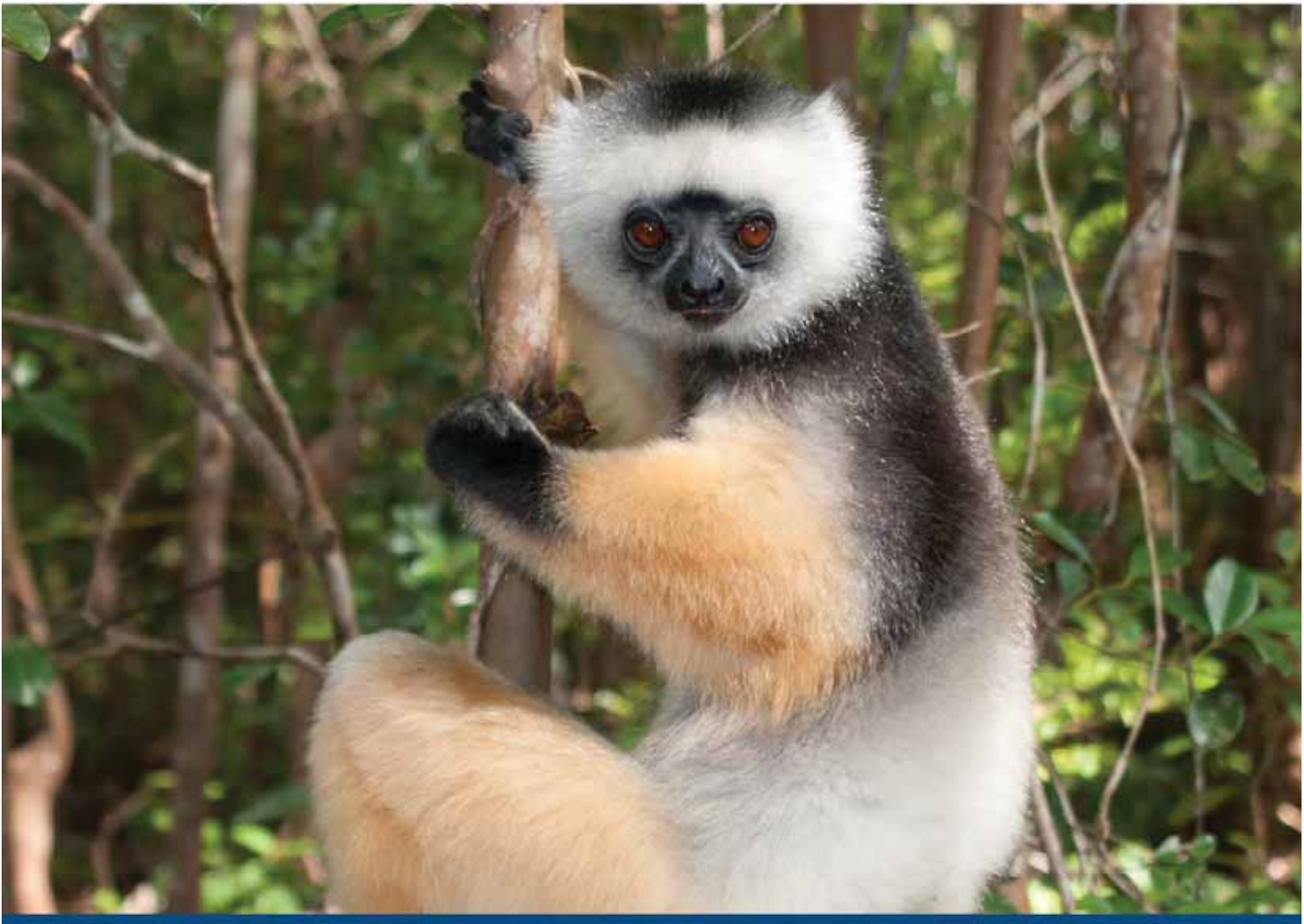
IUCN

Lemurs of Madagascar

A Strategy for their Conservation 2013-2016

Edited by Christoph Schwitzer, Russell A. Mittermeier, Nicola Davies, Steig Johnson, Jonah Ratsimbazafy, Josia Razafindramanana, Edward E. Louis Jr. and Serge Rajaobelina



SSC
Species Survival Commission

CONSERVATION INTERNATIONAL

Bristol Conservation & Science Foundation

Cover photo: Diademed sifaka (*Propithecus diadema*), Critically Endangered. (Photo: Russell A. Mittermeier)
Back cover photo: Indri (*Indri indri*), Critically Endangered. (Photo: Russell A. Mittermeier)

Lemurs of Madagascar

A Strategy for Their Conservation 2013–2016

Edited by
Christoph Schwitzer, Russell A. Mittermeier, Nicola Davies,
Steig Johnson, Jonah Ratsimbazafy, Josia Razafindramanana, Edward E. Louis Jr.,
and Serge Rajaobelina

Illustrations and layout by Stephen D. Nash

IUCN SSC Primate Specialist Group
Bristol Conservation and Science Foundation
Conservation International

This publication was supported by the Conservation International/Margot Marsh Biodiversity Foundation Primate Action Fund, the Bristol, Clifton and West of England Zoological Society, Houston Zoo, the Institute for the Conservation of Tropical Environments, and Primate Conservation, Inc.











Published by: IUCN SSC Primate Specialist Group, Bristol Conservation and Science Foundation, and Conservation International

Copyright: © 2013 IUCN

Reproduction of this publication for educational or other non-commercial purposes is authorized without prior written permission from the copyright holder provided the source is fully acknowledged. Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.

Inquiries to the publisher should be directed to the following address: Russell A. Mittermeier, Chair, IUCN SSC Primate Specialist Group, Conservation International, 2011 Crystal Drive, Suite 500, Arlington, VA 22202, USA

Citation: Schwitzer C, Mittermeier RA, Davies N, Johnson S, Ratsimbazafy J, Razafindramanana J, Louis Jr. EE, Rajaobelina S (eds). 2013. *Lemurs of Madagascar: A Strategy for Their Conservation 2013–2016*. Bristol, UK: IUCN SSC Primate Specialist Group, Bristol Conservation and Science Foundation, and Conservation International. 185 pp.

ISBN: 978-1-934151-62-4

Illustrations: © Stephen D. Nash, Conservation International, Arlington, VA, and Department of Anatomical Sciences, Health Sciences Center, State University of New York at Stony Brook, NY

Layout: Stephen D. Nash

Printed by: Goltze GmBH & Co. KG, Göttingen, Germany

June 2013

Available from: Jill Lucena, Conservation International, Arlington, VA
Email: <jlucena@conservation.org>

The designation of geographical entities in this publication, and the presentation of the material, do not imply the expression of any opinion whatsoever on the part of IUCN concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The views expressed in this publication do not necessarily reflect those of IUCN.

Contents

Foreword / Teny fanolorana
Leon Rajaobelina ..... vi, vii

Acknowledgements 1

Glossary of Terms and Abbreviations 2

Introduction
Russell A. Mittermeier, Christoph Schwitzer, Steig Johnson & Jonah Ratsimbazafy 5

Strategic Planning for Lemur Conservation: The Process
Christoph Schwitzer, Russell A. Mittermeier, Steig Johnson & Jonah Ratsimbazafy 12

Lemur Conservation Status Review: An Overview of the Lemur Red-Listing Results 2012
Nicola Davies & Christoph Schwitzer 13

Vision 28

Objectives 29

Factors Contributing to Lemur Population Decline on a National Scale, and Proposed Immediate and Longer-Term Mitigation Actions
Christoph Schwitzer, Merrill Baker-Médard, Rainer Dolch, Christopher Golden, Mitchell Irwin, Steig Johnson, Erik Patel, Brigitte M. Raharivololona, Jonah Ratsimbazafy, Josia Razafindramanana & Sylviane Volampeno 34

Lemur Action Fund: A Rapid Response Fund for Lemur Conservation
Russell A. Mittermeier, Anthony B. Rylands & Christoph Schwitzer 52

Site-Based Action Plans:

Marojejy National Park and Anjanaharibe-Sud Special Reserve
Erik Patel & Charles Welch 53
Masoala
Amavatra Herve Andrianjara, Aristide Andrianarimisa & Felix Ratelolahy (translation by Matthew Richardson) 54
Makira
Felix Ratelolahy, Vonjy Andrianjakarivelo & Aristide Andrianarimisa 56
Mananara Nord National Park
Jocelyn Bezara & Felix Ratelolahy 59
Lake Alaotra
Fidimalala Ralainasolo, Jonah Ratsimbazafy, Richard Lewis & Herizo Andrianandrasana 62
Ankeniheny–Zahamena Corridor (CAZ)
Harison Randrianasolo, Tovonanahary Rasolofoharivelo, Rainer Dolch, Tony King, Lucien Randrianarimanana & Tianasoa Ratolojanahary 67
Andriantantely
Tony King, Tovonanahary Rasolofoharivelo, Harison Randrianasolo, Rainer Dolch, Lucien Randrianarimanana & Tianasoa Ratolojanahary 69
Torotorofotsy–Ihofa
Rainer Dolch, Tianasoa Ratolojanahary, Harison Randrianasolo, Tovonanahary Rasolofoharivelo, Tony King & Lucien Randrianarimanana 71
Western Portion of the Ankeniheny–Zahamena Corridor (CAZ)
Tovonanahary Rasolofoharivelo, Lucien Randrianarimanana, Tony King, Harison Randrianasolo, Rainer Dolch & Tianasoa Ratolojanahary 74
Prevention and Reduction of Bushmeat Hunting in the Ankeniheny–Zahamena Corridor (CAZ)
Harison Randrianasolo, Tovonanahary Rasolofoharivelo, Rainer Dolch, Tony King, Lucien Randrianarimanana & Tianasoa Ratolojanahary 76

Betampona Natural Reserve
Ingrid Porton, Maya Moore & Karen L. M. Freeman 79
Anjozorobe–Angavo & Tsinjoarivo
Mitchell Irwin, Marina Blanco, Jean-Luc Raharison & Karen Samonds 83
Ambositra–Vondrozo Corridor (COFAV)
Steig Johnson 86
Ranomafana National Park
Patricia C. Wright & Steig Johnson 89
Fandriana–Marolambo Forest Corridor
Jonah Ratsimbazafy & Shawn Lehman 92
Kianjavato
Edward E. Louis Jr., Jean Freddy Ranaivoarisoa, Susie McGuire & Steig Johnson 95
Manombo Forest
Fidimalala Ralainasolo, Brigitte M. Raharivololona & Steig Johnson 98
Kalambatritra Massif
Tovonanahary Rasolofoharivelo, Laingoniaina Herifito Fidèle Rakotonirina & Tony King 101
Andohahela & Tsitongambarika
Giuseppe Donati, Andriamandranto Ravoahangy, Jacques Rakotondranary & Andreas Hapke 103
Mahafaly and Mandrare: The Spiny Forest Ecosystem
Barry Ferguson, Joerg Ganzhorn, Alison Jolly, Edward E. Louis Jr., Domoina Rakotomalala & Tiana Ramahaleo .. 106
Makay
Evrard Wendenbaum, Anne Laudisoit & Jean-Michel Bichain 109
Kirindy–Ambadira (Central Menabe)
Matthias Markolf, Peter Kappeler, Rebecca Lewis & Ibrahim Antho Youssouf Jacky 113
Tsingy de Bemaraha
Edward E. Louis Jr., Jean Freddy Ranaivoarisoa, Liva Rajoharison & Hery Lala Ravelomanantsoa 116
Ambato Boeny
Laingoniaina Herifito Fidèle Rakotonirina, Tovonanahary Rasolofoharivelo & Tony King 119
Ankarafantsika National Park
Ute Radespiel & Josia Razafindramanana 121
Mahavavy Kinkony
Josia Razafindramanana, Jonah Ratsimbazafy & Vony Raminoarisoa 123
Antrema
Rivo Ramanamisata & Hanta Razafindraibe 126
Bombetoka–Belemboka
Josia Razafindramanana, Rado Rakotondrabe & Jonah Ratsimbazafy 128
Anjiamangirana and Marosely
Gilbert Rakotoarisoa, Ute Radespiel & Lounes Chikhi 130
Sahamalaza – Iles Radama
Melanie Seiler, Guy Randriatahina, Sylviane Volampeno & Christoph Schwitzer 132
Nosy Be
Guy Randriatahina & Sylviane Volampeno 135
Daraina
Jordi Salmona & John Rigobert Zaonarivelo 137
Analamerana and Andrafiamena
Jordi Salmona, John Rigobert Zaonarivelo & Matthew Banks 140
Montagne des Français
Edward E. Louis Jr., John Zaonarivelo, Jean Freddy Ranaivoarisoa & Susie McGuire 142

Data Deficient Lemur Species
Linn Groeneveld & Nicola Davies 144

Integrating *Ex situ* and *In situ* Conservation of Lemurs
Christoph Schwitzer, Tony King, Eric Robsomanitrandrasana, Christelle Chamberlan & Tovonanahary Rasolofoharivelo ... 146

Budget Summary 153

Lemur Conservation Success Stories:

Maromizaha: Conservation and Community Involvement
Marco Gamba, Rose Marie Randrianarison, Valeria Torti, Giancarlo Bounous, Cesare Avesani Zaborra, Jonah Ratsimbazafy & Cristina Giacoma 155
Anja Community Reserve and the Association Anja Miray (AMI)
Lisa Gould & Denise Gabriel 157

References 159

Lemur Conservation Sites: Contacts of Main Actors 167

Contributors' Addresses 171

Appendix: Site-Based Objectives and Indicative Budgets 175

Foreword

It is undeniable that Madagascar is a very special island for its exceptional wealth of biodiversity, its unique flora and fauna, which make our country one of the world's foremost nature sanctuaries. Unfortunately, particularly over the last two decades, anthropogenic change has drastically affected Madagascar's natural treasures. Every year, thousands of hectares of forest disappear due to logging and slash-and-burn agriculture. Most of the endemic fauna of Madagascar is forest-dependent, which means that once the forest becomes degraded or vanishes, the animals also disappear. Many species of endemic Malagasy reptiles, birds and mammals are currently on the verge of extinction due mainly to habitat loss and illegal exploitation.

But I am happy to say that there are committed NGOs, institutions and individuals who are aware of the urgent need to set up strategies for environmental protection before it is too late. This is particularly true for these unique creatures, the lemurs, which symbolise the uniqueness of Madagascar's biodiversity. During the past twenty years, almost every year, new species of these "denizens of the forest" have been discovered because of the fruitful collaboration of Malagasy and foreign primatologists, and there are probably still some hidden treasures in our forests. Almost 20% of the world's primates are found in Madagascar. The loss of lemurs has implications for the entire country, and without efforts to better safeguard this precious national resource, all of Madagascar's residents will ultimately suffer.

I would like to take this opportunity to thank the Primate Specialist Group of the IUCN SSC for organising the Lemur Red-Listing and Conservation-Planning Workshop in July 2012 in Antananarivo. This meeting of 60 hard-working national and international primatologists agreed on a common strategy for the conservation of lemurs. The wide variety of both conservation and development projects in the different priority sites for lemur conservation is a key feature of this new strategy. Without doubt, using lemurs as "flagships" for public awareness and education campaigns will be crucial to stimulate general interest in conservation within Madagascar and to draw even more international attention to the importance of this country for conserving global biological diversity.

In this regard, I do believe that the lemurs will continue to exercise their attractive powers over tourists: seeing lemurs in their natural habitats once in a lifetime is a dream for nature lovers and naturalists around the world. Notably, tourism contributes a substantial amount of foreign exchange to Madagascar's economy.

Conservation is a collective task that demands the involvement of all of us. Implementing this lemur conservation strategy will thus only be successful if we work together to face the challenges ahead. We will not let the lemurs vanish from our forests because we are not alone in our battle. Lemurs are a world heritage for future generations.

Leon Rajaobelina

Regional Vice-president
Conservation International

Teny fanolorana

Madagasikara dia fanta-daza eran'izao tontolo izao noho ny fananany ireo harena voajanahary (biby sy zava-maniry). Indrisy anefa fa tena mihazakazaka ny fahasimban'ireo voaary mampiavaka ity firenena ity noho ny tsindry mianjady amin'ny ala vokatry ny fanimbana ny ala (doro-tany, fakàna hazo tsy am-piheverana) sy ny fanangonana tsy ara-dalàna ireo biby sy zava-maniry zanatany izay tsy hita afa-tsy eto amin'ity nosy lehibe ity. Ny vokatr'ireo fahapotehana mianjady amin'ireo voaary tsy manam-paharoa ireo dia maro ny biby sy zavamaniry ahiana ho ringana sy hanjavona tsy ho hita intsony raha tsy misy fepetra entitra raisina hisakanana ireo tsindry isan-karazany misy ankehitriny.

Ny mahafaly anefa dia mbola misy ireo fikambanana na vondrona na olon-tsotra mpikaroka mahatsapa ny mety tokony ametrahana lamina sy paika tsara rindra entina hiarovana ireo voaary sisa tavela sy hanampiana ireo mponina mivelona amin'ireny faritra misy ireny harena ireny.

Anisan'ny mampiavaka an'i Madagasikara sy azo ambara fa reharehan'ny Malagasy ny fananantsika ireo varika (gidro) maro isan-karazany. Fantatra anefa fa miisa dimy ambin'ny folo ireo karazany efa voaporofo fa lany tamingana, ka mbola maro ireo fahalalana mahakasika ny fomba fiainany, ny feony, ny lokon'ny volony sy zavatra maro hafa no tsy fantatra feno mandrak'ankehitriny momba azy ireo. Anisan'ny vaovao mahafaly ny mahare fa Isan-taona dia misy karazan' ireo "mponina an'ala" (varika) vaovao hitan'ny mpikaroka Malagasy sy vahiny miara-miasa na dia tsy mitsahatra mitombo aza ny olana mianjady amin'ny toeram-ponenana ahitana azy ireny.

Singanina manokana ary mendrim-piderana ny vondrona "Primate Specialist IUCN/SSC", izay mbola nametraka an'i Madagasikara ho loha-laharana eo amin'ny asa fiarovana ireo varika eto amintsika. Io vondrona io tokoa mantsy no namory teto Antananarivo, tamin'ny volana Jolay 2012, ireo mpikaroka vahiny sy tera-tany, miisa 50 mahery: tamin'izany no namolavolana ny paik'ady entina hiarovana ireo varika ireo tsy ho lany tamingana. Vokatry izany atrikasa izany no nafahana namoaka ity boky ity dia ny "Lemur Action Plan 2013 – 2016". Inoako tsy ampihambahambana fa fitaovana ahomby ahasarika ny Malagasy teratany ka hampitombo ny fitiavan'izy ireo izany harena mampiavaka antsika izany ity boky ity ary koa ho fitaovam-panabeazana mahomby ho an'ny ankizy. Fa indrindra koa ho fitaovana entintsika misintony ny mpizahantany sy ny mpamatsy vola ho tonga eto Madagasikara.

Miankina amin'ny fahasahiana sy ny fahavononantsika handray andraikitra no antoky ny fahaveloman'ireo biby mitondra ny lazan'i Madagasikara sy ny Malagasy, dia ny varika.

Leon Rajaobelina

Regional Vice-president
Conservation International



Photos showing representatives of each of the fifteen genera of living lemurs.

Key: A. *Microcebus;* B. *Mirza;* C. *Alloceus;* D. *Cheirogaleus;* E. *Phaner;* F. *Lepilemur;* G. *Hapalemur;* H. *Prolemur;* I. *Lemur;* J. *Eulemur;* K. *Varecia;* L. *Avahi;* M. *Propithecus;* N. *Indri;* O. *Daubentonia.*

Acknowledgements

Many people have contributed to this Lemur Conservation Strategy, and we would like to thank them all here.
It would have been impossible to organise and run the conservation-planning workshop, and manage the editing process of this document, without the institutional support provided to Christoph Schwitzer and Nicola Davies by the Bristol, Clifton and West of England Zoological Society and its director, Bryan Carroll. The Conservation International /Margot Marsh Biodiversity Foundation Primate Action Fund, the Bristol, Clifton and West of England Zoological Society, Houston Zoo, the Institute for the Conservation of Tropical Environments, and Primate Conservation, Inc. kindly provided the funds for printing the document.

Our most sincere thanks go to the Ministry of the Environment and Forests (MEF) and the Ministry of Higher Education and Scientific Research (MESUPRES) of the Republic of Madagascar for their support of the IUCN SSC lemur red-listing and conservation-planning workshop in July 2012 in Antananarivo, Madagascar. We are particularly grateful to Mr Pierre Manganirina Randrianarisoa, Secretary General of the MEF, and to Prof. André Totohasina, former Secretary General of the MESUPRES, and Dr Armand Rasoamiaramanana, former Director General of Higher Education at the MESUPRES, for assisting the official closing ceremony of the workshop. We would also like to thank Sir Richard Branson (Virgin Group) for the kind and encouraging words addressed to the workshop participants in his video message.

We are grateful to Ambatovy Minerals S.A., Hotel Carlton Madagascar, the Margot Marsh Biodiversity Foundation, the Mohamed bin Zayed Species Conservation Fund, and Virgin Unite, for their financial and logistical support of the workshop. Noro Ratsimbazafy (Ambatovy Minerals S.A.) and Tiana Andriamanana (Fanamby) provided invaluable help with its organisation and smooth running. Institutional support was also provided by the Association Européenne pour l'Etude et la Conservation des Lémuriens (AEECL), Conservation International Madagascar, Durrell Wildlife Conservation Trust – Madagascar Programme, Fanamby, the Groupe d'Etude et de Recherche sur les Primates de Madagascar (GERP), Sapienza Università di Roma, and the Zoo Outreach Organisation.

The workshop was organised by Andrew Cooke, Jörg Ganzhorn, Vanessa Mass, Jonah Ratsimbazafy and Christoph Schwitzer under the auspices of the IUCN SSC Primate Specialist Group (Chair: Russell A. Mittermeier). We are grateful to Sanjay Molur for his patient and impartial facilitation, and to Federica Chiozza for her excellent assistance with mapping the extent of occurrence and area of occupancy of all lemur species. We would like to extend our sincerest thanks to all 61 workshop participants:

Nicole Andriaholinirina, Andrea Baden, Marina Blanco, Lounes Chikhi, Federica Chiozza, Andrew Cooke, Nicola Davies, Rainer Dolch, Giuseppe Donati, Jörg Ganzhorn, Christopher Golden, Linn Fenna Groeneveld, Andreas Hapke, Mitch Irwin, Steig Johnson, Peter Kappeler, Tony King, Rebecca Lewis, Edward E. Louis Jr., Matthias Markolf, Vanessa Mass, Russell A. Mittermeier, Sanjay Molur, Rina Nichols, Erik Patel, Clément Josef Rabarivola, Brigitte Raharivololona, Serge Rajaobelina, Gilbert Rakotoarisoa, Barson Rakotomanga, Jacques Rakotonanahary, Haja Rakotondrainibe, Gilbert Rakotondratsimba, Marius Rakotondratsimba, Laingoniaina Rakotonirina, Fidimalala Bruno Ralainasolo, José Ralison, Tiana Ramahaleo, Jean Freddy Ranaivoarisoa, Sahoby Ivy Randrianahaleo, Blanchard Randrianambinina, Lucien Randrianarimanana, Harison Randrianasolo, Guy Randriatahina, Hanta Rasamimananana, Tovonanahary Rasolofoharivelo, Solofonirina Rasoloharijaona, Felix Ratelolahy, Jonah Ratsimbazafy, Noro Ratsimbazafy, Hanta Razafindraibe, Josia Razafindramanana, Noel Rowe, Jordi Salmona, Christoph Schwitzer, Melanie Seiler, Sylviane Volampeno, Patricia Wright, Jacky Youssouf, John Zaonarivelo, Alphonse Zaramody.

With regard to writing this strategy, we would like to thank all 83 contributors, who are listed by name elsewhere in the document. Many of them have authored or co-authored multiple chapters and devoted considerable time and effort. Sincerest thanks go to Stephen Nash (Conservation International), who has not only provided his beautiful lemur illustrations for the introduction, but also spent many hours on the layout of the document. Thanks also to Lucy A. Taylor and Christina Paddock (both Bristol Conservation and Science Foundation) for their help with referencing and proofreading.

On behalf of the editors,



Christoph Schwitzer

Glossary of Terms and Abbreviations

Actions	The activities that need to be implemented to achieve the Strategy's Objectives and, ultimately, its Goals and Vision
Actors	Those individuals responsible for Actions
AEECL	Association Européenne pour l'Etude et la Conservation des Lémuriens
Area of Occupancy	The Red List term "Area of occupancy" is defined as the area within its "extent of occurrence" which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases (e.g., irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon, the nature of threats and the available data. (For an illustration, see: http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories criteria#definitions accessed 15 April 2013.)
AZE Site	Alliance for Zero Extinction Site
CBSG	Conservation Breeding Specialist Group of the IUCN Species Survival Commission
COBA	Communauté de Base (local community association)
DREF	Direction Régionale de l'Environnement et des Forêts (Regional Directorate of the Environment and Forests)
Extent of Occurrence	Red List term used to define the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred, or projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g., large areas of obviously unsuitable habitat; but see "area of occupancy"). Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).
GERP	Groupe d'Etude et de Recherche sur les Primates de Madagascar
GIS	Geographic Information System
GPS	Global Positioning System
ICTE	Institute for the Conservation of Tropical Environments
IUCN	International Union for Conservation of Nature
MBP	Madagascar Biodiversity Partnership
MEF	Ministère de l'Environnement et des Forêts (Ministry of Environment and Forests)
MFG	Madagascar Fauna and Flora Group
MNP	Madagascar National Parks
NP	National Park
NPA	New Protected Area

NGO Non-governmental organization

Objective Broad summaries of the approaches to be taken in attempting to achieve a strategy's Vision; each objective usually relates to a logically related set of threats and constraints; for example, if lack of capacity were to be identified as a constraint on effective conservation of a species, then one obvious objective would be to develop capacity

PA Protected Area

PVA Population Viability Analysis

Red List The IUCN Red List of Threatened Species is an annually updated inventory of the extinction risk and global conservation status of plant and animal species.

Red List Categories The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. The general aim of the system is to provide an explicit, objective framework for the classification of the broadest range of species according to their extinction risk

Extinct (EX) Species for which extensive surveys show there is no reasonable doubt that the last individual has died

Extinct in the Wild (EW) Species that survive only in cultivation, in captivity or as a naturalized population (or populations) well outside the past range

Critically Endangered (CR) Species that are facing an extremely high risk of extinction in the wild when the best available evidence indicates that they meet any of the criteria for the category Critically Endangered

Endangered (EN) Species that are facing a very high risk of extinction in the wild when the best available evidence indicates that they meet any of the criteria for the category Endangered

Vulnerable (VU) Species that are facing a high risk of extinction in the wild when the best available evidence indicates that they meet any of the criteria for the category Vulnerable

Near Threatened (NT) Species that do not qualify for Critically Endangered, Endangered or Vulnerable now, but are close to qualifying for or are likely to qualify for a threatened category in the near future.

Least Concern (LC) Species that do not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant species are included in this category.

Data Deficient (DD) Species for which there is inadequate information to make a direct, or indirect, assessment of extinction risk based on distribution and/or population status. A species in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat.

Not Evaluated (NE) A species is considered "Not Evaluated" when it has not yet been evaluated against the criteria. NE species are not shown on the IUCN Red List.

REDD Reducing Emissions from Deforestation and forest Degradation

SAGE	Service d'Appui à la Gestion de l'Environnement
SIMPONA	Silky Sifaka Conservation and Research in Madagascar
Species Action Plans	Publications written by IUCN/SSC Specialist Groups and other organizations and groups (e.g., WWF, the European Union, and others) that assess the conservation status of species and their habitats and outline conservation priorities.
SRI	System of Rice Intensification
SSC	Species Survival Commission
Threat	A factor that causes either a substantial decline in the numbers of individuals of that species, or a substantial contraction of the species' geographic range. Threats can be divided into proximate and ultimate threats. Proximate threats are immediate causes of population decline, usually acting on birth or death rates (e.g., habitat loss, over-harvest). Ultimate threats are root causes of proximate threats, and are almost always anthropogenic (e.g., habitat loss (a proximate threat) might be driven by human population growth (an ultimate threat)).
Threatened Species	Threatened Species are any of those classified as CR, EN, or VU. See http://www.iucnredlist.org (accessed 15 April 2013)
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
Vision	An inspirational and relatively short statement that describes the desired future state for the species (i.e., it describes in broad terms the desired range and abundance for the species, its continuing ecological role, and it relationship with humans). The Vision is an essential part of the new SCS process in that those writing a SCS should discuss explicitly what it means to save a species and use the answer to this question to develop the associated Goals. The Vision should, therefore, be derived from a range-wide analysis of a species' status and a detailed presentation of the long-term range-wide conservation needs of the species (informed by the threat analysis)
VOI	Vondron'Olona Ifototra (Malagasy term for Communauté de Base)
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature
ZOP	Zone of Protection

Introduction

Russell A. Mittermeier, Christoph Schwitzer, Steig Johnson & Jonah Ratsimbazafy

Madagascar, in the opinion of many, is the world's single highest priority biodiversity hotspot. It is the world's fourth largest island (after Greenland, New Guinea, and Borneo) and the largest oceanic island. It has been separated from other landmasses for at least 88 million years, and from mainland Africa, its closest neighbor, for at least 130 million years. As a result, much of the evolution that has taken place in Madagascar has been in isolation, resulting in levels of endemism at the species, genus and family levels that are simply unmatched by any other country. Diversity is very high for those plant and animal groups represented on Madagascar, and endemism is extremely high, ranging from 55–100% at the species level. Endemism at the genus and family level far surpasses that of any other hotspot, with more than 480 genera and 26 families endemic to this island nation. This means that we are not just conserving species in Madagascar, rather entire deep lineages and very significant portions of evolutionary history.

Unfortunately, as has been documented extensively over the past two decades, Madagascar is also one of the most heavily impacted countries in the world in terms of habitat loss, with some estimates indicating that as much as 90% of the original natural vegetation has already been destroyed and with much of what remains being severely fragmented. Erosion is as severe as anywhere on Earth, and every year millions of tons of soil – and future potential – are washed into the ocean. Action to prevent further habitat and species loss in Madagascar must be considered one of the highest global priorities, and it is essential that large-scale measures be put in place as soon as possible. This should concentrate heavily on efforts to conserve the country's most important groups of flagship species and their critical habitats that represent both an immense scientific and cultural asset and, at the same time, the greatest long-term competitive economic advantage for Madagascar's people. Madagascar is one of the world's poorest countries, and long-term human wellbeing depends heavily on maintaining the country's natural capital, best represented by its lemurs and others groups of living organisms and the forests in which they occur.

Table 1: Primate diversity in four major habitat regions.

Region	Family	Genus*	Species	Species & subspecies
Africa	4	25	110	197
Madagascar	5	15	99	103
Asia	5	17	116	179
Neotropics	5	20	156	204
Total	16	76*	480**	682**

*The column adds up to one more than the total given because Asia and Africa share one genus: *Macaca*.
**The column adds up to one more than the total given because Asia and Africa share one species: *Papio hamadryas*.

Just as the country as a whole is a global concern, the lemur fauna of Madagascar is the single highest primate conservation priority in the world. Its very high species diversity and its endemism at the species, genus and family level is simply unmatched anywhere else, and this is all the more impressive given its relatively tiny land area compared to the other three landmasses where primates occur. Indeed, Madagascar is so important for primates that it is considered one of the four major biogeographic regions for primates, together with South and Central America, mainland Africa, and Asia (Tab. 1), in spite of being only about 1.3–2.9% the size of each of the three continental regions. At 581,540 km^2, Madagascar's total land area is only about 7% that of Brazil, the world's richest country for primates, and yet its primate diversity is comparable and its endemism much higher (Tab. 2–4). Furthermore, given that only 10% of Madagascar's land area remains as suitable primate habitat, the high concentration of unique species, genera, and families in a tiny area becomes even more extreme.

Table 2: The top countries on Earth for nonhuman primate species diversity.

Country	Families	Genera	Species	Taxa
Brazil	5	19	116	139
Madagascar	5	15	99	103
Indonesia	5	10	56	70
Democratic Republic of Congo	4	18	49	66
Colombia	5	13	45	52
Peru	5	14	44	50

Table 3: Primate endemism in the most diverse countries on Earth: Species.

Country	Families	Genera	Species	Endemism
Madagascar	5/5	15/15	99/99	100%
Indonesia	0/5	1/10	37/53	66%
Brazil	0/5	4/19	61/116	53%
Colombia	0/5	0/13	12/45	27%
Democratic Republic of Congo	0/4	0/18	10/49	20%
Peru	0/5	1/14	6/44	14%

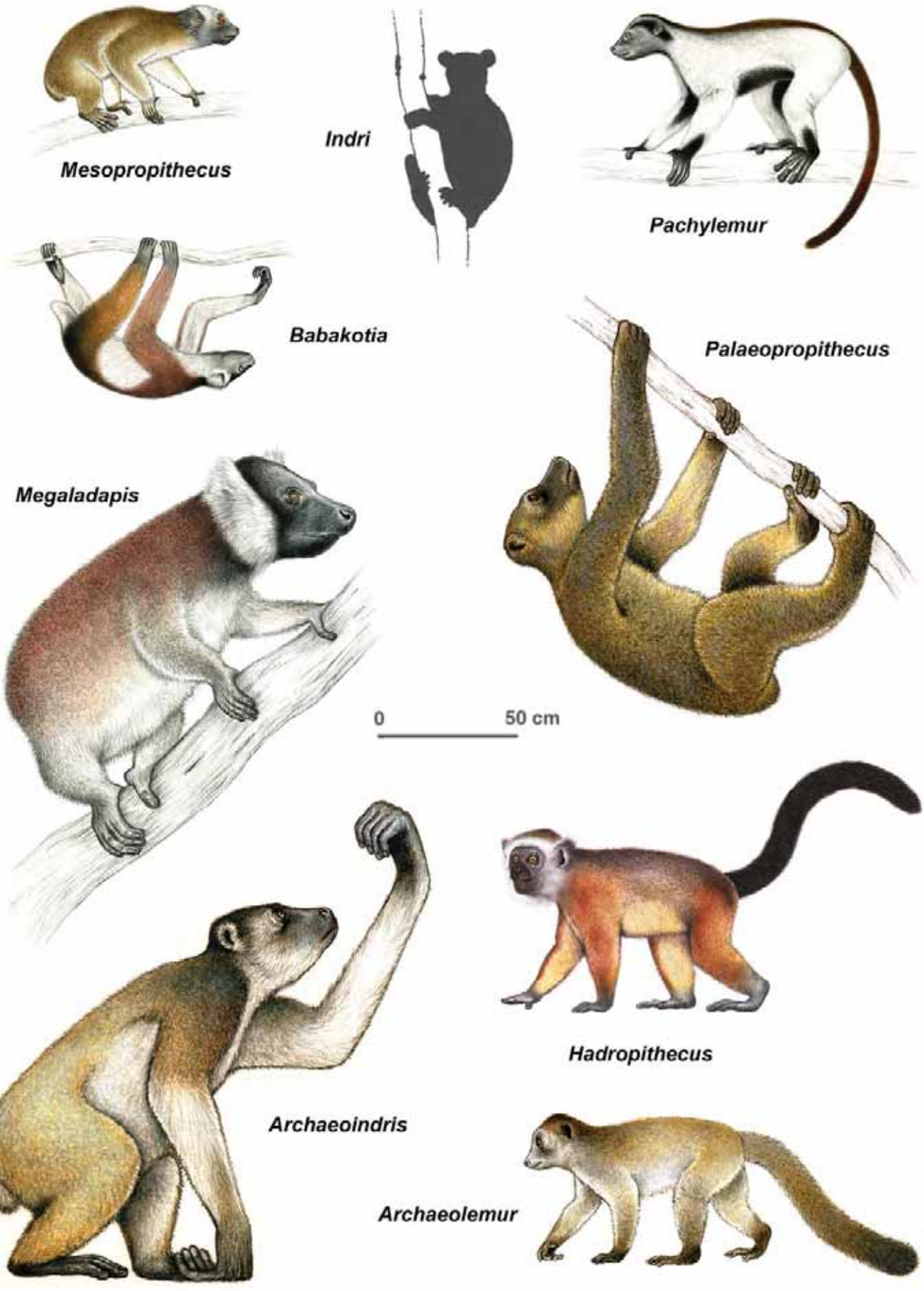
Table 4: Primate endemism in the most diverse countries on Earth: Taxa.

Country	Families	Genera	Taxa	Endemism
Madagascar	5/5	15/15	103/103	100%
Indonesia	0/5	1/10	53/70	75%
Brazil	0/5	4/19	83/139	60%
Colombia	0/5	0/13	17/52	32%
Democratic Republic of Congo	0/4	1/18	15/66	23%
Peru	0/6	1/14	7/50	14%

At latest count, Madagascar is home to five families, 15 genera, 99 species, and 103 taxa (including subspecies), all of them packed into an area that is probably on the order of 50,000–60,000 km^2, much of it inadequately or not at all protected. Particularly noteworthy is the presence of five endemic primate families representing unique evolutionary lineages found nowhere else. All of Madagascar's lemurs are endemic to that country and only a handful of species are kept in captivity in sustainable numbers, meaning that the future of the vast majority of species will remain in situ in the country.

Looking at the importance of Madagascar's primate fauna in another way, although the country is only one of 91 to have wild primate populations, it alone is home to 15% of all primate taxa (103 of 682), 21% of all primate species (99 of 480), 19% of all primate genera (15/77), and 29% of all primate families (5/17) – a great responsibility for any one country and a concentration of unique primate species unmatched by any other nation.

Our understanding of this unique biodiversity is undergoing extraordinary changes. New species are being discovered in Madagascar at an astonishing rate over the past two decades. When we wrote the first Field Guide to the Lemurs of Madagascar in 1994, we recognized a total of 50 species and subspecies. When we produced the second edition of this guide in 2006, we were already up to 71. In the most recent third edition of the field guide, published in 2010, we had reached 101. Since then, two more species have been described, and we know of quite a few more that await publication. These new discoveries are all the more remarkable given how little habitat remains.



Reconstructions of the eight subfossil lemur genera already extinct in Madagascar. The indri, the largest of the living genera, is included in silhouette to show scale. (Artwork by S. D. Nash, based on information provided by L. R. Godfrey and W. L. Jungers)

The diversity of the lemur fauna of Madagascar is even more impressive when one looks at the giant lemur species that disappeared since the arrival of humans on the island some 2,000–2,500 years ago. These included at least eight genera and 17 species, all of them larger than the surviving species and including animals that occupied niches comparable to those of the living tree sloths of South America, the extinct giant ground sloths of North and South America, the koala of Australia, and the baboons and vervets of savannah Africa. The largest of these extinct species, *Archaeoindris*, grew to be as large as an adult gorilla, and several others were in the 10–85 kg range, far larger than the indri, the largest surviving species, which reaches a maximum weight of 9 kg. The fact that this entire radiation of giant lemur species disappeared in very recent times (perhaps as recently as the end of the 19th century for some of these species), largely the result of human hunting pressure and modification of the environment, indicates clearly that large-scale extinctions are not a feature of the distant past but a modern human-induced phenomenon.

The future of Madagascar's lemurs has long been a conservation concern, and there have been quite a few publications documenting their status over the years (e.g., Richard and Sussman, 1975; Harcourt and Thornback, 1990; Mittermeier *et al*., 1992, 1994; Ganzhorn *et al*., 1996; Mittermeier *et al*., 2003, 2006, 2010). What is more, there has been considerable research on the behavior, ecology, and taxonomy of these animals, dating back to the first field studies in the late 1950s and early 1960s (Petter, 1962, 1965; Jolly, 1966), but increasing dramatically in the mid 1980s and continuing to the present day. There has also been a lot of conservation activity, including an Action Plan that we produced in 1992 (Mittermeier *et al*., 1992), and a host of field programs by organizations such as the WWF, Conservation International, the Wildlife Conservation Society, Durrell Wildlife Conservation Trust (formerly Jersey Wildlife Preservation Trust), the Institute for the Conservation of Tropical Environments at Stony Brook University, the Association Européenne pour l'Etude et la Conservation des Lémuriens (AEECL), the German Primate Center (DPZ), The Aspinall Foundation, Omaha's Henry Doorly Zoo & Aquarium, the Peregrine Fund, the Madagascar Fauna Group, and a number of Malagasy organizations such as GERP, Fanamby, Vahatra, to name but a few. This has all been positive, has greatly increased our knowledge of these animals, has resulted in some very important on-the-ground conservation impacts, and clearly has had an effect in preventing the extinction of some of the more threatened species.

Protected areas are absolutely critical to the future of lemurs and other biodiversity in Madagascar. As of 2003, only about 3% of Madagascar's land area was protected, corresponding to around 17,000 km^2 (1.7 million ha) or slightly more than the size of Connecticut, and only a small portion of this was effectively managed. However, under the administration of former President Marc Ravalomanana (2002-2009), there was real support for protected areas. At the World Parks Congress in Durban, South Africa (September 2003), the president declared his commitment to tripling protected area coverage and proceeded to implement this in what came to be known as the Durban Vision. This process was put in place, and good progress was made towards the objective, creating 29 new protected areas covering 3 million ha, with a further 1.1 million ha still in process. By January 2010 there were 4.7 million ha of protected areas in Madagascar, representing about 8% of the country and much of what remains in natural vegetation.

Sadly, that historic and very positive step was severely hampered by the unconstitutional change of power and the resulting political crisis that has engulfed Madagascar since early 2009. Although the Durban process is still in place, its implementation has been difficult due to the breakdown of government controls in many parts of the country. What was especially tragic was the almost immediate invasion of some of the country's most important eastern rainforest protected areas, notably Masoala and Marojejy National Parks in the northeast, for illegal cutting of valuable timber species such as rosewood, palissandre and others, as soon as law enforcement had broken down. Similar, though not as dramatic, impacts have been felt in other protected areas as well.

Outside of protected areas, the situation is even worse, since slash-and-burn agriculture, illegal logging, and, perhaps worst of all, hunting of lemurs is on the rise in many areas, with disastrous results. Indeed, there have even been sporadic incidents of commercial lemur hunting in some areas such as the Daraina region of northern

Madagascar and in several areas of the eastern rain forest where indris and diademed sifakas are being hunted to local extinction.

Exacerbating the problem is the fact that many donors suspended their environmental programs as a result of the unconstitutional change of power. USAID, for example, put on hold a comprehensive 25-year environmental program, although it continued to provide humanitarian assistance. Several European governments acted in a similar manner. Germany, one of the largest bilateral donors to Madagascar, temporarily suspended all development cooperation on a government level until the eventual return of the country to democracy. Likewise, Norway stopped all bilateral aid to Madagascar after the change of power in 2009, as did the European Union. Only the World Bank maintained its commitment, but even the substantial support that it has provided has not been effectively absorbed by the transition government.

In April 2005, we carried out an assessment of the conservation status of the lemurs for the IUCN Red List in the capital city of Antananarivo, as part of a comprehensive Global Mammal Assessment that was published in 2008. At that time, we found that 66% (45/68) of the 68 species and subspecies then known to science were in one of the three IUCN categories of threat, with 11 taxa Critically Endangered, 16 Endangered, and 18 Vulnerable, along with 14 in the Data Deficient category and only 6 taxa Near-Threatened or of Least Concern. In July 2012 we carried out a Red List re-assessment of all known lemurs (the first of a series of workshops as part of a new Global Mammal Assessment), now 103 taxa, again in Antananarivo and with the participation of more than 60 Malagasy and international experts. Perhaps not surprisingly, the results were worse than seven years earlier. Almost 94% of those lemur taxa for which sufficient data were available to enable their assessment against the Red List criteria are now classified as being threatened with extinction. Out of the 103 taxa, a staggering 24 were assessed as Critically Endangered, 49 as Endangered, 20 as Vulnerable, 3 as Near Threatened, 3 as Least Concern, and 4 as Data Deficient. Even species such as the well-known ring-tailed lemur (the taxon most often kept in captivity), previously considered to be relatively secure, was reassessed as Endangered. To ensure immediate action, the second half of this Red-Listing Workshop was used to prepare this Conservation Strategy, which we are now very pleased to present here.

Given all these threats, it is easy to become frustrated or even despondent. However, the situation is by no means hopeless. The key to achieving conservation action on behalf of lemurs, especially in this difficult transitional period for the Malagasy government, rests on several key elements.

The first of these is working closely with local communities. Madagascar has a strong tradition of community-based guide associations and other local groups working to achieve conservation in the areas surrounding key protected areas. Where there has been adequate training and basic support, this has worked very well, especially in places like Andasibe, Ranomafana, Maroantsetra, Daraina, Sahamalaza, Menabe, and many other sites. Indeed, in some areas such as Andasibe, local guide and community associations such as the Association des Guides d'Andasibe (AGA) and Mitsinjo have even created their own community reserves adjacent to national protected areas. These community groups can be supported at very low cost, and the models that already exist can be replicated in virtually every one of the priority project sites identified here.

The second key element is closely associated with the first, and focuses on the development of lemur ecotourism. Lemurs are already Madagascar's number one tourist attraction, and the number of sites to visit can be increased tenfold over the next five years, and probably a hundredfold over the next decade if adequate funding is available. Primate ecotourism, and especially primate watching and primate life-listing based on the bird model is taking off, and Madagascar is the number one destination for primate ecotourism in the world. There is simply no other place on Earth where one can see as many species in a short visit as in Madagascar, where a 7–10-day trip is sure to result in sighting of 15–20 species in the wild. This is a major asset for Madagascar, and should result in numerous economic benefits in terms of livelihood development for local communities and a major source of foreign exchange for the country as a whole. Indeed, in spite of the unstable political situation, tourism is still one



Sahamalaza sportive lemur (*Lepilemur sahamalazensis*), Critically Endangered. (Photo: Klaus Krieger)

of the largest foreign exchange earners for the country. But the potential is far greater, and there is no reason why tourism should not become the number one foreign exchange earner in the next five years. Lemurs hold the key to making this happen.

The third key element is maintaining a long-term research presence in important sites and creating new research projects on species and in areas not yet benefitting from such a presence. It has been proven time and time again that one of the best possible deterrents to poaching and habitat encroachment is a strong research presence in the form of a field station and a permanent presence of field workers, both international and local. This kind of scientific activity works closely with local communities, provides employment, enhances understanding, and serves as watchdog against illegal activities. Examples of this abound in Madagascar, with Ranomafana and Marojejy in the eastern rain forest, Kirindy in the western dry forest, Sahamalaza in the semi-humid forest of the northwest, and Berenty and Beza-Mahafaly in the southern spiny desert providing some of the best examples. This needs to be replicated or strengthened in the other key sites identified in this document, and it needs to be put in place as soon as possible.

It is also important to recognize that the establishment of captive colonies of endangered lemurs can play a role in our strategy to prevent lemur extinction. Although it will never be possible to keep all 103 species and subspecies in self-sustaining captive colonies, captive assurance colonies can be important for a number of species. Notable among these are the red-ruffed and black-and-white ruffed lemurs, both of which breed very well in captivity, as well as several species of brown lemur, the blue-eyed black lemur, the aye-aye, and several of the bamboo lemurs. The

conservation potential of the latter programs can be greatly enhanced by keeping them as open metapopulations sensu Lacy (2012), with continuing exchange between captive colonies and wild lemur populations. The sifakas, though rarely kept in captivity thus far, could also become a possibility for such assurance colonies, and they would serve as excellent ambassadors for Madagascar in foreign collections. And the animal with the most potential for an ambassadorial role, probably comparable to that of the giant panda for China, is the indri. Although it has never been kept successfully in captivity, the last time anyone tried was in the 1970s, when primate captive husbandry was at a very early stage. We should experiment with keeping this animal in a semi-natural setting in Madagascar, and then investigate possibilities for establishing breeding groups in key zoos on a long-term loan basis, similar to what has been achieved with the giant panda.

In closing, it is important to note that there exists a strong cadre of professional lemur conservationists, both in Madagascar and internationally. As should be evident from this plan, we know what is needed to prevent lemur extinctions. We know where most of the species occur (although we still have several new ones to describe), we know what the key protected areas are and where new ones should be located, we know what is needed to provide proper enforcement of existing legislation to protect lemurs, we know how to engage local communities to protect lemurs and their habitats, and we know how to create the mechanisms to ensure that these communities improve their quality of life in the process. What is lacking is adequate funding to put the required actions into place, to deploy our cadre of professional conservationists, and to get the job done as quickly as possible. We have a very short window of time to accomplish this, perhaps to the end of this decade. But if current trends continue, we will lose this opportunity for many of the species in the Critically Endangered and Endangered categories. The time is now, and we need everyone who has ever been enchanted by these wonderful, unique creatures to join with us over the next three years to get the job done.



Russell A. Mittermeier
Chair,
IUCN SSC Primate Specialist Group



Christoph Schwitzer
Vice-Chair for Madagascar, and
Red List Authority Coordinator,
IUCN SSC Primate Specialist Group



Jonah Ratsimbazafy
Vice-Chair for Madagascar,
IUCN SSC Primate Specialist Group



Steig Johnson
Deputy Vice-Chair for Madagascar,
IUCN SSC Primate Specialist Group

Strategic Planning for Lemur Conservation: The Process

Christoph Schwitzer, Russell A. Mittermeier, Steig Johnson & Jonah Ratsimbazafy

This Lemur Conservation Strategy 2013–2016 is one of the outputs from the Lemur Red-listing and Conservation Planning Workshop organized by the IUCN/SSC Primate Specialist Group on 9–14 July 2012, the first in a series of workshops to re-assess all mammals for the IUCN Red List. The workshop took place in Antananarivo, Madagascar, and was attended by more than 60 lemur experts, about 40 of whom were from Madagascar. It was supported financially and logistically by the Margot Marsh Biodiversity Foundation, Ambatovy Minerals S.A., the Mohamed bin Zayed Species Conservation Fund, Conservation International, and Virgin Unite.

The participants reviewed the status of all 103 described extant lemur taxa (species and subspecies); 96 of these taxa were reassessed, while seven were newly assessed using the IUCN Red List criteria. The preliminary results of the Red List assessments were as follows: 24 taxa Critically Endangered, 49 Endangered, 20 Vulnerable, 3 Near Threatened, 3 Least Concern, 4 Data Deficient. With almost 94% of all lemur taxa (for which sufficient data were available to enable their assessment against the Red List criteria) now classified as being threatened with extinction, this status review indicates that lemurs are probably the most endangered mammal group worldwide.

The second half of the workshop was dedicated to preparing a new Lemur Conservation Strategy. A previous lemur conservation action plan (Mittermeier *et al*., 1992) had been drawn up in 1992 and had expired in 1999. The workshop participants decided to draft a site-based conservation strategy as opposed to a taxonomy-based or threat-based plan; mainly since the lemur community in any one site is usually subjected to the same threats in its entirety. Two working groups, one covering eastern Madagascar and one dealing with the west, came up with 28 priority sites, based on the number of CR and EN species present in each site, overall species richness, and whether or not they were Alliance for Zero Extinction (AZE) sites (i.e., included species found only in a single location, and nowhere else in the world). Two regional groups then listed and prioritised threats to lemurs at each of their sites (divided into site-specific and cross-regional threats), specified mitigation measures, and listed site-level actions and actors, including budgets for implementation over the next three years. An auxiliary action plan was added for lemur species remaining in the Data Deficient category of the IUCN Red List. An additional small working group was tasked with defining a vision and desired state for the conservation strategy, and another one with drafting a strategy for *ex situ* conservation and captive assurance colonies for lemurs.

At the end of the workshop, small site-specific working groups were asked to write up two-page action plans for their respective sites, along with a more detailed table of actions and a budget for three years. The reader should note that the budgets provided indicate the general level of funding needed; more specific budgets for individual projects are available on request. These site-based action plans, along with the above-mentioned additional chapters, have been compiled into this Conservation Strategy for the Lemurs of Madagascar.

In addition to red-listing and conservation planning, the workshop participants also assessed all lemurs against vulnerability to climate change as part of an IUCN/WWF Madagascar-led pilot project. The results of that will be published elsewhere.

Lemur Conservation Status Review: An Overview of the Lemur Red-Listing Results 2012

Nicola Davies & Christoph Schwitzer



Coquerel's sifaka (*Propithecus coquereli*), Endangered (Photo: Nicola Davies)

The review of the conservation status of lemurs reported here was carried out in combination with a reassessment of all 103 extant lemur taxa against the IUCN Red List criteria during the IUCN workshop in Antananarivo in July 2012. The sites of occurrence of those taxa classified as Critically Endangered and Endangered were also assessed against the criteria for designation of AZE (Alliance for Zero Extinction) sites. The outcome of this status review was that almost 94% of those lemur taxa for which sufficient data were available to enable their assessment against the Red List criteria are now classified as being threatened with extinction. Out of the 103 taxa, 24 were assessed as Critically Endangered, 49 as Endangered, 20 as Vulnerable, 3 as Near Threatened, 3 as Least Concern, and 4 as Data Deficient. Fourteen sites with 18 Critically Endangered and Endangered species qualified as AZE sites.

The classification of species and subspecies into the three IUCN Red List "threatened" categories (Critically Endangered, Endangered and Vulnerable; see Table 1 for a definition) is based on a number of criteria and sub-criteria. These include: criterion A – which is concerned with population reduction and looks at percentage population declines that have occurred in the past and/or are expected in the future; criterion B – which is concerned with the geographic range of a species; criterion C – which accounts for population size and decline and looks at the number of mature individuals in the population; criterion D – which accounts for very small or restricted populations; and criterion E – which is a quantitative analysis used to indicate the probability of extinction in the wild[1]. AZE sites are defined as (a) containing at least one Endangered

[1]See IUCN Red List Categories and Criteria version 3.4 for a full account of the Red-Listing process used.

(EN) or Critically Endangered (CR) species; (b) being the sole area where that EN or CR species occurs, containing the overwhelmingly significant known resident population (>95%) of the species, or containing the overwhelmingly significant known population (>95%) for one life history segment (e.g. breeding or wintering) of the species; and (c) having a definable boundary within which habitats, biological communities, and/or management issues have more in common with each other than they do with those in adjacent areas (AZE, 2011).

The last full Red-List assessment of lemurs had been carried out by the Madagascar Section of the Primate Specialist Group at a workshop in Antananarivo, Madagascar, in 2005 (part of the Global Mammal Assessment). In the three years following that workshop, a plethora of new lemur species were described, and the IUCN Red List Unit added most of them as Data Deficient to the Red List in 2008 (without holding another workshop). This led to the unusual situation of 42 lemur taxa being classified as Data Deficient, a percentage almost triple as high as that for all mammals on the IUCN Red List (Vié et al., 2009). One aim of the 2012 workshop was thus to bring together enough new data to allow re-classification of the majority of the DD species.

Comparing the lemur classifications on the 2008 Red List with the results of the 2012 reassessment, the percentage of taxa in the three "threatened" categories increased from 74% to almost 94% (calculated according to IUCN criteria as [CR+EN+VU]/[Total–EX–DD–NE]*100; Tab. 2)[2]. This is against a background of primates becoming increasingly threatened with extinction worldwide. Whereas in 1996 41% of primates were threatened with extinction (96 out of 233 assessed species), and in 2004 38% (114/296), the 2012 Red List classified as threatened 56% of all primate species with known conservation status (206/362), and 57% of taxa (311/541), not taking into account the recent lemur re-assessments. Madagascar has now overtaken Asia (78% in 2012) as the primate habitat region with the highest percentage of threatened primate taxa. The reasons for the increase in the number of lemur taxa classified as threatened are two-fold. Firstly, escalating habitat destruction and alteration, severe habitat fragmentation, and unprecedented high levels of lemur hunting, enhanced by the political crisis gripping Madagascar since 2009, have inevitably led to the uplisting of several taxa. Secondly, the workshop re-classified 39 lemur taxa, most of them recently described, from Data Deficient to one of the "threatened" categories in the light of new data on their distribution ranges, population sizes and threats having become available (Table 3). The unusually high number of Data Deficient lemur taxa on the 2008 Red List had the effect of 'artificially deflating' the percentage of taxa in the "threatened" categories, a situation that was rectified by the 2012 reassessment.

Recent genetic and taxonomic research has resulted in the splitting of previously widespread species into new species with much smaller distribution ranges. Many of these newly described species were classified as threatened under the B criterion of the Red List at the 2012 workshop (Table 3). This is reflective of the severe fragmentation of forest habitats in Madagascar. An increasing number of lemurs are restricted to very small geographic ranges of decreasing habitat quality, some of which are unlikely to be viable, and are declining in number of subpopulations as well as mature individuals.

Many lemur taxa were also classified as threatened under criterion A, highlighting the significant reduction in population numbers due primarily to decline in area and quality of their habitat, as well as unsustainable levels of hunting by the local human population (Table 3). Concerns are also high for still wide-ranging species such as the aye-aye and ring-tailed lemur. Despite their relatively large ranges and adaptability, population densities of these species are now very low at many sites, and populations are restricted to isolated fragments.

Increasing threats, in addition to new information, warranted this reassessment and status review. And as the results show, new action and new conservation strategies are urgently needed. During the second half of the workshop, a list of 30 priority sites for lemur conservation was drawn up. The priority sites were chosen based on the number of Critically Endangered and Endangered lemur taxa that occur there (Table 4; Figs. 1–3), in addition to whether or not the sites qualified for AZE recognition. These priority sites form the basis of this conservation strategy. Conservation action plans have been formulated for each of them and are described in the following chapters.

[2]Note that the 2012 results are preliminary and had, at the time of printing, not yet been published on the IUCN Red List website.

Table 1: IUCN Red List categories. (Source: IUCN Red List Categories and Criteria version 3.1; IUCN, 2001)

EXTINCT (EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed Extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
EXTINCT IN THE WILD (EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), through-out its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
CRITICALLY ENDANGERED (CR)	A taxon which is Critically Endangered is considered to be facing an extremely high risk of extinction in the wild.
ENDANGERED (EN)	A taxon which is Endangered is considered to be facing a very high risk of extinction in the wild.
VULNERABLE (VU)	A taxon which is Vulnerable is considered to be facing a high risk of extinction in the wild.
NEAR THREATENED (NT)	A taxon which is Near Threatened is close to qualifying for or is likely to qualify for a threatened category in the near future.
LEAST CONCERN (LC)	A taxon which is Least Concern does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
DATA DEFICIENT (DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.
NOT EVALUATED (NE)	A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Table 2: Comparison of Red List assessments of lemurs in 2008 and 2012

Category	**2008**		**2012**	
	No. of species	**%**	**No. of species**	**%**
CR	6	5.9	24	23.3
EN	17	16.8	49	47.6
VU	14	13.9	20	19.4
LC/NT	13	12.8	6	5.8
DD	42	41.6	4	3.9
NE	9	8.9	0	0.0
Total	**101**		**103**	
% CR+EN+VU[3]		**74**		**93.9**

[3]Calculated according to IUCN criteria as (CR+EN+VU)/(Total-EX-DD-NE)*100

Table 3: Lemur re-assessments - categories on 2008 Red List, and categories and criteria after 2012 workshop.

Scientific name	Common name	Red List status 2008	Post Workshop Red List status	Post Workshop Category	Occurrence in Alliance for Zero Extinction (AZE) Site
CRITICALLY ENDANGERED					
Microcebus mamiratra	Claire's mouse lemur	DD	**CR**	B1ab(i,ii,iii)	Yes
Microcebus gerpi	Gerp's mouse lemur		**CR**	B1ab(iii)+2ab(iii)	Yes
Microcebus marohita	Marohita mouse lemur	NE	**CR**	B1ab(iii)	
Cheirogaleus sibreei	Sibree's dwarf lemur	DD	**CR**	B2ab(iii)	
Lepilemur jamesorum	James' sportive lemur	DD	**CR**	B1ab(iii,v)	Yes
Lepilemur fleuretae	Madame Fleurette's sportive lemur	DD	**CR**	B2ab(iii)	Yes
Lepilemur septentrionalis	Northern sportive lemur	CR	**CR**	A2acd+3cd+4acd;B2ab(i,ii,iii,iv,v);C2a(i,ii);D	
Lepilemur tymerlachsonorum	Nosy Be sportive lemur	DD	**CR**	B1ab(i,iii,v)	Yes
Lepilemur sahamalazensis	Sahamalaza sportive lemur	DD	**CR**	A2acd+3cd+4acd;B2ab(i,ii,iii,iv,v)	Yes
Hapalemur alaotrensis	Lake Alaotra bamboo lemur	CR	**CR**	A2acd	Yes
Hapalemur aureus	Golden bamboo lemur	EN	**CR**	C2a(i)	
Prolemur simus	Greater bamboo lemur	CR	**CR**	A4cd	
Eulemur cinereiceps	White-collared brown lemur	EN	**CR**	A4cde	
Eulemur flavifrons	Blue-eyed black lemur	CR	**CR**	A4cd	Yes
Eulemur mongoz	Mongoose lemur	VU	**CR**	A4bcde	
Varecia variegata		CR	**CR**	A2cd	
Varecia variegata ssp. variegata	Black-and-white ruffed lemur	CR	**CR**	A2cd	
Varecia variegata ssp. editorum	Southern black-and-white ruffed lemur	CR	**CR**	A2cd	
Varecia variegata ssp. subcincta	White-belted ruffed lemur	CR	**CR**	A2cd	
Varecia rubra	Red ruffed lemur	EN	**CR**	A3cd	Yes
Propithecus tattersalli	Tattersall's sifaka	EN	**CR**	A3cd	
Propithecus diadema	Diademed sifaka	EN	**CR**	A3cd	
Propithecus candidus	Silky sifaka	CR	**CR**	C2a(i)	
Propithecus perrieri	Perrier's sifaka	CR	**CR**	C2a(ii)	
Indri indri	Indri	EN	**CR**	A3cd	
ENDANGERED					
Microcebus berthae	Madame Berthe's mouse lemur	EN	**EN**	B1ab(i,ii,iii,iv,v)	
Microcebus ravelobensis	Golden-brown mouse lemur	EN	**EN**	B1ab(iii)	
Microcebus bongolavensis	Bongolava mouse lemur	DD	**EN**	B1ab(iii)	
Microcebus danfossorum	Danfoss' mouse lemur	DD	**EN**	B1ab(i,ii,iii,iv,v)	
Microcebus margotmarshae	Margot Marsh's mouse lemur		**EN**	B1ab(iii)	
Microcebus sambiranensis	Sambirano mouse lemur	EN	**EN**	B1ab(iii)	
Microcebus arnholdi	Arnhold's mouse lemur		**EN**	B1ab(iii)	
Microcebus jollyae	Jolly's mouse lemur	DD	**EN**	B1ab(iii)	Yes
Microcebus simmonsi	Simmons' mouse lemur	DD	**EN**	B1ab(iii)	
Microcebus macarthurii	MacArthur's mouse lemur		**EN**	B1ab(iii)	
Microcebus mittermeieri	Mittermeier's mouse lemur	DD	**EN**	B1ab(iii)	

Scientific name	Common name	Red List status 2008	Post Workshop Red List status	Post Workshop Category	Occurrence in Alliance for Zero Extinction (AZE) Site
Mirza coquereli	Coquerel's giant mouse lemur	NT	**EN**	A2c+3c+4c	
Mirza zaza	Northern giant mouse lemur	VU	**EN**	A4cd	
Phaner pallescens	Pale fork-marked lemur	LC	**EN**	A2bc+3bc+4bc	
Phaner parienti	Sambirano fork-marked lemur	VU	**EN**	B1ab(ii,iii)	
Phaner electromontis	Montagne d'Ambre fork-marked lemur	VU	**EN**	B1ab(iii)	
Lepilemur betsileo	Betsileo sportive lemur	DD	**EN**	B1ab(iii)	Yes
Lepilemur microdon	Small-toothed sportive lemur	DD	**EN**	B1ab(iii,v)	
Lepilemur wrightae	Wright's sportive lemur	DD	**EN**	B1ab(i,iii,v)	Yes
Lepilemur hollandorum	Holland's sportive lemur		**EN**	B1ab(i,iii)	Yes
Lepilemur scottorum	Scott's sportive lemur		**EN**	B1ab(i,iii,v)	
Lepilemur milanoii	Daraina sportive lemur	DD	**EN**	B1ab(iii,v)	
Lepilemur ankaranensis	Ankarana sportive lemur	EN	**EN**	B1ab(iii,v)	
Lepilemur mittermeieri	Mittermeier's sportive lemur	DD	**EN**	B1ab(i,iii,v)	
Lepilemur grewcockorum	Grewcock's sportive lemur	DD	**EN**	B1ab(iii,v)	
Lepilemur otto	Otto's sportive lemur	DD	**EN**	B1ab(i,iii,v)	
Lepilemur edwardsi	Milne-Edwards' sportive lemur	VU	**EN**	A3cd+4cd	
Lepilemur ahmansonorum	Ahmanson's sportive lemur	DD	**EN**	B1ab(iii)	
Lepilemur randrianasoloi	Randrianasolo's sportive lemur	DD	**EN**	B1ab(i,iii,v)	
Lepilemur hubbardorum	Hubbard's sportive lemur	DD	**EN**	B1ab(iii)	Yes
Lepilemur leucopus	White-footed sportive lemur	DD	**EN**	B1ab(iii,v)	Yes
Hapalemur griseus ssp. gilberti	Gilbert's grey bamboo lemur	DD	**EN**	B1ab(iii)	
Lemur catta	Ring-tailed lemur	NT	**EN**	A4cd	
Eulemur albifrons	White-fronted brown lemur	VU	**EN**	A2cde	
Eulemur sanfordi	Sanford's brown lemur	EN	**EN**	B1ab(i,ii,iii,v)	
Eulemur collaris	Collared brown lemur	VU	**EN**	A2cd+4cd	
Eulemur coronatus	Crowned lemur	VU	**EN**	A3cd	
Avahi mooreorum	Moore's woolly lemur		**EN**	B1ab(iii,v)	Yes
Avahi betsileo	Betsileo woolly lemur	DD	**EN**	B1ab(iii)	Yes
Avahi meridionalis	Southern woolly lemur	DD	**EN**	B1ab(iii,v)	
Avahi occidentalis	Western woolly lemur	EN	**EN**	B1ab(iii)	
Avahi cleesei	Cleese's woolly lemur	EN	**EN**	B1ab(i,ii,iii)	Yes
Avahi unicolor	Sambirano woolly lemur	DD	**EN**	B1ab(i,iii)	
Propithecus verreauxi	Verreaux's sifaka	VU	**EN**	A2cd+3cd+4cd	
Propithecus deckenii	Decken's sifaka	VU	**EN**	A2cd+3cd+4cd	
Propithecus coronatus	Crowned sifaka	EN	**EN**	A2cd	
Propithecus coquereli	Coquerel's sifaka	EN	**EN**	A2cd	
Propithecus edwardsi	Milne-Edwards' sifaka	EN	**EN**	A2cd+3cd+4cd	
Daubentonia madagascariensis	Aye aye	NT	**EN**	A2cd+4cd	

Scientific name	Common name	Red List status 2008	Post Workshop Red List status	Post Workshop Category	Occurrence in Alliance for Zero Extinction (AZE) Site
VULNERABLE					
Microcebus myoxinus	Pygmy mouse lemur	DD	**VU**	A2c+4c	
Microcebus tavaratra	Tavaratra mouse lemur	EN	**VU**	B1ab(iii)	
Microcebus rufus	Red mouse lemur	LC	**VU**	B1ab(iii)	
Microcebus lehilahytsara	Goodman's mouse lemur	DD	**VU**	B1ab(iii)	
Allocebus trichotis	Hairy-eared mouse lemur	DD	**VU**	A2c+3c+4c	
Phaner furcifer	Masoala fork-marked lemur	LC	**VU**	A2c+3c+4c	
Lepilemur seali	Seal's sportive lemur	DD	**VU**	B1ab(i,iii,v)	
Lepilemur dorsalis	Grey-backed sportive lemur	DD	**VU**	B1ab(iii)	
Lepilemur aeeclis	AEECL's sportive lemur	DD	**VU**	B1ab(iii)	
Lepilemur ruficaudatus	Red-tailed sportive lemur	DD	**VU**	B1ab(i,iii,v)	
Lepilemur petteri	Petter's sportive lemur	DD	**VU**	B1ab(i,iii,v)	
Hapalemur griseus		VU	**VU**	A2cd	
Hapalemur griseus ssp. griseus	Grey bamboo lemur	VU	**VU**	A2cd+3cd+4cd	
Hapalemur meridionalis	Southern bamboo lemur	VU	**VU**	B1ab(iii,v)	
Hapalemur occidentalis	Northern bamboo lemur	VU	**VU**	A2cd	
Eulemur rufus	Rufous brown lemur	DD	**VU**	A4cd	
Eulemur macaco	Black lemur	VU	**VU**	B1ab(i,ii,iii,v)	
Eulemur rubriventer	Red-bellied lemur	VU	**VU**	A2cd	
Avahi laniger	Eastern woolly lemur	LC	**VU**	A3cd	
Avahi peyrierasi	Peyrieras' woolly lemur	DD	**VU**	A3cd	
Avahi ramanantsoavanai	Ramanantsoavana's woolly lemur	DD	**VU**	B1ab(i,iii,v)	
NEAR THREATENED					
Lepilemur mustelinus	Weasel sportive lemur	DD	**NT**		
Eulemur fulvus	Common brown lemur	NT	**NT**		
Eulemur rufifrons	Red-fronted brown lemur	NT	**NT**		
LEAST CONCERN					
Microcebus murinus	Common mouse lemur	LC	**LC**		
Microcebus griseorufus	Grey-brown mouse lemur	LC	**LC**		
Cheirogaleus medius	Fat-tailed dwarf lemur	LC	**LC**		
DATA DEFICIENT					
Cheirogaleus major	Greater dwarf lemur	LC	**DD**		
Cheirogaleus crossleyi	Crossley's dwarf lemur	DD	**DD**		
Cheirogaleus minusculus	Lesser iron-grey dwarf lemur	DD	**DD**		
Hapalemur griseus ssp. ranomafanensis	Ranomafana grey bamboo lemur		**DD**		

Table 4: Action plan site locations of lemur taxa.

