. Thus, this report can provide a basic framework for the future development of a wild cat action plan for Sabah.



**Figure 1.** The four threatened Bornean wild cats. Clockwise from top left: marbled cat, Sunda clouded leopard, bay cat and flat-headed cat

As such, the principal target audience for this report is the Sabah

Wildlife Department, but it is intended and, indeed hoped, that this report will also be of interest and value to land managers and wildlife researchers in Sabah and across Borneo.

## 1.2 Project Overview



**Figure 2.** A male Sunda clouded leopard photo-captured in the Ulu Segama Forest Reserve

The *Bornean Wild Cats and Clouded Leopard Project* was formed as a result of a recognised need by our partners, the Institute for Tropical Biology and Conservation (ITBC), Universiti Malaysia Sabah, and the Sabah Wildlife Department (SWD), for information regarding Bornean wild cats in Sabah. These organisations regarded the lack of information pertaining to the Bornean wild cats as an impediment to designing effective conservation programmes for these species, and suggested that there was a lack of training in certain specialist mammal research techniques in Sabah and a low awareness of these felids amongst the local population.

In an attempt to address these needs, in October 2006 the Global Canopy Programme (GCP) a UK registered NGO, and the WildCRU, at the University of Oxford, in partnership with the ITBC and the SWD initiated a three-year, multi-disciplinary project. With core funding from the Darwin Initiative, this project aimed to help protect Sabah's five resident wild cat species through the merging of pioneering ecological research, conservation awareness and training.

Project objectives were to:

- Study the behaviour and ecology of the Bornean wild cats, with a focus on the Sunda clouded leopard.
- Investigate the effects of habitat alteration on Bornean wild cats
- Increase awareness of the Bornean wild cats and their conservation needs, using the clouded leopard as a flagship species
- Train host country students in specialist mammal field research techniques
- Investigate threats to the Bornean wild cats
- Investigate awareness of Bornean felids within the local population.

Prior to the commencement of this project, virtually nothing was known about the threatened wild cats of Borneo. The project provided base-line data regarding the behaviour and ecology of the five species of Bornean wild cat, their responses to selective logging, and their principal threats. The awareness of these felids in Sabah has been raised, both locally, through the display of information posters, training courses and presentations at various events, and internationally, through publications and conference presentations. Host country capacity for future felid-focused research has been increased, by the training of 63 undergraduate students from the ITBC. The ITBC provide excellent training in Conservation Biology through their BSc programme, however, discussions with

our partners at the ITBC revealed that there was a need for training in specialist mammal research techniques such as carnivore live trapping, radio tracking and camera trapping, and that research on many of the threatened, non-primate Bornean mammals by Malaysian scientists remains uncommon. Training courses were thus designed address these training requirements and also to raise the profile of the conservation needs of the threatened Bornean mammals and to stimulate interest in studying these species.

By proxy, wild cats, especially the Sunda clouded leopard, act as umbrella species and through their effective conservation, a wide array of biodiversity is automatically protected. This project has now established a basis for the conservation of Sabah's wild cats and will serve as a foundation for a long-term conservation programme for wild cats across Borneo; a strong collaborative network on wild cat conservation in Sabah and Borneo is currently being forged.



## PART IIA.

### TECHNICAL AND SCIENTIFIC FINDINGS

#### 2.1 General study design

Camera trapping and radio tracking approaches provided initial data regarding the conservation status, activity, spatial ecology and responses of Bornean felids to habitat modification. Data continue to be analysed, but some key findings are already clear, and presented below.

#### 2.2 Project study sites in Sabah

Camera trap surveys were conducted within five study sites; each exposed to different land management practices (Table 1; Figure 4). Sites consisted of three contiguous forest areas, including two commercial forests: the INFAPRO\* region of the Ulu Segama (20-30 year post selectively logged forest undergoing rehabilitation – hereafter referred to as Ulu Segama) and Malua (1 year post selectively logged) Forest Reserves, and an adjacent area of primary forest, the Danum Valley Conservation Area and Palum Tambun Watershed Reserve. Vegetation, topography and soil chemistry across the three study sites is similar, yet each area has been subjected to different management strategies and exposed to varying levels of hunting, and thus provide a unique opportunity to investigate responses of Bornean felids to anthropogenic habitat modification and associated activities. A fourth study site, the Tabin Wildlife Reserve (20-30 year post selective logging), is surrounded almost entirely by agricultural plantations, and thus provides an opportunity to investigate Bornean felid responses to the combined effects of logging and fragmentation. A fifth study site, an oil palm plantation adjacent to the Ulu Segama and Malua Forest Reserves, was used to investigate to what extent mammals, especially the cats, utilise oil palm habitat.



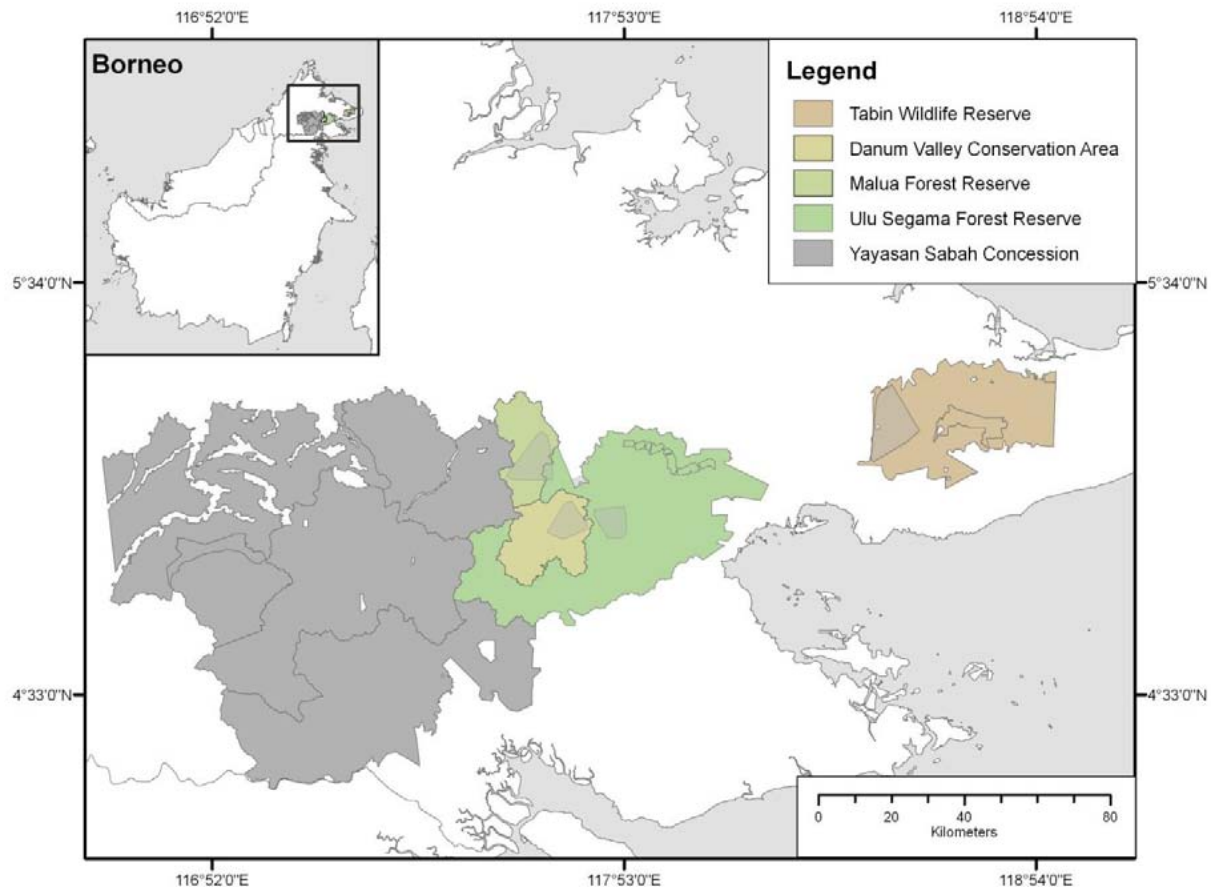
**Figure 3.** A bay cat, photo-captured in the Malua Forest Reserve. This species is endemic to Borneo, and one of the least known cats in the world

Study area	Habitat type	Relative threat from poaching <sup>1</sup>
Ulu Segama Forest Reserve	Logged 20-30 years ago, rehabilitated	2
Malua Forest Reserve	Recently logged	5
Danum Valley Conservation Area	Primary Forest	1
Oil palm	Oil palm plantation	3
Tabin Wildlife Reserve	Logged 20-30 years, no rehabilitation	4

**Table 1.** Study areas. The indicated threat from poaching applies to these study areas only, with 1 being the lowest apparent level and 5 the highest. <sup>1</sup>Hunting threat was subjectively gauged by the number of suspected poachers and/or poacher's vehicles captured on the camera traps, the number of camera traps stolen from the field, and the incidence of shotgun cartridges and kill remains observed in the field.

\* Innoprise and Forest Absorbing CO2 Emissions (FACE) Foundation Rainforest Rehabilitation Project





**Figure 4.** Map of the five study sites within Sabah, Malaysia. Shaded polygons within the study represent the five areas surveyed by camera traps.

## 2.3 Estimation of Bornean felid density

### 2.3.1 Methodology

Population densities of individually identifiable animals can be derived from the analysis of photographic data from camera traps surveys within a capture-recapture framework. This technique was originally developed to enable the estimation of tiger densities (Karanth, 1998) but is suitable for use with any species with individually patterned coats. We applied this approach to derive estimates of Bornean felid density. Camera surveys were tailored to produce estimates of Sunda clouded leopard density in our four forest study sites, but were also of appropriate study design to attempt to derive density estimates of the other two individually identifiable Bornean felids (marbled cat and leopard cat). The relatively uniformly patterned pelages of flat-headed and bay cats prevent individual identification, precluding this approach to estimate their density. A survey of the oil palm plantation adjacent to the Malua and Ulu Segama Forest Reserves was specifically tailored to estimate leopard cat density.

### 2.3.2 Results and discussion

To derive robust density estimates using the camera trap approach it is essential to obtain sufficient numbers of photo-captures of the target species. Photo-capture success was sufficiently high to enable the estimation of Sunda clouded leopard in our forest study sites. Relatively high photo capture rates were obtained of leopard cats in the majority of our sites (see section 2.4), but final analyses of these data await completion, and are not presented here. Photographic data were

sufficient to enable an estimate of the density of marbled cats in the Tabin Wildlife Reserve, the first and to date only estimate of this species' density, but in all other sites photo-capture rates precluded the capture-recapture approach to density estimation.

### 2.3.2.1 Sunda clouded leopard density



**Figure 5.** A rarely photographed Sunda clouded leopard cub, photographed in Danum Valley Conservation Area

This study provides the first robust density estimates for any Sunda clouded leopard population (Table 2). The survey of Danum Valley Conservation Area yielded insufficient photo-captures to allow density estimation, but a minimum density based on our data is provided, although this likely significantly underestimates the true value. We recorded the highest clouded leopard density in the enrichment planted and relatively well protected Ulu Segama study site. The adjacent Malua study site, which, having been recently selectively logged, has a higher level

of disturbance, and is exposed to an apparently high level of poaching activity, appears to support a lower clouded leopard population density than that of Ulu Segama. The relatively isolated Tabin Wildlife Reserve, surrounded to a large degree by plantations and apparently exposed to a higher level of poaching than Ulu Segama, appears to support the lowest clouded leopard density of our surveyed sites.

While we are unable to quantify the potential relative importance of abiotic factors associated with sampling in different locations, these data provide tentative evidence that higher levels of anthropogenic disturbance, higher poaching activity, and/or higher degrees of isolation/reduced connectivity can result in a reduced clouded leopard density. Thus, forest management and prevention of poaching activity are potentially important tools in the future management and conservation of clouded leopard populations in Sabah.

Study area	Habitat	Density (ind/100 km <sup>2</sup> ±SE)	Estimated population size
Ulu Segama Forest Reserve	Logged 20-30 years ago, rehabilitated	7.85 ± 1.79	100
Malua Forest Reserve	Recently logged	4.77 ± 2.00	16
Danum Valley Conservation Area	Primary Forest	1.21 <sup>1</sup>	34 <sup>1</sup>
Tabin Wildlife Reserve	Logged 20-30 years ago; relatively isolated and surrounded by oil palm plantations	3.05 ± 1.09	36

**Table 2.** Population densities of Sunda clouded leopard in the four forest areas and approximate population sizes based on extrapolations of the associated density estimates. <sup>1</sup>Forest structure within Danum more closely resembles that of the INFAPRO-Ulu Segama area (e.g., Edwards et al., 2009), and we therefore used our density estimate from INFAPRO to extrapolate to the whole of the Danum area.

Following Wilting *et al.*, (2006) our study provides further evidence that selectively logged forests in Borneo can have high conservation potential for the Sunda clouded leopard. Our surveys in eastern Sabah have demonstrated that Sunda clouded leopard density varies considerably across a relatively small spatial scale, and so it is likely to do so across the landscape, and thus further population assessments are needed across the Sunda clouded leopard's range before a robust assessment of this species conservation status can be made. Nevertheless, total estimated population sizes in each of the individual forest management units surveyed to date are relatively low (Table 2), and thus our data strongly suggest that no single Conservation Area, Wildlife reserve or Forest Reserve in Sabah is sufficiently large to support a sustainable and genetically viable clouded leopard population of 500 individuals over the long term. As a very approximate guideline, we predict that a forest area of 10,000 km<sup>2</sup> is required to support a population of this size. To put this into perspective, we estimate that the extensive forests of the Yayasan Sabah Forest Management Area, one of the largest remaining contiguous areas of lowland Dipterocarp forest in Southeast Asia, at approximately 8,000 km<sup>2</sup>, may hold around 400 individual clouded leopards. Thus this is the spatial scale at which we will probably need to act if this species is to persist in Sabah. It is therefore imperative that corridors of suitable habitat are maintained between protected areas and commercial forest reserves, and that connectivity is restored between isolated forest blocks to allow gene flow between sub-populations.

### 2.3.2.2 Marbled cat density



**Figure 6.** A marbled cat from Tabin Wildlife Reserve.

Sufficient numbers of marbled cat photo captures were obtained within Tabin Wildlife Reserve to enable the estimation of this felid's approximate density using the capture-recapture approach (Table 3). This is the first, and to date only estimate of density for this species in any part of its range. However, we must strongly emphasise that the data produced variable results depending on the analytical modelling approach used to estimate density. Consequently we feel it is unwise to provide a population estimation for this felid in the Tabin Wildlife Reserve based on extrapolation of this figure, and stress that this density

estimation should be used only as an approximation. Low photographic capture rates of this felid outside of Tabin (see section 2.4) preclude the application of the capture recapture approach to density estimation. The positive result from Tabin came as the result of our most intensive camera trapping effort to date (70 camera stations over an approximately 150 km<sup>2</sup> area), and it is clear that such a resource intensive approach is needed to be able to estimate this felid's density. Such studies are urgently required for this species in Sabah and indeed throughout its range.

Study area	Habitat	Density (No. Ind./100 km <sup>2</sup> ±SE)
Tabin Wildlife Reserve	Logged 20-30 years ago; relatively isolated and surrounded by oil palm plantations	16.67 ± 6.84

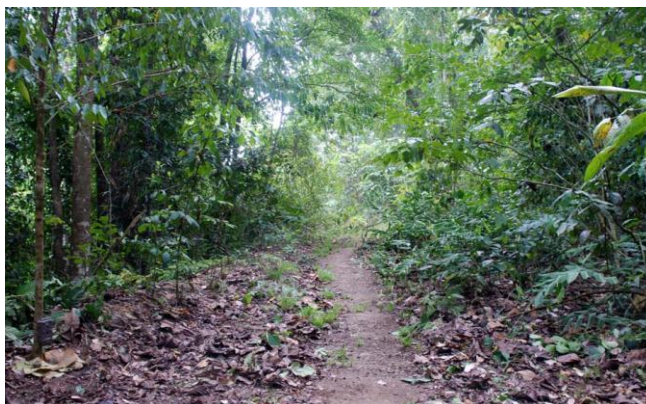
**Table 3.** The estimated population density of marbled cat in Tabin Wildlife Reserve. The surveys of Danum Valley Conservation Area and Ulu Segama and Malua Forest Reserves yielded insufficient photo-captures to allow density estimation.



## 2.4 Bornean felid relative abundance and habitat use

### 2.4.1 Methodology

Photographic capture rates (i.e., the number of photographs of a given species per unit effort) derived from our camera trap surveys in each of our study sites was used to provide an indication of Bornean felid relative abundance and habitat use. This approach makes the untested assumption that photographic capture rates are positively correlated with actual animal abundance. Unlike the capture–recapture approach, this approach does not take into account the probability of capture, and should therefore be viewed only as a very approximate indication of abundance. Nevertheless, the application of this approach can provide a useful assessment of abundance and is particularly useful for species in which individuals cannot be identified, such as flat-headed cat and bay cat. The approach can also provide essential information on felid habitat use and can provide an indication of felid responses to habitat management and anthropogenic disturbance.



