Madagascar Biodiversity Databases and Maps: An Assessment

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1994

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Acronyms

The following table provides acronym definitions for some of the organizations involved with biodiversity in Madagascar:

BPS	Biodiversity Planning Service
SAVEM	Sustainable Approaches to Viable Environmental Management
ANGAP	National Association for the Management of Protected Areas
NEAP	National Environmental Action Plan
NRICG	Natural Resource Information Consultative Group
ICDP	Integrated Conservation Development Program
CIESIN	Consortium for International Earth Science Information
USNHM	U.S. Natural History Museum
ICTE	Institute for the Conservation of Tropical Environments, SUNY at Stonybrook
FTM	Foibe Taosaritan'i Madagasikara
ANAE	Association Nationale d'Actions Environnementales
ANGAP	Association Nationale pour la Gestion des Aires Protégées
ONE	Office National de l'Environnement
COEFOR	Contribution à l'êtude des forets classe
ORSTOM	Office de la Recherche Scientifique et Technique d'Outre Mer

Executive Summary

This project was conducted at the World Resources Institute to identify biodiversity databases and maps available outside of Madagascar itself. The information gathered during this project is described and assessed in this report. Available maps depicting Madagascar biodiversity resources are also presented here. Information is provided, when available, about the format, scale, and preparation of these maps. The databases presented in this report are chronicled, when possible, both by a list of the fields that comprise each database and by the number of Madagascar biodiversity data records held by each database. A summary of the available high resolution multi-spectral Landsat Thematic Mapper images held outside the country is also included. All information needed to access these maps, images, and databases are provided.

During this project, a large number of individuals and institutions were contacted in regard to available databases and maps that include Madagascar biodiversity information. For databases, meta-information was collected from divisions within the Natural History Museum at the Smithsonian Institute, the U. of Michigan, the U. of Chicago, Duke U., the New York Zoological Society, FAO, ORSTOM, UNEP/GRID, the World Conservation Monitoring Centre, the Plants Database Consortium, and the Musée National d'Historie Naturelle in Paris. Map information was collected from Conservation International, the State U. of New York at Stonybrook, the World Conservation Monitoring Centre, Dr. Glen M. Green, and Dr. Ronald I. Miller. Additional information sources identified but not accessed during this project are presented in the section of this report entitled Next Steps.

Information about many of the plants and animals and for most of the rare and threatened species in Madagascar was identified during this project. Many maps showing deforestation patterns, protected areas, habitats, and vegetation on the island were also identified.

The majority of Madagascar biodiversity information is currently held in published and unpublished reports and documents. Many of these documents are attached to on-going or completed biological scientific investigations in Madagascar. Nonetheless, many biodiversity databases are currently under development and/or they are being populated with biodiversity data. In a few years time, databases to store and monitor many of the biodiversity resources in Madagascar will be available.

1. Introduction

Approximately one hundred million years ago, the land mass known as Madagascar separated from the African continent. The animals and plants on Madagascar subsequently experienced at least 95 million years of complete isolation from the African continent. Through evolution this has resulted in the many unique forms of plants and animals that are today found on Madagascar. More than three-fourths of the native species of Madagascar occur nowhere else in the world, and little is known about the characteristics and behavior of many of these species. Preserving this rich endowment of biodiversity is critical to preserving the island's irreplaceable wealth of biological resources. Adding urgency to this task is the accelerating rate of environmental destruction on the island.

This project focuses upon the documentation[1] of databases and maps held outside of Madagascar that identify current biodiversity resources on the island. A most direct identification of biodiversity data resources was achieved by our focus upon these information tools (i.e., databases and maps). Many other types of biodiversity information were encountered during this project. For example, field guides for a number of the different taxonomic groups on the island are in preparation.[2] Existing databases and maps are singularly highlighted in this report.

The subject of biodiversity covers a wide spectrum of information categories. The goal of this project was to maximize the number and types of databases and maps available outside of Madagascar which contain biodiversity information.

2. Databases

In the past, data associated with Madagascar biodiversity was predominantly collected and analyzed by scientists located in many different parts of the world. Computer databases with information about the biodiversity resources of Madagascar did not exist before the late 1980's.

Many databases for Madagascar are only now in the development stages. Meta-information regarding these databases is difficult if not impossible to obtain at this time. Nevertheless, I have included any available access information about these databases so that the appropriate contacts can be made in the future. The following sections contain information compiled regarding databases that contain Madagascar biodiversity information.

2.1 Institutions Contacted

A number of institutions collect biodiversity data from around the globe. Contacts were made to appropriate institutions during the course of this study to obtain documentation of their possible

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[1]This identification process was conducted in the late spring and summer of 1994.

[2]Information regarding the contents and estimated dates of publication for these field guides was not pursued in this project.

Madagascar biodiversity data holdings. Information obtained from each institution is included in the following listing.

a. Smithsonian Institution

The Smithsonian Natural History Museum has been striving to produce standard databases for museum specimens and field observation records since the spring of 1992. Currently, each different division in the museum is involved in a different stage of development in regard to the design and building of a database. In the Smithsonian divisions with functioning databases, from 10-100% of the Madagascar biodiversity data have been input into the database. The percentage of current data input for a particular database is indicated in the following Assessments.

Divisions within Smithsonian with specimen databases were contacted during this project for Madagascar biodiversity information. In this Section, the fields and number of records for the identified databases are listed. Names have not been assigned to the individual databases at the Smithsonian Natural History Museum. Rather each specimen database is identified with the Division in which it is located.

Division of Birds

Description:

This division does not currently have an operating database system. The bird data are currently stored in a Lotus 1-2-3 spreadsheet format. Some of the categories of information listed in this Lotus format include: scientific name, collectors name, location information, date, sex, skins, skeletons, eggs, nests, storage label information.

Assessment:

Biodiversity information regarding birds in Madagascar are held by the Ornithology Division at Smithsonian. This information has not yet been gathered together and input into a database. Information about the current development status of the Smithsonian ornithological database or about the the number of records held for Madagascar was not available at this time. Some effort is still required before the bird data is ready to be input into a database format.[3] Also some effort will be required to transfer the data held in the Lotus 1-2-3 format to the database format. Therefore, the accuracy and status of the Madagascar ornithological data held at Smithsonian Institution is unknown at present. The time frame for the establishment of this ornithological database is currently unknown.

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[3]This refers to the structure of the database records that will be decided upon by the Ornithology Division. All the bird specimen data held by the Division will then need to be recompiled so that it can be input into this database.

Access:

Gary Graves,
Curator,
Division of Ornithology,
Museum of Natural History,
Smithsonian Institution,
Washington, DC 20560
USA

Tel: +1-202-357-2335
Fax: +1-202-357-4122

Division of Mammals

Description:

This database is part of a larger database that is being developed and implemented at the present time for all of the Smithsonian. The field names and formats for the database held by this Division are listed in Appendix A.

Assessment:

The fields structure of this database, presented in Appendix A, provides room for the storage of extensive information about both the biological and geographic characteristics of the museum specimens. Most importantly for map making purposes, this database includes a series of location fields for storage of geographical location data that will be available at different resolutions.

A summary of the database records for Madagascar mammals currently held in the database of the Mammals Division of the Smithsonian Natural History Museum in Washington, DC is listed below:

Family	Dry Specimins	Wet Specimins[4]	Total
Tenrecidae	268	225	493
Soricidae	26	12	38
Pteropodidae	50	34	84
Emballonuridae	1	0	1

[4]Mammal specimens at Smithsonian are stored in wet and dry conditions to ensure long-term preservation. The kind of conditions that are used are specific to each species. Therefore, the mammal specimen records stored in the database at Smithsonian are separated into wet and dry categories and these are the categories into which the mammal data are stored.

Hipposideridae	7	1	8
Myzopodidae	6	12	18
Vespertilionidae	50	36	86
Molossidae	79	2	81
Cheirogaleidae	2	3	5
Lemuridae	67	2	69
Indriidae	20	0	20
Daubentoniidae	3	0	3
Leporidae	1	0	1
Nesomyinae	207	97	304
Murinae	156	21	177
Viverridae	5	0	5
Herpestidae	7	0	7
Suidae	1	0	1
Total	956	445	1401

Access:

Craig Ludwig,
Division of Mammals,
Natural History Museum,
Smithsonian Institution,
Washington, DC 20560
USA

Tel: +1-202-357-2172
Email: mnhvz002@sivm.si.edu

Division of Amphibians and Reptiles

Description:

The amphibian and reptile records for both specimens and observations that are stored in the database maintained by this Division contain the following categories of information:

* USNM Catalog Number
* Locator

* Numerical Taxonomic Code
* Genus
* Species
* Subspecies
* Type Designation
* Continent
* Oceanic Region
* Country
* Secondary Geographic Subdivision
* Tertiary Geographic Subdivision
* Specific Locality
* Elevation
* Latitude/Longitude
* Collector
* Expedition/Project Name
* Date Collected
* Field or Original Number
* Number of Specimens (Lot Catalogued)
* Accession Number
* Donor
* Remarks
* Description of Specimen
* Voucher
* Field Notes
* Status
* Nature of Specimen

Assessment:

Each Division within Smithsonian defines the fields in its database based upon the needs of its particular collection. In the Division of Amphibians and Reptiles database, the geographic information[5] linked to each specimen is stored in the fields listed above named Continent, Oceanic Region, Country, Secondary Geographic Subdivision, Tertiary Geographic Subdivision, specific locality, and latitude/longitude. Similar to the Mammals Division Database, the geographical location data stored in this database will permit map production at both large and small map scales.

This amphibian and reptile database currently contains the following Madagascar biodiversity information:

* Number of amphibian specimens currently catalogued in the database for Madagascar = 125.
* Number of reptile specimens currently catalogued in the database for Madagascar = 300.

[5]Information is at a higher resolution than the country level.

This represents a complete record of the specimens held in this Division from Madagascar.

Access:

George Zug,
Curator,
Division of Amphibians and Reptiles,
Natural History Museum,
Smithsonian Institution,
Washington, DC 20560
USA

Tel: +1-202-357-2778
Fax: +1-202-357-4779
Email: mnhvz059@sivm.si.edu

Division of Botany

Description:

The Botany Division Database has been developed using dBaseIII+ and the following is a listing and description of the current database field names:

Field Name	Description
flag	
plantgrp	Plant group: cryptograms, bryophytes, algae, ferns, blank = flowering plant
project	
sheet_no	Catalogue number
division	
order	
family	
type	i.e., holotype, isotype, syntype, lectotype
genusn_no	Genus number
genus_hybd	Generic hybrid Flag
genus	Generic name
orth_var	Orthographic variant
spec_hybd	Species hybrid flag

species	Specific epithet
rank1	Subspecific rank
epithet1	Subspecific epithet
rank2	Subspecific rank
epithet2	Subspecific epithet
rank3	Subspecific rank
epithet3	Subspecific epithet
authorname	Author of the name
title	Title of publication
collation	Volume: page number
year_pub	Year published
collector1	Primary collector
collector2	Collecting team number
collector3	Collecting team number
fieldnumb	Collectors collection number
coll date	Date of collection
region	Herbarium region
country	
state	First geopolitical division
county	Second geopolitical division
Place	Formatted locality
locality	Specific locality
elev1	Lowermost elevation
elev2	Uppermost elevation
tax_remark	Taxonomic remarks
coll_remark	Collection remarks
sht_remark	Sheet remarks
cultivated	Cultivated flag
phenology	Flowering, fruiting condition

habitat	
barcode	Numeric value of barcode label
srcecde	Degree of certainty of type status
vouchid	Specimen is vouchered by pressed material
vouchsp	Indicates specimen, wood collection, greenhouse material
chrmcmt	Chromosome number

Assessment:

The plant families for Madagascar represented on the Botany Division Database are listed in Appendix B. Only 10% of the total plant collection held in the Botany Division of the Smithsonian Natural History Museum is currently inventoried. Therefore the plant specimens for Madagascar currently listed in the Botany Division database were taken from only 10% of the total plant collection. The following numbers of Madagascar plant records are currently listed in the Smithsonian Botany Division Database:

* 410 plant specimens currently catalogued in the database for Madagascar.
* 309 type plant specimens currently catalogued in the database for Madagascar.

The collection sites for these records can be mapped using the information stored in the geographic fields of this database (i.e., region, country, state, county, place, locality). A methodology has recently been presented for mapping this kind of plant information.[6]

Access:

Curator,
Division of Botany,
Museum of Natural History,
Smithsonian Institution,
Washington, DC 20560
USA

Tel: +1-202-357-1882
Fax: +1-202-786-2563

[6]Miller, R.I., J.R. Press, M. West, and R.M. Baldini. 1994. "Assessing Local Distribution of Threatened Species: A Case Study Considering the Threatened Plants of Italy." In Systematics and Conservation Evaluation by P.L. Forey, C.J. Humphries, and R.I. Vane-Wright, Clarendon Press, Oxford, England, 433 pp.

b. U. of Michigan, Museum of Zoology, Division of Herpetology

Description:

At the moment, the largest collection of data involving reptiles and amphibians in Madagascar are held in a database that contains information that covers the entire collection of the herpetology division in the Museum of Zoology at the U. of Michigan. This database includes reptile and amphibian specimens from around the world. This database is stored in the U. of Michigan Computing Center and it uses software named TAXIR. In 12 months the herpetology database will be installed on a PC network. In addition, the Madagascar file, which will include a gazetteer of localities, will be available on diskette.

Assessment:

The museum at the U. of Michigan was one of the first museums to convert its records into a digital format. This is the most complete available database with records of reptiles and amphibians in Madagascar. The Paris museum also contains a large collection of Madagascar reptile and amphibian records, but these are not electronically accessible at the present time.

Currently this database contains 2,665 amphibian records from Madagascar and these represent information about approximately 90-95% of the known Madagascar amphibian species. The database also contains 2,740 reptile records from Madagascar and these represent approximately 90% of the known Madagascar reptile species. Currently about 3,000 records for both amphibians and reptiles remain to be entered into the database.

The Division of Herpetology has established an accord with the Malagasy government that involves the deposit of specimens into museums in Madagascar (the precise terms of this accord are not available). These specimens are currently being deposited in the museum in Antananarivo. However, records of these specimens are not currently entered into a database.

Access:

Ron Nussbaum,
Curator of Madagascar Collection,
Division of Herpetology,
U. of Michigan,
Ann Arbor, MI

Tel: +1-313-747-2000
Fax: +1-313-763-4080
Email: r_anussbaum@um.cc.umich.edu

Chris Racksworthy,
Curatorial Assistant,
Divsion of Herpetology,
U. of Michigan
Ann Arbor, MI

c. U. of Chicago, Field Museum

Description:

An extensive database of bird observations has been established by a consortium of the following ornithologists:

* Steve Goodman, U. of Chicago
* Olivier Langrand, World Wide Fund for Nature,, Antananarivo
* Lucienne Wilmé World Wide Fund for Nature, Antananarivo

Steve Goodman spends nine months of the year in Madagascar and the other two scientists are based on the island.

The bird database is now part of the databases being maintained by ORSTOM in Antananarivo. This ornithological database is built using a software package entitled Fourth Dimension (translated from French). ORSTOM technicians have modified the database structure provided in Fourth Dimension to fit the needs of the bird database. The database has been adapted to receive field observations, published records, and unpublished records.

Assessment:

Meta-information regarding this database was not obtainable at the time of this project.

Access:

Dr. Steve Goodman,
Field Museum,
U. of Chicago,
Chicago, IL
USA

Tel: +1-312-922-9410 ext. 412
Fax: +1-312-663-5397

Dr. Olivier Langrand,
Boite Postale 738,
World Wide Fund for Nature,
Aires Protégées,
Antananarivo 101
Madagascar

d. FAO

Description and Assessment:

The Madagascar section of the 1990 FAO Forest Resources Assessment Project Report is presented in Appendix E. The FAO/UNESCO Soil Map is held in digital form at the UNEP/GRID office in Geneva and it contains the soils data for Madagascar. Two publications that describe the information on this map in detail are:

FAO/UNESCO. 1974. Soil Map of the World. Volume 1: *Legend.* FAO, Tipolitographia, Rome.