Scientific name	Common name	Action Plan Site Locality
CRITICALLY ENDANGERED		
Microcebus mamiratra	Claire's mouse lemur	Nosy Be
Microcebus gerpi	Gerp's mouse lemur	
Microcebus marohita	Marohita mouse lemur	Ambositra–Vondrozo Corridor
Cheirogaleus sibreei	Sibree's dwarf lemur	Makira; Anjozorobe–Angavo & Tsinjoarivo; Ambositra–Vondrozo Corridor; Ranomafana National Park
Lepilemur jamesorum	James' sportive lemur	Manombo Forest
Lepilemur fleuretae	Madame Fleurette's sportive lemur	Andohahela & Tsitongambarika
Lepilemur septentrionalis	Northern sportive lemur	Montagne des Français
Lepilemur tymerlachsonorum	Nosy Be sportive lemur	Nosy Be
Lepilemur sahamalazensis	Sahamalaza sportive lemur	Sahamalaza – Iles Radama
Hapalemur alaotrensis	Lake Alaotra bamboo lemur	Lake Alaotra
Hapalemur aureus	Golden bamboo lemur	Ambositra–Vondrozo Corridor; Ranomafana National Park
Prolemur simus	Greater bamboo lemur	Ankeniheny–Zahamena Corridor (CAZ); Anjozorobe–Angavo & Tsinjoarivo; Ambositra–Vondrozo Corridor; Ranomafana National Park; Kianjavato
Eulemur cinereiceps	White-collared brown lemur	Ambositra–Vondrozo Corridor; Manombo Forest
Eulemur flavifrons	Blue-eyed black lemur	Sahamalaza – Iles Radama
Eulemur mongoz	Mongoose lemur	Ambato Boeny; Ankarafantsika National Park; Mahavavy Kinkony; Antrema; Bombetoka–Belemboka
Varecia variegata		Ankeniheny–Zahamena Corridor (CAZ); Betampona Natural Reserve; Fandriana Marolambo Forest Corridor
Varecia variegata ssp. variegata	Black-and-white ruffed lemur	Ankeniheny–Zahamena Corridor (CAZ); Betampona Natural Reserve
Varecia variegata ssp. editorum	Southern black-and-white ruffed lemur	Ambositra–Vondrozo Corridor; Ranomafana National Park; Kianjavato; Manombo Forest; Fandriana Marolambo Forest Corridor
Varecia variegata ssp. subcincta	White-belted ruffed lemur	Makira; Mananara Nord National Park; Nosy Be
Varecia rubra	Red ruffed lemur	Masoala
Propithecus tattersalli	Tattersall's sifaka	Daraina

Scientific name	Common name	Action Plan Site Locality
Propithecus diadema	Diademed sifaka	Mananara Nord National Park; Ankeniheny–Zahamena Corridor (CAZ); Betampona Natural Reserve; Anjozorobe–Angavo & Tsinjoarivo
Propithecus candidus	Silky sifaka	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Makira
Propithecus perrieri	Perrier's sifaka	Analamerana and Andrafiamena
Indri indri	Indri	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Makira; Mananara Nord National Park; Ankeniheny–Zahamena Corridor (CAZ); Betampona Natural Reserve; Anjozorobe–Angavo & Tsinjoarivo
ENDANGERED		
Microcebus berthae	Madame Berthe's mouse lemur	Kirindy–Ambadira (Central Menabe)
Microcebus ravelobensis	Golden-brown mouse lemur	Ankarafantsika National Park
Microcebus bongolavensis	Bongolava mouse lemur	Anjiamangirana and Marosely
Microcebus danfossorum	Danfoss' mouse lemur	Anjiamangirana and Marosely
Microcebus margotmarshae	Margot Marsh's mouse lemur	
Microcebus sambiranensis	Sambirano mouse lemur	
Microcebus arnholdi	Arnhold's mouse lemur	
Microcebus jollyae	Jolly's mouse lemur	Kianjavato; Manombo Forest
Microcebus simmonsi	Simmons' mouse lemur	Ankeniheny–Zahamena Corridor (CAZ); Betampona Natural Reserve
Microcebus macarthurii	MacArthur's mouse lemur	Makira
Microcebus mittermeieri	Mittermeier's mouse lemur	Marojejy National Park and Anjanaharibe-Sud Special Reserve
Mirza coquereli	Coquerel's giant mouse lemur	Makay; Kirindy–Ambadira (Central Menabe); Tsingy de Bemaraha
Mirza zaza	Northern giant mouse lemur	Sahamalaza – Iles Radama
Phaner pallescens	Pale fork-marked lemur	Kirindy–Ambadira (Central Menabe); Tsingy de Bemaraha
Phaner parienti	Sambirano fork-marked lemur	
Phaner electromontis	Montagne d'Ambre fork-marked lemur	Daraina; Analamerana and Andrafiamena
Lepilemur betsileo	Betsileo sportive lemur	Ambositra–Vondrozo Corridor; Fandriana Marolambo Forest Corridor
Lepilemur microdon	Small-toothed sportive lemur	Ambositra–Vondrozo Corridor; Ranomafana National Park
Lepilemur wrightae	Wright's sportive lemur	Kalambatritra Massif
Lepilemur hollandorum	Holland's sportive lemur	Mananara Nord National Park
Lepilemur scottorum	Scott's sportive lemur	Masoala

Scientific name	Common name	Action Plan Site Locality
Lepilemur milanoii	Daraina sportive lemur	Daraina
Lepilemur ankaranensis	Ankarana sportive lemur	Analamerana and Andrafiamena
Lepilemur mittermeieri	Mittermeier's sportive lemur	Sahamalaza – Iles Radama
Lepilemur grewcockorum	Grewcock's sportive lemur	Anjiamangirana and Marosely
Lepilemur otto	Otto's sportive lemur	Anjiamangirana and Marosely
Lepilemur edwardsi	Milne-Edwards' sportive lemur	Ankarafantsika National Park; Antrema
Lepilemur ahmansonorum	Ahmanson's sportive lemur	
Lepilemur randrianasoloi	Randrianasolo's sportive lemur	Tsingy de Bemaraha
Lepilemur hubbardorum	Hubbard's sportive lemur	
Lepilemur leucopus	White-footed sportive lemur	Andohahela & Tsitongambarika; Mahafaly and Mandrare: The Spiny Forest Ecosystem
Hapalemur griseus ssp. gilberti	Gilbert's grey bamboo lemur	Ambositra–Vondrozo Corridor
Lemur catta	Ring-tailed lemur	Ambositra–Vondrozo Corridor; Kalambatritra Massif; Andohahela & Tsitongambarika; Mahafaly and Mandrare: The Spiny Forest Ecosystem; Makay
Eulemur albifrons	White-fronted brown lemur	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Masoala; Makira; Mananara Nord National Park; Betampona Natural Reserve; Nosy Be
Eulemur sanfordi	Sanford's brown lemur	Daraina; Analamerana and Andrafiamena
Eulemur collaris	Collared brown lemur	Kalambatritra Massif; Andohahela & Tsitongambarika
Eulemur coronatus	Crowned lemur	Daraina; Analamerana and Andrafiamena; Montagne des Français
Avahi mooreorum	Moore's woolly lemur	Masoala
Avahi betsileo	Betsileo woolly lemur	Ambositra–Vondrozo Corridor
Avahi meridionalis	Southern woolly lemur	Andohahela & Tsitongambarika
Avahi occidentalis	Western woolly lemur	Ankarafantsika National Park
Avahi cleesei	Cleese's woolly lemur	Tsingy de Bemaraha
Avahi unicolor	Sambirano woolly lemur	
Propithecus verreauxi	Verreaux's sifaka	Andohahela & Tsitongambarika; Mahafaly and Mandrare: The Spiny Forest Ecosystem; Makay; Kirindy–Ambadira (Central Menabe)
Propithecus deckenii	Decken's sifaka	Tsingy de Bemaraha; Mahavavy Kinkony

Scientific name	Common name	Action Plan Site Locality
Propithecus coronatus	Crowned sifaka	Ambato Boeny; Mahavavy Kinkony; Antrema; Bombetoka–Belemboka
Propithecus coquereli	Coquerel's sifaka	Ankarafantsika National Park; Anjiamangirana and Marosely
Propithecus edwardsi	Milne-Edwards' sifaka	Ambositra–Vondrozo Corridor; Ranomafana National Park; Fandriana Marolambo Forest Corridor; Andohahela & Tsitongambarika
Daubentonia madagascariensis	Aye aye	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Masoala; Makira; Mananara Nord National Park; Ankeniheny–Zahamena Corridor (CAZ); Betampona Natural Reserve; Anjozorobe–Angavo & Tsinjoarivo; Ambositra–Vondrozo Corridor; Ranomafana National Park; Kianjavato; Manombo Forest; Kalambatritra Massif; Andohahela & Tsitongambarika; Makay; Tsingy de Bemaraha; Anjiamangirana and Marosely; Sahamalaza – Iles Radama; Nosy Be; Daraina; Analamerana and Andrafiamena
VULNERABLE		
Microcebus myoxinus	Pygmy mouse lemur	Tsingy de Bemaraha; Mahavavy Kinkony
Microcebus tavaratra	Tavaratra mouse lemur	Daraina; Analamerana and Andrafiamena; Montagne des Français
Microcebus rufus	Red mouse lemur	Lake Alaotra; Ambositra–Vondrozo Corridor; Ranomafana National Park
Microcebus lehilahytsara	Goodman's mouse lemur	Ankeniheny–Zahamena Corridor (CAZ); Anjozorobe–Angavo & Tsinjoarivo
Allocebus trichotis	Hairy-eared mouse lemur	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Masoala; Mananara Nord National Park; Ankeniheny–Zahamena Corridor (CAZ)
Phaner furcifer	Masoala fork-marked lemur	Masoala; Makira; Mananara Nord National Park; Ankeniheny–Zahamena Corridor (CAZ); Makay
Lepilemur seali	Seal's sportive lemur	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Makira
Lepilemur dorsalis	Grey-backed sportive lemur	
Lepilemur aeeclis	AEECL's sportive lemur	
Lepilemur ruficaudatus	Red-tailed sportive lemur	Makay; Kirindy–Ambadira (Central Menabe)
Lepilemur petteri	Petter's sportive lemur	Mahafaly and Mandrare: The Spiny Forest Ecosystem
Hapalemur griseus		
Hapalemur griseus ssp. griseus	Grey bamboo lemur	Betampona Natural Reserve; Kianjavato
Hapalemur meridionalis	Southern bamboo lemur	Manombo Forest; Kalambatritra Massif; Andohahela & Tsitongambarika

Scientific name	Common name	Action Plan Site Locality
Hapalemur occidentalis	Northern bamboo lemur	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Masoala; Makira; Mananara Nord National Park; Ankeniheny–Zahamena Corridor (CAZ); Mahavavy Kinkony; Sahamalaza – Iles Radama; Daraina; Analamerana and Andrafiamena
Eulemur rufus	Rufous brown lemur	Tsingy de Bemaraha; Ambato Boeny; Mahavavy Kinkony
Eulemur macaco	Black lemur	Sahamalaza – Iles Radama; Nosy Be
Eulemur rubriventer	Red-bellied lemur	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Ankeniheny–Zahamena Corridor (CAZ); Ambositra–Vondrozo Corridor; Ranomafana National Park; Kianjavato
Avahi laniger	Eastern woolly lemur	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Makira; Mananara Nord National Park; Ankeniheny–Zahamena Corridor (CAZ); Anjozorobe–Angavo & Tsinjoarivo
Avahi peyrierasi	Peyrieras' woolly lemur	Ambositra–Vondrozo Corridor; Ranomafana National Park; Kianjavato
Avahi ramanantsoavanai	Ramanantsoavana's woolly lemur	Ambositra–Vondrozo Corridor; Manombo Forest
NEAR THREATENED		
Lepilemur mustelinus	Weasel sportive lemur	Ankeniheny–Zahamena Corridor (CAZ); Betampona Natural Reserve
Eulemur fulvus	Common brown lemur	Ankeniheny–Zahamena Corridor (CAZ); Fandriana Marolambo Forest Corridor; Ankarafantsika National Park; Anjiamangirana and Marosely
Eulemur rufifrons	Red-fronted brown lemur	Ambositra–Vondrozo Corridor; Ranomafana National Park; Kianjavato; Makay; Kirindy–Ambadira (Central Menabe)
LEAST CONCERN		
Microcebus murinus	Common mouse lemur	Andohahela & Tsitongambarika; Makay; Kirindy–Ambadira (Central Menabe); Ankarafantsika National Park; Mahavavy Kinkony; Antrema; Anjiamangirana and Marosely
Microcebus griseorufus	Grey-brown mouse lemur	Andohahela & Tsitongambarika; Makay
Cheirogaleus medius	Fat-tailed dwarf lemur	Andohahela & Tsitongambarika; Makay; Kirindy–Ambadira (Central Menabe); Ankarafantsika National Park; Mahavavy Kinkony; Anjiamangirana and Marosely; Sahamalaza – Iles Radama; Nosy Be; Daraina; Analamerana and Andrafiamena

Scientific name	Common name	Action Plan Site Locality
DATA DEFICIENT		
Cheirogaleus major	Greater dwarf lemur	Marojejy National Park and Anjanaharibe-Sud Special Reserve; Masoala; Mananara Nord National Park; Betampona Natural Reserve; Ambositra–Vondrozo Corridor; Ranomafana National Park; Manombo Forest
Cheirogaleus crossleyi	Crossley's dwarf lemur	Ankeniheny–Zahamena Corridor (CAZ); Ambositra–Vondrozo Corridor; Ranomafana National Park
Cheirogaleus minusculus	Lesser iron-grey dwarf lemur	
Hapalemur griseus ssp. ranomafanensis	Ranomafana grey bamboo lemur	Ambositra–Vondrozo Corridor; Ranomafana National Park; Makay; Tsingy de Bemaraha

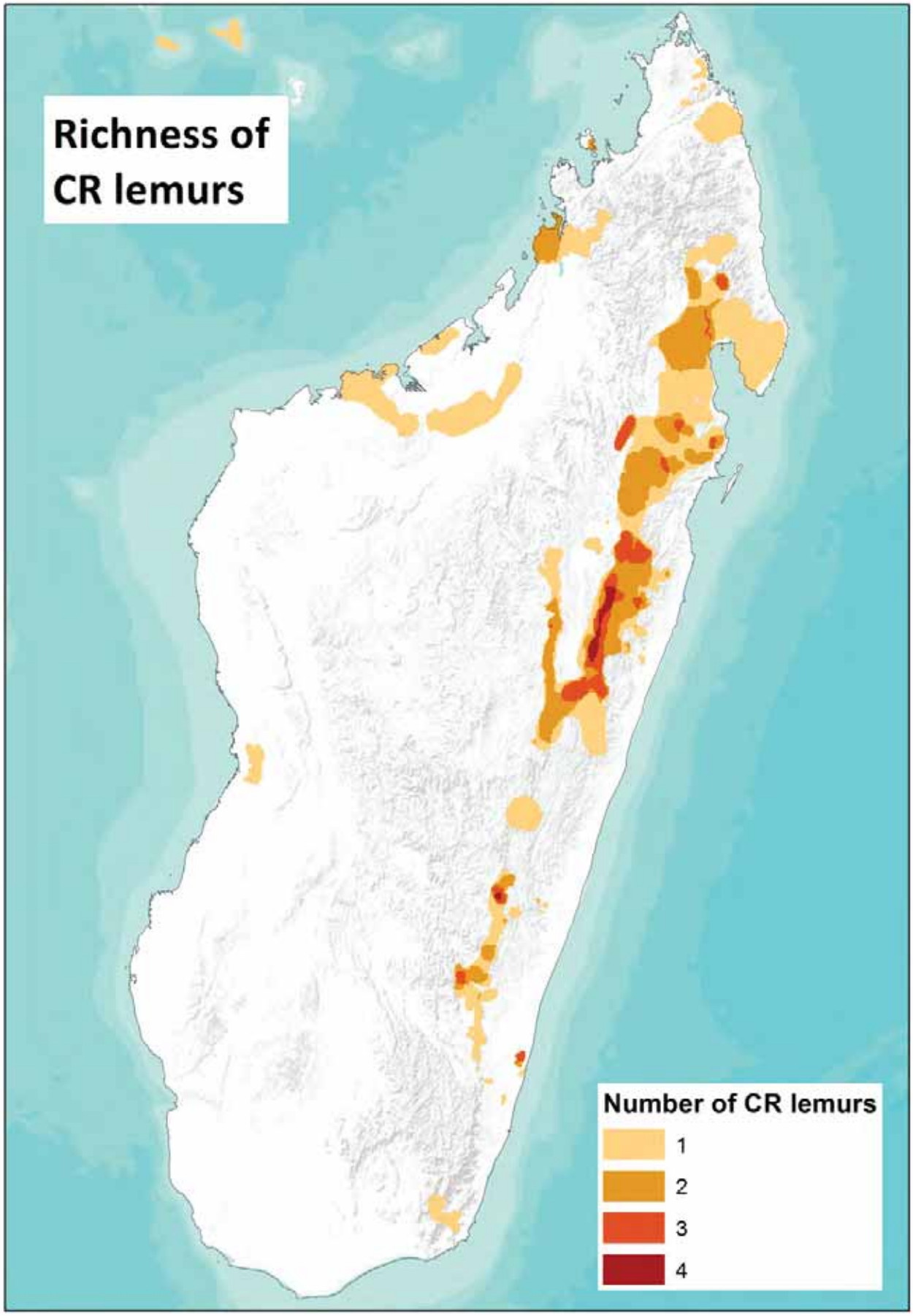


Fig. 1: Distribution and richness of Critically Endangered lemurs (results from 2012 Red List workshop). (Source: Federica Chiozza, Department of Biology and Biotechnology, Sapienza Università di Roma)

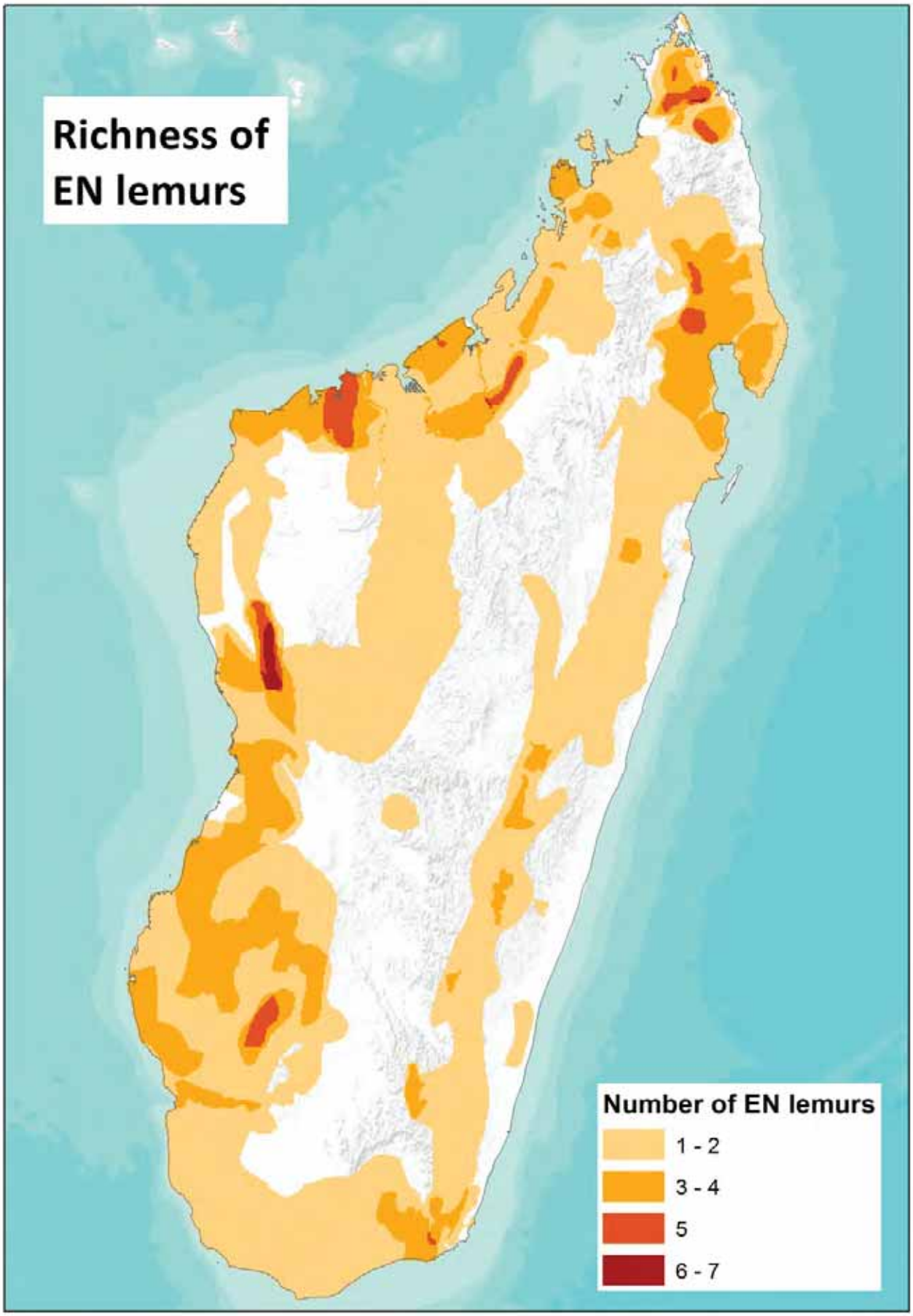


Fig. 2: Distribution and richness of Endangered lemurs (results from 2012 Red List workshop). (Source: Federica Chiozza, Department of Biology and Biotechnology, Sapienza Università di Roma)

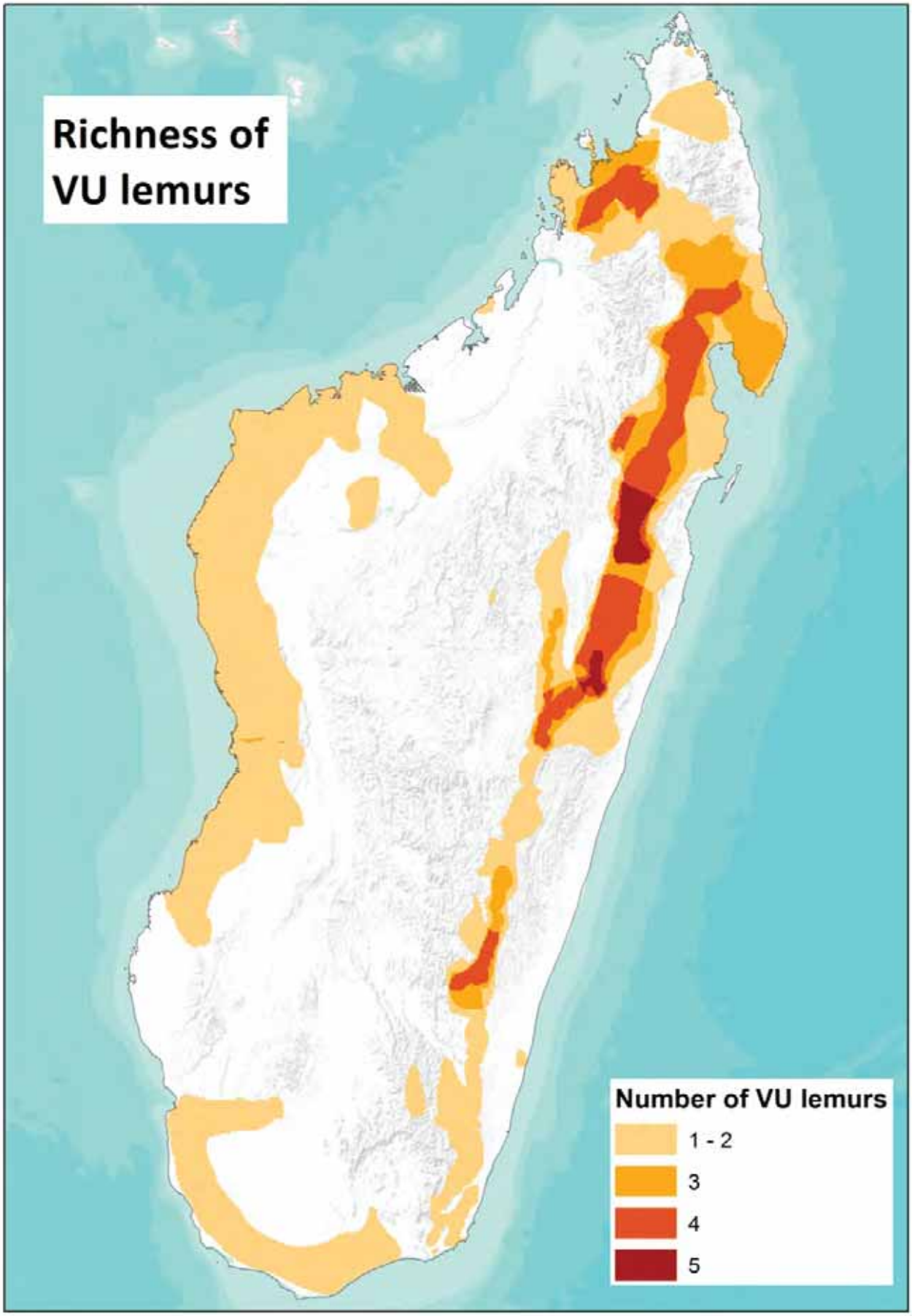


Fig. 3: Distribution and richness of Vulnerable lemurs (results from 2012 Red List workshop). (Source: Federica Chiozza, Department of Biology and Biotechnology, Sapienza Università di Roma)

Vision

Many lemur species are on the very brink of extinction. Ninety-one per cent of all lemur taxa (species and subspecies) are now classified as Critically Endangered, Endangered, or Vulnerable on the IUCN Red List of Threatened Species. This probably makes lemurs the most threatened group of mammals on Earth.
We know what is needed to prevent lemur extinctions, yet we have a very short window of time to accomplish this. Given the very high and imminent risk of extinction faced by all lemurs, we must act *now*.

The vision of this Lemur Conservation Strategy is to:

• Prevent the extinction of all lemur species within the next decade and ensure their long-term survival by reversing the current decline of populations and habitats;

• Implement immediate conservation action that directly supports sustainable development and improves livelihoods in local communities, while affirming respect for human rights;

• Increase and share the scientific and traditional knowledge critical for conservation; and

• Promote lemurs as a unique natural and cultural heritage for Madagascar and the world.



Ankarana sportive lemur (*Lepilemur ankaranensis*), Endangered. Ankarana. (Photo: Russell A. Mittermeier)

Objectives and Actions: An Overview

After having established a joint vision for the Lemur Conservation Strategy, the workshop participants formed two working groups, one for eastern and one for western Madagascar, and prioritised lemur conservation objectives and actions for the three-year period of 2013–2016. The resulting list of objectives and actions was then used to draw up site-based conservation strategies for each of the 30 priority lemur conservation sites subsequently identified by the working groups. Since the site-based strategies were written by different teams of contributors, the list of objectives and actions addressed the need for a common terminology from which the teams were able to draw for their respective lists of site-based objectives/actions.

The list, subsequently cleared of redundancies, is reproduced below. Actions are divided into national (N) and local (L) scales.

1. Stop habitat loss and degradation

a. Promote awareness of environmental laws, through:
   i. Education (N, L);
   ii. Lobbying (N);
   iii. Clearer demarcation of PA boundaries (L).
b. Promote enforcement of environmental laws:
   i. Create or support civil society organizations that focus on environmental justice (N);
   ii. Create a task force to propose a para-governmental law enforcement service specifically for wildlife, with the aim of such an organization eventually becoming a permanent part of the government (N);
   iii. Implement the Madagascar Bushmeat Strategy, particularly for priority lemur conservation sites and priority species (N).
c. Finalize the status of new protected areas and create additional protected areas where needed:
   i. Provide logistical and financial support to DSAP activities (N).
d. Increase the productivity and sustainability of use of already deforested lands:
   i. Improve efficiency and permanency of agricultural production (N, L).
   ii. Improve efficiency and permanency of agroforestry (N, L).
   iii. Review land tenure laws (N, L).
   iv. Create and expand timber/firewood plantations (N, L).
e. Reduce charcoal production:
   i. Develop new technologies (N).
   ii. Subsidize the promotion and adoption of alternative cooking fuels (L).
f. Prevent forest and bush fires through education (N, L).
g. Limit industrial resource extraction to no-net-loss operations with improved EIAs (N).
h. Limit impacts of artisanal resource extraction (N, L).

2. Increase suitable lemur habitat and habitat connectivity

a. Conduct research to promote effectiveness of reforestation and regeneration:
   i. Inventory plant species (L);
   ii. Identify native tree species important for lemur survival (L);
   iii. Identify target species for reforestation, regeneration, and eradication (L).
b. Provide education:
   i. Train reforestation/restoration personnel (L);
   ii. Provide environmental education within school curriculum (L);
   iii. Stage expositions and demonstrations for local communities (L).
c. Carry out reforestation:
   i. Build and maintain tree nurseries (L);

ii. Identify reforestation areas to maximize connectivity, biodiversity and economic benefit (L);
iii. Produce seedlings and plant trees (L);
iv. Protect seedlings and promote growth (L).

d. Restore degraded habitat:
i. Promote naturally-existing restoration forces (e.g. bats, lemurs, birds) (L);
ii. Eliminate exotic plant species with negative biodiversity impacts (L);
iii. Plant native species that have been reduced or eradicated, especially important lemur food resources (L).

3. Stop illegal commercial timber exploitation of natural forests

a. Monitor protected areas:
i. Increase number and skills of MNP Park Rangers "Agents du Parc" (N);
ii. Establish more Comités Locales du Parc (CLP) / VOI (L).

b. Increase public awareness of existing laws and long-term effects of exploitation:
i. Distribute educational materials ("Poste Radio", posters, books) (N, L);
ii. Make use of the national press to increase awareness (N);
iii. Establish local, national, international information networks (social networking) (N).

c. Reassess level of threat (IUCN) and international trade status (CITES) of targeted timber species (N).

d. *Dina maitso:*
i. Enforce existing *dina*/law (L).

e. Make use of modern technologies to aid enforcement:
i. Use DNA barcoding on exported hardwood (N).

f. Conduct political lobbying:
i. Lobby the regional administration for more efficient enforcement (N, L);
ii. Lobby the national government for more efficient enforcement (N);
iii. Raise awareness internationally, especially in importing countries (N).

g. Reforest/restore degraded/selectively logged forest using exploited timber species (N, L).

4. Ensure that local population's use of forests is sustainable

a. Identify local needs and conservation needs, and establish where they overlap (L).
b. Identify conservation actions that are in agreement with communal and regional action plans (PCD/ PRD) (L).
c. Provide environmental education/raise awareness: distribute posters, leaflets, educational comics; produce TV/Radio programs; support schools (e.g. pay/subsidize school teachers' salaries, provide infrastructure, books, etc.) (L).
d. Provide practical environmental education: fuel-efficient stoves, fuel savers (L).
e. Develop local tree nurseries (L).
f. Plant fast-growing trees for local use (L).
g. Establish forest patrols (local park rangers) (L).
h. Establish permanent presence of conservationists (L).
i. Establish regular communication between conservationists and local communities (L).

5. Stop lemur hunting

a. Enforce protection of lemurs:
i. Establish forest patrols (local park rangers/VNA, KASTI) (L);
ii. Update conservation laws: provide updated rules to the government (N);
iii. Apply amended law and dina (local rules) (L);
iv. Identify boundaries of PAs to facilitate law enforcement and respect of parks (L);



Ring-tailed lemur (*Lemur catta*), Endangered. Berenty. (Photo: Russell A. Mittermeier)

v. Provide environmental education/raise awareness: distribute posters, leaflets, educational comics; produce TV/Radio programmes; support schools (e.g. pay/subsidize school teachers' salaries, provide infrastructure, books, etc.) (L).

b. Provide alternative protein sources:
   i. Introduce short-cycle breeding (chicken, ducks) and provide equipment (L).
   ii. Provide veterinary services to local communities (L).

6. Community-based sustainable development and capacity building around priority lemur sites

a. Intensify and improve efficiency of agricultural practices and agroforestry:
   i. Train villagers in new and sustainable agricultural techniques, provide materials (L);
   ii. Introduce short-cycle breeding (chicken, ducks) and provide equipment (L).
b. Provide alternative livelihoods:
   i. Introduce alternatives such as commuity bee-keeping or fish farming (L);
   ii. Establish ecotourism: train local guides and provide infrastructure (L);
   iii. Promote local handmade crafts (L).
c. Reinforce the local traditions and culture: meetings with migrant population (L).
d. Reforest/restore degraded/selectively logged forest:
   i. Identify forest tree species (L);
   ii. Establish tree nurseries for native species (L);
   iii. Train professional nursery staff (L);
   iv. Establish fire breaks around forests (L).

7. Fill knowledge gaps in population ecology and biodiversity of lemurs, and increase training of Malagasy scientists

a. Implement population monitoring across threatened and poorly-known species' ranges:
   i. Use cost-effective methods (e.g. community-based monitoring) (L);
   ii. Combine field surveys (using line-transects or complete count censuses), geo-referencing of survey data (using GIS and remote sensing), and molecular techniques where possible (L).
b. Quantify threats:
   i. Conduct research on forest degradation (L);
   ii. Study hunting, using rigorous methodology (hunter follows, market surveys, village surveys, trap density, etc.) (L);
   iii. Investigate fires and the feasibility of fire prevention (L).
c. Conduct a taxonomic review, including additional data on genomics, morphology, ecology, reproduction, and social behaviour of species defined thus far based on a subset of available genetic markers (N).
d. Assess distribution of all described species and conduct field surveys (N).
e. Conduct research on mitigation programs, with objective targets and metrics of success (N, L):
   i. Reforestation;
   ii. Education;
   iii. Ecotourism;
   iv. Alternative resources and economic activities;
   v. Community-based management.
f. Conduct long-term research to establish the ecological requirements and long-term threats of target species (L):
   i. Community-based monitoring.
g. Share and centralize relevant data (N):
   i. Implement mechanisms for transfer of traditional knowledge.
h. Improve access to cutting-edge technologies and methodology in biodiversity research (N, L).
i. Promote independence of Malagasy science (N).

8. Increase environmental awareness nationally and internationally

a. Increase social media profile of lemur conservation (N).
b. Engage conservationists and scientists in countries implicated in the international trade of Madagascar's natural resources (e.g. CITES representatives) (N).
c. Implement and improve lemur conservation education curriculum on a national level, focusing on both primary and secondary school students (N):
    i. E.g., eco-pedagogy;
    ii. Promote concept of ownership and cultural heritage.
d. Produce and distribute Malagasy language media and educational materials promoting lemur conservation (N).
e. Promote non-school based educational exchange, emphasizing two-way communication and knowledge transfer (L):
    i. E.g., women's groups, church organizations, tourist guide associations.
f. Implement lemur conservation module for all new protected area managers and/or associations (N).



Southern black-and-white ruffed lemur (*Varecia variegata editorum*), Critically Endangered. Manombo Special Reserve. (Photo: Russell A. Mittermeier)

Factors Contributing to Lemur Population Decline on a National Scale, and Proposed Immediate and Longer-Term Mitigation Actions

Christoph Schwitzer, Merrill Baker-Médard, Rainer Dolch, Christopher Golden, Mitchell Irwin, Steig Johnson, Erik Patel, Brigitte M. Raharivololona, Jonah Ratsimbazafy, Josia Razafindramanana & Sylviane Volampeno



Deforestation and degraded forest edge at Tsinjoarivo. (Photo: Mitchell Irwin)

Contents

INTRODUCTION 35
PROBLEMS AND IMMEDIATE ACTIONS 35
Habitat loss and degradation arising from commercial exploitation and *tavy* 35
Habitat loss 35
Habitat modification and degradation 38
Wildlife harvest and its impact on lemur species 39
Impact of mining on lemurs 41
Large-scale mining 42
Small-scale mining 43
LONGER-TERM SOLUTIONS 43
Increasing habitat and connectivity 43
Community development and sustainable use 45
Conservation education: increasing environmental awareness nationally and internationally 47
Component 1: Lemur conservation education in schools 48
Component 2: Creating a network for conservation education 48
Component 3: Making conservation education memorable 49
Research and Higher Education 50
Taxonomic review 50
Population monitoring 51
Long-term behavioural and ecological research 51
Quantification of threats 51
Mitigation of threats 51



Recent *tavy* at Tsinjoarivo. (Photo: Mitchell Irwin)

INTRODUCTION

The participants of the conservation planning workshop divided the objectives of the conservation strategy, and the corresponding actions, into local and national scales according to whether they would show effect if carried out locally at specific lemur conservation sites or had to be applied on a cross-regional or national level instead. Whilst the local objectives and actions provided the basis for the ensuing 30 site-based action plans, in this chapter we summarise the biggest current contributors to the decline of lemur populations on a national scale, identify the most important immediate actions that would need to be taken in order to eliminate or reduce those threats, and describe additional objectives and actions to ensure the long-term conservation of lemurs and their habitats while also improving human livelihoods.

The first three parts of this chapter overview the threats posed to lemurs from habitat loss and degradation from commercial exploitation and *tavy*; wildlife harvest; and large-scale and small-scale mining. They also attempt to identify and describe short- and medium-term conservation actions. The subsequent four parts provide longer-term objectives and actions for increasing lemur habitat and connectivity; community development and sustainable use; conservation education; and research and higher education.

PROBLEMS AND IMMEDIATE ACTIONS

Habitat loss and degradation arising from commercial exploitation and tavy

Habitat loss

Arguably the single most important factor driving historic losses for lemurs (in terms of species diversity and overall numbers) has been habitat loss. All lemurs need intact forest ecosystems for food, with even the largely terrestrial ring-tailed lemur relying on intact forests for food resources and sleeping sites.
Recent estimates of forest cover vary from 99,000 km^2 (Harper *et al.*, 2007) to 173,032 km^2 (Dufils, 2008), with this variation likely driven by different classification methods, especially for the more dry and open forest types. Nevertheless, this range represents only 16.9–29.5 % of Madagascar's land area – a huge decrease from its original state (in which the majority of its 581,540 km^2 were thought to be forested), and a shockingly rapid decrease in recent decades. For example, Harper *et al.* (2007) calculated that 38% of the remaining forest cover was lost from the 1950s to 2000, with a period of extremely rapid deforestation (1.7% loss per year) between the 1970s and 1990s.

Although the causes of habitat loss nationwide are hard to rank quantitatively, they appear to be largely small-scale. To a large degree, Madagascar lacks the extensive industrial operations (such as clear-cutting and oil palm plantations) that drive deforestation in many other tropical countries. Instead, much of the loss seems to be driven by economic and subsistence decisions at the household level. This is often reflected in the configuration of remaining forest; rather than large areas of clearance interspersed with large intact areas, Madagascar's deforestation is much more patchy and often consists of a large number of very small cleared areas. This has led to a staggering degree of fragmentation, with more than 80% of remaining forest existing within 1 km of a forest edge (Harper *et al*., 2007), leaving it extremely vulnerable to edge effects (Ries *et al*., 2004) and other habitat change.

Habitat fragmentation is known to inhibit gene flow between populations, resulting in a loss of genetic diversity, usually linked to inbreeding depression and reduced fitness (Begon *et al*., 2006), and lemurs do not appear to be exempt from that. A negative influence of habitat fragmentation on genetic diversity of Milne-Edwards' sportive lemur (*Lepilemur edwardsi*) has been found (Craul *et al*., 2009). Likewise, ruffed lemurs (*Varecia* spp.) restricted to small fragments may undergo population bottlenecks as a consequence (Razakamaharavo *et al*., 2010; Holmes *et al*., in press). Habitat fragmentation is also known to have fostered demographic collapse among mouse lemurs, driving them into population bottlenecks (Olivieri *et al*., 2008), as their movement between fragments of suitable habitat appears to be significantly hampered by stretches of unsuitable habitat in between (Radespiel *et al*., 2008).

However, patterns for other lemur species are not consistent. Some mouse lemur populations revealed only limited effects of habitat fragmentation on fitness indicators (Schad *et al*., 2004). Similarly, habitat connectivity does appear to have only a limited influence on gene flow in the golden-crowned sifaka (*Propithecus tattersalli*), which may be linked to its survival of severe habitat fragmentation already during pre-human times (Quéméré *et al*., 2010a, 2010b, 2012). Similarly, the greater bamboo lemur (*Prolemur simus*) persists in very small habitat fragments that have been isolated for at least several decades (Ravaloharimanitra *et al*., 2011; Wright *et al*., 2008). This dietary specialist might be able to do so as long as its favourite bamboo, on which it almost exclusively depends, is available in sufficient quantities. On the other hand, folivorous or frugivorous lemur species that depend on a diverse miscellany of plant species for food are more likely to be impacted by habitat fragmentation and isolation, as Irwin *et al.* (2010) have shown for diademed sifakas (*Propithecus diadema*).

Negative impacts of edge effects on lemur populations may include higher vulnerability to predators (e.g. Irwin *et al*., 2009) as well as changes in food supply and sleeping sites. Some lemurs appear to tolerate edge effects, providing one possible explanation for the fact that many have survived extreme habitat loss and fragmentation until present (Lehmann *et al*., 2006). However, habitat fragmentation can also have repercussions on other crucial species co-existing with lemurs. Their possible extinction and subsequent trophic cascades may lead to the interruption of food chains, seed dispersal, pollination, and other ecological functions, threatening the long-term survival of these habitat fragments. While release from seed predators can favour the recruitment of certain tree species and thereby cause an apparent positive outcome for lemur populations in the near term (Dausmann *et al*., 2008), the negative consequences of altered forest structure may outweigh it in the long run. Irrespective of the underlying cause of the decline of lemurs in habitat fragments, perfect nestedness of lemur assemblages in fragments of different sizes suggests a stepwise extinction of species over time from a once continuous habitat as a function of fragmentation size (Ganzhorn *et al*., 2000).

In humid forest areas, *tavy* is the traditional agricultural practice (Styger *et al*., 2007) and the major driver of deforestation. *Tavy*, also known as slash-and-burn agriculture, is the cutting of primary or secondary vegetation within a plot, waiting for that vegetation to dry, and then burning it to release nutrients from the vegetation directly into the soil. This nutrient input allows one to a few seasons of farming before soil fertility declines to a point that it is no longer productive, and the plot is abandoned (at least temporarily). The following regeneration depends on the state of the soil and the surrounding environment; less-depleted plots in a more intact environment can quickly grow back as secondary forest, gradually returning towards its original primary character. More commonly, fallow vegetation is composed of small trees, shrubs, or eventually grass. As with other parts of the world, this practice has been sustainable at times in the past when human population densities were extremely low and fallow times quite long, but all signs suggest it no longer is. Styger *et al.* (2007) documented rapidly decreasing fallow times in Betsimisaraka plots in the past 30 years, causing a more serious and irreversible sequence of land degradation and nutrient depletion that ended in stable Aristida grasslands which could no longer support either cultivation or forest formation.

The problem of *tavy* today is twofold: more rapid land depletion causes more forest clearing per farmer in the course of a lifetime, and the recent rapid population growth (2.68% annually; CIA Factbook 2013) means that each successive generation collectively needs more land area for cultivation. Some efforts have been made to intensify agricultural production and prolong the time frame for which a single plot can be utilized. For example rice intensification (SRI; Moser & Barrett, 2003) has been publicized as a partial solution to deforestation pressures, but so far the implementation of such programs has been patchy, and even where implementation is attempted, efforts may fail. The typical reality for Malagasy farmers is that few or

no other options are known: traditional *tavy*, passed down from the ancestors, is the only known way to survive in a rural environment.

Another massive driver of deforestation is the production of wood charcoal (*charbon*) for cooking. People in rural areas cut and partially burn natural forest in order to harvest the remains as charcoal – still energy-rich but much lighter and easier to carry. Only a small part of this problem is supplying the rural areas where the charcoal is obtained – the larger problem is the sale and transport to urban markets. These markets have access to gas and electric stoves, but charcoal is substantially cheaper and therefore widely used. It is common on all highways throughout Madagascar to see large stocks of charcoal for sale at the roadsides, and trucks laden with charcoal travelling towards the larger cities.







Forest fire raging inside Sahamalaza–Iles Radama National Park (Photos: Melanie Seiler), and (below) charcoal production near Sambava (Photo: Erik Patel).

Clearly the solution to the *tavy* and charcoal problems must be multifaceted. Application of the laws preventing deforestation is necessary, though certainly not sufficient. What is needed is a broader effort reaching out to rural farmers and restoring the balance between the quality and quantity of ecosystem services that people need (including food production) and the inherent limits of what the landscape can offer, as well as taking into account the minimum forest areas and connectivity required to sustain healthy ecosystems. In the case of *tavy*, this will include more effective and sustainable agricultural techniques, while in the case of charcoal this will necessitate the broad adoption of more efficient and sustainable cooking methods, perhaps through subsidizing the currently out-of-reach alternatives.

Habitat modification and degradation

Although the amount of forest habitat Madagascar has lost (and is still losing) is staggering, it is also crucial to consider that much of the remaining forest has been degraded through human actions. Despite the fact that it may still appear in satellite images and forest inventories, its capacity to support viable lemur populations may be diminished. Extraction of forest products for local use (both timber and non-timber) has been occurring since the arrival of humans on Madagascar. Although worth monitoring, especially as the human population increases, it is the extraction feeding regional, national and international markets that is much more damaging.

The most pervasive form of habitat degradation is selective logging. Logging affects different primate species in different ways (Cowlishaw and Dunbar, 2000; Johns and Skorupa, 1987). Although much variation exists, folivores are more likely to increase in density in the face of moderate disturbance (Ganzhorn, 1995; Irwin, 2008), and frugivores more likely to decline; however, all species start to decline as disturbance becomes severe, and even small amounts of disturbance may significantly reduce the primate species richness in an area.

Selective logging of hardwood has always existed in Madagascar, and a demand in the capital and other large cities has fueled a supply from primary forest areas, both protected and unprotected. Some of this logging, that arising from management transfers (*transfert de gestion*) giving local communities limited extraction privileges, has been legal; the rest is illegal. The 2009 political crisis triggered a crisis in illegal logging of a magnitude not before seen in Madagascar. However, illegal logging of rosewood (*Dalbergia* spp.) and ebony (*Diospyros* spp.) did not begin in 2009. A major illegal logging crisis in World Heritage Sites (Masoala National Park and Marojejy National Park) took place during 2004/05 (Patel, 2007), a time of political stability. Foreign exports of Madagascar rosewood occurred at "low" levels (1,000–5,000 t) between 1998 and 2007. In 2008, exports jumped to 13,000 t, and jumped again in 2009 to more than 35,000 t (Randriamalala and Liu, 2010; Global Witness and Environmental Investigation Agency, 2009). In 2009, approximately 100,000 rosewood and ebony trees were illegally cut in the UNESCO World Heritage Sites of Masoala National Park, Marojejy National Park, the Makira Conservation Site, and Mananara Biosphere Reserve (also a national park).

In actual practice, rosewood logging has turned out to be far less selective than widely believed. Often, rafts made of a lighter species of wood (*Dombeya* sp.) are constructed to float the much more dense rosewood logs down rivers. Approximately five Dombeya trees are cut as "raft wood" for every rosewood tree (Randriamalala and Liu, 2010). Tall adult trees of a variety of species, that simply happen to be very close to rosewood trees, must often be cut to gain access to cut down a rosewood tree. All told, the impacts of such selective logging include (but are not limited to), increased likelihood of fire, invasive species,





Illegally logged rosewood stockpiled in Maroantsetra (Photo: Erik Patel) and (right) logging under *transfert de gestion* agreement at Tsinjoarivo, 2006 (Photo: Jean-Luc Raharison).

impaired habitat, loss of genetic diversity, as well as violating local taboos, as ebony is sacred to some Sakalava ethnic groups in Madagascar (Patel, 2007).

Red ruffed lemurs (*Varecia rubra*) are probably the most negatively impacted lemur species, since many were hunted by loggers and this species is known to feed on ebony trees (*Diospyros* spp.) as well as pallisandre (*Dalbergia* spp.) in Masoala (N. Vasey, pers. comm.). *Varecia rubra* probably also feeds on the fruits and leaves of the "raft wood" *Dombeya* sp., as *Varecia v. editorum* does in Manombo Forest in southeastern Madagascar (Ratsimbazafy, 2006). In Mantadia National Park, *Indri indri* and *Propithecus diadema* consume young leaves of one species of rosewood (*Dalbergia baronii*), which is also consumed by Milne-Edwards' sifakas (*Propithecus edwardsi*) in Ranomafana National Park (Powzyk and Mowry, 2003; Arrigo-Nelson, 2006). *Propithecus diadema* at Tsinjoarivo consume the unripe fruits of ebony trees (Irwin, 2006). In Marojejy, silky sifakas (*Propithecus candidus*) commonly feed on the fruits, seeds and leaves of ebony trees (*Diospyros* spp.) and to a lesser extent the young leaves of pallisandre (*Dalbergia chapelieri*), which is also a preferred sleeping tree (Patel, 2011).

At the 16th CITES Conference of the Parties in March 2013, all 48 accepted species of *Dalbergia* and 83 accepted species of *Diospyros* endemic to Madagascar were uplisted from Appendix 3 to Appendix 2, and an action plan was adopted to facilitate adequate implementation of the listings. Appendices 2 and 3 only aim to regulate trade, not prohibit it. Appendix 2, unlike Appendix 3, does require that the CITES authorities in the export nation determine that the specimens were legally obtained and that their export will not be detrimental to species survival. The surest way to reduce illegal logging of ebony and rosewood in Madagascar, however, would be to list all species of *Dalbergia* and *Diospyros* on Appendix 1 of CITES. Globally, only one species of rosewood, Brazilian rosewood (*Dalbergia nigra*), is listed on Appendix 1. This is the most stringent category and prohibits all commercial trade of that wood from the date of listing. Guitars in the United States made of Brazilian rosewood are known to have risen in price and are harder to find since Appendix 1 listing. Similarly, Appendix 1 listing of Alerce (*Fitzroya cupressoides*), a heavily logged South American conifer, has significantly reduced logging and trade (Barrett *et al*., 2010; Keong, 2006). In any case, the agency chosen as the CITES management authority should be free of corruption and have experience in forest management, and current problems with species identification need to be overcome. For the latter, genetic techniques would be of great assistance. DNA testing has already been used to track timber, but not yet in Madagascar. One of the biggest methodological challenges is extracting DNA from the heartwood of dead tree trunks (e.g. rosewood stockpiles), which consist of dead cells with partly degraded DNA. Nevertheless, several new techniques have successfully extracted DNA from dry wood, including 1000-year-old beech (*Fagus* spp.) (Nielsen and Kjaer, 2008).

In addition to CITES listing, actual improvements in forest monitoring on the ground are needed. A new system called independent forest monitoring (IFM) may help reduce illegal logging (Tegtmeyer *et al*., 2010). IFM has been defined as "the use of an independent third party that, by agreement with state authorities, provides an assessment of legal compliance, and observation of and guidance on official forest law enforcement systems" (Global Witness, 2005, p.18). It is similar in principle to unbiased international election observers. Local and international expertise is utilized, and monitoring teams operate independently but with the consent of the host government. Independent forest monitors are observers; law enforcement remains the responsibility of local officials and governments. IFM has already been used successfully in several African and Central American countries seeking to improve the effectiveness of their forest monitoring. Examples of the impact of IFM in these countries include: documentation of hundreds of forest crimes, cancellation of logging concessions, moratoriums on logging and timber transport, and creation of new "forest crime monitoring units" within the forestry administrations.

Wildlife harvest and its impact on lemur species

Throughout Madagascar, wildlife harvest for food has become an increasingly recognized threat to the viability of lemur populations (Golden, 2009; Golden *et al*., 2011; Jenkins *et al*., 2011). In many parts of Africa and South-East Asia, hunting is pervasive and yet practiced by only a skilled fraction of the population, and wild meats are then marketed to consumers from various social strata in villages, towns and cities. This type of market/commercial hunting is a major threat to species viability and requires very specific conservation solutions. In Madagascar, the vast majority of wildlife harvest is driven by a need for food. This requires different types of interventions, especially where the behaviour is common. For instance, in the Makira Protected Area, approximately one half of the population actively harvests and consumes lemur species (Golden, unpublished data), even though lemurs are illegal to hunt throughout Madagascar (whether inside or outside of a protected area). In other areas of Madagascar, it is believed that hunting is increasingly becoming a threat as social values dissolve and political support for conservation becomes elusive (Jenkins *et al*., 2011). Further, people have worried that as central government support for the environment weakens from a lack of political stability, a commercial trade of luxury bushmeat may emerge (Barrett and Ratsimbazafy, 2009). Thus far, hunting behaviours have been reported widely across the island (e.g. Cardiff *et al*., 2009; Garcia and Goodman, 2003; Goodman, 2006; Bollen and Donati, 2006) and continue to become better known.











White-fronted brown lemur (*Eulemur albifrons*), Endangered, that has been snared (top left photo) and then cooked over an open fire, prior to consumption (top right photo) (Photos: top left: Gerlain; top right: Christopher Golden); Indri (*Indri indri*), Critically Endangered, hunted for human consumption (below left photo) (Photo: Madagasikara Voakajy); Tree with *Lepilemur sahamalazensis* sleeping tree hole, cut open at the bottom to harvest the animal (below center photo) (Photo: Melanie Seiler); Sahamalaza sportive lemur (*Lepilemur sahamalazensis*), Critically Endangered, roasted for human consumption (below right photo) (Photo: Melanie Seiler).

As far as we can tell from documented evidence, rural farmers who hunt as a side activity to their primary pursuit of rice agriculture conduct the majority of hunting. Hunting with firearms, although a known threat to primate species around the world, does not appear to be the primary threat to lemurs in Madagascar. People actively hunt with slingshots (for small carnivore and lemur species), spears (for lemurs and bush pigs), nets (for bats) and dogs (for lemur, carnivore and tenrec species). However, hunters harvest the majority of mammals with passive traps and snares. For lemur hunting, two snare types are frequently used that utilize a method of clearing areas of forest to force lemur movement across specified wooden bridges. When these bridges are constructed to connect forest fragments the snares are called *laly lava* and can capture lemurs regardless of their preference for particular fruit trees. If the bridges are constructed to connect a fruit tree to surrounding forest fragments, the snares are called *laly totoko* and focus on the capture of species that utilize a particular type of fruit tree.

Active hunting may target the largest animals, and those will usually be adult males and females in reproductive age that are necessary for population sustainability. Lemurs, like most primates, have life history characteristics that put them at high risk of rapid depletion in the presence of hunting. Populations of species such as lemurs, with late ages of first reproduction, long gestation periods, long lifespans and small litter sizes, can withstand only *very* low levels of extrinsic mortality, such as hunting (Golden 2009).

Knowledge of hunting methods can help conservationists understand the distribution of human hunting pressure. For instance, data collected on hunters' travel behaviour in the Makira Protected Area (86 reports of distance covered and 154 reports of time spent travelling) indicated that people covered a radius of 4.40 ± 2.90 km from village centres for hunting activities (mean ± SD; Golden, in review). Information like this can inform the creation of buffer areas around protected areas where humans are free to use resources.

Madagascar has one of the most rapidly growing human populations of all countries that possess rainforest (CIA World Factbook, 2013). Moreover, the human population of Madagascar has increased sevenfold in the past 100 years. As forested areas become increasingly inhabited, areas that once held unexploited wildlife may soon become depleted. Pressure to provide food for families, complicated by a lack of livestock farming and other livelihood strategies, creates a multifaceted incentive for bushmeat hunting.

Recently published data showed that households in the Makira Protected Area that consumed wildlife were less likely to have children with iron deficiency anaemia, an important factor in delayed childhood development (Golden *et al*., 2011). A conundrum exists. Unbridled hunting will lead to local biodiversity and habitat loss. Restricting wildlife hunting through enforcement of wildlife conservation policies will have a negative impact on the nutritional status of local people, unless strategies are in place to mitigate these effects. There is a potential solution: the ubiquitous village chicken. A major factor behind hunting is the inconsistent availability of alternative animal food sources such as chicken, a source of high-quality food and income through meat and egg production. Village chickens are raised extensively and require minimal input of food and labour. Unfortunately, extensively raised chickens are susceptible to adverse events such as predation, theft, and epidemic disease, and so they are not a secure food item. Frequent disease epidemics can decimate entire village flocks, and when an epidemic strikes, it often spreads quickly to adjacent communities, rendering an entire region without a primary food source.

Improvements in village chicken production have been shown to have profound effects on the wellbeing of rural families, directly contributing to household food security, income generation, poverty alleviation, and wildlife conservation. Even simple husbandry improvements, such as predator-proof night housing, separate chick rearing and egg-laying quarters, and disease prevention through quarantine can lead to improvements in overall chicken health. When appropriate, more comprehensive poultry health interventions such as vaccination can result in greater enhancements of chicken health.
Aside from chickens, native freshwater fish farms also represent a sustainable and desirable source of animal protein. In the Andapa region, *Paratilapia* sp. (*fony*) projects, originally initiated by Dr Paul Loiselle and colleagues, have found this endangered fish to be easy to raise and breed by rural residents, who reintroduce 25% of their harvest into local streams while eating or selling the rest. However, digging the ponds can be labour-intensive and theft can be a problem.

Impact of mining on lemurs

Madagascar has a wide variety of metals, industrial minerals, and mineral fuels located across the island. Currently, Madagascar accounts for 3% of ilmenite production globally and prior to the political upheaval of 2009 was one of the top global producers of sapphires (Yager, 2010). Most of Madagascar's mining and mineral processing operations are privately owned. However, artisanal miners produce a large proportion of the gemstones, gold and crystal (Yager, 2010; Duffy, 2005; Sarrasin, 2006).

There is a great difference between artisanal and industrial mining in terms of mining practices, laws and enforcement relevant to each sector. All mining operations theoretically must comply with the existing "Making Investment Compatible with



Native freshwater fish farm near Andapa. This single pond now contains thousands of endemic *Paratilapia*; less than one year ago only 400 fishlings were added. (Photo: Erik Patel)

the Environment" (MECIE)[1] legislation, which requires all companies to incorporate budget provisions for environmental impact assessments, submit Environmental Impact Evaluation (EIE), and advance environmental authorization before conducting operations (Sarrasin, 2006; Code Minier, 2005). Given high levels of corruption in the mining sector coupled with frequent shifts in the political regime in Madagascar, not all companies, especially smaller operations, fully comply with the required practices for documentation (Baker-Médard, 2012). Also, despite more recent efforts of the Mineral Resource Governance Project (PGRM) to decentralize governmental management of mineral resources and formalize the artisanal mining sector, much small-scale mining occurs illegally (Tilghman *et al.*, 2007; Economist, 2005).

Large-scale mining

Large-scale mining operations such as QMM/Rio Tinto's ilmenite and titanium dioxide project (QMM) along the south-eastern coast or the Ambatovy Nickel Project (Ambatovy) in the forested eastern corridor of Madagascar have well-developed environmental programs operating in conjunction with their mines. Both companies claim to not only comply with the environmental rules and regulations imposed by the Malagasy government, but to exceed requirements. QMM aims for a net "positive" impact on the environment via reforestation and funding new conservation areas as an offset for the deforestation and environmental destruction caused by the mineral extraction process (Ganzhorn *et al.*, 2007a). Both companies have programs that target lemurs specifically. For example, Ambatovy's biodiversity team identified and "salvaged" all lemurs from mining, pipeline and plant site clearings and relocated them to refuge forests where they were monitored (Dickenson and Berner, 2010). QMM also has a threatened lemur translocation program[2] (Vincelette *et al.*, 2007). To address the problem of increased lemur habitat fragmentation, lemur bridges were constructed by Ambatovy to facilitate movement between forested patches divided by new roads constructed by the mining company. According to company reports, these bridges are currently being used by six lemur species and have been used increasingly over time (Mass *et al.*, 2011). QMM also avoided mining and has committed to reforesting a set of corridors between forest patches specifically to enhance connectivity of lemur habitat to help conserve species such as *Cheirogaleus* spp., *Avahi meridionalis*, and *Eulemur collaris* (Ganzhorn *et al.*, 2007a).

[1]MECIE (Mise En Compatibilité des Investissements avec l'Environnement) Decree: Decree No. 99-954 of December 15, 1999 relating to the compatibility of investments with the environment (Republic of Madagascar, 2000:2)

[2] They determine threat level according to a study of population dynamics in association with forest fragmentation in the larger mining area.

The destruction of habitat, decreasing the size and increasing fragmentation of forested areas, is one of the most harmful aspects of large-scale mining on lemur populations. However, the impact of deforestation on lemur populations varies by species; generally larger species with larger home ranges are more negatively impacted (Ganzhorn *et al*., 2007b). Other impacts on lemurs engendered by large-scale mining operations include emission and effluents from mining that contribute to toxics in the soil, air and water, the introduction of new species into a region, and noise pollution. Recently, a group of primatologists found that in the Ambatovy mining region, *Indri indri* living in forests adjacent to mining operations experienced physiological changes that increased their susceptibility to parasitism, thus impairing reproductive success and long-term survival (Junge *et al*., 2011).

Small-scale mining

Small-scale, largely artisanal mining in Madagascar has a different set of dynamics concerning environmental degradation and impact on lemur populations. Unfortunately, as a map produced by USAID in 2004 showed, much of the country's potentially gem-rich areas are contiguous with protected areas and tropical rainforests with high levels of biodiversity (Duffy, 2005). There are three major categories of environmental degradation that can be assigned directly to artisanal mining in Madagascar, as well as a variety of indirect impacts that stem from the boom in migrant miners that often accompany new discoveries of precious and semi-precious stones or minerals. Similar to large-scale mining, artisanal mining often leads to deforestation. In order to access soil for digging, trees are cleared and/or roots are damaged; tree trunks, limbs and shrubs are often chopped down to reinforce mine shafts, build structures to haul stones out of holes, and construct tools for mining. Some deforestation also occurs due to uncontained fire, which is used in some gemstone mining areas to crack and render brittle hard substrate under or in which gems could be found.

In addition to some of the direct impacts on lemur habitat from deforestation due to mining, there is a host of non-mining activities that threaten lemurs as the number of people living in a mining area increases and the standing economy is disrupted. Perhaps the most destructive component of artisanal mining on lemur populations is the indirect pressure caused by a rush of hundreds, or even thousands, of migrant miners to a small area that was previously inhabited by few or no people. This accelerates the destruction of lemur habitat as people chop down trees for basic needs such as shelter, fuel, and household items. Additionally, secondary economies emerge in mining sites such as charcoal production and bushmeat trade, both of which directly impact lemur habitat and survival. Lemur hunting is commonly associated with artisanal mining boomtowns. Lemur meat supplements the diets of miners working in areas farther away from towns and villages, which are more regularly provisioned with regional or national sources of meat than the booming mining towns. Many artisanal mining areas are located in highly biodiverse areas that harbour numerous lemur species. For example, there is a recent explosion of gemstone mining in the Ankeniheny–Zahamena corridor (Mongabay, 2012), ongoing sapphire extraction in Ankarana (Walsh, 2003; Walsh, 2004; Baker-Médard, 2012), amethyst and beryl mining near Andapa (Pezzotta, 2001), quartz in Mananara (Sodikoff, 2012; Yager, 2000), and quartz and gemstones in Makira (Jaozandry and Holmes, 2005). Bushmeat hunting by artisanal miners in these areas is likely to have a significant and negative impact on lemur populations.

Madagascar's mineral industry is likely to grow significantly because of recent increases in cobalt, ilmenite, nickel, rutile, and zircon production, as well as the start-up of vanadium production in 2014 (Yager, 2010). Therefore, enforcing the variety of regulations already established to protect lemurs in Madagascar is of increasing importance.

LONGER-TERM SOLUTIONS

Increasing habitat and connectivity

While conservation priorities should still primarily focus on preserving what forests are left, the conservation community should also step up measures to reverse the loss, fragmentation and isolation of lemur habitats. Natural regeneration that could compensate for habitat loss and reverse habitat fragmentation only takes place very slowly. Indeed, Madagascar's forests usually have long recovery cycles after slash-and-burn (Klanderud *et al*., 2010) and might actually degrade beyond the point of recovery when intervals between fires become shorter (Styger *et al*., 2009). The regenerative capacity of Madagascar's forests is particularly hampered by a depauperate community of volant seed-dispersing animals when compared to continental environments (Böhning-Gaese, 2007). Additionally, natural succession is often constrained by the higher competitiveness of exotic invasive plant species. Studying natural regeneration of corridors in Andohahela, De Wilde *et al.* (2012) found that corridors between mature forests are not colonized by species from them but are likely to be dominated by invasives.

As a consequence, restoring lemur habitats and connectivity between them require comprehensive assistance by conservationists. While the planting of trees in Madagascar's past was largely driven by economic necessities rather than ecological reflections (e.g. Carrière and Randriambanona, 2007), reforestation with native trees has only been attempted at very modest scales and with little success until the turn of the present century.

This changed in 2004 with the launch of a pioneering large-scale project called *Tetik'asa Mampody Savoka* (TAMS), which formed part of the larger Ankeniheny–Zahamena–Mantadia Biodiversity Conservation Corridor and Restoration Project (Clean Development Mechanism, 2010). Unfortunately, the project suffered from a proliferation of stakeholders and a rather inflexible top-down approach unsuited to reconciliation of community expectations and conservation objectives with tough targets for carbon sequestration set by the Kyoto Protocol (Pollini, 2009). Although it did not live up to its original multifaceted purpose as outlined by Holloway (2004), the achievements of TAMS were ground-breaking, including the establishment of Madagascar's most species-rich tree nurseries, the plantation of more than a million native trees, and invaluable experience of reforestation techniques gained. In part, project performance was due to (1) high survival rates following the inoculation of tree seedlings with fungi forging versicular-arbuscular mycorrhizae; (2) the selection of a subset of slow, modest and fast-growing trees suited to mimic natural forest structure; and (3) the selection of tree species attracting seed-dispersers (such as lemurs) that bring in seeds from even more species.







Community-based reforestation programme in Sahamalaza. (Photos: Guy Randriatahina)

Subsequently, a multitude of reforestation projects using native trees has sprung up, many of them also trying to increase suitable habitat for lemurs and other wildlife and re-establish connectivity between habitat fragments. While Association Mitsinjo and MATE, two organizations involved in TAMS, have since continued reforestation work around Andasibe, others focus on very fragmented sites like Ambohitantely (Pareliussen *et al.*, 2006) or on connectivity of larger forest corridors such as Fandriana–Marolambo (WWF, 2012) or Fandriana–Vondrozo. Other reforestation initiatives comprise those of the Madagascar Fauna Group in Betampona and the Madagascar Biodiversity Partnership in Kianjavato, Vakanala in Manambolo, Madagascar Feedback's TreeMad project in south-central Madagascar, Coeur de Forêt in Masoala, Tany Meva in Ankotrofotsy, Planète Urgence in the Itasy region, Graine de Vie in the SAVA region, Ho Avy in Madagascar's spiny forest and the Eden Reforestation Project in the mangroves of the Mahabana Estuary, to name but a few. A (still incomplete) compilation of Madagascar's reforestation projects has been attempted by Lisan (2012). Conventional Internet search engines produce more than 300,000 hits for the combined keywords 'reforestation Madagascar'. This digital profusion is not nearly reflected by relevant publications in scientific journals. It is therefore impossible to assess how serious, successful or long-lived all these projects are. Appreciably, most of them attempt to integrate local communities, but there seems to be little cohesion and even less exchange between existing projects.

It is highly recommended that organisations and initiatives focusing on reforestation and habitat restoration set up a network, providing for exchange of experience, mutual learning and dissemination of promising approaches. This would also facilitate evaluating successes and failures and the performance of these projects in general. Furthermore, it would also create competitiveness among them, leading to better results in the long term. Certain aspects of reforestation (germination, seedling survival, growth rates, establishment of species, changes in species composition, etc.) should also be subject to scientific scrutiny. A network of organisations and projects involved in reforestation would help to harmonize different approaches and schools, based on scientifically sound methodology. It is likely to yield the best results when it comes to restoring lemur habitat and reversing the effects of habitat fragmentation on a nationwide scale.

Community development and sustainable use

While lemur populations invariably continued to decline, Madagascar's human population has almost doubled over the last 20 years (United Nations, 2010). Most of the human population lives in rural areas, very often in dire living conditions, which have additionally been exacerbated by the political disorder and instability after the chaotic regime change of 2009 (Randrianja, 2012).

Poverty-driven environmental degradation has always been a key feature of Madagascar's past (Pollini, 2011; Réau, 2002). In combination with demographic growth, increasing poverty continues to accelerate the conversion of natural habitats into arable and degraded land. Many of the island's impoverished communities live in close vicinity to existing protected areas or other ecologically valuable sites. They directly compete with lemurs for space and natural resources, ultimately leading to shrinking lemur habitat.