**Figure 7.** A typical camera trap set. Cameras were deployed along old logging roads, ridgelines and existing and newly cut human forest trails, features which are frequently used by Bornean felids.

### 2.4.2 Results and discussion

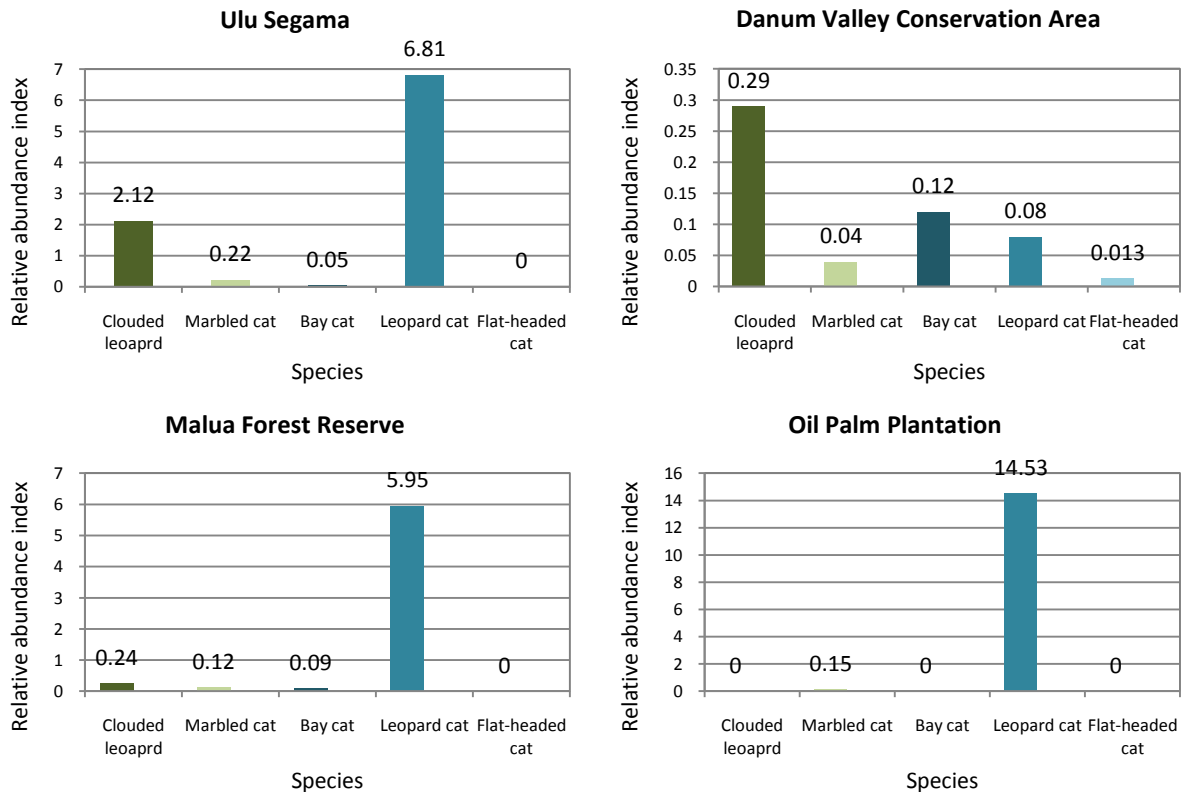


**Figure 8.** The only camera trap image of a flat-headed cat recorded during three years of camera surveys

Relative abundance indices for all five felids in the different study sites are presented in Figure 9. Data from Tabin are still being analysed and consequently not presented here. Leopard cats were the most frequently recorded species in all disturbed habitats, especially in the plantation habitat, but were infrequently recorded in the primary forest. In contrast, marbled cat, bay cat, and in particular, flat-headed cat (which was only photo captured on one occasion; Figure 8) were infrequently photographed in any of the forest habitats, suggesting that these felids are found at significantly lower densities than leopard cat. As a fish specialist the flat-headed cat is closely associated with rivers; forest close to rivers was included in the camera surveys, however, all of the survey areas were above 100 m asl (although the forest is classed as lowland rainforest), adding further support to the hypothesis that this felid has very specific habitat requirements, and is restricted to extreme lowland habitats (Wilting *et al.*, 2010). It is the more low lying areas that are affected first by anthropogenic modification and therefore, a large proportion of this felid's suitable habitat has already been lost. These results serve to highlight the critical status of this endangered felid, both in Sabah, and through its range.

Sunda clouded leopard, bay cat and marbled cat were all repeatedly detected in all the forest habitats, suggesting that these felids can potentially utilise forests that have been subjected to

varying levels of disturbance, and thus highlighting the conservation importance of the remaining selectively logged Forest Reserves in Sabah. Nevertheless, the relative infrequency of photo-capture for the three smallest threatened Bornean felids raises real concern as to their current conservation status. Although we detected a single individual marbled cat on the very periphery of the oil palm plantation our data provide tentative evidence that of the five Bornean felid species only the apparently highly adaptable leopard cat is able to persist in this modified habitat. However, it should be noted that our data do not reflect the situation in the centre of large plantations where leopard cat populations may exist at lower densities. Thus, these data provide further, albeit tentative evidence that the four threatened Bornean felids are forest dependant, and that consequently forest loss is the principal threat to the continued survival of these felids.



**Figure 9.** Bornean felid relative abundance in four study areas. The relative abundance index is the number of independent photographs of a given species per 100 trap nights of survey effort, where one camera pair operating for a 24 hour period is equal to a trap night.



**Figure 10.** Photographic evidence of felids utilising disturbed habitats. An extensive camera survey of an oil palm plantation detected only leopard cats in the plantation area; the only other Bornean felid detected during this survey was a marbled cat, recorded walking along the very periphery of the plantation/forest edge (left). Our data further support the notion that Sunda clouded leopard, leopard cat, marbled cat and bay cat (right) utilise selectively logged habitats, of varying levels of disturbance.

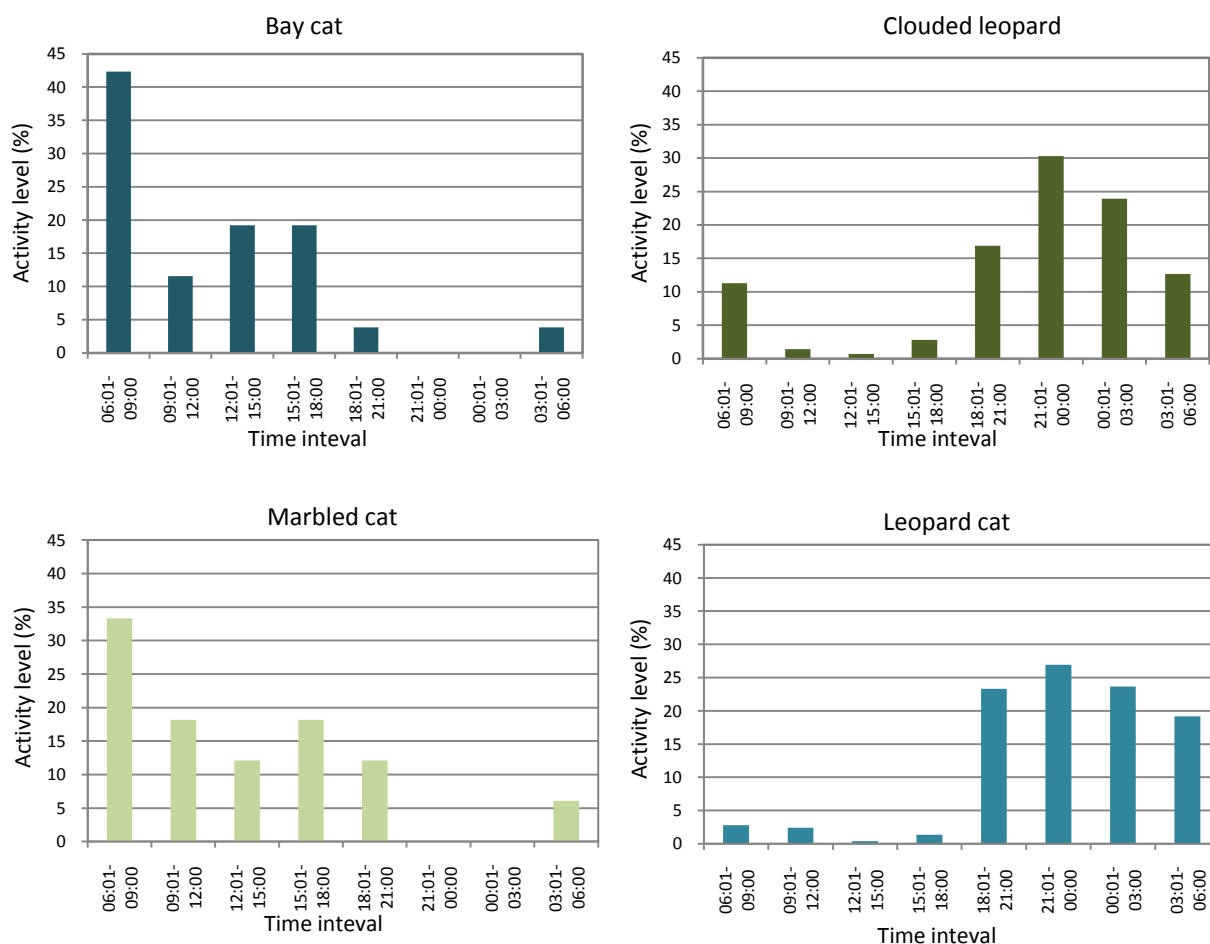
## 2.5 Bornean felid activity patterns

### 2.5.1 Methodology

Following the assumption of van Schaik and Griffiths (1996) that photo-capture frequency and activity is constant throughout the day and night, we used temporal data from photo-capture events to assess Bornean felid patterns of activity. To avoid potential bias caused by multiple captures of the same animal, only one record for each species, per hour, was used.

### 2.5.2 Results and discussion

The camera data has provided the first evidence that both the marbled cat and bay cat exhibit diurnal activity patterns in contrast to the predominantly nocturnal activity patterns of the clouded leopard and leopard cat (Figure 11). This previously unknown evidence of temporal segregation within the guild suggests the cats exploit different prey bases, which could have consequences for management as it must be ensured that specific and potentially very different prey species are conserved to support the entire guild. Further studies of these felids' ecology are urgently required.



**Figure 11.** Temporal segregation within the Bornean felid guild. A clear temporal split is evident within the guild of Bornean felids, with the Sunda clouded leopard and leopard cat exhibiting a primarily nocturnal activity pattern, whereas the bay cat and marbled cat are almost exclusively diurnal.

## 2.6 Bornean Felid Spatial Ecology

### 2.6.1 Methodology

A live trapping programme was conducted in order to live-capture Bornean felids with the intention of fitting radio collars and consequently investigating Bornean felid spatial ecology. There were two main blocks of live trapping: April-June 2008 and January-March 2009 totalling 5.5 months of intensive trapping, using 30 live traps of varying size.

### 2.6.2 Results and discussion

Prior to the trapping commencing in earnest, a female Sunda clouded leopard, was successfully trapped and collared on 31<sup>st</sup> January 2008. This is the first, and to date only individual of this species to be radio-tagged. The remainder of the trapping sessions resulted in the trapping and collaring of nine leopard cats, six males and three females. No other felid species were live captured.

#### 2.6.2.1 Sunda clouded leopard

The live-trapped individual is the first known Sunda clouded leopard to be immobilised in situ and radio-tagged. Table 4 presents morphometric data for this individual alongside that of an adult male (CL M2), previously recorded on our camera traps, which was discovered shot within the Ulu Segama Forest Reserve in November 2007.



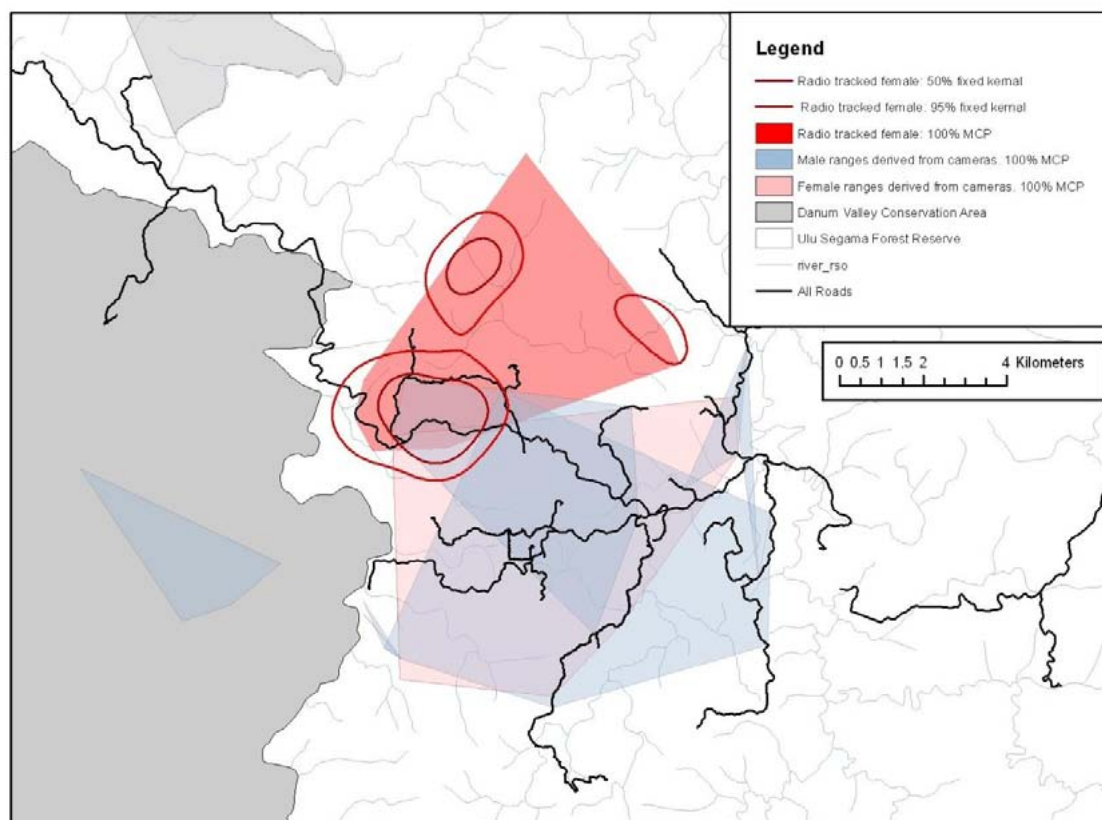
**Figure 12.** 'Alumis', meaning 'beautiful' in the local Dusan language, the first and to date only Sunda clouded leopard to be radio-collared.

Over a 109 day period, 37 radiolocations were obtained and used to calculate the home-range size for the tagged female Sunda clouded leopard (Table 5; Figure 13). The radio-collared female was located 22 times on consecutive days and showed movement on all days. Distances between consecutive daily locations averaged 797 m ( $\pm$  667 m SD, range 97 – 3042 m). After 109 days the female was located in the northern part of her range; thereafter we were unable to detect the radio signal, despite repeated attempts over an increasingly wider area. In October 2008 an attempt was made to locate the animal from a helicopter. A radio signal transmitting on the correct frequency was detected approximately 9 km north-north-east of the previously most northerly point of her range. However, the signal was distorted, despite attempts to re-tune the receiver, indicating that the collar had likely malfunctioned or had been damaged. Extensive follow up searches on foot failed to locate the animal.

Specimen	Sex	Age	HB (mm)	T (mm)	HF (mm)	HS (mm)	Weight (kg)
CL F7: radio-tagged	F	SA	870	770	145	380	12
CL M2	M	A	1040	790	200	510	23.3

**Table 4.** Morphometric measurements for two Sunda clouded leopards from the Ulu Segama Forest Reserve, Sabah. F: female; M: male; HB: head-body length; T: Tail length; HF: Hind-foot length; HS: Height at Shoulder.





**Figure 13.** Sunda clouded leopard home-ranges derived from radio telemetry and camera trapping in the Ulu Segama Forest Reserve and Danum Valley Conservation Area.

Naïve range sizes derived from point location data from the camera survey in the Ulu Segama were also calculated for seven individuals in which  $\geq 3$  locations were obtained (six males, one female) (Table 5; Figure 13). Such naïve range estimates will likely underestimate true range size, but given the paucity of data for this species, they are at least indicative. Range sizes varied from 20.6 – 45.1 km<sup>2</sup>, (Table 5). Range sizes of Sunda clouded leopards in our study were similar to those calculated for the closely related mainland clouded leopard in Thailand by Austin (2007: 39.5 – 42.2 km<sup>2</sup>; 95% fixed-kernel) and Grassman *et al.* (2005b: 22.9 – 45.1 km<sup>2</sup>; 95% MCP). The core range of our tagged subadult female is identical to that of Grassman *et al.*'s mean core-range in Phu Khieo National Park: 5.2 km<sup>2</sup> (50% fixed-kernel) for clouded leopards in Phu Khieo.