FAO/UNESCO. 1974. Soil Map of the World. Volume 6: *Africa.* UNESCO, Paris, France.

This soils map of Africa was originally prepared at the 1:5,000,000 scale of the topographic map series of the American Geographical Society. In addition, other information caches held by FAO include information about wood and wood products, land use, and freshwater fisheries.

Access:

K.D. Singh,
FAO,
Via delle Terme di Caracalla,
00100 Rome,
Italy

Tel: +39-6-5225-4115
Fax: +39-6-5225-5137

e. ORSTOM

Description:

This organization is just now completing the data input for databases which include extensive information about soils and climate in Madagascar.

Assessment:

I believe that this database is held in Madagascar. Information about the specific structure of this database was not collected since this current project focused upon materials held outside of the country.

Access:

Jon Marque Elouard (French speaker),
ORSTOM,
Boite Postale 4334,
Antananarivo 101
Madagascar

Francois Marie Gibon (English speaker)
ORSTOM,
Boite Postale 4334,
Antananarivo 101
Madagascar

f. UNEP/GRID-Nairobi

Description:

Holdings at UNEP/GRID as of June 1994 related to Madagascar biodiversity are as follows:

1. NDVI images every 10 days from 1981-1991 (7.6 km resolution) produced by the FAO.

2. Climatic data on a per station basis for various years.

3. Topographic map layers from the 1:1,000,000 Digital Chart of the World produced by the U.S. Defense Mapping Agency.

4. 1:1,000,000 Digital Tropical Forest Map of Madagascar produced by the WCMC.

Assessment:

UNEP/GRID-Nairobi needs to be contacted for specific information about these data holdings.

Access:

Laura Meszaros,
UNEP/GRID,
Nairobi,
Kenya

Tel: +254-2-623442
Fax: +254-2-624274
Email: laura.meszaros@unep.no

g. World Conservation Monitoring Centre

Plants Database

Description:

General Database Structure

Components	Fields
Names	* each component of the scientific name * source of the name * is it an accepted name, an orthographic variant, or a synonym * infrageneric classification * IUCN Red Data Book global conservation category * endemism code * distribution completeness * international trade * cultivation
Distributions	* links distribution to a WCMC are record * geographic qualifiers * conservation status
Data Sources	* type of reference * date of publication * authors * title * subtitle * source * publisher * language * location * keywords * citation notes * abstract

Assessment:

The WCMC Plant Database primarily tracks the identities of plants classified as globally threatened. Very limited geographical location information for threatened plant species in Madagascar is available on this database.

The list of plant families and the number of genera represented in this database is presented in Appendix C.1. A detailed status report of the endangered and threatened plants occurring in Madagascar and stored on the WCMC Plant Database is presented in Appendix C.2. The following listing summarizes the information presented in Appendix C.

Statistical Summary Count of Threatened Plants in Madagascar

Threatened Plants in Madagascar	Endemic	Non-endemic	Total
Extinct/Endangered	37	0	37
Endangered	44	0	44
Endangered/Vulnerable	1	0	1
Vulnerabl	54	1	55
Rare	34	0	34
Indeterminate	24	1	25
All Other Plants in Madagascar			
Insufficiently known	190	0	190
No information	120	73	193
Not threatened	20	36	56

Access:

The Species Unit,
World Conservation Monitoring Centre,
219 Huntingdon Road,
Cambridge CB3 0DL
UK

Tel: +44-223-277314
Fax: +44-223-277136

Animals Database

Description:

The WCMC Animals Database primarily tracks the identities of animals classified as globally threatened.

Assessment:

Current geographic distribution information stored in the Animals Database is very limited. The following list represents the current[7] number of species records for Madagascar held by the WCMC Animals Database.

Species Records for Madagascar in the WCMC Animals Database

Taxonomic Group	Species Records
Mammals	111
Birds	31
Reptiles	33
Amphibians	0
Fishes	0
Insects	29
Crustacea	15
Molluscs (Bivalves)	2
Molluscs (Gastropods)	317
Total	538

General Reports: A WCMC report on the status of biodiversity in Madagascar is presented in Appendix D.

Access:

The Species Unit,
World Conservation Monitoring Centre,
219 Huntingdon Road,
Cambridge CB3 0DL
UK

Tel: +44-223-277314
Fax: +44-223-277136

h. Plants Database Consortium

Description:

This is a collaborative project between the Missouri Botanical Gardens (MBG), the Laboratoire de Phanerogamie of the Museum National d'Histoire Naturelle (P) in Paris and the two principal

[7]As of June 22, 1994.

botanical institutions in Madagascar: Parc Botanique et Zoologique de Tsimbazaza (TAN) and FO.FI.FA (TEF).[8] This project is entitled "Conspectus of the Vascular Plants of Madagascar" and each of these institutions is an equal partner. This project is funded by the National Science Foundation with in-country support from USAID/Madagascar.

This database is comprised of three main components:

1. Names: Information about scientific nomenclature. This database currently contains 25,000 name records for species and infraspecies in Madagascar.

2. Exsiccatae: Information about specimen records from field observations and museum specimens. This includes geographical information, whenever possible, about record locations. This database currently contains 30,000 records of this type. Within the next several months, 30,000 additional records of this type are to be added.

3. Bibliography: Information about all books and journal articles pertaining to the plants of Madagascar. This database currently contains approximately 2,000 bibliographic records.

This information was provided by Dr. George E. Schatz in June from Antananarivo.

Assessment:

This database is called TROPICOS at the Missouri Botanical Gardens in St. Louis and it is run on an IBM RS/6000. In Madagascar the database is pcTROPICOS and with a Revelation run-time license it runs on any PC. This is by far the best available database for biological and geographical information about vascular plants in Madagascar.

Access:

Dr. Peter Lowry,
Curator,
Africa & Madagascar Department,
Missouri Botanical Garden,
P.O. Box 299,
St. Louis, MO 63166-0299
USA

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[8]The acronyms in parentheses are the official herbarium acronyms and these institutions prefer to be referred to using these acronyms.

George E. Schatz,
Associate Curator,
Africa & Madagascar Department,
Missouri Botanical Garden,
P.O. Box 299,
St. Louis, MO 63166-0299
USA

Tel: +1-314-577-9512
Fax: +1-314-577-9596

3. Maps and Images

3.1 Landsat Thematic Mapper

Landsat Thematic Mapper (TM) images provide 30 m resolution, multi-spectral land cover information useful at mapping scales of 1:100,000 or smaller. Each TM image covers 185 by 185 km. Many different organizations hold TM images for Madgascar, of which CSIR is by far the mosr important. Below is a summary of the archives encountered during the survey.

a. Eosat, Inc.

Description:

Eosat stocks 111 TM images covering Madagascar. These are available for $4,500 per image.

Access:

Eosat, Inc.
Customer Services,
4300 Forbes Boulevard,
Lanham, MD 20706
USA

Tel: +1-301-552-0642 or 1-800-344-9933
Fax: +1-301-552-3762

b. USGS/EROS Data Center

Description:

USGS/EROS Data Center stocks 16 TM images for Madagascar acquired between 1984-90. These are available only on 6250 bpi CCT's in system corrected, path-orientated format for $1,500 per image - one-third of the regular price. These images are off the shelf products and parameters such as map projection, resampling technique, and format may not be changed.

Access:

(same address as Eosat).

c. CSIR

Description:

With the deterioration of Landsat 5 and the demise of Landsat 6, only line of sight ground receiving stations can receive new Landsat images. CSIR is the only receiving station that receives current Landsat images for Madagascar. They have hundreds of 1993-94 Landsat TM images. They also receive and stock SPOT images.

Access:

I.J. Marais,
Satellite Applications Centre,
CSIR,
P.O. Box 395,
Pretoria 0001
South Africa

Tel: +12-841-2911
Fax: +12-841-4720
Email: imarais@sac.csir.co.za

d. U. of Maryland

Description:

The following images area available:

Sensor	Path/Row	Date	Scene Center
MSS	158/71	03/01/85	15°54'S 49°23'E
TM	160/74	05/29/89	23°13'S 45°18'E
TM	158/71	09/07/90	15°54'S 49°23'E
TM	158/70	09/23/90	c.175 km N of 158/71

Access:

Mark Heinicke,
U. of Maryland,
Department of Geography,
Lefrak Hall,
College Park, MD 20742-8225
USA

Tel: +1-301-405-7642

3.2 Individuals and Institutions

The following individuals and institutions hold current maps which identify biodiversity resources. Access information for each institution or individual is included in the front portion of each section. Subsequently, a description and an assessment of each map is provided.

a. Conservation International

The mapping program at Conservation International, directed by Silvio Olivieri, is currently producing a map that will display deforestation patterns in Madagascar in relation to protected areas. Maps 1 and 2 below will be overlaid and the resulting map will be published by Conservation International in the Fall 1994. This published map will help to indicate forested areas in Madagascar in need of protection.

In January 1995, Conservation International is holding an expert meeting in Madagascar. This will be organized similarly to the meetings of this kind held previously in Manaus, Brazil, and in Papua New Guinea. Scientists with expert knowledge of particular elements of biodiversity in that part of the world are all brought together to map all the known information in regard to biodiversity. This approach produces up-to-date biodiversity maps, produced in successive refinments derived from consultations with experts with first-hand knowledge of the area under study. The biodiversity experts for Madagascar will be brought together in Antananarivo in January 1995.

Access:

Silvio Olivieri,
Conservation International,
1015 18th Street NW,
Suite 1000,
Washington, DC 20036
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Map 1

Description:

Map Title:	Major Madagascar Vegetation Types
Map projection:	Lambert Azimuthal
Scale:	1:1,000,000
Method:	Manual interpretation of Landsat TM data
Digital Formats:	ARC/INFO, CISIG (A GIS system developed by CI)
Map Caption:	41 vegetation classes; Vegetation codes and classes listed in Appendix 5

Assessment:

The vegetation types presented on this map were developed in the 1980's by a Malagasy Ph.D student named Faramalala Miadana Harison. This 1:1,000,000 unpublished map is entitled "Carte des Formations Végétales de Madagascar". This is probably the best country-wide map vegetation classification available for Madagascar at the present time (August 1994). Codes and vegetation classes used in this map are presented in the following pages.

Légende de la carte de végétation au 1/1 000 000

I - Zones éco-floristique orientale de basse altitude : 0 à 800 m.

1 Forêt dense humide sempervirente.

2 Formation secondaire : Saveka à *Ravenala madagascariensis*.

3 Savane boisée.

4 Savane.

5 Forêt littorale.

6 Mosaïque savane-culture-plantation.

II - Zone éco-floristique occidentale de basse altitude : 0 à 800 m.

7 Forêts denses sèches.

8 Formations secondaires.

9 Faciès karstique.

10 Faciès karstique dégradé.

11 Faciès riplicole.

12 Zone à mangrove.

13 Dunes et sables salés.

14 Savane boisée.

15 Savane.

16 Mosaïque forêt-savane.

III - Zone éco-floristique orientale de moyenne altitude : 800 à 1800 m.

17 Forêt dense humide sempervirente saisonnière.

18 Formation secondaire.

19 Savane boisée ou non.

20 Mosaïque forêt-savane.

IV - Zone éco-floristique occidentale de moyenne altitude : 800 à 1800 m.

21 Forêt sclérophylle basse très dégradée.

22 Savane

V - Zone éco-floristique particulière du Sambirano : 0 à 800 m.

23 Forêt dense ombrophile.

24 Formation secondaire.

25 Savane boisée ou non.

26 Mosaïque savane-culture-forêt secondaire.

VI - Zone éco-floristique méridionale de basse altitude : 0 à 300 m.

27 Forêt dense sèche à *Didierea* et Euphorbes.

28 Fourré dense sec.

29 Formation secondaire.

30 Faciès riplicole.

31 Savane.

32 Mosaïque fourré - sol nu.

VII - Zone éco-floristique montagnarde : 1800 à 2000 m.

33 Forêt dense humide basse montagnarde.

34 Fourré à *Philippia*.

35 Savane de montagne.

VIII - Zone éco-floristique des hautes montagnes : alt. > 2000m.

36 Fourré dense.

37 Savane d'altitude.

38 Plantation.

39 Marécages.

40 Riziculture.

41 Sol nu.

42, 43 } rien donné

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Forêt dense humide sempervirente

Formation secondaire

Savane boisée

Savane

Forêt littorale

Mosaïque savane-culture-plantation

Forêt denses sèches

Formations secondaires

Faciès karstique

Faciès karstique dégradé

Faciès ripicole

Zone à mangrove

Dunes et sables salés

Savane boisée

Savane

Mosaïque forêt-savane

Forêt dense humide sempervirente saisonnière

Formation secondaire

Savane boisée ou non

Mosaïque forêt-savane

Forêt sclérophylle basse très dégradée

Savane

Forêt dense ombrophile

Formation secondaire

Savane boisée ou non

Mosaïque savane-culture-forêt secondaire

Forêt dense sèche à Didiereas et Euphorbes

Fourré dense sec

Formation secondaire

Faciès ripicole

Savane

Mosaïque fourré - sol nu

Forêt dense humide basse montagnarde

Fourré à Philippia

Savane de montagne

Fourré dense

Savane d'altit

Plantation

Marécages

Riziculture

Sol nu

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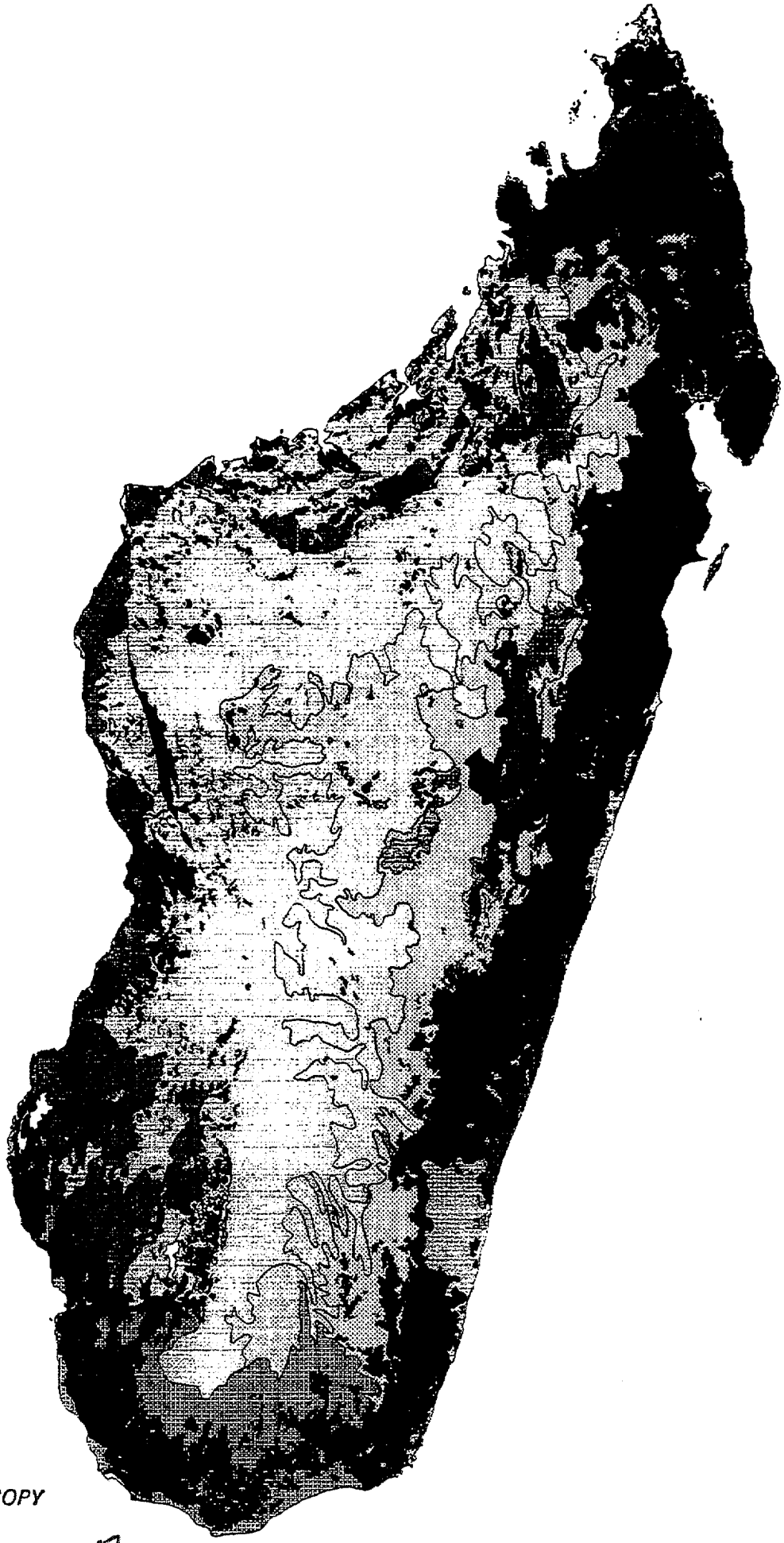