Yet, these habitats provide numerous ecological services – such as protection from erosion, water retention, climate regulation and pollination – that are vital for the local communities' agricultural performance (Wendland *et al*., 2010). Runaway habitat destruction thus further fuels rural impoverishment. In order to break this vicious circle, the improvement of rural livelihoods is vital and the integration of local communities into the conservation of lemurs and their habitats is imperative.
Many conservation projects all over Madagascar attempt to integrate local communities into the management of natural resources and lemur populations (Andrianandrasana *et al*., 2005; Raik and Decker, 2007; Volampeno and Downs, 2009). Management of natural resources can be legally transferred to local communities if they are organized in associations called COBAs or *communautés de base* (Toillier *et al*., 2009).

During the last two decades, there has been a plethora of management transfers all over Madagascar, originally applauded as the ultimate solution to both habitat destruction and poverty. It had to be learned that only a handful of COBAs were economically viable, and that community-based natural resource management can only work when it generates revenue. Management transfer as a conservation tool can only be successful if it generates higher revenue from sustainable economic activities or alternative sources than conventional (destructive) practices would fetch. In reality, most local communities struggle to be viable, even if they are legally entitled to manage their own resources. Ironically, timber and charcoal from the forests they manage remain the primary source of income for most COBAs, thus often contradicting conservation objectives (Hockley and Andriamaravololona, 2007).

Moreover, the potential of Madagascar's non-timber forest products to sustainably generate sufficient revenue for local communities appears to be overrated. Although the collection and use of medicinal plants, fruits and honey may play an important role in the livelihoods of local communities (Brown *et al*., 2011; Dawson and Ingram, 2008), these commodities appear inadequate to generate auxiliary revenue. Still, if processed, some non-timber forest products may be better qualified to do so. In several sites throughout the eastern rainforest, wild silk from cocoons of native moth species is collected in

community-managed forests, processed into textiles and sold abroad as a luxury good (SEPALI, 2012; Razafimanantosoa *et al*., 2006). In Vohimana, also a rainforest site, essential oils from aromatic plants are produced and sold (Danthu *et al.*, 2008). However, ecological and economic viability of both approaches need to be questioned. In the case of essential oils, considerable amounts of fuel wood are used to provide the energy needed for distillation. It is required that the added value of the essential oils generates higher revenue for the local communities than the direct sale of fuel wood would have fetched. Moreover, processing and marketing of either wild silk or essential oils requires technical know-how, establishing business contacts with wholesale buyers and marketing experience, all of which local communities usually lack.

At first glance, ecotourism requires less know-how and is therefore often cited as an even more important potential source of sustainable revenue for local communities in Madagascar (Pawliczek and Mehta, 2008; Jensen, 2010). Showing lemurs and other Malagasy wildlife to tourists can additionally be combined with the production and sale of handicraft, thus providing income for both guides and craftspeople. Two successful examples of community-based ecotourism are the Anja Community Reserve close to Ambalavao and Association Mitsinjo's Analamazaotra Forest Station in Andasibe (Dolch, 2008). It comes as no surprise that both are situated along ingrained tourist routes, benefitting from geographic location and existing infrastructure. Unfortunately, most of Madagascar's COBAs are not equally advantaged since they are characterized by their geographic isolation and remoteness, off any tourist paths. Yet, remote destinations appear to be particularly promising as they might be interesting targets for both high-end and backpacker tourism (Hockley and Andriamaravololona, 2007). Again, developing these destinations requires the capacity to identify and attract potential business partners, which local communities are unlikely to achieve without assistance. Adequate mechanisms of profit (and cost) sharing within and among COBAs could also facilitate increased ecotourism.

The employment of local communities for conservation-minded research could also generate sustainable revenue. Conservation action taken for the greater bamboo lemur (*Prolemur simus*) is a prime example of how the implication of local communities into research and monitoring programmes contributes to both conservation success and improved livelihoods. Local knowledge was crucial in the discovery of new populations of the species (Dolch *et al*., 2008; Ravaloharimanitra *et al*., 2011). Trained as para-ecologists by the project leadership, members of the local community patrol these sites to monitor their populations and eventual threats to them (Randrianarimanana *et al*., 2011). In doing so, they are protecting the forest and are getting paid for the monitoring, creating pride and bringing money into the coffers of the community. This approach could easily be adapted and replicated for a variety of species in different sites all over Madagascar, ideally forming a network of small community-run research stations.

Another source of revenue could be capturing the value of ecosystem services. Direct payments for ecosystem services, including maintaining biodiversity and carbon sequestration, offer considerable promise for local communities. Several conservation organizations incite competition among local communities and reward them for preserving natural habitat (e.g. Sommerville *et al*., 2011). Carbon sequestration through avoided deforestation and/or forest restoration has also been used as a tool to generate revenue through the trading of carbon credits (Ferguson, 2009). Following the change of power in 2009, some of these incentives, such as the TAMS Project in Andasibe (Paiva and Randrianarisoa, 2010; Pollini, 2009), have been stifled by the cancellation of existing contracts at the exact time when local communities should have reaped the fruit in form of payments for carbon credits generated. Still, if executed properly, direct payments for ecosystem services (and 'direct' is the operative word here) could bring considerable revenue for local communities.

Conservationists often tend to overestimate the forest's capacity as a source of vital resources for the local communities, omitting the fact that it is primarily agricultural performance from the areas surrounding it that determines their viability. As a consequence, it is indispensable that novel forms of agriculture that are better performing and more sustainable are being developed at the same time. It has been shown that adoption of novel techniques by Malagasy farmers leads to higher crop yields (Minten and Barrett, 2008). Yet, few conservation organizations have the capacity or commitment to assist local communities on agricultural issues at the scale needed. Therefore, viable partnerships with state institutions or NGOs that specialize in agriculture should be developed and the private sector implicated. It appears essential for the conservation of lemurs and other biodiversity that agricultural programs primarily focus on local communities living close to lemur habitats. It should also not be forgotten that environmental degradation caused by local communities might not be exclusively driven by economic necessities. Alternatively, it is often considerably shaped by social and cultural dynamics within those communities (Scales, 2012; Hume, 2006; Casse *et al*., 2005). If natural resource management by local communities is to be successful, socio-cultural contexts must therefore be considered. Generally, a holistic approach is needed. It should focus its attention on comprehensive and genuine assistance in agriculture as well as assistance in marketing through establishing contacts with the private sector (wholesale buyers, ecotourism operators, payers for ecosystem services). This requires the support of local communities by partners with long-term commitment and a local presence, likely to increase local capacities. Building organizational and managerial capacity within local communities is imperative (e.g. Fritz-Vietta and Stoll-Kleemann, 2008). The pooling of COBAs in several federations to create a network according to their geography was an important step in that direction. It is hoped to facilitate the exchange of experience among local communities and the dissemination of successful approaches.



Conservation education in a rural school in Sahamalaza. (Photo: Guy Randriatahina)

Many lemur species and populations occur outside Madagascar's traditional protected areas. The success of the establishment of a new Protected Areas System (SAPM) launched in 2003 is therefore critical for their survival. It has been recognized by the relevant authorities that the implication of local communities in the co-management of crucial habitats within SAPM is key to success, and a federated COBA network should play an important role in it.

Conservation education: increasing environmental awareness nationally and internationally

We all understand the need for improved education about the environment. Public opinion affects the success or failure of environmental management efforts. Researchers could spend years designing plans or studying biological processes, but fail to achieve conservation goals if they lack adequate public support. Conservation education shares many goals with the broader field of environmental education. These include providing learners with an opportunity to gain awareness, knowledge, attitudes, skills and participation. Conservation education also shares goals with newer programmes such as education for sustainable development: protect the environmental system that sustains life, and ensure appropriate economic development (Jacobson *et al*., 2006).

In Madagascar, as part of a lemur conservation strategy, effective conservation education is essential to raise awareness of lemur conservation on national and international scales. This will improve people's knowledge of lemurs and their habitat, promote pro-conservation behaviours and involve more people in lemur conservation and sustainability initiatives. Primate conservation education addresses cross-disciplinary issues (Jacobson, 2010); its systematic planning, implementation and evaluation as well as efficient collaboration, should help bring successful conservation strategies.
In Madagascar, rural communities often live in or near lemur forest habitats. These people depend for their survival on the biodiversity and services provided by healthy ecosystems. This is even more important for more impoverished communities. Lemurs are now one of the most threatened groups of larger vertebrates on the planet. In order to conserve lemurs and prevent further extinctions, conservation must include, work with, and educate local communities. Local communities need to be educated to take responsibility for conserving and managing natural resources in their vicinity. Keeping in mind the vital role of local community involvement, this section provides important components of conservation education programmes. These aim to (1) increase the likelihood for success of conservation education programmes; and (2) raise awareness of lemur conservation nationally and internationally. As recommended by Wallis and Lonsdorf (2010), conservation education should be relevant to the audience (welcoming ideas for protecting animals and its relation to well-being of local populations), include educator training, address poverty issues and local people's needs, and be part of an active conservation project. As conservation education grows as a focus and as a discipline, evaluation of results and exchange of information will encourage long-term success.

Component 1: Lemur conservation education in schools

Conservation education in schools takes many forms, including the use of occasional supplementary materials funded by wildlife agencies (e.g. Dolins *et al*., 2010) and integration of the environmental component into the curriculum. Conservation education in schools can range from a one-day field trip to the forest to greening initiatives contributing to sustainable development. In Madagascar, children are not taught about native wildlife or the science of conservation in schools (Dolins *et al*., 2010). Instead, they are more familiar with animal species that do not exist on the island (Ratsimbazafy, 2003). Malagasy culture includes many traditional proverbs inspired by domestic animals observed in daily life. Although non-governmental organizational efforts are important in conservation education, the Ministry of Education needs to incorporate biodiversity education in the curriculum at all levels from primary school to university (Dolins *et al*., 2010).

In Madagascar, integrating conservation education into legislation and educational policy is urgently needed. In the long term, comprehensive conservation education in the schools will require the systematic inclusion of environmental concepts in educational standards, capacity building for teachers and non-formal educators, funding, material development and legislative support for increasing the environmental literacy of the students (Jacobson, 2010).

a. *Environmental education handbook*
The creation of this handbook aims to bring supplementary educational materials to Malagasy schools. As with all other subjects taught in class, the capacity of teachers to integrate environmental education into their lessons needs to be built. They need to better know the value of natural resources, including lemurs, of the protected areas surrounding them and also to take part in environmental protection. The handbook should be distributed to the teachers of primary schools in the peripheries of protected areas. It is intended to be simple, easy to understand and written in the Malagasy language.

b. *Active approach in conservation education*
This approach is environment-based education that focuses on the use of the local environment, either natural or social, as a framework for the students' educational experience, with the goal of increased student achievement. Integrating the ecosystem/environment in relation to lemurs and their ecology will shape more responsible behaviour for creating a more sustainable future. This approach involves engaging students in selecting, planning, implementing and evaluating a real-world environmental project and making informed choices for action in the community. For example, schools can plan and implement a productive, healthy and ecologically sustainable environmental management system on school land, such as a garden or permaculture. Comprehensive training for teachers and students is needed to implement these active educational tools. This approach will raise awareness at the local level in the community where students' projects are conducted, and at the student's level.

c. *Connecting classrooms through lemur conservation topics*
Connecting classrooms could be part of the lemur conservation education programme to engage teachers, students and partners in direct interactions regarding conservation, ecology, ecosystems and the environment (Jacobson, 2010). This creates links between classes at the national level and could be broadened with international schools. Although this activity may need a high standard of technology, some Malagasy schools in cities would be able to be part of this connection programme to increase the awareness of lemur conservation in cities and abroad. Many schools and universities abroad adopt this connection to exchange information, cultures and experiences between teachers and students. Teachers and students in cities could take advantage of educational technology to share, to learn and to exchange conservation issues with other national or international schools, for example using video, websites and distance education. UNICEF is taking the lead on this initiative in Madagascar. Close collaboration with them should be sought to spread this to a national level.

Component 2: Creating a network for conservation education

Effective conservation demands the skill of networking to build relationships in a community. Networking for conservation allows teachers and students to become advocates for each other and find common interests. Networks can create synergy between groups, generate resources and support, and promote conservation objectives.

a. *Environmental clubs and groups*
Creating environmental clubs mobilizes individuals with a common interest or stake in conservation issues. Environmental clubs in schools and universities can be creative and productive. Environmental education for youth can provide significant life experiences that help develop environmental interests and actions (Chawla, 1999). The role of environmental clubs is to provide practical experiences in outdoor settings, develop hands-on conservation experiences, increase knowledge of endemic biodiversity and environmental issues, and develop environmental responsibility in young people. Developing motivation and skills through such clubs could increase positive attitudes and activities towards lemurs and their habitats, promote awareness of ways to care for the earth and its resources, enhance knowledge about surrounding schools and the community, empower students to implement environmental change, and build participation in conservation actions.

b. *Workshops and seminars*
Workshops and seminars provide a structured forum where people come together to increase their knowledge and skills, work on a common task, and build consensus for action. They constitute positive tools for raising awareness at three levels: local, national and international. Workshops use strategies such as lectures, discussions, and small and large group activities, and encourage reflection. They may address a public audience, teachers, students or members of organizations, and provide an opportunity to present the latest scientific data, influence attitudes and behaviours, and respond to questions in a community or clarify public misconceptions.

c. *Creating and printing leaflets, posters and T-shirts*
Leaflets, posters and T-shirts are important ways to publicise a direct conservation message. These resources could be distributed on any occasion including environmental and community development events such as World Environment Day, tree-planting day, local or national festivities such as local fairs, Independence Day and School Day. They should be printed in three languages: Malagasy, French and English, so that these resources could also be distributed to tourists. Regarding the leaflets, we suggest that they will show three categories of information: basic background information on the lemurs present within the protected areas, threats to the lemurs, and the conservation measures to be carried out. Concerning the posters, the message should be short and easily understood by all potential audiences. We suggest that the message should highlight flagship lemur species of the protected areas. Posters should convey information in a visual format in order to share research results and network with the public, students, teachers and professionals.

Component 3: Making conservation education memorable

The objective is to bring conservation education to life, generating enthusiasm and excitement about lemurs, biodiversity and environmental conservation. Conservation education can be made memorable by celebrating the wonders of nature, immersing learners in different perspectives, and using the outdoors as a context for new inspiration.

a. *Installation of permanent educational plaques*
Permanent educational plaques constitute another method to pass a conservation message. We suggest that information on the lemurs which make the forest habitat unique could be written on such plaques. Metal plaques could be installed within the commune or village close to the lemur forest habitats so that the villagers or visitors could see and read the messages permanently.

b. *Radio/ television broadcast on environmental topics*
Radio and TV are useful to broadcast lessons and news on environmental issues. The information could be passed on to audiences through reading text, discussions or interviews. Different topics such as threats to the lemurs, advantages and benefits from the forest and lemur conservation actions should be developed. This could be broadcasted on national or local radio/ TV. The programme could be repeated twice weekly for several weeks.

c. *Games, storytelling, role-playing, field trips*
Games constitute a complementary method of conservation education. They provide a strategy to introduce or reinforce concepts taught through other conservation education methods and could target both children and adults. Storytelling is an effective means in transmitting information. Based on Jacobson *et al.* (2006), storytelling is "simple, timeless, empowering, appealing to different audiences, fun, a form of recognition, an excellent strategy to pass along traditions". Storytelling can teach vital conservation lessons and inspire environmental actions. At the national level, compilations of lemur/biodiversity stories constitute an important resource for educators in conservation education. By assigning roles to learners in a scenario, role-playing builds real-world skills and understanding of perspectives. For example, by playing the role of a lemur, children could understand the ecology, threats and needs of these animals. This technique encourages communication and problem-solving skills, and raises awareness on conservation issues. Field trips provide first-hand experience of conservation sites and resources to enhance learning about biodiversity and conservation.

For conservation education to be successful, the topic should be integrated into teaching at all levels (primary school to university). Networking is an important component to enable sharing of activities and achievements. Making teaching memorable will engage children and people in learning and will be enhanced through direct experience. Education alone cannot achieve the desired conservation impact; a combination of the many strategies outlined in this document is needed to address the situation as a whole. Effective education and outreach are essential for influencing conservation policy, involving more people in conservation initiatives, improving people's knowledge and changing behaviours, garnering funds, and sharing scientific advances. The fate of Madagascar's fragile environments depends on effective communication with a great variety of audiences.

Research and Higher Education

Since publication of the first lemur conservation action plan (Mittermeier *et al.*, 1992), there has been a remarkable proliferation of research on lemurs. These studies have enhanced our understanding of lemur taxonomy, population genetics, distribution and abundance, demography, parasites and disease, endocrinology, feeding and ranging ecology, social behaviour, and many other important research areas (e.g., Gould and Sauther, 2006; Kappeler and Ganzhorn, 1993; Kappeler and Watts, 2012; Rakotosamimanana *et al.*, 1999, and sources therein). Moreover, this research has spread over many new habitats and species, providing an ever-increasing knowledge base to inform conservation management. However, there remains much work to be done. In particular, we highlight the need for long-term monitoring of populations, environments, and threats, as well as improved management and sharing of the data critical for lemur conservation. We also underscore the necessity for encouraging the independence of Malagasy scientists through increasing their training opportunities, funding mechanisms, and access to cutting-edge research technologies and techniques, both abroad and whenever possible within Madagascar, and the implication of all conservation stakeholders, including local communities, in the research process. In the following section, we offer specific suggestions for urgent research needs.

Taxonomic review

Taxonomic and phylogenetic research is essential for establishing units and setting priorities in conservation. In the past decade, there has been extraordinary growth in the number of described lemur species (see Mittermeier *et al.*, 2008). While some of these represent former subspecies now elevated to species, many are wholly new to science (e.g., Louis *et al.*, 2006; Yoder *et al.*, 2000). However, many taxa have been described largely based on a limited range of maternally-inherited mitochondrial DNA sequences, leading some to call for incorporating a broader set of markers and traits (Horvath *et al.*, 2008; Markolf *et al.*, 2011). Multi-locus genomics data sets with appropriate analysis techniques may be especially promising for resolving lemur phylogenies (Weisrock *et al.*, 2012). Moreover, it may be necessary to include type specimens found in museum collections in some phylogenetic analyses to apply the appropriate nomenclature, especially when locality information for original specimens is patchy.



Conservation posters at the annual Lemur Festival in Sahamalaza. (Photo: Guy Randriatahina)

Population monitoring

Many surveys have been conducted to document the distribution and density of lemur populations across remaining habitats (e.g., Irwin *et al*., 2005). We recommend further surveys to continue to refine the known range limits, to indicate areas of exceptional diversity or abundance, and to reveal underlying biogeographical patterns and processes. This research is especially critical for the least known and more endangered taxa. To improve upon existing data, it is important to increase sampling effort for robust estimates of population density (e.g., distance methods or complete count census) and to repeat surveys at regular intervals to assess long-term demographic trends. Simultaneous documentation of the sorts of habitat conditions that may influence population size is also recommended, including landscape and vegetation types, phenology, disturbance, and climate. In parallel with ground surveys, we suggest population genetic studies, especially using non-invasive sample collection (Quéméré *et al*., 2010a, 2010b); such research promises complementary information on genetic variation, as well as data on past demographic processes and future potential. We strongly support increased application and testing of population survey methods that involve local communities, and that results are shared among all partners in conservation. To this end, we suggest the development and distribution of GIS databases that include survey localities, vegetation plots, lemur presence/absence or abundance data, and sample collection sites.

Long-term behavioural and ecological research

In addition to population surveys, we recognize the tremendous conservation value of lemur behavioural ecology studies conducted over at least several decades in a few key sites, such as Ranomafana, Beza Mahafaly, Berenty, and Kirindy (Kappeler and Watts, 2012). This research has provided data critical for assessing the ecological requirements of threatened species. Such long-term study also offers more indirect – but no less important – conservation benefits, including local employment and capacity building and a presence in the forest to deter illegal hunting, logging, or mining. Such long-term commitment may also foster better relationships and communication among conservation stakeholders (researchers, managers, and local communities). We hope that this work will continue, and should be expanded to include many more new sites and ecosystems throughout Madagascar.

Quantification of threats

While habitat loss and fragmentation, hunting, mining, and perhaps climate change are generally known to be among the significant threats to lemur survival, little research has been conducted to date to precisely measure these activities and their relative impact. For instance, deforestation has been quantified through remote sensing techniques (e.g., Green and Sussman, 1990; Harper *et al*., 2007), yet comparatively little is known about forest degradation and its potential impacts on lemur populations. There are several model research programs for assessing fragmentation and edge effects (e.g., Irwin, 2008; Lehman *et al*., 2006); similar studies are recommended across Madagascar's diverse environments and distinctive lemur communities. Hunting of lemur species and the commercial bushmeat trade are also topics of critical research importance. There is now extensive anecdotal evidence for widespread hunting pressure, but more systematic studies are needed, including hunter follows, market and village surveys, records of trap densities, etc. (Golden, 2006, 2009). Threats that are presently less urgent because they are localized (e.g., fire) or more long-term (e.g., climate change) nonetheless also require increased research activity.

Mitigation of threats

In addition to studying the threats to lemurs, we strongly recommend more research on the programs designed to reduce them. A wide variety of tactics are used across Madagascar for these conservation aims, as well as to improve livelihoods in local communities. These include reforestation (including research on the effectiveness of forest corridors for long-term lemur adaptation and viability); development of alternative resources; community-based management of protected areas and natural resources; ecotourism and other alternative economic activities; and conservation-oriented education. There must be rigorous study, with standardized metrics of success, to evaluate these programs and ensure the best possible outcomes for lemurs, their environments, and the communities that rely on them.

Lemur Action Fund: A Rapid Response Fund for Lemur Conservation

Russell A. Mittermeier, Anthony B. Rylands & Christoph Schwitzer

Most of the action plans proposed in this Lemur Conservation Strategy are composed of site-based activities to be carried out in the highest priority areas for lemur conservation in Madagascar, and they are accompanied by budgets for all actions required at these sites over a three-year period. However, there always exists a need to provide small grants for a variety of urgent, very targeted projects, and these need to be funded as quickly as possible, with minimal bureaucracy. Examples of these kinds of projects include short-term, species-specific studies carried out by local or international graduate students; targeted conservation education and public awareness activities at the local village level in close proximity to key lemur conservation sites; emergency actions to deal with crisis situations (e.g., a bushmeat hunting episode, or the recent burning of the marshes around Lake Alaotra); short-term training for ecotourism guides and forest guards; and travel for Malagasy researchers to national and international conferences.

Based on our long-term experience managing a Primate Action Fund, first at WWF-US, and more recently at Conservation International (with support from the Margot Marsh Biodiversity Foundation), we find that projects of this kind usually range in size from US$1,000 to US$5,000, yet they can have enormous impact. Indeed, they often lay the groundwork for much larger, longer-term projects, or help to resolve a particular issue before it escalates into a much bigger problem. The key to success in such small projects is a rapid turnaround time, providing the applicant with a response in less than one month and often within a matter of days. We now have a portfolio of experiences with projects of this kind that dates back to 1980 – a period of 32 years – and we are certain of the viability and effectiveness of such an approach.

Consequently, to ensure the success of this Lemur Conservation Strategy, we are also including here a Lemur Action Fund of US$200,000 per year over the three-year period 2013–2015 – to be managed by the Primate Program of Conservation International in close collaboration with the Madagascar Section of the IUCN/SSC Primate Specialist Group. Donors interested in this kind of rapid action can earmark their gifts specifically for this fund, for which they will receive reports and updates once every six months.

Budget: US$ 200,000 per year, or US$ 600,000 over 3 years



Northern giant mouse lemur (*Mirza zaza*), Endangered. Sahamalaza - Iles Radama National Park. (Photo: Eva Johanna Rode)

Site-Based Action Plans

Marojejy National Park and Anjanaharibe-Sud Special Reserve

Erik Patel & Charles Welch

Marojejy National Park and Anjanaharibe-Sud Special Reserve are remarkable mountainous reserves found in north-east Madagascar. Protecting over 820 km^2 of mainly pristine rainforest, they are one of the largest protected area complexes in Madagascar. Some of the last remaining large tracts of undisturbed low-elevation rainforest are found here, as well as rare high elevation habitats. Due to the large number of elevational zones, biodiversity is magnificently high. Both reserves are World Heritage Sites as part of the UNESCO Atsinanana site. Indeed, eminent botanist Henri Humbert's classic 1955 book about Marojejy is entitled "A Marvel of Nature". He felt the massif was the most impressive range in Madagascar due to its floral diversity, size, and pristine natural state. More than 2000 species of angiosperms are found here. This region may contain more pteridophytes or ferns (Rakotondrainibe, 2000), reptiles and amphibians (Raselimanana *et al.*, 2000), and forest-dwelling birds (Goodman *et al.*, 2000) than any other protected area in Madagascar. Cophyline frog (Microhylidae) species richness and endemism in the Marojejy region is among the highest in Madagascar (Wollenberg *et al.*, 2008). Dung beetle diversity is also high as with other eastern rainforests (Viljanen *et al.*, 2010).





Silky sifaka *(Propithecus candidus)*, Critically Endangered. (Photo: Jeff Gibbs)

Primate diversity is profound as well, with 11 species of lemur in each reserve. Silky sifakas (*Propithecus candidus*), one of the World's 25 Most Endangered Primates, are found in both reserves, which protect approximately 75% of the remaining population of this species. Less than 2000 silky sifakas remain in the wild, and none have ever survived in captivity (Patel, 2009). In Anjanaharibe-Sud, silky sifakas and a unique all-black colour variant of indri (*Indri indri*), live in the same forests.



Location of Marojejy National Park and Anjanaharibe-Sud Special Reserve. (Source: Erik Patel)

Due to a variety of new and ongoing threats, all lemur species in Marojejy and Anjanaharibe-Sud are considered by the IUCN as threatened (except for elusive greater dwarf lemurs) and nearly half face a serious risk of extinction, being either Endangered or Critically Endangered. Nearby cities of Andapa and Sambava contain large and rapidly growing human populations. Rural communities found all around these reserves extract fuel-wood for cooking at unsustainable rates. Habitat disturbance from slash-and-burn agriculture remains the primary threat, although in recent years, illegal hunting of lemurs and selective logging of rosewood and ebony have harshly impacted this region. Mining of precious stones poses an additional threat for Anjanaharibe-Sud.

Since the political crisis in Madagascar began in 2009, all forms of habitat disturbance have drastically increased. Immediate action is required in order to save Marojejy and Anjanaharibe-Sud. A multi-faceted community-based conservation suite is proposed, which expands upon projects already known to be successful, and includes Madagascar National Parks, Duke Lemur Center, and SIMPONA as partners.

Forest monitoring will be improved through new support of park rangers and local villagers who assist them, called CLP's (Comité Locale du Parc). Not only will needed materials such as boots, raincoats, and GPS units with cameras be provided, but population surveys for lemurs will also be conducted more regularly. Such surveys will also include habitat disturbance assessments and removal of all bushmeat traps and illegal huts used by hunters in the protected areas. Demarcation of reserve boundaries will be clarified by new metal signs, paint, and boundary markers along the borders. Indeed, boundary demarcation could be improved for both reserves, particularly since Anjanaharibe-Sud has recently been expanded.

Tourism and research are high priorities as well. Long-term monitoring of the main silky sifaka tourist and research group at Camp 2 of Marojejy NP will ensure that all tourists can observe the region's flagship species and that data collection can continue on this very rare species. Ecotourism facilities will finally be established in Anjanaharibe-Sud with the proposed construction of this reserve's first bungalows, facilitating encounters with wild indri and silky sifakas.

Surrounding communities will benefit from new trainings by experienced fish farm experts, so that local communities can develop and breed locally endemic freshwater fish, which can alleviate their need for bushmeat. Bee-keeping trainings will also provide local residents with an alternative source of income and reduce the need for wild harvesting. Finally, the introduction of fuel-efficient "rocket stoves" will reduce the constant need for fuel-wood and wasteful cooking practices.

Budget: US$ 150,000 over 3 years

Masoala

Amavatra Herve Andrianjara, Aristide Andrianarimisa & Felix Ratelolahy
(translation by Matthew Richardson)

Situated in the north-east of Madagascar, the Masoala Peninsula extends from latitude 15°27'S to 15°59'S, and from longitude 49°54'E to 50°30'E. It is bounded to the west by the Bay of Antongil, and on the east by the Indian Ocean. The peninsula straddles the districts of Maroantsetra and Antalaha. Masoala National Park has a total area of 240,520 ha. It is composed of eight different areas: a large terrestrial parcel, three detached terrestrial parcels, three marine parcels, and the Nosy Mangabe Special Reserve.

The terrestrial ecosystem of Masoala National Park belongs to the eastern Madagascar ecoregion. It consists of dense, humid



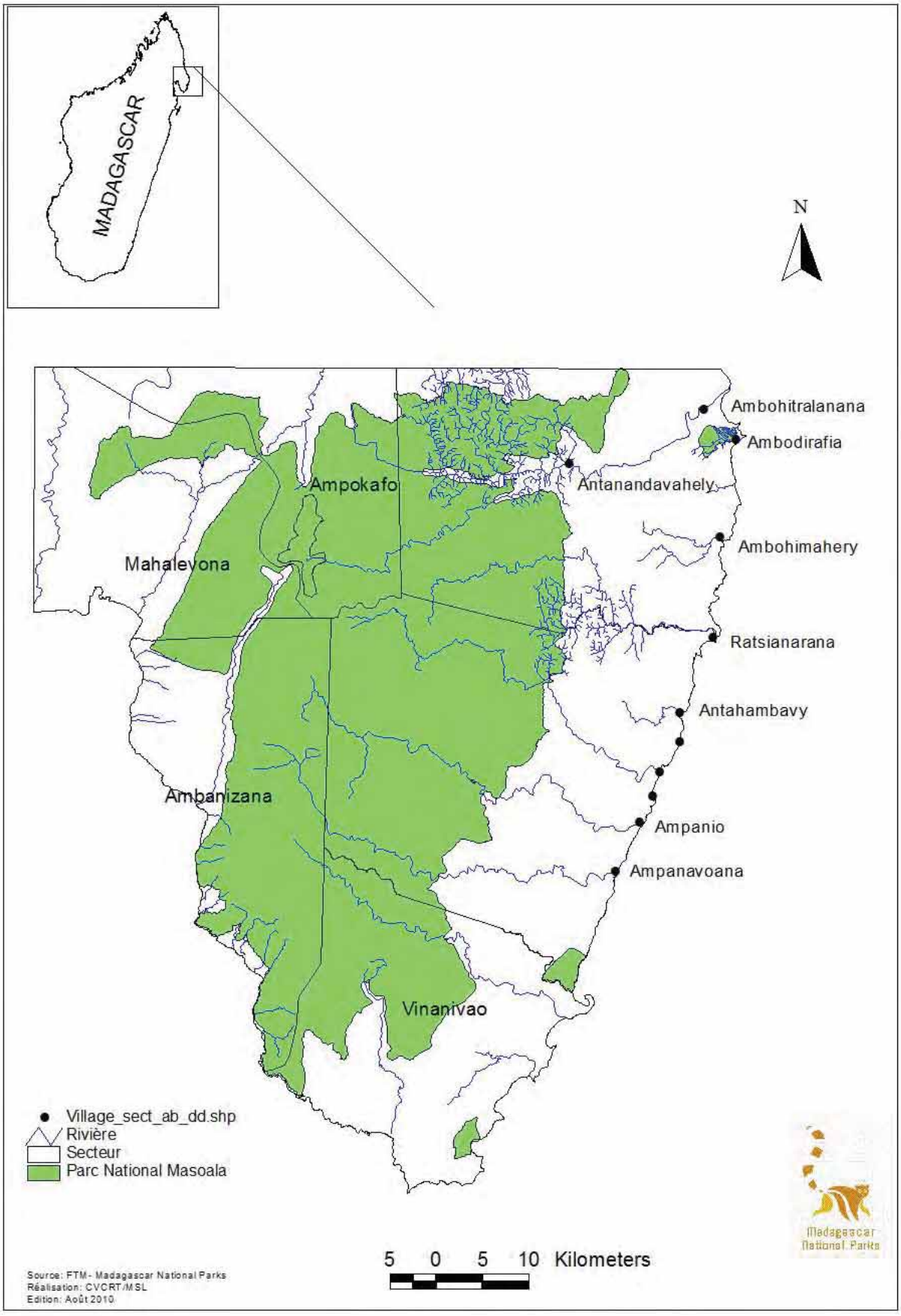


Red ruffed lemur (*Varecia rubra*), Critically Endangered. (Photo: Madagascar National Parks, Masoala)

evergreen forests from 0–1,300 m in altitude. In terms of biodiversity, Masoala is home to 11 species of lemur, of which the large diurnal species such as the Critically Endangered red ruffed lemur (*Varecia rubra*), Endangered white-fronted brown lemur (*Eulemur albifrons*) and Vulnerable northern bamboo lemur (*Hapalemur occidentalis*), are the object of the most serious hunting by the surrounding communities, owing to a lack of protein-based foods.

To ensure the conservation of these animals, it is imperative to conduct further efforts of patrol and surveillance, campaigns of environmental education and awareness, and support for small-scale husbandry of domestic animals as a source of protein.

General objective:
To reduce any form of threat to the integrity of the park and its lemurs, while involving the local communities in the process of park management. The project aims to protect and



Masoala National Park. (Source: FTM, Madagascar National Parks)

monitor the dynamics of lemur populations within the zone of protection of Masoala National Park.

Specific objectives:
Strengthening of the control and surveillance of the park through continuing systematic and periodic patrols in the interior and exterior, by agents of the park and of the local communities.

Realization of ecological monitoring by transect, following the existing protocols of the park. Such monitoring of lemurs as well as other fauna are to be undertaken according to the following strategies: ranger-based monitoring, ecological monitoring involving the participation of the local communities, ecological monitoring undertaken by scientists, and scientific research according to the context and needs of the park.

Support for the implementation of small-scale alternative-development projects for the benefit of the surrounding communities. Efforts will be focused on economic activities addressing the lack of animal protein-based foods. The goal over the medium and long term is to transform such microprojects into revenue-generating activities.

Reinforcement of environmental education and awareness for students as well as adults. The objective is to reach all of the surrounding communities with concrete efforts of environmental education and awareness.

Expected results :
Lemur populations as well as overall biodiversity of the park are protected:

• Biomedical research monitoring by sector is undertaken per trimester.

• A monitoring of lemur populations by transect is undertaken per year.

• Twelve foot patrols by sector are undertaken per year.

• Subsistence activities and / or generators of revenue respectful of the environment are underway in the peripheral zone of the park.

• The surrounding communities are made aware of the park, and are effectively involved in its protection.

Budget: US$ 181,000 over three years



Male white-fronted lemur (*Eulemur albifrons*), Vulnerable. (Photo: Russell A. Mittermeier)

Makira

Felix Ratelolahy, Vonjy Andrianjakarivelo & Aristide Andrianarimisa

Makira's forests cover 372,470 ha and lie within the Antongil Bay landscape in north-east Madagascar. They represent one of the largest expanses of humid forest left in the biologically rich eastern rainforest biome of the island. The forests of Makira are a key, intact biodiversity stronghold and a vital bridge maintaining long-term connectivity and altitudinal gradient protection across protected areas in the north-eastern region. These protected areas include Anjanaharibe-Sud Special Reserve and Marojejy National Park to the north; Masoala National Park to the east; and Mananara-nord National Park.

The Makira Forest Protected Area Project, hereafter referred to as the Makira Project, is located 40 km west of the town of





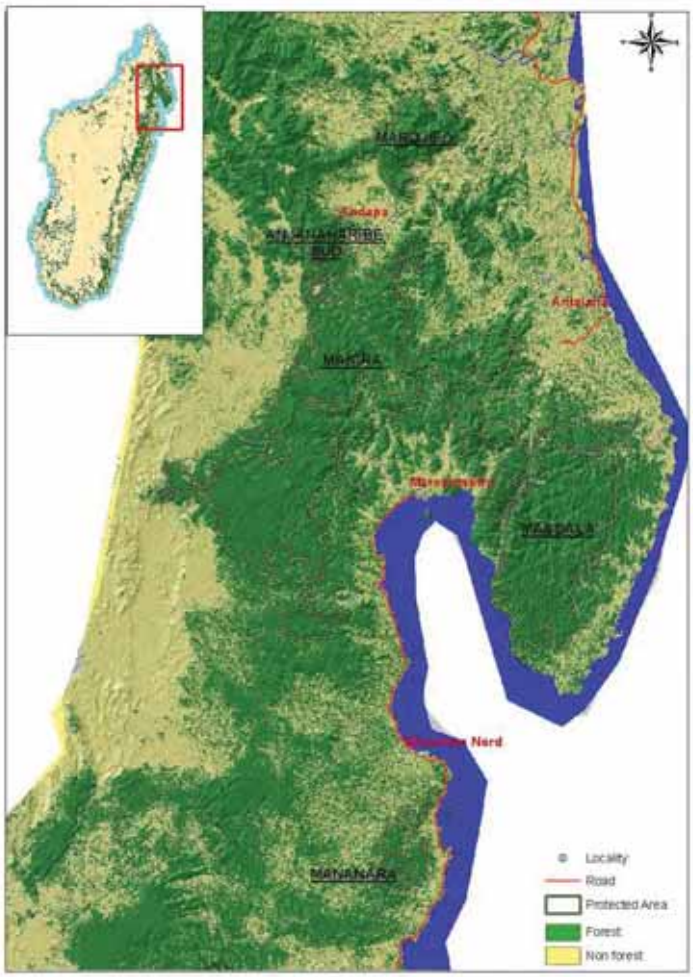
Indri (*Indri indri*), Critically Endangered. (Photo: Russell A. Mittermeier)

Maroantsetra, within the following boundaries: 14°41'40.7" S – 15°51'40.8" S, 48°58'20.18" E – 50°1'3.7" E. The Makira Project falls within three regions (Analanjirofo, Sava and Sofia) and five districts (Maroantsetra, Antalaha, Andapa, Befandriana Nord and Mandritsara). The Makira Project also involves 21 communes and 63 Fokontany.

The main objective of the Makira Project is to ensure the conservation of the biodiversity and the sustainable use of natural resources in the north-eastern part of Madagascar through engagement with the local population. The conservation of biodiversity thus goes hand in hand with the development of local communities.

About 97% of the population of the Makira region consists of farmers (Ramanandriana, 2004). Socio-economic survey results concluded that households are not able to meet their subsistence needs if they do not combine subsistence agriculture with cash crops (Holmes, 2007). Among the most encountered threats to the biodiversity of Makira's forests are forest clearing for rice cultivation, bush and forest fires, hunting for bushmeat, small-scale selective illegal logging, and mining. Subsistence and economic pressures are principal drivers of these threats. Continued bushmeat hunting in the absence of management and livelihood alternatives will reduce the natural populations of targeted species, such as the diurnal lemur species endemic to Makira, by up to 60% (Golden, 2009).

For this reason, the Wildlife Conservation Society (WCS) has promoted alternative agricultural methods such as intensive



Location of Makira in north-east Madagascar. (Source: WCS Madagascar)

agriculture (SRI, SRA), income-generating activities (growing vanilla, cloves, coffee etc.), and chicken, duck and fish farming. In addition, the Makira Project will develop a community ecotourism program to increase local economic activity in Andaparaty (E 49,614111; S -15,188083). Currently the Makira Project has a pilot community ecotourism site in Ambodivoangy (E 049°59'858"; S 15°26'382"), and one community-based resource management (GCF) site that is preparing to receive tourists.

Mitigation of possible negative biodiversity impacts will proceed through extension of community support efforts to off-site communities in the peripheral zone, so as to promote sustainable economic alternatives to destructive and unsustainable activities. Among principal components of this effort will be the development of an Information, Education and Communication (IEC) program that will raise off-site community awareness of the economic, health and human welfare benefits of environmental protection.

In collaboration with Madagascar National Parks (MNP), WCS has already initiated a pilot forest restoration project targeting two forest corridors inside Masoala National Park: the one at Ambatolaidama began in 1997 and the second one at Ilampy corridor started in 2006. Since 2010, WCS have established two new restoration corridors in Makira: Lokaitra (E 49,432415; S -15,717974) and Vohitaly (E 49,534883, S -15,4393), and the Betaimposa Corridor in Masoala. Working with local people, this project has already restored 10.5 ha of forest. The positive and very promising results obtained at these sites encourage and urge WCS to continue and even enlarge its restoration activities to other empty forest in the corridors.

The floral and faunal composition of Makira is still not fully known, but preliminary studies recorded at least 469 plant species (including about 43 species of palm, making Makira an extraordinarily diverse area in terms of palms), 114 amphibian species, 103 reptile species, 125 bird species, 17 lemur species and subspecies (the highest diversity of lemurs found within any of Madagascar's protected areas) as well as 44 other mammal species. Nevertheless, scientific research and data collection on lemur abundance and distribution, taxonomy, genetics and ecology are still needed. WCS will promote such research especially in regions not yet explored.

Endemic to the north-eastern forests of Madagascar, the Critically Endangered silky sifaka (*Propithecus candidus*) was previously believed to be restricted to Marojejy National Park (Sterling and McFadden, 2000) and Anjanaharibe-Sud Special Reserve (Schmid and Smolker, 1998), with a few groups in the Betaolana Corridor (Fara and Andriamarosolo, 2010). To date, these sites have served as the primary source of information on the species' conservation status, ecology, and behavior. In 2007, silky sifakas were first observed in the Makira forests.

To minimize the pressures and promote new information on this species, a long-term monitoring program for silky sifaka groups at two localities, Andaparaty (E 49,614111; S -15,188083) and Soavera (E 49,453871; S -14,98801), will be continued. These two sites are subject to heavy pressures such as hunting, fires and mineral exploitation. Monitoring was initiated by Erik Patel's team (Duke Lemur Center) in May 2011 at the Andaparaty site (E 49,614111; S -15,188083).

The surrounding local communities have rights to use forest resources for their own subsistence. Illegal activities consist mainly of logging precious woods, mining, and hunting, which are all mainly carried out by non-residents and are very often a source of conflict between residents and new migrants. The Makira Project is working in collaboration with the Environment and Forest agents, the Gendarmerie and local authorities on controlling these illegal activities and ensuring law enforcement. In addition, local communities are empowered through forest resource management contracts (GCF) and supported by WCS in the practice of their management and monitoring responsibilities.

Complementing these efforts, WCS will continue the expansion of a collaborative ecological monitoring program within the community-based natural resource management sites (CBNRM) bordering Makira by means of direct payment for conservation action. The project will train permanent community-based ecological monitoring teams and provide continued technical advice and ongoing mentoring to ensure effective monitoring.



Silky sifakas (*Propithecus candidus*), Critically Endangered, in Makira. (Photo: WCS Madagascar)

Recent studies conclude that in the near future it is quite possible that natural forest will cease to exist outside of protected areas in Madagascar (MEFT, 2008). Studies targeting critical species and ecosystem indicators show increasing evidence that rapid changes in meteorological patterns are already reducing narrow habitat niches (Raxworthy *et al*., 2008; Schatz and Cameron, 2008). Critically Endangered primate species found in the project region that are highly vulnerable to climate change and climate variability include the black-and-white ruffed lemur (*Varecia variegata*), the red ruffed lemur (*Varecia rubra*), the silky sifaka (*Propithecus candidus*), and the indri (*Indri indri*). Vulnerable species include the hairy-eared dwarf lemur (*Allocebus trichotis*) (MEFT, 2008). For this reason, WCS will initiate climate change vulnerability monitoring on lemur species. Community vulnerability will be measured through changes in rainfall and temperature patterns.

Budget: US$ 197,500 over 3 years

Mananara Nord National Park

Jocelyn Bezara & Felix Ratelolahy

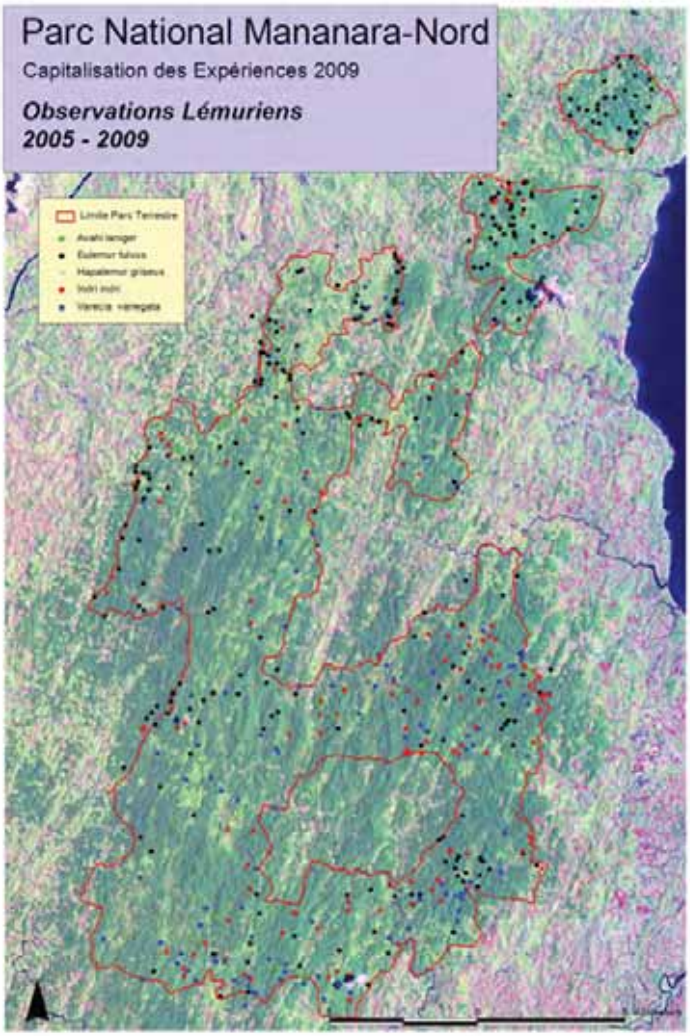
Mananara Nord National Park is a Protected Area located in north-east Madagascar, at the entrance to Antongil Bay. It was established by Presidential Decree in 1989 and constitutes the core of the first Biosphere Reserve created in Madagascar. Management of the Mananara Nord Biosphere Reserve began in October 1988 with UNESCO as an operator through the "Man and Biosphere" program. The funding sources were UNDP (1988-91) and the Malagasy Government, UNESCO, UNDP, the World Bank, and the Dutch Government, followed by the Dutch Government with the Malagasy Government's contribution since 1995, and the European Union with the contribution of the Malagasy Government and Intercoopération from 2003. Currently it is funded by the Foundation for the Protected Areas and Biodiversity of Madagascar, KFW. The Biosphere Reserve is located between 16°09'-16°39'S and 49°30'-49°54' E. With a total area of 23,000 ha and an altitude range of 0 to 569 m, the park consists of three large forests: North Ivontaka, South Ivontaka, and Verezanatsoro, whose boundaries were established for the classification of the forest in 1964. The forest is a habitat for 9 species of lemurs, including the Vulnerable hairy-eared mouse lemur (*Allocebus trichotis)*, which was thought to be extinct until its discovery in 1989, and the Endangered aye-aye (*Daubentonia madagascariensis)*, which was thought to have disappeared, but was rediscovered in the forest of Mananara Nord in 1953 (Erbergt *et al.*, 1999). One should also note the extreme rarity of the Critically Endangered diademed sifaka (*Propithecus diadema)* which is described in scientific literature, but poorly understood by the park managers and supervisors of the park village. The Critically Endangered indri (*Indri indri)* is currently being selected by park managers as a specific target of conservation despite the lack of scientific data concerning threats to it.





Aye-aye (*Daubentonia madagascariensis*), Endangered. (Photo: Russell A. Mittermeier)

The climate is tropical and humid, and flora and fauna are abundant. The average annual rainfall is 2935 mm with the wettest month being February (383 mm) and the driest being November (82 mm). The average monthly temperature is 25.2°C, with the coldest months being July and August



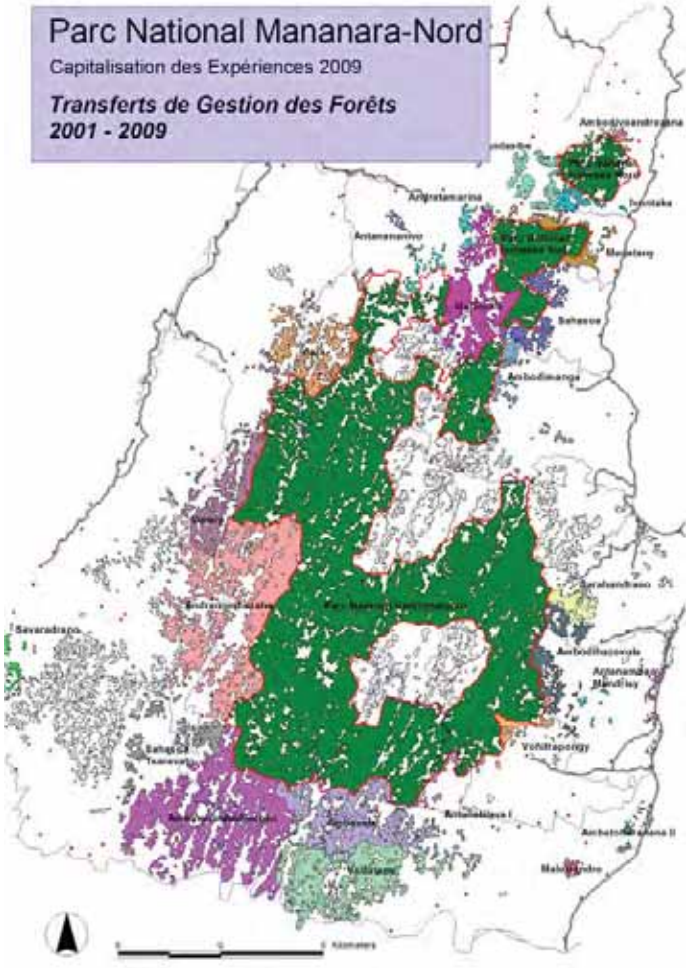
Lemur observations inside Mananara-nord National Park during 2005–2009. (Source: Madagascar National Parks-Mananara Nord)

(22.2°C), and the hottest being January (27.7°C).
Although the park is protected, the lowland rainforest is currently threatened by fragmentations along the north-south divide. These fragmentations originate from clearings made along the valleys, and follow the geological contexts of the region (PGC Mananara North, 2005).

Additional efforts are needed to avoid the isolation of existing protected areas within the band of high altitude humid rainforest that still exists in the western region. Thus, the conservation of the natural habitats of the Makira Plateau and a forest corridor between the National Park Mananara North and the surrounding forests in the South and West are the first priority in the future. Faced with the political situation and current decentralization, GCF contracts (contractual management of forests) as the initial forms of protection are more effective and rapid, and were conducted with funding from the European Union (2003-09); they form a "green belt" to protect forest habitats, with the flora and fauna associated outside the park to the interior of the Biosphere Reserve. However, the lack of necessary training, resources, and research on lemurs hamper the management committees (COBA) and park managers.

Preservation of hardwoods in the Park is an absolute priority for conservation in the near future, as the exploitation of precious wood and timber is a common practice in and around the NTP. As well as this, exploitation of useful plants in the villages also puts pressure on lemurs, as landlocked and isolated villages rely on a high level of natural forest resources. A participatory survey in four villages near the park identified 141 plants that are used. There are 9 species used for crafts, 70 for medical use, 29 for consumption, 35 for making boxes and 7 for woodworking. Presumably, many of these plants are still harvested in the forests outside NTP.

However, extensive studies are needed to identify the species that have become rare outside the park and are currently being taken from within the NTP (PAG RBMN, 2002). A participatory study on local knowledge of biodiversity in 2001 showed that almost all villages hunt lemurs for food. Between 7 and 13 species of mammals are known to be hunted and consumed, and one species is killed without being eaten. Presumably much of this hunting takes place inside the park and forests.



Management transfers of forest parcels in the periphery of Mananara-nord National Park during 2001–2009. (Source: Madagascar National Parks-Mananara Nord)

Lately another type of threat has been the passage of large herds of zebu cattle from the highland region of Mandritsara, intended for the market of Tamatave. Sometimes these herds are taken through the National Park, leaving behind a trail of completely trampled and damaged land. Therefore, the control of paths and the prohibition of Park cattle has become an important and urgent issue.

The Park management history shows a lack of research on wildlife. Since its inception they have not exceeded 25% of the studies in the Biosphere Reserve (Huttel *et al.*, 2002). Yet there have been proposals by researchers to preserve and enhance natural resources. The few early studies conducted on lemurs in this area relate only to the behavior of *D. madagscariensis* and rapid inventories of existing species. Since 2005, three specific studies have been conducted by the team at Omaha's Henry Doorly Zoo & Aquarium, the University of Antananarivo and the Botanical and Zoological Park of Tsimbazaza, focusing on the conservation genetics and phylogeny of *I. indri, V. variegata, Lepilemur* and *Hapalemur*.

Given the current state of knowledge on lemurs, the importance of conservation, and the threats they face, the following procedures are necessary to ensure that in the near future the desired protection and conservation of habitats are acheived.

Implementation of participatory research and ecological monitoring requires the acquisition of equipment suitable for 18 agents and 41 village supervisors (6 Garmin GPS 12 XL, 6 cameras). Their effectiveness will be strengthened through training, research, and ecological monitoring of permanent populations of lemurs and their natural habitats; this monitoring will complement the Park agents.

The development of two sites in the park for basic research will provide a permanent standing arrangement to increase the knowledge of the forest. Setting aside 60 ha each year for plots of previously degraded natural restoration and implementation of active restoration at the bridge forest of North Ivontaka in an area totalling approximately 40 ha will maintain the integrity of the forest in the corridor between the park and North and South Ivontaka.

To enforce the law, a 120 km limit will be created for hardwood visibility of the park, field equipment (10 tents and 60 waterproofs for agents and village supervisors) will be acquired for implementation of patrols and surveillance of coastal populations, and the implementation of environmental education at 12 primary schools and 24 villages on the causes of pressure around the park will give efficient results.

The 14 COBA around the Park will be strengthened through the renewal of contracts to ensure the sustainability of management. Their capacity for research and implementation of participatory ecological monitoring at their land will also be strengthened through training.

To increase and diversify household incomes around the protected area, development activities as alternatives to micro pressure will be implemented, for example, the identification and implementation of micro-short-cycle livestock, fish and the annuity industry, and the study and development of five works to overcome agricultural tavy. The two women's groups will receive tourism community support to ensure their sustainability.

Budget: US$ 176,500 over 3 years

Lake Alaotra

Fidimalala Ralainasolo, Jonah Ratsimbazafy, Richard Lewis & Herizo Andrianandrasana

Lake Alaotra is located in the Alaotra-Mangoro region in central-east Madagascar, covering an area of 20,000 ha in the central highlands of the island (17031'S, 48026'E) (Andrianandrasana *et al*., 2005). It is the largest lake in Madagascar and was designated as a wetland of international importance under the Ramsar Convention in 2003 (Ramsar, 2007). The government of Madagascar recognized the conservation value of this area by classifying it as a New Protected Area within national law N°381-2007/ MINENVEF/MAEP on 17th January 2007.

The surrounding 23,000 ha of marshes are dominated by papyrus (*Cyperus madagascariensis*) and rushes (*Phragmites*



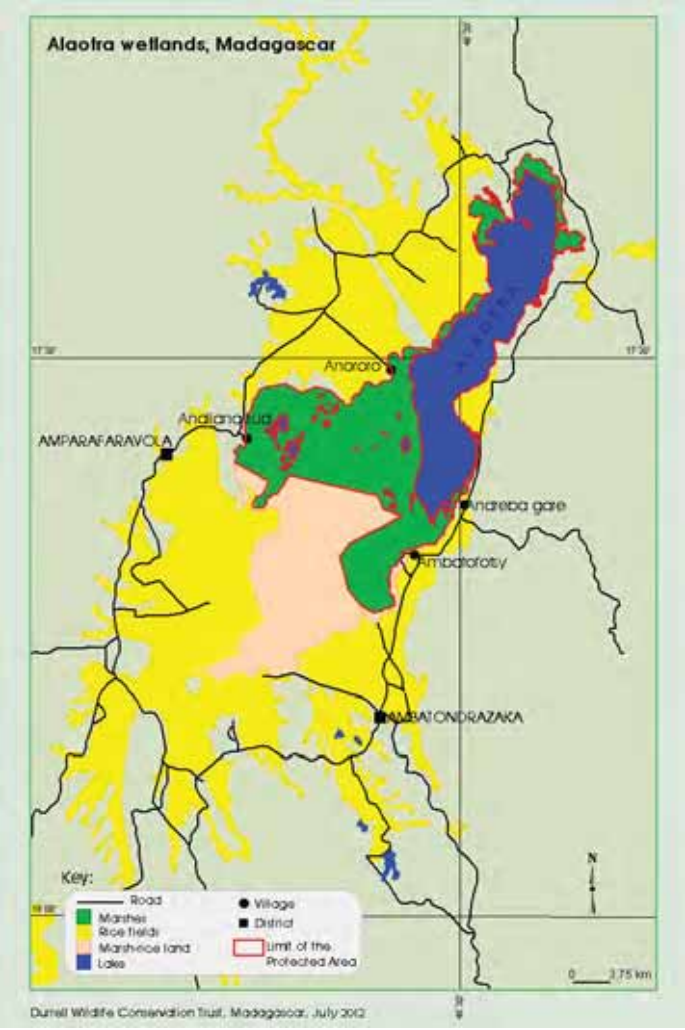


Lake Alaotra bamboo lemur (*Hapalemur alaotrensis*), Critically Endangered. (Photo: Durrell Wildlife Conservation Trust)

communis), and adjoining this, 120,000 ha of rice fields within a watershed encompassing 722,500 ha. The lake and marshes support at least three Critically Endangered and locally endemic species, including the Lake Alaotra bamboo lemur (*Hapalemur alaotrensis*) (Andrianandrasana, 2005; Durbin *et al.*, 2007). The latter is the only primate taxon in the world that lives exclusively in a wetland habitat. The species is classified as Critically Endangered due to its extremely reduced geographic range. The rufous mouse lemur (*Microcebus rufus*) is also found in the marshes.

Lake Alaotra is also an area of great importance for water birds, with populations of Malagasy endemics such as Meller's duck (*Anas melleri*). Two endemic bird species, the Madagascar pochard (*Aythya innotata*) and the Alaotra little grebe (*Tachybaptus rufolavatus*), have disappeared from the lake and the latter is now considered extinct. The aquatic environment has been more seriously altered by sedimentation and by invasion of exotic plants (water hyacinth, water fern) and fish (tilapia, snakehead and carp). Urgent action is needed to safeguard the marsh home of the Alaotra bamboo lemur in order to prevent this species from disappearing like the endemic Alaotra water birds.

Lake Alaotra is not only a centre of great biological importance, but is also the main area of rice production in the country,



Alaotra wetlands. (Source: Durrell Wildlife Conservation Trust)

and an important supplier of fish to the capital city and other urban centres. Cattle farming, growing vegetables, keeping small livestock (geese, chickens etc.) and the commercial manufacture of textiles from woven reeds are also practised (Jarosz, 1994). Around 500,000 people live around its shores, placing increasing pressure on natural resources and the wetland ecosystem. The loss of habitat has had serious implications for the endemic wildlife, much of which relies on the wetland vegetation for food and shelter (Feistner, 1999). Thus, the biodiversity of the lake is threatened by extinction if actions are not taken. For the Alaotra bamboo lemur, the main causes of its decline have been conversion of its marsh habitat to rice fields, widespread and repeated burning of remaining areas of marsh, and hunting for local consumption.

Durrell Wildlife Conservation Trust's Madagascar Program has worked with partners, particularly the regional directorate of the Ministry of the Environment and Forests (DREF), and the Fisheries services, since 1997 to raise awareness of the lemurs, the biodiversity of Alaotra and the ecological and economic importance of their wetland home. In 2001, Durrell started an annual program of participative ecological monitoring in 16 key villages around the lake, covering around 90% of the marsh area. In 2007, the entire lake and the surrounding marshes were given temporary protected area status. It was agreed that this new protected area would be managed collaboratively between community groups and government authorities. A co-management structure is being created, called 'Alaotra Rano Soa'.

Ecotourism for lemur observation is being promoted by the NGO Madagascar Wildlife Conservation and the French department Ille-et-Vilaine. Conservation agriculture cropping systems are promoted in the area by a consortium of several international institutions including JICA, CIRAD and AVSF.

Community associations sustainably manage the marshes adjoining their ancestral territory according to contracts with the State. All fishermen on the lake now belong to a village-level fishermen's association. These associations are grouped into a federation to agree on and monitor sustainable fishing regulations. There are currently 16 fishing associations and 9 fish traders' associations grouped in 2 federations (E and W). Twenty-eight marsh management associations are grouped and supervised by 3 inter-commune federations. The co-management structure will enable these community users to participate in orientation and management of the protected area through their local associations and federations.

In order to ensure the survival of Lake Alaotra's lemurs and their habitat, the following strategies need implementing:

- Stop habitat loss and degradation by:
1. Finalising legal creation of the Protected Area (PA)
2. Demarcating high risk zones of the PA
3. Implementing PA management plans
4. Developing a comprehensive communication/education programme for the Alaotra watershed (promoting pride of lemurs and understanding of ecological services)
5. Continuing current system of permanent patrolling and law enforcement support
6. Developing a fire management strategy
7. Implementing marsh restoration to reconnect fragments
8. Protecting the four main water sources

- Implementation of population monitoring by:
9. Developing a system for counting H.alaotrensis (drone or balloon) by flying over the marshes

- Auditing conservation effectiveness by:
10. Monitoring socio-economic and environmental indicators over time

- Conduct community-based sustainable development by:
11. Improving sustainable agricultural productivity of buffer zones
12. Supporting sustainable fishing practices
13. Developing income-generating mechanisms through payments for ecological services

Budget: US$ 150,000 over 3 years

Ankeniheny–Zahamena Corridor (CAZ)

Harison Randrianasolo, Tovonanahary Rasolofoharivelo, Rainer Dolch, Tony King, Lucien Randrianarimanana & Tianasoa Ratolojanahary

The Ankeniheny–Zahamena Corridor (CAZ) covers an area of almost 550,000 ha of low, mid and high altitude rainforest, located along the Betsimisaraka Cliff in eastern Madagascar. The corridor is characterized by the major river system that provides irrigation of agricultural areas and supplies hydroelectric power to both Antananarivo and Toamasina. Approximately 180 km long, and up to 30 km wide, the corridor includes well-established and world-famous protected areas such as Andasibe–Mantadia and Zahamena National Parks and the Ramsar site of Torotorofotsy. Most of the corridor connecting these sites has only recently been categorised as a new protected area, with the objective of community-based sustainable use of natural ecosystems buffering a core conservation area.





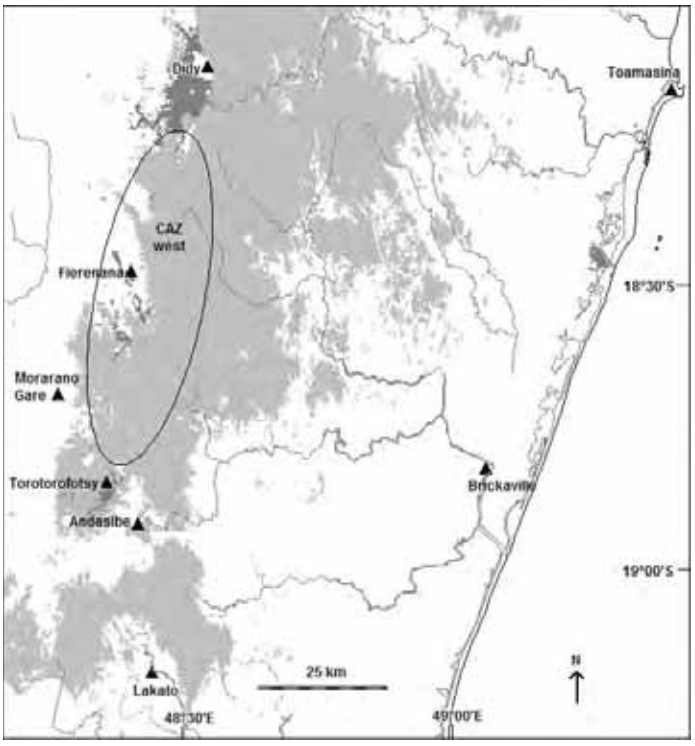
Greater bamboo lemur (*Prolemur simus*), Critically Endangered. (Photo: Hery Andrianiantefana/The Aspinall Foundation)

The Ankeniheny–Zahamena Corridor is one of the largest remaining areas of moist evergreen forest in Madagascar, and hosts many endemic species. A hundred and twenty-nine species of reptiles and amphibians, 89 species of birds, and over 2,000 plant species have been recorded in the corridor. A remarkable 17 species of lemur are known from the corridor, including the emblematic and Critically Endangered indri (*Indri indri*), the Critically Endangered diademed sifaka (*Propithecus diadema*), the Critically Endangered black-and-white ruffed lemur (*Varecia variegata*), and the Critically Endangered greater bamboo lemur (*Prolemur simus*). Nocturnal lemurs include the remarkable and Endangered aye-aye (*Daubentonia madagascariensis*), the very elusive and Vulnerable hairy-eared dwarf lemur (*Allocebus trichotis*), and a multitude of mouse lemurs, dwarf lemurs, fork-marked lemurs, sportive lemurs and woolly lemurs.

Conserving this immense corridor and its lemur community is a great challenge. In a collaborative discussion between several organizations involved in the region we have identified four priority projects designed to mitigate immediate threats to the survival of the unique lemur communities in the corridor. The first three projects focus on implementing targeted site-specific conservation actions to conserve the four highest priority lemur species occurring in the corridor, namely the greater bamboo lemur, black-and-white ruffed lemur, indri and diademed sifaka. These site-based projects aim to ensure effective community-based conservation of the three known sites supporting all four of these priority species, namely the Andriantantely lowland forest in the Brickaville District, the Torotorofotsy-Ihofa complex near



Indri (*Indri indri*), Critically Endangered. (Photo: Tony King)



The Ankeniheny–Zahamena Corridor (CAZ) in eastern Madagascar. (Source: Tony King)

Andasibe, and the western portion of the main CAZ corridor. The fourth project aims to reduce hunting pressure on lemurs throughout the corridor, by implementing wide-ranging awareness programs and promoting alternative protein sources amongst local communities living close to the forest. We will discuss each of these four projects separately below.

Total Budget (includes Andriantantely, Torotorofotsy-Ihofa complex, CAZ west, and regional awareness program and promotion of alternative protein sources):

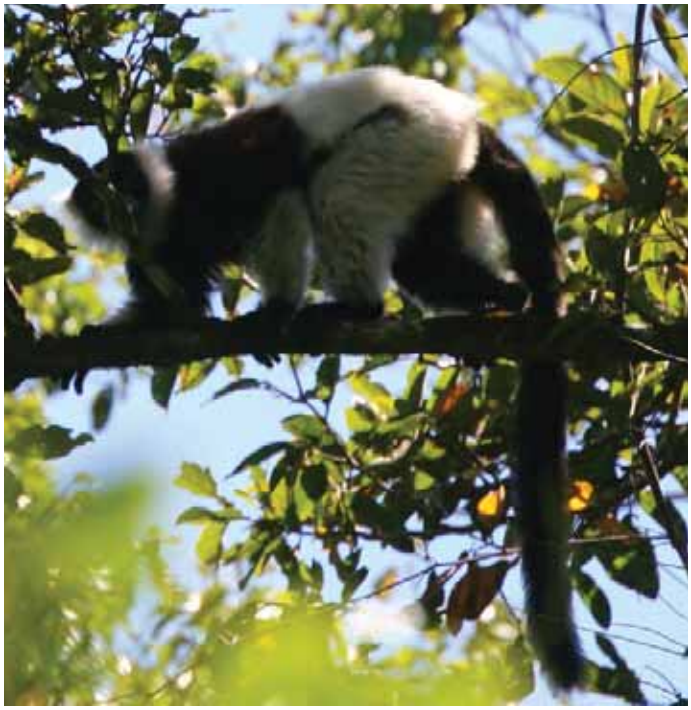
US$ 725,000 over 3 years

Andriantantely

Tony King, Tovonanahary Rasolofoharivelo, Harison Randrianasolo, Rainer Dolch, Lucien Randrianarimanana & Tianasoa Ratolojanahary

The Andriantantely forest is one of the few patches of lowland rainforest remaining in Madagascar. Located in the Brickaville District of eastern Madagascar, 85 km south-west of Toamasina, the forest is over 4,000 ha in size and was identified as a high conservation priority during a series of rapid biodiversity assessments undertaken in 1998 and 1999 by Conservation International. It was the only site surveyed for which the surveys of all taxonomic groups (plants, lemurs, small mammals, birds, amphibians, reptiles, insects, ants) indicated that the forest remained in good condition. Large diurnal lemurs are surprisingly abundant, including the Critically Endangered black-and-white ruffed lemur (*Varecia variegata*), indri (*Indri indri*) and diademed sifaka (*Propithecus diadema*). In addition, several groups of greater bamboo lemurs, considered one of the most endangered primates in the world, have recently been discovered in the dense bamboo thickets surrounding the forest.





Black-and-white ruffed lemur (of the *Varecia variegata editorum* pelage pattern), Critically Endangered diurnal lemur occurring in Andriantantely that will benefit from improved protection by the proposed project. (Photo: Tony King)

Conservation of the newly discovered greater bamboo lemur sites surrounding Andriantantely was rapidly implemented within the framework of the "Saving *Prolemur simus*" project of The Aspinall Foundation. However, there is a desperate need to expand conservation activities into the forest itself, to mitigate the heavy threats to Andriantantely, which are primarily hunting, slash-and-burn forest destruction, and illegal timber harvesting.