Photographic capture data from all camera stations were used to investigate Sunda clouded leopard territoriality. Sunda clouded leopard were recorded at 46 stations. Of these,  $\geq 2$  individuals were recorded at 12 stations (26 %),  $\geq 2$  males were recorded at eight stations (17.4%), including one station at which three males were recorded. Two or more females were recorded at three stations (6.5%) and eight stations (17.4%) recorded both males and females. Together, the radio-tracking and camera-trap data suggest that Sunda clouded leopard do not hold exclusive territories, and exhibit extensive inter- and intrasexual overlap in space-use. Our photo-captures suggest that clouded leopards travel extensively on the ground and may be less arboreal than previously thought (Rabinowitz *et al.*, 1987; Austin *et al.*, 2007).



Data collection method	Animal	Sex	No. locations	No. occasions	Home range estimator (km <sup>2</sup> )				
					Minimum convex polygon <sup>1</sup>			Fixed-Kernal <sup>1</sup>	
					100%	95%	50%	95%	50%
Radio tracking	CL F7	Female	37		29.86	22.6	5.2	16.1	5.4
Camera trapping	CL M1	Male	13	22	20.6	-	-	-	-
	CL M2	Male	13	39	45.11	-	-	-	-
	CL M3	Male	4	1	0.16	-	-	-	-
	CL M5	Male	3	5	9.93	-	-	-	-
	CL M6	Male	3	6	1.58	-	-	-	-
	CL M8	Male	4	7	6.26	-	-	-	-
	CL F2	Female	10	12	41.73	-	-	-	-

**Table 5.** Sunda clouded leopard home ranges derived from both radio-telemetry and camera trapping surveys in eastern Sabah, Malaysia. <sup>1</sup>To allow comparison with studies of other felids' range sizes we used the two most commonly applied range size calculation methods, Minimum convex polygons and fixed kernel analyses, and express these ranges as 100% (MCP only) 95%, and 50% values. The 95% can be thought of as the total area utilised by the study animal during the observation period, whereas the 50% value provides an indication of the animal's core area.

#### 2.6.2.2 Leopard cat



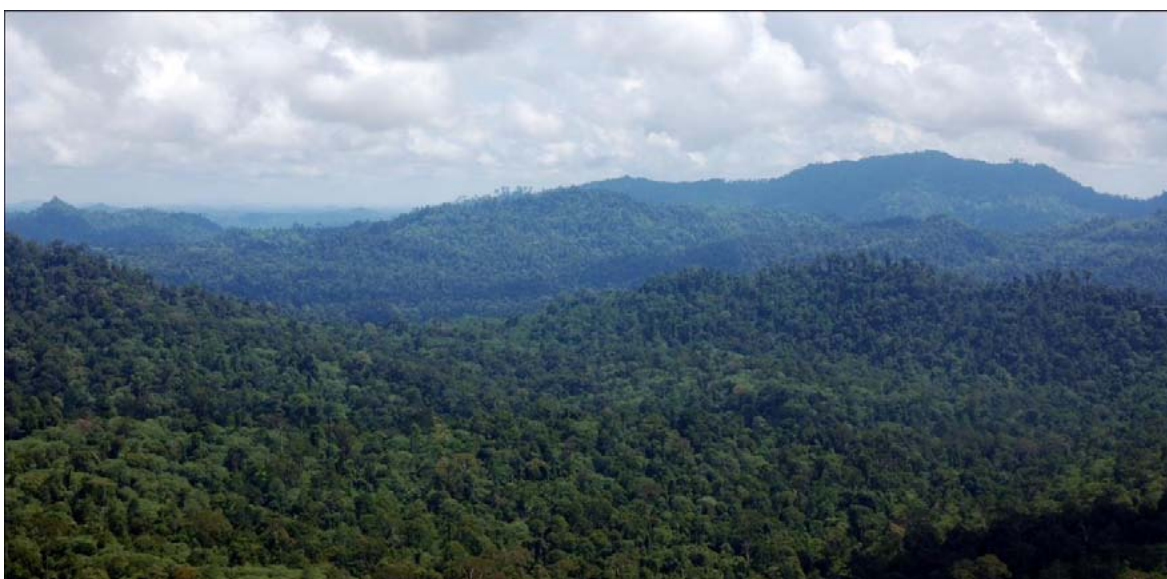
**Figure 14.** A collared leopard cat photographed by a camera trap in the oil palm plantation. This cat is one of two males that moved from an apparently stable home range in the adjacent Ulu Segama Forest Reserve and settled more than 25 km away in the plantation.

Further analysis is still required for the leopard cat spatial ecology data, however, preliminary findings are presented here. Data from the collared leopard cats in the Ulu Segama Forest Reserve revealed an average home range of approximately 3 km<sup>2</sup>, with old logging roads forming an important habitat feature. Male ranges were characterised as being more closely associated with roads and adjacent habitats than females. Primary forest formed part of the home range of one focal male. Apparent shifts in home range were observed for two adult males; these individuals re-established their home ranges in an adjacent oil palm plantation, which was approximately about 25 km from their previous

ranges. One of these males was recorded on >1 occasion returning to his old range, but returned to the oil palm shortly thereafter. This suggests that larger areas of forest may be required for leopard cats than suggested by their small body size and previous home range estimates (e.g., ca. 3 km<sup>2</sup>: Rajaratnam et al., 2007). Data also suggest that leopard cats may have a relatively high mortality rate. Five of the nine collared cats were killed during the study. Of these deaths it was possible to attribute two to road traffic accidents on the main logging road, and two were eaten by pythons.

## 2.7 Key conclusions

- *Large home range requirements and low population densities exhibited by Sunda clouded leopards mean that they require extensive areas of forest to survive*
- *It is assumed that a population of 500 individuals would be sustainable over the long term and to support a population of this size contiguous forest areas of approximately 10,000 km<sup>2</sup> are likely required. Smaller populations may be sustainable in the shorter term; however, using the same reasoning, to support a population of only 250 clouded leopards an area of around 5,000 km<sup>2</sup> would be required.*
- *No single Conservation Area, Wildlife Reserve or Forest Reserve in Sabah is sufficiently large to support a sustainable population of 500 or even 250 Sunda clouded leopards*
- *Marbled cat, bay cat, and flat-headed cat appear to exist at low densities. Further studies are urgently needed to assess their conservation status and habitat needs.*
- *Sunda clouded leopard, marbled cat, bay cat and flat-headed cat do not appear to utilise palm oil plantations, but appear able to utilise both primary and selectively logged forest, highlighting the importance of commercial Forest Reserves to Bornean felid conservation.*
- *Flat-headed cat has an extremely restricted distribution in Sabah and throughout its range, being confined to extreme lowland (>100 m) areas of forest, few areas of which still exist in Sabah. Therefore, this is, likely the most threatened species of the Bornean felids, and requires urgent conservation action.*
- *Forest loss and fragmentation likely poses the largest risk to the continued survival of the four threatened Bornean wild cats in Sabah.*
- *Leopard cats appear relatively abundant in both forest and oil palm plantation habitats. However, in plantations it appears that these felids are likely reliant on adjacent areas of forest to survive. The species is not currently a conservation concern in Sabah, but populations should be monitored.*



**Figure 15.** The predominantly selectively logged, but extensive forests of the Yayasan Sabah Forest Management Area, one of the most important areas for the conservation of felids in Borneo. Our study highlights the importance of disturbed forests for Bornean felid conservation.

## **PART IIB**

### **ASSESSING THE ANTHROPOGENIC THREATS TO BORNEAN WILD CATS**

#### **2.8 Conservation awareness questionnaire**

##### **2.8.1 Methodology**

A questionnaire survey was implemented to investigate local people's knowledge and perceptions about Bornean wildlife and to try to gain any insight into any illegal hunting of wild cats and their prey. This is a delicate issue and as such local people are wary of discussing these matters. To help ease this situation, the surveys were conducted by a recent Conservation Biology graduate from the ITBC, Gilmore Bolongon, who had experience of similar surveys during his undergraduate research. No direct questions regarding hunting were asked, however, it was found that local people were, nonetheless, rather suspicious and were very reluctant to speak about wildlife and as a result only 12 interviews were completed, out of 97 people approached. Nevertheless, the questionnaire survey was successful in providing some very useful information regarding perceptions and attitudes towards wildlife of rural people in Sabah.

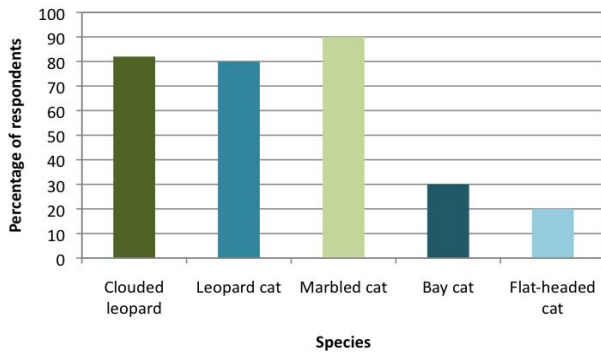
Interviewees were shown photographs of the wild cats and a selection of other species and asked if they could recognise and name each one, they were also asked if they had ever seen any of the cats and when the sightings had been. Respondents were asked to identify any dangerous animals from the pictures shown and whether any of the species caused problems in their village. To investigate hunting, people were asked if they had ever heard about animals being hunted and, if they had, whether they knew why the animals had been hunted (e.g. for personal consumption, to sell the meat, for traditional medicines etc.). The questionnaire also aimed to investigate general awareness of conservation and issues such as animals becoming extinct. Lastly, the respondents were asked whether they would like to be able to use the forest near their village and for what purpose and whether they agreed, in principle, with having totally protected forest reserves where access is restricted.

##### **2.8.2 Results**

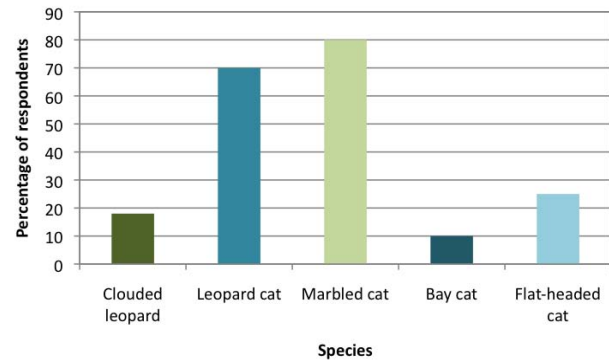
###### *2.8.2.1 Local awareness of Bornean felids*

Most people were able to recognise and name the Sunda clouded leopard, leopard cat and marbled cat, conversely most interviewees were unable to name the bay cat or the flat-headed cat (Figure 16). If respondents were unable to distinguish between certain species their answers were discounted. Although most people reported having seen a marbled cat (Figure 17), the leopard cat was the only cat that was reported to be seen often and was also the only cat reported to have been sighted in the last year. Although there is no way to validate these claims, it certainly seems plausible that the most commonly sighted wild cat would be the leopard cat and that fewer people would have seen a flat-headed cat or bay cat. One person claimed to have seen a marbled cat, bay cat and flat-headed cat in an area of primary forest in 1979/1980. This person also mentioned that he observed the flat-headed cat catching fish from the river, adding weight to this claim. Although these species are sighted infrequently nowadays it is possible that 30 years ago these species may have been rather more common and there is no reason to discount these claims.

## A Framework for a Wild Cat Action plan for Sabah



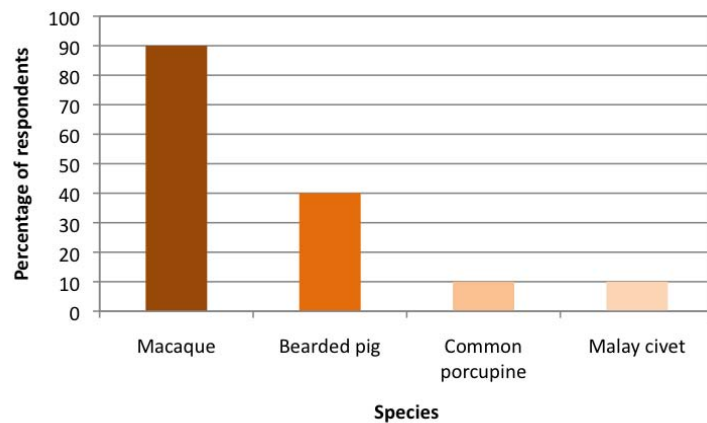
**Figure 16.** The percentage of people able to name the species of Borneo's wild cats



**Figure 17.** The percentage of people who had seen each species of Borneo's wild cats

### 2.8.2.2 Local perceptions of danger and problems from wild animals

It appears that the clouded leopard is perceived as dangerous; two interviewees identified the clouded leopard as a dangerous animal, along with sun bears and elephants and 63% of people said they would run away from clouded leopards, marbled cats and bay cats, suggesting that they fear these animals. One person said they might shoot a clouded leopard if they saw one; however there was no evidence from these interviews that cats are targeted by hunters.



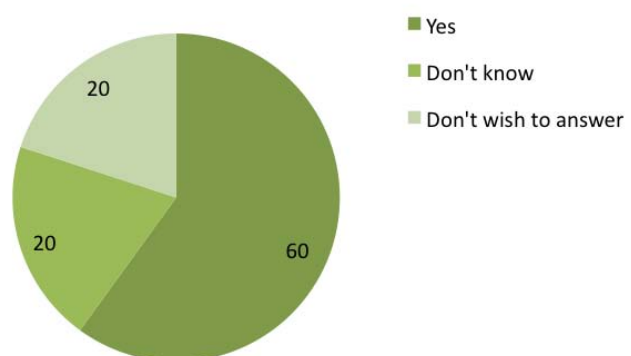
**Figure 18.** The species identified as causing problems in the village environment

The majority of interviewees regarded macaques as problematic in the village; bearded pigs were also commonly mentioned as causing problems (Figure 18). The other species mentioned as being troublesome were the common porcupine and the Malay civet with the latter apparently raiding chicken's eggs. None of the cat species were mentioned as being problematic in these villages.

### 2.8.2.3 Hunting of wild animals

Most people admitted that they were aware of animals being illegally hunted; the remainder of interviewees were unsure or declined to answer this question (Figure 19).

Of those who admitted they knew about hunting, the majority (87.5%) said that animals were hunted for food only, although selling the meat and traditional medicine in the form of rhino horn were also mentioned.



**Figure 19.** The awareness of illegal hunting activities

#### 2.8.2.4 Level of education

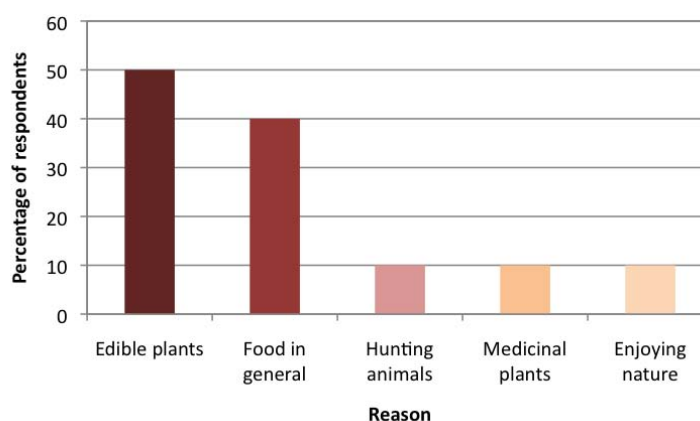
Interviewees were asked if they learned about conservation or wildlife when they were younger, 60% said they did, but when asked to elaborate it became apparent that they were not taught these issues at school or through any formal programme, but learned about the local, common wildlife through other villagers or family members. Only two people said their children learn about conservation; one of these said their children only learn about these issues from the television. Over half of the people interviewed (57.1%) did not know if their children were taught about conservation.

#### 2.8.2.5 Awareness and interest in local wildlife conservation

Everybody questioned understood the concept of extinction and 100% of interviewees said that it does matter if animals become extinct. When asked why it matters, 70% of people said that they do not want their children to grow up without seeing wildlife, or only being able to see animals in photographs. However, importantly, none of the people interviewed were aware that four of the wild cats are threatened with extinction.

#### 2.8.2.6 Local use of forest resources

When asked if they would like to be able to use the forest near their village all respondents said they would like to be able to, the majority of these cited collecting edible plants as the reason for wanting to use the forest. Collecting food in general was mentioned by several people; while hunting animals, collecting medicinal plants and enjoying nature were also given as reasons for wanting to use the forest (Figure 20). Only 2 people said that some areas of forest should be completely protected with no access, the majority of people (80%) did not agree with this.