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Map 2

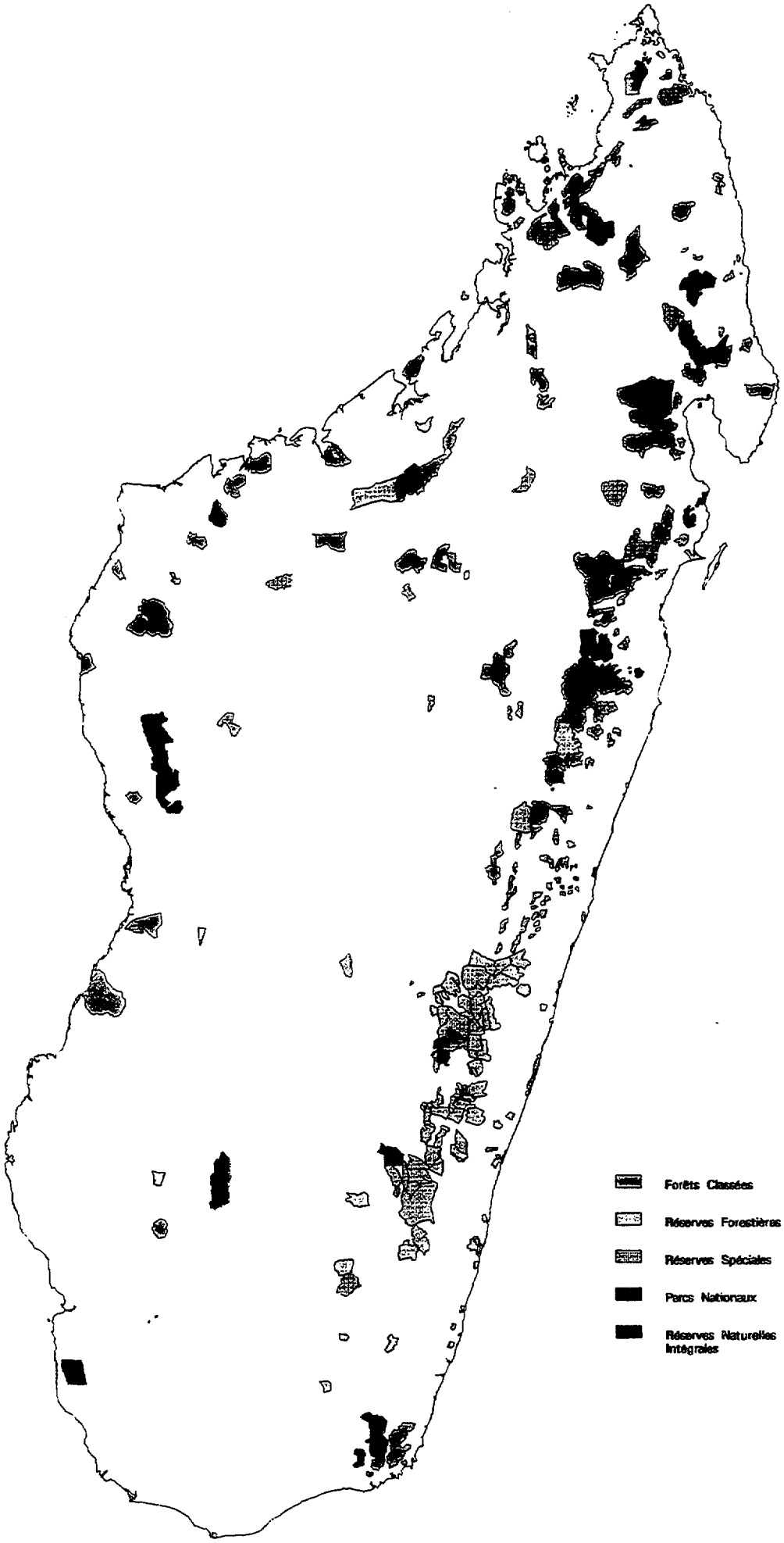
Description:

Map Title:	Protected Areas
Map projection:	Lambert Azimuthal
Scale:	1:2,000,000
Method:	A product of the COEFOR mapping project
Digital Formats:	ARC/INFO, CISIG
Map Caption:	Five classes of protected areas recognized in Madagascar: * Forêts Classées * Réserves Forestières * Réserves Spêciales * Parcs Nationaux * Réserves NaturellesIntêgrales

Assessment:

An excellent representation of protected areas in Madagascar. The available boundaries data were gathered with the cooperation of ANGAP in Antananarivo. This is the protected area map that will be superimposed on the vegetation map.

This map is at a small map scale but it nevertheless clearly identifies the current boundaries of many of the protected areas on the island. The data used to produce this map are held at Conservation International in Washington, DC.


Forêts Classées
Réserves Forestières
Réserves Spéciales
Parcs Nationaux
Réserves Naturelles Intégrales

Map 3

Description:

A map of landcover and deforestation patterns in the Mahajariga-Ankarafanstsika region of Madagascar. Ten protected area and landcover classes are presented on the caption for this map. The data layers used to produce this map were:

* major vegetation
* 1985 deforestation
* 1991 deforestation
* 1985 settlement areas
* 1991 settlement areas
* reserve boundaries
* villages
* roads
* rivers

This map is at approximately a 1:750,000 scale. The major vegetation on this map is defined from the satellite imagery interpretation done by Faramalala Miadana Harison. Features such as roads and rivers were taken from the Digital Chart of the World. The base data for this map were produced by the original COEFOR project. The protected area boundaries were digitized using the CISIG system. The map is stored in both CISIG and ARC/INFO at Conservation International in Washington, DC.

The L'Ankarafantsika protected area is 60,520 ha and it is categorized by IUCN as a strict nature reserve. It is located in the area of 15°59'-16°22'S and 45°56'-47°12'E.[9]

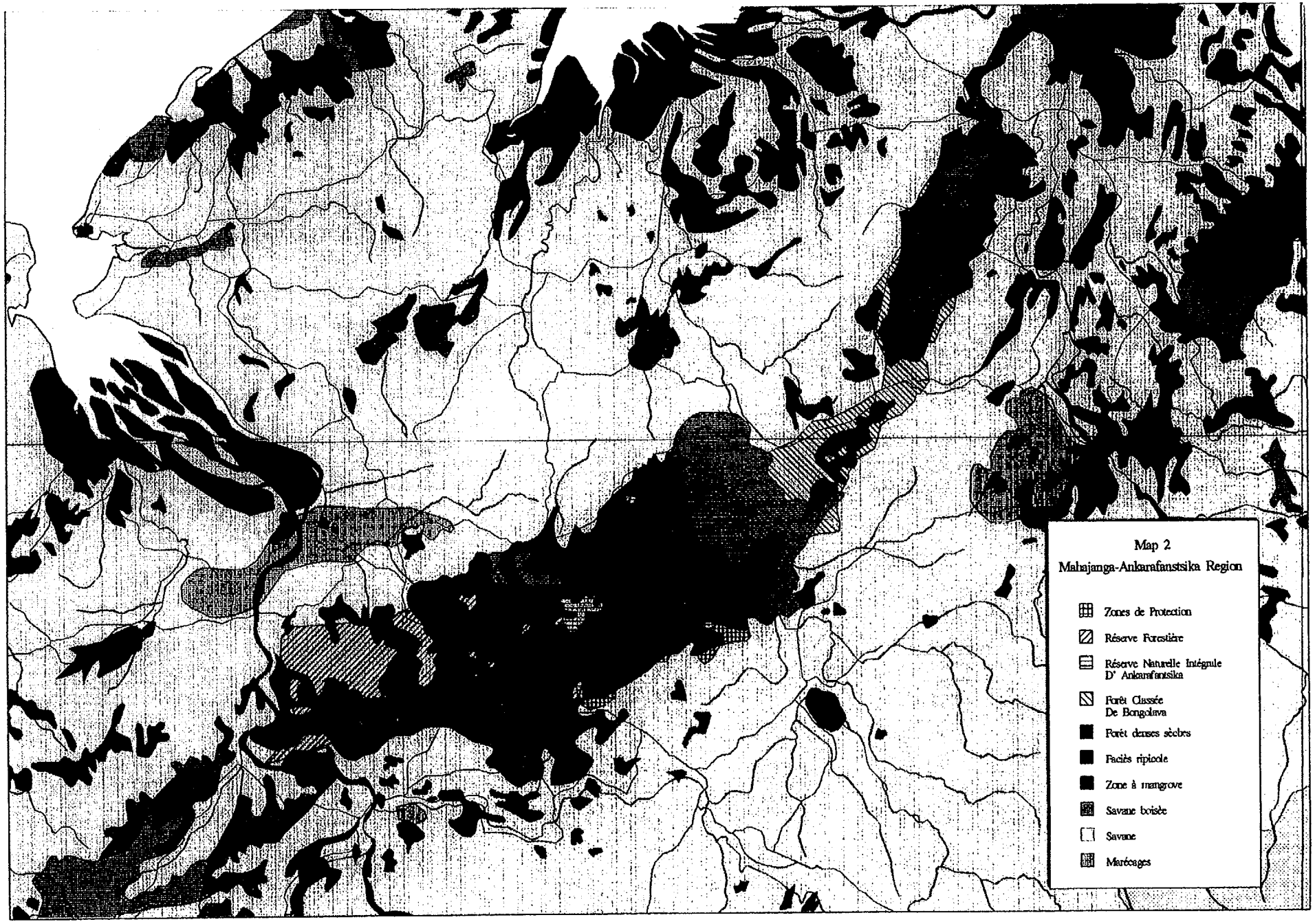
Assessment:

This map was produced from a manual interpretation of aerial photos, Landsat, and SPOT imagery.[10] This is an excellent, relatively high resolution representation of an important protected area region. This map is presented to demonstrate the capabilities of high resolution mapping for monitoring a protected area in Madagascar. Projects focused upon protected areas that produce maps of this type are being coordinated by ANGAP in Antananarivo.

---

[9]These location coordinates are reprinted from IUCN, UNEP, and WWF. 1987. Madagascar: An Environmental Profile. Edited by M.D. Jenkins, IUCN, Gland, Switzerland and Cambridge, UK, 374 pp.

[10]Conservation International should be contacted for additional information regarding the format and availability of this map.


Map 2
Mahajanga-Ankarafantsika Region
Zones de Protection
Réserve Forestière
Réserve Naturelle Intégrale D' Ankarafantsika
Forêt Classée De Bongolava
Forêt denses sèches
Faciès ripicole
Zone à mangrove
Savane boisée
Savane
Marécages

Map 4

Description:

An approximately 1:100,000 scale map of La Rêserve Naturelle Integrele No. 3 de Zahamena in Madagascar[11] produced by Conservation International. The Zahamena protected area is categorized by IUCN as a strict nature reserve. It is approximately 73,160 ha in area and it is located in the area of 17°26'-17°44'S and 48°56'-49°00'E.[12]

Assessment:

This map presents a good example of a regional layout for a protected area in Madagascar. This is a map which represents the current status of the Zahamena protected area in Madagascar.[13] Historically, given the paucity of detailed location information for many protected areas in Madagascar, this type of map may prove to be a very useful tool in the future.

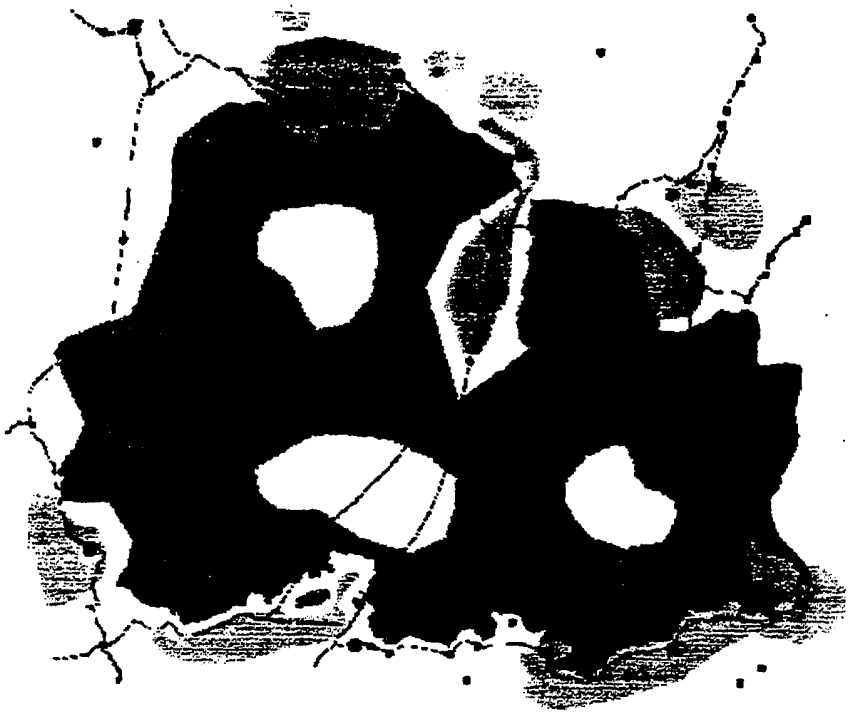
---

[11]Conservation International should be contacted for additional infomation regarding the formats and availability of this map.

[12]These data are reprinted from IUCN/UNEP/WWF. 1987. Madagascar: An Environmental Profile. Ed. M.D. Jenkins, IUCN, Gland, Switzerland and Cambridge, UK. 374 pp.

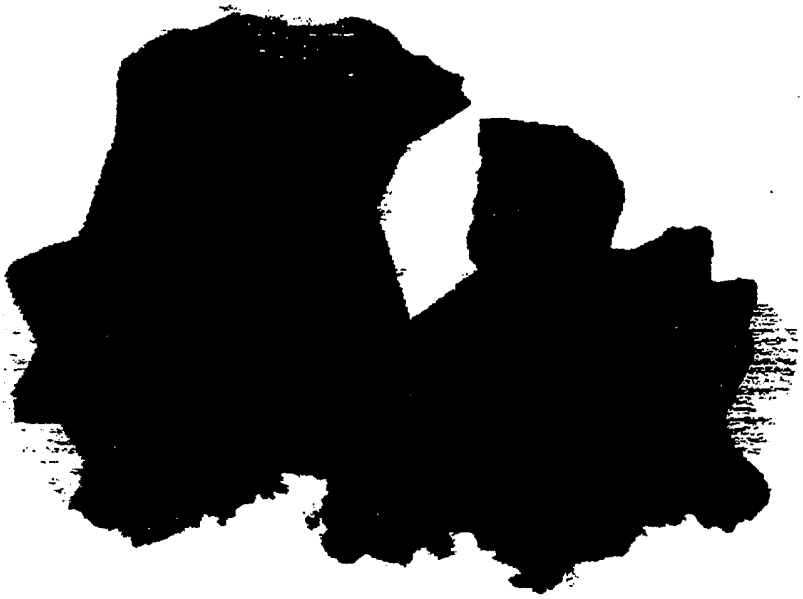
[13]The illustration presented here is supported by a GIS map produced with the CISIG mapping system being currently used by Conservation International.