The legal and administrative foundations for the effective conservation of Andriantantely are already in place. The forest is recognised as a protected area as part of the Ankeniheny-Zahamena Corridor (CAZ), and several local community associations (COBAs) have been created to take legal responsibility for the management and conservation of designated zones of the forest. We will therefore implement several urgent conservation actions to ensure the COBAs can effectively manage the forest for conservation:

1. Fund, train and supervise part-time patrol teams from the COBAs to protect lemur populations and monitor conservation indicators in Andriantantely;
2. Hire a Malagasy primatologist to train, supervise and work alongside the local patrol teams;
3. Complete the inventory of lemur species occurring in Andriantantely;
4. Determine density estimates for priority lemur species, including black-and-white ruffed lemur, indri, and diademed sifaka, and monitor changes over time;



The forest of Andriantantely in the background, viewed from the south-east, with bamboo thickets in the foreground. (Photo: Tony King)

5. Study the biology of priority species, and identify threats to their survival;
6. Raise awareness of forest and lemur conservation amongst local communities;
7. Empower COBAs to reduce anthropogenic pressures on Andriantantely lemurs by developing and supporting appropriate community programmes.

These activities will be organised by The Aspinall Foundation in collaboration with various national and local partners, and will ensure participation of local communities in each activity. Several teams of local COBA representatives will be hired and trained as forest guardians. The teams will patrol different areas of the Andriantantely forest for an average of 14 days per month, collecting information on lemurs in general and on endangered large diurnal lemurs in particular. The patrol teams will simultaneously mitigate threats to lemurs and the forest by dismantling lemur traps and reporting other threats so that the COBAs and their partners can organise appropriate responses in accordance with their management transfer agreements. A Malagasy primatologist will be hired to train and supervise the patrol teams, and to undertake more rigorous studies of diurnal lemurs in Andriantantely and the threats facing them. The project will organise community-based education and awareness programmes, and work with the COBAs and other local partners to develop or support development activities aimed at reducing anthropogenic pressures on the forest. Such activities will be designed based on local needs, but typically include reforestation using native forest tree seedlings, and in particular species used as food plants by lemurs, promoting of fuel-efficient stoves, training in improved agricultural techniques and poultry breeding, and encouraging bee-keeping.



Indri (*Indri indri*; a dark individual, although black-and-white forms also occur), Critically Endangered diurnal lemur occurring in Andriantantely. (Photo: Tony King)

Budget: US$ 150,000 over 3 years

Torotorofotsy–Ihofa

Rainer Dolch, Tianasoa Ratolojanahary, Harison Randrianasolo, Tovonanahary Rasolofoharivelo, Tony King & Lucien Randrianarimanana

The Torotorofotsy–Ihofa complex in the Alaotra–Mangoro Region of central eastern Madagascar comprises a series of rainforest and wetland areas of critical importance to conservation. These lie adjacent to Andasibe–Mantadia National Park and within the larger landscape of the Ankeniheny–Zahamena Corridor (CAZ) that has recently been established as a new protected area within the SAPM. However, the Torotorofotsy–Ihofa complex does not enjoy legal protection, although its southern parts have been declared a Ramsar site. The total area covers about 18,000 ha and is centered around S18 51.123 E48 22.957. It is home to a staggering 13 species of lemurs, including the Endangered aye-aye (*Daubentonia madagascariensis*) and eastern woolly lemur (*Avahi laniger*), as well as four Critically Endangered species, the indri (*Indri indri*), the diademed sifaka (*Propithecus diadema*), the black-and-white ruffed lemur (*Varecia variegata*), and the greater bamboo lemur (*Prolemur simus*).





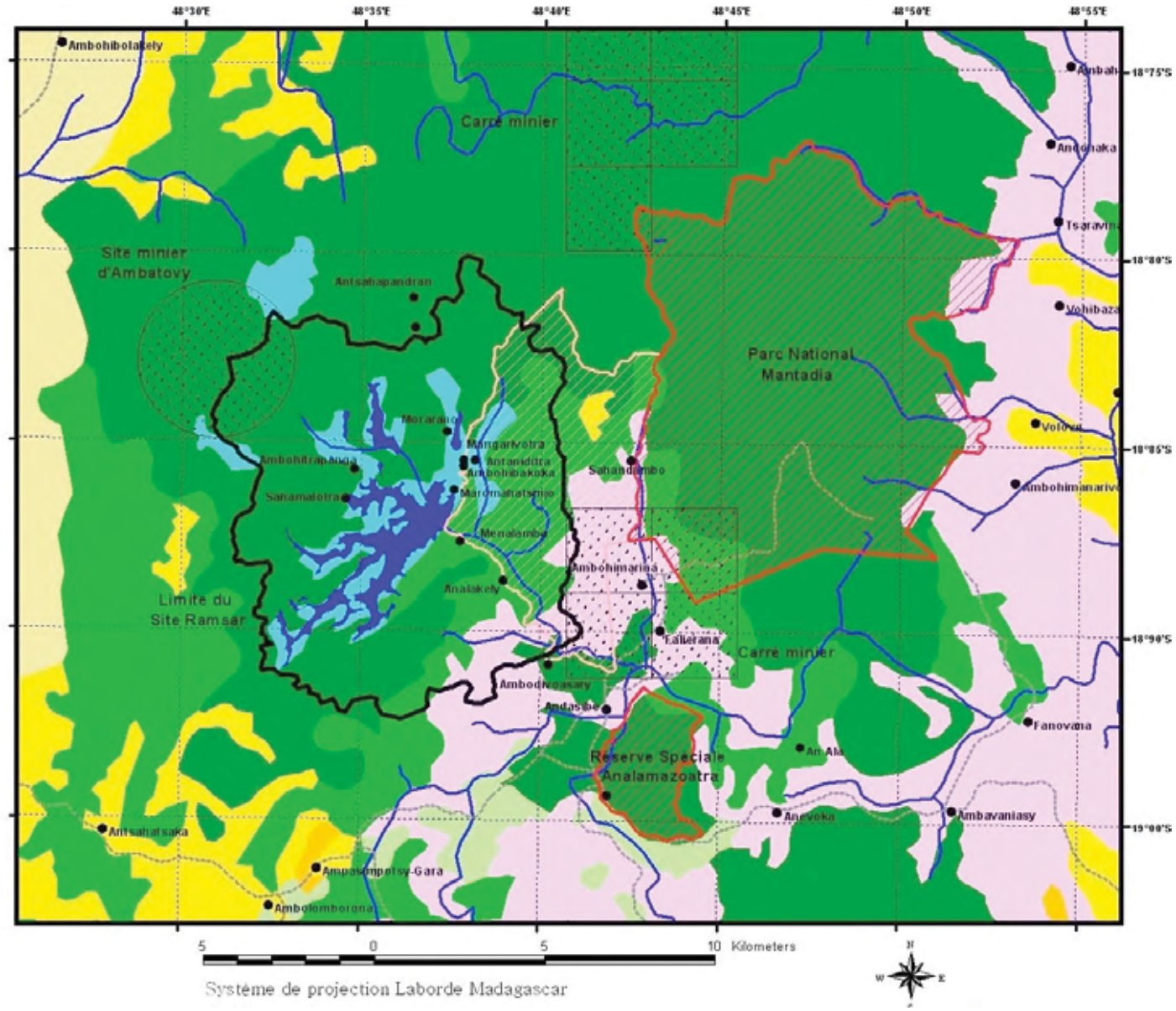
Greater bamboo lemur (*Prolemur simus*), Critically Endangered. (Photo: Jonathan Fiely/Association Mitsinjo)

Torotorofotsy–Ihofa is a critical area for the maintenance of continuous lemur habitat. It is also the site of rediscovery for the northern population of the greater bamboo lemur (*Prolemur simus*), which had not been recorded north of the Mangoro River for more than a century. The conservation of this site would not only contribute to the survival of this Critically Endangered and highly specialized monospecific genus of primate, but also assure the long-term survival of an array of threatened species all occurring here.

Torotorofotsy's wetlands are threatened by draining for conversion into rice fields. The surrounding rainforest is under pressure from both industrial and artisanal mining, slash-and-burn agriculture, and selective logging. Opportunistic and targeted trapping of lemurs is also practised.

Association Mitsinjo has been designated as the management entity for the Torotorofotsy Ramsar site by the Ministry of the Environment and Forests. Working closely with local communities (COBAs) and the respective Federations to which they are attached, it focuses on community-based natural resource management and conservation through the application of mutually accepted traditional local rules (dina). These efforts include ecological research, and Association Mitsinjo operates a research camp close to the Ihofa River.

In order to address progressing threats to the area and effectively protect the highly threatened lemurs of the



Location of Torotorofotsy. (Source: Association Mitsinjo)

Torotorofotsy–Ihofa complex, a number of actions need to be taken immediately. Efforts will be stepped up to transform the Ramsar site into a new protected area and synchronise its management with existing protected areas around it – a process that has already been instigated in order to implement the Conservation Action Plan for the greater bamboo lemur.

The establishment of the Mitsinjo research camp in Torotorofotsy over the last 5 years has helped strengthen the close relationship and mutual trust with local communities that date back to the early 2000s. The continuous presence of both technical and scientific project staff as well as visiting researchers has proved to be the most effective means of ensuring long-term protection of the forest and its biodiversity.

It is therefore proposed to establish a permanent research facility. The facility will have both permanent managing and research staff and host visiting scientists. Permanent staff will include community-based and locally trained para-scientists and field guides that monitor resident lemur populations with a focus on the four Critically Endangered species. Community-based patrols will also monitor and report threats. This will be in compliance with nationwide monitoring efforts, e.g. as outlined in the National Bushmeat Strategy. Thus, any evidence for trapping, logging or artisanal mining in lemur habitat will be effectively communicated and addressed.

Monitoring staff will closely work with Malagasy and international students and researchers. To support the effective protection of the endemic lemurs, basic scientific information on range boundaries, habitat requirements, other ecological needs and genetics of these species and populations need to be assessed.

According to the Torotorofotsy Management Plan, assistance will be provided to villagers for the maintenance of tree

nurseries. A variety of seedlings of native forest trees will be produced and used for forest regeneration and reforestation, re-establishing links between forest fragments. At the same time, tree nurseries will produce fruit trees designed to enhance sustainable livelihoods through the promotion of agroforestry and a diversification of produce.

Training will also be provided in other sustainable and intensive agricultural techniques such as "SRI" as alternatives to slash-and-burn agriculture. Fish breeding as well as bee keeping will be promoted and supported by training and provision of materials needed. The production of local handicraft will be supported. In addition to direct protection measures, social infrastructure will be improved, based on existing activities that have so far led to the construction of a primary school, a dispensary and several drinking water wells. Schoolteachers already subsidised by Association Mitsinjo will be trained to deliver conservation education lessons to their students.

Aided by the construction of the permanent research facility (which will also function as an information and education centre), a community-based conservation education programme will be implemented. Educational materials such as leaflets, posters, caps and T-shirts will be produced and distributed among villagers. Additionally, a community-based ecotourism project especially focusing on the extraordinary lemurs of the site will be started, providing employment for local guides and support staff.

Budget: US$ 200,000 over 3 years

Western Portion of the Ankeniheny–Zahamena Corridor (CAZ)

Tovonanahary Rasolofoharivelo, Lucien Randrianarimanana, Tony King, Harison Randrianasolo, Rainer Dolch & Tianasoa Ratolojanahary

The Ankeniheny–Zahamena Corridor (CAZ) is one of the largest continuous rainforests remaining in Madagascar and comprises several management units, from national parks to community-managed sustainable-use reserves. The corridor supports a remarkable 17 species of lemur, including the emblematic and Critically Endangered indri (*Indri indri*). The western portion of the CAZ is one of the only known areas where four of the most unique and Critically Endangered large rainforest lemurs can be observed living together: the indri (*Indri indri*), the black-and-white ruffed lemur (*Varecia variegata*), the diademed sifaka (*Propithecus diadema*) and the greater bamboo lemur (*Prolemur simus*). These four species represent some of the highest-priority primate conservation challenges in the world.





Diademed sifaka (*Propithecus diadema*), Critically Endangered. (Photo: Tony King)

The conservation strategy for the majority of the CAZ is based on ensuring participatory community-based management of the entire boundary of the forest corridor. Over 100 community associations (COBAs) take responsibility for the sustainable management of the boundary zones, grouped into six federations that help channel the necessary technical and financial support to the associations. The current project proposal focuses on supporting 18 COBAs within the Vahatriniala federation that protects the western boundary of the CAZ, from the Morarano Gare commune to the southern parts of the Didy commune. The major threats to the survival of lemurs in this area are hunting, slash-and-burn agriculture, and illegal mining and logging. Hunting levels can be rapidly reduced by funding selected COBA members to patrol the forest on a regular basis, whilst also collecting baseline data on lemur populations. Reducing habitat destruction is more difficult. The COBA patrol activities can have a positive impact in the short-term, whilst long-term solutions can best be found through clear incentive-based conservation contracts between partner organisations and each COBA, so long as the community development incentives are sufficiently attractive and are linked directly to conservation performance.



Indri (*Indri indri*). Critically Endangered. (Photo: Tony King)

We therefore propose to hire and train several teams of local COBA representatives as forest guardians. The teams will patrol different areas of the western CAZ, dismantling lemur traps and reporting other threats so that the COBAs and their partners can organise appropriate responses in accordance with their management transfer agreements, while simultaneously collecting information on lemurs in general and on endangered large diurnal lemurs in particular. The teams will be supported by the quasi-permanent presence of a Malagasy primatologist. The project will organise community-based education and awareness programmes, and implement incentive-based conservation contracts with the COBAs and other local partners to develop or support development activities aimed at reducing anthropogenic pressures on the forest. Such activities will be designed based on local needs, but typically include reforestation using native forest tree seedlings, and in particular species used as food plants by lemurs, promoting the use of fuel-efficient stoves, training in improved agricultural techniques and poultry breeding, and encouraging bee-keeping.

Budget: US$ 175,000 over 3 years

Prevention and Reduction of Bushmeat Hunting in the Ankeniheny–Zahamena Corridor (CAZ)

Harison Randrianasolo, Tovonanahary Rasolofoharivelo, Rainer Dolch, Tony King, Lucien Randrianarimanana & Tianasoa Ratolojanahary

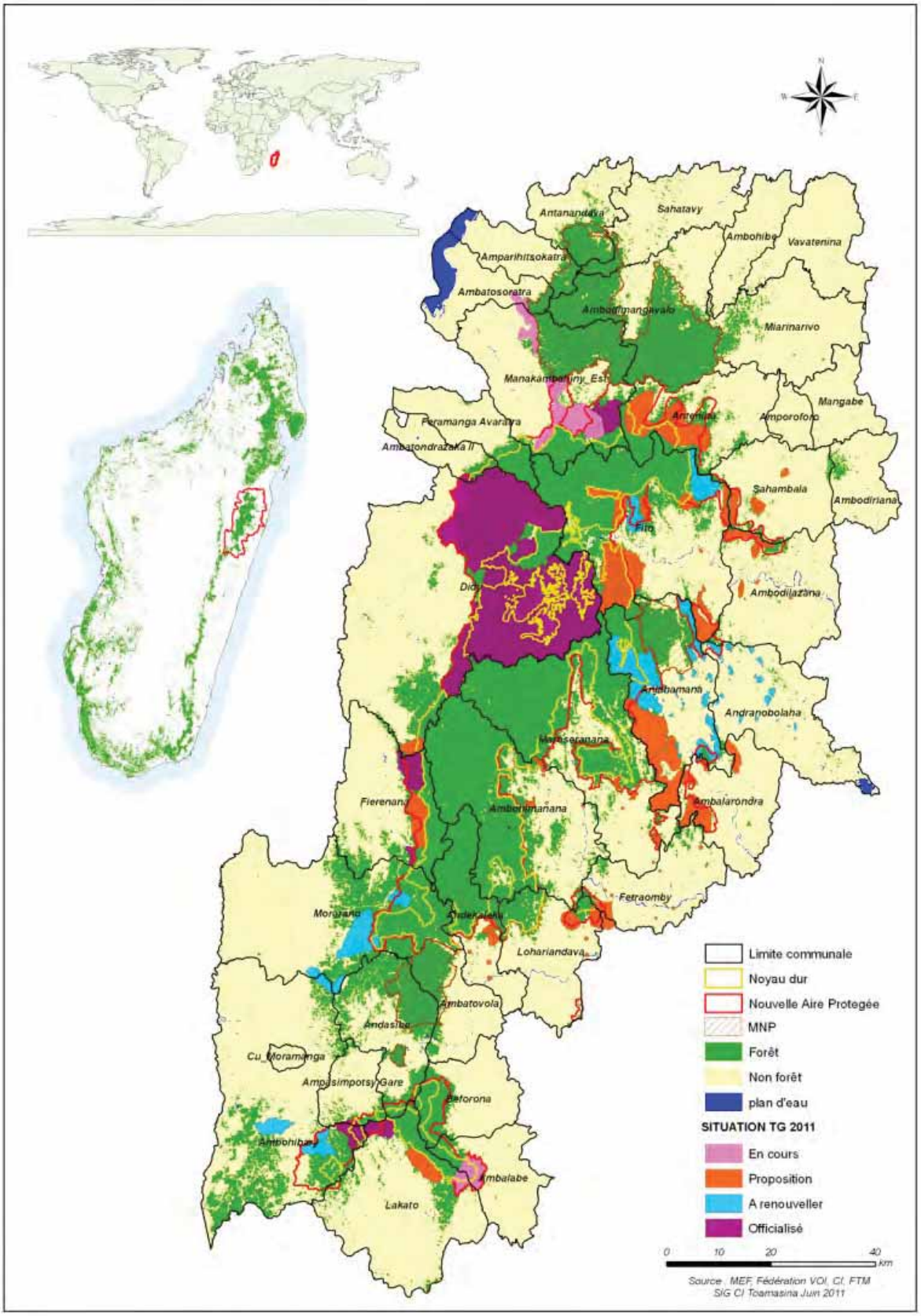
The Ankeniheny–Zahamena Corridor (CAZ) is located along the Betsimisaraka Cliff in the eastern part of Madagascar. The CAZ is bordered to the north by the Zahamena National Park and in the south by the municipality of Lakato. The corridor stretches over an area approximately 180 km long by 30 km wide, covering some 371,000 ha. The corridor falls within the regions of Atsinanana and Alaotra–Mangoro and contains 25 municipalities. According to a survey conducted in May 2010, 64,516 people live around the area, relying heavily on small-scale agriculture as their primary food source. Increasingly poor yields, however, are forcing more people to seek supplementary food such as tubers, bushmeat, fish and honey from the surrounding forests.



The Ankeniheny–Zahamena Corridor is rich in biodiversity, characterized by a very high level of endemism. This portion of forest, specific to the eastern part of the island, ranges from lowland forests, below 400 m, to high-elevation forests, between 1,200 and 1,600 m. These forests contain 15 species of lemurs, including the Critically Endangered black-and-white ruffed lemur (*Varecia variegata*), greater bamboo lemur (*Prolemur simus*), diademed sifaka (*Propithecus diadema*), and indri (*Indri indri*), and the Vulnerable Goodman's mouse lemur (*Microcebus lehilahytsara*) and hairy-eared dwarf lemur (*Allocebus trichotis*), as well as a currently Data Deficient species, Crossley's dwarf lemur (*Cheirogaleus crossleyi*). The CAZ is also home to globally threatened bird species, including *Lophotibis cristata*, *Aviceda madagascariensis*, *Brachypteracias squamiger*, *Brachypteracias leptosomus*, *Atelornis pittoïdes*, *Pseudobias wardi*, *Monticola sharpei*, *Dromaeocercus brunneus*, *Hartertula flavoviridis*, *Randia pseudozosterops* and *Sarothrura watersi*. A number of sites in the corridor have also been identified as Alliance for Zero Extinction (AZE) sites, therefore being internationally recognized as locations where species assessed as Endangered or Critically Endangered under IUCN criteria are restricted to single sites.

The new protected area (NAP) of the Ankeniheny–Zahamena Corridor is classified as category VI of the IUCN protected area categories. Category VI – a protected area with sustainable use of natural resources – aims to encompass a mutually beneficial correlation between nature conservation and sustainable management of natural resources. The core area is defined by restricted monitoring and research only, while the buffer zone can be utilized in a sustainable fashion. In the buffer zone, natural resources are open to sustainable use by the local communities in accordance with the closed contract and dina, or traditional local rules, under which management transfers are met. The selective cutting of timber for house construction or tombs is authorized. The hunting of unprotected species is not prohibited. The buffer zone also includes areas important to cultural and religious pilgrims.

Around the CAZ, local people are differently affected by the proposed creation of the new protected area. There are people who depend on a permanent basis on natural resources (major PAP), as well as those that only make seasonal or sporadic use of such resources (minor PAP). Potential constraints could be generated by the creation of the protected area, including public access to natural resources. The restriction affects 30% of resources due to the ban on access to the core area. Thus, 2,500 households are affected by the project, including 2,101 for major PAP and 399 for minor PAP. The impact of the access restrictions in the CAZ affects households by limiting the practice of hunting (birds, bats, lemurs, tenrecs), limiting access to foods traditionally collected in the forest (honey, wild tubers), and the prohibition of expansion of agricultural land by slash-and-burn agriculture.



Location of the new protected area of the Ankeniheny–Zahamena Corridor (CAZ) with different management transfers to the local population. (Source: MEF, VOI federation, FTM, CI)



Lemur trap in Ankeniheny-Zahamena Corridor. (Photo: Centre ValBio/Conservation International)

The traditional organization of rural communities in the CAZ has a village chief or "Tangalamena" as the holder of the supreme authority of the village. Immigrants have to pass by him before conducting any activity. Technical services from different ministries (Agriculture, Fisheries, Environment and Forests) have particular responsibility for monitoring the exploitation of natural resources and the evaluation of transfer efficiency of resource management, as well as for general monitoring and implementation of the legislation. Administrative authorities (regions and municipalities) have an important role in the formalization/approval of actions taken for the proper functioning of sustainability management measures.

Along the CAZ, transfers of management were performed in the buffer zone to the various VOIs, which are groups of local communities whose role it is to protect certain areas. The participating communes included Ambodilazana, Ambatovola, Ambohibary, Ambohimanana, Ampasimpotsy, Andasibe, Andekaleka, Andranobolaha, Anjahamana, Beforona, Didy, Fetraomby, Fierenana, Fito, Lakato, Lohariandava, Manakambahiny Est, Maroseranana and Morarano. A hundred and two VOIs were created and regrouped into six federations.

National and international non-governmental organizations, along with local associations, have the expertise needed to help with the implementation of alternative measures for conservation, develop and initiate education and awareness campaigns, and reinforce the efforts of local partners.

Budget: US$ 200,000 over 3 years

Betampona Natural Reserve

Ingrid Porton, Maya Moore & Karen L. M. Freeman

Created in 1927, Betampona Natural Reserve, located 40 km north-west of Toamasina, was Madagascar's first protected reserve. Once contiguous with the Zahamena forest corridor and 50 years ago still adjacent to Sahivo and Antanamalaza classified forests (Britt *et al*., 1999), Betampona's 2,228 ha of lowland rainforest are now an isolated patch surrounded by agriculture and degraded land.

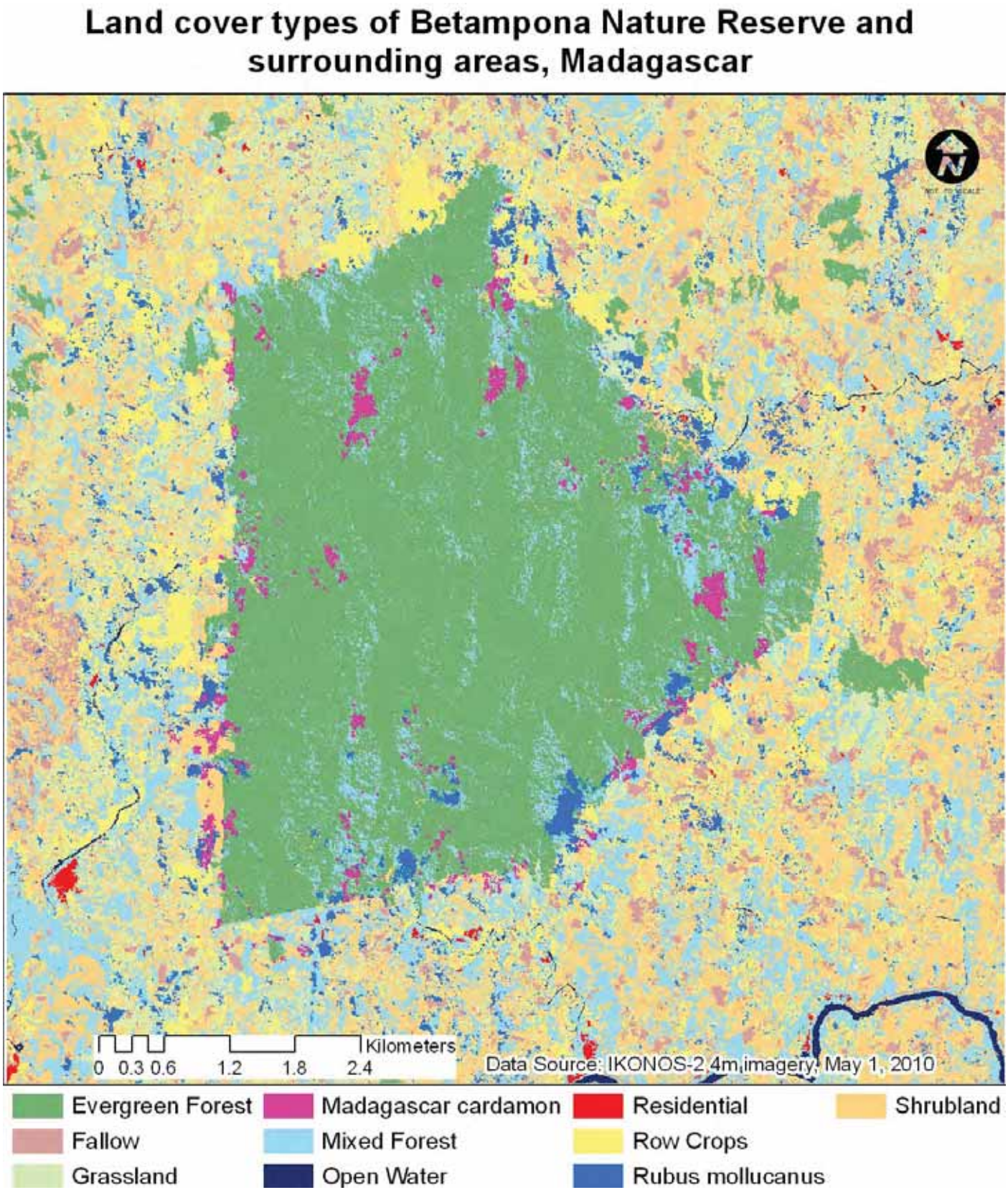
The Madagascar Fauna & Flora Group (MFG) began surveying Betampona's lemur populations in 1990 which, following a Population Viability Analysis (PVA) carried out by the IUCN's Conservation Breeding Specialist Group, led to the 1997–2001 restocking of 13 captive-born Critically Endangered black-and-white ruffed lemurs (*Varecia variegata*) into the Reserve. A more diverse and holistic research program was established in 2004 that, in part, aimed to document Betampona's faunal and floral diversity. This work has contributed significantly to the wider recognition of the Reserve's high level of biodiversity and importance. The MFG has been Madagascar National Parks' (MNP) research partner for over 15 years; all its research is based on conservation priorities set by MNP, and outcomes are provided to them through annual reports. MFG's research station is staffed with six MFG Conservation Agents, project support staff and visiting researchers whose continual presence serves to protect the forest's biodiversity.





Indri (*Indri indri*), Critically Endangered. (Photo: Fidisoa Rasambainarivo)

Eleven lemur species are found in Betampona. Studies by ex-pat and Malagasy graduate students and veterinarians have primarily focused on the feeding ecology, habitat use and health of four of the five diurnal lemur species: The Critically Endangered indri *Indri indri*, Critically Endangered diademed sifaka *Propithecus diadema*, Critically Endangered black-and-white ruffed lemur *Varecia variegata* and Endangered white-fronted brown lemur *Eulemur albifrons*. Its faunal diversity also includes five carnivores (including *Cryptoprocta* and *Salanoia*), 88 birds, 67 reptiles, 45 ants and multiple new invertebrate taxa. An important finding was Betampona's unusually high level of frog species when compared to larger rainforests in Madagascar; its 76



Betampona Natural Reserve: Land cover types. (Source: Wasit Wulamu, Saint Louis University)

frog taxa include 36 candidate species (Rosa *et al*., 2012). A detailed study by Armstrong *et al*.(2011) showed Betampona's tree diversity at 49 families and at least 244 species of trees, which the author deemed very high when evaluated against data from rainforests of similar size worldwide. The MFG recently collated and updated the taxonomy of all of Betampona's herbarium specimens collected to date, which revealed a floral diversity of 114 families, 296 genera, and 807 angiosperm species, with 14 of them endemic to the Reserve.

Betampona is encircled by nine villages, and in all of them the human population is growing rapidly and likely at the country's average of 2.9%. An initial socioeconomic survey of 213 households, conducted by a Malagasy graduate student, found that most families have no more than a 500 m plot of land to cultivate rice and crops, 54% admitted to practicing tavy (slash-and-burn agriculture), 67% hunt their own bushmeat, and 97% gather wood from the wild. Food animals that are commonly found in the villages include chickens, ducks and pigs; however, problems with disease-related mortalities result in limited production. The MFG recently partnered with Dr. Christopher Golden to conduct a more in-depth assessment of bushmeat practices and attitudes by villagers living around Betampona. The MFG has an established child education program (Saturday School) that helps rural children pass the national exam to enter secondary school while introducing them to locally relevant conservation messages. The MFG's capacity building program targets villagers, natural resource practitioners, politicians and university students in such subjects as ecoagriculture, environmental law, environmental education, ecotourism, research methods, and conservation biology.



Diademed sifaka (*Propithecus diadema*), Critically Endangered. (Photo: Fidisoa Rasambainarivo)

In order to extract the power and value of the biological and socioeconomic data the MFG has collected, we partnered with Dr. Wasit Wulamu, Saint Louis University's Department of Earth and Atmospheric Sciences, to develop a single relational, georeferenced database. In addition to adding the raw data collected by MFG staff and researchers, the analytical capabilities of the database are being augmented by populating it with hyperspectral data for species inventory and habitat quality mapping; high and middle spatial resolution data for mapping invasive species and tree type classification at finer-scale; low and high frequency RADAR images to remove clouds from optical images and mapping under-the forest-canopy as well as model tree height and 3D topography. Field observations are used to validate results obtained from satellite data and GIS analysis. This tool will enable MNP and MFG to evaluate the effectiveness of their conservation action.



Black-and-white ruffed lemur (*Varecia variegata*), Critically Endangered. (Photo: Fidisoa Rasambainarivo)

The primary threats to the survival of Betampona's lemur populations are accidental or purposeful fires encroaching into the Reserve; poverty that may lead more people to extract resources from the forest; the spread of exotic, invasive plants (especially strawberry guava, *Psidium cattleianum*) that MFG research has shown to outcompete regeneration of native flora; and the small population sizes of the *V. variegata*, *P. diadema*, *I. indri* and likely *D. madagasacariensis* that, over time, will suffer from inbreeding and other stochastic events, thus leading to population extinctions. The MFG has instituted a multidimensional program to protect Betampona's lemurs; as flagship species, protecting lemurs protects all of Betampona's biodiversity.

MFG's Betampona program includes:

1. Reforestation of Betampona's 100-meter Zone of Protection (ZOP) with native trees: This program, now entering its fifth year, began by partnering with the local communities, learning their needs, establishing tree nurseries at 4 villages and agreeing upon a strategy of planting native trees in the ZOP and food or income-generating plants in community areas. As an added incentive, each year the work is evaluated and prizes are awarded to the winning participants. To date, the program has worked with nearly 400 villagers to plant 42,000 trees covering 126 hectares around the Reserve.

2. Eradication of invasive exotic plants, including guava, one of the world's worst invasives, in Betampona: The MFG has documented the extent to which invasives have penetrated the Reserve and their impact on the regeneration of native species. Unless the invasives are controlled/eradicated, the structure and ecological integrity of Betampona's primary forest will be forever altered. A Malagasy PhD student is half-way through his research, comparing the efficacy and environmental impact of four non-chemical methods of removing guava in Betampona. The results of his research will be applied to Betampona and available to other conservationists in the form of a manual.

3. Metapopulation management of Betampona's endangered lemurs: Research is underway to assess the genetic diversity and health of *I. indri*, *P. diadema*, *V. variegata* and *E. albifrons* (as a comparison). Translocations will be required to sustain Betampona's most endangered lemurs and genetic data are needed to develop species-specific translocation plans while health data are required for any translocation. An immediate need is a rigorous population census of these species to analyze and interpret the genetic and health data and to develop an accurate and effective management plan.

4. Community Development and Livelihoods Project around the Reserve: The MFG has adopted the slogan "Betampona Voaaro, Mponina Mandroso" meaning "Protect Betampona, Develop Communities". To this end, the MFG will expand its Parc Ivoloina-based ecoagriculture program to communities around the Reserve. Data from Golden's survey will also be incorporated to build the capacity of villagers in domestic food animal husbandry and to undertake a targeted disease surveillance program. Identifying the appropriate vaccinations for food animals is a key action to increasing livestock production. Improved production may reduce bushmeat hunting and serve as a source for generating income. In addition, the MFG will initiate capacity building opportunities focused on the needs of women as identified by participants in local women's associations.

Budget: $150,000 over 3 years

Anjozorobe–Angavo & Tsinjoarivo

Mitchell Irwin, Marina Blanco, Jean-Luc Raharison & Karen Samonds

This forest corridor extends from the Anjozorobe–Angavo Protected Area in the north to the Tsinjoarivo Classified Forest in the south, and is entirely contained between two of eastern Madagascar's largest rivers (the Onive River to the south and the Mangoro River to the east). Because of its westerly position relative to other eastern rainforest sites, and its biogeographic position spanning eastern and western drainages, it contains higher altitude forest that represents a transition between typical eastern humid forest and sub-humid high plateau forest (now represented only in extremely small fragments such as Ambohitantely). This forest's climate reflects its altitude and westerly position – Tsinjoarivo receives just 2,000 mm of rainfall per year, much less than lower-altitude coastal sites, and temperature ranges from daily highs of about 26°C in January to daily lows of 7°C in July.



Diademed sifaka (*Propithecus diadema*), Critically Endangered. (Photo: Mitchell Irwin/SADABE)



The Anjozorobe–Angavo–Tsinjoarivo forest is rich in biodiversity. It contains twelve primate species, including three Critically Endangered taxa: Sibree's dwarf lemur (*Cheirogaleus sibreei*), indri (*Indri indri*) and diademed sifaka (*Propithecus diadema*); and one Endangered taxa: aye-aye (*Daubentonia madagascariensis*). There have also been sightings of the Critically Endangered greater bamboo lemur (*Prolemur simus*) at Tsinjoarivo. It is especially important as a refuge for the newly rediscovered dwarf lemur *C. sibreei*, as this species seems to be restricted to highest-altitude humid forest (>1,300 m), and is currently known only from two highly restricted areas in this corridor and one additional, isolated site within Ranomafana National Park. The region's



Sibree's dwarf lemur (*Cheirogaleus sibreei*), Critically Endangered. (Photo: Mitchell Irwin/SADABE)



Anjozorobe-Angavo & Tsinjoarivo forest corridor. (Photo: Mitchell Irwin/SADABE)

unique and transitional biogeographic position has also led to rich and unique biodiversity in other animal and plant groups, such as a record-setting 17 tenrec species (including 12 sympatric *Microgale* species) – the highest tenrec diversity of any site in Madagascar.

Protection of this forest corridor was practically non-existent until 2005, when the Anjozorobe–Angavo corridor was given protected area status by the Malagasy government. This area is managed by the NGO Fanamby, which has installed tourist infrastructure and initiatives (see http://www.sahaforestcamp.mg). However, the southern half of the corridor, including Tsinjoarivo Classified Forest, still has no official protection, and pressures on the remaining forest are considerable – especially tavy (deforestation), illegal logging and gold mining. These pressures pervade the forest corridor but are most acute in the western areas (due to the close proximity to high plateau human settlements). This is unfortunate because the western, highest altitude forests (reaching 1,650 m) are among the last of their kind in Madagascar, and the last strongholds of the high altitude dwarf lemur *C. sibreei*. The NGO Sadabe (http://www.sadabe.org) has been working at Tsinjoarivo since 2000, and currently manages several research, conservation and development projects there. Urgent action is needed to preserve this unique ecosystem – specifically, strengthening of the protection of Anjozorobe–Angavo, and the creation of a new protected area at Tsinjoarivo.

At Tsinjoarivo, SADABE will pursue three major initiatives that, in combination, will protect threatened lemur populations. First, it will continue its research, conservation and development programs, which have been effective at preserving forest cover in their intervention areas, and expand these activities from existing areas (approx. 40 km^2) to cover the southern half of this forest corridor (approx. 2,000 km^2). The fragmented forest site of Mahatsinjo (where SADABE



Waterfall on the Onive River adjacent to theTsinjoarivo Rova (Queen's Palace). (Photo: Mitchell Irwin/SADABE)



Eastern woolly lemur (*Avahi laniger*), Vulnerable. (Photo: Russell A. Mittermeier).

teams have worked since 2000) will be the region's "Model Station", hosting demonstrations and training sessions for pisciculture, apiculture, improving agricultural production, reforestation and tree farming, environmental education, and ecological monitoring. Educational materials will be created and distributed widely during surveys, educational events, and within existing schools. SADABE researchers will also work with international and local collaborators and students to increase research activities, following three major priorities: spatial variation in anthropogenic threats and lemur population densities, population genetics and dispersal abilities, and the impacts of habitat disturbance on lemur populations' health and viability. Targeted surveys will seek to clarify the distributional limits and population size of the most threatened lemurs (*Cheirogaleus sibreei, Prolemur simus* and *Propithecus diadema*). Finally, ecological monitoring and forest patrols will be initiated to detect and control illegal exploitation. Such patrols have already been initiated at Tsinjoarivo (KASTI: Komitin'ny Ala sy Tontolo Iainana). These activities will necessitate the establishment of seven new intervention sites to complement the three existing sites (Mahatsinjo, Ankadivory and Vatateza); all ten sites will become local training and education centers.

Second, in parallel with these grassroots initiatives, SADABE will work with the Malagasy government to establish a new protected area. We will host government and local consultations to identify priority sites for protection, dividing this region among MNP-administered protected areas and community-managed protected areas via management transfer. This will ensure that the region's biodiversity will be protected, while its forest ecosystems will continue to contribute to human well-being in a sustainable manner.

Third, SADABE will develop infrastructure and human capital for tourism at Tsinjoarivo. In addition to its rich biodiversity, Tsinjoarivo has a rich cultural history: it is the site of a royal palace (rova) that was used as a vacation residence by three queens and various prime ministers. The site was chosen by Queen Ranavalona I in 1832, and a five-building complex was built in 1834-1836, overlooking two massive waterfalls on the Onive River. SADABE teams will build and replace existing infrastructure (lodging, food preparation, roads and bridges), and train local village associations to work directly in tourism or provide necessary local products and services. By partnering with national and international tour agencies, we will increase tourist visitation rates and promote a broader appreciation for Tsinjoarivo's biological and cultural richness.

In the northern part of the forest corridor (Anjozorobe–Angavo), efforts will be made to strengthen existing protection and infrastructure through four major activities. First, teams will demarcate the recently-legislated protected area boundaries. Second, existing ecological monitoring and forest patrols will be strengthened and expanded to cover all regions of the protected area. Third, environmental education activities will also be strengthened and expanded to cover all regions of the protected area. Finally, we will launch extensive reforestation and tree-farming programs in all the communities implicated in the management transfers and around the periphery of the protected area; this activity will help reduce future pressures on forest timber products within the corridor.

Budget: US$ 195,000 over 3 years

Ambositra–Vondrozo Corridor (COFAV)

Steig Johnson

The Ambositra–Vondrozo Corridor (COFAV) is located on the escarpment dividing the central highlands from the coastal plain in south-east Madagascar. The corridor covers 285,800 ha and spans over 300 km from north to south between the Nosivolo and Mananara rivers. Though it measures nearly 50 km across in the widest portions, most sections are only 5–10 km wide. Fragmentation has led to discontinuity of natural forest in sections between Fandriana and Ranomafana. Administratively, the area includes five regions and 43 communes. The largely rural population bordering the forest corridor numbers over 700,000 (Mohamed, 2008). Subsistence agriculture is the primary economic activity for these inhabitants. The ecotourism industry is also well developed in proximity to the flagship national parks in the region.

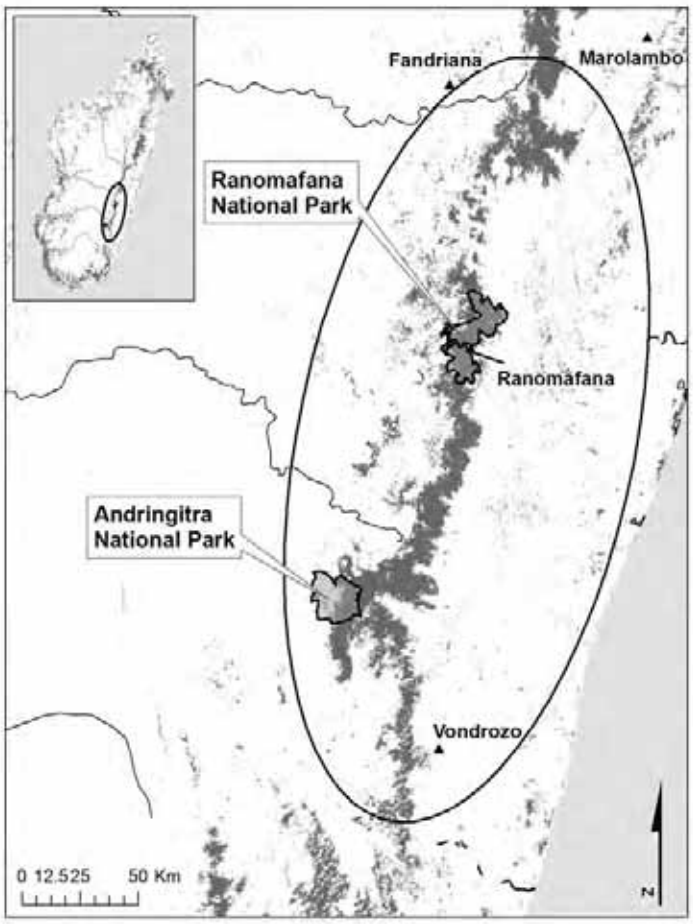




White-collared brown lemur (*Eulemur cinereiceps*) female with offspring, Critically Endangered. (Photo: Steig Johnson)

The COFAV region has a highly varied topography, ranging from 200 m asl in the south and where the escarpment drops off in the east, to nearly 2,000 m asl in the Andringitra Massif, the second highest mountain chain in Madagascar. Numerous major rivers have their headwaters in the corridor (e.g., Faraony, Mananara); as COFAV rests on the continental divide, some rivers (e.g., Mangoky) eventually drain into the Mozambique Channel and provide water to the more arid western Madagascar. The climate in COFAV is generally humid, with mean annual rainfall ranging from 1,300 mm in the south to over 2,000 mm in the north. The rainforests in this region have distinct structure and composition in low, middle, and high elevation zones, as well as along the north-south gradient. In the southern portion, COFAV is adjacent to the Andringitra Mountains, where the high peaks divide the starkly different biomes of the humid east and dry west.

With its varied environments, COFAV maintains a striking diversity of flora and fauna. At least 800 plant and 300 animal species are endemic to this region. Beyond simple species counts, the region holds tremendous conservation importance. Because of its enormous area connecting multiple ecosystems, COFAV allows for dispersal and gene flow across populations, and longer-term dynamics of range contractions and expansions. For instance, the presence of both extensive forest cover and a large elevation gradient provide the best opportunity for species to shift their ranges in response to global climate change. COFAV is thus uniquely suited to preserving large-scale ecological, biogeographic, and even evolutionary processes. The extensive biodiversity in these forests also provides essential ecosystem services at local, regional and global levels, including plants for traditional medicines, drinking water to the southern half of Madagascar, and carbon sequestration.



The Ambositra–Vondrozo Corridor (COFAV). (Source: Conservation International)

The richness of lemur species in COFAV forests is extraordinary – the highest of any protected area in Madagascar, with at least 19 presently recognized species and subspecies and one additional species to be described. A disproportionate number of the lemurs present are in elevated threat categories. These include the Critically Endangered southern black-and-white ruffed lemur (*Varecia variegata editorum*), greater bamboo lemur (*Prolemur simus*), Sibree's dwarf lemur (*Cheirogaleus sibreei*), and white-collared brown lemur (*Eulemur cinereiceps*), a species whose entire range is contained within the southern portion of COFAV and a few coastal forest remnants. Endangered lemurs present are: the aye-aye (*Daubentonia madagascariensis*), small-toothed sportive lemur (*Lepilemur microdon*), Betsileo sportive lemur (*L. betsileo*), Betsileo woolly lemur (*Avahi betsileo*), Peyrieras' woolly lemur (*A. peyrierasi*), Milne-Edwards' sifaka (*Propithecus edwardsi*), golden bamboo lemur (*Hapalemur aureus*), ring-tailed lemur (*Lemur catta*), and a new mouse lemur (*Microcebus* sp. nov.) to be described soon. In addition to their Endangered status, the Betsileo sportive lemur and Betsileo wooly lemur are both AZE species, found only in Fandriana. The red mouse lemur (*Microcebus rufus*), Ramanantsoavana's woolly lemur (*Avahi ramanantsoavanai*), and red-bellied lemur (*Eulemur rubriventer*) are Vulnerable, while the red-fronted brown lemur (*E. rufifrons*) is Near Threatened. The greater dwarf lemur (*Cheirogaleus major*), Crossley's dwarf lemur (*C. crossleyi*), and Ranomafana grey bamboo lemur (*Hapalemur griseus ranomafanensis*) remain Data Deficient. The Endangered Gilbert's grey bamboo lemur (*H. griseus gilberti*) may also be found in the northernmost portion of COFAV.

A human population growing at approximately 3% annually, coupled with rising immigration to the forest periphery, has placed increasing pressure on the forests of COFAV (Mohamed, 2008). Tavy (slash-and-burn agriculture) is a primary threat to the flora and fauna. Population pressures have reduced fallow periods, leading to degradation of agricultural lands and increased clearing of forests. Falling prices in coffee, the traditional cash crop of the region, has necessitated the expansion of subsistence agriculture. Selective logging for household needs, as well as commercial products such as timber and crafts, is also a significant threat to the COFAV forests. All commercial licenses have been suspended since 2000, however, illicit activity continues. Overall deforestation rates have fluctuated markedly over time, but have been reduced to approximately 0.5% annually in recent years. Unlicensed mining for gold and precious stones has also increased dramatically following the breakdown in law enforcement since the current political crisis began in 2009. These activities involve forest clearing and indirect effects such as increased hunting. Evaluation of the overall risk to wildlife from hunting is confounded by a critical lack of quantitative data on harvests and baseline animal population growth rates. However, researchers and conservation managers in the COFAV region have noted frequent instances of trapping and hunting with projectile weapons, targeting birds, tenrecs, bush pigs, and lemurs. These activities appear to have increased substantially since 2009.

COFAV is in the process of becoming established as a New Protected Area, with Conservation International serving as the initial managing partner in cooperation with government authorities and local stakeholders throughout the region. The area was assigned temporary protected status in 2005. Eventually, responsibility for management of the natural resources of COFAV will be transferred to local communities, represented by community associations (Vondron' Olona Ifotony, or VOI). Two protected areas managed by Madagascar National Parks also exist within the forest corridor: Ranomafana National Park (gazetted in 1991) and Andringitra National Park (founded in 1999). These parks are connected by COFAV, but are separate administrative units with stricter protection (IUCN Category II, vs. Category VI in the remainder of the corridor).

The region has been the target of concerted efforts to preserve natural environments and improve health and livelihoods by numerous local and international organizations, including Voahary Salama, USAID, ERI, Conservation International, WWF, Kew Royal Botanic Gardens, and the Institute for the Conservation of Tropical Environments (ICTE). Programs initiated by these groups have sought to improve food security through alternative farming techniques and crops, develop management capacity in community associations, and restore natural ecosystems, among many other initiatives. This region has also been the focus of extensive

scientific research on biodiversity, especially in the national parks. In Ranomafana, long-term studies on the ecology and population biology of lemurs and other key plant and animal groups began in the 1980s, producing hundreds of scholarly publications. The Centre International de Formation pour la Valorisation de la Biodiversité (Centre ValBio), founded in 2003 and located on the boundary of Ranomafana National Park, is among the premier biological and conservation research centers anywhere in the tropics. Elsewhere, Andringitra National Park, the Ranomafana–Andringitra corridor, and the Fandriana–Marolambo corridor were the subject of large-scale biological inventories conducted by WWF and ICTE in the 1990's. Several other relatively short-term studies have been conducted on lemur populations in the Andringitra and Vondrozo regions.

To preserve the exceptional lemur diversity of COFAV in the face of enormous economic hardship and political instability, these programs, aimed at improving our knowledge base, supporting livelihoods in local communities, and reducing the threats to forests and lemurs, must be supported. The regional scale and the conservation challenges mirror those of the adjoining Ankeniheny–Zahamena corridor (CAZ) to the north. Accordingly, we propose a similar program to confront the immediate threats to the lemurs of COFAV. This will include two primary components. In the first project, we will recruit teams of forest guardians from local communities (organized by COBA/VOI). With technical assistance from research and conservation groups (e.g., Conservation International), the teams will perform two primary tasks: 1) collect data on the distribution and abundance of threatened lemur species; and 2) monitor and intervene in threats to wildlife, including dismantling traps and reporting other illicit resource extraction so that local communities can develop appropriate control measures. The project will also develop incentive-based conservation contracts with local communities to reward reductions in the conservation threats in the region. The second project will implement a direct mitigation program to reduce lemur hunting and forest loss in COFAV through educational activities and promotion of alternative food sources (including improved husbandry, apiculture, and other farming methods) and ecosystem restoration programs. Such activities will vary across the region, based on anthropogenic pressures, as well as local needs and preferences.

Budget

Project 1:	**US$ 175,000 over 3 years**
Project 2:	**US$ 200,000 over 3 years**
Total:	**US$ 375,000 over 3 years**



Ankarimbelo, part of the Ambositra–Vondrozo Corridor (COFAV). (Photo: Steig Johnson)

Ranomafana National Park

Patricia C. Wright & Steig Johnson

Ranomafana National Park (RNP), with an area of 41,600 ha, was gazetted in 1991 and is managed by Madagascar National Parks. The site is also part of the Rainforests of Antsinanana UNESCO World Heritage site, a cluster of six eastern rainforest protected areas established in 2007. The climate of RNP is seasonal, with a cool, dry season from April to October and a hot, rainy season from November to March. Annual rainfall is 1,500-4,000 mm. The site has an elevation gradient from approximately 500 m to 1,400 m asl, generally rising from east to west. This montane environment includes a mix of primary and mature secondary humid forests, with mature canopy up to 30 m.

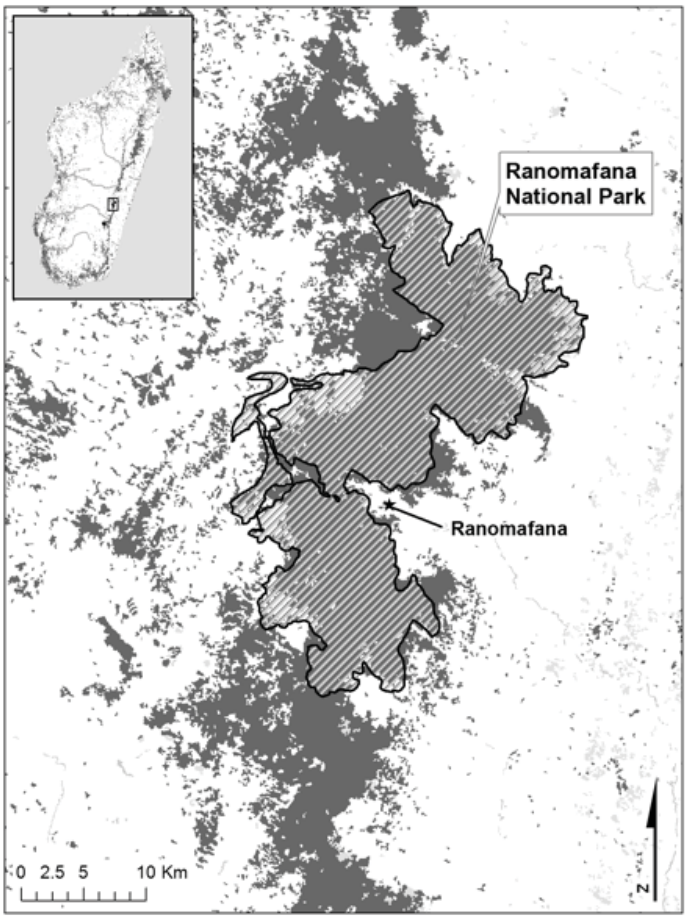
The rainforests of Ranomafana support a remarkable diversity of plants and animals. For example, there are at least 114 bird species (nearly half of all species in Madagascar, including 30 microendemics), 98 amphibians, and 62 reptiles. The park also contains at least 13 lemur species, including the Critically Endangered Sibree's dwarf Lemur (*Cheirogaleus sibreei*), southern black-and-white ruffed lemur (*Varecia variegata editorum*), greater bamboo lemur (*Prolemur simus*), golden bamboo lemur (*Hapalemur aureus*), whose discovery in 1986 eventually led to the establishment of the park, as well as the Endangered Milne-Edwards' sifaka (*Propithecus edwardsi*), small-toothed sportive lemur (*Lepilemur microdon*), and aye-aye (*Daubentonia madagascariensis*). Other lemur species occurring within the boundaries of RNP include the Vulnerable red mouse lemur (*Microcebus rufus*), Peyrieras' woolly lemur (*Avahi peyrierasi*), and red-bellied lemur (*Eulemur rubriventer*), and the Near Threatened red-fronted brown lemur (*Eulemur rufifrons*). The Data Deficient Ranomafana grey bamboo lemur (*Hapalemur griseus ranomafanensis*) is also present, likely along with two additional dwarf lemur species (Crossley's dwarf lemur, *Cheirogaleus crossleyi*, and greater dwarf lemur, *Cheirogaleus major*).



Female red-bellied lemur (*Eulemur rubriventer*), Vulnerable. (Photo: Russell A. Mittermeier)



As a national park, RNP has suffered less exploitation than surrounding areas in the eastern rainforest corridor. Very little forest within the park has been lost to deforestation, although the timber exploitation conducted from 1986–1989 can still be perceived. To help improve livelihoods of the communities surrounding the park, Madagascar National Parks has begun community-based natural resource management in 2012. Several local and international organizations, including the Institute for the Conservation of Tropical Environments (ICTE), USAID and others, have been continually working in health and education in over 30 peripheral zone villages since 1991. Many activities are based at the Centre International de Formation pour la Valorisation de la Biodiversité (Centre ValBio), which borders the national park. A consortium of Malagasy and



Ranomafana. (Source: Conservation International, Tracy Wyman)

international universities manages this world-class research and training centre. In 2012, Centre ValBio completed the construction of new laboratories, creating opportunities to conduct molecular genetics, endocrinology, and infectious disease studies to benefit people and wildlife.

In order to continue to protect the Ranomafana National Park and its highly threatened lemurs, a number of actions need to be taken immediately. Experience from over 26 years has shown that a continuous presence of researchers and conservationists is the most effective means of ensuring protection of the forest. Although the areas south of the park have been protected by communities thanks to a joint program with Conservation International and ICTE, the forests to the north of RNP have received no sustained conservation interventions; consequently this once continuous forest is now fragmented. We therefore propose to establish a satellite field station in the northern sector at Ambohimiera. This station will serve as a deterrent to illicit forest clearing and a bridge to local communities for education, health, and economic development activities. Research activities will focus on surveys of lemur populations in the fragmented northern forests, which have not been documented since 2001. To support the effective protection of the endemic lemurs, basic scientific information on range boundaries and ecological requirements of these species will be assessed.

The post will have a permanently present station manager and five support staff, including research technicians, recruited from communities in the periphery of the park. These individuals will work with Centre ValBio and Madagascar National Parks to implement forest restoration in the recently deforested areas, following a complete inventory of tree species in the different forest fragments. MNP park agents, in collaboration with community representatives, will patrol the forest fragments, demarcating the boundaries of the protected area with signs to remind people of park regulations. Firebreaks will be established and maintained around the main forest fragments with the participation of the local communities, coupled with educational campaigns to minimize risks of forest fires. Support will be provided to local communities to establish nurseries with a variety of native forest tree species that will be purchased by the project. The seedlings will be used for forest regeneration and reforestation, with the aim to link forest fragments by corridors. The establishment of fruit tree plantations and medicinal plant gardens in areas outside of natural forest will also be supported. The ultimate goal will be the expansion of the park boundaries to the north. This objective is consistent with providing increased protection to endangered lemur



Golden bamboo lemur (*Hapalemur aureus*), Critically Endangered. Photo: Russell A. Mittermeier)

populations. It also may provide a sustainable financing mechanism for both Madagascar National Parks and local communities through participation in REDD+ programs.

Among the emerging threats throughout the park, but especially in western portions, is illegal gold mining. This activity involves clearing of forest and increases hunting pressure in previously less accessed parts of the park. Outreach and patrol projects will be put in place in communities surrounding the park to deter these activities.

In addition to direct protection measures, the Centre ValBio team will extend their conservation education program to these northern villages. Regular meetings will be held with the leaders and elders of all villages surrounding the protected area, discussing the needs of the local population, including economic and cultural needs. We will include these villages into the ValBio Vao Vao, a local newsletter focusing on conservation and research issues. Educational materials such as booklets, posters, comics and T-shirts will be produced and distributed among these northern communities.

We also propose two research projects aimed at assessing the survival prospects of lemurs at extreme risk of local extinction and definitively establishing the diversity of the lemur community. The first project involves the translocation of greater bamboo lemurs from small fragments outside of protected areas into RNP in order to maintain genetic diversity in this Critically Endangered species. Funding for the first translocation (restocking) in 2012 has been secured. However, additional funds are required for research technicians to monitor the translocated individuals over a three-year period to assess survival and reproduction. The second project seeks to clarify the taxonomy of species belonging to the genera *Cheirogaleus* and *Lepilemur* inside RNP. As noted, there may be as many as three sympatric dwarf lemurs; there may also be an additional sportive lemur taxon present at RNP that is not currently known to science. Confirmation of these species could bring the lemur richness at RNP to 15 species, one of the highest of any single protected area in all of Madagascar.

Budget: US$ 240,000 over 3 years



Ranomafana National Park. (Photo: Steig Johnson)

Fandriana–Marolambo Forest Corridor

Jonah Ratsimbazafy & Shawn Lehman

The Fandriana–Marolambo Forest Corridor is comprised of five sites (Mananjara, Ranomena, Korikory, Garaonina, and Andrano Korofisaka), and is currently being assessed for the status of National Park. In 2000, a Rapid Assessment survey Program (RAP) was conducted on lemur communities in all five sites. Results showed little variation in total number of species between the five sites; however there was considerable inter-site variation in species composition. Such variation was found to be due primarily to loss of habitat and hunting (with traps and/or blow guns). Indeed, forest destruction and illegal hunting have seriously compromised the lemur communities (Lehman & Ratsimbazafy, 2001; Lehman *et al*., 2005).



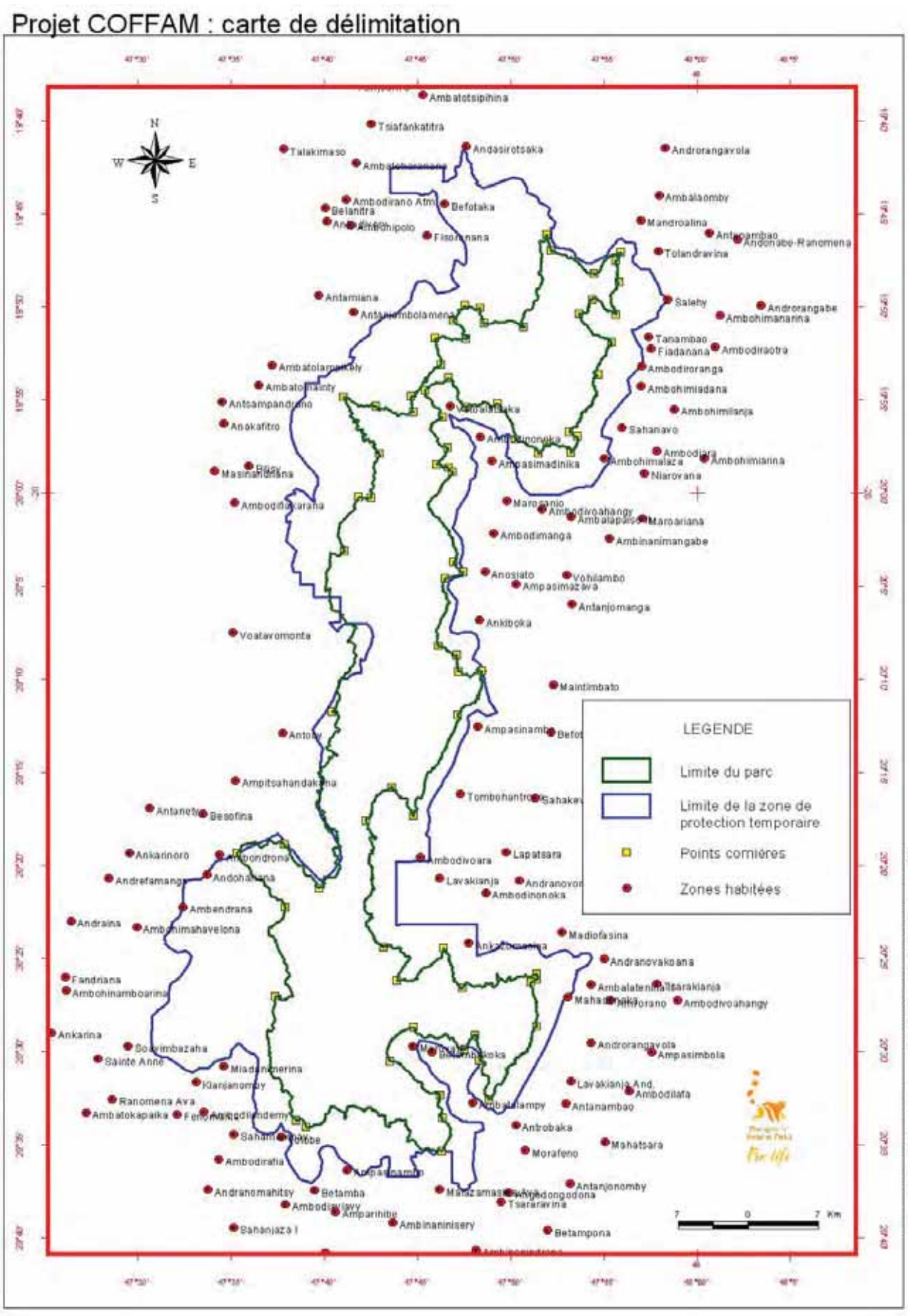


Milne-Edwards' sifaka (*Propithecus edwardsi*), Endangered. (Photo: Russell A. Mittermeier)

The Critically Endangered black-and-white ruffed lemur (*Varecia variegata*) was only seen at the first site (Mananjara). The Endangered Milne-Edwards' sifaka (*Propithecus edwardsi*) and the Near Threatened common brown lemur (*Eulemur fulvus*) were not seen at all during surveys, although local people reported them to be present throughout the corridor. No local people near Mananjara reported seeing or hearing either *P. edwardsi* or *V. variegata* in the last 1–10 years. Although *Propithecus* spp. have been seen crossing open areas of up to 400 m between fragments (S.M. Lehman, pers. obs.), it not clear whether they can successfully traverse the extensive open areas from sites south of the corridor.

Regular and intensive lemur surveys are needed. In addition, forest patrollers should be instated in the corridor. Reintroduction of wild/captive individuals of *V. variegata*, and translocation of wild individuals of *P. edwardsi* into the corridor would also help re-establish these populations.

In order to ensure the survival of the Fandriana–Marolambo lemur species and their habitats, the following strategies need to be developed:
Stop habitat loss and degradation:
-Finalise the legal creation of the National Park;
-Implement PA management plans;



Delimitation of the Fandriana-Marolambo Forest Corridor protected area. (Source: Madagascar National Parks)

-Develop a comprehensive communication/education programme;
-Implement permanent patrolling and law enforcement support;
-Develop a fire management strategy;
-Implement forest restoration in order to reconnect fragments.

Implement population monitoring:
-Develop a system for counting lemurs in forest fragments in the corridor;
-Monitor socio-economic and environmental indicators over time.

Audit conservation effectiveness:
-Monitor socio-economic and environmental indicators over time.

Translocation/reintroduction of *V. variegata* and *P. edwardsi*:
-Reintroduce 6 groups of wild/captive *V. variegata* (2 groups per year within 3 years), and translocate 6 groups of *P. edwardsi* (2 groups per year within 3 years).

Conduct community-based sustainable development:
-Improve sustainable agricultural productivity of buffer zones;
-Support sustainable agriculture practices;
-Develop income-generating mechanisms;
-Promote ecotourism.

Budget: US$ 150,000 over 3 years

Kianjavato

Edward E. Louis, Jr., Jean Freddy Ranaivoarisoa, Susie McGuire & Steig Johnson

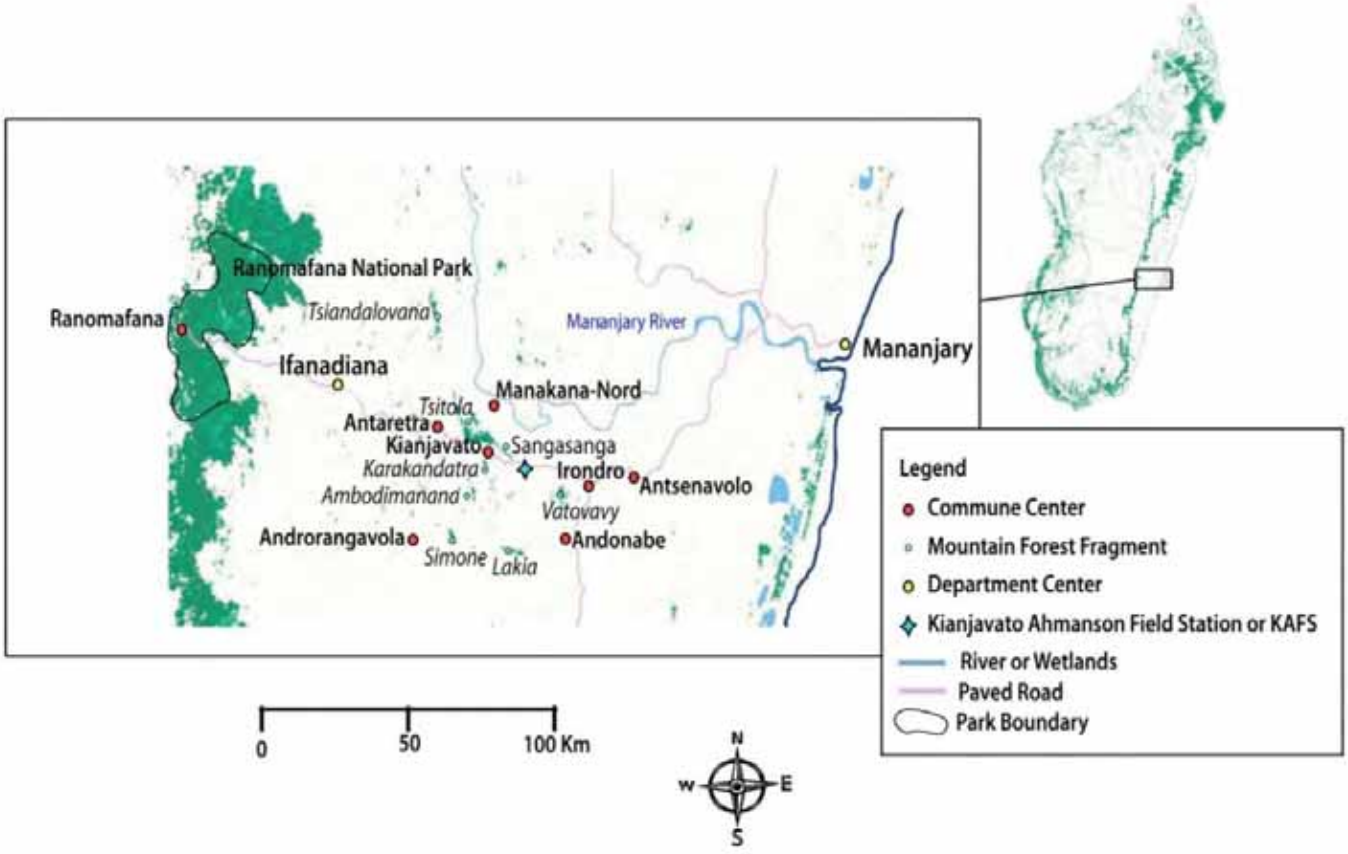
Kianjavato Classified Forest in the Vatovavy Fitovinany region (-21.37708333; 47.86586111) in south-east Madagascar is a landscape of primary forest remnants on mountain tops, lined at the lower elevations by dense bamboo and secondary regrowth. Kianjavato is part of the Ambositra–Vondrozo Forest Corridor (COFAV) established in 2008, but it is essentially detached from the major portion of this corridor. Within its forests reside significant populations of the Critically Endangered greater bamboo lemur (*Prolemur simus*) and the southern black-and-white ruffed lemur (*Varecia variegata editorum*). Other Endangered lemur species occurring within the Kianjavato region are Jolly's mouse lemur (*Microcebus jollyae*), an AZE species (Louis *et al.*, 2006a), and the enigmatic aye-aye (*Daubentonia madagascariensis*). Additionally, the Vulnerable grey bamboo lemur (*Hapalemur griseus griseus*), Peyrieras' woolly lemur (*Avahi peyrierasi*), and red-bellied lemur (*Eulemur rubriventer*), along with the Near Threatened red-fronted brown lemur (*Eulemur rufifrons*), are found within the Kianjavato forest.