**Figure 20.** Reasons given by interviewees for wishing to use the forest close to their village

## 2.9 Key conclusions

- ***The majority of people interviewed were able to name the more common leopard cat and also the clouded leopard and rather more surprisingly the much rarer marbled cat***
- ***Most people interviewed were unable to recognise or name the least common of the wild cats – the bay cat and the flat-headed cat***
- ***Most of the respondents had seen a marbled cat and/or a leopard cat, although only the leopard cat had been seen within the past year***
- ***The clouded leopard is often perceived as a dangerous animal***
- ***Nobody interviewed identified any of the wild cats as causing problems in the village***

- *The majority of interviewees were aware of animals being illegally hunted, the majority of these people believed that animals are usually hunted for personal consumption of the meat only*
- *None of the respondents had in the past learnt, nor currently do their children learn about conservation issues at school, suggesting that a structured education programme would be invaluable*
- *Everybody questioned believed that it does matter if animals become extinct, yet nobody knew that four of Sabah's wild cat species are threatened with extinction*
- *All respondents believed that they should be able to use the forest near their village, with collecting edible plants and food in general being the main reasons; only two people thought that some areas of forest should have restricted access.*



## PART III

### SPECIES SUMMARIES

#### 3.1 Leopard cat, *Prionailurus bengalensis* (Kerr, 1792)



Figure 21. The leopard cat

##### 3.1.1 Population Status

The IUCN class the leopard cat as Least Concern. Some island populations are threatened by habitat loss; however, the species is stable in many areas and even appears to thrive in some altered habitats.

##### 3.1.2 Protection Status

In 1994 leopard cat populations were downlisted to CITES Appendix II for all range countries with the exceptions of Bangladesh, India and Thailand whose populations are on CITES Appendix I.

##### 3.1.3 Principal Threats

Although the leopard cat appears to be relatively tolerant of habitat alteration, in comparison to other Asian felids it is not invulnerable as population declines, attributed to forest loss, on small islands have shown. There is also a higher level of mortality in such altered habitats.

##### 3.1.4 Description and behaviour

The leopard cat's pelage varies from yellow to grey-brown and is covered with black spots or rosettes. Leopard cats are small, typically weighing around 3 kg. The diet of leopard cats is comprised principally of rodents. Few data exist regarding leopard cat home ranges. In Sabah ranges of approximately 3.0 km<sup>2</sup> have been reported; these ranges appear smaller than elsewhere in its range.

##### 3.1.5 Habitat and Distribution

The leopard cat has a wide geographical distribution (Figure 22) and is found in a wide variety of habitats, occurring in primary and logged forest and also agricultural and timber plantations.

###### 3.1.5.1 Sabah

In Sabah the leopard cat has been recorded in many areas including Danum Valley Conservation Area, Ulu Segama Forest Reserve, Malua Forest Reserve, Tabin Wildlife Reserve, Deramakot Forest Reserve, and Tangkulap Forest Reserve.

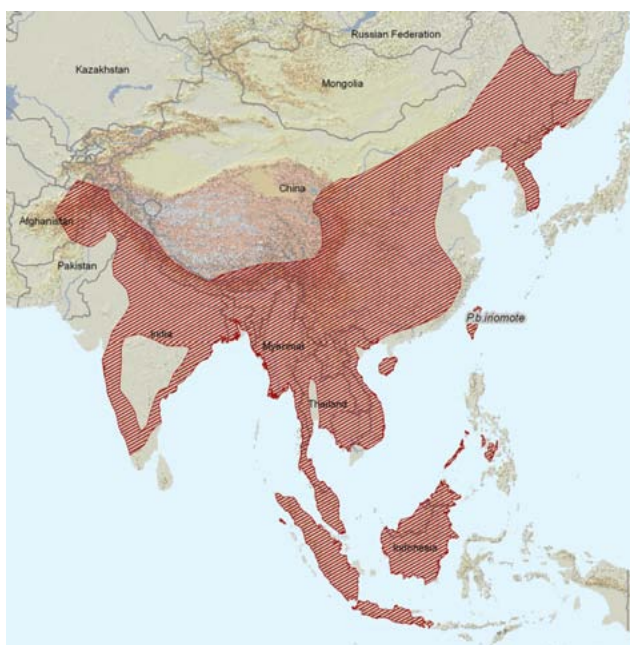


Figure 22. The distribution of the leopard cat. From Sanderson et al., 2008

### 3.2 Flat-headed cat, *Prionailurus planiceps* (Vigors and Horsfield, 1827)



**Figure 23.** The flat-headed cat

#### 3.2.1 Population Status

The flat-headed cat is listed as Endangered by the IUCN. The population is believed to be declining and it seems to have a localised distribution restricted to the extreme lowlands and around bodies of water.

#### 3.2.2 Protection Status

The flat-headed cat has been listed on CITES appendix I since 1975. Hunting and trade is prohibited in Indonesia, Malaysia and Thailand.

#### 3.2.3 Principal Threats

Habitat loss has been detrimental in the past and continues to be a threat

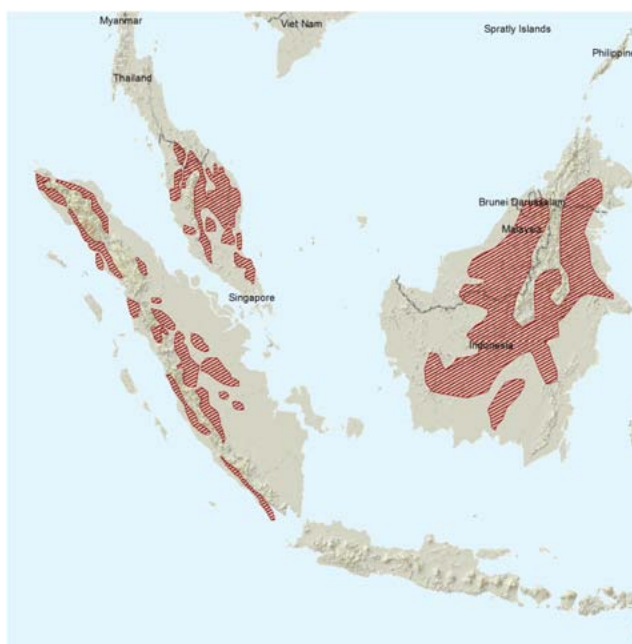
in the present. Water pollution caused by logging, agriculture and gold mining poses a serious threat through contamination of prey. The depletion of fish stocks due to over-exploitation is also considered to be a serious threat for this species.

#### 3.2.4 Description and Behaviour

The flat-headed cat's pelage is thick, reddish-brown and tinged with grey. The claws are semi-retractable and the toes are partially webbed. Flat-headed cats are very small, weighing as little as 1.5 kg and the tail is very short. The diet consists largely of fish and frogs. The flat-headed cat is possibly nocturnal. There are no data regarding population densities or home ranges of the flat-headed cat.

#### 3.2.5 Habitat and Distribution

The distribution of the flat-headed cat is highly fragmented (Figure 24). Most records for the flat-headed cat are from swampy areas, oxbow lakes and riverine forests. They have been recorded in both primary and logged forests.



**Figure 24.** The distribution of the flat-headed cat. From Hearn et al., 2008a

##### 3.2.5.1 Sabah

In Sabah the flat-headed cat has been recorded from Tangkulap and Deramakot Forest Reserves, Palum Tambun Watershed Reserve, Kinabatangan Wildlife Sanctuary, Tabin Wildlife Reserve and Maliau Basin Conservation Area.



### 3.3 Bay cat, *Pardofelis badia* (Gray, 1874)



**Figure 25.** *The bay cat*

#### 3.3.1 Population Status

The bay cat is classed as Endangered by the IUCN, with an effective population size believed to be below 2,500 mature individuals, although this is thought to be decreasing. There are no bay cats held in captivity.

#### 3.3.2 Protection Status

The Bay cat has been included on appendix II of CITES since 1977. In Indonesia (Kalimantan) and Malaysia (Sabah and Sarawak) hunting and trade are prohibited; however, in Brunei there is no legal protection outside of protected areas.

#### 3.3.3 Principal Threats

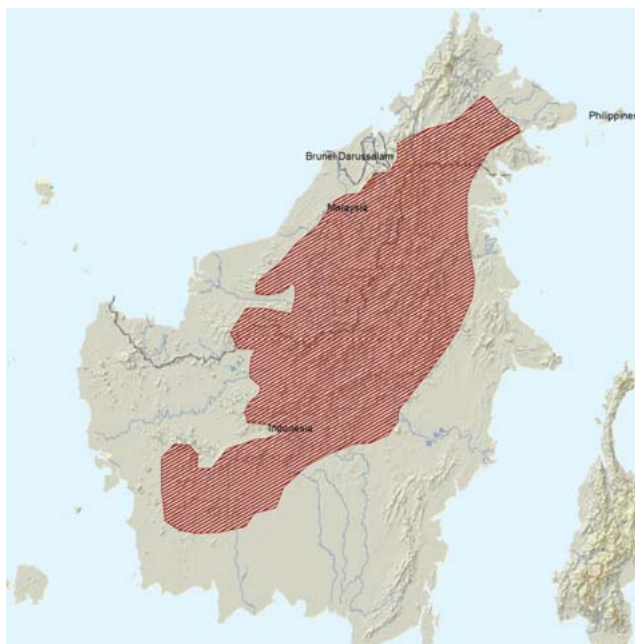
As so little is known about the bay cat it is difficult to determine the main threats. It is thought that deforestation poses the most significant threat at present.

#### 3.3.4 Description and Behaviour

The bay cat has two colour phases: chestnut red and grey. There are three dark stripes on the top of the head and the tail is long. The estimated weight is 3 - 4 kg. The bay cat is so elusive it was not recorded by camera trap until 2003. From recent camera trapping data and observations the bay cat appears to be largely diurnal. There are no data regarding home range size or population density of the bay cat.

#### 3.3.5 Habitat and Distribution

The bay cat is restricted to the island of Borneo. Camera trap images and sightings have been made in logged forest, including a recently logged area. The bay cat is known to occur in Indonesian and Malaysian Borneo, its presence is uncertain in Brunei (Figure 26).



**Figure 26.** *The distribution of the bay cat. From Hearn et al., 2008b.*

##### 3.3.5.1 Sabah

In Sabah the bay cat has been recorded in Deramakot Forest Reserve, Danum Valley Conservation Area, Ulu Segama Forest Reserve, Malua Forest Reserve and Tabin Wildlife Reserve.

### 3.4 Marbled cat, *Pardofelis marmorata* (Martin, 1837)



**Figure 27.** The marbled cat

#### 3.4.1 Population Status

The marbled cat is classed as Vulnerable by the IUCN. Due to continuing deforestation across the range of the marbled cat, the population is believed to be declining.

#### 3.4.2 Protection Status

The marbled cat has been included on CITES appendix I since 1975.

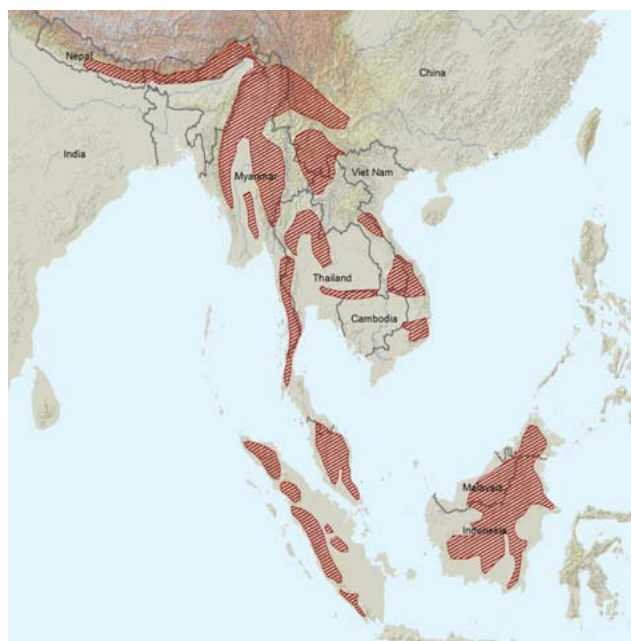
#### 3.4.3 Principal Threats

Habitat loss due to deforestation is believed to be the main threat. Although the species has been recorded in logged forest the degree to which it can tolerate habitat

alteration is unknown. It is valued for its skin, meat and bones, and indiscriminate snaring is prevalent throughout much of its range and is likely to pose a major threat.

#### 3.4.4 Description and Behaviour

The colour of the marbled cat's coat varies from dark grey-brown to yellowish-grey and red-brown. The flanks and back are patterned with large irregularly shaped markings. The tail is extremely long. The marbled cat weighs around 5 kg. The majority of camera trap records from Borneo have been taken during the day. The diet has been reported to consist of squirrels and rats. A single individual was radio-collared and tracked for one month in Thailand and found to have a range of 5.3 km<sup>2</sup> over this period. A rough population density of 16.67 individuals/100 km<sup>2</sup> was estimated for Tabin Wildlife Reserve in Sabah.



**Figure 28.** The distribution of the marbled cat. From Hearn et al., 2008b.

#### 3.4.5 Habitat and Distribution

The marbled cat is primarily associated with moist tropical forest. Marbled cats have been observed in primary forest, secondary forest, clearings and mangroves. Although the marbled cat has a relatively wide geographical distribution, its range is highly fragmented (Figure 28).

##### 3.4.5.1 Sabah

Within Sabah the marbled cat has been recorded in Danum Valley Conservation Area, Palum Tambun Watershed Reserve, Ulu Segama Forest Reserve, Malua Forest Reserve, Tabin Wildlife Reserve, Deramakot Forest Reserve and Tangkulap Forest Reserve.



### 3.5 Sunda clouded leopard, *Neofelis diardi* (Cuvier, 1823)



**Figure 29.** *The Sunda clouded leopard*

#### 3.5.1 Population Status

The Sunda clouded leopard is classed as Vulnerable by the IUCN. Due to the continued loss of habitat across its range it is assumed that the population is decreasing.

#### 3.5.2 Protection Status

The Sunda clouded leopard has been included on CITES Appendix I since 1975. The species is fully protected in Sumatra and Kalimantan (Indonesia), Sabah and Sarawak (Malaysia) and Brunei.

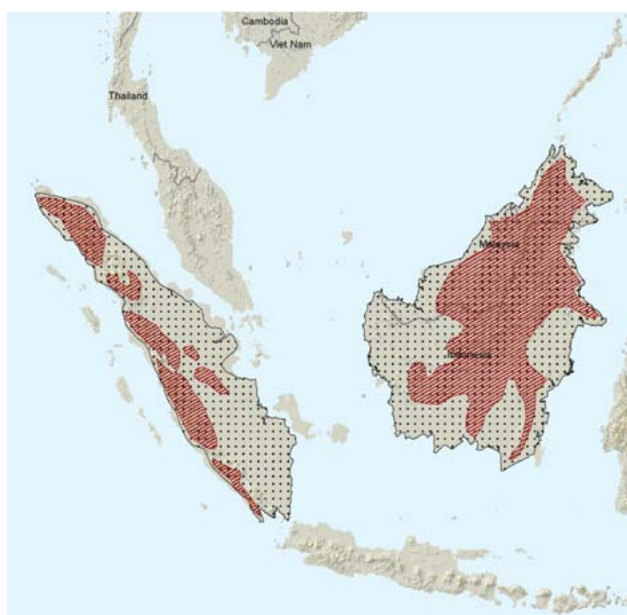
#### 3.5.3 Principal Threats

Deforestation and habitat alteration are believed to be the major threat; the status of trade in skins and body parts is uncertain. Sunda clouded leopards occasionally prey on livestock such as goats, which may invoke retribution killings.

#### 3.5.4 Description and Behaviour

The Sunda clouded leopard is a recently recognised species. The greyish coat is patterned with ellipses edged in black. The limbs are short and the tail very long. The canines are longer relative to skull size than any other living felid. The Sunda clouded leopard is mainly nocturnal; the diet is varied, including monkeys, porcupines, bearded pigs, deer and pheasants.

Only one Sunda clouded leopard has ever been radio-collared. This female was found to have a range of 29.86 km<sup>2</sup>. Density estimates on Borneo are variable, ranging from 3.05 - 7.85 individuals/100 km<sup>2</sup> based on camera trap surveys.



**Figure 30.** *The distribution of the Sunda clouded leopard.*

*From Hearn et al., 2008d.*

#### 3.5.5 Habitat and Distribution

The Sunda clouded leopard is restricted to the islands of Borneo and Sumatra (Figure 30). It is found in primary forest, but has also been recorded from logged forest and peat swamp forest; use of oil palm is uncertain.

##### 3.5.5.1 Sabah

Within Sabah the Sunda clouded leopard has been recorded from Danum Valley Conservation Area, Ulu Segama Forest Reserve, Malua Forest Reserve, Tabin Wildlife Reserve, Crocker Range National Park, Gunung Madalon, Sugut, Sepilok, the Upper Sungai Segama and Kalabakan Forest Reserve, and Tawau Hills National Park and is thought to occur in most protected areas.