Zahamena



La Réserve Naturelle Integrale No. 3 de Zahamena, localisée à l'est du Lac Alaotra, fut établie en 1927 et délimitée en 1966. Elle protége le chateau d'eau de la region de l'Alaotra et de la rivière Onibe. Zahamena est une forêt tropicale humide dans laquelle habitent 13 especes de lemuriens et qui montre une diversité importante à cause du changement d'altitude de l'Est à l'Ouest (de 500 à 1500 mètres). La réserve couvre une superficie de environ 73.000 hectares. Les pressions des villages voisins ont causé une déforestation des zones limitrophes de la réserve, qui metent en peril sa fonction écologique.

La carte produite par CISIG montre les limites officielles de la Réserve de Zahamena, avec ses zones de protection, entourée des villages. La partie Sud de la Réserve limite avec la rivière de Onibe. Cette carte montre aussi des zones prioritaires pour la recherche scientifique sur la biodiversité (en jaune) et des zones de moyennes et fortes pressions (rose et orange) et les comités villageois établis par le projet CI-Zahamena en 1993 pour impliquer les habitants dans la conservation et le développement de leur ecosystème.



Cette image montre la superposition des aires encore boisées (selon une image satellite de Juin, 1990) sur les limites de la réserve, et sa zone de protection. Elle montre que 13 % de la réserve a été déjà defrichée avant 1990. L'image précedente montre (en violet foncé) des aires où on a constaté des défrichements récents. Etant donné que l'image satellite a été interpreté manuellement, ces chiffres sont approximatifs et sujet à des vérifications sur terrain.

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b. Glen M. Green

Dr. Glen M. Green has been working to document deforestation patterns and conservation priorities in Madagascar for a number of years. Much of this work was done in collaboration with Robert W. Sussman at Washington U. in St. Louis. In 1990 Glen M. Green and Robert W. Sussman produced the principal modern study of deforestation in Madagascar which employed the interpretation of satellite imagery.[14]

The grids in maps 1-4 present an updated perspective of both the topographic and deforestation maps currently available for Madagascar. Map 5 represents the modern day capability for mapping and monitoring deforestation on the island. Map 6 presents the capability of imagery interpretation for high resolution map production on the island.

Dr. Green most recently conducted work in Madagascar at the beginning of 1994. Thus the status of the data presented in these maps are contemporary. Two important recent studies conducted by Dr. Green in Madagascar which include maps of biodiversity resources are presented in Appendices F and G.

Access:

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Email: ggreen@crsa.bu.edu

[14]Green, Glen M. and R.W. Sussman. 1990. "Deforestation History of the Eastern Rainforests of Madagascar from Satellite Images." *Science* 248:212-215.

Map 1

Description:

A guide to the 1:100,000 topographic map sheets currently available from the government map office in Madagascar (FTM). These maps use a Laborde projection[15] that displays elevation information at 25 m contour intervals. The printed base map used here as a template by Dr. Green was originally produced for the 1:50,000 quadrangles. However the quadrangles marked with X's on this base map indicate currently available 1:100,000 map sheets.

Assessment:[16]

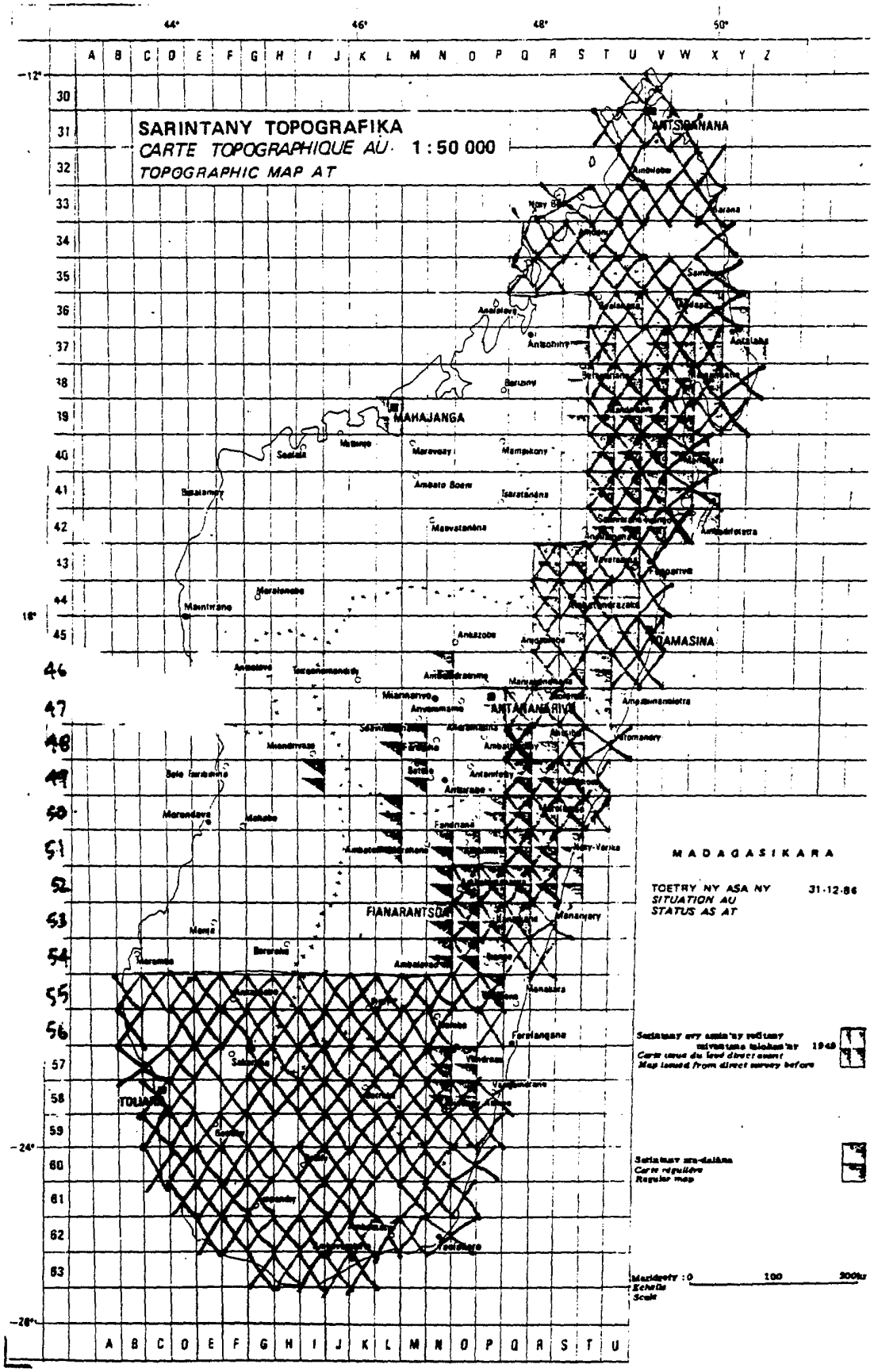
Glen Green has spent a significant amount of time over the last several years using maps and conducting landscape research in Madagascar. He therefore was in an excellent position to chronicle available topographic maps on the island.

---

[15]This projection type was originally developed by the French and it is only used for maps of Madagascar.

[16]The Assessments for Maps 1, 2, and 3 are identical and are presented here only.

TOPO 1:100,000



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Map 2

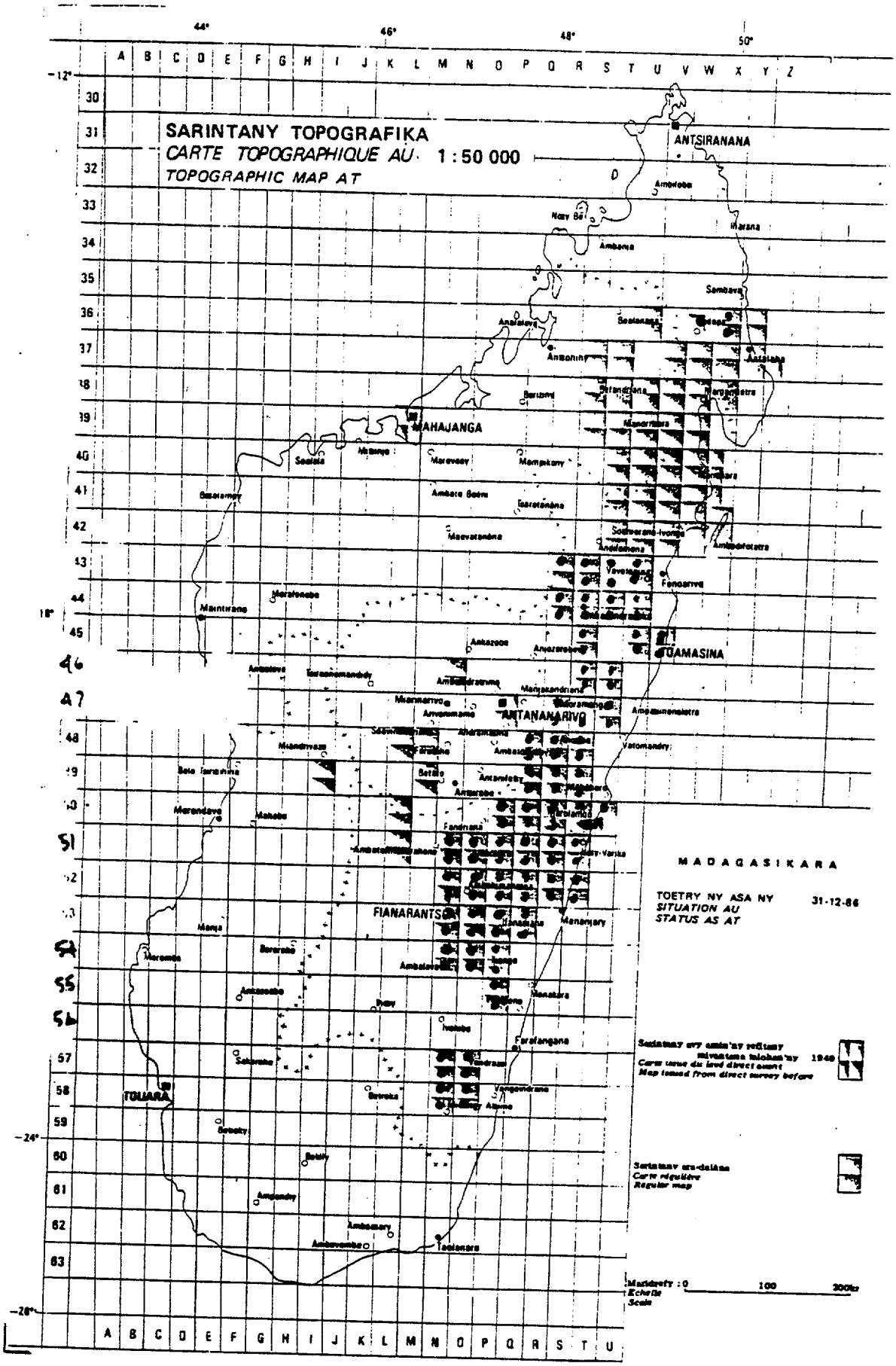
Description:

A guide to the 1:50,000 topographic map sheets currently available from the government map office in Madagascar (FTM). These maps use a Laborde projection that displays elevation information at 25 m contour intervals. The quadrangles marked with X's indicate currently available 1:50,000 map sheets.

Assessment:

The assessment for Map 1 applies here.

TOPO. 1:50,000 July 21, 1993



39

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Map 3

Description:

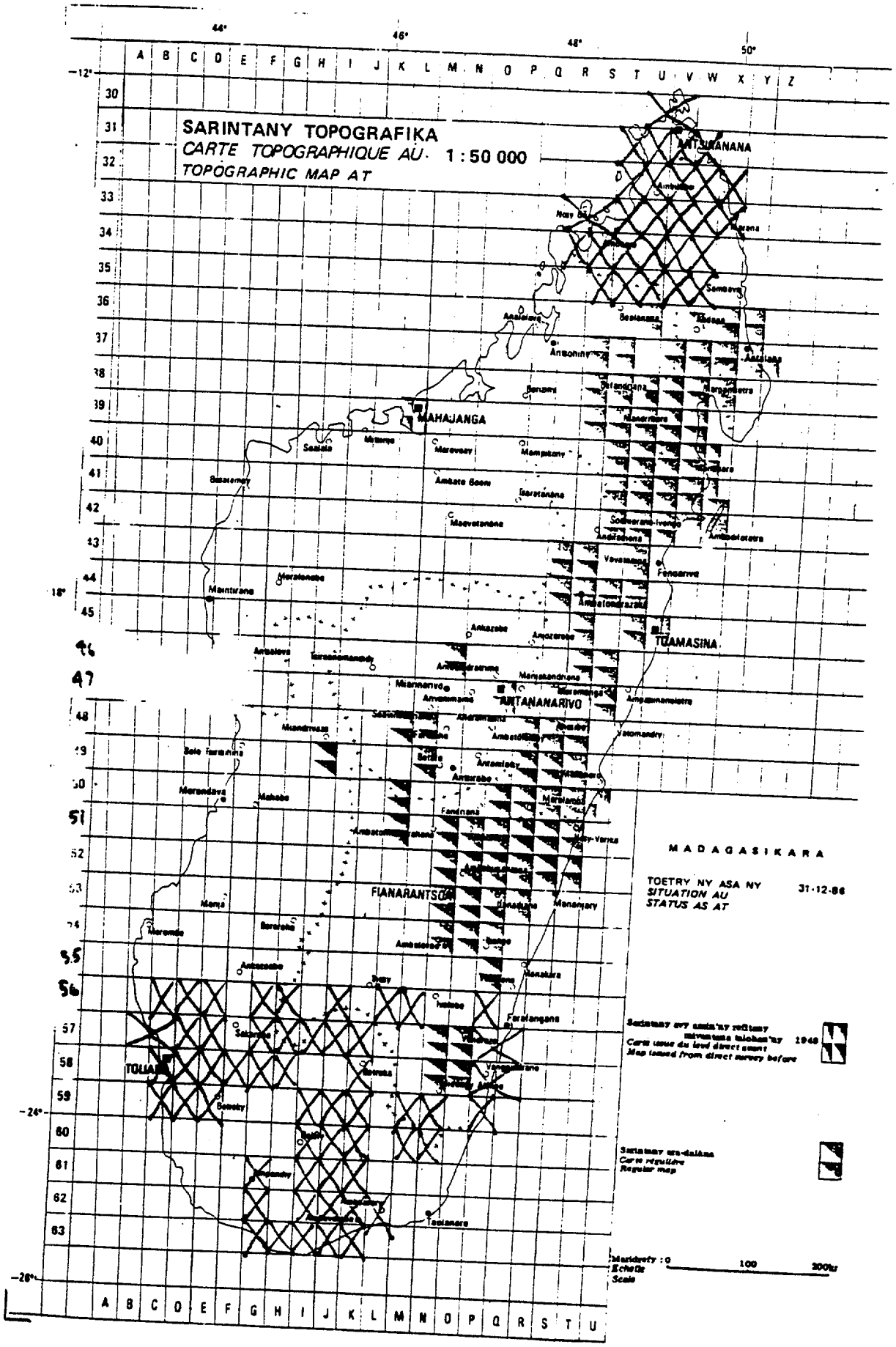
This illustration indicates the availability of 1:100,000 scale forest maps available from and produced by the Department of Water and Forests (Direction des Eaux et Forêts) in Madagascar. The original printed map represented 1:50,000 topographic quadrangles. Here this map is being used to represent the current coverage of the available 1:100,000 forestry maps. The quadrangles with an X indicate areas for which the forestry maps are available.

Assessment:

As indicated on this chronicle, map sheets are available for only limited areas in the north and south of the island. Also these forest maps are of a relatively generalized nature and are of very limited use for any site specific projects.