Greater bamboo lemur (*Prolemur simus*), Critically Endangered. (Photo: Edward E. Louis Jr.)

Habitat loss through slash-and-burn agricultural practices or tavy, and hunting represent the primary threats to lemurs; a forest habitat that formerly extended (in the 1960s) from the coastal city of Mananjary to west of Ranomafana contrasts sharply with the currently remaining forest fragments (see regional map). Historically, the Centre National De Recherche Appliquée au Développement Rural or FOFIFA Kianjavato was an important location for coffee production, along with Madagascar's biodiversity repository for endemic coffee plants, all of which were located south of the Sangasanga Mountain in the village of Kianjavato. A Vondron'Olona Ifototra (VOI), an organization that provides local government at the village level, was developed and subsequently established in 2008, but has not functioned successfully since 2009.



Location of Kianjavato.

The Madagascar Biodiversity Partnership (MBP), a national Malagasy NGO and its founding partner, Omaha's Henry Doorly Zoo and Aquarium (OHDZA), began the Education Promoting Reforestation Project (EPRP) in 2008 in Kianjavato. The EPRP is an innovative project that utilizes the endemic lemur populations of the black-and-white ruffed lemur and local communities to reforest and restore Kianjavato's natural habitat after 50 years of deforestation, providing signed contracts between the commune, MBP, and district that establishes direct local ownership (commune, village or individual) of this regenerated forest.

Starting in June 2009, the MBP/OHDZA constructed the Kianjavato Ahmanson Field Station (KAFS), a base from which numerous international research projects are conducted, which also serves as a community and training center of the Kianjavato commune (McGuire *et al*., 2009). Conservation Fusion, Inc., an international education NGO, working in conjunction with the MBP, have also launched community education efforts and practical technologies that improve daily living by incorporating conservation in the local school's daily curriculum.

The climate of Kianjavato and south-east Madagascar is seasonal and driven by rainfall, with a cooler dry season from May to October and a hot, rainy season from November to April. With two major cyclones having devastated the Kianjavato region in 2010 and 2012, the climate is strongly influenced by the cyclone season, which primarily runs from December to March. Despite the threat of seasonal storms, the climate is extremely conducive to restoration programs, as over 50,000 seedlings have been planted by KAFS and Vatovavy since 2010.

In order to reduce lemur hunting and habitat loss in the region of Kianjavato, it is necessary to continue and encourage the interconnectivity between the VOI, the local community, conservation organizations (MBP, OHDZA, Conservation International, Madagasikara Voakajy) and local government organizations (Direction Régionale des Eaux et Forêts and the mayoral offices of the surrounding communes). The centrally located field station can be used as a base for this programme.

Principal conservation strategies will include reforestation, research, monitoring and education; the over-all aim being to rebuild the fragile lowland forest ecosystem in south-east Madagascar and increase biodiversity. The fragmented forests which run westerly from Tsitola to Vatovavy will be reconnected by establishing and monitoring a corridor of established contracts defining permanent and commercial crop agriculture. In doing this, sustainable, alternative agricultural practices will also be promoted with the continued introduction of fuel-efficient rocket stoves and briquette technology as part of a conservation credit and reward program.



Southern black-and-white ruffed lemur (*Varecia variegata editorum*), Critically Endangered. (Photo: Edward E. Louis Jr.)

The proximity of Kianjavato to Ranomafana National Park also presents a unique opportunity to capitalize on the budding ecotourism industry. Additionally, a local, community level appreciation of natural resources will be encouraged by integrating improvements in standard of living with conservation measures. By facilitating food accessibility and promoting increased economic well-being in the local communities, we also hope to ensure the long-term survival of significant populations of the greater bamboo lemur and black-and-white ruffed lemurs.

Budget: US$ 152,100 over 3 years



Jolly's mouse lemur (*Microcebus jollyae*), Endangered, AZE species. (Photo: Edward E. Louis Jr.)

Manombo Forest

Fidimalala Ralainasolo, Brigitte M. Raharivololona & Steig Johnson

Manombo forest is located in the southern region of Madagascar, specifically in the District of Farafangana in the former province of Fianarantsoa. The forest is located 37 km south of Faranfangana along the Route Nationale 12 towards Vangaindrano and extends between 22° 58' and 23° 07' East and between 47° 42' and 47° 47' South with an elevation range of 0-137m asl. Originally it was a forest reserve but the establishment of the Special Reserve by Decree 62-637 of 5th December 1962 led to its division into two parts: the Manombo Classified Forest (MCF) with an area of about 7,000 ha, and the Manombo Special Reserve (MSR); MSR includes a lowland humid forest section known as Parcel I with an area of 2,080 ha and a littoral forest called Plot II (2,220 ha). From an administrative standpoint, MSR is managed by Madagascar National Parks (MNP) and MCF is under the supervision of the Ministry of Environment and Forests (MEF), locally represented by the Regional Director of the Environment and Forests (DREF).

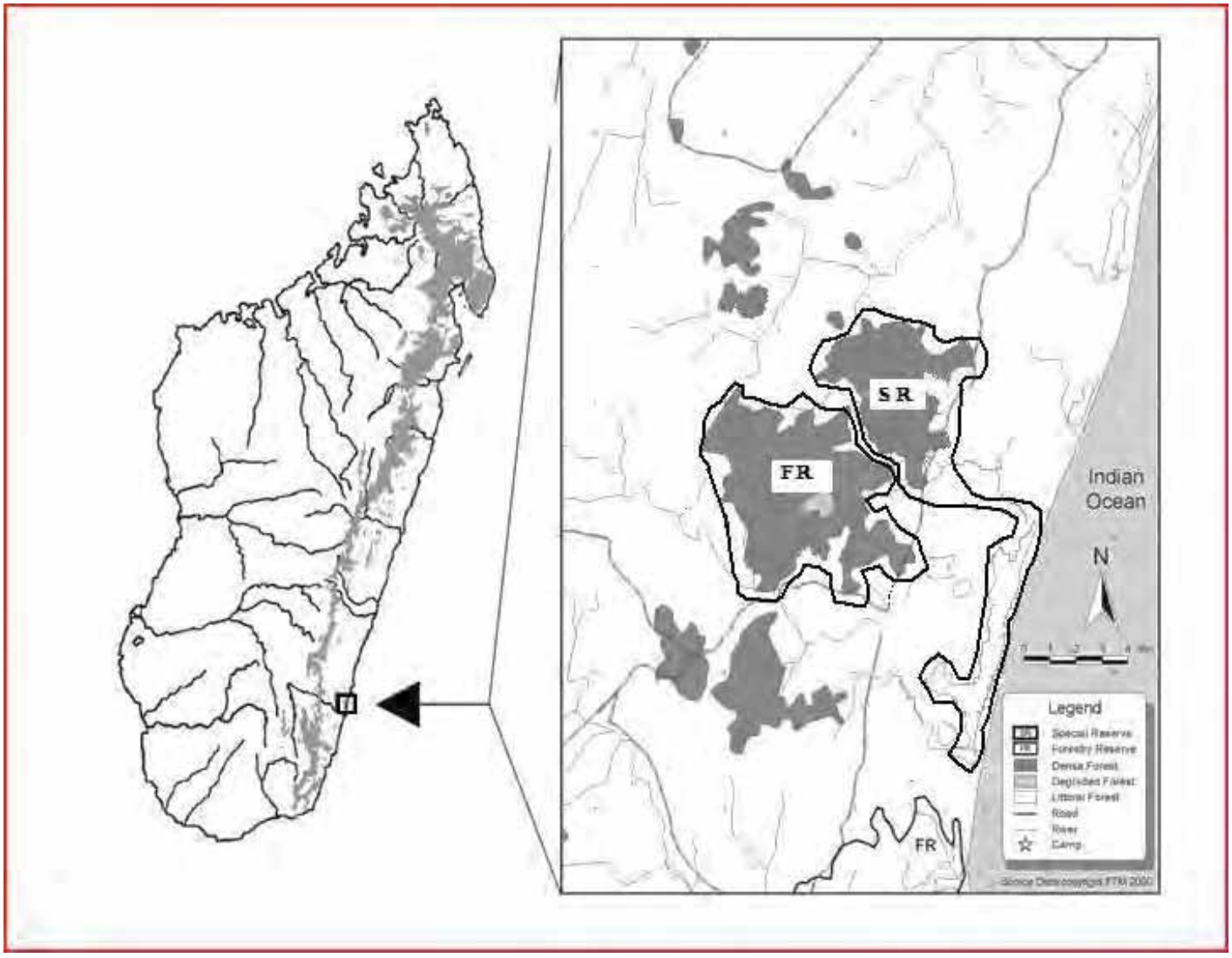




White-collared brown lemur (*Eulemur cinereiceps*), Critically Endangered. (Photo: Inaki Relanzon)

Once part of a vast rain forest on the coastal plain, Manombo includes some of the last remaining forests in the region; these are divided among many distinct fragments of varying sizes and isolation distances, and are surrounded by anthropogenic grasslands. Manombo has been separated from the main eastern rain forest block for at least 60 years. The unique biodiversity found in these lowland and littoral forests is under persistent threat of hunting and habitat loss from agricultural activities and logging. In addition to anthropogenic disturbance, Manombo is susceptible to cyclones such as Gretelle, which struck the region in 1997 and sheared or uprooted over half of the canopy trees.

Manombo Forest is home to eight lemur species, three of which are classified as Critically Endangered (CR) according to the 2012 IUCN Red List: the southern black-and-white ruffed lemur (*Varecia variegata editorum*), the white-collared brown lemur (*Eulemur cinereiceps*), and the Manombo



Location of Manombo.

sportive lemur (*Lepilemur jamesorum*). Manombo also includes several other species of major conservation concern: Jolly's mouse lemur (*Microcebus jollyae*; EN), the aye-aye (*Daubentonia madagascariensis*; EN), the southern bamboo lemur (*Hapalemur meridionalis*; VU), and Manombo woolly lemur (*Avahi ramanantsoavanai*; VU), while the greater dwarf lemur (*Cheirogaleus major*) remains Data Deficient (DD). The white-collared brown lemur and Manombo sportive lemur are flagship species for Manombo, as both are confined to small ranges within this region. Indeed, the Manombo sportive lemur is not found in any other protected area. The white-collared brown lemur, while revered by local communities, is also the species most frequently hunted; this greatly exacerbates the risks associated with their restricted distribution and small population size.

Along with MNP and MEF, the Durrell Wildlife Conservation Trust is actively engaged in conservation programs at Manombo. Their objective is to find all possible means to prevent the disappearance of endemic species, while engaging with local and traditional authorities and never forgetting the needs of local communities. In 2004, the Durrell team began research and conservation activities on the Critically Endangered white-collared brown lemur and southern black-and-white ruffed lemur in both MSR and MCF. They focused on the ecology, behaviour, abundance and distribution of these two representative species. Part of the study also aimed to identify and understand the impact of various anthropogenic pressures and constraints on the lemurs. Following the results of these studies, a conservation strategy for the forest and its biodiversity will be implemented, based primarily on broad-scale participation of local residents.

Participatory ecological monitoring, drawing from villages in the periphery of Manombo, is one important means of protecting the forest and wildlife. In particular, 68 patrol agents from 16 villages, known as Local Forest Committee (LFC) officers, will survey lemurs and other fauna, as well as forest characteristics. The data will be used to evaluate trends in threatened lemur populations, identify changes in habitat conditions (including vegetation structure and microclimate), and monitor anthropogenic disturbance. In addition, by their presence in the forest, LFC officers act as strong deterrents to illegal activities, including logging and hunting of lemurs. The results of this work will be presented by the LFC office managers to government authorities at



Southern black-and-white ruffed lemur (*Varecia variegata editorum*), Critically Endangered. (Photo: Steig Johnson)

MNP and MEF in order to identify and respond to immediate threats and to facilitate long-term conservation planning of the Manombo Forest.

In order to improve the living conditions of local communities, Durrell and its partners provide support to 16 village associations established in the peripheral zone surrounding Manombo Forest. Based on the recommendations of these associations, Revenue Generating Activities (RGA) are implemented in each village. These include activities such as beekeeping, vegetable gardening, and investment in staple (rice) and cash crops (coffee and cloves), established in each village according to the needs that the communities themselves have identified. In addition, school supplies will be distributed to local public primary schools (EPP), and assistance will be provided for construction and maintenance of these schools. The aim is to help sustain enrolment levels and thus improve the long-term economic prospects for local communities.

A final objective is to raise awareness regarding Manombo's fragile environments and threatened lemur species. This must be done at all levels (local, regional, national, and international) and using multiple forms of communication (posters, t-shirts, presentations to community groups, websites, etc.) to help garner additional support for conservation efforts. These activities will also serve to raise the profile of Manombo for ecotourism, providing tangible benefits to local communities and powerful incentives to ensure the survival of the flagship lemur species and their habitats.

Budget: US$ 159,500 over 3 years

Kalambatritra Massif

Tovonanahary Rasolofoharivelo,
Laingoniaina Herifito Fidèle Rakotonirina & Tony King

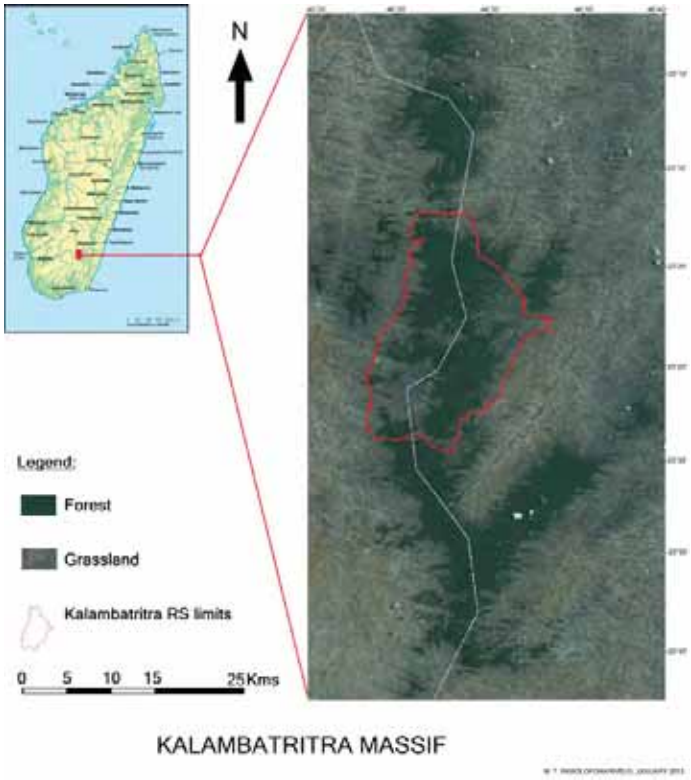
The Kalambatritra Massif in south-east Madagascar supports the most westerly of all remaining rainforest in Madagascar. The fairly extensive expanse of forest ranges in altitude from around 1,000 to 1,750 m, and is reputed to contain some of the oldest and largest trees of any rainforest on the island. Some of the forest areas on the massif are virtually pristine and are considered to be amongst the most impressive forests to behold in the entire country. The massif straddles the continental divide between eastern (Ianaivo River) and western (Ihosy) drainages, and supports floral and faunal species mostly typical of eastern rainforests, but also includes some typical of drier western and southern forests, such as Madagascar's best-known flagship species, the ring-tailed lemur (*Lemur catta*).





The Kalambatritra Massif is the only site where the Endangered Kalambatritra sportive lemur (*Lepilemur wrightae*) occurs. (Photo: E. Louis Jr.)

Currently one lemur species is known to be endemic to the massif, the Endangered Kalambatritra sportive lemur (*Lepilemur wrightae*). Larger than any other known sportive lemur species, it is also unique in being sexually dimorphic, with the female easily distinguishable due to its contrasting grey head. The proposed conservation actions will therefore focus on ensuring the survival of the Kalambatritra sportive lemur, but will also benefit the remarkable forests of the massif and other threatened wildlife hiding within them, much of which remains to be discovered. For example, several reports from brief research missions suggest the existence of an unidentified large bamboo lemur, a species potentially unknown to science. Other lemur species that have been reported to occur include red-collared brown lemur (*Eulemur collaris*), southern bamboo lemur (*Hapalemur meridionalis*), aye-aye (*Daubentonia madagascariensis*), and various nocturnal lemurs for which species identifications have not yet been adequately determined (mouse lemurs, dwarf lemurs, woolly lemurs).



Location of Kalambatritra Massif. (Source: Tovonanahary Rasolofoharivelo)

About half the forests of the Kalambatritra massif occur in the Kalambatritra Special Reserve, managed by Madagascar National Parks, whilst the remaining forests are unprotected. In order to conserve the endemic Kalambatritra sportive lemur and other threatened (and in some cases probably undiscovered) lemurs in the massif, we will implement several urgent conservation actions:

1. Complete the inventory of lemur species occurring in the Kalambatritra massif
2. Determine density estimates for *L. wrightae* and other lemur species, and monitor changes over time
3. Study the biology of *L. wrightae* and other priority lemur species, and identify threats to their survival



Ring-tailed lemur (*Lemur catta*), Endangered. (Photo: Tony King)



Collared brown lemur (*Eulemur collaris*), Endangered. (Photo: Laingo Rakotonirina)

4. Organise information, education and communication programmes in local communities covering issues related to lemur conservation and protected area management
5. Ensure monitoring and control patrols by local forest agents are carried out at least once a week in each priority forest fragment
6. Develop and support community programmes to reduce anthropogenic pressures on the forests

These activities will be organised by The Aspinall Foundation in collaboration with Madagascar National Parks and other relevant partners, and will ensure participation of local communities in each activity. A team of local community representatives will be hired and trained as forest guardians, who will then patrol each priority forest fragment within the massif at least once a week, to monitor lemur populations and identify threats. The guardians will report their findings directly to project partners, protected area managers and community associations to ensure rapid responses to any issues they encounter. They will also work with any researchers visiting to undertake the lemur inventory and subsequent long-term studies, and as guides for any potential tourists. A locally based lemur conservation coordinator will be hired to ensure communication and coordination amongst all partners, to facilitate contact between the guardians and visiting researchers, and to organise the community-based education and awareness programmes.

The project will also develop or support community development activities aimed at reducing anthropogenic pressures on the local forests. Such activities will be designed based on local needs, but typically include reforestation using native forest tree seedlings, and in particular species used as food plants by lemurs, promoting of fuel-efficient stoves, training in improved agricultural techniques and poultry breeding, and encouraging bee-keeping.

Budget: US$ 125,000 over 3 years

Andohahela & Tsitongambarika

Giuseppe Donati, Andriamandranto Ravoahangy, Jacques Rakotondranary & Andreas Hapke

Situated in the transitional zone between the eastern wet domain and the western dry region, the south-east corner of Madagascar harbours a steep climatic gradient and one of the most diverse vegetation and animal assemblages of the island. The lemur fauna of Andohahela National Park (AND) includes species adapted to extremely dry habitats: the Endangered white-footed sportive lemur (*Lepilemur leucopus*), the Endangered Verreaux's sifaka (*Propithecus verreauxi*), and the Endangered ring-tailed lemur (*Lemur catta*), as well as species restricted to humid forests: the Critically Endangered Andohahela sportive lemur (*Lepilemur fleuretae*), the Endangered red-collared brown lemur (*Eulemur collaris*), and the Endangered southern woolly lemur (*Avahi meridionalis*). In addition, littoral forest on sandy soil – one of the most threatened vegetation types in Madagascar – can still be found in the region. The New Protected Area of Tsitongambarika (TGK) is mainly distributed below 800 m altitude. It contains major parts of the last remaining low-altitude humid forests in southern Madagascar. Both AND and TGK are located south of the tropic of Capricorn at 23˚26'S and include some of the southernmost "tropical rainforest" in the world (Fenn, 2003).





Red-collared brown lemurs (*Eulemur collaris*), Endangered. (Photo: Valentina Morelli)

Despite the obvious interest in the entire south-east region in terms of lemur diversity, we have decided to focus this Action Plan on the wet areas of AND parcel 1 and TGK for four main reasons. First, concerning lemur research, AND parcel 1 and TGK represent the least-known areas in the south-east region. To date, no long-term studies have been conducted there. Second, effective protection and conservation activities in these large blocks of forest, especially in TGK, are still in their infancy (compared to littoral forests or the dry portions of AND) and a major effort is necessary to strengthen them. Third, while it is impossible to establish effective conservation programs over many different areas, AND parcel 1 and TGK are connected by a corridor and together can be considered the largest block of continuous forest in the region. Fourth,



Protected areas of Andohahela (left) and Tsitongambarika (right).

the two areas, especially TGK, are close to populated coastal villages and to the growing town of Fort Dauphin. During the last ten years, large portions of the humid forests near the town have been destroyed. In the southern part of TGK, only small fragments remain of a formerly continuous band of humid forest. This extremely rapid deforestation is certainly linked to the recent economic development of Fort Dauphin, which has led to a greatly increased pressure on humid forests, particularly in the low-altitude zone.

AND became a National Park in 1997, and has been classified as World Natural Heritage since 2007. It comprises 76,020 ha spread over altitudes of 120 to 1,972 m. The TGK Protected Area was created in 2008 by the Ministry of the Environment and Forests, with technical and financial support from Asity Madagascar, Rio Tinto QMM, USAID, and Conservation International. It covers an area of over 60,000 ha of humid lowland and mid-altitude forest, located just north of Fort Dauphin. In terms of lemur diversity, AND parcel 1 and TGK forests are still poorly known. Recent surveys confirm the presence of one Critically Endangered species: the Andohahela sportive lemur (*Lepilemur fleuretae*); three Endangered species: red-collared brown lemur (*Eulemur collaris*), southern woolly lemur (*Avahi meridionalis*), and aye aye (*Daubentonia madagascariensis*); and one Vulnerable species: southern bamboo lemur (*Hapalemur meridionalis*) (Bird Life International, 2011). Genetic data to check for the presence of further, still undescribed and potentially endangered species in the region are needed. Almost all available data about the lemurs of AND and TGK, including the Critically Endangered *L. fleuretae,* have been gathered in low-altitude humid forest. It is largely unknown which of these species occur in higher elevations. Since the low altitude humid forest is currently under extreme pressure, many of these species may face the risk of complete habitat loss in the immediate future.

AND parcel 1 is managed by Madagascar National Parks (MNP), while the TGK Protected Area is currently co-managed by Asity Madagascar and more than 60 community forest management groups (CoBas) (Bird Life International, 2011). However, forest edges are being rapidly degraded by increasing human pressures due to the growing coastal villages and the town of Fort Dauphin. Forest clearance for agriculture, particularly on the eastern side, is the primary cause of habitat loss. Hunting is also an issue, particularly for some lemur species (i.e. *E. collaris*), (G. Donati, pers. obs.). Moreover, management by CoBas is far from satisfactory, and illegal exploitation of the forest persists (Bird Life International, 2011).

In order to effectively protect this unique area and its as yet poorly understood lemur community, we propose to intervene in two ways. First, a consortium of European and Malagasy universities (Oxford Brookes, Mainz, Hamburg, and Antananarivo) will undertake a number of lemur-focused studies in the area. Second, in order to improve conservation, we will support some key initiatives already

settled by MNP and WWF in AND parcel 1, and by Asity in TGK, to help local communities manage their own forests.

The first necessary action will be the recruitment of a person in charge of coordinating and assuring the implementation of the Action Plan in the field. The presence of a conservationist in the field with good organizational skills is vital for the success of the operation. This person will be working with the Asity staff and be based in Fort Dauphin. He/she will be coordinating both the research aspects and the conservation actions listed in this plan. He/she will be a Malagasy national with previous experience in the area and good conservation knowledge.

In terms of research, we will work in four areas: one research station, which has been set up in the north of the TGK (Ampasy), and three other temporary stations, one in the south of TGK and two in AND parcel 1. The research will focus mainly on three aspects: i) distribution assessment of all lemur species present in the area (including genetic identification of species with unclear taxonomic status); ii) long-term data collection on behavioural ecology and ecological requirements of Critically Endangered *L. fleuretae* and Endangered *D. madagascariensis, A. meridionalis*, and *E. collaris*; iii) quantitative data collection and monitoring on hunting pressure in the area, especially on the most targeted species.

Conservation work will be conducted in six model areas (three in AND parcel 1 and three in TGK) in close collaboration with MNP, WWF, Asity, and the local CoBas. One of the main problems causing forest loss in the area is the low yield of irrigated and rain-fed rice production and other crops which leads to increased forest use. Rice is cultivated both for local consumption and as a cash crop. Increasing demand in Fort Dauphin is increasing slash-and-burn cultivation of cassava, even in rice-producing areas.

We will provide support to improve agricultural methods, especially through the building of irrigation infrastructure (canals, etc.), to reduce the need for shifting cultivation methods and increase cultivation and yields in the currently underused plain. This action will be developed based on previous experiences accumulated by WWF in AND with the help of local NGOs such as Agriculture Farming Training. We will also provide education and training on fire control and fuel-saving techniques to reduce/minimize the impact of wildfires and fuel wood harvesting on the remaining forest. Recent reports from Asity in TGK indicate that despite the existence of Dinas (local agreement on forest use), the COBAs have difficulties meeting their commitments. COBAs also face serious problems of management and organization. We will provide organizational support for the implementation of the existing Dinas and for ensuring a common vision. These actions should result in more efficient forest patrolling in areas where harvesting of construction wood (one major pressure in the area) is forbidden by the local community agreement. This support will also include economic help to guarantee communication between local COBAs.

Hunting has been reported to decrease in some areas due to the presence of researchers, although it remains one of the major difficulties facing lemur conservation. In order to tackle the problem of hunting in the long-term, we aim at providing alternative sources of protein to people. This will include breeding programs of fast-growing animals, such as chicken and ducks, as well as fish farming. Finally, a program to boost the ecotourism industry both in AND parcel 1 and in TGK will be implemented. This is a key aspect for the long-term sustainable development of the area and may profit from the improved accessibility (and predicted increase of tourism) of Fort Dauphin due to a recently constructed port. We will establish a program of ecotourism training for local guides in TGK and support the existing structure/ organization in AND parcel 1. Some simple infrastructure (e.g. marked trails in the forest, improved site reception) will be created in the model areas. We will also help to establish links with local, national, and international operators. These activities will be coupled with specific environmental education programs both at local schools (providing posters, leaflets, books, and t-shirts) and for adults in an effort to highlight the importance of lemurs for the present and for the future of the region.

Budget: US$ 150,000 over 3 years



Sportive lemur (*Lepilemur* sp.) in the protected area of Tsitongambarika. (Photo: Andriamandranto Ravoahangy)

Mahafaly and Mandrare: The Spiny Forest Ecosystem

Barry Ferguson, Joerg Ganzhorn, Alison Jolly, Edward E. Louis, Jr., Domoina Rakotomalala & Tiana Ramahaleo

The spiny forest ecosystem of southern Madagascar is a globally unique ecosystem. Due to its remoteness and climatically harsh conditions, it has long been outside the focus of conservation priorities. However, after the demise of most of Madagascar's dry and humid forests, the region has suffered the highest deforestation rates of Madagascar, with more than 30% of the spiny forest lost between 1970 and 2000 (Harper *et al*., 2007). For the purpose of this action plan, the spiny forest ecosystem is split into western and eastern portions as follows:

• Western portion: Mahafaly Plateau



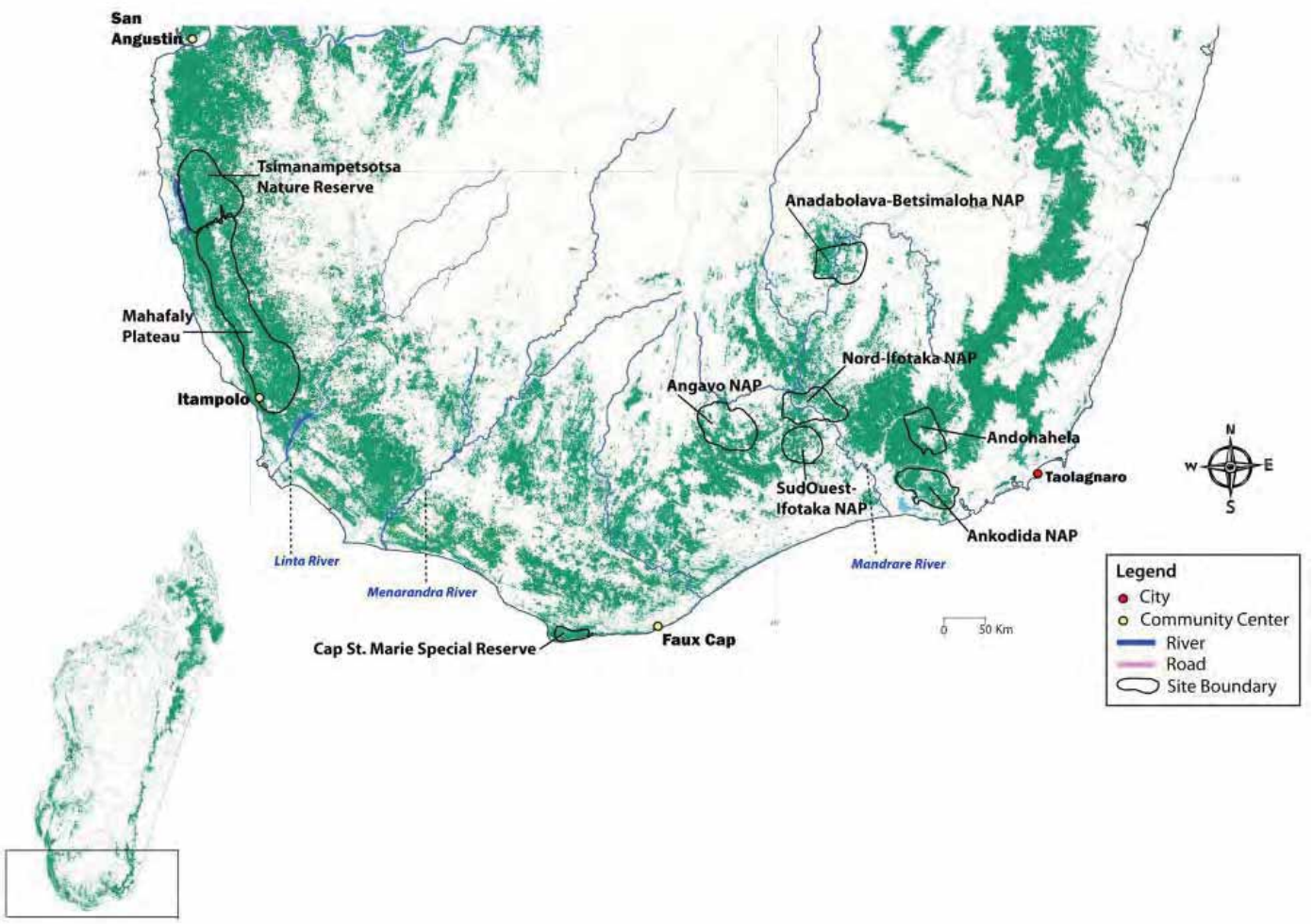


White-footed sportive lemur (*Lepilemur leucopus*), Endangered. (Photo: Edward E. Louis, Jr.)

• Eastern portion: Spiny and gallery forests of the Mandrare Valley and its hinterland (Amboasary, Ifotaka, Angavo, Ankodida and Anadabolava)

Apart from physical destruction, many of the spiny forest species reach their physiological limits either due to drought or increasing temperatures (Hannah *et al*., 2008; Bohr *et al*., 2011). According to the 2012 IUCN Red List assessment of lemurs, the region is the last stronghold for the best known lemur species, the ring-tailed lemur (*Lemur catta*), which is now classified as Endangered, as well as Verreaux's sifaka (*Propithecus verreauxi*), also now classified as Endangered. Among the nocturnal species, the white-footed sportive lemur (*Lepilemur leucopus*) from the eastern portion of the spiny forest is again classified as Endangered and represents an AZE species. Its western counterpart, Petter's sportive lemur (*Lepilemur petteri*) is classified as Vulnerable, but is likely to suffer substantially from habitat destruction and habitat becoming unsuitable due to climate change. Apart from locally very restricted studies at Berenty and Beza-Mahafaly, the population status of all lemur species of the spiny forest ecosystem and in particular the status of the nocturnal species is basically unknown.

Portions of the eastern and western part of the spiny forest are within the national parks of Andohahela (Parcel II)



Location of the western portion (Mahafaly Plateau) and eastern portion (Mandrare Valley) of the spiny forest ecosystem action plan.

and Tsimanampetsotsa, spaced some 300 km apart. These national parks are insufficient to guarantee the survival of the species in question as they risk becoming isolated in the near future. It is of paramount importance to maintain buffer zones and corridors in an otherwise unsuitable environment. Suitable forest habitats can be maintained within the context of transferring community forest management and responsibilities to the communities (politics of "transfert de gestion"). While community-based management seems to be the conditio sine qua non for sustainable conservation, the present focus on ecosystem services, ecosystem functions and payment schemes for either one or both have led to an imbalance of efforts towards sustainable economic land management and actual conservation goals at the expense of nature conservation in the region.

In collaboration with Madagascar National Parks, NGOs active in the regions and regional research facilities (Université de Toliara, Centre Ecologique de Libanona [CEL]) need to carry out the following objectives and activities:

Objectives:

1. Local communities need to be involved in forest patrol and monitoring of lemurs within their managed forest (community or sacred forest).
2. MNP managers need support to develop and run participative monitoring with local communities within the park boundary.
3. The areas need further inventory works as our knowledge of this vast region is restricted to very few sites.
4. Developing communication strategies for the interdependent activities supporting development (incentive for conservation) and conservation (as incentive for development); e.g., as part of the school curriculum; awareness campaigns.

Activities:

1. Lemur status assessment: Lemur densities vary by two orders of magnitude between sites without us understanding the driving forces (natural, anthropogenic) behind this phenomenon.
2. Developing a standardized biodiversity monitoring plan for the whole region in collaboration with MNP.
3. Training of MNP staff, students from universities in the region (CEL and Tulear) and local community rangers in standardized monitoring methods.
4. Creating the capacity for local data storage and management



Verreaux's sifaka (*Propithecus verreauxi*), Endangered. (Photo: Edward E. Louis, Jr.)



The spiny forest ecosystem. (Photo: Edward E. Louis, Jr.)

that feeds into higher level databases.
5. Standardized inventories and population status assessments in little known areas.
6. Developing a payment system for biodiversity conservation.
7. Feedback of results and comparisons to local communities.
8. Environmental education and conservation awareness programs.

The activities will be closely integrated in existing GO and NGO structures. One person per region (the PI) will be financed and will therefore be directly responsible for the performance of the program. This cannot currently be achieved by the existing staff of the understaffed GOs or NGOs as additional projects. The PI will then be in charge to communicate and organize the various activities in collaboration with GOs, NGOs and the local communities.

The conservation activities will be integrated in a large number of development projects on and around the Mahafaly Plateau (e.g., Projects: SLM, COGESFOR, SuLaMa; organizations: WWF, GIZ, Blue Ventures, HoAvy, MBP, Conservation Fusion, various national and international universities) and in the region of Amboasary, Ifotaka and Ankodida, including the Mandrare Valley (CEL, MBG, OPWALL, WWF).

Western portion Budget: US$ 150,000 over 3 years

Eastern portion Budget: US$ 149,000 over 3 years

Makay

Evrard Wendenbaum, Anne Laudisoit & Jean-Michel Bichain

The spectacular Makay Massif, composed of sandstones and conglomerates of late Triassic origin (Razafimbelo, 1987), is located north of the Mangoky River, straddling both the Atsimo–Andrefana and Menabe regions, approximately 100 km inbound from Madagascar's west coast. This 4,000 km^2 wide region, with a maximum height of 1,034 m, stretches for 150 km between the locality of Beroroha (21°41' S, 45°10' E) in the south to Malaimbandy (21°20' S, 45°36' E) in the north, being less than 40 km in its broadest part. It is characterized by meandering rivers that have carved deep canyons into steep and high (up to 400 m) cliff walls, forming a complex tangle of cashed valleys and inaccessible mountains.



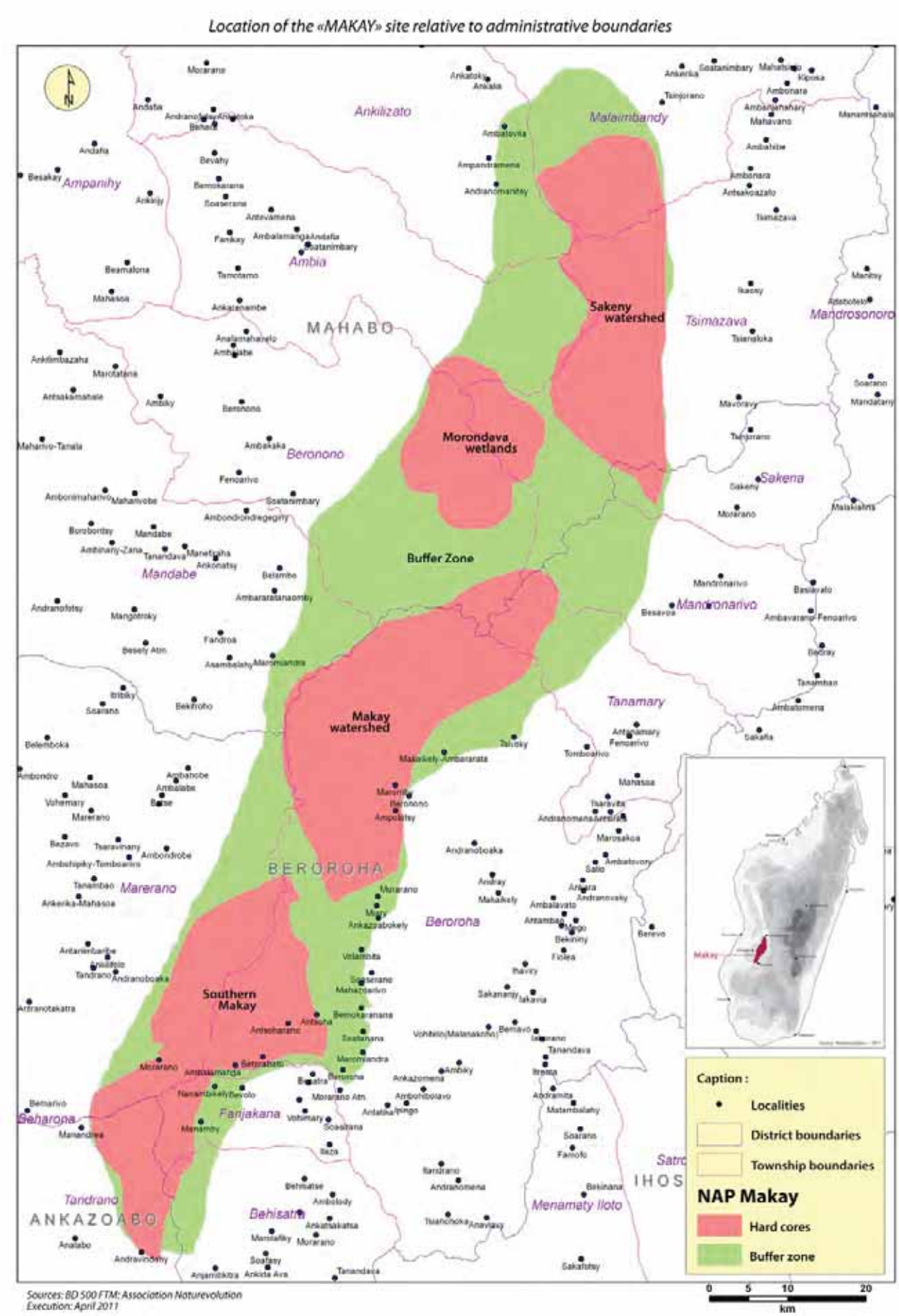


Verreaux's sifaka (*Propithecus verreauxi*), Endangered. (Photo: Russell A. Mittermeier)

The distribution of forest cover in Makay is highly scattered. Whereas the ridges and plateaus are often void of any notable vegetation except for a few remaining subtropical dry forest patches with typical xerophytic vegetation (Didieraceae and Euphorbiaceae) on the mountain tops, the subtropical climate and dense hydric system allowed for the development of gallery forests as well as riparian and bamboo assemblages along the rivers and valley bottoms. The smaller canyons harbour deep lakes or swamps that are characterized by a special vegetation dominated by Pandanus, palms - including the largest population of the Endangered Ravenea rivularis - and ferns.

Our knowledge and scientific understanding of the biodiversity of the area was extremely limited up until 2010, mainly due to its remoteness and inaccessability. However, aware of the species richness of the area, and concerned about the various threats to its biodiversity, the NGO Naturevolution carried out three scientific expeditions dedicated to an inventory of the fauna and flora in the heart of the Makay in 2010 and 2011. The massif appears to harbour many locally endemic species, as its patches of forest have been isolated for a long time. Furthermore, the forests along the Mangoky River potentially represent one of the pathways that permitted exchange between western and eastern lemur ranges during the Pleistocene (Wilmé *et al.*, 2006).

During these missions, scientists surveyed 12 different sites of the Makay, covering both the dry and humid forests with their multitude of canyons and plateaus, and applying a range of methodologies. In total, 2,000 animal and plant species were inventoried, among which at least nine different lemur species in four families, including three diurnal and six nocturnal species: the red-fronted brown lemur (*Eulemur rufifrons*), the Endangered Coquerel's giant mouse lemur (*Mirza coquereli*), the grey mouse lemur (*Microcebus murinus*), the fat-tailed dwarf lemur (*Cheirogaleus medius*), the Endangered pale



Location of the New Protected Area (NAP) of Makay. (Source: Naturevolution)

fork-mark lemur (*Phaner pallescens*), the Vulnerable red-tailed sportive lemur (*Lepilemur ruficaudatus*), the grey-brown mouse lemur (*Microcebus griseorufus*) (further genetic analyses are needed to confirm the correct species designation for this phenotypic observation), the Endangered Verreaux's sifaka (*Propithecus verreauxi*) (Dolch *et al*., 2012), and the Data Deficient Ranomafana grey bamboo lemur (*Hapalemur griseus ranomafanensis*) (E. Louis, pers. comm.). Moreover, despite the fact that the Mangoky River has long been considered as the northernmost limit of their distribution, local people mentioned the presence of the Endangered ring-tailed lemur (*Lemur catta*), as well as the Endangered aye-aye (*Daubentonia madagascariensis*) in the area. If confirmed, these observations would mean an even higher number of species in the Makay, and further scientific surveys could undoubtedly lead to the discovery of additional species. Harbouring such a unique primate assemblage living in sympatry, the Makay deserves an official and sustainable protection status.

Given that this diverse lemur community and its habitat are already under threat from anthropogenic pressures, survey results have advocated swift conservation measures for the remaining forest fragments of the Makay, and intensification of research on other aspects of their ecology. Indeed, this site is threatened due to rural immigration and the presence of dahalo (cattle thieves), which has been increasing in recent times, resulting in spectacular and largely uncontrolled forest clearing. Zebu grazing and slash-and-burn practices, fostered by the Makay's geomorphology with its hundreds of small canyons, have led to the advanced fragmentation and degradation of the forests in this area. This, together with high hunting pressure on lemurs (especially in temporary camps used by hunters and fishermen), setting intentional and uncontrolled fires, and more recently mining activities such as oil exploration, will most likely result in a loss of the lemur populations if we are not actively protecting them. This would be highly regrettable, since we have only just started to explore this fascinating place.

A preliminary MODIS-based study using NDVI and EVI, revealed that – between 1994 and 2010 – an overall decrease in forest cover has been taking place in the south-western area of the Makay (Moeyersoons and Zörner, 2011), and that there are no large connected areas of intact primary forest left. Habitat loss is not only critical for the ecosystem equilibrium, but it impacts directly on the distribution of specialist species and their long-term conservation perspective, raising the alarm for diet-restricted species such as *H. griseus* that only relies on bamboo stems. Unsustainable hunting further leads to a significant decrease in populations of large diurnal lemurs such as *E. rufifrons* and *P. verreauxi*. The recent activities of an oil company exploring the area for petroleum resources is a major threat, too, since they cut trees and use explosives that frighten lemurs and make them escape to open lands where they get easily killed by locals. Finally, if the presence of the wild cat (*Felis silvestris*), an introduced species in western Madagascar, is confirmed in the Makay, an additional risk looms upon the lemurs, including large species such as *P. verreauxi* (Brockman *et al*., 2008).

In order to protect the extremely small and relict forest fragments in the Makay and its highly threatened lemurs, a number of actions need to be taken immediately. Subsequent to their three biodiversity assessments, the NGO Naturevolution has been carrying out a conservation program based on five aspects: obtaining a protected area status, research, reforestation, ecotourism, and education and sensitization. This program can only be successful if the local population is involved in the conservation measures and management of the site.

The Makay, with its recently revealed biological importance, does not have a protection status yet. Based on the expeditions' results, a request is currently being made to the Malagasy authorities in order to obtain protected area status. For that purpose, coordinators have been employed. They lead all discussions with local communities and with the authorities in order to submit a comprehensive application. After having obtained national protection status, and to protect Makay's cultural richness (such as rock art) as well, the Malagasy delegation at the UNESCO will ask for the massif to become a UNESCO World Heritage site.

The regular presence of scientists and/or conservationists in the Makay over the last 3 years has turned out to be the most effective means of ensuring protection of the area. Consequently, Naturevolution offers to facilitate the scientists' access and work by building a research station in the largest remaining forest fragment (Menampanda), as well as establishing at least 3 satellite field stations in other remarkable sites (Behetaheta, Anosilahy and Ankolitsiky). The largest station may become a lemur rescue centre.

While both the Menampanda and Ankolitsiky stations will have permanent managers, the other two stations will only need temporary support staff such as field guides. The station managers as well as park wardens, together with Malagasy and international students and researchers, will monitor the Makay's resident lemur populations. To support the effective protection of the whole assemblage of lemurs, basic scientific information on range boundaries and ecological requirements of these species need to be assessed. They will also report degradations and all illegal activities such as lemur hunting.

In Beroroha, Tsivoko and Beronono villages, the NGO already employs locals to establish three tree nurseries in order to limit the extent of forest destruction by people gathering firewood and timber. In these nurseries, also used for educational purposes since they are partly managed by children during their school time, fruit trees are also grown to improve food quality. Fuel-efficient stoves have been introduced as well to limit the use of firewood. After this first step, villagers will be encouraged to set up additional tree nurseries and grow a variety of native forest tree seedlings close to the most threatened forest fragments. The seedlings will be used for forest regeneration and reforestation, with the aim of linking forest fragments by corridors at an initial rate of 100 ha/year.

To support the whole conservation project and offer alternative sources of income to herdsmen, hunters and fishermen, a community-based ecotourism project will be implemented, providing employment for local guides and support staff. In order to avoid mass tourism, the project only promotes high quality infrastructure and services. Two landing strips and adapted circuits in the canyons have been developed. In Beronono, a guiding office at the entrance of the Makay has been built, in which some gear such as tents, maps, backpacks and shoes have been provided for free loan to future guides for guiding and portage activities. Guiding and hotellerie trainings have been implemented, and a few other training courses are planned in order for Makay people to be the main beneficiaries of the project. A carbon-free emission ecolodge, fully integrated into nature, will be built in the Menampanda Forest, as well as an observation platform for lemurs and birds. It is planned to mix the ecolodge and scientific station infrastructures, since tourists mainly visit Madagascar during the dry season, while scientists are more interested in coming during the rainy season. The production of local handicrafts will also be promoted.

In addition to the reforestation, ecotouristic and scientific activities, a conservation education program will be implemented. Primary and secondary school teachers, subsidised by Naturevolution, will be trained to deliver conservation education lessons to their students. For educational purposes, a library has been set up in Beroroha. Regular meetings will be held with the leaders and elders of all villages surrounding the protected area, discussing the needs of the local human population, the enforcement of traditional local rules (dina), as well as updating people about ongoing and future conservation work in their areas. Educational materials such as booklets and posters will be produced and distributed among villagers. Booklets informing local people about the new regulations and boundaries of the protected area will also be distributed, and signs will be installed at the entrance of the most threatened and sensitive forest fragments.

Budget: US$ 199,009 over 3 years



Verreaux's sifaka (*Propithecus verreauxi*), Endangered, hunted and killed for local consumption. (Photo: Evrard Wendenbaum)

Kirindy–Ambadira (Central Menabe)

Matthias Markolf, Peter Kappeler, Rebecca Lewis & Ibrahim Antho Youssouf Jacky

The forests of Kirindy and Ambadira are situated between the rivers Morondava and Tsiribihina in the Central Menabe region on Madagascar's west coast. The Central Menabe region is unique because of its exceptional diversity of local endemism (Durbin *et al.*, 2005). Madame Berthe's mouse lemur (*Microcebus berthae*), Critically Endangered and the smallest primate known to science, is endemic to the forests of Kirindy and Ambadira. In total, Kirindy and Ambadira harbour eight lemur species. With Verreaux's sifaka (*Propithecus verreauxi*), Coquerel's mouse lemur (*Mirza coquereli*) and the western fork-marked lemur (*Phaner pallescens*) classified as Endangered, half of the total lemur diversity in the area is at risk of going extinct in the near future without further protection.

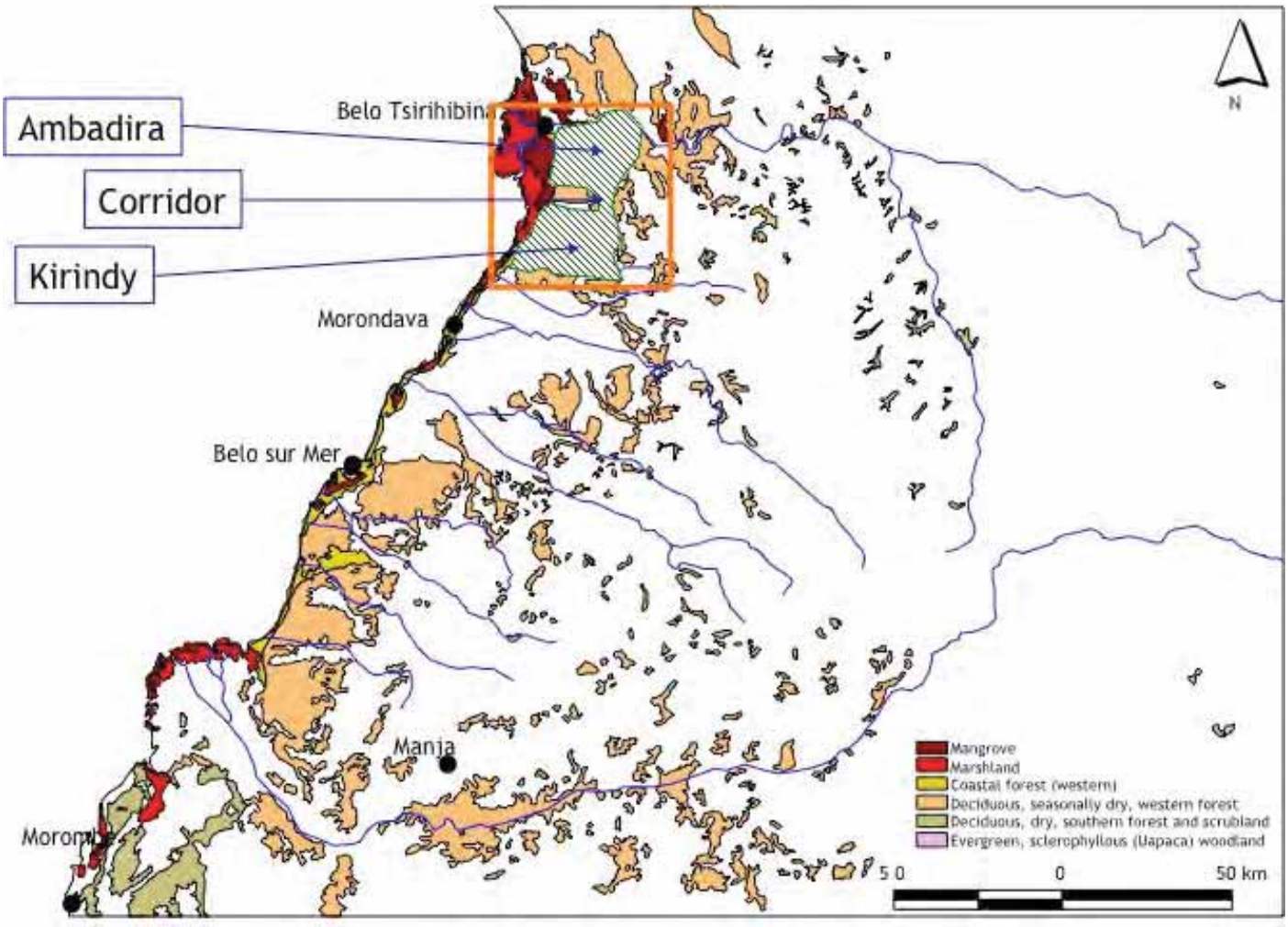




Madame Berthe's mouse lemur (*Microcebus berthae*), Critically Endangered. (Photo: M. Dammhahn)

The climate of the region is typically seasonal for dry deciduous forests of western Madagascar, with a dry season from May to November and a wet season from April to October. Madagascar's dry deciduous forests are some of the world's most diverse and unique habitats, but also one of the most threatened biomes of our time (Ganzhorn *et al.,* 2001). The remaining forests of Kirindy and Ambadira are still among the largest fragments of Madagascar's dry deciduous forests, but increasing deforestation in recent years not only threatens the survival of lemurs and other vertebrates endemic to the area (giant jumping rat, narrow-striped mongoose, flat-tailed tortoise), but also a unique global biome. Because species diversity of lemurs has been shown to highly depend on fragment size of undisturbed forests (Irwin *et al.* 2010), efforts to conserve the relatively large remaining areas of dry deciduous forest in Kirindy and Ambadira are needed immediately.

In 2010, a management plan to implement the protected area of Menabe–Antimena (Central Menabe), including the forests of Kirindy and Ambadira, was developed and submitted to the Malagasy Government. However, due to ongoing political instability, the documents have not yet been processed by Malagasy authorities and the region still lacks any form of official protection. Several stakeholders present in Central Menabe were involved in this management plan and are currently active in the area. The NGOs Longon'i Kirindy, Durrell Wildlife Conservation Trust and Fanamby have ongoing projects for conservation and development in the region. The German Primate Center (DPZ) runs a



Close-up of the Central Menabe area with the forests of Kirindy and Ambadira. (Source: Durbin *et al.*, 2005)

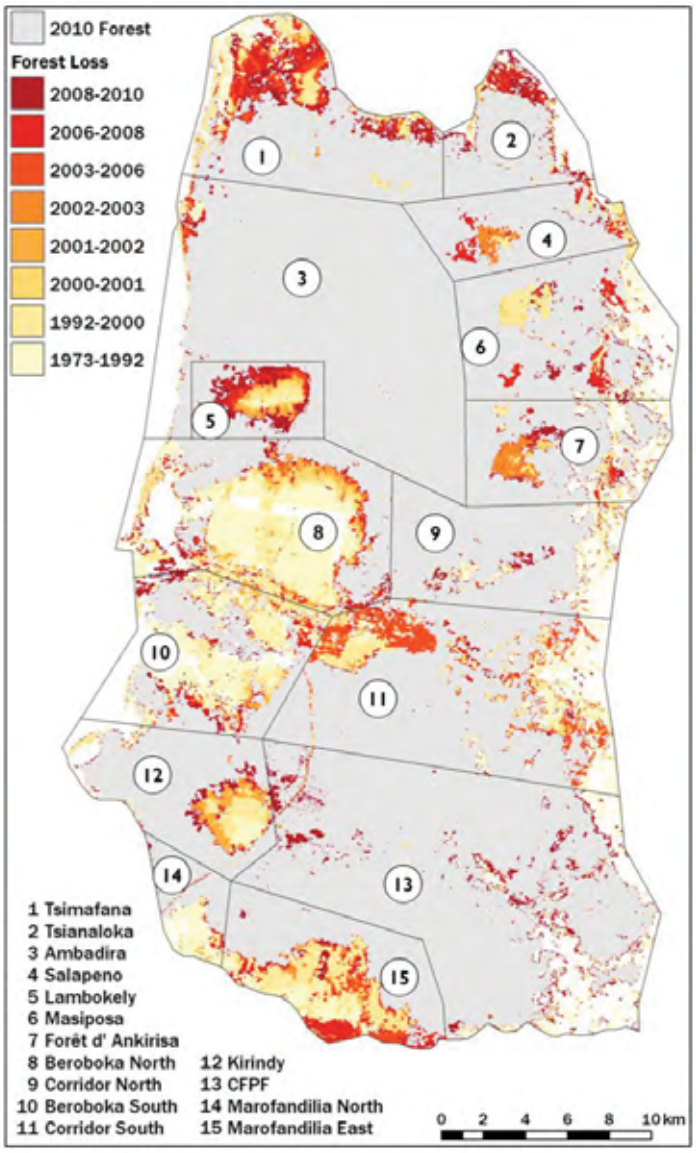
scientific field station in a forest concession administrated by the CNFEREF (Le Centre National de Formation en Environnement et Recherche Forestière) in the Kirindy Forest.

The main threats to the forests of the Central Menabe region are manifold and mostly induced by human activities. Most prominent is the highly destructive agricultural technique of tavy (slash-and-burn agriculture), but also selective logging, hunting and mining are present threats. Satellite image analyses revealed that deforestation is highest around the villages of Kirindy, Tsimafana, Beroboka and Marofandilia. The forests of Ambadira and Kirindy are only connected by a narrow forest corridor.

The implementation of the protected area Menabe–Antimena as proposed in 2010 cannot be expected in the near future, but should be facilitated by local stakeholders. However, in order to protect suitable habitat for lemur species, several immediate actions can be taken despite non-existent official protection. These basically fall under three objectives. First, in order to establish a better knowledge of the status of threatened species, information on the distribution, ecology and the threats lemurs are exposed to will be gathered and analyzed. Second, environmental education will be improved locally and on the regional level. And third, immediate-term threat mitigation actions will be initiated.

The presence of Fanamby, Durrell, DPZ and local authorities such as the CNFEREF should be used to combine and increase conservation efforts on the regional level. Responsibilities for different actions in local communities can be distributed in order to increase effectiveness of conservation in the Central Menabe region. Essential for these combined actions would be a co-ordinator of the site-based project of Kirindy–Amabadira. The co-ordinator has to facilitate the implementation, by Malagasy authorities, of the existing management plan, as well as coordinate and ensure the conservation actions of different parties present in the area.

Specifically, actions to gather more information on endangered lemur populations, threats and local needs are as follows: field surveys, using line transects or complete count censuses will be done by students from DPZ or local universities: Antananarivo and Toliara. Community-based monitoring will be established with the help of Fanamby, CNFEREF and students from the above-mentioned institutions. Students will also investigate the pressure and prevention of hunting and fire on local populations.



Forest loss in Kirindy and Ambadira from 1973-2010. (Source: Zinner *et al.*, submitted)

Although one of Madagascar's most famous sights, the Alley of Baobabs, attracts several thousand tourists each year, nature ecotourism is still under-developed in the area and revenues do not benefit the local communities. A research project on improving income through ecotourism will be initiated with the CNFEREF (who already operates an ecotourism site in the Kirindy Forest) to analyze the economic situation of tourism and propose alternative strategies for the region.

Because recent studies (Scales, 2011) suggest that forest clearance for agriculture is seen as productive and reasonable by local communities as long as it is done responsibly according to local traditions (fady), the need for education and awareness-raising is probably the most important objective to achieve sustainable use of natural resources in the long-term. Education of local communities will be improved by regular expositions and demonstrations, as well as the distribution of printed material for awareness-raising and environmental education. Finally, the efficiency of local agricultural production will be increased through local demonstrations of improved agricultural techniques. Villagers will also be encouraged and taught to grow native plants. These native seedlings will be used for reforestation, especially in the forest corridor between Kirindy and Ambadira.

In order to immediately decrease the threat to the forest and lemurs posed by illegal poaching, alternative protein sources will be popularized and facilitated in different villages. Short-cycle chicken farms will be installed in several communities. Moreover, more efficient rocket stoves (fatapera mitsitsy) will be introduced as well as the knowledge to produce eco-charcoal and assemble the fatapera mitsitsy locally, hence reducing the need for charcoal, and establishing alternative incomes for local communities.

Budget: US$ 125,850 over 3 years

Tsingy de Bemaraha

Edward E. Louis Jr., Jean Freddy Ranaivoarisoa, Liva Rajoharison & Hery Lala Ravelomanantsoa

Located in western Madagascar in the District of Antsalova, Tsingy de Bemaraha National Park and Strict Nature Reserve has been nationally listed since 1927, and became a designated World Heritage Site in 1991 with the financial support of UNESCO and WWF. Tsingy de Bemaraha is considered an iconic eco-region of this unique island, a genuine cathedral of limestone canyons and karst towers that is intermingled with forests in the western portions of the park and extensive anthropogenic savannas throughout the region. This protected area is part of the Melaky region in the province of Mahajanga, located between 44°34' to 44°57' longitude east and 18°12' to 19°09' latitude south with an estimated total area of 152,000 ha.





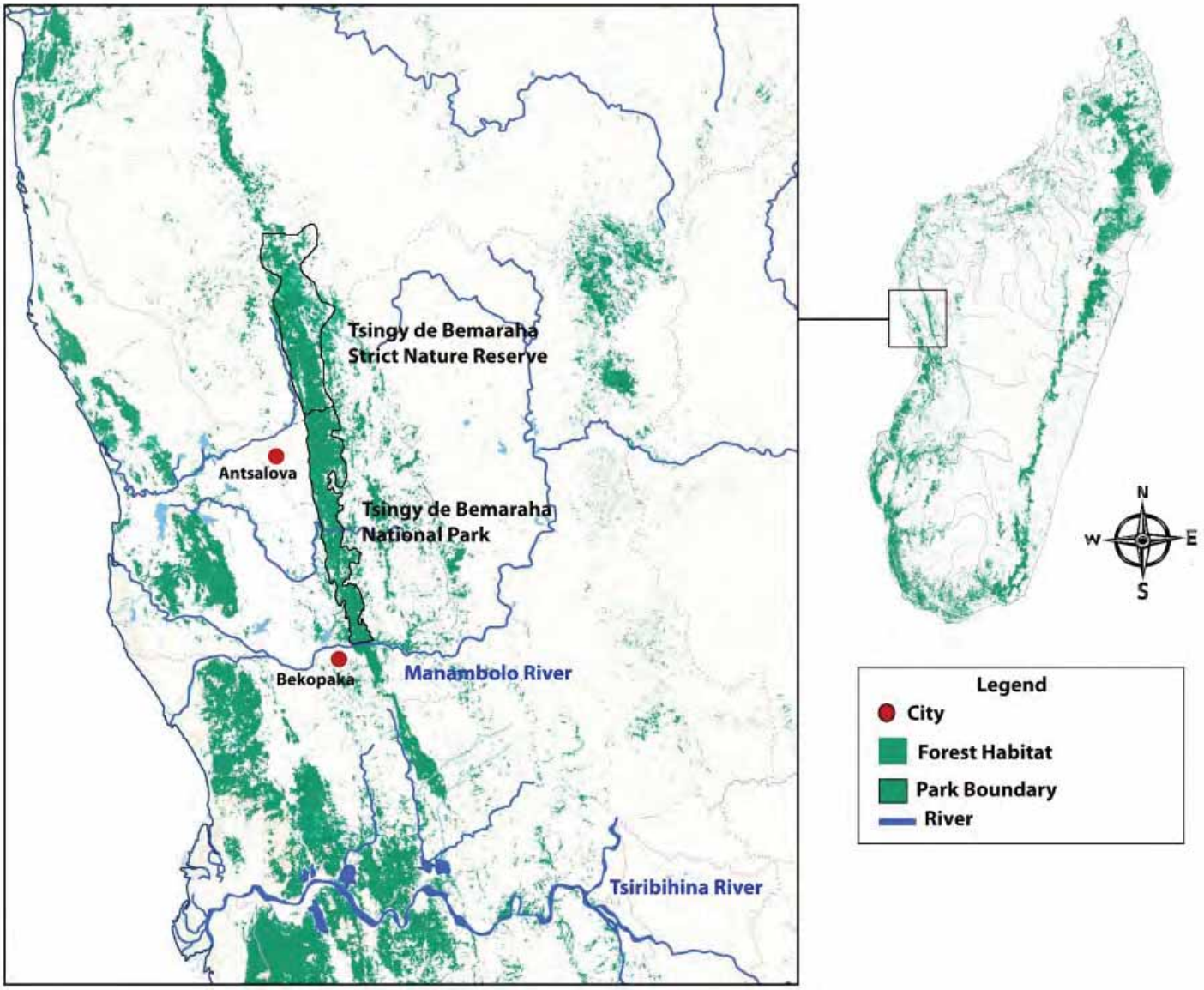
Cleese's woolly lemur (*Avahi cleesei*), Endangered. (Photo: Edward E. Louis Jr.)



Decken's sifaka (*Propithecus deckenii*), Endangered. (Photo: Edward E. Louis Jr.)

Within the forests and limestone towers and spires of Tsingy de Bemaraha reside significant populations of Endangered lemur species, including Decken's sifaka (*Propithecus deckenii*), Cleese's woolly lemur (*Avahi laniger*; an AZE species (Thalmann and Geissmann, 2005)), Coquerel's giant mouse lemur (*Mirza coquereli*), Randrianasolo's sportive lemur (*Lepilemur randrianasoloi*; another potential AZE species), and it is the southern extent of the western distribution of the aye-aye (*Daubentonia madagascariensis*). Additionally, the Vulnerable pygmy mouse lemur (*Microcebus myoxinus*) and the rufous brown lemur (*Eulemur rufus*) are found within Tsingy de Bemaraha's forests.

Although the karst formations and towers of Tsingy de Bemaraha have provided protection for the forest fauna and flora in the past, persistent pressure from tavy along with immigration into the surrounding region will continue to impact the long-term survival of this unique habitat.



Location of Tsingy de Bemaraha National Park and Strict Nature Reserve, central-western Madagascar. (Source: Edward E. Louis Jr; Madagascar National Parks)

Tourism is potentially the biggest economic benefit to Tsingy de Bemaraha and to this region, but due to its isolation in west central Madagascar, easy access remains the largest obstacle and restricts the tourist season from May through mid-November of the calendar year. Most visitors to Tsingy de Bemaraha have to travel by 4 x 4 automobile, which consists of primarily coming by a dirt or sand road from the coastal city of Morondava, and crossing over the Tsiribihina and Manambolo rivers by ferry.

The climate of Tsingy de Bemaraha and western Madagascar consists of seasonal rainfall with a dry season of six to eight months, and a wet season around December–March. The annual rainfall is about 980 mm per year, though the Tsingy is wetter than all areas lying to the west. The mean annual temperature for Tsingy de Bemaraha is above 26°C, with the mean monthly temperatures remaining above 20°C, though extremes of 38°C and 9°C have been registered in December and July, respectively.



Pygmy mouse lemur (*Microcebus myoxinus*), Vulnerable. (Photo: Edward E. Louis Jr.)



Although Tsingy de Bemaraha continues to persist through its natural architecture of the karst limestone, Madagascar National Parks is faced with an enormous and logistically difficult territory to monitor and preserve. Funding is required to develop a comprehensive research program to examine the impact that the local community and tourism have on this unique ecosystem. Additionally, basic knowledge of the population ecology and diversity of lemurs is needed, especially for the AZE sportive and woolly lemurs. This information should be allied to the MNP guides and the local community to augment conservation education programs with collaborative non-governmental organizations. Networking these educational programs with restoration and alternative agriculture projects would reduce the continuous anthropogenic overexploitation of the remaining forests, along with eliminating tavy (slash-and-burn agricultural practices). These programs would provide economic incentives through conservation-related credits and income. Improvements in agriculture and water irrigation will increase local resources and provide a relationship to the hotels and restaurant businesses that support the tourist industry. Collaborations between the universities and research organizations will support, develop and promote Malagasy research leaders. Development of relationships between Madagascar National Park personnel and the local communities would ensure a local monitoring program that would benefit the communities that surround the national park and reserve. Finally, conservation education programs immersed within the daily curriculum of the local schools and coupled to community involvement would cultivate a sustainable approach that encourages the community into protecting the local resource that Tsingy de Bemaraha National Park and Strict Nature Reserve represents.





Tsingy de Bemaraha National Park and Strict Nature Reserve. (Photos: Edward E. Louis Jr.)