## PART IV

### CHALLENGES TO WILD CAT CONSERVATION IN SABAH

#### 4.1 Habitat loss



**Figure 31.** Natural and anthropogenically modified landscapes in Sabah. Top: Primary forests of Danum Valley Conservation Area; middle: severely degraded selectively logged forest in north Ulu Segama Forest Reserve; bottom: interface between an oil palm plantation and north Ulu Segama forest Reserve.

To support the rapidly increasing human population, the planet's natural habitats are increasingly coming under pressure for use and development, consequently habitat alteration and destruction are the principal forces driving species extinctions around the globe. Over the last 500 years, human activity has caused the extinction (or extinction in the wild) of 869 species and the number of species threatened with extinction has now reached 16,928 (*IUCN 2009*).

Forest loss across Borneo has proceeded at an alarming rate. In the mid 1980s 75% of Borneo was covered in forest, by 2005 forest cover had reduced to 50%. If this rate of deforestation continues, it is projected that by 2020 forest cover will have reduced to less than one third (*Rautner et al., 2005*). Forest loss across Borneo is not uniform; the rate in Kalimantan (Indonesia) is higher than in the rest of the island. Although 6.9% of Borneo's forests are protected as National Parks, illegal logging continues to occur in some areas, especially in Kalimantan (*Rautner et al., 2005*). The amount of forest cover in Sabah is rather more positive than elsewhere in Borneo with 59% still under forest cover in 2003 compared with less than 50% in Kalimantan (*Rautner et al., 2005*). Around 41% of Sabah's land has some form of legal protection (*Wilting et al., 2006*).

Fire is an additional problem resulting in massive habitat loss across Borneo. In 1997/1998 6.5 million ha of forest was lost in Kalimantan due to fire. Although there was an unusually strong El Niño effect during this time, the majority of these fires were anthropogenic in origin (*Rautner et al., 2005*). Fire is not a natural part of forest ecosystem processes in Borneo and therefore the trees and other vegetation are not adapted to fire; consequently fires can be extremely destructive. The problem of fire is aggravated by logging and other processes that disturb the forest structure as

opening the canopy allows the forest to become dry and fallen trees and dead wood accumulated during the logging process burn easily (Meijaard *et al.*, 2005).

All the Bornean felids with the exception of the leopard cat appear to be forest dependent (Ross *et al.*, *in litt.* – this study) and therefore forest clearance and fragmentation is detrimental to wild cat populations. Although all five species of wild cat have been recorded in logged forest, the degree to which they can tolerate this modification is uncertain and the effects on population density, breeding behaviour and diet are unknown.

Felid response to oil palm conversion is a different matter. During a recent camera trap survey of a small oil palm plantation Ross *et al.*, (*in litt.* – this study) recorded only leopard cats within the plantation. Radio-tracked leopard cats in the same plantation were found to have daytime rest sites in patches of scrubby forest within the plantation, suggesting that the retention of such areas is important to allow the persistence of leopard cats in this altered habitat. Rajaratnam *et al.*, (2007) found a similar pattern and speculated that fragments of logged forest may be important features for breeding females. Although there is anecdotal evidence of clouded leopards utilising oil palm (Wilting *et al.*, 2006) these sightings are usually made close to the edge of the plantation and it is, therefore, probable that large plantations form barriers to cat movement.

It is possible that habitat corridors will allow felid movement between larger otherwise isolated areas of forest; however to date, it is unknown how effective corridors would be in facilitating movement and what habitat features would be required to form a suitable corridor. It is currently unknown how fragmentation of cat populations will affect the genetic health of these species; however it is likely that, akin to other wildlife, reduced gene flow and genetic variability will result.

Reducing the area of suitable habitat for wild felids through forest clearance and fragmentation also draws human and cat populations into ever closer proximity and consequently wild cats will be increasingly exposed to anthropogenic threats. These will comprise, but are not limited to, increased hunting activities, including both direct hunting of felids and hunting of wild cat prey; disease transmission from populations of feral cats and dogs; predation upon wild cats by feral dogs; pollution of water sources (this is particularly relevant to flat-headed cats) and an increased incidence of road traffic accidents.

Given the extremely large areas of forest required to support healthy, viable populations of Sunda clouded leopards they are increasingly imperilled by habitat loss and fragmentation. Within Sabah there is no single block of *totally protected* forest large enough to support a sustainable population of clouded leopards. Therefore, healthy and viable populations of Sunda clouded leopards and, indeed the other felid species, rely on a matrix of totally protected areas and commercial forest reserves. The Yayasan Sabah Forest Management Area is the largest contiguous block of forest in Sabah and as such is likely instrumental in the conservation and future persistence of these species. However even this large block of forest may only contain around 400 clouded leopards (Hearn *et al.*, *in litt.* – this study). In this area marbled cats, bay cats and flat-headed cats were recorded less frequently than clouded leopards (Ross *et al.*, *in litt.* – this study) which may indicate even lower population densities and a consequent need for even larger tracts of forest.

On a more positive note, in Sabah this process of large scale forest conversion is now coming to an end, and large tracts of forest are still remaining and although it is probable that the consequences of this forest loss to Sabah's wild felid populations will never become fully clear (Hearn *et al.*, 2010b) the remaining forests of Sabah are likely to be vital for the future conservation of wild cats in Borneo.



## 4.2 Hunting and trade



**Figure 32.** Poachers photographed by camera trap. Where old logging roads allow access in to the forest, a common method of poaching is to use a vehicle and a high-powered torch, which picks out the eye-shine of any animals close by.

Historically and traditionally wild cats have been highly prized for their fur and in many cultures around the world cat pelts are worn by the tribal elite as symbols of status and power (Nowell and Jackson, 1996) and used for ceremonial purposes. Cat pelts legally used in the fur trade are entirely from wild caught rather than farmed animals and have a higher commercial value than pelts from other species. Illegal hunting for cat pelts has the potential to be one of the fastest and most destructive threats to wild cat populations; this illegal trade is worst in Asia with tigers being particularly targeted (Nowell and Jackson, 1996). The uncontrolled hunting of, and trade in big cats, especially tigers, leopards, jaguars and

snow leopards was one of the primary reasons for the establishment of CITES in 1975.

The threat to wild felids from illegal hunting for pelts appears to be much greater than that for food; however, clouded leopards have been featured on the menus of restaurants that cater to wealthy Asian tourists (Nowell and Jackson, 1996).

The use of felid body parts in traditional medicines is very much focused on the tiger, the bones of which can be sold for much higher prices than the skins. Other Asian felids are also targeted for this trade and bones of leopard, snow leopard, clouded leopard, golden cat and leopard cat are sold as substitutes for tiger bones (Tan, 1987). It can only be assumed that as the tiger becomes increasingly scarce across its range and prices for body parts consequently rise, other cats will become more highly persecuted to fulfil this demand.

Borneo is an incredibly diverse island in terms of demography and there is a consequent diversity in traditional use of wild cats. In Sarawak the demography includes a high proportion of rural dwelling people and there is a relatively high number of villages in the interior with consequently a high dependence on, and use of, forest products and animals. In the past clouded leopards were highly sought after by the indigenous ethnic groups in Sarawak; their canine teeth were used as ear ornaments and their pelts were used as ceremonial coats and as floor mats for seating (Rabinowitz *et al.*, 1987). A comprehensive social survey conducted by Caldecott (1988) in Sarawak concluded that although clouded leopards can easily become extinct locally due to hunting pressure, the level of hunting at that time posed no great threat to clouded leopard populations. Kalimantan also has a relatively high proportion of the population living in the interior and, traditionally, clouded leopard pelts and teeth are used in a similar manner to that in Sarawak (Rustam *pers. comm.*). Traditional use of the smaller cats is often not mentioned in the literature; however, bay cat fur has been seen in Dayak ceremonial hats in north-east Kalimantan (Nowell and Jackson, 1996).

The situation in Sabah is rather different in that the human population is largely concentrated in coastal towns and villages, with relatively few interior villages. Rabinowitz *et al.* (1987) found that although hunters in Sabah would shoot clouded leopards on sight there was no market for skins or

body parts. Another, more recent, survey conducted within a community of Buayan-Kionop in the Crocker Range National Park, Sabah, reported similar findings. Although people in this area had, on occasion, killed and eaten clouded leopards and leopard cats, these species were not specifically targeted, rather they were shot opportunistically. There also did not appear to be any tradition of using cat body parts for medicinal purposes (Murphy, 2007; Murphy pers. comm.). Another much smaller, pilot survey in Eastern Sabah revealed a similar pattern. Although local people were aware of animals being hunted there was no evidence from this survey that any of the cat species were directly targeted for any reason (Ross *et al.*, in litt. – this study). While wild cats do not appear to be directly targeted by hunters in Sabah, it should be noted that wherever snares are used for hunting there exists a threat of trapping wild cats in snares set for other species.

Although pressure on wild populations from hunting and trade appears to be less in Sabah than elsewhere in Borneo, the international demand remains and trade routes exist from Borneo to elsewhere in Southeast Asia; therefore there is the potential for the future exploitation of Sabah populations.

### **4.3 Key Conclusions**

#### **4.3.1 Habitat loss**

- *At current rates of deforestation, it is projected that by 2020 less than one third of Borneo will be covered by tropical rainforest.*
- *The rate of forest loss in Kalimantan is higher than for the rest of the island and illegal logging confounds the problem*
- *The situation in Sabah is more positive with 59% still being forested and 41% of the land being under some form of legal protection.*
- *Fire is not a natural part of forest processes in Borneo and as a result forest fires can be extremely destructive and is aggravated by logging as this disturbs the forest structure and allow the forest to dry.*
- *All Bornean felids with the exception of the leopard cat appear to be forest dependent and therefore forest clearance and fragmentation is detrimental to wild cat populations*
- *All five species of wild cat have been recorded in logged forest, however the degree of modification that can be tolerated by each species remains unclear*
- *Only leopard cats appear to utilise oil palm plantations to any great extent; however, population densities or habitat use of leopard cats in the centre of very large plantations is still unknown*
- *Within Sabah there is no single block of totally protected forest large enough to support a sustainable population of 500, or even of 250 clouded leopards. Therefore, healthy and viable populations of Sunda clouded leopards and, indeed the other felid species, rely on a matrix of totally protected areas and commercial forest reserves.*
- *Within Sabah the process of large scale forest conversion is now coming to an end; with large tracts of forest still remaining, Sabah is likely to be instrumental in the continued persistence of wild cat populations in Borneo.*

#### 4.3.2 Hunting and trade

- *Traditionally some ethnic groups of Borneo have targeted clouded leopards for their canine teeth and pelts, and possibly some of the other wild cats also.*
- *However, this threat varies greatly across the island and is probably lowest in Sabah where it appears that there is little or no direct, targeted hunting of clouded leopards or the smaller wild cats.*
- *However, throughout Borneo and including Sabah, wild cats will be caught in snares set for other animals, killed through fear or in retribution for taking domestic livestock.*
- *In mainland Southeast Asia clouded leopard bones are sold as substitutes for tiger bones, it is likely that as the tiger becomes scarcer, other felids will become more highly persecuted to fulfil the demand.*
- *There currently does not appear to be trade in clouded leopards or other wild cats from Borneo to mainland Southeast Asia, however the international demand is clearly evident and trade routes exist between Borneo and the mainland the future exploitation of Bornean populations is a concern.*



## PART V

### FUTURE DIRECTIONS

#### RECOMMENDED ACTIONS AND PRIORITY RESEARCH

##### 5.1 Recommended actions

A number of key actions were identified by the delegates of the Bornean Wild Cat Workshop, held in November 2009 (Hearn *et al.*, 2009). The following table summarises the main threats to the future of wild cats in Sabah discussed during this workshop and the mitigating actions identified to help combat each threat.

Threat	Affected species	Suggested mitigating actions <sup>1</sup>
Habitat loss	CL, MC, BC, FHC to a lesser extent LC	Aim to maintain large <sup>2</sup> tracts of forest, encourage enrichment planting of logged areas. Although logged forest is not a substitute for primary forest it should be promoted as a valuable conservation resource
Habitat fragmentation	Primarily CL, also MC, BC, FHC, LC	Promote the maintenance of habitat corridors, re-establish corridors between isolated, but otherwise viable, forest patches
Genetic isolation	Primarily CL	Promote the maintenance of habitat corridors, re-establish corridors between isolated, but otherwise viable, forest patches
Direct hunting	Possibly CL in some areas	Educate local people
Hunting and/or fishing of cat prey	CL, FHC	Educate local people, enforce existing hunting regulations, increase anti-poaching patrols in key areas, ensure access to forest reserves is restricted
Lack of education and understanding among local people	CL, MC, BC, FHC, LC	Design and implement a structured education programme
Lack of knowledge regarding the ecological requirements of wild cats	CL, MC, BC, FHC, LC	Encourage further research
Lack of knowledge regarding key areas of importance for wild cat conservation	CL, MC, BC, FHC, LC	Encourage further research with a specific emphasis on identifying areas crucial to the future persistence of wild cats
Water pollution (e.g. run-off from plantations)	Primarily FHC	Educate plantation managers, implement a water quality monitoring programme
Conflict with local people e.g. retribution killing	CL, possibly LC	Implement a structured education programme, respond quickly to local people's concerns regarding potential problem animals
Cross-breeding with domestic cats	LC	Educate local people, control the numbers of feral domestic cats
Being killed by domestic dogs	Primarily LC, also CL, MC, BC, FHC	Educate local people, control the number of feral dogs
Road traffic accidents	Primarily LC, also CL, MC, BC, FHC	Restrict development of settlements and roads in key areas

**Table 6.** Summary of threats and recommended mitigating actions.

CL = clouded leopard, MC = marbled cat, BC = bay cat, FHC = Flat-headed cat, LC = leopard cat

<sup>1</sup> These are the suggested mitigating actions for each identified threat, and represent an ideal to aim for; however, it is understood that sufficient and suitable resources may not always be available to alleviate each problem. In many cases collaboration with other departments or overseas partners may be appropriate.

<sup>2</sup> Our research suggests that to maintain a healthy clouded leopard population of 500 animals over the long term, contiguous forest areas of possibly over 10,000 km<sup>2</sup> are required.

## 5.2 Priority Research Needs

There is currently the need for the further camera trapping surveys into different habitats and different regions across Sabah. Conducted within a highly collaborative framework, these surveys should build upon existing information and will provide baseline information on status, community structure and ecology of Bornean felids. Information arising from such surveys should possibly be collated and held on an accessible database to avoid needless duplication of research and to assist researchers in the future in identifying priority research areas.

In conjunction with scientific research, social science research needs to focus on the attitudes and perceptions of local people and, if deemed necessary, the most productive way to alter these for the benefit of felid conservation. Future conservation strategies should be formed from an amalgamation of scientific and social studies to be as effective as possible.

### 5.2.1 Species specific research needs

There follows suggested projects for each of the five Bornean wild cats. These ideas are not all encompassing but merely provide an indication of some urgently required research. Most of the suggested projects will apply to all species and where this is the case the project titles are not repeated.

#### 5.2.1.1 Clouded leopard

Project 1: *The distribution and population density of Sunda clouded leopards across Sabah.\**

*Objectives:* To establish the population density of Sunda clouded leopard within different habitats and in areas under different management strategies; to identify areas critical for Sunda clouded leopard conservation and to determine the most effective management strategies for the species.

Project 2: The home range size, movements and habitat use of Sunda clouded leopards across Sabah.

*Objectives:* To determine the home range size of Sunda clouded leopards and to evaluate the relative importance of different habitats to this species within Sabah.

Project 3: The genetic status of Sunda clouded populations in Sabah.

*Objectives:* To determine if habitat fragmentation is resulting in genetically isolated populations of Sunda clouded leopard, to assess the seriousness of this problem and to identify priority areas to attempt to rectify the situation.

#### 5.2.1.2 Marbled cat

Projects 1-3 proposed for the Sunda clouded leopard are also relevant to the marbled cat.

#### 5.2.1.3 Flat-headed cat

Projects 1-3, with a focus on the flat-headed cat, in addition:

Project 4: The effects of modification of riverine forests and agricultural run-off on the flat-headed cat.

*Objectives:* The flat-headed cat is very much dependent on extreme lowland forests and is closely associated with riverine habitats. Much of Borneo's lowland and riverine forest has been modified by settlements and agricultural development. This project aims to assess the effects that this modification has had on the flat-headed cat, in terms of distribution, habitat use and diet.

#### 5.2.1.4 Bay cat

Projects 1-3, with a focus on the bay cat.

#### 5.2.1.5 Leopard cat

Projects 1-3, with a focus on the leopard cat, in addition:

Project 5: Population density and habitat use of leopard cats in oil palm plantations in Sabah\*.

*Objectives:* To determine the population density of leopard cats within an oil palm dominated landscape and to evaluate the extent to which leopard cats utilise habitats in the centre of large plantations, far from the forest-plantation boundary.

### 5.2.2 General research topics

Project 6: Felid response to habitat modification in Sabah\*

*Objectives:* To evaluate the extent to which felid populations of all five species are affected by habitat modification arising from timber harvesting and conversion to oil palm, agricultural and timber plantations; to propose recommendations to minimise negative impacts.