4/6

Foresting Maps 1:100,000



41 BEST AVAILABLE COPY

Map 4

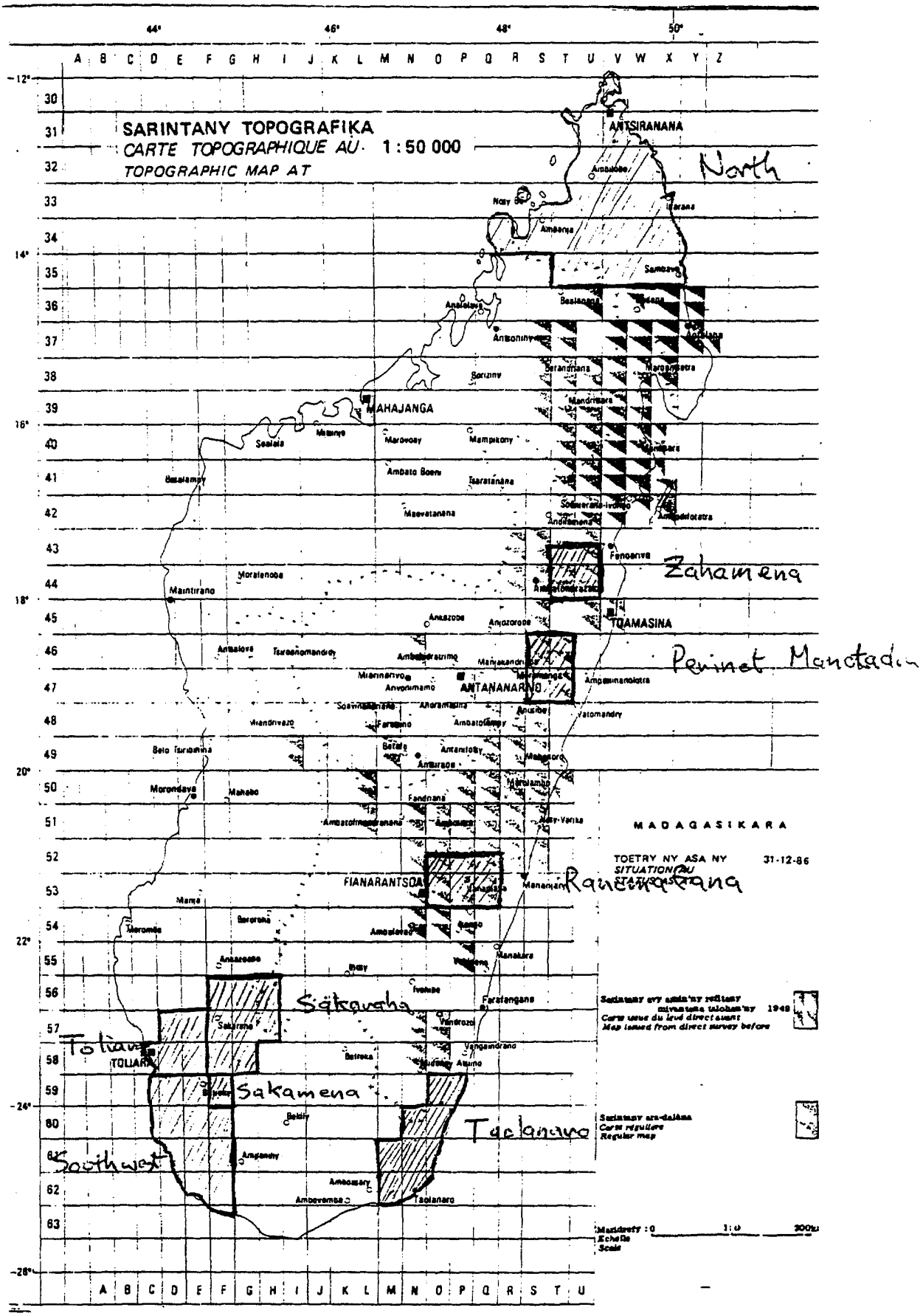
Description:

These are the specific areas for which deforestation maps have been produced or are currently being produced by Glen Green, often working in association with Robert Sussman. These zones generally include designated protected areas. The hand-lettered titles on this map of zone localities are the zone names used by Dr. Green. These names often are also the names of the protected areas included within these zones.

Assessment:

These deforestation maps are by far the most useful deforestation maps produced for these areas in Madagascar. These maps are produced employing a manual interpretation of TM satellite imagery. Map 5 presents a specific example of one of these maps.

Deforestation Maps in Progress



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Map 5

Description:

This is an example of a specific deforestation map for the Ranopiso Quadrangle in Madagascar. The white and black classes represent the forested and non-forested areas as of 1950. The color classes represent deforestation patterns derived from manual interpretations of Landsat images from 1973 and 1982.

Assessment:

The classes on this illustration well represent the capability for the documentation of forest and deforestation patterns in Madagascar. This demonstrates clearly that the simple manual interpretation of satellite imagery produces an effective monitoring instrument.

Ranopiso Quadrangle

Not Forested 1950
Forested
Deforested 1950-1972
Deforested 1972-1981

46

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Map 6

Description:

A map illustration contained in a section of the CIESIN Report presented in Appendix G. This grid arrangement exemplifies the capacity of fine resolution interpretation of satellite imagery in a single locale within Madagascar. Represented on this grid are linear data representing the vegetation canopy.

Assessment:

This illustration represents a small area in Madagascar of approximately 1-2 km within the Beza-Mahafafly Special Reserve.[17] The collection of comprehensive field survey data in this area permitted this relatively very high resolution imagery interpretation indicated by the classes used in this illustration. Six of these classes represent specific plant species while the rest represent specific plant species groupings. This illustration may represent the finest resolution of canopy species done for any area in Madagascar.

[17]The linear data presented here result in thin colors to represent the canopy data distribution.

Ranopiso Quadrangle

Not Forested 1950
Forested
Deforested 1950–1972
Deforested 1972–1981

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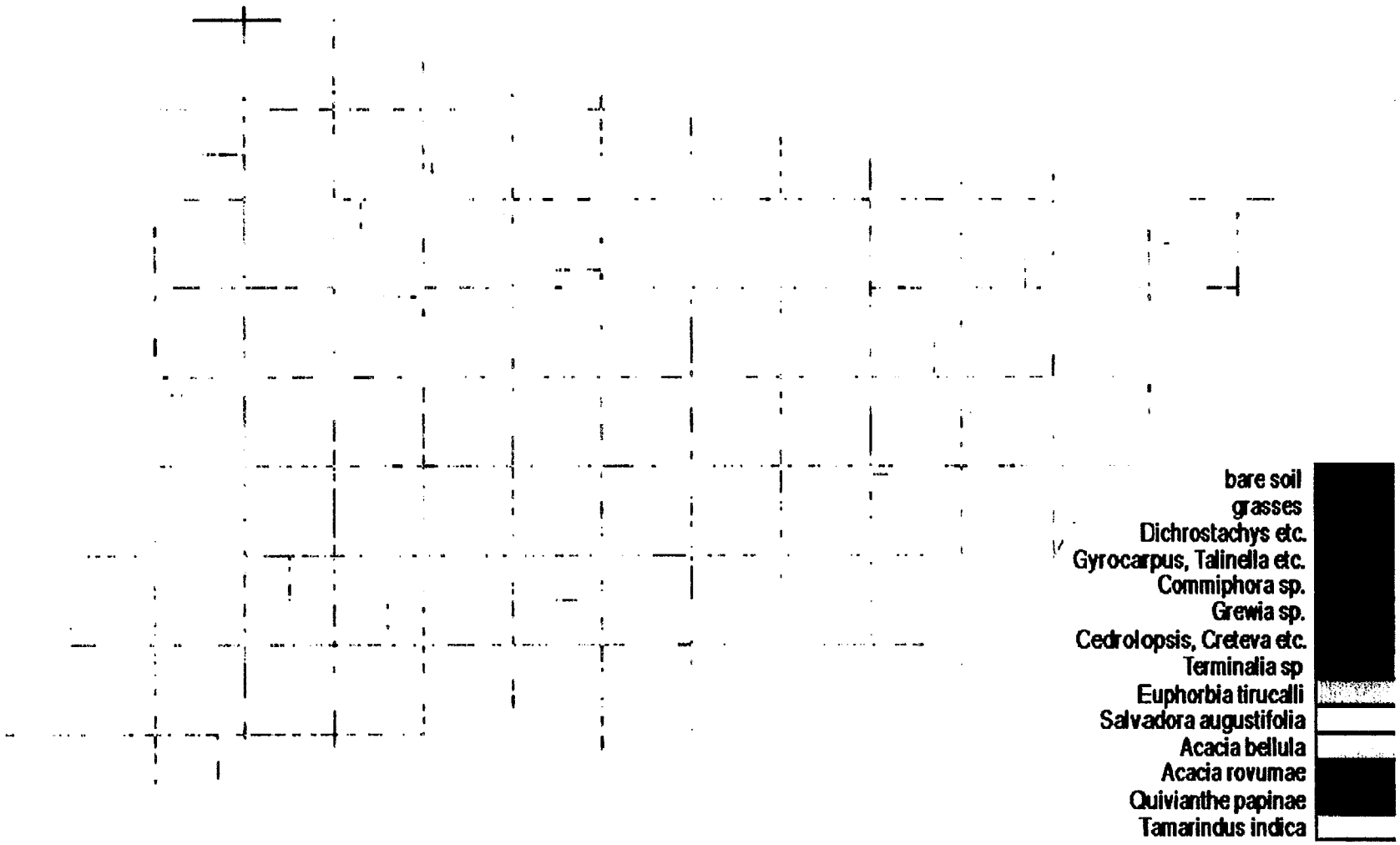
Canopy Species
Beza-Mahafaly Special Reserve



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Map 7

Description:

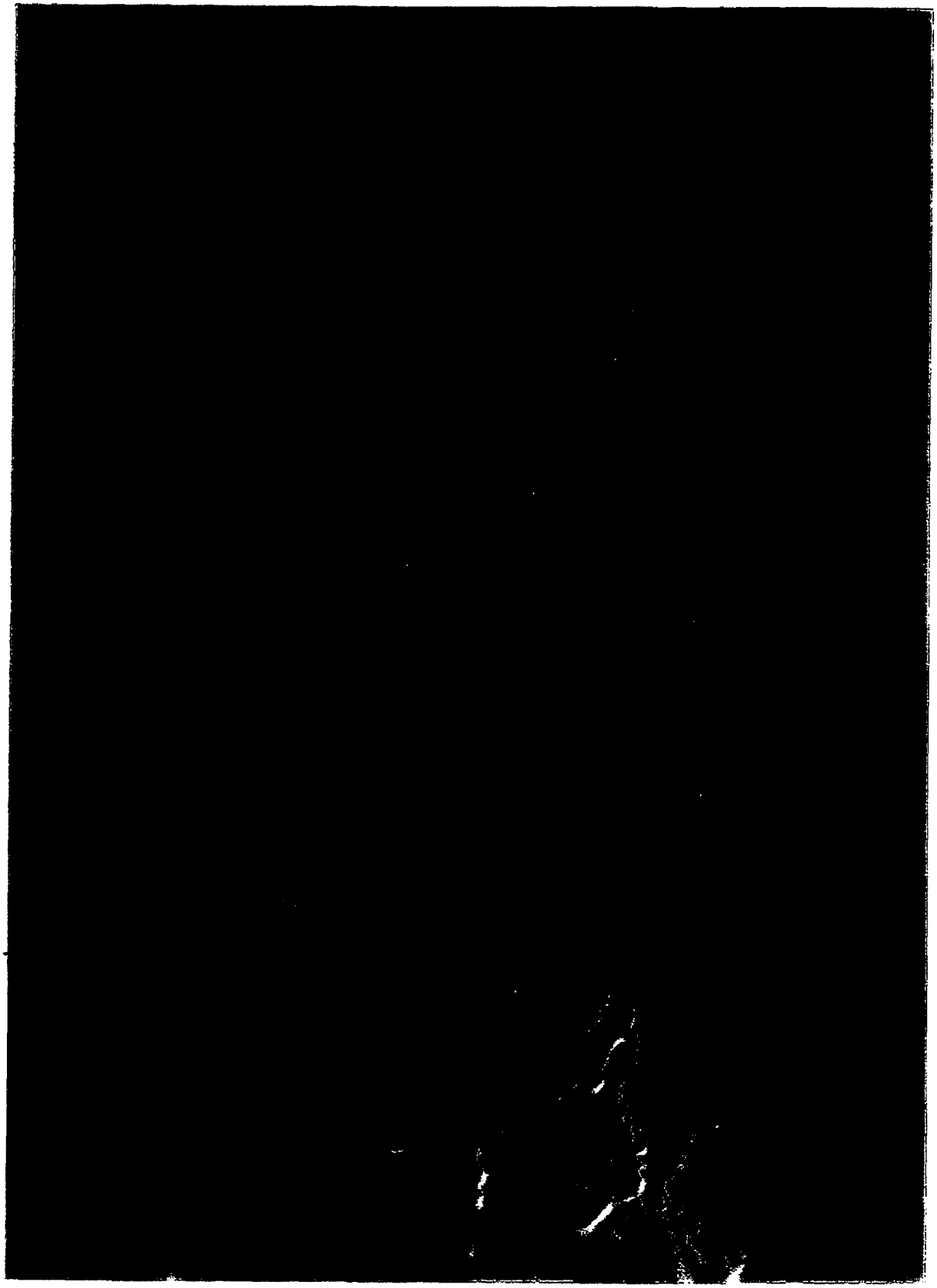
The data boundaries on this map were derived from a comparison of data obtained from 1957 aerophotographs, 1957-1976 MSS imagery, and 1976-1984 MSS imagery. The green color represents forested areas, the gray color non-forested areas, and the red and blue colors represent deforested areas.

Assessment:

In this map, data derived from interpretation of aerophotography and satellite imagery are overlaid upon a shaded relief elevation image. The background shaded relief image was produced by digitizing elevation data from a topographic map. This map presents an excellent depiction of deforestation history in relation to the elevation gradient in the Mantady region. The techniques used to produce this map will provide valuable tools for monitoring deforestation changes on the island.

This map is reproduced from:

Green, G.M. 1994. Remotely Sensed Determination of Deforestation History and Topographic Controls: Mantady National Park and Surroundings. Unpublished report presented to Randall A. Kramer, School of the Environment, Duke U.



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c. State U. of New York at Stonybrook

Dr. Patricia Wright directs the Institute for the Conservation of Tropical Environments (ICTE) at the State U. of New York at Stonybrook (SUNY). Over the last several years a number of scientists have traveled to Madagascar from this institute to conduct research on various vertebrate species, particularly lemurs. ICTE currently provides the infrastructure for management of the Ranomafana National Park Project. A GIS is currently being organized for this park.

Six of the 1:50,000 scale topographic maps covering the area of the park (418,000 ha) are currently being traced to mylar. This area includes the park and its extension and the forests to the north, south, and on the escarpment. In collaboration with USGS, these overlays will be used to create a Digital Elevation Model (DEM) for the park area. It is expected that this DEM will be completed by the end of 1994.

Access:

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Fax: +1-516-632-7692

d. World Conservation Monitoring Centre

WCMC has produced several reports and publications during the past several years that include maps of important Madagascar biodiversity resources. These are presented on the following pages.

Access:

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219 Huntingdon Road,
Cambridge CB3 0DL
UK

Tel: +44-223-277314
Fax: +44-223-277136

Map 1

Description:

Displayed on this map are:

Six vegetation types:
* spiny desert
* savanna and steppe
* savoka (degraded forest)
* dry deciduous forest
* dense rain forest
* montane forest

Four protected area types:
* national park (2)
* nature reserve (11)
* special reserve (23)
* private reserve (2)

Sixteen critical sites are also identified on this map.