Budget: US$ 226,000 over 3 years

Ambato Boeny

Laingoniaina Herifito Fidèle Rakotonirina, Tovonanahary Rasolofoharivelo & Tony King

Ambato Boeny is situated in the north-west of Madagascar (16.4667°S, 46.7167°E). Comprising low altitude (30-90 m) western dry forests, the remaining forest fragments currently lack any conservation activities from either Non Governmental Organizations or local communities, despite sheltering at least three threatened lemur species: mongoose lemur (*Eulemur mongoz*), which is Critically Endangered, crowned sifaka (*Propithecus coronatus*), which is Endangered, and rufous brown Lemur (*Eulemur rufus*), which is Vulnerable. Nocturnal lemurs have not yet been studied in the region.

The region is characterized by two major habitat types: western dry deciduous and evergreen forests. The climate of





Mongoose lemur (*Eulemur mongoz*), Critically Endangered. (Photo: Russell A. Mittermeier)

Ambato Boeny is characterized and marked by two seasons, a cool, dry season from April to October and a hot, rainy season from November to March. The mean annual rainfall is varying between 1000 mm and 1500 mm; and the average annual temperature is between 22° C and 25°C.

Anthropogenic disturbance, exerted by a growing human population, continues to put pressure on the remaining forests of Ambato Boeny. Conservation actions are therefore urgently required to safeguard the highly threatened lemur species occurring in the remaining fragmented habitats of the region. The Aspinall Foundation is currently facilitating a local community natural resource management and ecological survey programme for the forest fragment of Anaboazo, and once established will facilitate similar work in the forests of Ankirihitra. These are some of the most threatened forests in the Ambato Boeny region.

Little is known about lemur communities in the Ambato Boeny region. We will therefore undertake a complete inventory of lemur species occurring there, with particular emphasis on nocturnal species. We will subsequently determine density estimates for all lemur species, for comparison over time, and will facilitate long-term research of priority species and sites. One locally based site coordinator will be engaged in order to manage sites and follow up all activities related to the lemur conservation project. They will work with Malagasy students (preparing their DEA) from the universities of Mahajanga and Antananarivo and other researchers to expand the knowledge on Ambato Boeny's lemurs.

We will facilitate the transfer of management responsibility for priority forest fragments to local community associations, then provide technical and financial support to the associations to allow them to manage the forests for conservation. This programme will provide employment for local people through accompanying researchers and tourists



Location of Ambato Boeny. (Source: Google Maps)

and by ensuring monitoring and control patrols. These patrols will be carried out at least once a week in each priority forest.

We will work with the schools' administrative authority (CISCO) and the local schools (EPP and CEG) to implement education programmes related to lemur conservation and forest management. In addition, we will distribute relevant posters, school writing books, project T-shirts and baseball caps to the local communities.

During recent surveys we identified hunting as the primary threat weighing on lemurs in the Ambato Boeny region. The villagers of the Ankirihitra Commune, for example, have to walk for an entire day to reach the Ambato Boeny market. It favors them to hunt lemurs for food. The majority of the population in the region are Muslim, so pig breeding will be avoided, but the project plans to encourage local communities to breed poultry (chicken, ducks, geese), sheep and goats (both up to 10 kilos). Training will be organized and provision of animal stocks and materials will be provided by the project.

Forest fires, deforestation, illegal logging, gathering of non-timber forest products, and charcoal production are also major threats in the region. We will encourage local communities to establish 10m-wide firebreaks around forest fragments, and will provide training in forest regeneration and reforestation to increase connectivity between fragments, in particular preparing tree nurseries using native forest tree seedlings. We will provide financial incentives to local community associations for the planting and monitoring of seedlings. We will also promote the use of modern fuel-efficient stoves (Fatana mitsitsy) to further reduce the demand for firewood.

Budget: US$ 100,000 over 3 years



Crowned sifaka (*Propithecus coronatus*), Endangered. (Photo: Tony King)



Crowned sifaka (*Propithecus coronatus*), Endangered, roasted for local consumption. (Photo: Laingo Rakotonirina)

Ankarafantsika National Park

Ute Radespiel & Josia Razafindramanana

Ankarafantsika National Park lies in northwestern Madagascar. The first protected zone of 60,250 ha was established in the area as a Reserve Naturelle Integrale in 1927. A Reserve Forestière of 75,000 ha was added in 1929. These two parts were united in form of a National Park in 2002 under the decret N° 2002-798. Ankarafantsika is located about 450 km north of Antananarivo and 114 km south of Mahajanga, and is bisected by the RN4. It extends between 16°01'-16°24'S and between 46°35'-47°08'E over a surface of 135,000 ha, thereby forming one of the largest remaining continuous stretches of western dry deciduous forests of Madagascar. It is framed by the two large rivers Betsiboka to the west and Mahajamba to the east which constitute major biogeographic barriers.





Golden-brown mouse lemur (*Microcebus ravelobensis*), Endangered. (Photo: Ute Radespiel)

Ankaranfatsika National Park is part of the SAPM and officially managed by Madagascar National Parks which maintain park headquarters and a research station in Ampijoroa. The park is known for its high lemur diversity (8 species), five of which being Endangered or Critically Endangered: It harbours the Endangered Coquerel's sifaka (*Propithecus coquereli*), Milne-Edwards sportive lemur (*Lepilemur edwardsi*), western woolly lemur (*Avahi occidentalis*), and golden-brown mouse lemur (*Microcebus ravelobensis*). Moreover, one of the last populations of the Critically Endangered mongoose lemur (*Eulemur mongoz*) is found here. Besides, grey mouse lemurs (*Microcebus murinus*, Least Concern), fat-tailed dwarf lemurs (*Cheirogaleus medius*, Least Concern), and brown lemurs (*Eulemur fulvus*, Near Threatened) occur in many areas of the park. Altogether, the park contains one strictly diurnal, two cathemeral, and five nocturnal lemur species. The Ankarafantsika National Park has a highly seasonal climate with a dry season from April to October and a rainy season from November to March. Annual rainfalls sum up to about 1000-1500 mm with large rainfall peaks in January and February. The Park harbours a mosaic of dense dry deciduous forest, patches of savannah, riverine forests, a number of small lakes and surrounding wetlands, all of which containing a very diverse and highly endemic fauna and flora. Typical forest species include *Baudouinia fluggeiformis*, *Rothmannia reniformis*, *Strychnos madagascariensis*, and *Dalbergia greveana*. The Ankarafantsika National Park and its



Milne-Edwards' sportive lemur (*Lepilemur edwardsi*), Endangered. (Photo: Russell A. Mittermeier).

forested river system provides essential ecosystem services, e.g., by protecting the neighboring agricultural Marovoay area from siltation and aridification. Despite these important functions and its long-term status as a protected area, wildlife in the National Park is continuously threatened by bushfires, deforestation, the presence of zebu and human settlements in the forest, charcoal production and hunting activities. These threats are caused by the large human population that lives in various villages all around the park. Besides the central park headquarters at Ampijoroa, the park maintains a system of 12 decentralized base camps that are staffed with two forest wardens each. These forest wardens are responsible for surveying the forest and keeping human disturbances at a minimum. However, this system is not yet very effective and needs much improvement. In order to protect the unique and fragile forest mosaic habitats of the Ankarafantsika National Park and its threatened lemurs, a number of conservation actions need to be taken immediately in collaboration with Madagascar National Parks and the Park Administration.

Long-term experience shows that the presence of forest wardens, researchers, and conservationists in the forests is one important key to the long-term protection of Malagasy ecosystems. Therefore, the existing system of decentralized base camps at the park borders shall be employed as starting points for intensified conservation efforts in the park and for conservation education work around the park with the surrounding villagers. Additional temporary base camps close to the park borders will be needed to access the forest more easily during survey work.

In collaboration the the park administration, the park wardens/forest agents will receive an advanced training in methods of biodiversity assessment (monitoring of all lemur species and their forest) and data processing (course format with 3 small classes of 8 agents each, initial course (1 week) and subsequent follow-up classes with joint meta-analyses of all datasets (trends and problem-solving, 3 days each) at 2 months, 6 months, 12 months, and 24 months after the beginning. This group formation will be flanked with an individual adaptation of the survey routines for each base camp and initial training on the spot (2-3 weeks) by experienced Malagasy conservationists at each base camp and by two follow-up meetings in each camp taking place 4.5 months, 9 months and 18 months after the initial training to conduct a thorough and individual "trouble-shooting". There will be the need to establish temporary satellite camps that will be used during periods of intense survey work. This intensive 2-step-training (group-based & camp-based) aims to establish smoothly running routines in the park that will be continued successfully after this start-up period.

In addition, an effective long-term database and communication network will be established for transmitting and continuously evaluating the monitoring activities at each base camp and across the park. The data will serve to decide on the necessity for more severe and acute conservation actions at particular sites (e.g., intensified patrolling, anti-fire or anti-poaching activities or environmental education efforts).

Besides these camp-based activities, a series of short-term rapid assessment excursions shall be conducted to several locations in the interior of the park by an additional team of four park wardens and two experienced conservationists to check upon the condition of relatively inaccessable parts (for comparative reasons) and to survey and secure their long-term integrity. These excursions will be repeated once per year and shall be transformed into a yearly routine in subsequent years.

In addition to these measures, a conservation education programme will be implemented. Primary and secondary school teachers will be trained to deliver conservation lessons to their students. Regular meetings will be held with the leaders and elders of all villages around the park, discussing the needs of the local human population, as well as updating people about ongoing and future conservation work in their areas. Educational materials such as booklets, poster, comics and T-shirts will be produced and distributed among villagers.

Budget: US$ 165,500 over 3 years

Mahavavy Kinkony

Josia Razafindramanana, Jonah Ratsimbazafy & Vony Raminoarisoa

The Mahavavy Kinkony wetlands complex is located in the Mitsinjo District, Boeny Region in western Madagascar. The complex is framed by the District of Majunga I in the north, the Ambato-Boeny District in the south and Marovoay in the east. In the west, it opens to the Mozambique Channel. The site lies from 15˚46' – 16˚12'S to 45˚28' – 45˚56'E and covers a total area of 276,866 ha. It is characterized by different types of natural ecosystems such as estuaries, marshes, dry forests, gallery forests, savannah palm, mangroves, lakes and rivers. The creation of the New Protected Area of the Mahavavy Kinkony Wetlands was proposed in 2006, and a temporary status was granted in January 2007.

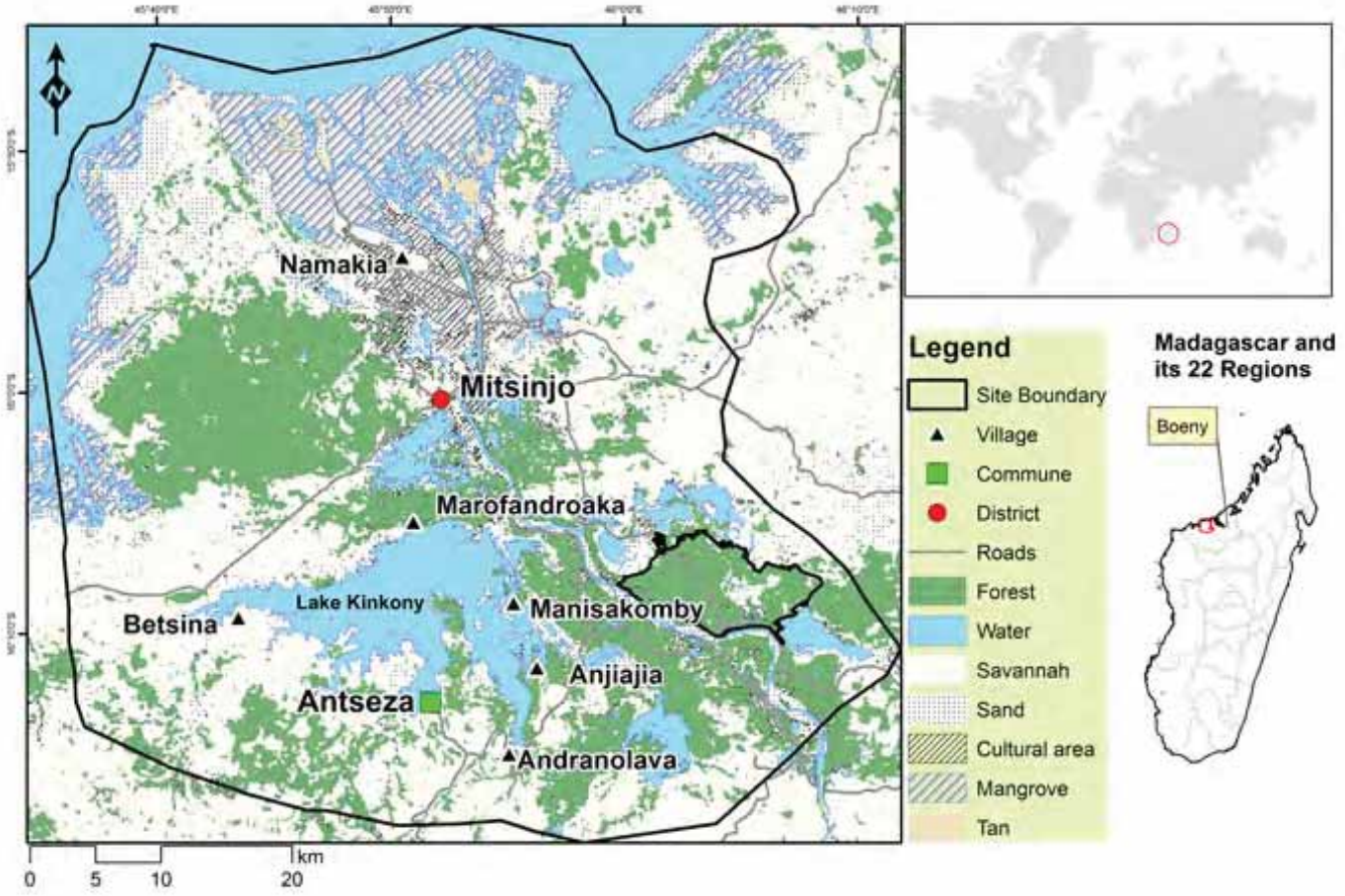




Crowned sifaka (*Propithecus coronatus*), Endangered. (Photo: Russell A. Mittermeier)

The wetlands complex is a priority area for bird conservation in Madagascar (ZICOMA 1999). The region is listed as an Important Bird Area by BirdLife International and is home to a rich variety of wetland bird species, some of which are threatened, and most of which occur nowhere else in the world. It is characterized largely by the presence of both aquatic and terrestrial ecosystems and hosts many threatened species, not only birds, but indeed lemurs. Since 2002, the Mahavavy Kinkony complex has been officially managed by the NGO ASITY. Their headquarters are located in Mitsinjo. Although ASITY aims to conserve biodiversity and to manage wetlands sustainably in close collaboration with other civil society organisations, their priorities are focused mainly on birds. Lemur conservation is currently grossly under-represented.

Previous inventories, conducted a decade ago, confirmed the presence of nine species of lemur, six of which are classified as threatened: the Critically Endangered mongoose lemur (*Eulemur mongoz*), the Endangered crowned sifaka (*Propithecus coronatus*) and Decken's sifaka (*Propithecus deckenii*), the Vulnerable rufous brown lemur (*Eulemur rufus*), pygmy mouse lemur (*Microcebus myoxinus*), and northern bamboo lemur (*Hapalemur occidentalis*), and the



Mahavavy Kinkony complex. (Source: R. Andriamasimanana)

fat-tailed dwarf lemur (*Cheirogaleus medius*) and common mouse lemur (*Microcebus murinus*), both currently of Least Concern. A *Lepilemur* species is also known to occur in the area, although it hasn't been identified yet due to a lack of research.

The Mahavavy Kinkony wetlands provide important food resources and income to the local people. The protection plan should therefore encompass sustainable management to enable a balance between people, forests and wetlands. Despite the efforts of ASITY working towards the protection of the wetlands, several actions need to be carried out in addition, in order to protect not only the wetlands, but indeed the other ecosystems such as the forests and the savannah which are home to endangered lemurs and other fauna (Ramanitrivonony, 2010).

Due to an increase in the human population (resulting from migration in the hope of a better life), the biodiversity of the site has become highly threatened. Overfishing and unsustainable hunting are threatening animals from the wetlands, particularly birds and fish. Lemurs and their habitat are mostly threatened by bushfires, deforestation, charcoal production and illegal hunting. Additionally, the fragmentation of the remaining forests represents a big issue for the survival of larger animals, especially lemurs.

Little is known about the lemurs of Mahavavy Kinkony. Both a research and a conservation programme are therefore required to safeguard the endangered lemur species occurring in the forest fragments. GERP (Groupe d'Etude et de Recherche sur les Primates de Madagascar) is currently establishing a collaboration with ASITY to implement these activities onsite. Through this we will undertake a complete inventory of lemur species with an additional focus on nocturnal species, which have not yet been sufficiently identified. A long-term research programme that ensures the presence of researchers and conservationists in the forests also plays an important role in forest and lemur protection.

In collaboration with ASITY, we will establish forest wardens specialized in lemur and habitat surveys. We will provide training on lemur assessments, behavioural observations and database creation. As part of the conservation programme, tree nurseries of native species will also be set up, with local people and associations carrying out reforestation activities. Fast-growing species will be planted in order to meet the requirements for timber and firewood in the local communities.

The provision of alternative sources of protein (by facilitating poultry and fish breeding) will also form an important part of the conservation strategy to protect lemur species from being hunted for food. Training and provision of stocks and necessary materials will be organized by the project. Environmental education will be developed to raise awareness, involve, and train local people about conservation work and attitudes. Education materials will be produced and distributed to schools, teachers, children and villagers. Practical environmental education will be implemented to help people solve common environmental problems and to reduce their disturbance of the forests and lemurs. This includes promotion of fuel-efficient stoves and permaculture.

Budget: US$ 151,500 over 3 years

Antrema

Rivo Ramanamisata & Hanta Razafindraibe

Antrema Forest Station (SFUM), in the Boeny Region, north-west Madagascar, is a terrestrial and marine park established in 2000. It is managed by the Projet bio-culturel d'Antrema in association with the Muséum national d'Histoire naturelle in Paris (MNHN) and Paris Zoo. The preserved zone extends between 15°42 and 15°50 of southern latitude and 46°00 and 46°15 of eastern longitude. It covers approximately 12,270 ha, of which 1,000 ha is a marine park (Gauthier *et al*., 1999).

SFUM is one of the hottest regions of Madagascar and is located in a highly seasonal zone, with a dry season that extends from May to October, and a wet season from November to April. It has one of the few remaining forests in Madagascar to be set on sand dunes. The climax vegetation type is semi-deciduous dry forest. Additional habitat types include shrub savannahs and mangroves.

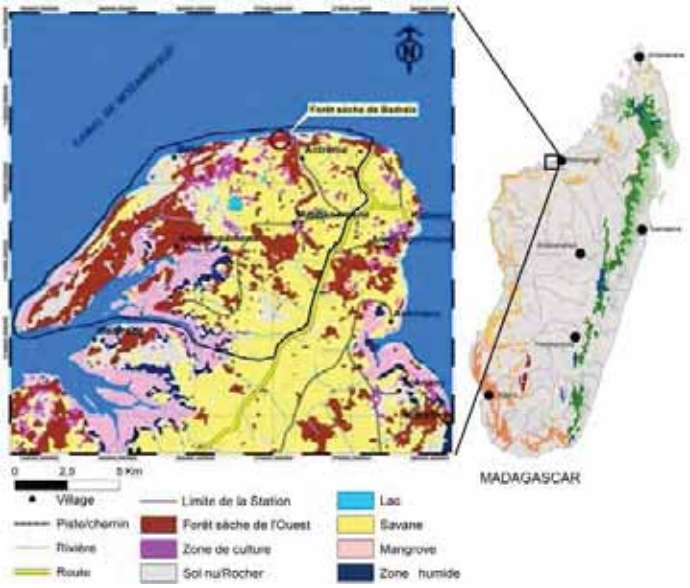




Crowned sifaka (*Propithecus coronatus*), Endangered. (Photo: GERP)

The SFUM has three species of lemur in the IUCN's Endangered and Critically Endangered categories. The Endangered crowned sifaka (*Propithecus coronatus*) is considered the flagship species of the region; its distribution is restricted to the north-west of Madagascar between the Betsiboka and Mahavavy rivers. An estimated one thousand individuals of *P. coronatus* are thought to remain in the wild (Razafindramanana *et al*., unpubl.). Certainly most of these individuals are found in SFUM, as this is the most densely populated area in the species' distribution range, with 300 individuals per km² (Pichon *et al*., 2010). Populations are highly threatened by habitat degradation due to illegal logging and fire. Other lemur species present include the Critically Endangered mongoose lemur (*Eulemur mongoz*), the Vulnerable AEECL's sportive lemur (*Lepilemur aeeclis*), and the grey mouse lemur (*Microcebus murinus*).

Since its launch, the pilot Projet bio-culturel d'Antrema has already developed actions to preserve the habitat of these lemurs by conducting research projects and implementing socio-cultural development. However, these efforts need to be strengthened in face of growing anthropogenic pressure, which is causing habitat fragments to become more and more isolated. A number of measures need to be taken immediately to prevent local extinction of the flagship species *P. coronatus*



Location of the Antrema Forest Station. (Source: Josia Razafindramanana)

and its associated habitat. Additional support to the Projet bio-culturel d'Antrema would be hugely advantageous. It is also necessary to map the area and to identify the most isolated fragments in order to establish a restoration plan using the plant target species for reforestation and forest regeneration.

Monitoring officers for nurseries need to be present on site, and local people need to be trained in forest restoration and maintenance of nurseries. Sustainable development needs to be promoted, and the capacity of local people to use new agricultural techniques needs to be strengthened. Environmental education also needs to be promoted using visual means such as posters, booklets, brochures, and other media.

Additionally, gaps in biological and ecological data need filling. Specifically, long term research will be conducted to determine the ecological requirements of target species and their different threats. This requires the permanent presence of an on-site researcher. (Note that researchers should also establish regular communication with local people).

Finally, promoting awareness and strengthening enforcement of environmental laws and social rules (dina), setting up forest patrols (VNA), and providing material support for civil organizations on site are all actions high on the agenda for conservation planning in SFUM.

Budget: US$ 95,500 over 3 years

Bombetoka–Belemboka

Josia Razafindramanana, Rado Rakotondrabe & Jonah Ratsimbazafy

Bombetoka–Belemboka is a New Protected Area (NAP) established in 2007. It was officially managed by the NGO Fanamby until recently. It is located in the Boeny region, north-west Madagascar. The NAP covers a total area of 71,943 ha of mangroves and dry deciduous forest.

Mangroves are known to be the natural habitat for many bird species, in particular Bernier's ibis or voronosy (*Threskiornis bernieri*). The dry forest is known for precious wood (ebony and palissandre) and lemurs. The NAP of Bombetoka–Belemboka was created to protect both ecosystem types, to promote sustainable development for local people, to restore the habitats and to promote ecotourism and community-based management. The site harbours threatened lemurs such as the Critically Endangered mongoose lemur (*Eulemur mongoz*), the Endangered crowned sifaka (*Propithecus coronatus*), and an as yet unidentified species of *Lepilemur*. Indeed, little is known about the lemurs inhabiting this site. A detailed lemur survey needs to be carried out to verify all lemur species occurring here.





Mongoose lemur (*Eulemur mongoz*), Critically Endangered. (Photo: Russell A. Mittermeier)

Many socio-economic and environmental problems occur in the Bay of Bombetoka, resulting from the proximity of the large seaport of Mahajanga and the heterogeneity of the surrounding communities. The traditional vision of a vast area "appropriate for local generations" seems far from the actual realities. Mobilizing local communities to apply a better management of natural resources is very difficult here due to poverty, local conflicts and the current political crisis. Illegal exploitation of natural resources (illegal logging of precious woods, production of charcoal, slash-and-burn agriculture) is increasing in order to meet the growing demands of the nearby city of Mahajanga. Although the use of dead wood as firewood is already adopted by local people, it would not be possible to provide firewood or charcoal permanently to the nearby city without introducing other alternatives such as solar cooking methods. The distribution of such materials would reinforce conservation, particularly in urban areas.

Fragmentation and forest destruction also constitute the main threats to the lemurs of the site. Urgent conservation actions should be conducted to ensure the protection of the ecosystem and its biodiversity.

A lemur research programme focused on inventory, habitat survey and behavioral ecology is urgently needed to start protecting these animals. A complete inventory of lemur species with particular interest on nocturnal species will be conducted. An evaluation of biodiversity loss through a rapid assessment programme will be established to understand priorities in conservation for the site. Conservation programmes will focus on habitat restoration and protection, promotion of sustainable development for local people and environmental education. Apart from establishing a forest restoration programme, a community tree-planting activity of fast growing species will also be organized to help solve the problems of forest destruction and lack of firewood.

Local communities will be trained to establish tree nurseries. Installing firebreaks will help in safeguarding dry forests against bush fires. Local patrols will be established to conduct surveys of all lemur species and their forest habitats. Advanced training will be provided to them in ecological methods and data processing. Malagasy conservationists and/or researchers will be based permanently or frequently on site to monitor the local survey and will ensure the long-term training of local patrols. This will also guarantee communication between local communities and conservationists. Livelihood alternatives will be provided to local households such as bee keeping, handcrafting, short cycle breeding, and modern agricultural methods (training in modern techniques for rice and maize culture). Local people will be trained in different techniques of saving fuel with traditional cooking methods to help them save money and time. Environmental education will focus on sensitization of local people, schools, teachers and children about the need for conservation and its benefits.

Regular meetings with villagers, stakeholders, leaders and elders of the surrounding villages will be organized to discuss conservation, the needs of local people and possible solutions. Education materials such as posters, comic books and T-shirts will be produced and distributed among schools and children.

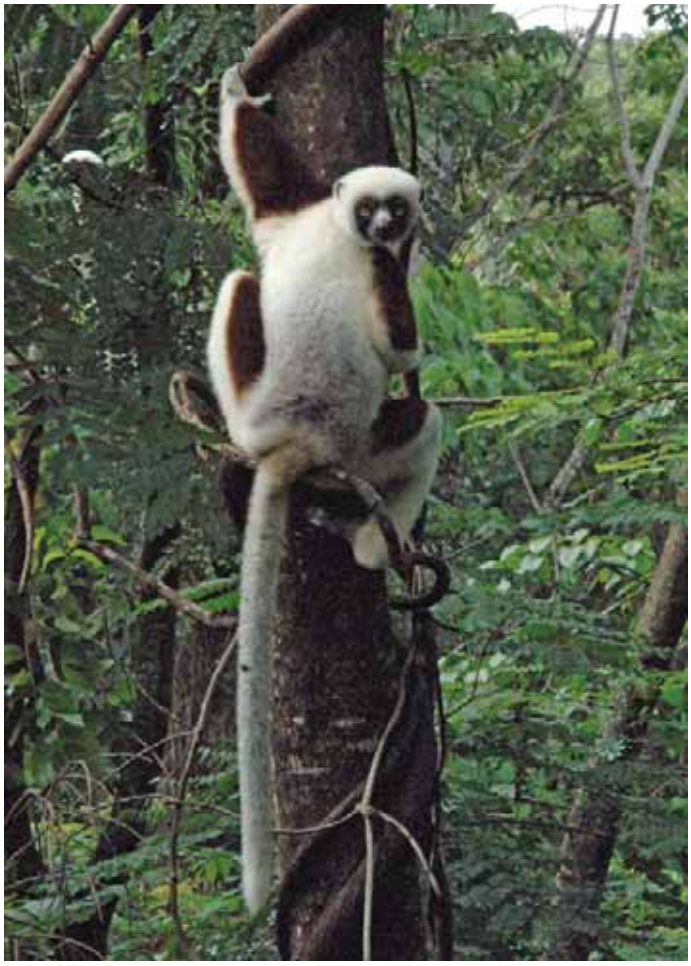
Budget: US$ 139,000 over 3 years

Anjiamangirana and Marosely

Gilbert Rakotoarisoa, Ute Radespiel & Lounes Chikhi

The Anjiamangirana Forest Station is a protected area located in the Sofia Region, in the Antsohihy District, in north-west Madagascar (15°09'22"S and 47°44'33"E), 3 km west of the Anjiamangirana village and 5 km from the Anahidrano and Ankerika villages. It is characterized by various types of vegetation depending on altitude, which varies between sea level and 409 m, and distance from the coast, and by the presence of a surrounding mosaic of anthropogenic savannas, farm land, and other open habitats. Forest fragments are mostly isolated from each other but sometimes connected by gallery forests. The dense dry deciduous forest on higher altitudes is composed of 10–12 m high trees belonging, for example, to the families *Fabaceae*, *Euphorbiaceae*, *Rubiaceae*, *Sapindaceae*, *Moraceae* and *Verbenaceae*. The alluvial and riparian forests, which can be considered semi-deciduous, are periodically flooded, and are comprised of 25–30 m high trees, mixing sempervirent and deciduous plants with palm trees (*Dypsis* sp.). Six lemur species have been observed to be present in Anjiamangirana. Among these are Coquerel's sifaka (*Propithecus coquereli*), aye aye (*Daubentonia madagascariensis*), Danfoss' mouse lemur (*Microcebus danfossorum*), and Grewcock's sportive lemur (*Lepilemur grewcockorum*), which are all classified as Endangered, the latter three being nocturnal. The nocturnal fat-tailed dwarf lemur (*Cheirogaleus medius*) and the cathemeral common brown lemur (*Eulemur fulvus*) can also be found here.





Coquerel's sifaka (*Propithecus coquereli*), Endangered. (Photo: Russell A. Mittermeier)

The Marosely forest mosaic (15°39'6"S, 47°34'56"E) lies about 13 km south-west of Port Bergé and about 3–5 km west of the RN6, right between the large rivers Sofia (ca. 23 km to the north) and Mahajamba (ca. 50 km to the south-west), which act as major biogeographic barriers in north-west Madagascar. Marosely is part of the Bongolava Classified Forest and consists of a dry deciduous forest that grows partly on sandy soils (plateau at about 250–300 m a.s.l.) or on red lateritic soils along the flanks of the plateau and in the adjacent valleys. The Bongolava Classified Forest as a whole is already highly fragmented, but gene flow may still be possible between fragments due to some low-level connectivity.



Forest fragment in Anjiamangirana. (Photo: G. Rakotoarisoa)

At least five species of lemur have already been documented in Marosely. Three of these are Endangered: Coquerel's sifaka (*Propithecus coquereli*), Otto's sportive lemur (*Lepilemur otto*), and Bongolava mouse lemur (*Microcebus bongolavensis*) (the latter two being nocturnal). Others include the nocturnal common mouse lemur (*Microcebus murinus*), and the cathemeral common brown lemur (*Eulemur fulvus*). Two species, *L. otto* and *M. bongolavensis*, are regional endemics that only occur in this particular Inter-River-System.

The main causes of deforestation and forest fragmentation in the north-western region are *tavy* (slash-and-burn agriculture), bushfires, wood exploitation for fire and house building, charcoal production and forest exploitation. As for the main threats to lemurs, they are hunting, charcoal production and fires.

Different actions can be suggested to protect the lemur species present in the forests and maintain biodiversity. The first is related to the coordination and facilitation of site-based conservation projects and would require, for example, support of the activities of the NGO Aye-aye Fund, as they are already present locally and very active in Anjiamangirana. Second, research should be supported to increase knowledge on the lemur diversity of the area. To that aim, five important activities can be identified: (i) long-term population monitoring of lemurs through repeated field surveys; (ii) identification of local needs and development of site-specific local plans of action to determine where they overlap with conservation needs, as conservation will be efficient where it fulfills local needs; (iii) reinforcement of the local traditions and cultures, by organising meetings with migrants' populations which may sometimes have different uses of forests; (iv) promotion of naturally existing restoration forces (e.g. bats, lemurs, birds); (v) long-term research to establish the ecological requirements and identify long-term threats of target species. Third, information, education and communication should be promoted with non-school based educational exchange, emphasizing two-way communication and knowledge transfer, and by training locals about new and sustainable agricultural techniques, and providing materials. Fourth, immediate-term threat mitigation must be achieved by (i) fire prevention and control; (ii) promoting adoption of alternative cooking fuels; (iii) reinforcing and supporting forest patrols (local park rangers/ VNA, KASTI). Fifth, long-term natural resource management and local development appear as a crucial issue and can be implemented by (i) implementation of the Madagascar Bushmeat Strategy; (ii) building and maintaining tree nurseries; (iii) identifying reforestation areas to maximize connectivity, biodiversity and economic benefits; (iv) creating or supporting civil society organizations that focus on environmental justice.

Budget: US$ 310,000 over 3 years

Sahamalaza – Iles Radama National Park

Melanie Seiler, Guy Randriatahina, Sylviane Volampeno & Christoph Schwitzer

The Sahamalaza-Iles Radama National Park in the Sofia Region of north-west Madagascar is a marine and terrestrial protected area established in 2007. It is part of the SAPM and officially managed by Madagascar National Parks. The site is also a UNESCO Biosphere Reserve under their "Man & Biosphere" programme since 2001. The protected area extends between 13°52'S and 14°27'S and 45°38'E and 47°46'E (WCS/DEC 2002). It harbours the last remaining populations of the Critically Endangered blue-eyed black lemur (*Eulemur flavifrons*) and Sahamalaza sportive lemur (*Lepilemur sahamalazensis*), both endemic to this region. Other lemur species occurring within the boundaries of the protected area are the Endangered northern giant mouse lemur (*Mirza zaza*) and aye-aye (*Daubentonia madagascariensis*), the fat-tailed dwarf lemur (*Cheirogaleus medius*), the northern bamboo lemur (*Hapalemur occidentalis*), and the black lemur (*E. macaco*).



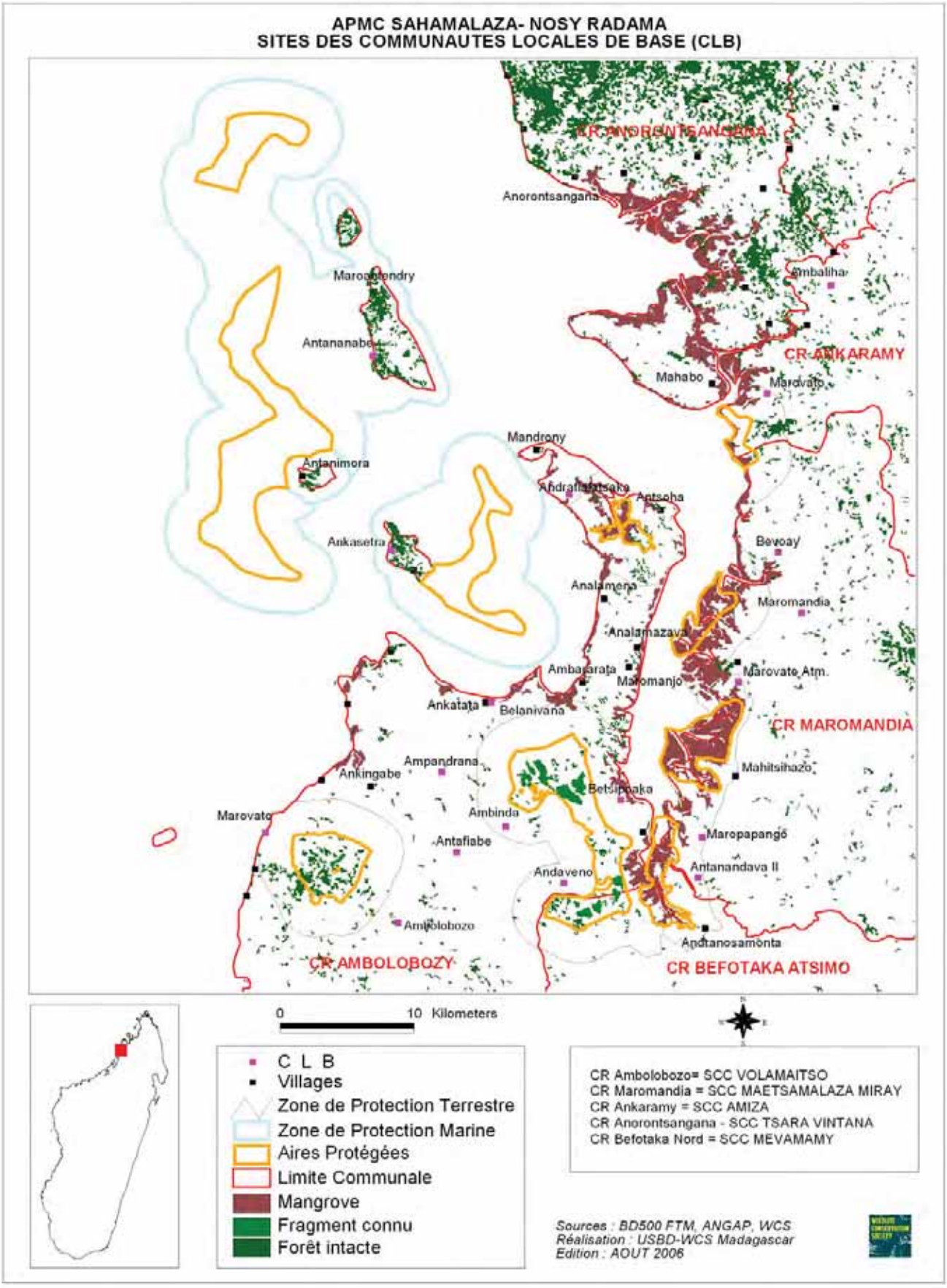
Blue eyed black lemur (*Eulemur flavifrons*), Critically Endangered. (Photo: Nora Schwitzer)



The climate of Sahamalaza is strongly seasonal, with a cool, dry season from May to October and a hot, rainy season from November to April. The site lies in a transition zone between the Sambirano region in the North and the western dry deciduous forest region in the South, harbouring evergreen forests with tree heights of up to 25 m. The forests in this area include a mixture of plant species typical of the western dry deciduous forest and of the Sambirano domain (Birkinshaw 2004).

There are no larger connected areas of intact primary forest left on the Sahamalaza Peninsula, and the remaining fragments all show some degree of anthropogenic disturbance and/or edge effects (Schwitzer *et al.*, 2007a; Schwitzer *et al.*, 2007b). The forests and forest fragments are separated through grassland with shrubs as a consequence of deforestation. The lemurs of Sahamalaza are highly threatened by increasing and presumably unsustainable levels of hunting, and by forest destruction and degradation, mainly through land conversion for subsistence agriculture (Schwitzer *et al.*, 2006).
The Association Européenne pour l'Etude et la Conservation des Lémuriens (AEECL) has been carrying out a community-based natural resource management and ecological research programme in Sahamalaza since 2001. AEECL manages a research station in the Ankarafa Forest.

In order to protect the extremely small and few remaining



Sahamalaza – Iles Radama National Park. (Source: BD500 FTM, MNP, WCS Madagascar)



Male black lemur (*Eulemur macaco*), Endangered. (Photo: Russell A. Mittermeier)

forest fragments in Sahamalaza and its highly threatened lemurs, a number of actions need to be taken immediately. The presence of the AEECL research station in the Ankarafa Forest over the last 8 years has shown that a continuous presence of researchers and/or conservationists is the most effective means of ensuring protection of the forest fragments surrounding the station. It is thus proposed to map all remaining forested areas in Sahamalaza, and to establish another two satellite field stations on the Sahamalaza Peninsula, namely in the forests of Anabohazo and Ambohitra. Each of the field stations will have a permanent station manager and four to five support staff such as field guides on site. The station managers and support staff will monitor the resident lemur populations in their forests. They will work with Malagasy and international students and researchers to further the existing knowledge on Sahamalaza's lemurs. To support the effective protection of the endemic lemurs, basic scientific information on range boundaries and ecological needs of these species needs to be gathered. Furthermore, for subsequent forest restoration and reforestation a complete inventory of tree species in the different forest fragments needs to be established.

In collaboration with MNP, the boundaries of the protected area will be demarcated with signs that remind people of the regulations inside the park. Fourteen additional park wardens will be employed by MNP and will report to the MNP Park Director and the Programme Director of AEECL. They will patrol the forest fragments in three different forests of the Sahamalaza Peninsula. Seven-meter wide firebreaks will be established and maintained around the main forest fragments with the help of the local communities. Villagers will be encouraged to set up tree nurseries and grow a variety of native forest tree seedlings that will be bought by the project. The seedlings will be used for forest regeneration and reforestation, with the aim to link forest fragments by corridors. The setting-up of sustainable fruit tree plantations in assigned areas will also be encouraged.

Short-cycle breeding of chickens (and potentially ducks), as well as bee keeping, will be promoted and supported by training and provision of animal stocks and materials. Training will be provided in more sustainable and intensive agricultural techniques such as "SRI" in order to discourage slash-and-burn agriculture. Fuel-efficient stoves will be introduced to limit the extent of forest destruction by people gathering firewood.

In addition to direct protection measures, a conservation education programme will be implemented. Primary and secondary school teachers already subsidised by AEECL will be trained to deliver conservation education lessons to their students. Regular meetings will be held with the leaders and elders of all villages surrounding the protected area, discussing the needs of the local human population, the enforcement of traditional local rules (Dina), as well as updating people about ongoing and future conservation work in their areas. Educational materials such as booklets, posters, comics and T-shirts will be produced and distributed among villagers.

A community-based ecotourism project will be implemented, providing employment for local guides and support staff. The production of local handicraft will be promoted.

Budget: US$ 183,000 over 3 years

Nosy Be

Guy Randriatahina & Sylviane Volampeno

Nosy Be Island is a famous tourist resort located off the coast of north-west Madagascar. It is home to one of Madagascar's Réserves Naturelles Intégrales, Lokobe. This protected area is little known and is less popular than coastal tourist activities. However, encouraging ecotourism of the forest could give a boost to the economy of the island.

Nosy Be has an area of approximately 320 km² and biogeographically belongs to the Sambirano domain of northern Madagascar. The Lokobe Strict Nature Reserve became a full national park in 2011, with an area of 1,602 ha. It is home to two nocturnal lemur species: Claire's mouse lemur (*Microcebus mamiratra*) and the Nosy Be sportive lemur (*Lepilemur tymerlachsonorum*), both of which have been classified as Critically Endangered following the 2012





Nosy Be sportive lemur (*Lepilemur tymerlachsonorum*), Critically Endangered. (Photo: Russell A. Mittermeier)

IUCN Red-Listing workshop. In addition to these species, three more lemur species inhabit the park, including the Vulnerable black lemur (*Eulemur macaco*). All are exposed to threats such as logging, hunting and slash-and-burn agriculture.

This conservation action plan aims to give better protection to these high priority species, and to protect the diversity, integrity, and viability of the park's natural ecosystems. The plan consists of short-term objectives to prevent any additional population decline, and medium-term objectives to improve the conservation status of the species (e.g. from Critically Endangered to Endangered) by reaching a target population and ensuring that it is viable.

Efforts to conserve the threatened species and their habitats will be increased, concentrating on control of invasive species, eradication of hunting, reduction of the impact of pressures

on the forest, maintaining or restoring the natural ecosystem processes which are necessary for proper functioning of the forests, maintaining or restoring the native plant and animal diversity, enhancement of the availability, quality and connectivity of habitat (e.g. buffer zones, ecological corridors outside the park), and limitation of cultivated areas in the protected zones.

A program of monitoring and research will be implemented, involving regular population monitoring and habitat description, and further research into species ecology. A research camp will be constructed to facilitate the presence of researchers in the park. An ecotourism scheme will be developed, which will involve supporting the park administrators in the planning and development of ecotourism (zoning, creation of circuits, guide training), as well as collaboration with the ORTN or the regional tourism office.

In order to raise awareness of conservation issues, various public campaigns (visiting schools and hotels) will be run, and educational sessions in schools and hotels will be organised. These will be supported with printed material (flyers, posters, information sheets, etc). Environmental events such as the World Environment Day will be organised and/or participated in, and the community will be included in a participative monitoring scheme to better involve them with the conservation programme. Park surveillance will be strengthened, park rangers will be recruited and/or trained, and equipment such as GPS systems, binoculars, and uniforms will be supplied. This will all enable improved supervision of the park.

Precautions will be taken to prevent the ecotourism scheme causing any damage to the park and to protect its ecological integrity. An ecotourism management plan will be drawn up to identify pressures, as well as hypothetical sources of pressure, caused by the scheme. The tour operators, park staff, local government agents, and community representatives must be involved in this process.

Finally, income-generating activities will be introduced in order to improve the livelihoods of the local population, thereby minimising damage caused to the park by them.

Budget: US$ 120,000 over 3 years



Claire's mouse lemur (*Miocrocebus mamiratra*), Critically Endangered. (Photo: Russell A. Mittermeier)

Daraina

Jordi Salmona & John Rigobert Zaonarivelo

The Daraina region (13°10'S / 49°40'E), also called Loky-Manambato region (using the names of the two rivers that delimit it), hosts a dozen large forest fragments separated by savannahs. The forest fragments of the region and the whole area are included in a New Protected Area managed by the Malagasy NGO Fanamby.

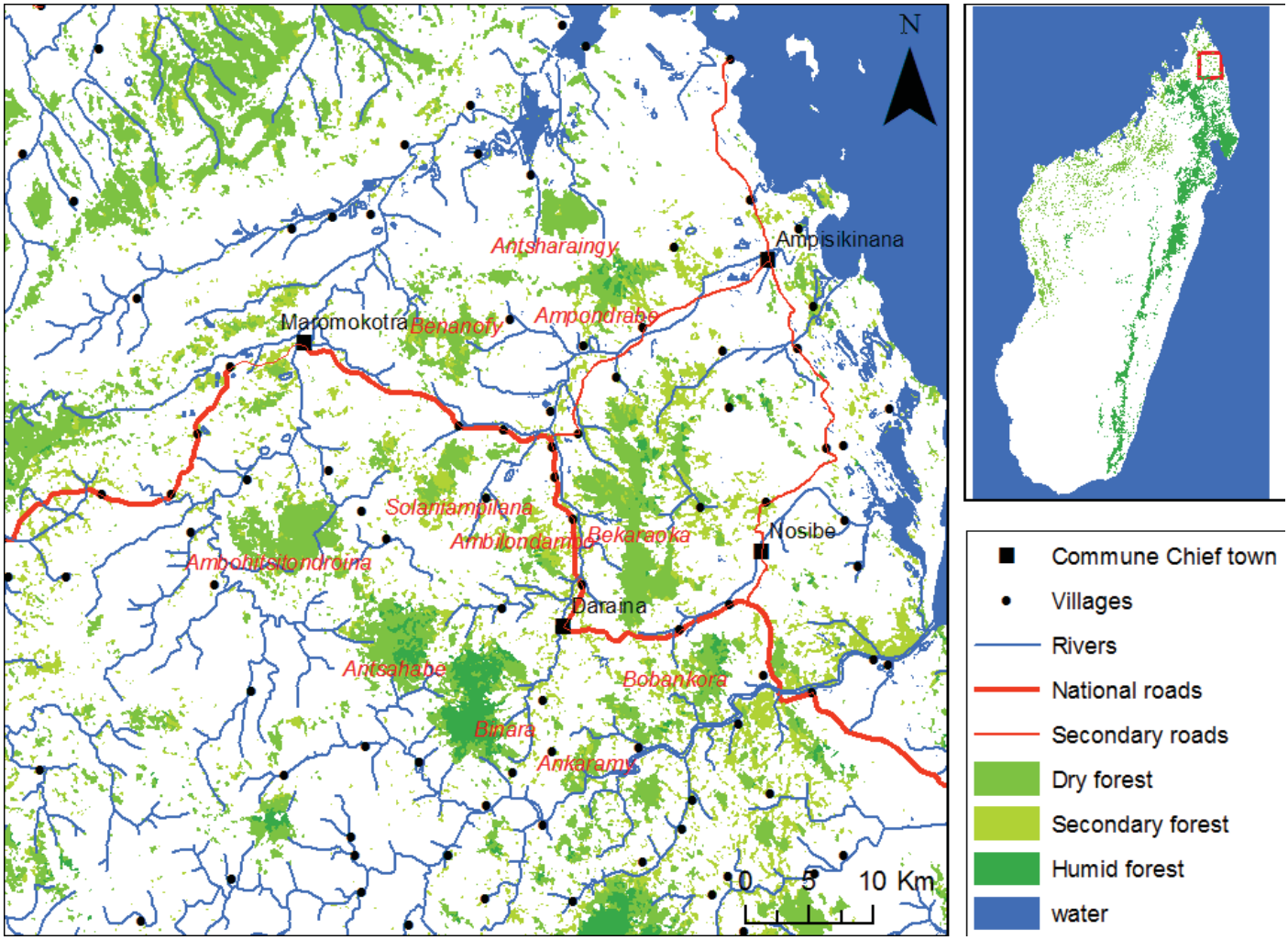
The forests located within the protected area harbour more than 90% of the remaining population of the Critically Endangered Tattersall's sifaka (*Propithecus tattersalli*), endemic to this region. The Endangered Daraina sportive lemur (*Lepilemur milanoii*) is also known to be endemic to the Daraina region, and the Endangered Montagne d'Ambre fork-marked lemur (*Phaner electromontis*) is suspected to be a distinct species in the region. Other lemur species occurring here are the Endangered Sanford's brown and crowned lemurs (*Eulemur sanfordi* and *E. coronatus*), and aye-aye (*Daubentonia madagascariensis*); the Vulnerable Tavaratra mouse lemur (*Microcebus tavaratra*) and northern bamboo Lemur (*Hapalemur occidentalis*); and the fat-tailed dwarf lemur (*Cheirogaleus medius*), which is currently of Least Concern. It is also possible that some additional lemur species have not yet been identified in this region.





Tattersall's sifaka (*Propithecus tattersalli*), Critically Endangered. (Photo: Jordi Salmona)

The climate of the region is strongly seasonal, with a cool, dry season from May to October and a hot, rainy season from November to April. The region is patchily covered with primary and secondary dry deciduous, dry evergreen, transition and humid forest separated by savannah and bush land. The eleven remaining large forests, and the numerous unconnected small forest fragments, all show some degree of anthropogenic disturbance associated with slash-and-burn agriculture, cattle grazing, hardwood harvesting and charcoal production (Quéméré *et al.*, 2012; J. Salmona, pers. obs.). The lemurs of the region are highly threatened by increasing and presumably unsustainable levels of hunting, and by forest destruction and degradation mainly through land conversion for subsistence agriculture.



Location of Daraina in northern Madagascar. (Source: Jordi Salmona)

The NGO Fanamby has been carrying out community-based natural resource management here since 2003. Since 2006 the population and conservation genetics group of the Instituto Gulbenkian de Ciencia has been carrying out research programs on lemur species in the region. In order to protect the remaining large fragments and small forest patches in both protected areas, along with their highly threatened lemurs, a number of actions need to be taken.

The continuous presence of researchers and conservationists is known to be an effective means of ensuring protection of the forest and of the lemur populations, as well as an efficient way to monitor lemur populations and gather data about their ecology. We thus first propose to increase the human capacity of the PA and to devote it to *P. tattersalli* population monitoring and reforestation project management. The PA will have 10 additional permanent surveillance patrols/guides/agents and a locally-based landscape manager assistant, devoted to forest surveillance, population monitoring and reforesting. Moreover, the PA will have two or three additional research stations located inside the PA, at close proximity to the main identified sifaka populations. The monitoring project will be driven by the manager and a PhD student from a Malagasy university. To support the effective protection of the endemic Endangered and Critically Endangered lemurs, basic scientific information on range boundaries and ecological needs of these species need to be collected.

Together with the managers and the new surveillance guards, villagers will be encouraged to set up tree nurseries and grow a variety of native forest tree seedlings that will be bought by the project. Each PA will also develop or increase its own nursery and reforestation capacity. The seedlings will be used for forest regeneration and reforestation, with the aim of restoring recently degraded areas and linking forest fragments by corridors. A geographic forest cover analysis will be performed by the PhD student in order to identify the high priority areas for reforestation. Setting up sustainable fruit tree plantations in assigned areas will also be encouraged. Short-cycle breeding of chickens (and potentially ducks), as well as bee keeping will be promoted and supported by training and provision of animal stocks and materials. Training will be provided in more sustainable and intensive agricultural techniques such as "SRI" in order to discourage slash-and-burn agriculture.

In addition to direct protection measures, a conservation education program will be implemented. Primary and secondary school teachers will be trained to deliver

conservation education lessons to their students. Regular meetings will be held with the leaders and elders of all villages surrounding the protected area, discussing the needs of the local human population and the enforcement of traditional local rules, as well as updating people about ongoing and future conservation work in their areas. Educational materials such as booklets, posters, comics and T-shirts will be produced and distributed among villagers. A community-based ecotourism project will be implemented, providing employment for local guides and support staff. The production of local handicrafts will also be promoted.

Budget: US$ 196,100 over 3 years

Analamerana and Andrafiamena

Jordi Salmona, John Rigobert Zaonarivelo & Matthew Banks

The Analamerana Special Reserve is managed by Madagascar National Parks (MNP), and the Andrafiamena Protected Area (PA) is managed by the Malagasy NGO Fanamby. Both protected areas are located to the east of the town of Anivorano Avaratra (Analamerana: 12°50'S / 49°30'E; Andrafiamena: 12°55'S / 49°19'E). These two areas harbor the last remaining population of the Critically Endangered Perrier's sifaka (*Propithecus perrieri)* that is endemic to this region. Other lemur species occurring in the region include the Endangered Sanford's brown and crowned lemurs (*Eulemur sanfordi*; *E. coronatus*), aye-aye (*Daubentonia madagascariensis*), Montagne d'Ambre fork-marked Lemur (*Phaner electromontis*), and Ankarana sportive lemur (*Lepilemur ankaranensis*); the Vulnerable northern bamboo lemur (*Hapalemur occidentalis*) and Tavaratra mouse lemur (*Microcebus tavaratra*); and the fat-tailed dwarf lemur (*Cheirogaleus medius*) that is currently of Least Concern.

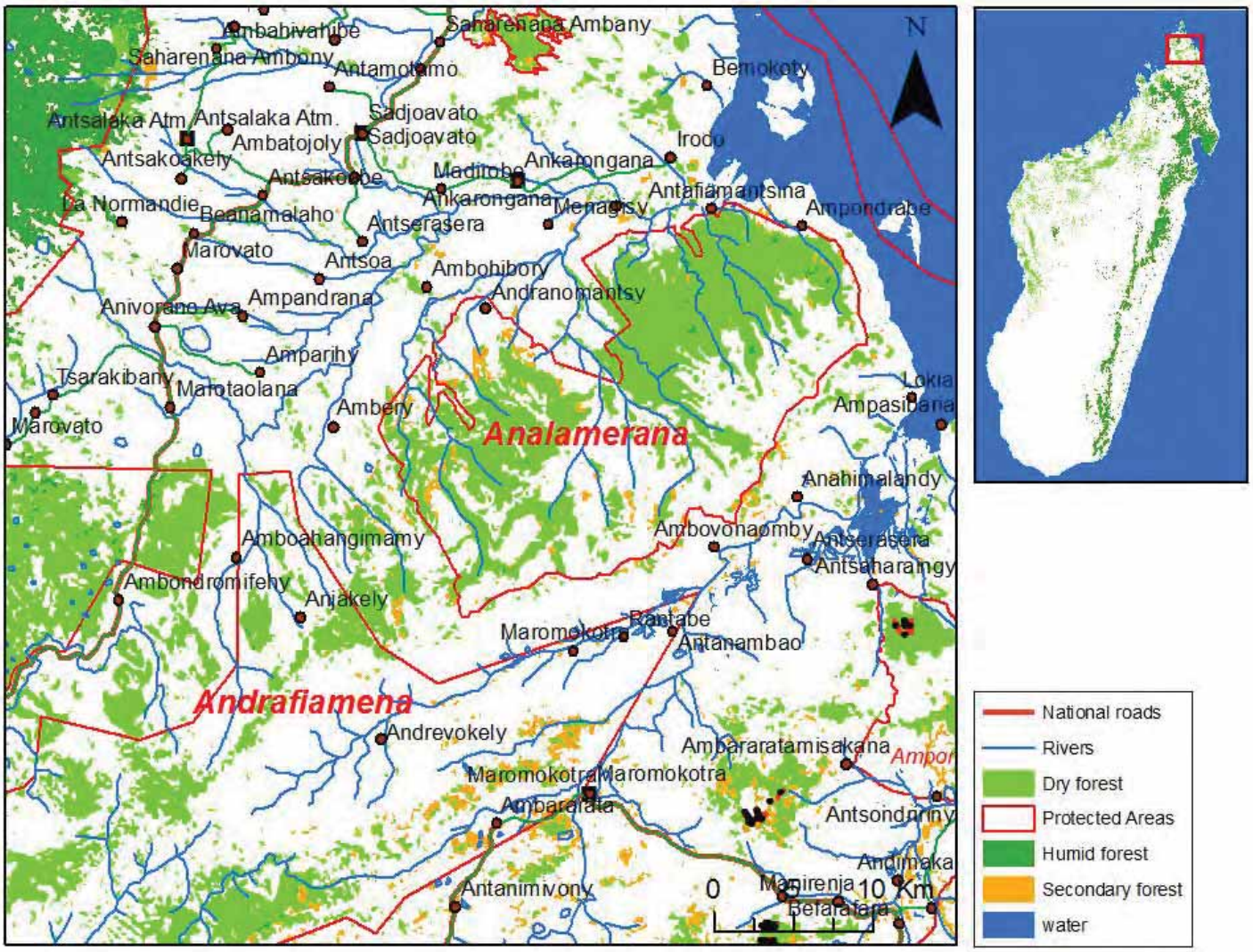




Perrier's sifaka (*Propithecus perrieri*), Critically Endangered. (Photo: Jordi Salmona)

The climate of the region is strongly seasonal with a cool, dry season from May to October and a hot, rainy season from November to April. The sites lie in the Andrafiamena Mountain chain and are patchily covered with primary and secondary dry deciduous and dry evergreen forest, separated by savannah and bush land. The three remaining large forests (two in Analamerana, and one in Andrafiamena) and the numerous unconnected small forest fragments all show some degrees of anthropogenic disturbance associated with slash-and-burn agriculture, cattle grazing, hardwood harvesting and charcoal production (Banks *et al.*, 2007; J. Salmona, pers. obs.). The lemurs of the region are highly threatened by increasing and presumably unsustainable levels of hunting, and by forest destruction and degradation, mainly through land conversion for subsistence agriculture.

In order to protect the remaining large fragments and small forest patches in both protected areas, along with their highly threatened lemurs, a number of actions need to be taken. The continuous presence of researchers and conservationists is known to be an effective means of ensuring protection of the forest and of the lemur population, as well as being an efficient way to monitor the Critically Endangered Perrier's sifaka population and gather data about its ecology. We thus first propose to increase the human capacity of both PAs and to dedicate it to P. perrieri population monitoring and reforestation project management. Each PA will have 10 additional permanent polyvalent field patrollers/guides/agents dedicated to forest patrolling, sifaka population monitoring and the reforestation project. Moreover, each PA will have one or two additional research stations located inside the PA, at close



Analamerana Special Reserve and Andrafiamena Protected Area.
(Source: Jordi Salmona)

proximity to the main identified sifaka populations. The monitoring project will be driven by the two PA Managers and a PhD student from a Malagasy University. A meeting between these partners will take place monthly to facilitate the coordination of the project. To support the effective protection of the endemic Endangered and Critically Endangered lemurs, basic scientific information on range boundaries and ecological needs of these species needs to be assessed. Furthermore, for subsequent forest restoration and reforestation, a complete inventory of tree species in each PA needs to be established.

Together with the managers and the new surveillance patrols, villagers will be encouraged to set up tree nurseries and grow a variety of native forest tree seedlings that will be bought by the project. Each PA will also develop or increase its own nursery and reforestation capacity. The seedlings will be used for forest regeneration and reforestation with the aim of restoring recently degraded areas and linking forest fragments via corridors. A geographic forest cover analysis will be performed by the PhD student in order to identify the priority areas for reforestation. Setting up of sustainable fruit tree plantations in assigned areas will also be encouraged.

Short-cycle breeding of chicken (and potentially ducks), as well as bee keeping will be promoted and supported by training and provision of animal stocks and materials. Training will be provided in more sustainable and intensive agricultural techniques such as "SRI" in order to discourage slash and burn agriculture.

In addition to direct protection measures, a conservation education program will be implemented. Primary and secondary school teachers will be trained to deliver conservation education lessons to their students. Regular meetings will be held with the leaders and elders of all villages surrounding the protected area, discussing the needs of the local human population, the enforcement of traditional local rules, as well as updating people about ongoing and future conservation work in their areas. Educational materials such as booklets, posters, comics and T-shirts will be produced and distributed among villagers.

A community-based ecotourism project will be implemented, providing employment for local guides and support staff. The production of local handicraft will also be promoted.

Budget: US$ 536,250 over 3 years

Montagne des Français

Edward E. Louis, Jr., John Zaonarivelo, Jean Freddy Ranaivoarisoa & Susie McGuire

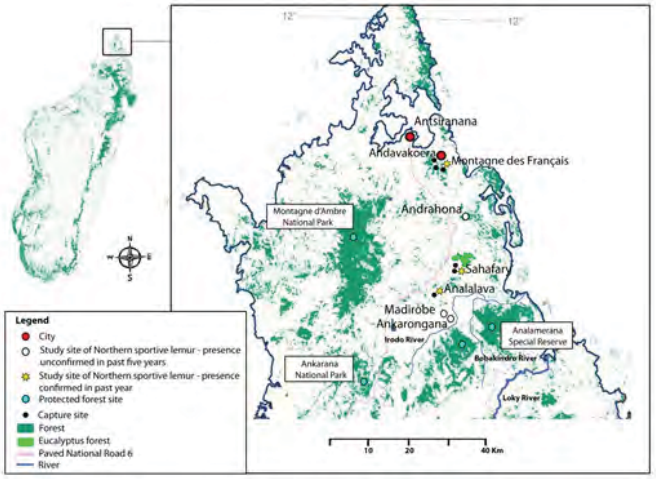
Montagne des Français, an area of 5,974 ha, consists mainly of calcareous massifs and dense dry semi-deciduous forest. Located in the DIANA region of northern Madagascar near the city of Antsiranana, Montagne des Français (-12.3345 and 49.3545) has a strong local biological, economic, social and cultural value. In September 2006, this region obtained, as an intermediate step, temporary protected status. In 2008, based on biodiversity surveys, the Service d'Appui à la Gestion de l'Environnement (SAGE), the Missouri Botanical Garden and Conservation International worked together to establish a complex of three new protected areas in northern Madagascar, Montagne des Français, Montagne d'Orangea and Ambodivahibe Bay, with the latter two regions obtaining protected status in December 2010. A Vondron'Olona Ifototra (VOI), an organization that provides local government at the village level, was developed and subsequently established by SAGE for Montagne des Français in 2010. This area harbours the last remaining population of the Critically Endangered northern sportive lemur (*Lepilemur septentrionalis*), a species of lemur registered on the list of the world's 25 most endangered primates since 2008 (Mittermeier *et al.*, 2009). Recent surveys have identified only 19 individuals (Ranaivoarisoa *et al.*, in prep.) in the region. Other lemur species occurring within the boundaries of Montagne des Français are the Endangered crowned lemur (*Eulemur coronatus*) and the Vulnerable Tavaratra mouse lemur (*Microcebus tavaratra*).



Northern sportive lemur (*Lepilemur septentrionalis*), Critically Endangered.



The climate of Montagne des Français and northern Madagascar is seasonal and driven by rainfall, with a cooler dry season from May to October and a hot, rainy season from November to April. The climate is strongly influenced by the cyclone season, which is primarily between December and March. The semi-deciduous forest is dominated by spiny scrub and lower canopy trees, along with the endemic Suarez baobab (*Adansonia suarezensis*). There are no longer large intact forests in this region, but only patches of forest



Location of Montagne des Français and Antsiranana region.

that encompass the rocky mountain steeps that form the features of Montagne des Français, as well as riparian forests that come off the larger mountain peaks. Otherwise, years of slash-and-burn agriculture or tavy has created a landscape scarred by erosion. This damage is especially evident in the western half of this region. Based on expeditions in 2005 by the NGO Madagascar Biodiversity Partnership (MBP) and Omaha's Henry Doorly Zoo and Aquarium (OHDZA), the northern sportive lemur was documented in the classified forests of Analalava and Sahafary and subsequently verified through molecular genetic analysis (Louis *et al.*, 2006b). Analalava Classified Forest still persists as a very small and degraded habitat approximately 80 ha in size. Sahafary Classified Forest (-12.607 and 49.4428) is embedded within an introduced Eucalyptus forest that is routinely utilized for charcoal production; thus, the amount of suitable habitat available makes it smaller than Analalava. SAGE estimates that approximately 20,000 people are exploiting this forest, even though Andavakoera, located on the outskirts of the Montagne des Français, has only 200 residents. Business interests from the nearby seaport of Antsiranana finance the exploitation of the remaining forests of Montagne des Français through the production of charcoal and collection of sand for city and port construction projects (D'Cruze *et al.*, 2007). Thus, habitat loss from uncontrolled long-term slash-and-burn practices, regrowth of non-endemic invasive plants, and the desertification effects of deforestation and erosion will be the primary challenges to overcome.

The development of an interconnected program between the VOI, the local Gendarmerie, local communities, conservation organizations (MBP, OHDZA, WWF, Madagasikara Voakajy) and local government organizations (SAGE, Direction Régionale des Eaux et Forêts, and Ministère du Tourisme), based at a field station, can provide the platform for reducing the illegal charcoal activities and habitat loss in the last remaining vestige for the northern sportive lemur. Conservation strategies that stress education, monitoring, reforestation, and research will be implemented to leverage the biodiversity and to rebuild the fragile ecosystem in northern Madagascar. To reconnect the fragmented forests running southwesterly from Montagne des Français to Sahafary Classified Forest, a corridor of established contracts defining permanent and commercial crop agriculture will be established and monitored. This multi-layered program will be linked to sustainable alternative agricultural practices and the introduction of fuel-efficient rocket stoves and briquette technology. The proximity of Montagne des Français to Antsiranana also presents a unique opportunity to capitalize on the budding ecotourism industry.

The integration of conservation measures, the creation of economic engines, and the associated improvements in the standard of living at the community level promotes local appreciation of natural resources. Ultimately, greater accessibility to food and increased income to the region, both of which are interconnected to habitat restoration, will ensure the long-term survival of the northern sportive lemur.

Budget: US$ 212,350 over 3 years



Montagne des Français and Suarez baobabs.

Data Deficient Lemur Species

Linn Groeneveld & Nicola Davies

During the latest Red List assessment of lemurs carried out in July 2012, four out of 103 assessed lemur species were classified as Data Deficient. Those are the greater dwarf lemur (*Cheirogaleus major*), Crossley's dwarf lemur (*Cheirogaleus crossleyi*), lesser iron-grey dwarf lemur (*Cheirogaleus minusculus*) and Ranomafana grey bamboo lemur (*Hapalemur griseus ranomafanensis*). Effective conservation measures to ensure their survival can only be implemented if detailed knowledge on these species' geographical distribution and population densities is known. Additional information such as data on hunting pressure, specific habitat requirements, and general life history data would also be beneficial for a precise assessment. It is thus imperative that we invest in research to clarify these species' distributions and abundances in order to obtain a reliable classification, which then informs conservation efforts.





Crossley's dwarf lemur (*Cheirogaleus crossleyi*), Data Deficient. Photo: Russell A. Mittermeier.

Even though a few studies on the nocturnal genus *Cheirogaleus* have been conducted in the last decade, there is very little data on the distribution and densities of *C. major* and *C. crossleyi*. These two species are very difficult to distinguish in the field, so it is virtually impossible to identify which species is present where without conducting genetic analyses. In order to clarify the extent of occurrence for these two species, we will collect samples from the field and carry out genetic analyses. Sampling will focus on the eastern rain forests where both species have been found to be present. All researchers that could contribute samples (tissue, hair, faeces) of *Cheirogaleus* sp. from their respective field sites will be encouraged to collaborate and share samples as well as existing genetic data to facilitate the study. Additional samples will be collected in an expedition from sites with no long-term field presence of researchers. Ideally, a few sites would subsequently be selected to carry out studies on the densities of the populations.

The situation with *C. minusculus* is slightly different. This species was described based solely on one skull, which

is housed in the British Museum of Natural History. Its sampling locality is given as "Ambositra", which is a town in central Madagascar. To date there exists no known population of this species in the field. There is hardly any forest left around the sampling locality, so we do not have high hopes of rediscovering it. Some authorities go even further and doubt the validity of this recently described species. We therefore do not want to focus our efforts on *C. minusculus*. Genetic analyses of the holotype housed at the NHM in London could potentially resolve the identity and validity of this species. Unfortunately, the NHM has a strict 'no destructive sampling' policy for type specimens and has (so far) not allowed sampling of tissue remainders from the holotype's skull.



Golden bamboo lemur (*Hapalemur aureus*), Critically Endangered. (Photo: Russell A. Mittermeier.)

Hapalemur griseus ranomafanensis is known to occur in two widely separated populations in east -central and west-central Madagascar. In the east it is known from the forests to the south of the Mangoro and Onive rivers (except Beanamalao, which is the type locality of Gilbert's grey bamboo lemur (*H. griseus gilberti*)). In the west it has been reported from the western forests of Tsingy de Bemaraha, probably as far as the Betsiboka River (Rabarivola *et al*., 2007). However, further field studies are urgently required to determine the exact extent of the distribution, in particular the boundaries between it and neighbouring forms of Hapalemur. In Ranomafana National Park it is sympatric with the Critically Endangered golden bamboo lemur (*Hapalemur aureus*) and greater bamboo lemur (*Prolemur simus*). Further research into the taxonomy, population status, and threats to this species is also needed in order to determine its Red List category and implement effective conservation measures.