Project 7: The identification of areas crucial to the future conservation of wild felids in Sabah\*

*Objectives:* With a focus on each species of wild cat, to identify and evaluate the conservation value of each protected forest area in Sabah.

Project 8: The dietary requirements of the Bornean felids and the possible consequent effects of hunting and fishing on wild felid populations.

*Objectives:* This project aims to assess the dietary needs of the Bornean wild cats. Once the principal prey species are known it will be possible to evaluate the effects of hunting and fishing of these species on wild felid populations.

Project 9: Local communities' perceptions towards, and awareness of, the Bornean wild cats

*Objectives:* This project will be interview based and will assess local people's knowledge of each of the Bornean wild cat species in terms of ecology and conservation needs. Perceptions in terms of local abundance, diet and level of danger or conflict posed by each species will also be investigated. Traditional use of, and folklore regarding, each species will also be evaluated.

\*Ongoing research projects.

### 5.3 Capacity building

It is imperative that the next generation of conservation biologists are motivated and receive adequate training in order for the SWD to have sufficient human capacity to ensure these mitigating actions are implemented and relevant research conducted.

## REFERENCES

- Anonymous. 1996. Marbled, golden and flat-headed cats photographed in Sumatra. *Cat News* 25: 19-20.
- Austin, S.C., Tewes, M.E., Grassman, L. I. and Silvy, N.J. 2007. Ecology and conservation of the leopard cat *Prionailurus bengalensis* and clouded leopard *Neofelis nebulosa* in Khao Yai National Park, Thailand. *Acta Zoologica Sinica* 53 (1): 1-14.
- Augeri, D. 2005. On the biogeographic ecology of the Malayan sun bear. PhD thesis. University of Cambridge.
- Azlan, M.J., Lading, E. and Munau. 2003. Bornean bay cat photograph and sightings. *Cat News* 39:2.
- Bezuijen, M. 2003. The flat-headed cat in the Merang river region of south Sumatra. *Cat News* 38: 26-27.
- Bezuijen, M. R. 2000. The occurrence of the flat-headed cat *Prionailurus planiceps* in south-east Sumatra. *Oryx* 34: 222-226.
- Bricknell, S. 2003. Bay cat sightings in Kalimantan. Central Kalimantan. *Cat News* 39: 3
- Buckley-Beason, V. A., Johnson, W. E., Nash, W. G., Stanyon, R., Menninger, J. C., Driscoll, C. A., Howard, J., Bush, M., Page, J. E., Roelke, M. E., Stone, G., Martelli, P. P., Wen, C., Ling, L., Duraisingam, R. K., Lam, P. V. and O'Brien, S. J. 2006. Molecular Evidence for Species-Level Distinctions in Clouded Leopards. *Current Biology* 16: 2371-2376.
- Caldecott, J., 1988. Hunting and wildlife management in Sarawak, IUCN, Gland, Switzerland and Cambridge, UK. 172 pp.
- Davis, D.D. 1962. Mammals of the lowland rainforest of North Borneo. *Bulletin of the Singapore Natural History Museum* 31: 1-129.
- Dinets, V. 2003. First photo of a bay cat in the wild? *Cat News* 38: 14.
- Edwards, D.P., Answell, F.A., Ahmad, A., Nilus, R., and Hamer, K. 2009. The Value of Rehabilitating Logged Rainforest for Birds. *Conservation Biology*, 23: 6, 1628-1633.
- Eisenberg, J.F. 1981. The mammalian radiations: an analysis of trends in evolution, adaptation and behaviour. University of Chicago Press, Chicago.
- Eizirik, E., Johnson, W.E. and O'Brien, S. J. Submitted. Molecular systematics and revised classification of the family Felidae (Mammalia, Carnivora). *Journal of Mammalogy*.
- Grassman, L.I., Tewes, M., Silvy, N.J., Kreetiyutanont, K. 2005a. Spatial organization and diet of the leopard cat *Prionailurus bengalensis* in north-central Thailand. *Journal of zoology*, 266: 45-54.
- Grassman, L.I., Tewes, M., Silvy, N.J., Kreetiyutanont, K. 2005b. Ecology of three sympatric felids in a mixed evergreen forest in north-central Thailand. *Journal of Mammalogy* 86(1): 29-38.
- Groves, C.P. 1982. Cranial and dental characteristics in the systematics of Old World Felidae. *Carnivore* 5(2): 35-46.

- Groves, C.P. 1997. Leopard-cats, *Prionailurus bengalensis* (Carnivora: Felidae) from Indonesia and the Philippines, with the description of two new species. *Zeitschrift für Säugetierkunde* 62: 330 pp.
- Guggisberg, C.A.W. 1975. *Wild Cats of the World*. David and Charles, London, UK.
- FAO. 2007. *State of the world's forests*. United Nations Food and Agriculture Organization, Rome, Italy.
- Harrison, J. 1974. *An introduction to the mammals of Singapore and Malaya*. Malayan Nature Society, Singapore.
- Hazebroek, H.P. and Abang Kasim bin Abang Morshidi. 2000. *National Parks of Sarawak*. Natural History publication (Borneo) Kota Kinabalu 502 p.
- Hearn, A. J. 2003. Bay cat sightings in Kalimantan. West Kalimantan. *Cat News* 39: 3
- Hearn, A. J., Ross, J., Pamin, D. and Macdonald, D. W. 2007. Factors affecting guild composition of wild felids in pristine and logged tropical forest in Sabah, Malaysia: a camera-trapping study. In: J. Hughes and R. Mercer (eds), *Felid biology and conservation conference 17-20 September 2007 Abstracts*, pp. 108. WildCRU, Oxford, UK.
- Hearn, A., Sanderson, J., Ross, J., Wilting, A. & Sunarto, S. 2008a. *Prionailurus planiceps*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <[www.iucnredlist.org](http://www.iucnredlist.org)>. Downloaded on 25 May 2010.
- Hearn, A., Sanderson, J., Ross, J., Wilting, A. & Sunarto, S. 2008b. *Pardofelis badia*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <[www.iucnredlist.org](http://www.iucnredlist.org)>. Downloaded on 25 May 2010.
- Hearn, A., Sanderson, J., Ross, J., Wilting, A., Sunarto, S., Ahmed Khan, J., Kukherjee, S. & Grassman, L. 2008c. *Pardofelis marmorata*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <[www.iucnredlist.org](http://www.iucnredlist.org)>. Downloaded on 25 May 2010.
- Hearn, A., Sanderson, J., Ross, J., Wilting, A. & Sunarto, S. 2008d. *Neofelis diardi*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. <[www.iucnredlist.org](http://www.iucnredlist.org)>. Downloaded on 26 May 2010.
- Hearn, A.J. Ross, J. Goosens, B., Ancrenaz, M. and Ambu, L. 2010a. Observations of flat-headed cat in Sabah, Malaysian Borneo. *Cat News* 52: 15-16.
- Hearn, A., Ross, J., Bernard, H., & Tuuga, A., & Secoy, K. 2010b. First steps towards the conservation of wild cats in Sabah. Report of the inaugural workshop on the Bornean Wild Cats. Global Canopy Programme, Oxford, UK.
- Hemmer, H. 1976. Gestation period and postnatal development in felids. Pp 143-165 in R.L. Eaton, ed. *The World's cats 3: contributions to breeding, biology, behaviour and husbandry*. Carnivore Research Institute, University of Washington, Seattle.
- Holden, J. 2001. Small cats in Kerinci Seblat National Park, Sumatra, Indonesia. *Cat News* 35: 11-14.
- Hose, C. 1893. *Mammals of Borneo*. British Museum of Natural History, London, UK.

Hutujulu, B., Sunarto, Klenzendorf, S., Supriatna, J., Budiman, A. and Yahya, A. 2007. Study on the ecological characteristics of clouded leopard in Riau, Sumatra. In: J. Hughes and M. Mercer (eds.), Felid Biology and Conservation Conference 17-20 September 2007 Abstracts, pp. 122. WildCRU, Oxford, UK.

Izawa, M. 1991. Ecological study on the two species of Felidae in Japan. In N. Maruyama *et al.*, eds. Wildlife Conservation: present trends and perspectives for the 21<sup>st</sup> century. Proceedings V international congress of ecology. Yokohama, Japan.

Izawa, M., Doi, T., Okamura, M., Nakanishi, N., Murayama, A., Hiyama, T., Oh, D., Teranishi, A. and Suzuki, A. 2007. Toward the survival of two endangered felid species of Japan. In: J. Hughes and R. Mercer (eds.), Felid biology and conservation conference 17-20 September: Abstracts, pp. 120-121. WildCRU, Oxford, UK.

IUCN. 2009. The IUCN Red List of Threatened Species. Version 2010.1. <http://www.iucnredlist.org>. Downloaded on 25 May 2010.

Johns, A.D., 1989. Timber, the environment and wildlife in Malaysian rainforests. Final report to the Institute of Southeast Asian Biology, University of Aberdeen, Aberdeen, Scotland.

Johnson, W. E., Ashiki, F. S., Menotti Raymond, M., Driscoll, C., Leh, C., Sunquist, M., Johnston, L., Bush, M., Wildt, D., Yuhki, N., O'Brien, S. J. and Wasse, S. P. 1999. Molecular genetic characterization of two insular Asian cat species, Bornean Bay cat and Iriomote cat. Evolutionary Theory and Process: Modern perspectives, Papers in Honour of Eivatar Nevo, pp. 223. Kulwer Academic Publisher.

Karanth, K. U., & Nichols, J. D. 1998. Estimation of tiger densities in India using photographic captures and recaptures. Ecology, 79: 2852-2862.

Kitchener, A. C., Richardson, D. and Beaumont, M. A. 2007. A new old clouded leopard. Cat News 46: 26-27.

Lekagul, B. and McNeely, J.A. 1977. Mammals of Thailand. Association for the conservation of wildlife, Bangkok, Thailand.

Leyhausen, P. 1979. Cat behaviour: the predatory and social behaviour of domestic and wild cats. Garland, New York. English translation: B.A. Tonkin.

Masuda, R. and Yoshida, M. C. 1995. Two Japanese wildcats, the Tsushima cat and the Iriomote cat, show the same mitochondrial DNA lineage as the leopard cat *Felis bengalensis*. Zoological Science 12: 655-659.

Medway, G. 1965. Mammals of Borneo: field keys and an annotated checklist. Royal Asiatic Society. Kuala Lumpur, Malaysia.

Medway, G. 1978. The wild mammals of Malaya (Peninsular Malaysia) and offshore islands including Singapore. 2<sup>nd</sup> edition. Oxford University Press, Kuala Lumpur, Malaysia

Meijaard, E. 1997. The bay cat in Borneo. Cat News 27: 21-23.

Meijaard, E. 2004. Biogeographic history of the Javan leopard *Panthera pardus* based on a craniometric analysis. Journal of Mammalogy 85: 302-310.



- Meijaard, E., Prakoso, B.B. and Azis. 2005. A new record for the Bornean bay cat. *Cat News* 43: 23-24.
- Meijaard, E., Sheil, D. and Daryono. 2005. Flat-headed cat record in east Kalimantan. *Cat News* 43: 24.
- Meijaard, E., Sheil, D., Nasi R., Augeri D., Rosenbaum, B., Iskandar, D., Setyawati, T., Lammertink, M., Rachmatika, I., Wong A., Soehartono, T., Stanley, S. and O'Brien, T. 2005. Life after logging: Reconciling wildlife conservation and production forestry in Indonesian Borneo. CIFOR and UNESCO, Jakarta, Indonesia.
- Mishra, C., Madhusudan, M.D. and Datta, A. 2006. Mammals of the high altitudes of western Arunachal Pradesh, eastern Himalaya: An assessment of threats and conservation needs. *Oryx* 40: 29-35.
- Mohamed, A., Samejima, H. and Wilting A. 2009. Records of five Bornean cat species from Deramakot Forest Reserve in Sabah, Malaysia. *Cat News* 51: 14-17.
- Mohamed, A. and Wilting A. 2009. Can commercial forest reserves contribute to the conservation of Bornean felids? In: A. J. Hearn; J. Ross; H. Bernard; A. Tuuga and K. Secoy (eds.), *First Steps Towards the Conservation of Wild Cats in Sabah. Report of the Inaugural International Workshop on the Bornean Wild Cats. Abstracts*, p. 16. Global Canopy Programme, Oxford, UK.
- Murphy, A. 2007. An Evaluation of Subsistence Hunting in the Community of Buayan-Kionop, Sabah. Final Report to the Rufford Foundation.
- Muul, I. and Lim, B.L. 1970. Ecological and morphological observations of *Felis planiceps*. *Journal of Mammalogy* 51(4): 806-808.
- Nowell, K. and Jackson, P. 1996. Wild Cats. Status Survey and Conservation Action Plan. IUCN/SSC Cat Specialist Group, Gland, Switzerland and Cambridge, UK.
- Pocock, R.I. 1932. The marbled cat (*Pardofelis marmorata*) and some other Oriental species, with the definition of a new Genus of the Felidae. *Proceedings of the zoological society of London* 1932: 741-766.
- Pocock, R.I. 1939. The fauna of British India, Mammalia, I. Primates and carnivore 2<sup>nd</sup> edition. Taylor and Francis, London.
- Prater, S.H. 1971. The book of Indian mammals. 3rd edition. Bombay Natural History Society, Bombay, India.
- Prater, T., Thomas, W.D., Jones, M. and M. Dee. 1988. A twenty-year overview of selected rare carnivores in captivity. Pp 191-229 in B. Dresser, R. Reece and E. Maruska, eds. *Proceedings of the 5<sup>th</sup> world conference on breeding endangered species in captivity*. Cincinnati, Ohio.
- Payne, J., Francis, C.M. and Philips K. 1998. A field guide to the mammals of Borneo. The Sabah Society, Malaysia.
- Rabinowitz, A. 1990. Notes on the behaviour and movements of leopard cats, *Felis bengalensis*, in a dry tropical forest mosaic in Thailand. *Biotropica* 22 (4): 397-403.
- Rabinowitz, A. 1993. Estimating the Indochinese tiger *Panthera tigris corbetti* population in Thailand. *Biological Conservation* 65: 213-217.

- Rabinowitz, A. Andau, P. and Chai, P.P.K. 1987. The clouded leopard in Malaysian Borneo. *Oryx* 21(2): 107-111.
- Rajaratnam, R., Sunquist, M., Rajaratnam, L. and Ambu, L. 2007. Diet and habitat selection of the leopard cat *Prionailurus bengalensis* in an agricultural landscape in Sabah, Malaysian Borneo. *Journal of Tropical Ecology* 23: 209-217.
- Rautner, M., Hardiono, M., and Alfred, R. J. 2005. Borneo: Treasure Island At Risk. Status of Forest, Wildlife and Related Threats on the Island of Borneo. WWF Germany, Frankfurt am Main.
- Roberts, T.J. 1977. The mammals of Pakistan. Ernest Benn, London.
- Sanderson, J., Sunarto, S., Wilting, A., Driscoll, C., Lorica, R., Ross, J., Hearn, A., Mujkherjee, S., Ahmed Khan, J., Habib, B. and Grassman, L. 2008. *Prionailurus bengalensis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1.
- Santiapillai, C. and Suprahman, H. 1985. On the status of the leopard cat in Sumatra. *Tigerpaper* 10(3): 8-13.
- Sunquist, M. and Sunquist F., 2002. Wild cats of the world. The University of Chicago Press, Chicago and London.
- Sunquist, M., Leh, C., Sunquist, F., Hills, D.M. and Rajaratnam, R. 1994. Rediscovery of the Bornean bay cat. *Oryx* 28 (1): 67-70.
- Tan, B. 1987. Current status of Chinese tigers. *Cat News* 6: 7-10.
- van Schaik, C. P., M. Griffiths, M. 1996. Activity periods of Indonesian rain forest mammals. *Biotropica*. 28(1): 105-112.
- Wilting, A., Fischer, F., Bakar, S.A. and Linsenmair, K. E. 2006. Clouded leopards, the secretive top-carnivore of South-East Asian rainforests: Their distribution, status and conservation needs in Sabah, Malaysia. *BMC Ecology* 6: 16.
- Wilting A., Buckley-Beason, V.A., Feldhaar, H., Gadau, J., O'Brien, S. J. and Linsenmair, S. E. 2007a. Clouded leopard phylogeny revisited: support for species and subspecies recognition. *Frontiers in Zoology* 4: 15.
- Wilting, A., Feldhaar, H., Buckley-Beason, V.A., Linsenmair, K.E. and O'Brien, S. J. 2007b. Two modern species of clouded leopards: a molecular perspective. *Cat News* 47: 10-11.
- Wilting, A., Cord, A., Hearn, A.J., Hesse, D., Mohamed, A., Traeholdt, C., Cheyne S.M., Sunarto Sunarto, Mohd-Azlan J., Ross, J., Shapiro, A.C., Sebastian, A., Dech, S., Breitenmoser, C., Sanderson, J., Duckworth, J.W., Hofer, H., 2010. Modelling the species distribution of flat-headed cats (*Prionailurus planiceps*), an endangered South-East Asian small felid. *PLoS ONE*.
- Yamada, J.K. and Durrant B.S. 1989. Reproductive parameters of clouded leopards (*Neofelis nebulosa*). *Zoo Biology*. 8: 223-2312.
- Yasuda M, Matsubayashi H, Rustam, Numata S, Rafiah J.A.S., *et al.* 2007. Recent Cat Records by Camera Traps in Peninsular Malaysia and Borneo. *Cat News* 47: 12–14.