Assessment:

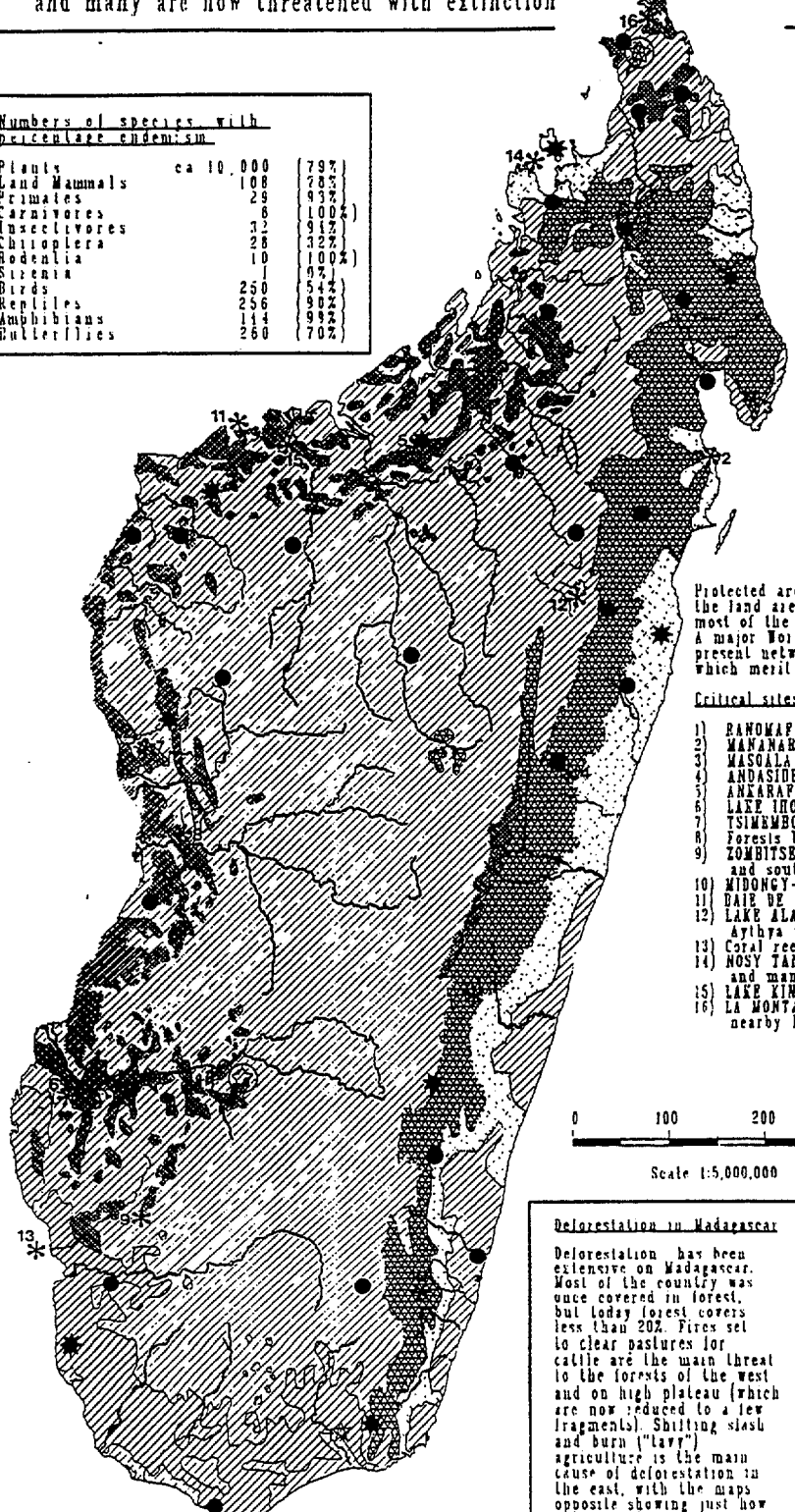
Map 1 was produced in 1991 for a Critical Ecosystems Project that WCMC conducted for the World Bank. This project collected and compiled information and mapped 'critical ecosystems' for the countries of Africa. This represents the best map of 'critical ecosystems' available as of 1991 based upon the literature review conducted at WCMC.

MADAGASCAR
Critical Ecosystems

Madagascar, the fourth largest island in the world, has been separated from the African mainland for at least 100 million years. As a result of this long separation and its varied topography and climate, its fauna and flora have developed in isolation and are exceptionally diverse, and unique. Madagascar's flora is one of the richest in the world with at least 10,000 species, of which almost 80 percent are found nowhere else. No other country in Africa has such a high level of endemism. Although the diversity of the fauna is comparatively modest, the degree of endemism is again very high. The majority of the native terrestrial animals are dependent on forested or wooded areas, and many are now threatened with extinction as a result of habitat destruction.

Numbers of species with percentage endemism

Plants	ca 10,000	(79%)
Land Mammals	108	(78%)
Primates	29	93%
Carnivores	6	(100%)
Insectivores	32	91%
Chiroptera	28	32%
Rodentia	10	(100%)
Sirenia	1	0%
Birds	250	(54%)
Reptiles	256	(90%)
Amphibians	144	99%
Butterflies	260	(70%)



Present Vegetation

- Spiny Desert
- Savanna and Steppe
- Savoka (Degraded Forest)
- Dry Deciduous Forest
- Dense Rain Forest
- Montane Forest

Protected Areas of Madagascar

	Number	Area (km)
National Park	2	997 4
Nature Reserve	11	5695 42
Special Reserve	23	3665
Private Reserve	2	N/A

Protected areas cover approximately 10,350 sq km (1.76%) of the land area. However, whilst the network covers samples of most of the island's habitats, none are adequately protected. A major World Wide Fund for Nature project has assessed the present network, and identified the following important areas which merit protection

Critical sites, and their importance

1) RANOMAFANA: rich in lemurs and birds.
2) MANANARA: best low altitude coastal forest.
3) MASOALA PENINSULA: rich in endemic plants
4) ANDASIBE: protects an portion of the eastern massif
5) ANKARAFANTSIKA: several endemic birds, reptiles and lemurs
6) LAKE IHOTRY and the forests between TOLIARA and MOROMBE
7) TSIMEMBO Forest and LAKES DEMAMBA and MASAMA: rich in bird
8) Forests between the RIVERS TSIRIBIHINA and ANDRANOMENA
9) ZOMBITSE and VOHIBASIA Forests transition between western and southern vegetation
10) MIDONGY-SUD: large faunal refugium in montane forest.
11) BAIE DE BALY: only habitat of the ~~turtle~~ tortoise Geochelone yniphora
12) LAKE ALAOTRA: habitat for two of the most endangered Birds, Aythya innotata and Tachybaptus rufolavatus.
13) Coral reefs of TOLIARA over 60 coral genera
14) NOSY TANIKELY and coral reefs of NOSY BE rich fauna and mangroves.
15) LAKE KINKONY: rich in birds.
16) LA MONTAGNE DES FRANCAIS: dry forest complementing the nearby Montagne d'Ambre National Park

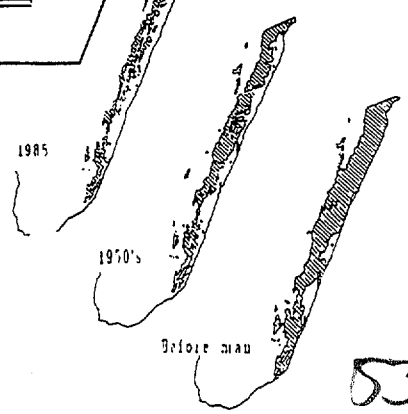
0 100 200 300km

Scale 1:5,000,000

Deforestation in Madagascar

Deforestation has been extensive on Madagascar. Most of the country was once covered in forest, but today forest covers less than 20%. Fires set to clear pastures for cattle are the main threat to the forests of the west and on high plateau (which are now reduced to a few fragments). Shifting slash and burn ("tavy") agriculture is the main cause of deforestation in the east, with the maps opposite showing just how startling deforestation has been there

Forest cover along the east coast of Madagascar (to Nosy Boraha)



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Map 2

Description:

A 1:4,000,000 vegetation areas map produced by WCMC and published on pages 226-227 in The Conservation Atlas of Tropical Forests: Africa by J.A. Sayer, C.S. Harcourt, and N.M. Collins (eds.), World Conservation Monitoring Centre, MacMillen, 1992.

Assessment:

This map is a compilation of data from several sources which include: a) Mangroves, Dry Deciduous Forest, and Spiny Forest - reproduced from Carte des Formations Vêgêtales de Madagascar, a 1:1,000,000 scale unpublihed map prepared by Faramala Miandana Harison; b) the Eastern Rainforests - reproduced from maps produced by Glen Green and Robert Sussman; c) vegetation types harmonized with the vegetation types presented in The Vegetation of Africa by Frank White (1983). Some of these data are from satellite imagery and some are not. This small scale map is therefore necessarily a generalization of the actual forest distribution on the island.

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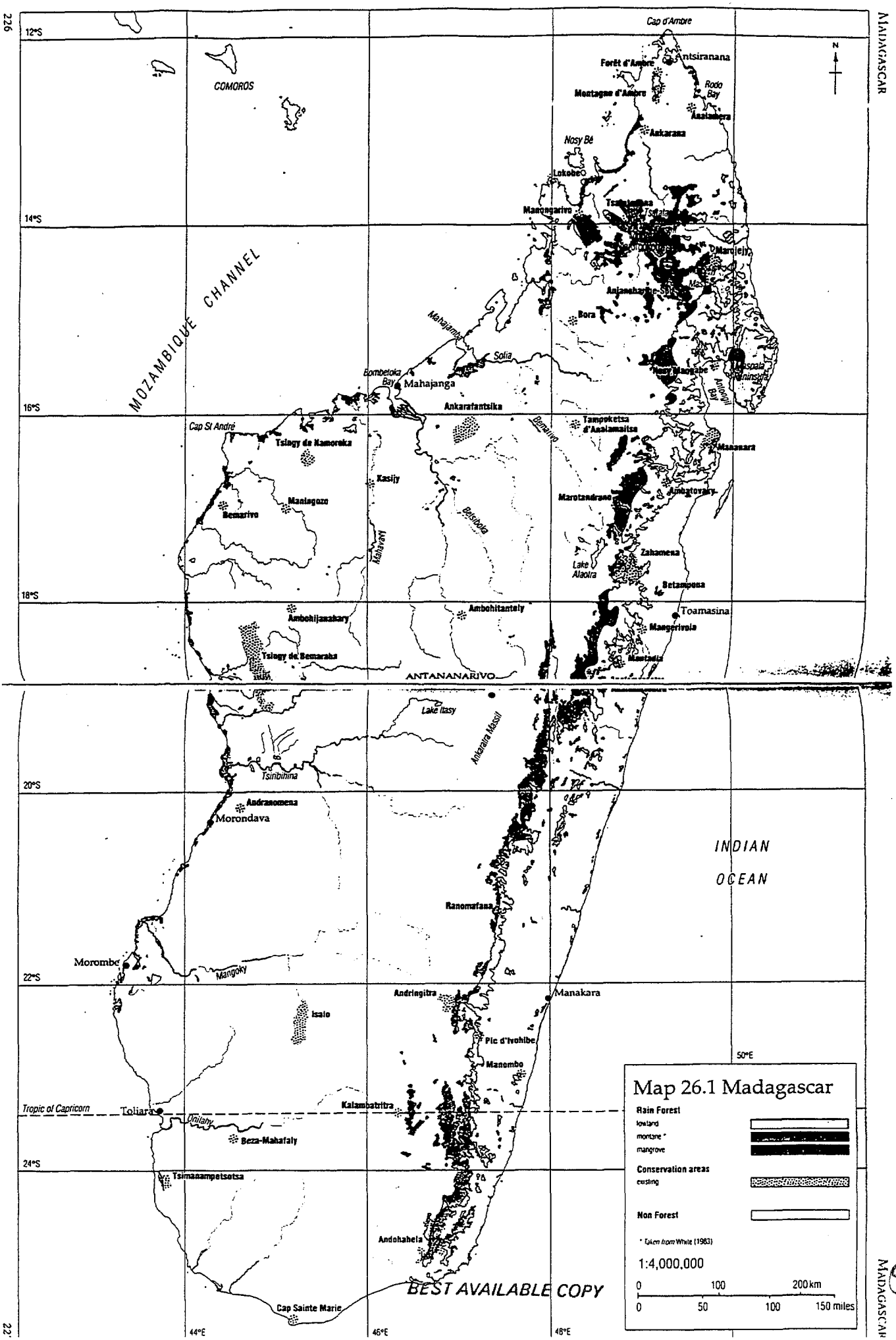

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Map 3

Description:

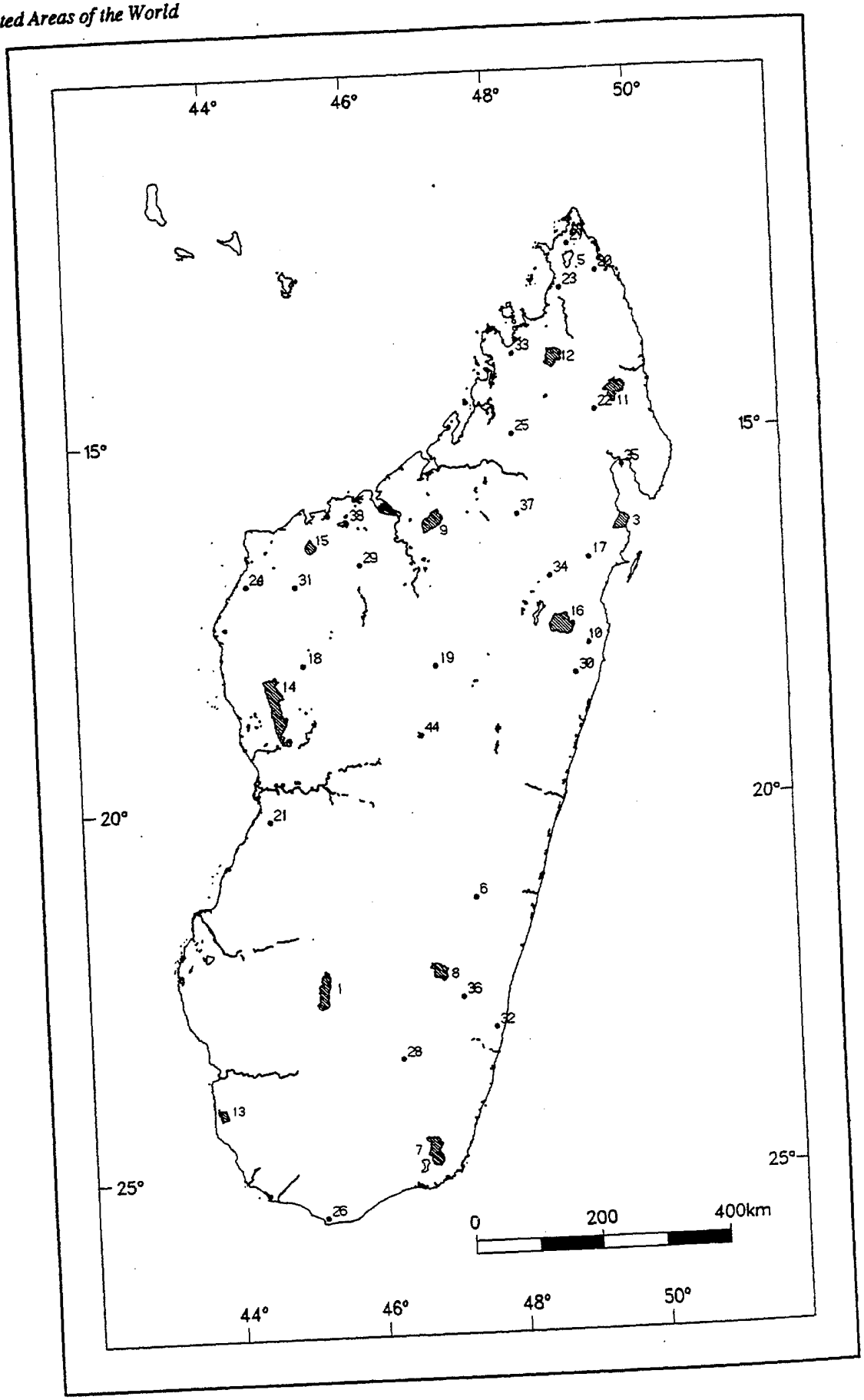
A protected areas map for Madagascar produced by WCMC and published in Protected Areas of the World: A Review of National Systems Vol. 3:*Afrotropical*, p. 149, IUCN, Madagascar, November 1991.