Budget: US$ 93,005 over 3 years

Integrating *Ex situ* and *In situ* Conservation of Lemurs

Christoph Schwitzer, Tony King, Eric Robsomanitrandrasana, Christelle Chamberlan & Tovonanahary Rasolofoharivelo

Site-based and cross-regional habitat and species conservation efforts in Madagascar, such as proposed in the previous chapters of this Lemur Conservation Strategy, should always be the main focus of lemur conservation. However, with many wild lemur populations rapidly declining and their habitat being lost at constantly high rates, captive assurance colonies are becoming increasingly important, and the need for closer integration of *in situ* and *ex situ* conservation initiatives is now widely recognized (Conde *et al*., 2011; Lacy, 2013). Indeed, for many of Madagascar's most threatened lemur species, and in particular those with small wild populations, it makes little sense to conduct separate and independent conservation planning efforts based on whether they live in the wild, in increasingly managed parks and reserves (Fig. 1), or in zoos. Rather, their conservation in the wild, in reserves and in captivity should be viewed as points on a collaborative continuum, the ultimate goal of which should be to ensure the continued survival of all species (Mittermeier *et al.*, 2010). In order to achieve this goal, the 'One Plan' approach, a framework developed by the IUCN SSC Conservation Breeding Specialist Group, proposes integrated species conservation planning that considers all populations of a species, inside and outside its natural range, under all conditions of management, engaging all responsible parties and all available resources (Byers *et al*., in prep). Populations across this spectrum are managed as open metapopulations in order to achieve demographic and genetic stability and long-term viability (Lacy, 2013). It is in the context of the 'One Plan' approach that we are proposing to integrate captive colonies of lemurs into current and future conservation planning efforts for these species.

Besides their obvious functions as safety nets against possible extinction in the wild and as reserves for future restocking of wild populations, lemur breeding programs in zoos and other dedicated facilities also play important roles in conservation



Fig 1. What is wild? A wild but well habituated crowned sifaka in Katsepy. (Photo: Christelle Chamberlan)



Fig 2. Critically Endangered mongoose lemurs at Parc Botanique et Zoologique de Tsimbazaza, Antananarivo. (Photo: Tony King)

education and research (Porton, 1993; Mittermeier *et al*., 2010). *Ex situ* lemur conservation programs are mostly managed by regional and national zoo associations in the developed world, such as the Association of Zoos and Aquariums (AZA) in North and Central America, the European Association of Zoos and Aquaria (EAZA), and the Zoo and Aquarium Association (ZAA) in Australasia. Examples of coordinated captive breeding programs for lemurs, as provided by Mittermeier *et al*. (2010), include the AZA's Species Survival Plan Programs (SSPs) for black and Sclater's lemurs (*Eulemur macaco* and *E. flavifrons*), mongoose lemurs (*E. mongoz*), and ruffed lemurs (*Varecia* ssp.); EAZA's corresponding European Endangered Species Programs (EEPs) for the same taxa, as well as for red-bellied lemurs (*Eulemur rubriventer*), Lake Alaotra gentle lemurs (*Hapalemur alaotrensis*), greater bamboo lemurs (*Prolemur simus*), crowned sifakas (*Propithecus coronatus*), and aye-ayes (*Daubentonia madagascariensis*); and ZAA's Australasian Species Management Plans (ASMPs) for ring-tailed lemurs (*Lemur catta*) and ruffed lemurs. In addition, regional and international studbooks are managed by a number of participating institutions and cover the following lemur genera: *Cheirogaleus, Daubentonia, Eulemur, Hapalemur, Lemur, Microcebus, Mirza, Propithecus,* and *Varecia*.

In Madagascar, there are currently three facilities keeping lemurs in captivity that contribute to coordinated global captive breeding programs: Parc Botanique et Zoologique de Tsimbazaza in Antananarivo, Ivoloina Parc Zoologique in Toamasina, and Lemurs Park, which is located 22 km southwest of Antananarivo on the road to Ampefy.

The Parc Botanique et Zoologique de Tsimbazaza (PBZT) was founded as a botanical garden during the French occupation of Madagascar in 1925 with the aim of collecting and reproducing local plant species and introducing "interesting foreign plants" to the island. Some cages with native animal species were added subsequently on request from the National Natural History Museum in Paris. In 1960 the park was integrated into the French Office de la Recherche Scientifique et Technique d'Outre-mer (ORSTOM). It was nationalised in 1974 and today is part of the Ministry of Higher Education and Scientific Research (Mittermeier *et al*., 2010). Lemurs are represented at PBZT by members of the genera *Eulemur, Lemur*, *Hapalemur*, and *Varecia*, with a nocturnal house also featuring aye ayes (*Daubentonia madagascariensis*) and mouse lemurs (*Microcebus* spp.). The park has bred some highly threatened lemur species (e.g. *Varecia variegata*, *Eulemur flavifrons*, *E. mongoz*; Fig. 2). Ivoloina Parc Zoologique is a 282-ha forestry station that includes a small zoo of about 4 ha. It is located 12 km north

of Toamasina and is operated by the Madagascar Fauna Group (MFG), a consortium of North American and European zoological gardens, under a long-term agreement with the Malagasy government (Katz and Welch, 2003). Ivoloina houses more than 100 lemurs in ten different species, several of which are breeding. Species of note include *Prolemur simus*, *Eulemur flavifrons* and *Varecia variegata*. The park also has aye ayes. Four lemur species are free-roaming to allow visitors to observe them in a more natural setting (*Varecia variegata, Eulemur coronatus, E. flavifrons* and *Hapalemur griseus*; I. Porton, pers. comm.). In recent years, Ivoloina has exchanged *Prolemur simus* with European zoos as part of the European Endangered Species Programme for that species (Roullet, 2012).

Lemurs Park is a private 5-ha site, founded in the early 2000s by Laurent Amouric and Maxime Allorge, with the goal of showing lemurs to the public and eventually reintroducing captive-born lemurs back into the wild. The park is home to about ten species of lemur, most of which are free-ranging in the pine forest vegetation of the site. Notable species are Coquerel's sifaka (*Propithecus coquereli*), crowned sifaka (*P. coronatus*; Fig. 3), mongoose lemur (*Eulemur mongoz*) and black-and-white ruffed lemur (*Varecia variegata*). The park is breeding Coquerel's sifakas, with several offspring having been born since 2007.



Fig 3. Endangered crowned sifaka at Lemurs Park, near Antananarivo. (Photo: Tony King)

It is participating in the European Endangered Species Programme for the crowned sifaka and has recently received one wild-caught female previously held by local villagers near Dabolava (GERP, 2012), which will allow captive breeding of the species to be started in Madagascar.

There are also numerous other facilities keeping captive lemurs in Madagascar, either in cages or free-ranging in restricted areas, often located on or near hotel premises and with tourism as their primary objective (Fig. 4). Some are fairly well managed and could potentially contribute to global breeding programs once appropriate legal and administrative frameworks have been established. Others are less well managed, often providing inadequate husbandry and diets. Hence it is mostly the more resilient and adaptable species (*Eulemur, Lemur, Varecia*) that are exhibited by such facilities. In many cases hybridisation occurs between closely related taxa held in close proximity that in the wild would live in allopatry (Fig. 5). The Malagasy government recognises these issues, and is currently developing a project to help regulate captive facilities.



Fig 4. What is captive? A captive Critically Endangered black-and-white ruffed lemur of the subcincta coat pattern on one of the "lemur islands" of Vakona Park, Andasibe. (Photo: Tony King)

Well-managed and appropriately regulated captive populations can contribute to reintroduction or reinforcement projects (Kleiman & Mallinson, 1998; King *et al*., 2012a). In Madagascar, there have been a number of releases of both captive-born and wild-born lemurs, often including direct translocations from one site to another. Some have resulted in population establishment, for example aye-ayes on Nosy Mangabe Island (Mittermeier *et al*., 2010); others have seen high mortality rates owing to predation (Britt *et al*., 2004; Donati *et al*., 2007). A recent translocation of black-and-white ruffed lemurs and diademed sifakas from forest designated for clearance by a mining company to the nearby Andasibe–Mantadia National Park has so far been successful (Day *et al*., 2009).

Currently, many of the most threatened lemur species are not kept in captivity at all, neither in Madagascar nor in zoos belonging to any of the major zoo associations. The sportive lemurs exemplify this: All 26 species comprising the Lepilemuridae family are now Red-Listed as either Critically Endangered, Endangered or Vulnerable, making them one of the most threatened primate families on earth. Yet, not one of them is kept in zoos anywhere in the world today, and we still know virtually nothing about their captive husbandry. Likewise the Indriidae: Of the three genera and 19 species in this family, most of which are highly threatened, only two *Propithecus* species from western Madagascar are represented in zoos; one in Europe and Madagascar, and one in North America and Madagascar.

Very few populations of those species that are represented in zoos are viable in the long term without supplementation of the founder base. Except for one (potentially two) species of mouse lemur, all of them belong to the Lemuridae family. This is not to say that zoos do not know how to keep and breed lemurs; quite the contrary is the case. Captive husbandry of lemurs has advanced considerably in the past four decades, and most of the current zoo populations simply suffer from too low numbers of individuals, often with highly skewed sex ratios, rather than from a lack of relevant expertise. Species that were regarded

as very difficult to keep alive in captivity just a few decades ago, such as the more folivorous sifakas, are now bred regularly in zoos, made possible by our much better understanding of the nutritional requirements of hindgut-fermenting folivores.

There is an increasing number of highly endangered lemur species for which captive assurance colonies, with the potential for future population reinforcement or reintroduction, could play a role in their conservation (Table 1). For some of these species, incorporating in-country breeding programs in Madagascar into globally managed studbooks would have significant benefits both within and outside Madagascar, as has been demonstrated with the greater bamboo lemur and crowned sifaka EEPs (Roullet, 2012; Roullet, in press).
Initial discussions in Madagascar have considered a number of regional lemur breeding facilities in the major ecoregions of the country (King *et al*., 2012b). These facilities would ideally incorporate semi-wild populations of the target species (managed populations living in semi-enclosed natural habitats) and could therefore also provide space for pre-release training in future reintroduction or reinforcement projects. They could act as hubs to facilitate the management of existing captive lemur populations, both in Madagascar and abroad, as open metapopulations *sensu* Lacy (2013), and they could be used to establish captive assurance colonies of threatened lemur species that are not yet in captivity.

In order to minimise risks, such colonies should ideally not be concentrated in single facilities, but rather spread across several institutions, as is already the case with existing captive lemur populations. There is thus not only a role for regional breeding facilities in Madagascar, but also for zoos inside and outside of Madagascar, and for facilities able to hold larger numbers of lemurs, such as the enclosures being built on the islands of Necker and Mosquito in the British Virgin Islands.



Fig 5. A free-ranging female crowned lemur (right) and a hybrid crowned x black lemur (left), at a hotel in eastern Madagascar. (Photo: Tony King)

Priority actions for the *ex situ* conservation of lemurs

We propose the following 10-point action plan for integrating *ex situ* and *in situ* conservation of some of the most threatened lemur species (see Table 1):

1. Maintain long-term viable, and genetically, demographically and phenotypically healthy captive populations of priority lemur species already in captivity, through managing them as open metapopulations *sensu* Lacy (2013), and through improving global population management and promoting better integration of breeding facilities in Madagascar. This concerns in particular the Lake Alaotra gentle lemur, greater bamboo lemur, blue-eyed black lemur, white-collared brown lemur, mongoose lemur, crowned lemur, black-and-white ruffed lemur (including the population of *Varecia variegata subcincta* of known origin currently kept in European and Malagasy facilities), red ruffed lemur, crowned sifaka, Coquerel's sifaka, and aye-aye.
2. Facilitate the exchange/translocation of individual animals within Madagascar, and between Madagascar and member zoos of the major regional zoo associations, through close collaboration with the relevant Malagasy authorities. Transfers to be facilitated will take place in four directions: Wild–wild; captive–captive; wild–captive; and captive–wild. All transfers will be part of regional or global species management programs, managed by the Malagasy authorities and/or one or more regional zoo association(s), and will be agreed by all relevant parties in consultation with the IUCN SSC Primate Specialist Group and, where appropriate, the Reintroduction Specialist Group.
3. Establish a collaborative species management plan for the Critically Endangered Perrier's sifaka, to include the protection of all or most remaining wild groups (see site-based action plan for Analamerana and Andrafiamena; Salmona *et al*., this volume) and the creation of a captive or semi-wild managed breeding facility that could provide release stock for potential reintroduction into the Ankarana National Park. This facility would probably best be located near Antsiranana and would also be able to keep and breed other threatened lemur species, including Tattersall's sifaka, crowned lemur, aye-aye, and northern sportive lemur (see point 9). Once successfully established, widen the captive breeding program to include zoos in other regions and use it to leverage further international support for the conservation of Perrier's sifaka and its habitat.
4. Establish a collaborative species management plan for the Critically Endangered Lake Alaotra gentle lemur, to include conservation of the wild population (see site-based action plan for Lake Alaotra; Ralainasolo *et al*., this volume) and the creation of a captive or semi-wild managed breeding population in Madagascar.
5. Establish a collaborative species management plan for the Critically Endangered blue-eyed black lemur, to include conservation of the wild population (see site-based action plan for Sahamalaza – Iles Radama; Seiler *et al*., this volume) and the creation of a captive or semi-wild managed breeding facility in Madagascar. This facility would probably best be located in or near Antsohihy and would also be able to keep and breed other threatened lemur species, including the Sahamalaza sportive lemur and the northern giant mouse lemur (see points 8 and 9), and mongoose lemur.
6. Establish a collaborative species management plan for the Critically Endangered white-collared brown lemur, to include community-based conservation of wild populations (e.g. site-based action plan for the Manombo Forest; Ralainasolo *et al*., this volume), and the creation of a captive or semi-wild managed breeding facility near the south-eastern COFAV rainforest corridor. This facility would also be able to keep and breed other southern rainforest lemurs including the golden bamboo lemur, greater bamboo lemur, black-and-white ruffed lemur, Milne-Edwards' sifaka, Kalambatritra sportive lemur (see point 9), and aye-aye.
7. Investigate the potential for developing a captive or semi-wild managed breeding facility for the Critically Endangered silky sifaka and red ruffed lemur. This facility would be located in north-east Madagascar and could also keep and breed white-fronted brown lemurs and aye-aye, among other species.
8. Establish collaborative species management plans and develop captive breeding programs at existing and proposed facilities for threatened nocturnal mouse and dwarf lemurs, including Madame Berthe's mouse lemur, Claire's mouse lemur, and Sibree's dwarf lemur. Once successfully established, widen the programs to include zoos in other regions and use them to leverage further international support for the conservation of these species.
9. Develop captive breeding programs at existing and proposed facilities for one western and one eastern *Lepilemur* species, and one western and one eastern *Avahi* species, to acquire and refine the necessary skills for their husbandry and captive propagation. Once these programs are successful, they can be widened to include other species of these genera, as well as the indri, and establish collaborative species management plans, including zoos in other regions.
10. Use the captive or semi-wild managed breeding facilities proposed under points 3–6 as hubs to facilitate the management of existing captive lemur populations, both in Madagascar and abroad, as open metapopulations *sensu* Lacy (2013) (see points 1 and 2 above).

Budget: US$ 600,000 over 3 years

Table 1: Priority lemur species for ex situ conservation.

	IUCN status	Region	Justification	Approximate captive population
Northern and western priority species				
Perrier's sifaka (*Propithecus perrieri*)	CR	north	tiny wild range, habitat destruction	0
Blue-eyed black lemur (*Eulemur flavifrons*)	CR	north-west	tiny wild range, habitat destruction	75
Sahamalaza Sportive Lemur (*Lepilemur sahamalazensis*)	CR	north-west	tiny wild range, habitat destruction	0
Madame Berthe's mouse lemur (*Microcebus berthae*)	CR	west	smallest primate in the world, tiny range	0
Mongoose lemur (*Eulemur mongoz*)	CR	west	forests highly threatened, probably low population densities	110
Eastern priority species				
White-collared brown lemur (*Eulemur cinereiceps*)	CR	south-east	tiny wild range	12
Greater bamboo lemur (*Prolemur simus*)	CR	east	fragmented range	20
Lake Alaotra gentle lemur (*Hapalemur alaotrensis*)	CR	east	only 1 (tiny) wild site	70
Black-and-white ruffed lemur (*Varecia variegata*)	CR	east	large but patchy distribution, heavily hunted	800 (incl. 54 of *V. v. subcincta*)
Red ruffed lemur (*Varecia rubra*)	CR	north-east	1 large site, hunting increasing	600
Silky sifaka (*Propithecus candidus*)	CR	north-east	smallish range, low population size	0
Sibree's dwarf lemur (*Cheirogaleus sibreei*)	CR	east	only 1 confirmed site	0
Kalambatritra sportive lemur (*Lepilemur wrightae*)	EN	south-east	only 1 site, currently threatened	0
Aye-aye (*Daubentonia madagascariensis*)	EN	widespread	low population densities, widely persecuted	50

Budget Summary

Site/Activity		Budget (US$)
Lemur Action Fund		600,000
Marojejy National Park and Anjanaharibe-Sud Special Reserve		150,000
Masoala		181,000
Makira		197,500
Mananara Nord National Park		176,500
Lake Alaotra		150,000
Ankeniheny–Zahamena Corridor (CAZ)		
Andriantantely	150,000	
Torotorofotsy–Ihofa	200,000	725,000
Western Portion of the CAZ	175,000	
Prev. and Reduction of Bushmeat Hunting in the CAZ	200,000	
Betampona Natural Reserve		150,000
Anjozorobe–Angavo & Tsinjoarivo		195,000
Ambositra–Vondrozo Corridor (COFAV)		375,000
Ranomafana National Park		240,000
Fandriana–Marolambo Forest Corridor		150,000
Kianjavato		152,100
Manombo Forest		159,500
Kalambatritra Massif		125,000
Andohahela & Tsitongambarika		150,000
Mahafaly and Mandrare: The Spiny Forest Ecosystem		299,000
Makay		199,009
Kirindy–Ambadira (Central Menabe)		125,850
Tsingy de Bemaraha		226,000
Ambato Boeny		100,000
Ankarafantsika National Park		165,500
Mahavavy Kinkony		151,500
Antrema		95,500
Bombetoka–Belemboka		139,000
Anjiamangirana and Marosely		310,000
Sahamalaza – Iles Radama National Park		183,000
Nosy Be		120,000
Daraina		196,100
Analamerana and Andrafiamena		536,250
Montagne des Français		212,350
Data Deficient Lemur Species		93,005
Integrating *Ex situ* and *In situ* Conservation of Lemurs		600,000
TOTAL		**7,628,664**

Lemur Conservation Success Stories

There is a growing number of very positive examples where community-based forest conservation, combined with (eco)tourism and research, is working well in Madagascar and making a difference to the conservation of lemurs. We are highlighting two such examples here.

Maromizaha: Conservation and Community Involvement

Marco Gamba, Rose Marie Randrianarison, Valeria Torti, Giancarlo Bounous, Cesare Avesani Zaborra, Jonah Ratsimbazafy & Cristina Giacoma

The primary forest of Maromizaha or "rainforest of the Dragon trees" (150 km east of Antananarivo on Route Nationale 2, 6.5 km from the Analamazaotra Reserve), at an altitude of between 890 and 1,210 m asl, harbours a unique community of highland and lowland species: 13 lemurs, 77 birds, 60 amphibians and 20 reptile species have been counted so far. This area represents an important link between the last remaining rainforests in the north and the south and is located within the Ankeniheny–Zahamena Corridor (CAZ). Maromizaha is home to the Critically Endangered indri (*Indri indri*), diademed sifaka (*Propithecus diadema*), southern black-and-white ruffed lemur (*Varecia variegata editorum*), the Endangered small-toothed sportive lemur (*Lepilemur microdon*), the Vulnerable eastern woolly lemur (*Avahi laniger*), red-bellied lemur (*Eulemur rubriventer*), grey bamboo lemur (*Hapalemur griseus*), red mouse lemur (*Microcebus rufus*), hairy-eared dwarf lemur (*Allocebus trichotis*), the Near Threatened common brown lemur (*Eulemur fulvus*), and the Data Deficient greater dwarf lemur (*Cheirogaleus major*).



Diademed sifaka (*Propithecus diadema*), Critically Endangered. (Photo: Russell A. Mittermeier)

The forest was put under protection in 2001, deforestation was stopped, agricultural exploitation limited, and an area of approximately 1,600 ha has been preserved. But at the edge of the protected area, trees are exploited for charcoal production, construction and burned for agriculture. The Maromizaha Forest is now managed by GERP (Groupe d'Etude et de Recherche sur les Primates de Madagascar). Understanding that conservation must have the participation and support of local people in order to be effective, we have

considered issues of development of the local communities, together with community involvement and awareness, general education outreach, as well as the need to enhance the capacity of local conservation managers and guides. To provide adequate resources for the effective management of the protected area, we focused on developing positive and sustainable societal attitudes towards wildlife in the local communities, both establishing small infrastructures and implementing capacity-building activities. To increase awareness and develop education outreach programmes in the Anevoka community, in close proximity with the forest of Maromizaha, a multi-purpose centre was built at 40 minutes walking distance from the Route Nationale 2 that links Antananarivo to Toamasina. The centre was built with substantial financial contribution from Parco Natura Viva – Breeding Centre for Endangered Species (Bussolengo, Italy). It became a pivotal point of the subsequent BIRD project (Biodiversity Integration and Rural Development), which has received financial support by an ACP-UE cooperation agreement to operate in Madagascar and the Comoro Islands (Contract FED/2009/217077). The project reflects a strong international partnership led by the Department of Life Sciences and Systems Biology in collaboration with the Department of Arboriculture and Pomology, both at the University of Torino, Italy, the University of Antananarivo (Ecole Supérieure des Sciences Agronomiques), the Groupe d'Etude et de Recherche sur les Primates de Madagascar (GERP), the University of Toamasina (Gestion des Ressources Naturelles et Environnement - GRENE), the University of the Comoros, and the Zoological Society of San Diego.

The project is centred on the valorisation of biodiversity and the development of initiatives to empower communities to increase control over their lives and take a leading role in conservation of local biodiversity. As the development of sustainable ecotourism activities has been seen to be an affordable way to generate an increase in the income of the villagers, a lot of effort was put into the training of tourist and research guides and the process of enabling the community to welcome tourists in Maromizaha. We trained four research guides and 10 tourist guides (of which three (former students of the University of Toamasina) have received specific training to become international guides), and 183 villagers (children and adults) attended English and French courses to improve their linguistic abilities. Three Malagasy managers have received training to supervise the research activities, to manage the research station and to overlook the development process. They were trained in Madagascar and Europe to acquire knowledge about data gathering and management, tourism attraction, research planning and biodiversity valorisation. At the same time we worked at the local schools to encourage a new sensibility towards nature and suggested the use of new experimental agricultural techniques and of new methods of crop production. The community was very receptive towards these alternative methods, which resulted in improving the quality of their lives. While Malagasy operators are now planning to develop small hosting opportunities for tourists visiting Maromizaha, the number of visitors in the forest (including students and researchers) has increased from 8 in 2009 to 208 in 2011. The presence of researchers generated an important income for the local community. We have now plans for new surveys on the biodiversity of Maromizaha Forest and its surroundings, and we keep on disseminating affordable policies for villagers to improve their health, conserve biodiversity and increase their income.

Anja Community Reserve and the Association Anja Miray (AMI)

Lisa Gould & Denise Gabriel

Anja Community Reserve (21°51'08"S, 46°50'28"E), a 34 ha forest fragment, is situated 13 km from the town of Ambalavao, adjacent to Route Nationale 7. This small reserve is operated by the Association Anja Miray (AMI) after management was transferred to the community from the Malagasy Government (Ministère des Eaux et Forêts) in 2000. Anja is an isolated forest fragment surrounded by savannah, rice fields, gardens and villages. The fragment houses a large population of Endangered ring-tailed lemur (*Lemur catta*) (~225), the only diurnal mammal in this forest, and a number of bird, reptile and insect species (Cameron and Gould, in press). Feral cats, locally known as *ampaha*, are occasionally seen and appear to be the only predators of *L. catta* at this site – other natural predators seen in continuous forest reserves are absent. One of the most prevalent tree species in the reserve is *Melia azedarach*, the leaves and year-round fruit of which make up the primary food resources for the Anja *L. catta* (Cameron and Gould, in press; Gould and Gabriel, under review). The lemurs also feed from village gardens planted next to the fragment, and have continual access to water from either the adjacent fish farm or from streams throughout the forest. The combination of plentiful food and water resources, lack of natural predators, the lemurs' use of the surrounding matrix, and their protected status has resulted in the highest population density of *L. catta* ever recorded (Gould and Gabriel, under review).



Ring-tailed lemur (*Lemur catta*), Endangered. (Photo: Russell A. Mittermeier)

AMI is composed of two villages working together to develop the forest for community use and ecotourism, the profits of which assist with community development and small-scale agriculture and pisciculture. Foreign tourists pay approximately US$ 6 entrance fee and US$ 12 for a four-hour guided tour of the reserve, and Malagasy tourists pay less. The tour includes lemur watching, medicinal plant information, viewing of Betsileo ancestral tombs in the reserve, and a visit to the AMI women's craft collective. AMI employs 25 guides from the villages as well as forest managers who maintain the reserve. Approximately 12,000 tourists visit each year, bringing in US$ 35,000–45,000 annually (Rahaovilahy, 2012). AMI's successful conservation/development model has brought global recognition: in 2012, AMI was a recipient of a prestigious UNDP Equator Initiative Prize, awarded to just 25 communities from around the world annually, which demonstrate 'local sustainable development solutions for people, nature, and resilient communities'. AMI was selected as a finalist from 812 entries and 66 countries. Respect for local customs (preservation of sacred forests) coupled with financial incentives from ecotourism that benefit local communities has allowed the Anja forest fragment to persist, despite surrounding deforestation (Gould and Gabriel, 2012).



Ring-tailed lemur (*Lemur catta*), Endangered. (Photo: Russell A. Mittermeier)

References

Andrianandrasana HT, Randriamahefasoa J, Durbin J, Lewis RE, Ratsimbazafy JH. 2005. Participatory ecological monitoring of the Alaotra wetlands in Madagascar. Biodiversity and Conservation 14: 2757-2774

Armstrong AH, Shugart HH, Fatoyinbo TE. 2011. Characterization of community composition and forest structure in a Madagascar lowland rainforest. Tropical Conservation Science 4: 428-444

Arrigo-Nelson S. 2006. The impact of habitat disturbance on the feeding ecology of the Milne-Edwards' sifaka (*Propithecus edwardsi*) in Ranomafana National Park, Madagascar. Ph.D. dissertation, State University of New York, Stony Brook

AZE [Alliance for Zero Extinction]. 2011. AZE overview. Retrieved on 18.01.2013 from <http://www.zeroextinction.org/overviewofaze.htm>

Baker-Médard M. 2012. Conflicting Treasures: Contrasting Resource Use Governance in Two Artisanal Gemstone Mining Sites in Madagascar. Journal of Political Ecology 19: 221-237

Banks MA, Ellis ER, Wright PC. 2007. Global population size of a critically endangered lemur, Perrier's sifaka. Animal Conservation 10: 254-262

Barrett MA, Brown JL, Morikawa MK, Labat, JN, Yoder AD. 2010. CITES designation for endangered rosewood in Madagascar. Science 328: 1109-1110

Barrett MA, Ratsimbazafy J. 2009. Luxury bushmeat trade threatens lemur conservation. Nature 461: 470-470

Begon M, Townsend CR, Harper JL. 2006. Ecology - From Individuals to Ecosystems. 4th edition. Oxford, UK: Blackwell. Pp. 759

BirdLife International. 2011. Tsitongambarika Forest, Madagascar. Biological and Socio-economic Surveys, with Conservation Recommendations. Cambridge, UK: BirdLife International

Birkinshaw CR. 2004. Priority areas for plant conservation. Ravintsara 2: 14-15

Böhning-Gaese K. 2007. Do seed dispersers matter? A biogeographical approach. In: Dennis AJ, Schupp EW, Green RA, Westcott DA, (eds.) Seed Dispersal - Theory and its Application in a Changing World. Wallingford, UK: CAB International. Pp. 545-560

Bohr YE-MB, Giertz P, Ratovonamana YR, Ganzhorn JU. 2011. Gray-brown Mouse Lemurs (*Microcebus griseorufus*) as an Example of Distributional Constraints through Increasing Desertification. International Journal of Primatology 32: 901–913

Bollen A, Donati G. 2006. Conservation status of the littoral forest of south-eastern Madagascar: a review. Oryx, 40: 57-66

Britt A, Axel A, Young R. 1999. Brief surveys of two classified forests in Toamasina Province, eastern Madagascar. Lemur News 4: 25-27

Britt A, Welch C, Katz A. 2004. Can small, isolated primate populations be effectively reinforced through the release of individuals from a captive population? Biological Conservation 115: 319-327

Brockman DK, Godfrey LR, Dollar LJ, Ratsirarson J. 2008. Evidence of invasive *Felis silvestris* predation on *Propithecus verreauxi* at Beza Mahafaly Special Reserve, Madagascar. International Journal of Primatology 29: 135-152

Brown KA, Flynn DF, Abram NK, Ingram JC, Johnson SE, Wright P. 2011. Assessing natural resource use by forest-reliant communities in Madagascar using functional diversity and functional redundancy metrics. PLoS ONE 6(9): e24107

Cameron A, Gould L. In press. Fragment adaptive behavioral strategies and intersite variation in *Lemur catta* in South-central Madagascar. In: Marsh L (ed.), Primates in Fragments II.

Cardiff SG, Ratrimomanarivo FH, Rembert G, Goodman SM. 2009 Hunting, disturbance and roost persistence of bats in caves at Ankarana, northern Madagascar. African Journal of Ecology 47: 640-649

Carriere SM, Randriambanona H. 2007. Biodiversité introduite et autochtone: antagonisme ou complé mentarité ? Le cas de l'eucalyptus à Madagascar. Bois et Forêts des Tropiques 292: 5-21

Casse T, Nielsen U, Ranaivoson S, Randrianamarivo JR. 2005. Farmer strategies and forest conservation: a case study from south-western Madagascar. International Journal of Social Economics 32: 704-716

Chawla L. 1999. Life paths into effective environmental action. Journal of Environmental Education 31: 15-26

CIA Factbook. 2013. Africa: Madagascar. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/ma.html

Clean Development Mechanism. 2010. Ankeniheny-Zahamena-Mantadia Biodiversity Conservation Corridor and Restoration Project (Reforestation Component). Clean Development Mechanism Project Design Document for Small-Scale Afforestation and Reforestation Project Activities (CDM-SSC-AR-PDD). CDM Executive Board, UNFCC, New York. Available from: http://cdm.unfccc.int/Projects/Validation/DB/7COYHD5A226DPJ9MMFBP9CGGTSAWSA/view.html

Code Minier. 2005. Loi n° 2005 - 021. Repoblikan'I Madagasikara.

Conde DA, Flesness N, Colchero F, Jones OR, Scheuerlein A. 2011. An emerging role of zoos to conserve biodiversity. Science 331: 1390-1391

Cowlishaw G, Dunbar R. 2000. Primate Conservation Biology. Chicago, IL: University of Chicago Press.

Craul M, Chikhi L, Sousa V, Olivieri GL, Rabesandratana A, Zimmermann E, Radespiel U. 2009. Influence of forest fragmentation on an endangered large-bodied lemur in northwestern Madagascar. Biological Conservation 142: 2862-2871

D'Cruze N, Sabel J, Green K, Dawson J, Gardner C, Robinson J, Starkie G, Vences M, Glaw F. 2007. The first comprehensive survey of amphibians and reptiles at Montagne des Français, Madagascar. Herpetological Conservation and Biology 2: 87-99

Danthu P, Rakotobe M, Mauclère P, Andrianoelisoa H, Behra O, Rahajanirina V, Mathevon B, Ralembofetra E, de Chatelperron PC. 2008. Essential oil production increases value of *Psiadia altissima* fallows in Madagascar's eastern forests. Agroforestry Systems 72: 127-135

Dausmann KH, Glos J, Linsenmair KE, Ganzhorn JU. 2008. Improved recruitment of a lemur-dispersed tree in Malagasy dry forests after the demise of vertebrates in forest fragments. Oecologia 157: 307-316

Dawson T, Ingram JC. 2008. Sustainable livelihoods and forest resources in Madagascar: a multi-scale analysis using remote sensing. Environmental Sciences 5: 129-143

Day SR, Ramarokoto REAF, Sitzmann BD, Randriamboahanginjatovo R, Ramanankirija H, Rence V, Randrianindrina A, Ravololonarivo G, Louis Jr EE. 2009. Re-introduction of diademed sifaka (*Propithecus diadema*) and black and white ruffed lemurs (*Varecia variegata editorum*) at Analamazaotra Special Reserve, eastern Madagascar. Lemur News 14: 32-37

De Wilde M, Buisson E, Ratovoson F, Randrianaivo R, Carrière SM, Lowry PP. 2012. Vegetation dynamics in a corridor between protected areas after slash-and-burn cultivation in south-eastern Madagascar. Agriculture, Ecosystems & Environment 159: 1-8

Dickenson S, Berner PO. 2010. Ambatovy project: mining in a challenging biodiversity setting in Madagascar. Malagasy Nature 3: 2-13

Dolch R. 2008. Sustainable natural resource management. The case of the Analamazaotra Forest Station, Andasibe, Madagascar. Monografie del Museo Regionale di Scienze Naturali di Torino 45: 377-384

Dolch R, Fiely JL, Ndriamiary JN, Rafalimandimby J, Randriamampionona R, Engberg SE, Louis Jr EE. 2008. Confirmation of the greater bamboo lemur, *Prolemur simus*, north of the Torotorofotsy wetlands, eastern Madagascar. Lemur News 13: 14-17

Dolch R, Ratsisetraina R, Markolf M, Ratolojanahary T, Rakotonirina H, Louis Jr E, Wendenbaum E. 2012. Assessment of lemur diversity in the Makay massif. Lemur News 16: 48–53

Dolins FL, Jolly A, Rasamimanana H, Ratsimbazafy J, Feistner ATC, Ravoavy F. 2010. Conservation Education in Madagascar: Three Case Studies in the Biologically Diverse Island-Continent. American Journal of Primatology 72: 391-406

Donati G, Ramanamanjato J-B, Ravoahangy AM, Vincelette M. 2007. Translocation as a conservation measure for an endangered species in the littoral forest of southeastern Madagascar: the case of *Eulemur collaris*. In: Ganzhorn JU, Goodman SM, Vincelette M (eds.), Biodiversity, Ecology and Conservation of littoral Forest Ecosystems in southeastern Madagascar, Tolagnaro (Fort Dauphin). Washington, D.C.: Smithsonian. Pp. 237-245

Duffy R. 2005. Global Environmental Governance and the Challenge of Shadow States: the impact of illicit sapphire mining in Madagascar. Development and Change 36: 825-843

Dufils JM. 2008. Couvert forestier restant. In: Goodman SM, editor. Paysages Naturels et Biodiversité de Madagascar. Paris, France: Museum Naturelle d'Histoire Naturelle. Pp. 67-79

Durbin J, Andrianandrasana H, Rakotoniaina LJ, Randriamahefasoa J, Lewis R, Ratsimbazafy J. 2007. Alaotra wetlands. Unpublished report. Antananarivo, Madagascar: Durrell Wildlife Conservation Trust

Durbin J, Ratsimbazafy J, Toto-Volahy A, Kappeler P, Zinner D, Rasoloarison R, Razafimanantsoa L, Glos J, Andrianjanahary T. 2005. Etudes sur la biodiversité de Menabe Central. Antananarivo, Madagascar: Durrell Wildlife Conservation Trust

Ebregt A, Rakotonindrina R, Balk C. 1999. Rapport de la mission d'évaluation tripartite – Projet d'éco-développement des populations de base pour la conservation de la réserve de biosphère de Mananara-Nord, phase II. Ministère de l'Environnement de Madagascar, Ambassade des Pays-Bas à Dar-Es-Salam, UNESCO Paris, IAC Wageningen. Pp. 97

Economist. 2005. Getting Stoned: Madagascar must try to reap more of a benefit from its plentiful gemstones. Available from: www.economist.com/printedition/2005-07-30

Fara LR, Andriamarosolo I. 2010. Conservation des lémuriens via la protection de leurs habitats et le développement communautaire dans les corridors de Betaolana et Tsaratanana- Betaolana, région de SAVA. Lemur News 15: 54-59

Feistner ATC. 1999. Conservation of the Alaotran gentle lemur: A multi-disciplinary approach. In: Rakotosamimanana B, Rasamimanana H, Ganzhorn J, Goodman SM (eds). New Directions in Lemur Studies. New York, NY: Plenum Press. Pp. 241-248

Fenn M. 2003. Learning Conservation Strategies: A case study of the Parc National d'Andohahela. In Goodman SM, Benstead JP (eds.), The Natural History of Madagascar. Chicago, IL: University of Chicago Press. Pp. 1494-1500

Ferguson B. 2009. REDD comes into fashion in Madagascar. Madagascar Conservation and Devlopment 4: 132-137

Fritz-Vietta NVM, Stoll-Kleemann S. 2008. How to foster organisational capacity for integrated Biosphere Reserve management - The Biosphere Reserve Mananara-Nord, Madagascar. GAIA - Ecological Perspectives for Science and Society 17: 169-176

Ganzhorn J. 1995. Low-level forest disturbance effects on primary production, leaf chemistry, and lemur populations. Ecology 76: 2084-2096

Ganzhorn JU, Langrand O, Wright PC, O'Connor S, Rakotosamimanana B, Feistner ATC, Rumpler Y. 1996. The state of lemur conservation in Madagascar. Primate Conservation 17: 70-86

Ganzhorn JU, Goodman SM, Ramanamanjato JB, Ralison J, Rakotondravony D, Rakotosamimanana B. 2000. Effects of fragmentation and assessing minimum viable populations of lemurs in Madagascar. Bonner Zoologische Monographien 46: 265-272.

Ganzhorn JU, Lowry II PP, Schatz GE, Sommer S. 2001. The Biodiversity of Madagascar: one of the world's hottest hotspots on its way out. Oryx 35: 346-348

Ganzhorn J, Goodman S, Vincelette M. 2007a. Biodiversity, Ecology and Conservation of Littoral Ecosystems in Southeastern Madagascar, Tolagnaro (Fort Dauphin). Washington, DC: Smithsonian Institution

Ganzhorn JU, Andrianasolo T, Andrianjazalahatra T, Donati G, Fietz J, Lahann P, Norscia I, Rakotondranary J, Rakotondratsima BM, Ralison J, Ramarokoto REAF, Randriamanga S, Rasarimanana S, Rakotosamimanana B, Ramanamanjato JB, Randria G, Rasolofoharivelo MT, Razanahoera-Rakotomalala M, Schmid J, Sommer S. 2007b. Lemurs in evergreen littoral forest fragments. In: Ganzhorn JU, Goodman SM, Vincelette M (eds). Biodiversity, Ecology and Conservation of Littoral Ecosystems in Southeastern Madagascar, Tolagnaro (Fort Dauphin), Washington, DC: Smithsonian Institution. Pp. 223-235

Garcia G, Goodman SM. 2003. Hunting of protected animals in the Parc National d'Ankarafantsika, north-western Madagascar. Oryx 37: 115-118

Gauthier CA, Deniaud JL, Leclerc-Cassan M, Rakotomalala M, Razafindramanana S, Renson G. 1999. Proc. 2nd Int. Symp. Biogeography, diversity and endemism in Madagascar. Paris.

GERP. 2012. Conservation of endangered crowned sifaka (*Propithecus coronatus*) and their habitat through *in situ* metapopulation management: Annual report 2012. Antananarivo, Madagascar: Groupe d'Etude et Recherche sur les Primates de Madagascar

Global Witness and Environmental Investigation Agency. 2009. Investigation into the illegal felling, transport and export of precious wood in SAVA Region Madagascar. Unpublished report to the Government of Madagascar. Available from: www.parcs-madagascar.com/doc/report_vsfinal.pdf. Downloaded on 15 April 2013.

Global Witness. 2005. A guide to Independent Forest Monitoring. Available from: www.globalwitness.org/sites/default/files/pdfs/Guide2IFM.pdf. Downloaded on 15 April 2013.

Golden CD. 2006. Sustainability and economics of mammalian bushmeat hunting and trade in the Makira Forest, NE Madagascar. International Journal of Primatology 27(Suppl 1): 576

Golden CD. 2009. Bushmeat hunting and use in the Makira Forest north-eastern Madagascar: a conservation and livelihoods issue. Oryx 43: 386-392

Golden CD, Fernald LCH, Brashares JS, Rasolofoniaina BJR, Kremen C. 2011. Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. Proceedings of the National Academy of Sciences of the United States of America 108: 19653-19656

Goodman SM. 2006. Hunting of microchiroptera in south-western Madagascar. Oryx 40: 225-228

Goodman SM, Hawkins AFA, Razafimahaimodison JC. 2000. Birds of the Parc National de Marojejy, Madagascar: With reference to elevational distribution. Fieldiana Zoology New Series 97: 175-200

Gould L, Gabriel D. 2012. Local community conservation at Anja Private Reserve and Tsaranoro Valley Forest in south-central Madagascar: Initiatives that benefit both local people and wildlife. (Abstract). Program of the XXIV Congress of the International Primatological Society 2012, Cancun, Mexico: p. 208

Gould L, Gabriel D. Under review. *Lemur catta* in rocky outcrop fragments: Will ecological flexibility and sacred forest status help conserve this flagship species? American Journal of Primatology

Gould L, Sauther ML. 2006. Lemurs - Ecology and Adaptation. New York, NY: Springer

Green GM, Sussman RW. 1990. Deforestation history of the eastern rain forests of Madagascar from satellite images. Science 248: 212-215

Hannah L, Radhika D, Lowry II PP, Andelman S, Andrianarisata M, Andriamaro L, Cameron A, Hijmans R, Kremen C, MacKinnon J, Randrianasolo HH, Andriambololonera S, Razafimpahanana A, Randriamahazo H, Randrianarisoa J, Razafinjatovo P, Raxworthy C, Schatz GE, Tadross M, Wilmé L. 2008. Climate change adaptation for conservation in Madagascar. Biology Letters 4: 590-594

Harcourt CS, Thornback J. 1990. Lemurs of Madagascar and the Comoros: the IUCN red data book. Gland, Switzerland: IUCN

Harper GJ, Steininger MK, Tucker CJ, Juhn D, Hawkins F. 2007. Fifty years of deforestation and forest fragmentation in Madagascar. Environmental Conservation 34: 325-333

Hockley NJ, Andriamaravololona M. 2007. The economics of community forest management in Madagascar: is there a free lunch? An analysis of Transfert de Gestion. Report to USAID Madagascar, Antananarivo

Holloway L. 2004. Restoration and sustainability: Ecosystem restoration and rehabilitation in Madagascar. Ecological Restoration 22: 113-119

Holmes, C. 2007. Linking livelihoods, land stewardship, and resource conservation in the Antongil Bay landscape, Madagascar. In: Redford KH, Fearn E (eds.), Protected areas and human livelihoods. New York, NY: Wildlife Conservation Society, Working Paper 32. Pp. 6-16

Holmes SM, Baden AL, Brenneman RA, Engberg SE, Louis Jr. EE, Johnson SE. Patch size and isolation influence genetic patterns in black-and-white ruffed lemur (*Varecia variegata*) populations. Conservation Genetics, in press. DOI 10.1007/s10592-013-0455-1.

Horvath JE, Weisrock DW, Embry SL, Fiorentino I, Balhoff JP, Kappeler P, Wray GA, Willard HF, Yoder AD. 2008. Development and application of a phylogenomic toolkit: Resolving the evolutionary history of Madagascar's lemurs. Genome Research 18: 489-499

Humbert H. 1955. Une merveille de la Nature à Madagascar. Première exploration botanique du massif du Marojejy et de ses satellites. Mémoires de l'Institut Scientific de Madagascar, série b 6: 1-210

Hume D. 2006. Swidden agriculture and conservation in eastern Madagascar - stakeholder perspectives and cultural belief systems. Conservation and Society 4: 287-303

Huttel C, Touber L, Clüsener-Godt M. 2002. La Réserve de Biosphère de Mananara-nord : un défi pour la conservation et le développement intégrés. UNESCO and ANGAP. Pp. 187
Irwin MT. 2006. Ecological impacts of forest fragmentation on diademed sifakas (*Propithecus diadema*) at Tsinjoarivo, Eastern Madagascar: Implications for conservation in fragmented landscapes. Ph.D. thesis, Stony Brook University, New York, USA
Irwin MT. 2008. Diademed sifaka (*Propithecus diadema*) ranging and habitat use in continuous and fragmented forest: Higher density but lower viability in fragments? Biotropica 40: 231-240
Irwin MT, Johnson SE, Wright PC. 2005. The state of lemur conservation in south-eastern Madagascar: Population and habitat assessments for diurnal and cathemeral lemurs using surveys, satellite imagery and GIS. Oryx 39: 204-218
Irwin MT, Raharison JL, Wright PC. 2009. Spatial and temporal variability in predation on rainforest primates: do forest fragmentation and predation act synergistically? Animal Conservation 12: 220-230
Irwin MT, Junge RE, Raharison JL, Samonds KE. 2010a. Variation in physiological health of diademed sifakas across intact and fragmented forest at Tsinjoarivo, eastern Madagascar. American Journal of Primatology 72: 1013-1025
Irwin MT, Wright PC, Birkinshaw C, Fisher BL, Gardner CJ, Glos J, Goodman SM, Loiselle P, Rabeson P, Raharison J-L, Raherilalao MJ, Rakotondravony D, Raselimanana A, Ratsimbazafy J, Sparks JS, Wilmé L, Ganzhorn JU. 2010b. Patterns of species change in anthropogenically disturbed forests of Madagascar. Biological Conservation 143: 2351-2362
IUCN. 2001. IUCN Red List Categories and Criteria. Retrieved on 18.01.2013 from <http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria#critical>
Jacobson SK, Mcduff MD, Monroe MC. 2006. Conservation Education and Outreach Techniques. New York, NY: Oxford University Press
Jacobson SK. 2010. Effective primate conservation education: gaps and opportunities. American Journal of Primatology 72: 414-419
Jaozandry JJ, Holmes C. 2005. Makira Forest Conservation Area Project - Annual Progress Report. New York, NY: Wildlife Conservation Society
Jarosz L. 1994. Taboo and Time-Work Experience in Madagascar. Geographical Review 84: 439-450
Jenkins RKB, Keane A, Rakotoarivelo AR, Rakotomboavonjy V, Randrianandrianina FH, Razafimanahaka HJ, Ralaiarimalala SR, Jones JPG. 2011. Analysis of Patterns of Bushmeat Consumption Reveals Extensive Exploitation of Protected Species in Eastern Madagascar. PLoS ONE 6(12): e27570
Jensen O. 2010. Social mediation in remote developing world tourism locations - the significance of social ties between local guides and host communities in sustainable tourism development. Journal of Sustainable Tourism 18: 615 - 633
Johns AD, Skorupa JP. 1987. Responses of rain-forest primates to habitat disturbance: A review. International Journal of Primatology 8: 157-191
Jolly A. 1966. Lemur behavior: A Madagascar field study. Chicago, IL: University of Chicago Press
Junge RE, Barrett MA, Yoder AD. 2011. Effects of anthropogenic disturbance on indri (*Indri indri*) health in Madagascar. American Journal of Primatology 73: 632-642
Kappeler PM, Ganzhorn JU. 1993. Lemur Social Systems and Their Ecological Basis. New York, NY: Plenum Press
Kappeler PM, Watts DP. 2012. Long-term Field Studies of Primates. Berlin, Germany: Springer Verlag
Katz AS, Welch CR. 2003. Parc Ivoloina. In: Goodman SM, Benstead J (eds.), The Natural History of Madagascar. Pp. 1555-1559. Chicago, IL: University of Chicago Press
Keong CH. 2006. The role of CITES in combating illegal logging: current and potential. TRAFFIC International. Online Report Series No. 13. Available from: www.traffic.org/forestry-reports/traffic_pub_forestry14.pdf. Downloaded on 15 April 2013.
King T, Chamberlan C, Courage A. 2012a. Assessing initial reintroduction success in long-lived primates by quantifying survival, reproduction and dispersal parameters: western lowland gorillas (*Gorilla gorilla gorilla*) in Congo and Gabon. International Journal of Primatology 33: 134-149
King, T, Rasolofoharivelo T, Chamberlan C. 2012b. Saving Madagascar's most endangered lemurs: Integrating ex-situ and in-situ efforts. Antananarivo, Madagascar: The Aspinall Foundation
Klanderud K, Mbolatiana H, Vololomboahangy M, Radimbison M, Roger E, Totland O, Rajeriarison C. 2010. Recovery of plant species richness and composition after slash-and-burn agriculture in a tropical rainforest in Madagascar. Biodiversity and Conservation 19: 187-204
Kleiman DG, Mallinson JJ. 1998. Recovery and management committees for lion tamarins: partnerships in conservation planning and implementation. Conservation Biology 12: 27-38
Lacy RC. 2013. Achieving true sustainability of zoo populations. Zoo Biology 32: 19-26
Lehman SH, Ratsimbazafy JH. 2001. Biological Assessment of the Fandriana-Marolambo forest corridor, Madagascar. Lemur News 6: 8
Lehman SH, Ratsimbazafy JH, Rajaonson A, Day S. 2005. Decline in the distribution of *Propithecus diadema edwardsi* and *Varecia variegata variegata* in Southeast Madagascar. Oryx 40: 1-4
Lehman SM, Rajaonson A, Day S. 2006. Edge effects and their Influence on lemur density and distribution in Southeast Madagascar. American Journal of Physical Anthropology 129: 232-241
Lisan B. 2012. Annuaire de la reforestation et de la protection des forê ts primaires à Madagascar. Available from http://benjamin.lisan.free.fr/projetsreforestation/Annuaire-reforestation-a-Madagascar.pdf
Louis EE, Coles MS, Andriantompohavana R, Sommer JA, Engberg SE, Zaonarivelo JR, Mayor MI, Brenneman RA. 2006a. Revision of the Mouse Lemurs (Primates, *Microcebus*) of Madagascar. International Journal of Primatology 27: 347-389

Louis EE, Engberg SE, Lei R, Geng H, Sommer JA, Randriamampionona R, Randriamanana JC, Zaonarivelo JR, Andriantompohavana R, Randria G, Prosper, Ramaromilanto B, Rakotoarisoa G, Rooney A, Brenneman RA. 2006b. Molecular and morphological analyses of the sportive lemurs (Family *Megaladapidae*: Genus *Lepilemur*) reveals 11 previously unrecognized species. Texas Tech University Museum Special Publications SP49: 1-47

Markolf M, Brameier M, Kappeler PM. 2011. On species delimitation: Yet another lemur species or just genetic variation? BMC Evolutionary Biology 11(1): 216

Mass V, Rakotomanga B, Rakotondratsimba G, Razafindramisa S, Andrianaivomahefa P, Dickinson S, Berner PO, Cooke A. 2011. Lemur bridges provide crossing structures over roads within a forested mining concession near Moramanga, Toamasina Province, Madagascar. Conservation Evidence 8: 11-18

McGuire SM, Bailey CA, Rakotonirina J-N, Razanajatovo LG, Ranaivoarisoa JF, Kimmel LM, Louis Jr EE. 2009. Population survey of the Greater bamboo lemur (*Prolemur simus*) at Kianjavato Classified Forest. Lemur News 14: 41-43

MEFT. 2008. Assessing the impacts of climate change on Madagascar's biodiversity and livelihoods: a workshop report. 109pp. Antananarivo, Madagascar: Ministère de l'Environnement et des Forêts.

Minten B, Barrett CB. 2008. Agricultural technology, productivity, and poverty in Madagascar. World Development 36: 797-822

Mittermeier RA, Konstant WR, Nicoll ME, Langrand O. 1992. Lemurs of Madagascar: an action plan for their conservation, 1993-1999. Gland, Switzerland: IUCN

Mittermeier RA, Tattersall I, Konstant WR, Meyers DM, Mast RB. 1994. Lemurs of Madagascar. Conservation International Tropical Field Guide Series. Washington, DC: Conservation International

Mittermeier RA, Konstant, WR, Rylands AB. 2003. Lemur conservation. In: Goodman SM, Benstead JP (eds.), The natural history of Madagascar. Chicago, IL: University of Chicago Press. Pp. 1538-1543

Mittermeier RA, Konstant WR, Hawkins F, Louis EE, Langrand O Ratsimbazafy J, Rasoloarison R, Ganzhorn JU, Rajaobelina S, Tattersall I, Meyers DM. 2006. Lemurs of Madagascar. 2nd edition. Conservation International Tropical Field Guide Series. Washington, DC: Conservation International

Mittermeier RA, Ganzhorn JU, Konstant WR, Glander K, Tattersall I, Groves CP, Rylands AB, Hapke A, Ratsimbazafy J, Mayor MI, Louis Jr, EE, Rumpler Y, Schwitzer C, Rasoloarison RM. 2008. Lemur diversity in Madagascar. International Journal of Primatology 29: 1607-1656

Mittermeier RA, Wallis J, Rylands AB, Ganzhorn JU, Oates JF, Williamson EA, Palacios E, Heymann EW, Kierulff MCM, Yongchen L, Supriatna J, Roos C, Walker S, Cortés-Ortiz L, Schwitzer C (eds.). 2009. Primates in Peril: The World's 25 Most Endangered Primates 2008–2010. IUCN/SSC Primate Specialist Group (PSG), International Primatological Society (IPS), and Conservation International (CI), Arlington, VA

Mittermeier RA, Louis Jr EE, Richardson M, Schwitzer C, Langrand O, Rylands AB, Hawkins F, Rajaobelina S, Ratsimbazafy J, Rasoloarison R, Roos C, Kappeler PM, MacKinnon J. 2010. Lemurs of Madagascar. 3rd edition. Conservation International Tropical Field Guide Series. Arlington, VA: Conservation International

Moeyersoons S, Zörner J. 2011. Extraction of land cover and land use change information from coarse and medium resolution multi-temporal satellite images for a study area in Madagaskar. Master thesis, University of Leuven (Belgium). Pp. 24

Mohamed S. 2008. Evolution de l'état du Corridor forestier Fandriana-Vondrozo depuis les années 1990. Retrieved from <tandavanala.org/evolutionetatcorridor2008.htm>

Mongabay. 2012. New Madagasar rainforest park invaded by sapphire miners. Available from http://news.mongabay.com/2012/0723-sapphire-mining-madagascar.html. Downloaded on 19 April 2013.

Moser CM, Barrett CB. 2003. The disappointing adoption dynamics of a yield-increasing, low external-input technology: The case of SRI in Madagascar. Agricultural Systems 76: 1085-1100

Nielsen LR, Kjær ED. 2008. Tracing timber from forest to consumer with DNA markers. Danish Ministry of the Environment, Forest and Nature Agency. Available from www.skovognatur.dk/udgivelser.

Olivieri GL, Sousa V, Chikhi L, Radespiel U. 2008. From genetic diversity and structure to conservation: Genetic signature of recent population declines in three mouse lemur species (*Microcebus* spp.). Biological Conservation 141: 1257-1271

PAG RBMN. 2002. Parc National Mananara-Nord: Plan d'Aménagement et de Gestion 2002-2006. Unpublished management plan, ANGAP, Mananara-Nord

Paiva A, Randrianarisoa J. 2010. Partnership structures and project management in two reforestation initiatives: Emas, Brazil and TAMS, Madagascar. In: Harvey CA, Zerbock O, Papageorgiou S, Parra A (eds.) What is needed to make REDD+ work on the ground? Lessons learned from pilot forest carbon initiatives. Arlington, VA: Conservation International. Pp. 40

Pareliussen I, Olsson EGA, Armbruster WS. 2006. Factors limiting the survival of native tree seedlings used in conservation efforts at the edges of forest fragments in upland Madagascar. Restoration Ecology 14: 196-203

Patel ER. 2007. Logging of rare rosewood and palisandre (*Dalbergia* spp.) within Marojejy National Park, Madagascar. Madagascar Conservation and Development 2: 11-16

Patel ER. 2009. Silky Sifaka, *Propithecus candidus*, 1871. In: Mittermeier RA, Wallis J, Rylands AB, Ganzhorn JU, Oates JF, Williamson EA, Palacios E, Heymann EW, Kierulff MCM, Yongchen L, Supriatna J, Roos C, Walker S, Cortés-Ortiz L, Schwitzer C (eds.), Primates in Peril: The World's 25 Most Endangered Primates 2008–2010. IUCN/SSC Primate Specialist Group (PSG), International Primatological Society (IPS), and Conservation International (CI), Arlington, VA. Pp. 84

Patel ER. 2011. Acoustic and olfactory communication in eastern sifakas (*Propithecus* sp.) and rhesus macaques (*Macaca mulatta*). PhD dissertation, Cornell University.

Pawliczek M, Mehta H. 2008. Ecotourism in Madagascar - how a sleeping beauty is finally awakening. In: Spenceley, A (ed.) Responsible tourism - critical issues for conservation and development. London, UK: Earthscan. Pp. 41-68
Petter JJ. 1962. Ecological and behavioral studies of Madagascar lemurs in the field. Annals of the New York Academy of Sciences 102: 267-281
Petter JJ. 1965. The lemurs of Madagascar. In: DeVore I (ed.), Primate Behavior. New York, NY: Holt, Rinehart & Winston. Pp. 292-322
Pezzotta F. 2001. Madagascar: A mineral and gemstone paradise. Easthampton: Lapis International
PGC Mananara Nord. 2005. Plan de Gestion de la Conservation – Parc National Mananara-Nord, ANGAP. Unpubl. Report, ANGAP RB Mananara-Nord, Union Européenne and Intercoopération Suisse, Mananara-Nord.
Pichon C, Tarnaud L, Bayart F, Hladik A, Hladik CM, Simmen B. 2010. Feeding ecology of the crowned sifaka (*Propithecus coronatus*) in a coastal dry forest in northwest Madagascar (SFUM, Antrema). Lemur News 15: 43-47
Pollini J. 2009. Carbon sequestration for linking conservation and rural development in Madagascar: The case of the Vohidrazana-Mantadia Corridor Restoration and Conservation Carbon Project. Journal of Sustainable Forestry 28: 322-342
Pollini J. 2011. The difficult reconciliation of conservation and development objectives: The case of the Malagasy Environmental Action Plan. Human Organization 70: 74-87
Porton I. 1993. The North American captive breeding program for lemurs. Lemur News 1: 9
Powzyk JA, Mowry CB. 2003. Dietary and feeding differences between sympatric *Propithecus diadema diadema* and *Indri indri*. International Journal of Primatology 24: 1143-1162
Quéméré E, Crouau-Roy B, Rabarivola C, Louis EE, Chikhi L. 2010a. Landscape genetics of an endangered lemur (*Propithecus tattersalli*) within its entire fragmented range. Molecular Ecology 19: 1606-1621
Quéméré E, Louis EE, Ribéron A, Chikhi L, Crouau-Roy B. 2010b. Non-invasive conservation genetics of the critically endangered golden-crowned sifaka (*Propithecus tattersalli*): High diversity and significant genetic differentiation over a small range. Conservation Genetics 11: 675-687
Quéméré E, Amelot X, Pierson J, Crouau-Roy B, Chikhi L. 2012. Genetic data suggest a natural prehuman origin of open habitats in northern Madagascar and question the deforestation narrative in this region. Proceedings of the National Academy of Sciences of the United States of America 109: 13028-13033
Rabarivola C, Prosper P, Zaramody A, Andriaholinirina N, Hauwy M. 2007. Cytogenetics and taxonomy of the genus *Hapalemur*. Lemur News 12: 46-49
Radespiel U, Rakotondravony R, Chikhi L. 2008. Natural and anthropogenic determinants of genetic structure in the largest remaining population of the endangered golden-brown mouse lemur, *Microcebus ravelobensis*. American Journal of Primatology 70: 860-870
Rahaovilahy V. 2012. Anja-Miray Madagascar. Presentation given at the 2012 UN Equator Prize finalists ceremony, Rio de Janeiro, June, 2012.
Raik DB, Decker DJ. 2007. A multisector framework for assessing community-based forest management: Lessons from Madagascar. Ecology and Society 12: 14
Rakotondrainibe F. 2000. Pteridophyte diversity patterns along an elevational gradient in the Parc National de Marojejy. Fieldiana Zoology New Series 97: 19-28
Rakotosamimanana B, Rasamimanana H, Ganzhorn JU, Goodman SM. 1999. New Directions in Lemur Studies New York, NY: Kluwer Academic/Plenum Publishers
Ramanandriana I. 2004. Monographie et analyse socio-économique de la Région de Makira. Unpublished report to Wildlife Conservation Society, Madagascar
Ramanitrivonony S. 2010. Stratégie de développement durable dans le complexe Mahavavy Kinkony. Antananarivo, Madagascar: Asity Madagascar
Ramsar. 2007. Signatories and Sites. Retrieved August 2007 from <http://www.ramsar.org>.
Ranaivoarisoa JF, Zaonarivelo JR, Lei R, Johnson SE, Wyman TM, Mittermeier RA, Louis, Jr. EE. In prep. Rapid survey and assessment of the Northern sportive lemur, Lepilemur septentrionalis, in northern Madagascar. Primate Conservation (Submitted)
Randriamalala H, Liu Z. 2010. Rosewood of Madagascar: Between democracy and conservation. Madagascar Conservation and Development 5: 11-22
Randrianarimanana L, Ravaloharimanitra M, Ratolojanahary T, Rafalimandimby J, Rasolofoharivelo T, Ratsimbazafy J, Dolch R, King T. 2011. Statut et conservation de *Prolemur simus* dans les sites de Ranomainty et Sakalava du Corridor Ankeniheny–Zahamena. Lemur News 16: 2-7
Randrianja S. 2012. Madagascar, le coup d'É tat de mars 2009. Paris, France: Editions Karthala. 334 pp
Raselimanana AP, Raxworthy CJ, Nussbaum RA. 2000. Herpetofaunal species diversity and elevational distribution within the Parc National de Marojejy, Madagascar. Fieldiana Zoology New Series 97: 157-174
Ratsimbazafy J. 2003. Lemurs as the most appropriate and best didactic tool for teaching. Lemur News 8: 19-21
Ratsimbazafy J. 2006. Diet composition, foraging, and feeding behavior in relation to habitat disturbance: Implications for the adaptability of ruffed lemurs (*Varecia v. editorium*) in Manombo forest, Madagascar. Pp. 403-422. In Gould L, Sauther ML (eds.) Lemurs - Ecology and Adaptation. New York, NY: Springer
Ravaloharimanitra M, Ratolojanahary T, Rafalimandimby J, Rajaonson A, Rakotonirina L, Rasolofoharivelo T, Ndriamiary JN, Andriambololona J, Nasoavina C, Fanomezantsoa P, Rakotoarisoa JC, Youssouf, Ratsimbazafy J, Dolch R, King T. 2011. Gathering local knowledge in Madagascar results in a major increase in the known range and number of sites for critically endangered greater bamboo lemurs (*Prolemur simus*). International Journal of Primatology 32: 776-792

Raxworthy CJ, Pearson RG, Rabibisoa N, Rakotondrazafy A, Ramanamanjato J B, Raselimanana AP, Wu S, Nussbaum RA, Stone DA. 2008. Extinction vulnerability of tropical montane endemism from warming and upslope displacement: a preliminary appraisal for the highest massif in Madagascar. Global Change Biolology 14: 1703-1720

Razafimanantosoa T, Ravoahangimalala OR, Craig CL. 2006. Indigenous silk moth farming as a means to support Ranomafana National Park. Madagascar Conservation and Development 1: 34-39

Razafimbelo E. 1987. The Morondva Basin, Madagascar: a geological and structural review. Thesis Ing. Doct., University Louis Pasteur, Strasbourg (France). Pp. 256

Razakamaharavo VR, McGuire SM, Vasey N, Louis EE, Brenneman RA. 2010. Genetic architecture of two red ruffed lemur (*Varecia rubra*) populations of Masoala national park. Primates 51: 53-61

Réau B. 2002. Burning for zebu: The complexity of deforestation issues in western Madagascar. Norwegian Journal of Geography 56: 219-229

Richard AF, Sussman RW. 1975. Future of the Malagasy lemurs: conservation or extinction. In: Tattersal I, Sussman RW (eds.), Lemur biology. New York, NY: Plenum Press. Pp. 335–350

Ries L, Fletcher Jr. RJ, Battin J, Sisk TD. 2004. Ecological responses to habitat edges: Mechanisms, models, and variability explained. Ann Rev Ecol Evol Syst 35: 491-522

Rosa GM, Andreone F, Crottini A, Hauswald JS, Jean N, Rabibisoa NH, Randriambahiniarime MO, Rebelo R, Raxworthy CJ. 2012. The amphibians of the relict Betampona low-elevation rainforest, eastern Madagascar: an application of the integrative taxonomy approach to biodiversity assessments. Biodiversity and Conservation 21: 1531-1559

Roullet D. 2012. The role of the captive population of greater bamboo lemurs *Prolemur simus* in the conservation of the species. Lemur News 16: 20-25

Roullet D. In press. The European captive population of crowned sifaka: review of 25 years of management. Primate Conservation

Sarrasin B. 2006. The mining industry and the regulatory framework in Madagascar: Some developmental and environmental issues. Journal of Cleaner Production 14: 388-396

Scales IR. 2012. Lost in translation: conflicting views of deforestation, land use and identity in western Madagascar. Geographical Journal 178: 67-79

Schad J, Sommer S, Ganzhorn JU. 2004. MHC Variability of a small lemur in the littoral forest fragments of southeastern Madagascar. Conservation Genetics 5: 299-309

Schatz G, Cameron A, Raminosoa T. 2008. Modeling of endemic plant species of Madagascar under climate change. Assessing the Impact of Climate Change on Madagascar's Livelihoods and Biodiversity. Conference. Antananarivo, Madagascar, 28 January 2008

Schmid J, Smolker R. 1998. Lemurs of the Reserve Speciale d'Anjanaharibe-Sud, Madagascar. Fieldiana Zoology New Series 90: 227-240

Schwitzer C, Schwitzer N, Randriatahina GH, Rabarivola C, Kaumanns W. 2006. Programme Sahamalaza: New perspectives for the in situ and ex situ study and conservation of the blue-eyed black lemur (*Eulemur macaco flavifrons*) in a fragmented habitat. In: Schwitzer C, Brandt S, Ramilijaona O, Rakotomalala Razanahoera M, Ackermand D, et al. (eds.), Proceedings of the German-Malagasy Research Cooperation in Life and Earth Sciences. Berlin, Germany: Concept Verlag. Pp. 135-149

Schwitzer N, Kaumanns W, Seitz PC, Schwitzer C. 2007a. Cathemeral activity patterns of the blue-eyed black lemur *Eulemur macaco flavifrons* in intact and degraded forest fragments. Endangered Species Research 3: 293-247

Schwitzer N, Randriatahina GH, Kaumanns W, Hoffmeister D, Schwitzer C. 2007b. Habitat utilization of blue-eyed black lemurs, *Eulemur macaco flavifrons* (Gray, 1867), in primary and altered forest fragments. Primate Conservation 22: 79-87

SEPALI. 2012. How the project works. Community-Based Silk Producers Association / Sehatry ny Mpamokatra Landy Ifotony (SEPALI). Available from www.sepalim.org. Dowloaded on 31 December 2012.

Sodikoff G. 2012. Forest and labor in Madagascar: from colonial concession to global biosphere. Bloomington: Indiana University Press.