## APPENDICES

### FULL SPECIES ACCOUNTS



## APPENDIX I

### LEOPARD CAT, *PRIONAILURUS BENGALENSIS* (KERR, 1792)



*The leopard cat*

#### Other names

Bengal cat (English); chat léopard du Bengale (French); Bengalkatze (German); gato Bengali, gato de Bangala (Spanish); chita biral, ban biral (Bangladesh); jin chien mao, bao mao, shih hu, shan mao (Chinese); psk janglely (Dari: Afghanistan); kucing batu, kucing congkok (Indonesia); chita billi (India, Pakistan); nam laniao (Kachin); huli bekku (Kannada: India); kla hla (Karen, Talain); sua meo, sua pa, sua nak (Laos); wagati (Mahratti, Ghats: India); kucing batu, rimau akar (Malaysia); kye thit, thit kyuk, kya

gyuk (Myanmar); maral, tamaral (Philippines); Amurskii kot, bengalskaya koshka (Russia); hen wap (Shan); maew dao (Thailand) (Nowell and Jackson, 1996).

#### Biology

**Birth Season:** In the northern part of their range breeding takes place once a year, in February or March (Roberts, 1977; Prater, 1971); however in the tropics breeding can take place year-round (Lekagul and McNeely, 1977; Santiapillai and Suprahman, 1985; Gao et al. 1987 cited in Nowell and Jackson, 1996).

**Estrus:** Unknown

**Estrus cycle:** Unknown

**Gestation:** In captivity, 56 – 70 days (Nawa, 1968, cited in Nowell and Jackson, 1996; Hemmer, 1976).

**Litter size:** 1 – 4, but usually 2 – 3 (Eisenberg 1981); however, 8 has been recorded (Heptner and Sludskii, 1972 cited in Nowell and Jackson, 1996).

**Age at sexual maturity:** In captivity 8 months.

**Longevity:** In captivity up to 15 years.

#### Description and Behaviour

There is great geographical variation in the pelage of the leopard cat. In the tropics, the most southern part of their range, they tend to be yellowish-brown, while in the northern part of their range they tend to be grey-brown (Pocock, 1939; Gao et al., 1987 cited in Nowell and Jackson, 1996).). The pelage is covered with solid black spots or black rosettes; the tail is relatively short and is banded with black rings. There is also geographical variation in the size of leopard cats; those in the north are larger, with individuals weighing up to 7.0 kg (Heptner and Sludskii, 1972 cited in Nowell and Jackson, 1996). Elsewhere males weigh 2.5 – 3.5 kg and females 1.6 – 2.6 kg (Rabinowitz, 1990; Grassman et al., 2005a; Hearn et al., in litt. – this study). Leopard cats on Borneo are smaller than those from mainland South East Asia (Hearn et al., in litt. – this study) although within any given part of their range males are larger than females. The diet of leopard cats is comprised principally of rodents (Rabinowitz, 1990; Grassman et al., 2005a); however, depending on geographical location they will also take young ungulates, hares, birds, reptiles, insects, eels and fish

(Heptner and Sludskii, 1972 cited in Nowell and Jackson 1996; Santiapillai and Suprahman, 1985; Gao et al., 1987 cited in Nowell and Jackson, 1996). Leopard cats are predominantly nocturnal although they also show some diurnal activity (Rabinowitz, 1990; Grassman et al., 2005a; Austin et al., 2007; Ross et al., in litt. – this study).

The taxonomic status of the leopard cat is controversial. There is currently one subspecies recognised in mainland Asia, *P. b. bengalensis* (Kerr, 1792) (Groves, 1997) and five island subspecies have been proposed: *P. b. borneoensis* Brongersma, 1936: Borneo; *P. b. heaneyi* Groves, 1997: Palawan island, Philippines; *P. b. javanensis* (Desmarest, 1816): Java and Bali; *P. b. rabori* Groves, 1997: Negros, Cebu and Panay islands, Philippines and *P. b. sumatranus* (Horsfield, 1821): Sumatra and Tebingtinggi Island. In addition, based on genetic evidence, the Iriomote cat *P. b. iriomotensis* found on Japan's Iriomote Island is now considered to be a subspecies of leopard cat rather than a distinct species (Masuda and Yoshida, 1995; Johnson et al., 1999).

### Habitat and Distribution

The leopard cat is found in a wide variety of habitats from tropical rainforest to temperate broadleaf forest; also shrub forest and successional grasslands (Heptner and Sludskii, 1972 cited in Nowell and Jackson, 1996; Lekagul and McNeely, 1977; Santiapillai and Suprahman, 1985). The leopard cat has been recorded as high as 3,000 m altitude in the Himalayas (Habibi, 1977; cited in Nowell and Jackson, 1996 Feng et al. 1986 cited in Nowell and Jackson, 1996), although its northern boundary appears to be limited by snow cover as it is not found where snow is more than 10 cm deep (Formozov, 1946 cited in Nowell and Jackson, 1996). They generally avoid arid areas and are usually found in fairly close proximity to water (Gao et al. 1987 cited in Nowell and Jackson, 1996). Although not arboreal in the true sense of the word, leopard cats will climb trees and in Thailand one was radio-located resting in a tree at a height of over 20 m (Rabinowitz, 1990). Leopard cats occur in both primary and logged forest and also agricultural and forest plantations (Harrison, 1974; Santiapillai and Suprahman, 1985). It has been speculated that secondary forest may be preferred to primary forest (Santiapillai and Suprahman, 1985). Indeed, recent camera trapping in Danum Valley Conservation Area, Palum Tambun Watershed Reserve, Ulu Segama Forest Reserve, Malua Forest Reserve, an oil palm plantation and Tabin Wildlife Reserve all in Sabah, Malaysian Borneo revealed a positive correlation between leopard cat numbers and level of habitat disturbance, with the highest number of leopard cats being recorded in an oil palm plantation, followed by logged forest and the lowest number being recorded in primary forest (Ross et al., in litt. – this study).

Few data exist regarding leopard cat home ranges. A radio telemetry study in Japan reported average ranges of 0.83 km<sup>2</sup> for five males and one female (Izawa et al. 1991). In Thailand, two radio-tracking studies found ranges of 1.5 – 7.5 km<sup>2</sup> (Rabinowitz, 1990; Grassman et al. (2005a) recorded average ranges (95% MCP) of 12.4 km<sup>2</sup> (males) and 14 km<sup>2</sup> (females). In Sabah ranges of approximately 3.0 km<sup>2</sup> (Rajaratnam et al., 2007; Hearn et al., in litt. – this study) have been reported.

The leopard cat is native to Afghanistan; Bangladesh; Bhutan; Brunei Darussalam; Cambodia; China; Hong Kong; India; Indonesia (Java, Kalimantan, Sumatera); Japan (Nansei-shoto); Korea, Democratic People's Republic of; Korea, Republic of; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Pakistan; Philippines; Russian Federation; Singapore; Taiwan, Province of China; Thailand; Viet Nam. Its presence in Macao is uncertain (Sanderson et al. 2008).

### Sabah

In Sabah the leopard cat has been recorded in many areas including Danum Valley Conservation Area, Ulu Segama Forest Reserve, Malua Forest Reserve, Tabin Wildlife Reserve (Ross et al., in litt. –



this study), Deramakot Forest Reserve (*Mohamed et al., 2009.*), and Tangkulap Forest Reserve (*Mohamed and Wilting, 2009.*).

### **Population Status**

The IUCN class the leopard cat as Least Concern (*Sanderson et al., 2008*) however some island populations are threatened by habitat loss. It has possibly become extinct on Cebu which is largely deforested and likely extirpated from most of its former range on other islands of the Philippines that have also suffered from deforestation (*Oliver 1993 cited in Nowell and Jackson, 1996*). In the 1960's there were an estimated 200 – 300 individuals on the Tsushima islands; this population has decreased over the last 30 – 40 years (*Izawa et al., 2007*) and now there are thought to be less than 100 (*Izawa, 1991*). However the species is stable in many areas and appears to thrive in some altered habitats (*Sanderson et al., 2008*).

### **Protection Status**

In 1994 leopard cat populations were downlisted to CITES Appendix II for all range countries with the exceptions of Bangladesh, India and Thailand whose populations are on CITES Appendix I. Leopard cats are protected at the national level over part of their range; hunting is prohibited in Bangladesh, Cambodia, Hong Kong, India, Indonesia, Japan, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Russia, Thailand and Taiwan, and hunting and trade regulations are in place in South Korea, Lao PDR and Singapore (*Nowell and Jackson 1996*). The species is on Afghanistan's 2009 Protected Species List, banning all hunting and trading of this species within the country. It is found in numerous protected areas (*Sanderson et al. 2008*).

### **Principal Threats**

Although the leopard cat appears to be relatively tolerant of habitat alteration, in comparison to other Asian felids it is not invulnerable as population declines, attributed to forest loss, on small islands have shown. There is also a higher level of mortality (e.g. being killed by vehicles or feral dogs) in such altered habitats (*Sanderson et al., 2008*). Commercial exploitation in the form of skins has been heavy in China, with Japan being the main consumer since Europe imposed an import ban on leopard cat skins in 1988. Although commercial trade is now much reduced, the leopard cat continues to be hunted throughout most of its range for fur, food and as pets. In addition, they are widely viewed as poultry pests and killed in retribution. Leopard cats can hybridize with domestic cats; this has been reported in the wild (*Heptner and Sludskii, 1972, cited in Nowell and Jackson, 1996*) but is not believed to pose a significant threat (*Sanderson et al. 2008*).



## APPENDIX II

### FLAT-HEADED CAT, *PRIONAILURUS PLANICEPS* (VIGORS AND HORSFIELD, 1827)



*The flat-headed cat*

#### Other names

Chat à tête plate (French); Flachkopfkatz (German); gato cabeciancho (Spanish); kucing hutan, kucing dampak (Indonesia); kucing hutan (Malaysia); gaung bya kyaung (Myanmar); maew pa hua baen (Thailand) (Nowell and Jackson, 1996).

#### Description and Behaviour

The flat-headed cat has a long snout and a flattened skull roof; its ears are small and set low on the head. The eyes are large and close-set which

gives good binocular vision; the upper pre-molars are larger and sharper than those of other cats (Groves, 1982). The claws are semi-retractable and the toes are more completely webbed than the fishing cats. These morphological adaptations suggest a semi-aquatic life-style, hunting slippery prey such as fish and frogs (Leyhausen, 1979). The pelage is thick and soft and is reddish-brown, tinged with grey; the top of the head is a brighter red (Nowell and Jackson, 1996). Flat-headed cats are very small with adults weighing as little as 1.5 kg (Muul and Lim 1970). The tail is very short, only 25-35% of head-body length (Yasuda and Alikodra, 1990; cited in Nowell and Jackson, 1996).

The diet consists largely of fish and frogs; the stomach contents of an adult shot in Malaysia contained only fish (Muul and Lim, 1970) and a male killed on a road in Kalimantan contained fish scales and shrimp shells. Although not observed often, in Borneo they are most frequently seen along riverbanks hunting fish and frogs (Rabinowitz, 1993). In captivity they will readily take live fish, carrying the prey some distance from the water before eating it, presumably a strategy to avoid aquatic prey escaping back into the water (Muul and Lim 1970). There is also some evidence that they may prey on small birds and may occasionally raid poultry (Guggisberg 1975).

The flat-headed cat is possibly nocturnal as all published observations of live animals have taken place at night or early morning (Nowell and Jackson 1996; Bezuken, 2000; 2003; Meijaard et al., 2005; Hearn et al., 2010a).

There are no data regarding population densities or home ranges of the flat-headed cat.

#### Biology

**Birth Season:** Unknown

**Litter size:** Unknown

**Estrus:** Unknown

**Age at sexual maturity:** Unknown

**Estrus cycle:** Unknown

**Longevity:** In captivity over 14 years

**Gestation:** In captivity approximately 56 days

## Habitat and Distribution

Much of what is known about the habitat preferences of the flat-headed cat has been deduced from absence records, historical information and incidental sightings. Most records for this species are from swampy areas, oxbow lakes and riverine forests. They have been recorded in both primary and logged forests, sightings from oil palm or other plantations are not confirmed. Although a historical record exists from 700 m in the Dulit Mountains in Sarawak (*Hose, 1893*) a recent study has revealed that over 80% of records since 1984 were from below 100 m altitude, suggesting that low-lying areas are preferred (*Wilting et al., 2010*). Flat-headed cats are not known north of the Isthmus of Kra (*Lekagul and McNeely, 1977*) and their distribution across their range is highly fragmented. In Sabah a camera trapping study which resulted in over 40,000 photographs of wildlife obtained only one record of the flat-headed cat from a disturbed area of the Palum Tambun Watershed Reserve close to Danum Valley Field Centre (*Ross et al. in litt. – this study*). However, additional camera trapping surveys in Sabah (*Mohamed et al., 2009*) and Kalimantan (*S. Cheyne pers. comm.*) have both reported higher photo-capture rates of this species, the former in the logged forest of Deramakot Forest Reserve and the latter in the logged peat swamp forests of Sebangau National Park.

### Sabah

In Sabah the flat-headed cat has been recorded from Tangkulap and Deramakot Forest Reserves, Palum Tambun Watershed Reserve, Kinabatangan Wildlife Sanctuary, Tabin Wildlife Reserve and Maliau Basin Conservation Area (*Wilting et al., 2010*).

The flat-headed cat is native to Brunei Darussalam; Indonesia (Kalimantan, Sumatera); Malaysia (Peninsular Malaysia, Sabah, Sarawak) and Thailand (*Hearn et al., 2008a*)

## Population Status

The flat-headed cat is listed as Endangered by the IUCN (*Hearn et al., 2008a*). The population is believed to be declining due to habitat loss, there are few records and it seems to have a localised distribution restricted to the extreme lowlands and around bodies of water.

## Protection Status

The flat-headed cat has been listed on CITES appendix I since 1975. The species is fully protected by national legislation over its range. Hunting and trade is prohibited in Indonesia, Malaysia, and Thailand (*Nowell and Jackson 1996*). It occurs in several protected areas including Berbak (*Bezuijen 2000*), Way Kambas (*Anon 1996*), Kerinci Seblat in Sumatra; the Danum Valley area (*Ross et al., in litt. – this study*), Tabin Wildlife Reserve (*Yasuda et al., 2007*) and Kinabatangan Wildlife Sanctuary in Sabah (*Hearn et al., 2010a*); Kutai and Kayan Mentarang National Parks (Wulfraat and Samsu 2000 cited in Nowell and Jackson, 1996) and Bukit Suharto Protection Forest in Kalimantan, and the Phru Tao Dang Peat Swamp Forest protected area in southernmost Thailand (*Nowell and Jackson 1996*). In Brunei it has been recorded from the Tasek Merimbun Heritage Park (*Yasuda et al. 2007*). It has not been recorded from any protected areas in Peninsular Malaysia (*Hearn et al., 2008a*).

## Principal Threats

Due to this cat's reliance on lowland forests and its close association with rivers, habitat loss has been detrimental in the past and continues to be a threat in the present. Low-lying areas are among the first to be modified by humans and, as such, the flat-headed cat has suffered greatly. In addition, water pollution caused by logging, agriculture and gold mining pose a serious threat through contamination of prey. The depletion of fish stocks due to over-exploitation is also considered to be a serious threat for this species (*Hearn et al., 2008a*).

## APPENDIX III

### BAY CAT, *PARDOFELIS BADIA* (GRAY, 1874)



*The bay cat*

#### Other names

Chat bai (French); Borneo-katze (German); gato rojo de Borneo (Spanish); kucing merah (Indonesia, Malaysia); kucing Kalimantan (Indonesia) (Nowell and Jackson, 1996).

#### Description and Behaviour

The bay cat has two colour phases one is a chestnut red and the other grey (Pocock 1932; Sunquist *et al.*, 1994). The ears are rounded and set low on the head; the backs of the ears are darker than the rest of the pelage.

Both colour phases have three darker stripes on the top of the head (Payne *et al.*, 1998). The tail is long, in one specimen 73% of head-body length (Sunquist *et al.*, 1994) and has a lighter coloured, whitish stripe down the ventral surface of the terminal half of the tail.

The bay cat is so little known that no healthy animals have ever been weighed. In 1992 a female bay cat captured by local trappers on the Sarawak-Kalimantan border was brought to the Sarawak museum. The cat weighed 1.95 kg and was so emaciated she died soon afterwards. It was estimated that she would have weighed 3 – 4 kg when healthy (Sunquist *et al.*, 1994).