Assessment:

This presents a fair representation of Madagascar protected areas on the small map scale. However, it is most probably will be useful only for general guidance to the positions of protected areas. WCMC holds precise boundary information for only a percentage of the protected areas in Madagascar.

The Conservation International (Map 2) map of protected areas is based upon more up-to-date information than this WCMC protected areas map. In addition, the CI map is at a larger map scale than the WCMC map and it includes more precise data about boundary locations of protected areas in Madagascar.

56



Protected Areas of Madagascar

e. Ronald I. Miller

In 1988-89, a pilot study was conducted at the World Bank in Washington, DC to test mapping procedures which document rare species distribution patterns in a developing country. The following three Madagascar maps representing the distribution patterns of lemurs, butterflies, and reptiles and amphibians were produced during this study. These maps were part of a display entitled "Environmental Management and Sustainable Development" presented at the World Bank Annual Meeting in Washington, DC in September 1989. The procedures developed during this pilot study are being published by Chapman & Hall during the Summer of 1994 in Mapping the Diversity of Nature by Ronald I. Miller.

Access:

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Department of Forestry and Wildlife Management,
U. of Massachusetts,
Amherst, MA 01003
USA

Tel: +1-413-545-1224
Fax: +1-13-545-4358

Maps 1-3

Description:

These maps represent the distribution of the threatened lemurs, reptiles, and butterflies of Madagascar as documented in the field notes published in Madagascar: An Environmental Profile.[18] The procedures used to produce these 1:1,000,000 scale maps are described in Mapping the Diversity of Nature.[19]

Assessment:

The final presentation maps produced in this project are useful for the early stages of the biodiversity planning process within a country. The methodology used to produce these maps is presented in Mapping the Diversity of Nature. For the more detailed work that is part of the later stages, the tabulated Madagascar species data presented in Mapping the Diversity of Nature provide a more precise guide to measure the impacts of projects on rare species.

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[18]IUCN, UNEP, and WWF. 1987. Madagascar: An Environmental Profile. Edited by M.D. Jenkins. IUCN, Gland, Switzerland and Cambridge, UK, 374p.

[19]Miller, R.I. (editor). 1994. Mapping the Diversity of Nature. Chapman & Hall, London.

Distribution patterns for the following threatened species in Madagascar are presented on these maps:

Map 1

The Rare Lemurs of Madagascar

Allocebus trichotis (Hairy-eared dwarf lemur): Endangered species, endemic to Madagascar, and considered to be the rarest of all the lemurs. Known to occur in the eastern tropical forest.

Indri indri (Indri): The largest living lemur, an endangered species, restricted to parts of the northeastern tropical forests of Madagascar.

Propithecus diadema (Didemed sifaka): Vulnerable species, endemic to eastern Madagascar, this lemur occurs naturally at low population densities and is severely threatened due to habitat loss from deforestation.

Daubentonia madagascariensis (Aye-aye): Endangered species, endemic to Madagascar, rare due to the destruction of the forest habitat.

Hapalemur simus (Broad-nosed gentle lemur): Endangered species, endemic to Madagascar, known only from the southeast region of the island. Found along river banks where the Giant Bamboo species occurs.

Lemur macaco macaco (Black lemur): Vulnerable species, endemic to northwest Madagascar, found in the humid forests and on the coastal islands.

Lemur macaco flavifrons (Sciater's lemur): Endangered species, endemic to a coastal forest strip in the northwest of Madagascar.

Lemur mongoz (Mongoose lemur): Vulnerable species, occurs in the deciduous forests of northwest Madagascar, and also occurs in the Republic of the Comoros.

Lemur rubriventer (Red-bellied lemur): Threatened species, endemic to the eastern forests of Madagascar.

Varecia variegata (Ruffed lemur): Threatened species, endemic to the eastern humid forests of Madagascar.

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Map 2

Some Rare Reptiles and Amphibians of Madagascar

Geochelone radiata (Radiated Tortoise or Sokake): Vulnerable, endemic, terrestrial species restricted to dry forest.

Geochelone yniphora (Angonoka): Endangered, endemic, terrestrial species restricted to an area around Baly Bay. In imminent danger of extinction.

Pyxis planicauda (Madagascar flat-tailed tortoise or Kapidolo): Restricted, endemic, terrestrial species threatened by agricultural encroachment and habitat destruction.

Pyxis arachnoides (Madagascar spider tortoise or Tsakafy, Kapila): Restricted, endemic, small terrestrial tortoise species found in xeric thorn-bush scrub of coastal regions.

Erymnochelys Madagascariensis (Madagascar sideneck turtle or Rere): Restricted, endemic, aquatic turtle species, found in extensive aquatic habitats on the west and northwest of the island.

Map 3

The Rare Butterfies of Madagascar

Papilio grosesmithi: Rare, endemic, butterfly species known from the deciduous forests of western Madagascar.

Papilio morondavana: Vulnerable, endemic, attractive swallowtail butterfly species found in the deciduous forests in western Madagascar. Seriously threatened by habitat destruction.

Papilio mangoura: Rare, endemic, butterfly species restricted to some of the eastern rainforests.

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MADAGASCAR
DISTRIBUTION OF RARE LEMURS

Allocebus trichotis (Hairy-eared dwarf lemur)
Endangered species, endemic to Madagascar, and considered to be the rarest of all the lemurs. Known to occur in the eastern tropical forest.

Indri indri (Indri)
The largest living lemur, an endangered species, restricted to parts of the northeastern tropical forests of Madagascar.

Propithecus diadema (Diademed sifaka)
Vulnerable species, endemic to eastern Madagascar, this lemur occurs naturally at low population densities and is severely threatened due to habitat loss from deforestation.

Daubentonia madagascariensis (Aye-aye)
Endangered species, endemic to Madagascar, rare due to the destruction of the forest habitat.

Hapalemur simus (Broad-nosed gentle lemur)
Endangered species, endemic to Madagascar, known only from the southeast region of the island. Found along river banks where the Giant Bamboo species occurs.

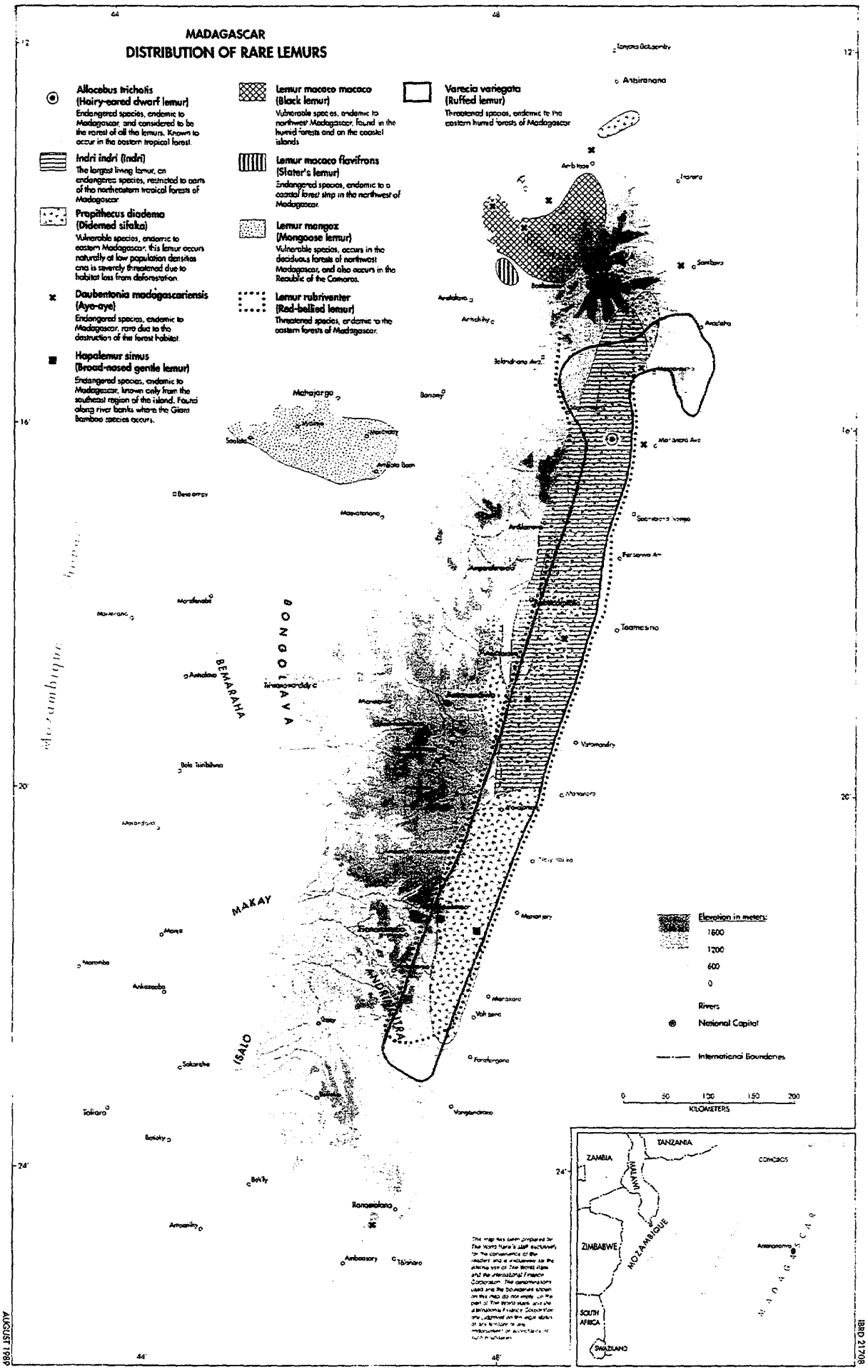
Lemur macaco macaco (Black lemur)
Vulnerable species, endemic to northwest Madagascar, found in the humid forests and on the coastal islands.

Lemur macaco flavifrons (Sclater's lemur)
Endangered species, endemic to a coastal forest strip in the northwest of Madagascar.

Lemur mongoz (Mongoose lemur)
Vulnerable species, occurs in the deciduous forests of northwest Madagascar, and also occurs in the Republic of the Comoros.

Lemur rubriventer (Red-bellied lemur)
Threatened species, endemic to the eastern forests of Madagascar.

Varecia variegata (Ruffed lemur)
Threatened species, endemic to the eastern humid forests of Madagascar.



The map has been prepared by The World Bank's staff exclusively for the convenience of the readers and is inclusive as the planning use of The World Bank and the International Finance Corporation. The denominations used and the boundaries shown on this map do not imply, on the part of The World Bank and its affiliates, Finance Corporation any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries.

AUGUST 1986

IBRD 21708

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4. Next Steps

Currently a number of organizations are involved with the formation of Madagascar biodiversity data. The following is a synopsis of organizations identified during this project Future investigation of the relevant projects at each of these institutions is clearly suggested.

* The World Wide Fund for Nature (WWF) in the USA[20] is rapidly developing GIS and database capabilities. This organization will be involved with the formation of Madagascar biodiversity data once these technological tools are implemented.

* A Madagascar 'environmental database' project is currently being conducted by the World Bank.[21] The aim of this project is the design and construction of an environmental database to be used in Madagascar. This database project is still in the very early stages of development.

* A scientific research focus on Madagascar biodiversity subjects is long established at Duke U.[22] However I was not able to identify any databases or maps produced in current research activities. Duke scientists are currently involved in various species studies as well as with a socio-economic project related to the Mantadia National Park near Andasibe (formerly Perinet) in eastern Madagascar. Madagascar scientific projects based at Duke require follow-up so that the collected biodiversity data will be available in database and map formats for future utilization.

* Birdlife International[23] has mapped the distributions of all of the world's restricted-range birds.[24] Information about the distribution, habitat requirements, and altitudinal ranges of the restricted-range birds of Madagascar are included in the Birdlife International biodiversity database in Cambridge, UK.[25] In the future, these data and maps will need to be accessed for the Madagascar information and maps.

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[20]Richard Carroll, World Wide Fund for Nature, US Office, Madagascar Region, Washington, DC, USA. Tel: +1 202-293-4800, Fax: +1 202-293-9211.

[21]The World Bank, AFTES, 1818 H Street, NW, Washington, DC 20433, USA. Tel: +1-202-458-1389.

[22]Dr. Randall Kramer, Duke U., School of the Environment, Durham, NC 90328, USA. Tel: +1-909-613-8072, Fax: +1-909-684-8741.

[23]As of March 1993, the International Council for Bird Preservation (ICBP) has operated under the new name of Birdlife International.

[24]Defined as those bird species with ranges estimated to total less than 50,000 km^2. These comprise almost 28% of all bird species.

[25]Birdlife International, Wellbrook Court, Girton Road, Cambridge CB3 0NA, UK. Tel: +44-223-277318, Fax: +44-223-277200.

* Extensive scientific research on Madagascar biodiversity originated in France during the twentieth century. Professor Jean-Jacques Petter, director of the national zoo in Paris,[26] should be contacted for connections to other institutions in France with Madagagascar biodiversity information.

* The Museum National d'Historie Naturelle, Paris, includes a large collection of Madagascar biodiversity materials. However, most information pertaining to this collection is yet to be stored in a database. Summary statistics about Madagascar observations and specimens held in this museum were therefore not obtainable.

A database for fish specimens was the only database reportedly at the museum that might list specimens from Madagascar. The following two e-mail addresses should be contacted for further information about this database: murail@mnhn.fr (Computer Department) and hureau@mnhn.fr (Fish Database).

4.1 Collected Documents

Madagascar remains as a focus of biodiversity projects due to its status as one of the centers of unique biodiversity on the earth. Therefore the status of nature on Madagascar is a focus of study for many institutions worldwide. The following is a listing of several published and unpublished Madagascar biodiversity reports encountered during this project:

Albignac, R., G.S. Ramangason, V.S. Rakotonirina, S. Andriatsarafara, and H. Rabetaliana. 1992. "Ecodevelopment of Rural Communities for Biodiversity Conservation." UNESCO/UNDP - MAG/88/007.

Ramangason, G.S. 1993. "The Mananara-Nord Biosphere Reserve." *Nature and Resources* 29 (1-4):17-23.

UNESCO and UNDP. 1992. "Éco-Dévelopment des Communautés Rurales pour la Conservation de la Biodiversité." Les Projects MAG/88/007.

Albignac, R. and B. Bousquet. 1992. "Eco-développement des Communautés Rurales pour la Conservation de la Biodiversité: Mananara Nord 2." Les Projects MAG/88/007.

Nelson, R., Horning, N. 1993. "AVHRR-LAC Estimates of Forest Area in Madagascar 1990." *Int. J. Remote Sensing* 14(8): 1463-1475.

Greve, Albert M. (ed.). "Madagascar Environment Program Newsletter". ARTD, World Bank.

Keck, C.A. 1993. "Property Rights and Land Use in Madagascar's Eastern Rainforest." Masters Thesis, School of the Environment, Duke U.

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[26]Tel: +33-1-40793342.

4.2 Future Directions

Biodiversity data need to serve as the basis for future development and conservation in Madagascar. This project identified many sources of these data outside of Madagascar. A vital next step will be the development of a database/mapping system that is carefully linked both to the principal germane institutions and activities in Madagascar and to the many activities on the island that are being initiated in other parts of the world.

The design of this database/mapping system will need to include standards and protocols closely linked to the collection of data. The data will need to be closely linked to both broad and fine scales of geographic location. For each record, data should be stored at a resolution level appropriate to the information being collected.