Sommerville MM, Milner-Gulland EJ, Jones JPG. 2011. The challenge of monitoring biodiversity in payment for environmental service interventions. Biological Conservation 144: 2832-2841

Sterling E, McFadden K. 2000. Rapid census of lemur populations in the Parc National de Marojejy, Madagascar. Fieldiana Zoology New Series 97: 265-274

Styger E, Rakotondramasy HM, Pfeffer MJ, Fernandes ECM, Bates DM. 2007. Influence of slash-and-burn farming practices on fallow succession and land degradation in the rainforest region of Madagascar. Agriculture, Ecosystems and Environment 119: 257-269

Styger E, Fernandes EC, Rakotondramasy HM, Rajaobelinirina E. 2009. Degrading uplands in the rainforest region of Madagascar: Fallow biomass, nutrient stocks, and soil nutrient availability. Agroforestry Systems 77: 107-122

Tegtmeyer R, Johnson A, Rasarely E, Burren C, Robinson D, Bauert M, Sorg JP. 2010. Independent Forest Monitoring Madagascar. Madagascar Conservation and Development 5: 64-71

Thalmann U, Geissmann T. 2005. New species of woolly lemur Avahi (Primates: *Lemuriformes*) in Bemaraha (central western Madagascar). American Journal of Primatology 67: 371-376

Tilghman L, Baker M, DeLeon S. 2007. Artisanal sapphire mining in Madagascar: Environmental and social impacts. Burlington: University of Vermont

Toillier A, Lardon S, Herve D. 2009. An environmental governance support tool: community-based forest management contracts Madagascar. International Journal of Sustainable Development 11: 187-205

United Nations. 2010. Madagascar. In: World Population Prospects - The 2010 Revision. New York, NY: Population Division of the Department of Economic and Social Affairs, United Nations Secretariat
Vié JC, Hilton-Taylor C, Stuart SN (eds.). 2009. Wildlife in a Changing World – An Analysis of the 2008 IUCN Red List of Threatened Species. Gland, Switzerland: IUCN
Viljanen H, Wirta H, Montreuil O, Rahagalala P, Johnson S, Hanski I. 2010. Structure of local communities of endemic dung beetles in Madagascar. Journal of Tropical Ecology 26: 481-496
Vincelette M, Dean L, Ganzhorn JU. 2007. The QMM/Rio Tinto Project History in Tolagnaro and its Social and Environmental Concepts. In: Ganzhorn JU, Goodman SM, Vincelette M (eds). Biodiversity, Ecology and Conservation of Littoral Ecosystems in Southeastern Madagascar, Tolagnaro (Fort Dauphin), Washington, DC: Smithsonian Institution. Pp. 1-8
Volampeno MSN, Downs CT. 2009. Involving local communities in conservation: An example involving blue-eyed black lemurs (*Eulemur flavifrons*). Lemur News 14: 55-58
Wallis J, Lonsdorf EV. 2010. Summary of Recommendations for Primate Conservation Education Programs. American Journal of Primatology 72: 441-444
Walsh A. 2003. "Hot Money" and Daring Consumption in a Northern Malagasy Sapphire-Mining Town. American Ethnologist 30: 290-305
Walsh A. 2004. In the Wake of Things: Speculation in and about Sapphires in Northern Madagascar. American Anthropologist 106: 225-237
WCS/DEC. 2002. Etude de faisabilité de la création d'APMC et plan de développement pour le site de la RBM Sahamalaza – Nosy Radama. Antananarivo, Madagascar: Wildlife Conservation Society/Development Environment Consult
Weisrock DW, Smith SD, Chan LM, Biebouw K, Kappeler PM, Yoder AD. 2012. Concatenation and Concordance in the Reconstruction of Mouse Lemur Phylogeny: An Empirical Demonstration of the Effect of Allele Sampling in Phylogenetics. Molecular Biology and Evolution 29: 1615-1630
Wendland KJ, Honzák M, Portela R, Vitale B, Rubinoff S, Randrianarisoa J. 2010. Targeting and implementing payments for ecosystem services: Opportunities for bundling biodiversity conservation with carbon and water services in Madagascar. Ecological Economics 69: 2093-2107
Wilmé L, Goodman SM, Ganzhorn JU. 2006. Biogeographic Evolution of Madagascar's Microendemic Biota. Science 312: 1063-1065
Wollenberg KC, Vieites DR, Van Der Meijden A, Glaw F, Cannatella DC, Vences M. 2008. Patterns of endemism and species richness in Malagasy Cophyline frogs support a key role of mountainous areas for speciation. Evolution 62: 1558- 5646
Wright PC, Johnson SE, Irwin MT, Jacobs R, Schlichting P, Lehman S, Louis EE Jr, Arrigo-Nelson SJ, Raharison JL, Rafalirarison RR, Razafindratsita V, Ratsimbazafy J, Ratelolahy FJ, Dolch R, Tan C. 2008. The crisis of the critically endangered greater bamboo lemur (*Prolemur simus*). Primate Conservation 23: 5-17
WWF. 2012. Fandriana-Marolambo Forest Landscape Restoration. Available from: www.wwf.mg/ourwork/forestandwater/terrestrialprojects/fandriana_marolambo_forest_landscape_restoration. Dowloaded on 31 December 2012.
Yager T. 2000. The Mineral Industry of Madagascar. In: 2010 Minerals Yearbook, 5. United States Geologrical Survey, Department of Interior
Yager T. 2010. The Mineral Industry of Madagascar. In: 2010 Minerals Yearbook, 6. United States Geologrical Survey, Department of Interior
Yoder AD, Rasoloarison RM, Goodman SM, Irwin JA, Atsalis S, Ravosa MJ, Ganzhorn JU. 2000. Remarkable species diversity in Malagasy mouse lemurs (primates, *Microcebus*). PNAS 97: 11325-11330
ZICOMA. 1999. Zones d'Importance pour la Conservation des Oiseaux à Madagascar. Antananarivo, Madagascar: Asity Madagascar

Lemur Conservation Sites – Contacts of Main Actors

The following pages list, for each site-based action plan in this document, the priority lemur species occurring in the respective sites, the primary actors working on the conservation of the sites and of the lemurs, and the primary contacts for the authors/coordinators of the site-based action plans. Note that the authors/coordinators of the action plans are not always affiliated with the primary actors currently working at the sites, although normally there is close collaboration between all parties.

Marojejy National Park and Anjanaharibe-Sud Special Reserve:
Priority species: *Propithecus candidus* (CR), *Indri indri* (CR), *Daubentonia madagascariensis* (EN), *Allocebus trichotis* (VU), *Eulemur albifrons* (EN), and other rainforest lemurs
Primary actors: Duke Lemur Center, SIMPONA, Madagascar National Parks
Primary contacts: Erik Patel (patel.erik@gmail.com), Charles Welch (charles.welch@duke.edu)

Masoala:
Priority species: *Varecia rubra* (CR), *Eulemur albifrons* (EN), *Hapalemur occidentalis* (VU)
Primary actors: Madagascar National Parks
Primary contacts: Amavatra Hervé Andrianjara (cvcrtangapmas@yahoo.fr), Felix Ratelolahy (jeaf_ratel@yahoo.fr)

Makira:
Priority species: *Propithecus candidus* (CR), *Varecia variegata* (CR), *Varecia rubra* (CR), *Indri indri* (CR), *Allocebus trichotis* (VU)
Primary actors: Wildlife Conservation Society, Madagascar National Parks
Primary contacts: Felix Ratelolahy (jeaf_ratel@yahoo.fr)

Mananara-Nord National Park:
Priority species: *Propithecus diadema* (CR), *Indri indri* (CR), *Daubentonia madagascariensis* (EN), *Allocebus trichotis* (VU)
Primary actors: Madagascar National Parks, CoBas (Communautés de base)
Primary contacts: Felix Ratelolahy (jeaf_ratel@yahoo.fr)

Lake Alaotra:
Priority species: *Hapalemur alaotrensis* (CR)
Primary actors: Durrell Wildlife Conservation Trust, Madagascar Wildlife and Conservation
Primary contacts: Fidimalala Ralainasolo (ralainasolof@yahoo.fr), Jonah Ratsimbazafy (jonah.ratsimbazafy@durrell.org)

Ankeniheny–Zahamena Corridor (CAZ):
Priority species: *Prolemur simus* (CR), *Varecia variegata* (CR), *Indri indri* (CR), *Propithecus diadema* (CR), *Daubentonia madagascariensis* (EN), several other rainforest lemurs
Primary actors: Conservation International, Association Mitsinjo, The Aspinall Foundation
Primary contacts: Harison Randrianasolo (h.randrianasolo@conservation.org), Tovonanahary Rasolofoharivelo (tovonanahary@gerp-mg.org), Rainer Dolch (rainer@mitsinjo.org; rdolch@gmx.de), Tony King (tonyk@aspinallfoundation.org; tonyking643@gmail.com)

Andriantantely:
Priority species: *Prolemur simus* (CR), *Varecia variegata* (CR), *Indri indri* (CR), *Propithecus diadema* (CR), *Daubentonia madagascariensis* (EN), several other rainforest lemurs
Primary actors: The Aspinall Foundation
Primary contacts: Tony King (tonyk@aspinallfoundation.org; tonyking643@gmail.com), Tovonanahary Rasolofoharivelo (tovonanahary@gerp-mg.org), Harison Randrianasolo (h.randrianasolo@conservation.org), Rainer Dolch (rainer@mitsinjo.org; rdolch@gmx.de)

Torotorofotsy–Ihofa:
Priority species: *Prolemur simus* (CR), *Varecia variegata* (CR), *Indri indri* (CR), *Propithecus diadema* (CR), *Daubentonia madagascariensis* (EN), several other rainforest lemurs
Primary actors: Association Mitsinjo, Conservation International
Primary contacts: Rainer Dolch (rainer@mitsinjo.org; rdolch@gmx.de), Harison Randrianasolo (h.randrianasolo@conservation.org), Tovonanahary Rasolofoharivelo (tovonanahary@gerp-mg.org), Tony King (tonyk@aspinallfoundation.org; tonyking643@gmail.com)

Western portion of the CAZ:
Priority species: *Prolemur simus* (CR), *Varecia variegata* (CR), *Indri indri* (CR), *Propithecus diadema* (CR), *Daubentonia madagascariensis* (EN), several other rainforest lemurs
Primary actors: The Aspinall Foundation, Conservation International
Primary contacts: Tovonanahary Rasolofoharivelo (tovonanahary@gerp-mg.org), Harison Randrianasolo (h.randrianasolo@conservation.org), Tony King (tonyk@aspinallfoundation.org; tonyking643@gmail.com), Rainer Dolch (rainer@mitsinjo.org; rdolch@gmx.de)

Prevention and reduction of bushmeat hunting in the CAZ:
Priority species: *Prolemur simus* (CR), *Varecia variegata* (CR), *Indri indri* (CR), *Propithecus diadema* (CR), *Daubentonia madagascariensis* (EN), several other rainforest lemurs
Primary actors: Conservation International
Primary contacts: Harison Randrianasolo (h.randrianasolo@conservation.org), Tovonanahary Rasolofoharivelo (tovonanahary@gerp-mg.org), Rainer Dolch (rainer@mitsinjo.org; rdolch@gmx.de), Tony King (tonyk@aspinallfoundation.org; tonyking643@gmail.com)

Betampona Natural Reserve
Priority species: *Indri indri* (CR), *Propithecus diadema* (CR), *Varecia variegata* (CR), *Eulemur albifrons* (EN)
Primary actors: Madagascar Fauna & Flora Group, Madagascar National Parks
Primary contacts: Ingrid Porton (Porton@stlzoo.org), Maya Moore (maya@savethelemur.org)

Anjozorobe–Angavo & Tsinjoarivo:
Priority species: *Cheirogaleus sibreei* (CR), *Indri indri* (CR), *Propithecus diadema* (CR), *Daubentonia madagascariensis* (EN), *Avahi laniger* (VU)
Primary actors: Sadabe, Fanamby
Primary contacts: Mitchell Irwin (mirwin@niu.edu)

Ambositra–Vondrozo Corridor (COFAV):
Priority species: *Varecia variegata* (CR), *Prolemur simus* (CR), *Cheirogaleus sibreei* (CR), *Eulemur cinereiceps* (CR), *Hapalemur aureus* (CR), *Daubentonia madagascariensis* (EN), *Lepilemur microdon* (EN), *L. betsileo* (EN), *Avahi betsileo* (EN), *Propithecus edwardsi* (EN), *H. griseus gilberti* (EN), *Lemur catta* (EN), *Microcebus rufus* (VU), *A. peyrierasi* (VU), *Avahi ramanantsoavanai* (VU), *Eulemur rubriventer* (VU)
Primary actors: Conservation International, WWF-Madagascar, CoBas (Communautés de base)
Primary contacts: Steig Johnson (steig.johnson@ucalgary.ca), James MacKinnon (jmackinnon@conservation.org)

Ranomafana National Park:
Priority species: *Prolemur simus* (CR), *Cheirogaleus sibreei* (CR), *Varecia variegata* (CR), *Hapalemur aureus* (CR), *Propithecus edwardsi* (EN), *Lepilemur microdon* (EN), *Daubentonia madagascariensis* (EN), *Cheirogaleus* sp. and *Lepilemur* sp.
Primary actors: Madagascar National Parks, Centre International de Formation pour la Valorisation de la Biodiversité (Centre ValBio)
Primary contacts: Patricia Wright (patchapplewright@gmail.com), Steig Johnson (steig.johnson@ucalgary.ca)

Fandriana–Marolambo Forest Corridor:
Priority species: *Varecia variegata* (CR), *Propithecus edwardsi* (EN)
Primary actors: Madagascar National Parks, WWF
Primary contacts: Jonah Ratsimbazafy (jonah.ratsimbazafy@durrell.org), Shawn Lehman (shawn.lehman@utoronto.ca)

Kianjavato:
Priority species: *Prolemur simus* (CR), *Varecia variegata* (CR), *Microcebus jollyae* (EN)
Primary actors: Madagascar Biodiversity Partnership
Primary contacts: Edward E. Louis Jr., (kelynews1@yahoo.com; edlo@omahazoo.com), Steig Johnson (steig.johnson@ucalgary.ca)

Manombo Forest:
Priority species: *Varecia variegata* (CR), *Eulemur cinereiceps* (CR), *Lepilemur jamesorum* (CR)
Primary actors: Durrell Wildlife Conservation Trust, Madagascar National Parks
Primary contacts: Fidimalala Ralainasolo (ralainasolof@yahoo.fr), Steig Johnson (steig.johnson@ucalgary.ca)

Kalambatritra Massif:
Priority species: *Lepilemur wrightae* (EN), possibly others depending on inventory results
Primary actors: The Aspinall Foundation, Madagascar National Parks
Primary contacts: Tovonanahary Rasolofoharivelo (tovonanahary@gerp-mg.org), Laingoniaina Herifito Fidèle Rakotonirina (laingoniaina2000@yahoo.fr), Tony King (tonyk@aspinallfoundation.org; tonyking643@gmail.com)

Andohahela and Tsitongambarika:
Priority species: *Lepilemur fleuretae* (CR), *Eulemur collaris* (EN), *Avahi meridionalis* (EN), *Daubentonia madagascariensis* (EN), *Hapalemur meridionalis* (VU)
Primary actors: Madagascar National Parks, Asity Madagascar, CoBas (Communautés de base)
Primary contacts: Giuseppe Donati (gdonati@brookes.ac.uk), Andriamandranto Ravoahangy (aravoahangy@birdlife-mada.org), Jacques Rakotondranary (rsjacques@yahoo.fr), Andreas Hapke (ahapke@uni-mainz.de)

Mahafaly and Mandrare: The Spiny Forest Ecosystem:
Priority species: *Lemur catta* (EN), *Propithecus verreauxi* (EN), *Lepilemur leucopus* (EN)
Primary actors: Madagascar National Parks
Primary contacts: Domoina Rakotomalala (drakotomalala@wwf.mg), Joerg Ganzhorn (ganzhorn@zoologie.uni-hamburg.de), Edward E. Louis Jr., (kelynews1@yahoo.com; edlo@omahazoo.com)

Makay:
Priority species: *Mirza coquereli* (EN), *Phaner pallescens* (EN), *Propithecus verreauxi* (EN), *Lemur catta* (EN), *Daubentonia madagascariensis* (EN), *Lepilemur ruficaudatus* (VU)
Primary actors: Naturevolution
Primary contacts: Evrard Wendenbaum (evrard@naturevolution.org)

Kirindy–Ambadira (Central Menabe):
Priority species: *Microcebus berthae* (EN), *Propithecus verreauxi* (EN), *Mirza coquereli* (EN), *Phaner pallescens* (EN)
Primary actors: German Primate Center (DPZ), Fanamby, Longon'i Kirindy
Primary contacts: Matthias Markolf (mmarkol@gwdg.de), Peter Kappeler (pkappel@gwdg.de), Rebecca Lewis (rjlewis@austin.utexas.edu), Ibrahim Antho Youssouf Jacky (jackyantho@yahoo.fr)

Tsingy de Bemaraha:
Priority species: *Propithecus deckenii* (EN), *Mirza coquereli* (EN), *Lepilemur randrianasoloi* (EN), *Daubentonia madagascariensis* (EN)
Primary actors: Madagascar National Parks
Primary contacts: Edward E. Louis Jr., (kelynews1@yahoo.com; edlo@omahazoo.com), Hery Lala Ravelomanantsoa (bmr@parcs-madagascar.com)

Ambato Boeny:
Priority species: *Eulemur mongoz* (CR), *Propithecus coronatus* (EN), *Eulemur rufus* (VU)
Primary actors: The Aspinall Foundation
Primary contacts: Laingoniaina Herifito Fidèle Rakotonirina (laingoniaina2000@yahoo.fr), Tovonanahary Rasolofoharivelo (tovonanahary@gerp-mg.org), Tony King (tonyk@aspinallfoundation.org; tonyking643@gmail.com)

Ankarafantsika National Park:
Priority species: *Eulemur mongoz* (CR), *Propithecus coquereli* (EN), *Lepilemur edwardsi* (EN), *Avahi occidentalis* (EN), *Microcebus ravelobensis* (EN)
Primary actors: GERP (Groupe d'Étude et de Recherche sur les Primates de Madagascar), Madagascar National Parks
Primary contacts: Ute Radespiel (Ute.Radespiel@tiho-hannover.de), Josia Razafindramanana (josia.razafi@gmail.com), Shawn Lehman (shawn.lehman@utoronto.ca)

Mahavavy Kinkony:
Priority species: *Eulemur mongoz* (CR), *Propithecus coronatus* (EN), *Propithecus deckenii* (EN)
Primary actors: GERP, ASITY
Primary contacts: Josia Razafindramanana (josia.razafi@gmail.com), Jonah Ratsimbazafy (jonah.ratsimbazafy@durrell.org), Vony Raminoarisoa (vonyr@birdlife-mada.org)

Antrema:
Priority species: *Eulemur mongoz* (CR), *Propithecus coronatus* (EN), *Lepilemur edwardsi* (EN)
Primary actors: Projet bio-culturel d'Antrema in association with the Muséum national d'Histoire naturelle in Paris (MNHN) and Paris Zoo
Primary contacts: Josia Razafindramanana (josia.razafi@gmail.com), Hanta Razafindraibe (uadbeca@gmail.com)

Bombetoka–Belemboka:
Priority species: *Eulemur mongoz* (CR), *Propithecus coronatus* (EN)
Primary actors: GERP (Groupe d'Étude et de Recherche sur les Primates de Madagascar), Fanamby
Primary contacts: Josia Razafindramanana (josia.razafi@gmail.com)

Anjiamangirana and Marosely:
Priority species: *Propithecus coquereli* (EN), *Daubentonia madagascariensis* (EN), *Microcebus danfossorum* (EN), *Lepilemur grewcockorum* (EN)
Primary actors: None at the moment
Primary contacts: Ute Radespiel (Ute.Radespiel@tiho-hannover.de), Lounes Chikhi (chikhi@igc.gulbenkian.pt)

Sahamalaza – Iles Radama:
Priority species: *Eulemur flavifrons* (CR), *Lepilemur sahamalazensis* (CR), *Mirza zaza* (EN), *Eulemur macaco* (VU)
Primary actors: Madagascar National Parks, AEECL Madagascar, Mikaji Natiora, Bristol Conservation and Science Foundation
Primary contacts: Guy Hermas Randriatahina (pd@aeecl.org), Sylviane Volampeno (svolampeno@yahoo.fr), Christoph Schwitzer (cschwitzer@bristolzoo.org.uk)

Nosy Be:
Priority species: *Microcebus mamiratra* (CR), *Lepilemur tymerlachsonorum* (CR), *Eulemur macaco* (VU)
Primary actors: Madagascar National Parks, AEECL Madagascar
Primary contacts: Guy Hermas Randriatahina (pd@aeecl.org), Sylviane Volampeno (svolampeno@yahoo.fr)

Daraina:
Priority species: *Propithecus tattersalli* (CR), *Eulemur sanfordi* (EN), *Eulemur coronatus* (EN), *Phaner electromontis* (EN)
Primary actors: Fanamby
Primary contacts: Jordi Salmona (jordi.salmona@gmail.com), Serge Rajaobelina (s.rajaobelina@fanamby.org.mg)

Analamerana and Andrafiamena:
Priority species: *Propithecus perrieri* (CR), *Eulemur sanfordi* (EN), *Eulemur coronatus* (EN)
Primary actors: Fanamby, Madagascar National Parks
Primary contacts: Jordi Salmona (jordi.salmona@gmail.com)

Montagne des Français:
Priority species: *Lepilemur septentrionalis* (CR), *Eulemur coronatus* (EN)
Primary actors: Madagascar Biodiversity Partnership
Primary contacts: Edward E Louis Jr. (kelynews1@yahoo.com; edlo@omahazoo.com)

Data Deficient Lemur Species:
Priority species: *Cheirogaleus major* (DD), *Cheirogaleus crossleyi* (DD), *Cheirogaleus minusculus* (DD), *Hapalemur griseus ranomafanensis* (DD)
Co-ordinator: Linn Groeneveld (linn.groeneveld@geo.uni-goettingen.de)
Primary contacts: Linn Groeneveld (linn.groeneveld@geo.uni-goettingen.de)

Contributors' Addresses

Andrianandrasana, Herizo. Durrell Wildlife Conservation Trust - Madagascar Programme, Madagascar.
E-mail: <herizo.andrianandrasana@durrell.org>.

Andrianarimisa, Aristide. Wildlife Conservation Society, Madagascar. E-mail: <aristide@wcs.org>.

Andrianjakarivelo, Vonjy. Wildlife Conservation Society, Madagascar. E-mail: <vonjy@wcsmad.org>.

Andrianjara, Amavatra Herve. Madagascar National Parks, Madagascar. E-mail: <cvcrtangapmas@yahoo.fr>.

Avesani Zaborra, Cesare. Parco Natura Viva, Bussolengo, Italy. E-mail: <direzione@parconaturaviva.it>.

Baker-Médard, Merrill. University of California, Berkeley, USA. E-mail: <mezbaker@berkeley.edu>.

Banks, Matthew. Department of Anthropology, Stony Brook University, and Institute for the Conservation of Tropical Environments, USA. E-mail: <matiob@gmail.com>.

Bezara, Jocelyn. Madagascar National Parks, Madagascar. E-mail: <jbezara@yahoo.fr>.

Bichain, Jean-Michel. National Museum of Natural History, Paris, France; NGO Naturevolution.
E-mail: <jeanmichel@naturevolution.org>.

Blanco, Marina. Duke University Lemur Center, USA. E-mail: <marina.blanco@duke.edu>.

Bounous, Giancarlo. Department of Arboriculture, Torino University, Italy. E-mail: <giancarlo.bounous@unito.it>.

Chamberlan, Christelle. The Aspinall Foundation, Madagascar. E-mail: <cchamberlan@gmail.com>.

Chikhi, Lounes. Instituto Gulbenkian de Ciência, Portugal. E-mail: <chikhi@igc.gulbenkian.pt>.

Davies, Nicola. Bristol Conservation and Science Foundation, UK. E-mail: <ndavies@bcsf.org.uk>.

Dolch, Rainer. Association Mitsinjo, Madagascar. E-mail: <rdolch@gmx.de>, <rainer@mitsinjo.org>.

Donati, Giuseppe. Nocturnal Primate Research Group, Department of Social Sciences, Oxford Brookes University, UK. E-mail: <gdonati@brookes.ac.uk>.

Ferguson, Barry. Libanona Ecology Centre, Madagascar. E-mail: <ferguson.barry@gmail.com>.

Freeman, Karen L. M. Madagascar Fauna and Flora Group, Madagascar. E-mail: <karenlmfreeman@hotmail.com>.

Gabriel, Denise. Department of Anthropology, University of Victoria, Canada. E-mail: <denisegabrie@gmail.com>.

Gamba, Marco. Department of Life Sciences and Systems Biology, Torino University, Italy.
E-mail: <marco.gamba@unito.it>.

Ganzhorn, Jörg U. Institute of Zoology, Ecology and Conservation, University of Hamburg, Germany.
E-mail: <ganzhorn@zoologie.uni-hamburg.de>.

Giacoma, Cristina. Department of Life Sciences and Systems Biology, Torino University, Italy.
E-mail: <cristina.giacoma@unito.it>.

Golden, Christopher. Harvard University Center for the Environment, USA. E-mail: <cgolden@fas.harvard.edu>.

Gould, Lisa. Department of Anthropology, University of Victoria, Canada. E-mail: <lgould@uvic.ca>.

Groeneveld, Linn. Courant Research Centre Geobiology, Göttingen University, Germany.
E-mail: <linn.groeneveld@geo.uni-goettingen.de>.

Hapke, Andreas. Institute of Anthropology, Johannes Gutenberg University of Mainz, Germany.
E-mail: <ahapke@uni-mainz.de>.

Irwin, Mitchell. Department of Anthropology, Northern Illinois University, USA. E-mail: <mirwin@niu.edu>.

Johnson, Steig. Department of Anthropology, University of Calgary, Canada. E-mail: <steig.johnson@ucalgary.ca>.

Jolly, Alison. Sussex University, UK. E-mail: <alisonjolly@me.com>.

Kappeler, Peter. Behavioural Ecology & Sociobiology Unit, German Primate Center, Goettingen, Germany.
E-mail: <pkappel@gwdg.de>.

King, Tony. The Aspinall Foundation, Madagascar. E-mail: <tonyking643@gmail.com>, <tonyk@aspinallfoundation.org>.

Laudisoit, Anne. University of Liverpool, UK; University of Antwerp, Belgium; NGO Naturevolution.
E-mail: <anne@naturevolution.org>.

Lehman, Shawn. University of Toronto, Canada. E-mail: <slehman@chass.utoronto.ca>.

Lewis, Rebecca. Department of Anthropology, University of Texas at Austin, USA. E-mail: <rjlewis@austin.utexas.edu>.

Lewis, Richard. Durrell Wildlife Conservation Trust - Madagascar Programme, Madagascar.
E-mail: <Richard.Lewis@durrell.org>.

Louis Jr., Edward E. Madagascar Biodiversity Partnership, Henry Doorly Zoo, Omaha, USA.
E-mail: <edlo@omahazoo.com>.

Markolf, Matthias. Behavioural Ecology & Sociobiology Unit, German Primate Center, Goettingen, Germany.
E-mail: <mmarkol@gwdg.de>.

McGuire, Susie. Conservation Fusion, Omaha, USA. E-mail: <conservationfusion@gmail.com>.

Mittermeier, Russell A. Conservation International, Arlington, Virginia, USA. E-mail: <r.mittermeier@conservation.org>.

Moore, Maya. Madagascar Fauna and Flora Group, Madagascar. E-mail: <maya@savethelemur.org>.

Nash, Stephen. Conservation International, State University of New York, Stony Brook, USA.
E-mail: <stephen.nash@stonybrook.edu>.

Patel, Erik. SAVA Conservation Project, Duke University Lemur Center, USA. E-mail: <patel.erik@gmail.com>.

Porton, Ingrid. Madagascar Fauna and Flora Group, Saint Louis Zoo, USA. E-mail: <porton@stlzoo.org>.

Radespiel, Ute. Institute of Zoology, University of Veterinary Medicine Hannover, Germany.
E-mail: <Ute.Radespiel@tiho-hannover.de>.

Raharison, Jean-Luc. NGO Sadabe, Madagascar. E-mail: <jeanluc@sadabe.org>.

Rakotomalala, Domoina. WWF, Madagascar. Email: <drakotomalala@wwf.mg>.

Rakotondrabe, Rado. G.E.R.P. (Groupe d'Etude et de Recherche sur les Primates de Madagascar), Madagascar. E-mail: <yazradhoo@hotmail.fr>.

Rakotondranary, Jacques. SuLaMa (Participatory research to support sustainable land management on the Mahafaly Plateau in southwestern Madagascar), Madagascar. E-mail: <rsjacques@yahoo.fr>.

Rakotonirina, Laingoniaina Herifito Fidèle. The Aspinall Foundation, Madagascar. E-mail: <laingoniaina2000@yahoo.fr>.

Ralainasolo, Fidimalala Bruno. Durrell Wildlife Conservation Trust - Madagascar Programme, Madagascar. E-mail: <ralainasolof@yahoo.fr>.

Ramahaleo, Tiana. WWF, Madagascar. E-mail: <tramahaleo@wwf.panda.org>.

Ramanamisata, Rivo. Department of Animal Biology, University of Antananarivo, Madagascar. E-mail: <ramanamisata1@hotmail.fr>.

Raminoarisoa, Vony. Asity Madagascar, Madagascar. E-mail: <vonyr@birdlife-mada.org>.

Ranaivoarisoa, Jean Freddy. Madagascar Biodiversity Partnership, Antsiranana University, Madagascar. E-mail: <rjeanfreddy@yahoo.fr>.

Randrianarimanana, Lucien. The Aspinall Foundation, Madagascar. E-mail: <luxra_hery@yahoo.fr>.

Randrianarison, Rose Marie. G.E.R.P. (Groupe d'Etude et de Recherche sur les Primates de Madagascar); Department of Palaeontology Anthropology, University of Antananarivo, Madagascar. E-mail: <sissie@gerp-mg.org>.

Randrianasolo, Harison. Conservation International Madagascar. E-mail: <h.randrianasolo@conservation.org>.

Randriatahina, Guy Hermas. AEECL (Association Européenne pour l'Etude et la Conservation des Lémuriens), Madagascar. E-mail: <guyhrand@hotmail.com>.

Rasolofoharivelo, Tovonanahary Mamitiana. The Aspinall Foundation, Madagascar. E-mail: <tovonanahary@gerp-mg.org>.

Ratelolahy, Felix. Wildlife Conservation Society, Madagascar. E-mail: <felix@wcsmad.org>.

Ratolojanahary, Tianasoa. Association Mitsinjo, Madagascar. E-mail: <godroka@gmail.com>.

Ratsimbazafy, Jonah. Durrell Wildlife Conservation Trust - Madagascar Programme; G.E.R.P. (Groupe d'Etude et de Recherche sur les Primates de Madagascar), Madagascar. E-mail: <jonah.ratsimbazafy@durrell.org>.

Ravelomanantsoa, Hery Lala. Madagascar National Parks, Madagascar. E-mail: <bmr@parcs-madagascar.com>.

Ravoahangy, Andriamandranto. Asity Madagascar, Madagascar. E-mail: <aravoahangy@birdlife-mada.org>.

Razafindraibe, Hanta. Department of Animal Biology, University of Antananarivo, Madagascar. E-mail: <uadbeca@gmail.com>.

Razafindramanana, Josia. G.E.R.P. (Groupe d'Etude et de Recherche sur les Primates de Madagascar), Madagascar. E-mail: <r_josia@hotmail.com>.

Richardson, Matthew. IUCN/SSC Primate Specialist Group. E-mail: <livingprimates@hotmail.com>.

Robsomanitrandrasana, Eric. Ministry of the Environment and Forests, Madgasacar. E-mail: <robsomanitrandrasana@yahoo.fr>.

Rylands, Anthony B. Conservation International, Arlington, Virginia, USA. E-mail: <a.rylands@conservation.org>.

Salmona, Jordi. Population and Conservation Genetics Group, Instituto Gulbenkian de Ciencia, Portugal.
E-mail: <jordi.salmona@gmail.com>.

Samonds, Karen. Department of Biological Sciences, Northern Illinois University, USA. E-mail: <ksamonds@niu.edu>.

Schwitzer, Christoph. Bristol Conservation and Science Foundation, UK. E-mail: <cschwitzer@bcsf.org.uk>.

Seiler, Melanie. Bristol Conservation and Science Foundation; School of Biological Sciences, University of Bristol, UK. E-mail: <c.xanthosternos@googlemail.com>.

Torti, Valeria. Department of Life Sciences and Systems Biology, Torino University, Italy. E-mail: <valeria.torti@gmail.com>.

Volampeno, Sylviane. AEECL (Association Européenne pour l'Etude et la Conservation des Lémuriens), Madagascar; School of Biological and Conservation Sciences, KwaZulu Natal University, South Africa. E-mail: <svolampeno@yahoo.fr>.

Welch, Charles. Duke University Lemur Center, USA. E-mail: <charles.welch@duke.edu>.

Wendenbaum, Evrard. NGO Naturevolution, France. E-mail: <evrard@naturevolution.org>.

Wright, Patricia. Stony Brook University, Institute for the Conservation of Tropical Environments (ICTE), USA.
E-mail: <patchapplewright@gmail.com>.

Youssouf, Jacky Ibrahim Antho. Department of Biological Sciences, University of Toliara, Madagascar.
E-mail: <jackyantho@yahoo.fr>.

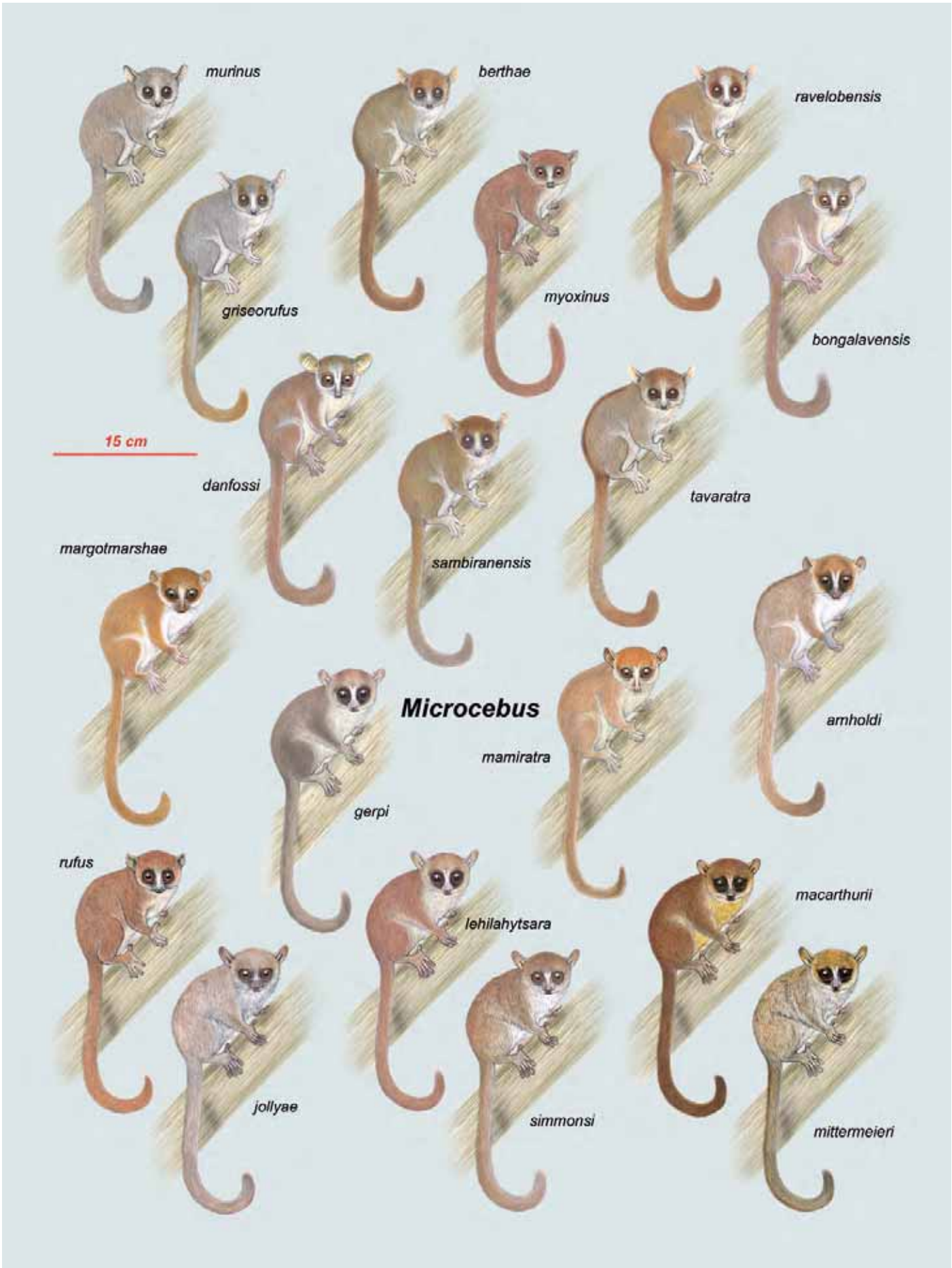
Zaonarivelo, John. Departement of Natural and Environmental Sciences, University of Antsiranana, Madagascar.
E-mail: <zaonarivelo@yahoo.fr>.

Appendix:

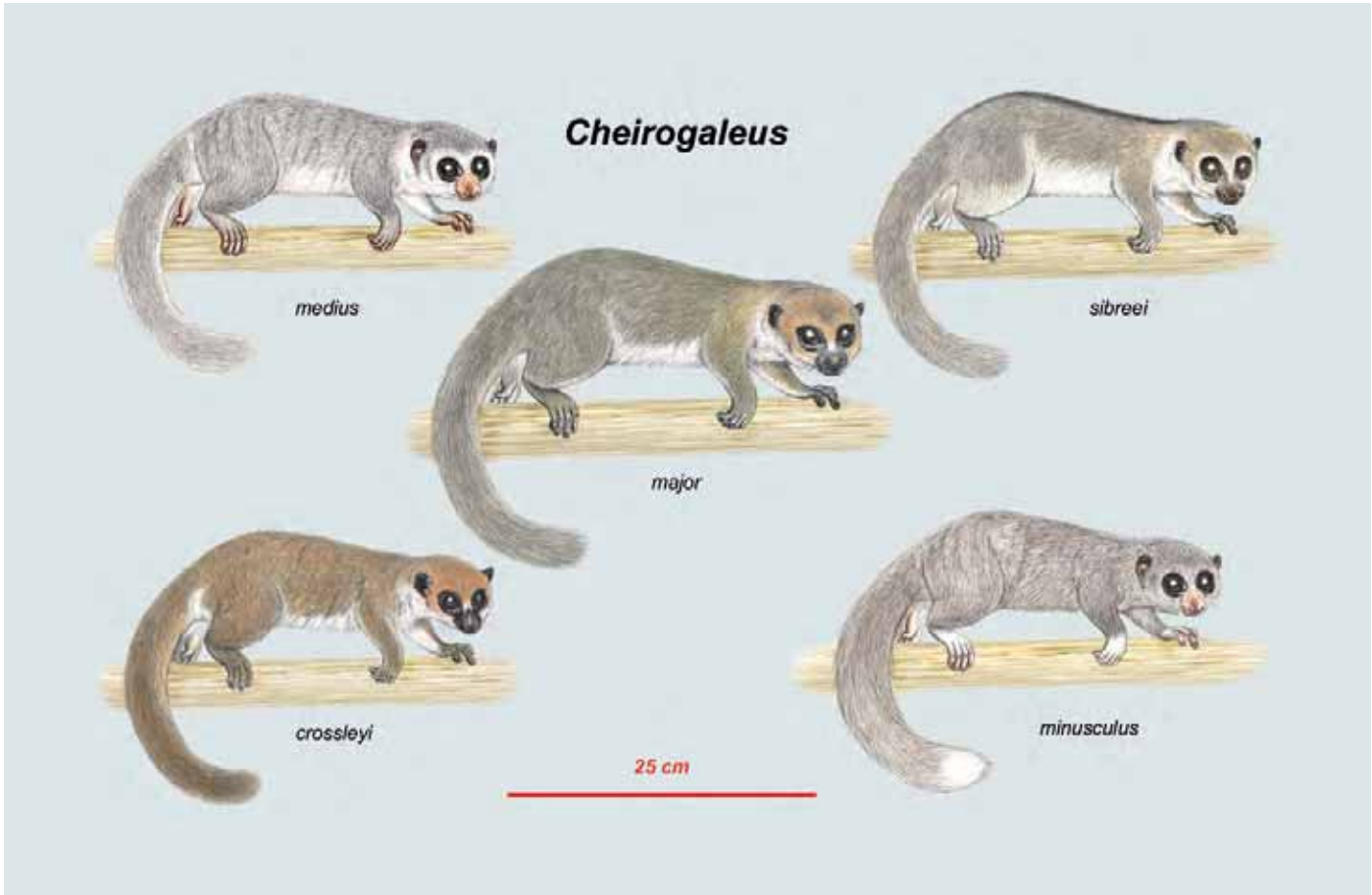
Site-Based Objectives and Budgets

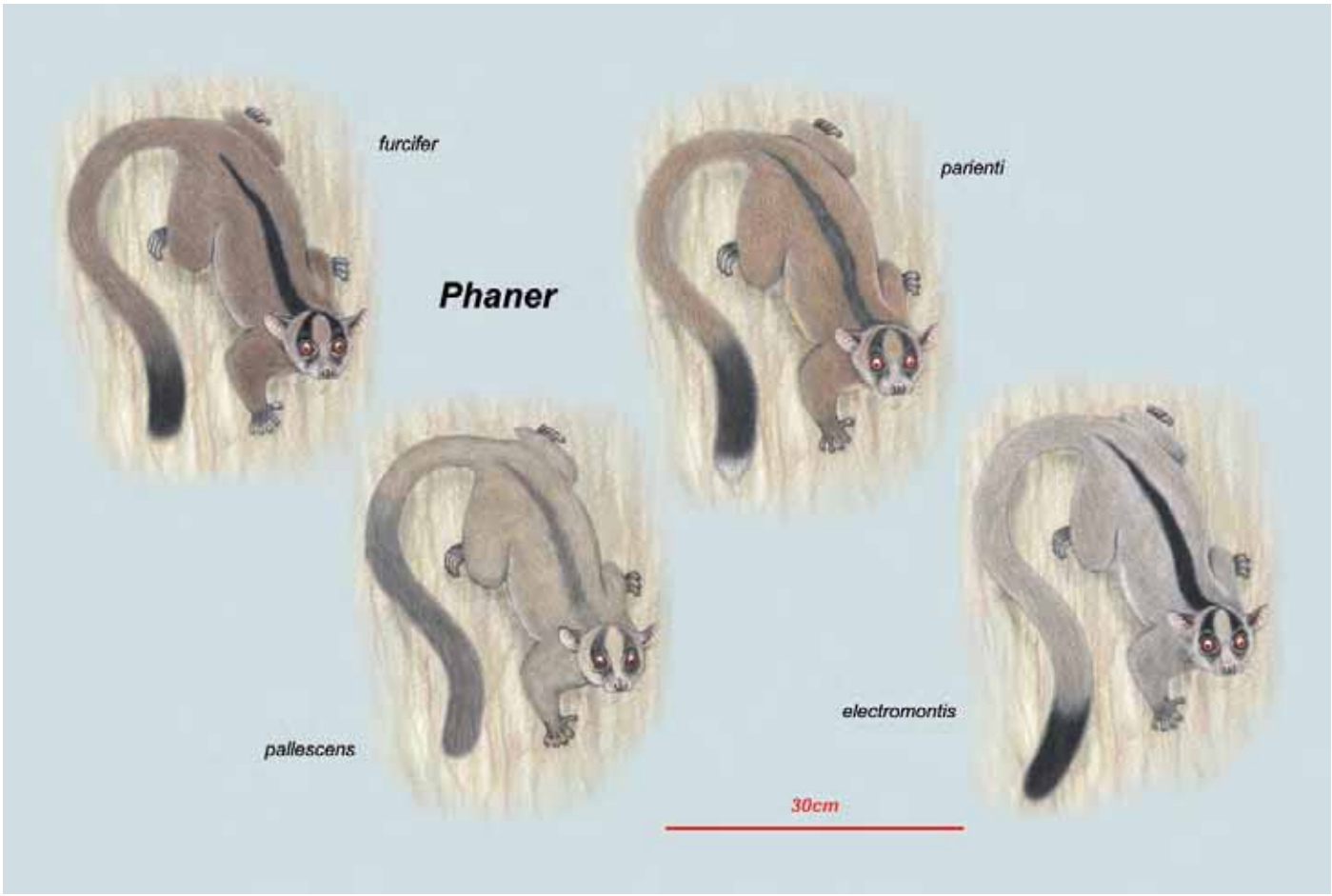
A list of conservation objectives and indicative budgets for each of the site-based action plans in this document can be downloaded from:

http://www.primate-sg.org/action_plans.

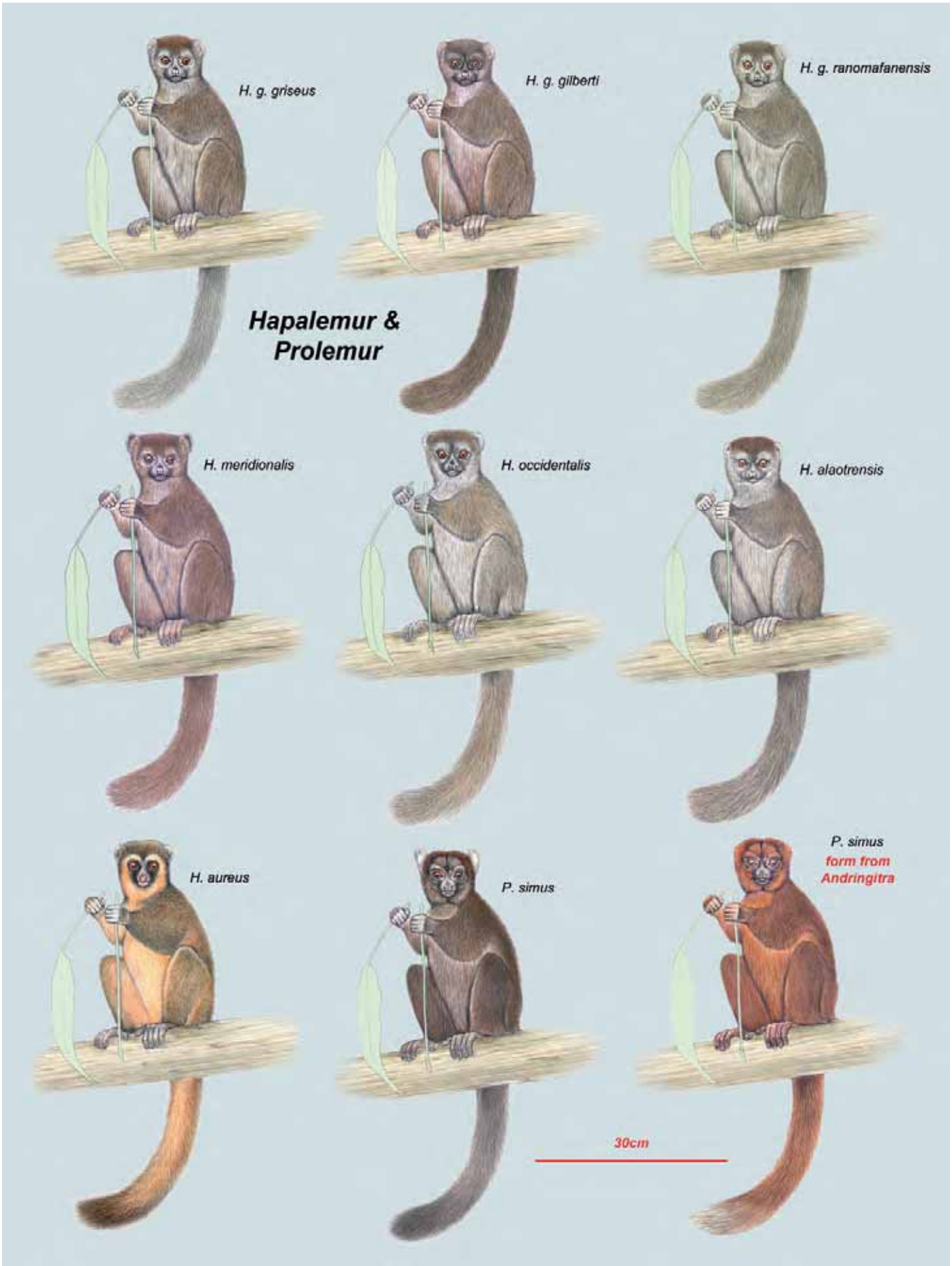

murinus
griseorufus
berthae
myoxinus
ravelobensis
bongalavensis
15 cm
danfossi
tavaratra
margotmarshae
sambiranensis
Microcebus
mamiratra
arnholdi
gerpi
rufus
lehilahytsara
macarthurii
jollyae
simmonsi
mittermeieri


Allocebus trichotis
Mirza zaza
Mirza coquereli
25cm


Cheirogaleus
medius
sibreei
major
crossleyi
minusculus
25 cm

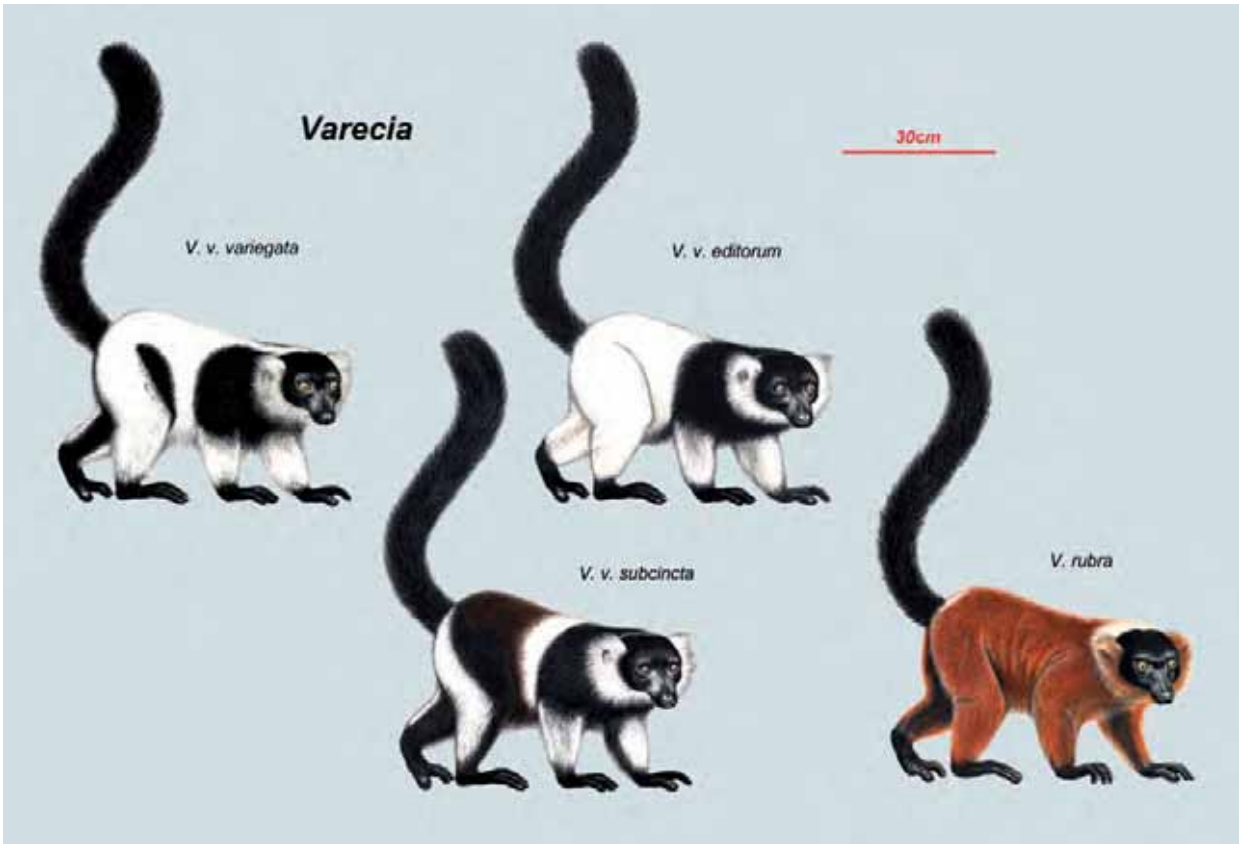

furcifer
Phaner
parienti
pallescens
electromontis
30cm

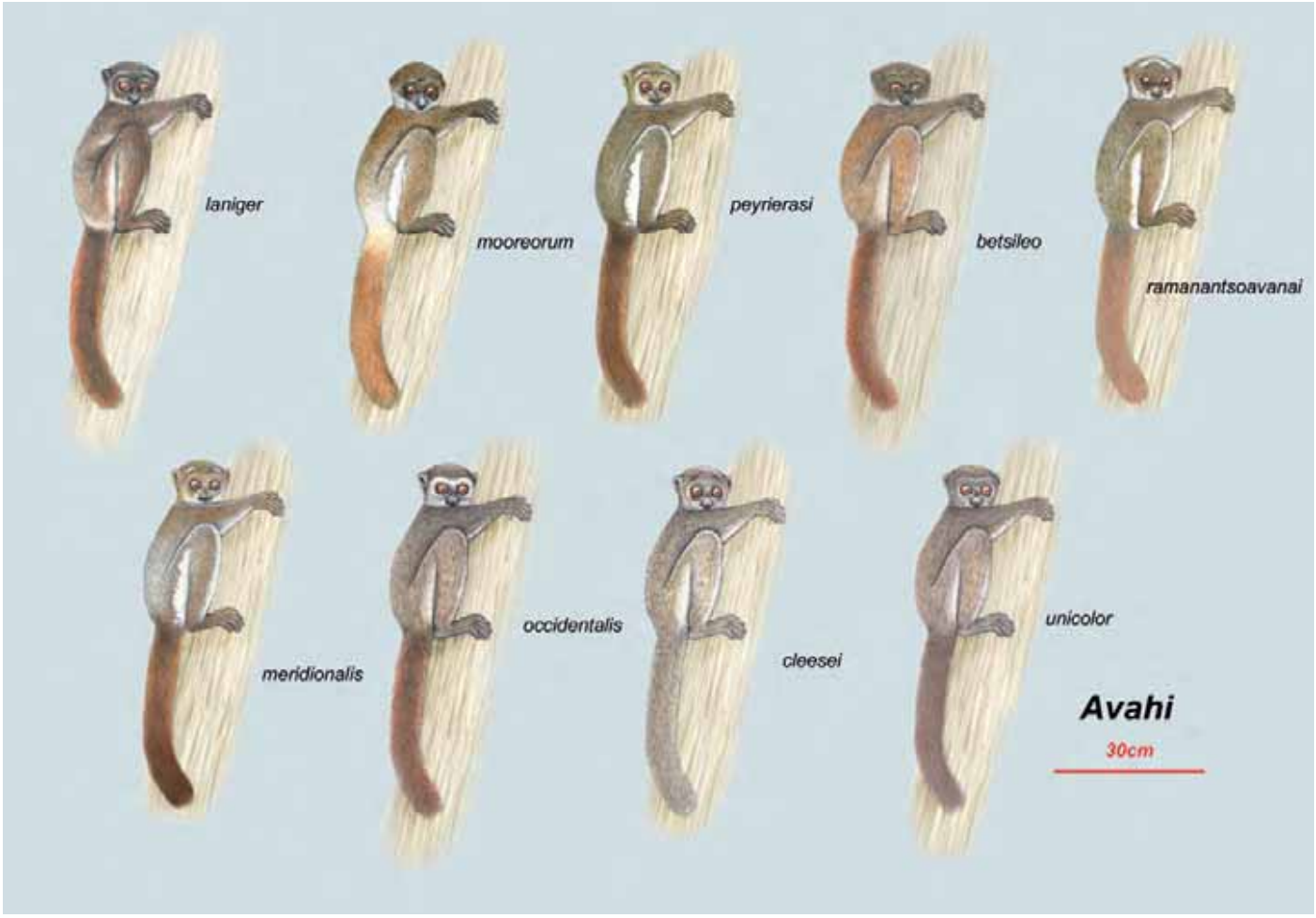

Lepilemur
mustelinus
betsileo
microdon
jamesorum
wrightae
male
wrightae
female
fleuretae
hollandorum
scali
scottorum
milanoii
ankaranensis
septentrionalis
dorsalis
tymerlachsonorum
mittermeieri
sahamalazensis
grewcockorum
otto
edwardsi
aeeclis
ahmansonorum
randrianasoloi
ruficaudatus
hubbardorum
petteri
leucopus
30cm

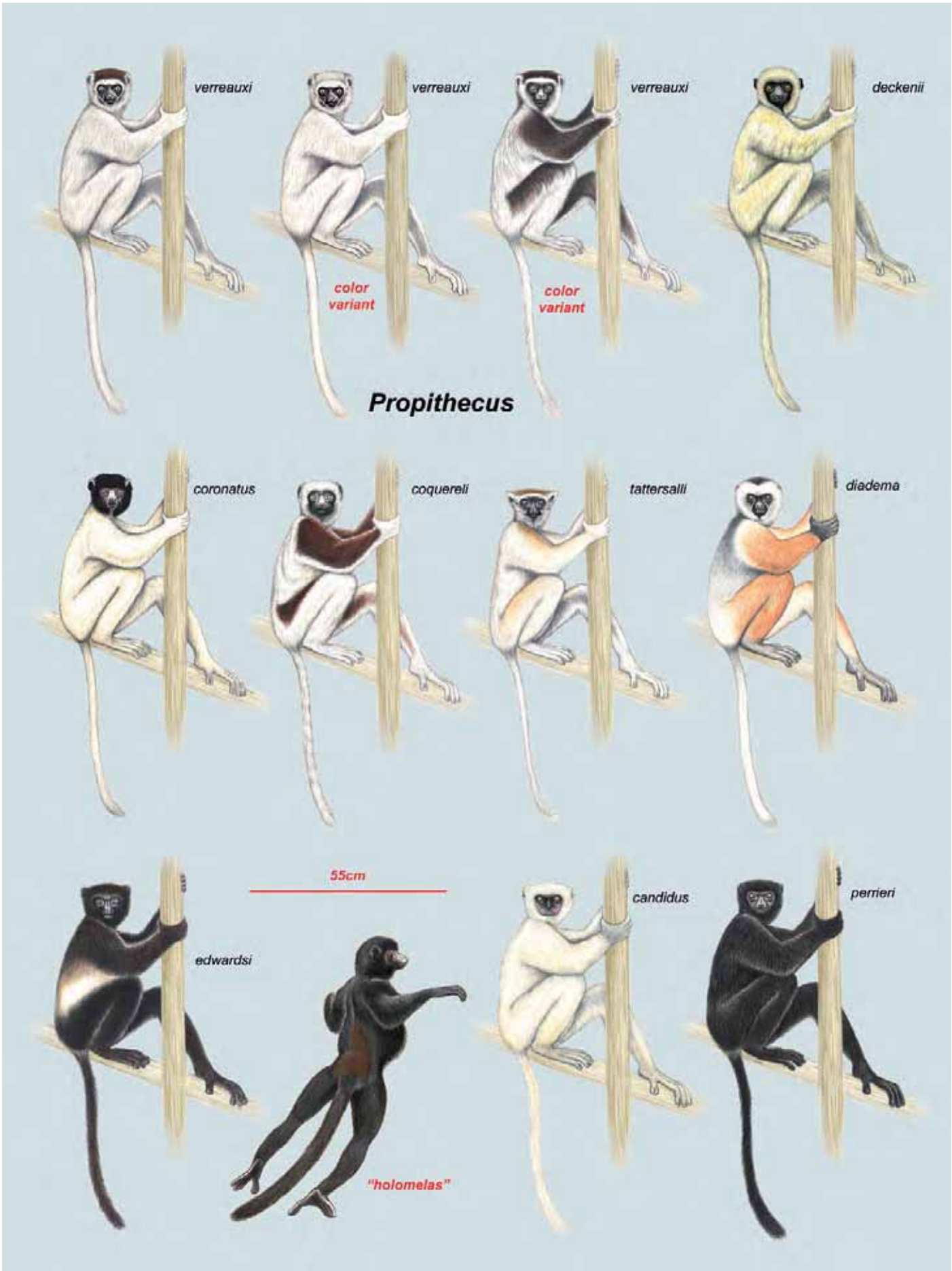

H. g. griseus
H. g. gilberti
H. g. ranomafanensis
Hapalemur &
Prolemur
H. meridionalis
H. occidentalis
H. alaotrensis
H. aureus
P. simus
P. simus
form from
Andringitra
30cm

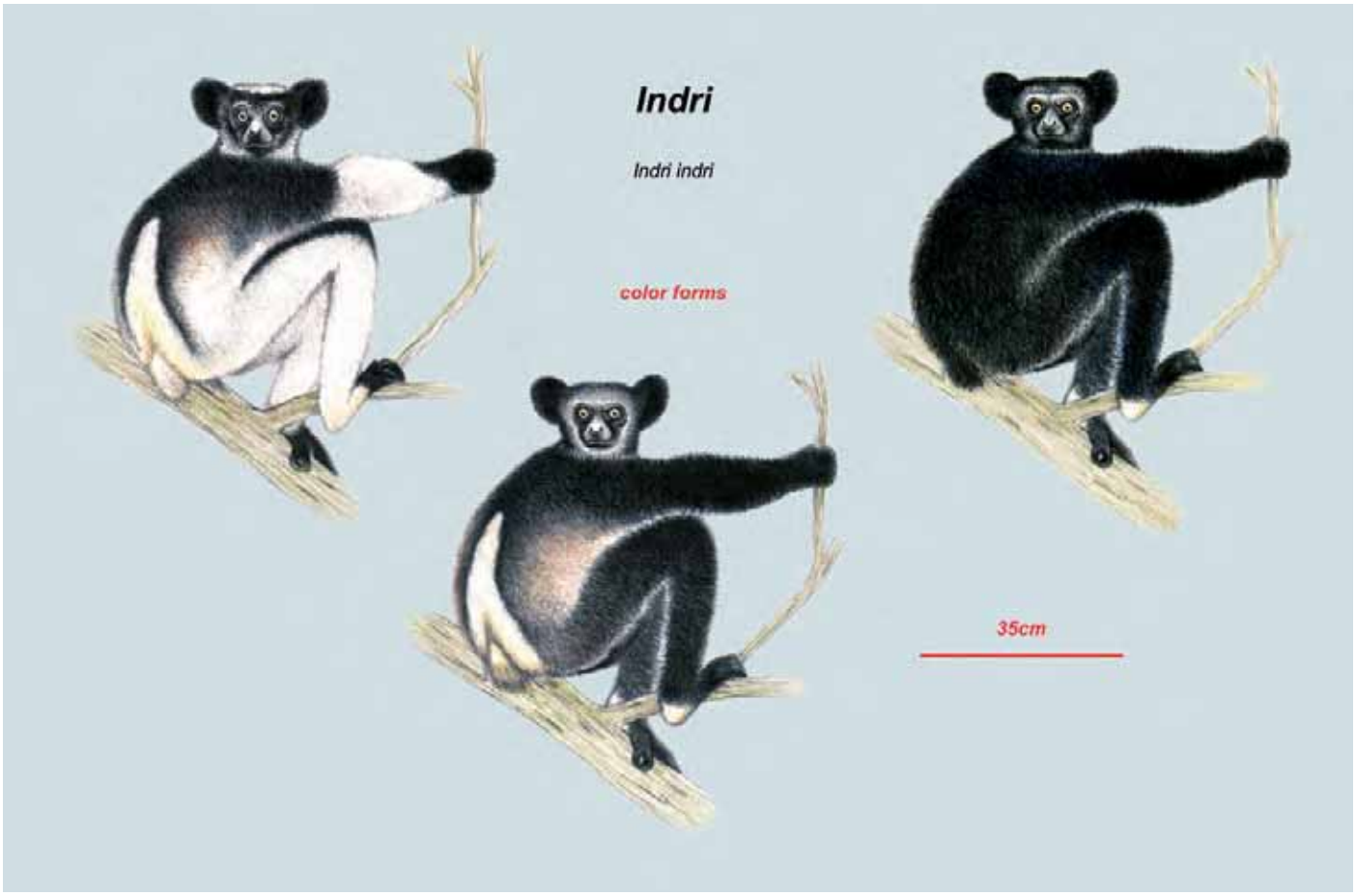

Lemur
Lemur catta
color variants
25cm


Eulemur
fulvus
male
female
rufus
male
female
rufifrons
male
female
50cm
albifrons
male
female
sanfordi
male
female
cinereiceps
male
female
collaris
male
female
macaco
male
female
flavifrons
male
female
coronatus
male
female
rubriventer
male
female
mongoz
male
female


Varecia
30cm
V. v. variegata
V. v. editorum
V. v. subcincta
V. rubra


laniger
mooreorum
peyrierasi
betsileo
ramanantsoavanai
meridionalis
occidentalis
cleesei
unicolor
Avahi
30cm


verreauxi
verreauxi
color variant
verreauxi
color variant
deckenii
Propithecus
coronatus
coquereli
tattersalli
diadema
55cm
edwardsi
"holomelas"
candidus
perrieri


Indri
Indri indri
color forms
35cm

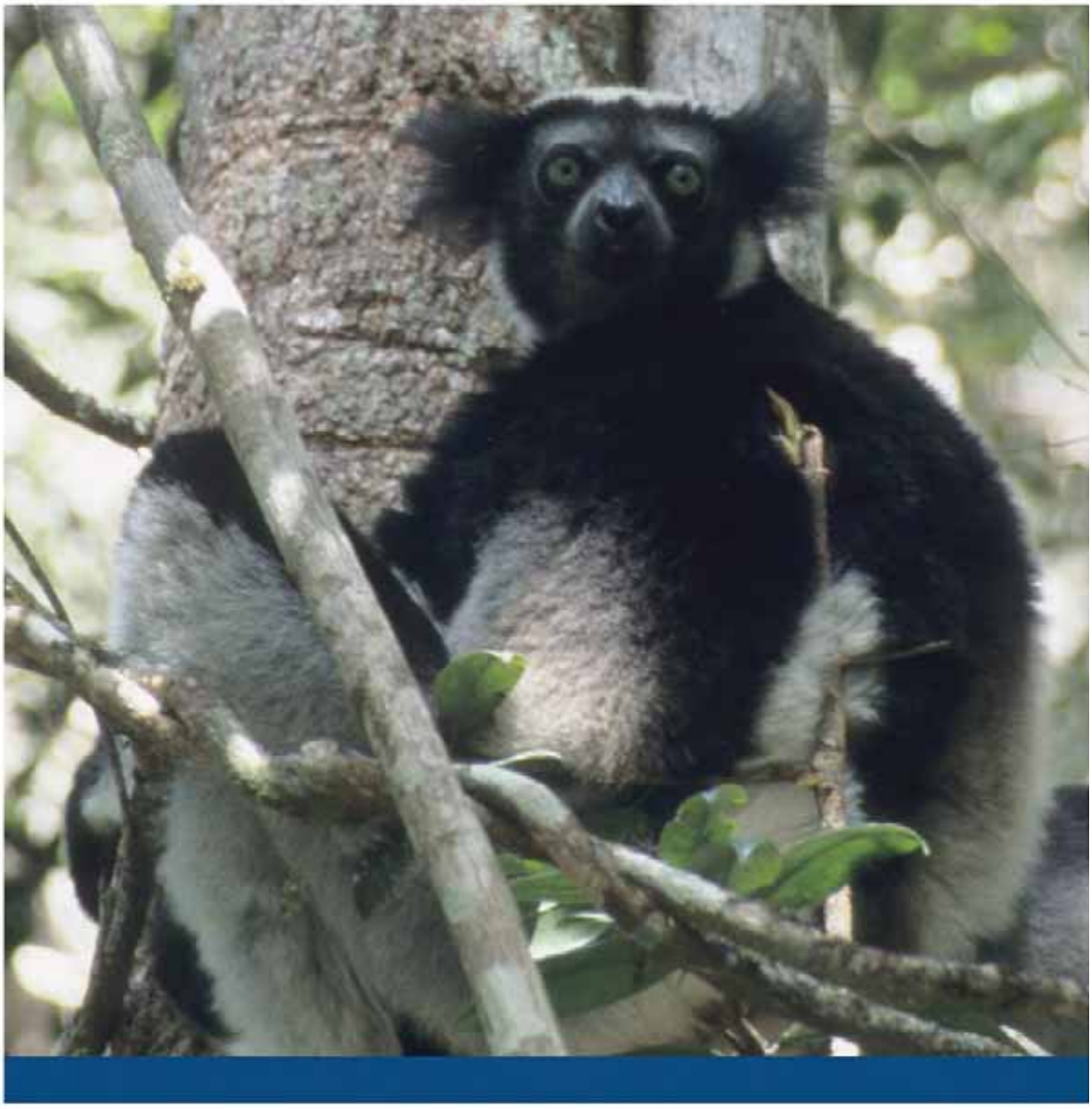

Daubentonia
Daubentonia madagascariensis
20cm

IUCN, International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges. IUCN works on biodiversity, climate change, energy, human livelihoods and greening the world economy by supporting scientific research, managing field projects all over the world, and bringing governments, NGOs, the UN and companies together to develop policy, laws and best practice. IUCN is the world's oldest and largest global environmental organization, with more than 1,200 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 45 offices and hundreds of partners in public, NGO and private sectors around the world. For more information about IUCN, visit <www.iucn.org>.

The **Species Survival Commission (SSC)** is one of six volunteer commissions of IUCN. SSC's mission is to conserve biological diversity by developing and executing programs to save, restore and wisely manage species and their habitats. Survival of the world's living primate species and subspecies is the principal mission of the IUCN SSC Primate Specialist Group (PSG), over 400 volunteer professionals who represent the front line in international primate conservation. The PSG website is <www.primate-sg.org>.

Bristol Conservation and Science Foundation (BCSF) is an operating unit of the Bristol, Clifton and West of England Zoological Society, which also runs Bristol Zoo Gardens. BCSF undertakes conservation action and conservation research in both the UK and the developing world. Its mission is to identify and implement sustainable solutions to species and ecosystem conservation challenges, through research, action and local collaboration. For more information about BCSF, visit <www.bcsf.org.uk>.

Conservation International (CI) applies innovations in science, economics, policy and community participation to protect the Earth's richest regions of plant and animal diversity in the biodiversity hotspots, high-biodiversity wilderness areas and key marine ecosystems. With headquarters in Arlington, VA, CI works in more than 40 countries on four continents. For more information about CI, visit <www.conservation.org>.



INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

WORLD HEADQUARTERS
Rue Mauverney 28
1196 Gland, Switzerland
mail@iucn.org
Tel +41 22 999 0000
Fax +41 22 999 0002
www.iucn.org