There were no confirmed records of the bay cat between 1928 and 1992 (Sunquist *et al.*, 1994) and it was assumed by some to have become extinct in parts of Borneo (Hazebroek and Abang Kasim, 2000). However in more recent years an increased use of camera traps in Borneo are providing some insights into this mysterious cat. It was first photographed by a camera trap in 2003 (Azlan *et al.*, 2003).

From camera trapping data (Ross *et al.*, *in litt.* – this study), and observations (Hearn, 2003; Bricknell, 2003) the bay cat appears to be largely diurnal although several sightings have also been made at night. (Meijaard *et al.*, 2005; S. Wong *pers. comm.*).

There are no data regarding home range size or population density of the bay cat.

#### Biology

**Birth Season:** Unknown

**Litter size:** Unknown

**Estrus:** Unknown

**Age at sexual maturity:** Unknown

**Estrus cycle:** Unknown

**Longevity:** Unknown

**Gestation:** Unknown

## Habitat and Distribution

The bay cat is restricted to the island of Borneo and is Borneo's only endemic cat. Historical records are all from the highlands and most are from near rivers, although this may reflect collection bias (*Sunquist et al., 1994*). There is an unconfirmed sighting from 1,800 on Mount Kinabalu (*Payne et al., 1985*). It was thought that the bay cat was restricted to dense primary forest (*Hose, 1893*), but recently, several camera trap images (*Ross et al., in litt – this study; Mohamed, et al., 2009*) and sightings (e.g. *Hearn, 2003; Meijaard, 2005; S. Wong pers. comm. G. Reynolds pers. comm.*) have been made in logged forest, including the recently logged area of Malua Forest Reserve (*Ross et al. in litt. – this study*). However, the most comprehensive camera survey to date did record the bay cat more often in primary forest than logged forest (*Ross et al., in litt. – this study*).

The bay cat is known to occur in Indonesian and Malaysian Borneo, its presence is uncertain in Brunei (*Hearn et al., 2008b*).

## Sabah

In Sabah the bay cat has been recorded in Deramakot Forest Reserve (*Mohamed et al., 2009*) Danum Valley Conservation Area, Ulu Segama Forest Reserve, Malua Forest Reserve and Tabin Wildlife Reserve (*Ross et al. in litt. – this study*).

## Population Status

The bay cat is one of only six cats to be classed as endangered by the IUCN, with an effective population size which is believed to be below 2,500 mature individuals (*Hearn et al., 2008b*). The bay cat is often not recorded in faunal surveys relative to other, sympatric felids and is also unknown to some villagers, who were able to recognise the other Bornean felids, in Sabah and Sarawak (*Rabinowitz et al., 1987*). There are no bay cats held in captivity and this rarity and consequent value to animal dealers was apparently known to the trappers who captured the bay cat in 1992. Due to the increasing loss of forest on Borneo, the bay cat's population is believed to be decreasing (*Hearn et al., 2008b*).

## Protection Status

The Bay cat has been included on appendix II of CITES since 1977. Across most of its range it is fully protected by national legislation; in Indonesia (Kalimantan) and Malaysia (Sabah and Sarawak) hunting and trade are prohibited (*Nowell and Jackson 1996*). In Brunei there is no legal protection outside of protected areas. The bay cat has been recorded in the following protected areas: It has been confirmed to occur in the following protected areas: Sabah: Danum Valley Conservation Area; Tabin Wildlife Reserve (*Ross et al., in litt. – this study*); Sarawak: Gunung Mulu National Park (*Dinets 2003*), Lanjak-Entimau Wildlife Sanctuary (*Azlan et al., 2003*); Kalimantan: Gunung Palung National Park, Bentuang Karimur National Park (*Meijaard, 1997*), Sungai Wain Protection Forest (*Yasuda et al. 2007*), Kayan Mentarang National Park (*Augeri, 2005*).

## Principal Threats

As so little is known about the bay cat it is difficult to determine the main threats. It is thought that deforestation poses the most significant threat at present. Although the species has been recorded in logged forest, it has not been recorded in oil palm plantations (*Ross et al., in litt. – this study*).

## APPENDIX IV

### MARbled CAT, *PARDOFELIS MARMORATA* (MARTIN, 1837)



*The marbled cat*

#### Other names

Chat marbré (French); Marmorkatze (German); gato jaspeado (Spanish); marbal biral (Bengali: Bangladesh, India); shih mao, shihban mao, xiao yunbao [small clouded leopard] (Chinese); kucing batu (Indonesia); kucing dahan (Malaysia); kyaung tha lin (Myanmar); maew laey hin on (Thailand) (Nowell and Jackson, 1996).

#### Description and Behaviour

The marbled cat's coat is very thick and soft, the underfur is well-developed and woolly. The base colour of the fur varies from dark

grey-brown to yellowish-grey and red-brown. The flanks and back are patterned with large irregularly shaped markings, the edges of which are a darker colour than the base coat. The legs and underparts are marked with black spots as are the forehead and top of the head; these merge into narrow longitudinal stripes on the neck and further into irregular stripes on the back. The tail has black spots proximally and rings distally. The marbled cat is slightly larger than a domestic cat, weighing up to 5 kg, although the tail is very bushy and extremely long, often equal to head-body length (Sunquist and Sunquist, 2002).

Very little is known of the marbled cat's behaviour or diet. The first camera trap photograph was taken in 1994 in Huai Kha Khaeng Wildlife Sanctuary in Thailand (K. Conforti, pers. comm., in Nowell and Jackson 1996). Although there have been observations at night, the majority of camera trap records have been during the day (Ross *et al.*, in litt. – this study). The diet has been reported to consist of squirrels and rats (Davis 1962; Ha Dinh Duc, Wang Yingxiang, pers comm., in Nowell and Jackson, 1996), in addition, there has been an observation of a marbled cat stalking birds in a tree. In captivity the marbled cat is an adept climber (Leyhausen, 1979).

There are very few data regarding home ranges or populations densities of marbled cats. A single individual was radio-collared and tracked for one month in Thailand and found to have a range of 5.3 km<sup>2</sup> over this period (Grassman *et al.*, 2005b). A very rough population density of 16.67 individuals/100 km<sup>2</sup> was estimated for Tabin Wildlife Reserve in Sabah (Hearn *et al.*, in litt. – this study).

#### Biology

**Birth Season:** Unknown

**Estrus:** Unknown

**Estrus cycle:** Unknown

**Gestation:** In captivity, 81 days

**Litter size:** In captivity, 1-4

**Age at sexual maturity:** In captivity 21 months

**Longevity:** Up to 12 years in captivity (Medway, 1978)



## Habitat and Distribution

The marbled cat is primarily associated with moist tropical forest; it has not been recorded from dry tropical forests (Nowell and Jackson 1996). Marbled cats have been observed in secondary forest in Vietnam (Trinh, 1991 cited in Nowell and Jackson, 1996), clearings in Sarawak (Hose, 1893) and Sabah (Johns, 1989). During an intensive camera trap survey in Sabah, Ross *et al.* (*in litt.* – this study) recorded marbled cats from the primary forest of Danum Valley Conservation Area, and logged forest in the Ulu Segama Forest Reserve (where what is believed to be the first photograph of a female and cub was taken) Malua Forest Reserve and Tabin Wildlife Reserve. A single individual was recorded during this study at the forest boundary of an oil palm plantation. The marbled cat has also been recorded in a swampy mangrove area of Sabah (Davies and Payne, 1982 cited in Nowell and Jackson, 1996). Although Hose (1893) noted that marbled cats are more often seen at low elevations than in the mountains, in India it is restricted to the eastern Himalayan foothills between 1,500 - 3,000 m where there is moist deciduous and semi-evergreen forest (Biswas and Ghose 1982; cited in Nowell and Jackson, 1996; Banerjee, 1984, cited in Nowell and Jackson, 1996).

There are few locality records for the marbled cat, however its presence has been confirmed in Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia (Kalimantan, Sumatra), Lao People's Democratic Republic, Malaysia (Peninsular Malaysia, Sabah, Sarawak), Myanmar, Nepal, Thailand and Viet Nam. The presence of marbled cats is uncertain in Bangladesh.

### Sabah

Within Sabah the marbled cat has been recorded in Danum Valley Conservation Area, Palum Tambun Watershed Reserve, Ulu Segama Forest Reserve, Malua Forest Reserve, Tabin Wildlife Reserve (Ross *et al.*, *in litt.* – this study), Deramakot Forest Reserve and Tangkulap Forest Reserve (Mohamed *et al.*, 2009; Mohamed and Wilting, 2009).

## Population Status

The marbled cat is classed as Vulnerable by the IUCN (Hearn *et al.*, 2008c). There is a distinct paucity of both records compared to sympatric felids. It may be a naturally rare species (Nowell and Jackson, 1996), although to some extent this perceived rarity may be due to its arboreal nature (Pocock, 1941, cited in Nowell and Jackson, 1996). Due to continuing deforestation across the range of the marbled cat, the population is believed to be declining (Hearn *et al.*, 2008c).

## Protection Status

The marbled cat has been included on CITES appendix I since 1975. Hunting is prohibited in Bangladesh, Cambodia, China (Yunnan only), India, Indonesia, Malaysia, Myanmar, Nepal and Thailand. Hunting regulations are in place in Lao PDR, Singapore (Nowell and Jackson 1996). It occurs in a number of protected areas (Hearn *et al.*, 2008c).

## Principal Threats

Habitat loss due to deforestation is believed to be the main threat to the marbled cat. Although the species has been recorded in logged forest the degree to which it can tolerate habitat alteration is unknown. It is assumed that the species may be hunted opportunistically rather than being targeted directly and consequently it is infrequently observed in the illegal Asian wildlife trade (Nowell and Jackson 1996). However, it is valued for its skin, meat and bones, and indiscriminate snaring is prevalent throughout much of its range and is likely to pose a major threat (Hearn *et al.*, 2008c). They have been reported as poultry pests (Nowell and Jackson 1996, Mishra *et al.* 2006) and in such cases retribution killing may occur.



## APPENDIX V

### SUNDA CLOUDED LEOPARD, *NEOFELIS DIARDI* (CUVIER, 1823)



*The Sunda clouded leopard*

#### Other names

Enkuli Clouded Leopard, Sunda Islands Clouded Leopard, Sundaland Clouded Leopard (English); macan dahan (Indonesia); harimau dahan (Malaysia); engkuli (Iban, Malaysia).

#### Description and Behaviour

The Sunda clouded leopard is so named for its distinctive coat pattern – ellipses partially edged in black, the insides of which are a darker colour than the base colour of the pelt which is greyish. Black and pale, whitish individuals have been reported from Borneo (Medway, 1965; Payne *et al.*,

1998; Rabinowitz *et al.*, 1987), but recent camera trapping has not confirmed these records (Ross *et al.*, *in litt.* – this study). The limbs are marked with black spots and are relatively short. The tail is very thick with black spots and black rings towards the end, the tail is also exceptionally long (770 (♀) - 790 (♂) mm, equivalent to 76 – 88 % of head-body length  $n = 2$  (Hearn *et al.*, *in litt.* – this study). The canines are longer relative to skull size than any other living felid (Guggisberg, 1975). The long tail and short legs enable the Sunda clouded leopard to display a high level of arboreality, although it probably uses trees for resting and only occasional hunting (Rabinowitz *et al.*, 1987). Camera trapping in Borneo has shown the Sunda clouded leopard to be mainly nocturnal, although there is also some activity at dawn (Ross *et al.*, *in litt.* - this study; Cheyne and Macdonald, *in litt.*).

The diet of the Sunda clouded leopard is varied and consists of primates such as proboscis monkeys (Davis, 1962), porcupines and bearded pigs (Rabinowitz *et al.*, 1987) along with muntjac and great Argus pheasants (Griffiths, 1993 cited in Nowell and Jackson, 1996).

To date there has only been one Sunda clouded leopard radio-collared (Hearn *et al.*, *in litt.* – this study). This female was tracked for 107 days and found to have a range of 29.86 km<sup>2</sup> (100% minimum convex polygon). Density estimates of Sunda clouded leopard on Borneo are variable, ranging from 3.05 - 7.85 individuals per 100 km<sup>2</sup> based on camera trap surveys (Hearn *et al.*, *in litt.* – this study). In Sumatra densities of 2.9 individuals per 100 km<sup>2</sup> have been reported (Hutujulu *et al.*, 2007).

The Sunda clouded leopard is a recently recognised species, previously considered a sub-species of *Neofelis nebulosa*.

#### Biology

There are no data available for *N. diardi*, the following are based on data from the closely related *N. nebulosa* in captivity.

**Birth Season:** Unknown

**Estrus:** 6 days on average

**Estrus cycle:** On average 30 days ( $n = 72$ )

**Gestation:** 93 ± 6 days (Yamada and Durrant, 1989)

**Litter size:** 1 – 5 cubs, most commonly 3

**Age at sexual maturity:** On average 26 months for both males and females.

**Age at last reproduction:** 12 – 15 years, however most litters are born to males and females between 2-4 years (Yamada and Durrant, 1989)

**Longevity:** Average is 11, but up to 17 years has been recorded (Prator *et al.*, 1988).

### Habitat and Distribution

The Sunda clouded leopard is restricted to the islands of Borneo and Sumatra (Buckley-Beason *et al.* 2006, Kitchener *et al.*, 2007, Wilting *et al.* 2007a,b, Eizirik *et al.* submitted). There may also be clouded leopards on the Batu Islands near Sumatra (Hearn *et al.*, 2008d). Clouded leopard fossils have been found on Java, however it has probably been extinct there since the Holocene (Meijaard, 2004). The Sunda region also includes the Malay peninsula, however all clouded leopards recorded there appear to be the mainland species *N. nebulosa* (Kitchener *et al.*, 2007). Malaysia is the only country to have both species of clouded leopard. The Sunda clouded leopard is found in primary forest, but has also been recorded from logged forest (Hearn *et al.*, *in litt.* - this study; Ross *et al.*, *in litt.* - this study; Mohamed *et al.*, 2009) mangroves (Davis, 1962; Davies and Payne, 1982 cited in Nowell and Jackson, 1996) and peat swamp forest (Cheyne and Macdonald, *in litt.*). There are anecdotal reports of sightings of this species from oil palm plantations (Wilting *et al.*, 2006), but a recent camera trap survey of an oil palm plantation in Sabah did not record Sunda clouded leopards (Ross *et al.*, *in litt.* - this study).

The Sunda clouded leopard has been recorded up to 1,500 m altitude on Gunung Dulit in Sarawak (Payne *et al.*, 1998).

### Sabah

Within Sabah the Sunda clouded leopard has been recorded from Danum Valley Conservation Area, Ulu Segama Forest Reserve, Malua Forest Reserve (Hearn *et al.*, *in litt.* - this study; Ross *et al.*, *in litt.* - this study), Tabin Wildlife Reserve (Hearn *et al.*, *in litt.* - this study., Ross *et al.*, *in litt.* - this study, Wilting *et al.* 2006), Crocker Range National Park, Gunung Madalon, Sugut, Sepilok, the Upper Sungai Segama and Kalabakan Forest Reserve (Payne *et al.*, 1998) and Tawau Hills National Park (M. Lakim *pers. comm.*) and is thought to occur in most protected areas.

The Sunda clouded leopard is native to Brunei Darussalam, Indonesia (Kalimantan, Sumatera) and Malaysia (Sabah, Sarawak) (Hearn *et al.*, 2008d).

### Population Status

The Sunda clouded leopard is classed as Vulnerable by the IUCN. Populations appear healthiest on Borneo rather than Sumatra, possibly due to the absence of competing species such as the tiger and leopard (Rabinowitz *et al.*, 1987). Due to the continued loss of habitat across its range and uncertainties regarding its ability to persist in plantations it is assumed that the population is decreasing.

### Protection Status

The Sunda clouded leopard has been included on CITES Appendix I since 1975. The species is fully protected in Sumatra and Kalimantan (Indonesia), Sabah and Sarawak (Malaysia) and Brunei. It occurs in most protected areas along the Sumatran mountain spine, and in most protected areas on Borneo (IUCN Cats Red List workshop, 2007).

### Principal Threats

Deforestation and habitat alteration are believed to be the major threat to this species. The expansion of oil palm plantations in conjunction with forest clearance for agriculture and settlement continue across Borneo and Sumatra (*Rautner et al., 2005, FAO 2007*), although in Sabah this process is now somewhat stabilized (*Hearn et al., 2010b*). The mainland clouded leopard is threatened by illegal hunting for skins and body parts. It is unclear whether the trade in skins and body parts of the Sunda clouded leopard is as widespread; in Sabah it is not believed to be a large problem (*Rabinowitz, et al., 1987*). However, in Sumatra Sunda clouded leopard body parts have a commercial value and seven were killed in Kerinci Seblat National Park from 2000 – 2001, due to an indiscriminate use of snares set for other species (*Holden, 2001*). Sunda clouded leopards occasionally prey on livestock such as goats which may invoke retribution killings (I. *Haidir pers. comm. 2009*).