Many different types of biodiversity related information are available for Madagascar. For example, information is available about the types of species, landcover, geological formations, climate patterns etc. The characteristics of these different data types will need to be carefully considered in the formulation of standards and protocols for any database/mapping system that is required to handle Madagascar biodiversity data.

5. Appraisal and Conclusions

Some important biodiversity data is stored on databases and maps held by several key organizations outside of Madagascar. The most important databases that were identified during this project are at the Smithsonian Institution, the U. of Chicago, the U. of Michigan, the Missouri Botanical Gardens, and at the World Conservation Monitoring Centre. The most important maps identified during this project are being produced by Conservation International, Dr. Glen M. Green, and by the World Conservation Monitoring Centre.

Somewhat surprisingly, the predominant technique being used today to identify forest biodiversity resources and deforestation patterns on maps in Madagascar is the manual interpretation of satellite imagery. Manual interpretation of imagery is a practical means for generating useful landcover map products with a minimum need for training and technological equipment. The two primary producers of Madagascar deforestation maps identified in this project (i.e., Conservation International and Dr. Glen M. Green) are both utilizing manual interpretation approaches in the production of their maps.

Scientific studies remain as the fundamental foundation of biodiversity data gathering in Madagascar. Today the creation of databases for biodiversity data is still considered to be somewhat of an extraneous component in much biological scientific research. Thus the majority of biological studies being conducted at the present time in Madagascar do not include the input of collected data into a database as part of their objectives. The databases being developed by the plants database consortium and by the birds database consortium are two excellent examples of upcoming databases that will serve as repositories of Madagascar biodiversity data in the future. Field data for these taxa, collected in Madagascar as part of independent scientific studies, will be easily transferable into digital database format with the completion of these databases in the not too distant future (6-18 months).

It is important that databases to be used as repositories for biodiversity information be maintained within Madagascar. The work of the International Institute of Biological Sciences in Costa Rica serves as an excellent model for the establishment of database and mapping facilities within a country noted for its biodiversity resources. The general strategies used in Costa Rica can serve as an excellent prototype for the biodiversity monitoring center in Madagascar. Costa Ricans are trained as parataxonomists and at the Institue they identify species collected in field studies. Costa Ricans then input these data into computers for tabulation and analysis. Local people in effect run the biodiversity monitoring facility in Costa Rica.

Similarly people in Madagascar can be trained both for field collection studies and for eventually running the computerized facilities for monitoring biodiversity resources. It is important that the databases to be used as repositories of information about biodiversity resources be maintained within Madagascar. Current versions of these databases can also be held outside of the country, but the core database should be established within Madagascar. This will insure that the information is kept accurate and up-to-date.

The primary next step in setting up a monitoring system for biodiversity resources in Madagascar is in the design of data collection and handling procedures. This will involve the design and implementation of standards and protocols for data collection and processing. Most importantly for map production, this will involve the formulation of standards and protocols particular to each of the different data types to be geographically registered.

Appendix A: Smithsonian Mammals Division Database Definition Table

The structure of the mammals database held at the US Museum of Natural History in Washington, DC. This table defines the fields and formats that comprise this mammals database.

Mammal INQUIRE Fields Definition Table

FIELD NAME	FORMAT	KEY	PRINT FORM	LEN	RPTS
TGNO	CHAR	PRE	NB	8	
ATGNO1	CHAR		NB	1	
ATGNO23	CHAR		NB	2	
ATGNO13	CHAR		NB	3	
ATGNO48	CHAR		NB	5	
ATGNO12	CHAR		NB	2	
ATGNO38	CHAR		NB	6	
ATGNO14	CHAR		NB	4	
ATGNO58	CHAR		NB	4	
ALCODE	CHAR	PRE	NB	1	
CATION	CHAR	VAL	NB	2	V 5
OCBLDG	CHAR		NB	1	V 5
OCAREA	CHAR		NB	1	V 5
CBTR	VAR		NB	25	V 5
CATR	VAR		NB	26	V 5
CATOR	VAR		B	15	
OSUR	CHAR		NB	1	
MCOD	CHAR	PRE	NB	4	
MILY	CHAR	PRE	NB	20	
NUS	CHAR	PRE	NB	20	
ECIES	CHAR	VAL	NB	20	V 2
BSPECS	CHAR		NB	20	V 2
PEPUB	VAR		B	118	
PE	CHAR	VAL	NB	1	
PETR	VAR		NB	4	
ECOLL	CHAR	PRE	NB	8	
YCOLL	CHAR		NB	4	
MCOLL	CHAR		NB	2	
DCOLL	CHAR		NB	2	
OLMDFR	CHAR		NB	1	
JNTRY	CHAR	PRE	NB	25	V 2
ATE	VAR	VAL	B	30	
UNTY	VAR		B	30	
ECLOC	VAR		B	50	
OLOC	VAR		B	120	
EAN	VAR	VAL	B	16	
A	VAR	VAL	B	28	
Y	VAR		B	30	
TITUDE	CHAR		NB	7	
ATDEG	CHAR		NB	2	
ATMIN	CHAR		NB	2	
ATSEC	CHAR		NB	2	
ATDIR	CHAR		NB	1	
NGTUDE	CHAR		NB	8	
ONGDEG	CHAR		NB	3	
ONGMIN	CHAR		NB	2	
ONGSEC	CHAR		NB	2	
ONGDIR	CHAR		NB	1	
EV	VAR		B	16	
LLCTOR	CHAR	VAL	NB	30	V 6
LDNUMB	VAR		B	25	
LDNUMB	CHAR	VAL	NB	15	V 3
NOR	VAR		B	128	
CSNNO	CHAR	VAL	NB	6	

FIELD NAME	FORMAT	KEY	PRINT FORM	LEN	RPTS
DTECATG	CHAR		NB	8	
YYCATG	CHAR		NB	4	
MMCATG	CHAR		NB	2	
DDCATG	CHAR		NB	2	
ECOLHAB	VAR		B	128	
REMARKS	VAR		B	750	
STATUS	CHAR	VAL	NB	4	
STATREM	VAR		B	90	
SEX	CHAR		NB	2	
SEXX	CHAR		NB	1	
SEXM	CHAR		NB	1	
COLCDE	CHAR	VAL	NB	3	
COLCDETR	VAR		NB	37	
BONEINV	VAR		B	422	
MWEIGHT	VAR		B	15	
WWFLD	CHAR		NB	11	
WWEIGHT	CHAR		NB	4	
WWTUNIT	CHAR		NB	2	
WWTMOD	CHAR		NB	5	
MMEASURE	VAR		B	128	
WMFLD	CHAR		NB	11	
WMEASURE	CHAR		NB	4	
WMSUNIT	CHAR		NB	2	
WMSMOD	CHAR		NB	5	
REPROD	VAR		B	250	
AGE	VAR		B	30	
AAFLD	CHAR		NB	11	
ABSAGE	CHAR		NB	4	
AAGEUNIT	CHAR		NB	3	
AAGEMOD	CHAR		NB	4	
ONO	CHAR	VAL	NB	15	V 5
BIBLIO	VAR		B	250	
INITIALS	CHAR	VAL	NB	3	
DATEENT	CHAR	VAL	NB	8	
INITCH	CHAR	VAL	NB	3	
DATECH	CHAR	VAL	NB	8	
STOMACH	VAR		B	64	
HISTPREP	VAR		B	64	
PARASITE	VAR		B	64	
INJURY	VAR		B	64	
RECSTAT	CHAR	VAL	NB	1	
RECSTTR	VAR		NB	39	
LORANC	CHAR		NB	5	V 3
NATURE	CHAR	VAL	NB	17	
NMFLD	CHAR		NB	8	
NMBR	CHAR		NB	3	
NMBRMOD	CHAR		NB	5	
CONDITN	CHAR	VAL	NB	2	
CONDTR	VAR		NB	34	
TISSUE	VAR		B	125	
PHOTO	CHAR	VAL	NB	10	V 20
$FIXED	CHAR		NB	185	
KEYS	VAR	PRE	B,	40	
ITEMNO	NUM	PRE	I	8	

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Appendix B: Smithsonian Botany Division Plant Families

A list of the families of plants represented by specimens from Madagascar in the Botany Division at the Smithsonian Natural History Museum in Washington, DC. These represent records at the museum inventoried for the database as of June 1, 1994. This represents only about 10% of the botanical Madagascar plants held by the museum. The remaining specimens are being catalogued into the database at this time.

Plant families from Madagascar

FAMILY----------
ACANTHACEAE
AMARYLLIDACEAE
ANACARDIACEAE
ANNONACEAE
APOCYNACEAE
APONOGETONACEAE
ARECACEAE
ASCLEPIADACEAE
ASTERACEAE
BALANOPHORACEAE
BASELLACEAE
BEGONIACEAE
BIGNONIACEAE
BUDDLEJACEAE
BURMANNIACEAE
BURSERACEAE
CACTACEAE
CAMPANULACEAE
CANELLACEAE
CELASTRACEAE
CHLAENACEAE
CLUSIACEAE
COMBRETACEAE
COMMELINACEAE
CONVOLVULACEAE
CORNACEAE
CUNONIACEAE
CYPERACEAE
DICHAPETALACEAE
DIDIEREACEAE
DILLENIACEAE
DROSERACEAE
EBENACEAE
ELAEOCARPACEAE
ERICACEAE
ERIOCAULACEAE
ERYTHROXYLACEAE
EUPHORBIACEAE
FABACEAE
FLACOURTIACEAE
GENTIANACEAE
GESNERIACEAE
HYDROSTACHYACEAE
ICACINACEAE
LOGANIACEAE
LYTHRACEAE
MALPIGHIACEAE
MALVACEAE
MARANTACEAE
MELASTOMATACEAE
MELIACEAE
MONIMIACEAE
MORACEAE
MYROTHAMNACEAE
MYRSINACEAE
MYRTACEAE
ORCHIDACEAE
PANDANACEAE
PASSIFLORACEAE
POACEAE
PODOSTEMONACEAE
RESTIONACEAE
RHAMNACEAE
RHIZOPHORACEAE
ROSACEAE
RUBIACEAE
RUTACEAE
SALVADORACEAE
SAPOTACEAE
SCROPHULARIACEAE
STERCULIACEAE
STRELITZIACEAE
TACCACEAE
TAXACEAE
PODOCARPACEAE
THEACEAE
TILIACEAE
ULMACEAE
VERBENACEAE
VITACEAE
XYRIDACEAE
ZINGIBERACEAE

Algae
BOODLEACEAE
CAULERPACEAE
CHAETANGIACEAE
CHAMAESIPHONACEAE
CLADOPHORACEAE
DASYCLADACEAE
GYMNOPHLAEACEAE
NOSTOCACEAE
OSCILLATORIACEAE
VALONIACEAE
UDOTEACEAE

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Appendix C.1: Numbers of Plant Genera in WCMC Plants Database

The number of genera represented in each plant family and represented in the Plants Database at WCMC. These numbers simply represent the number of genera per family for Madagascar stored in the database.

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# genera	Family
2	"ACANTHACEAE"
1	"AMARANTHACEAE"
21	"APOCYNACEAE"
48	"ASCLEPIADACEAE"
1	"ASPLENIACEAE"
1	"AVICENNIACEAE"
1	"BALANOPHORACEAE"
1	"BALSAMINACEAE"
12	"BOMBACACEAE"
1	"BORAGINACEAE"
1	"BURSERACEAE"
3	"CACTACEAE"
1	"COMBRETACEAE"
31	"COMPOSITAE"
1	"CONVOLVULACEAE"
96	"CRASSULACEAE"
2	"CRUCIFERAE"
9	"CUCURBITACEAE"
48	"CYATHEACEAE"
2	"CYCADACEAE"
1	"CYPERACEAE"
2	"DENNSTAEDTIACEAE"
11	"DIDIEREACEAE"
1	"DIOSCOREACEAE"

1	"EBENACEAE"
1	"ERICACEAE"
109	"EUPHORBIACEAE"
2	"FLACOURTIACEAE"
13	"GENTIANACEAE"
1	"GERANIACEAE"
1	"GUTTIFERAE"
1	"HAMAMELIDACEAE"
1	"HYPOXIDACEAE"
1	"IRIDACEAE"
2	"LABIATAE"
1	"LAURACEAE"
1	"LECYTHIDACEAE"
11	"LEGUMINOSAE"
80	"LILIACEAE"
1	"LORANTHACEAE"
2	"LYTHRACEAE"
1	"MALVACEAE"
1	"MELIACEAE"
2	"MORACEAE"
2	"MORINGACEAE"
1	"MYROTHAMNACEAE"
1	"MYRSINACEAE"
2	"NEPENTHACEAE"
3	"NYCTAGINACEAE"
1	"OLEACEAE"
1	"OPHIOGLOSSACEAE"
10	"ORCHIDACEAE"
128	"PALMAE"
5	"PASSIFLORACEAE"
10	"PEDALIACEAE"
1	"PIPERACEAE"
5	"PODOCARPACEAE"
1	"PROTEACEAE"
1	"RANUNCULACEAE"
2	"RHIZOPHORACEAE"
1	"ROSACEAE"
3	"RUBIACEAE"
1	"RUTACEAE"
1	"SALVADORACEAE"
1	"SAPINDACEAE"
1	"SCHIZAEACEAE"
1	"SCROPHULARIACEAE"
1	"SIMAROUBACEAE"
2	"STERCULIACEAE"
2	"TILIACEAE"
1	"ULMACEAE"
10	"VITACEAE"
1	"VITTARIACEAE"

Appendix C.2: Conservation Status Listing of Plants

A detailed status report of the endangered and threatened plants occurring in Madagascar and stored on the WCMC Plant Database. Each plant listed includes the current IUCN Threat Status, the Latin scientific plant name, and the record occurrence for Madagascar. This report also includes a listing of the Madagascar data sources that were accessed in the compilation of the Madagascar plant data.

Madagascar

Conservation Status Listing of Plants

Compiled from

The WCMC Plants Database

WORLD CONSERVATION MONITORING CENTRE

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The mission of the
World Conservation Monitoring Centre is to provide
information on the status, security and
management of the Earth's biological diversity.

	?		***Acalypha reticulata*** **(Poiret) Muell. Arg.** *10082* **(Euphorbiaceae)**
		?	Comoros *10082*
		?	Reunion *10082*
		?	Madagascar *10082*
		R	Mauritius *10082*
	K		***Adansonia alba*** **Jum. & H. Perrier** *10368* **(Bombacaceae)**
		K *10368*	Madagascar *10368*
	?		***Adansonia bernieri*** **Baill.ex H. poisson** *13272* **(Bombacaceae)**
		?	Madagascar *13272*
tree med./pharm.	nt		***Adansonia digitata*** **L.** *17833* **(Bombacaceae)**
		common name: baobab	
		K *10368*	Madagascar *10368*
		[I] *16162*	[introd.] Sri Lanka *16162*
		?	Puerto Rico *17833*
		nt	Many countries [distribution incomplete]
	K		***Adansonia fony*** **Baillon var.** ***fony*** *10368* **(Bombacaceae)**
		K *10368*	Madagascar *10368*
	K		***Adansonia fony*** **Baillon var.** ***rubristipa*** **(Jum. & H. Perrier) H. Perrier** *10368* **(Bombacaceae)**
		K *10368*	Madagascar *10368*
	K		***Adansonia grandidieri*** **Baillon** *10368* **(Bombacaceae)**
		K *10368*	Madagascar *10368*
	K		***Adansonia madagascariensis*** **Baillon** *13272* **(Bombacaceae)**
		K *10368*	Madagascar *10368*
	?		***Adansonia perrieri*** **Capuron** *13272* **(Bombacaceae)**
		?	Madagascar *13272*
	K		***Adansonia suarezensis*** **H. Perrier** *10368* **(Bombacaceae)**
		K *10368*	Madagascar *10368*
	K		***Adansonia za*** **Baillon var.** ***boinensis*** **H. Perrier** *10368* **(Bombacaceae)**
		K *10368*	Madagascar *10368*
	K		***Adansonia za*** **Baillon var.** ***bozy*** **(Jum. & H. Perrier) H. Perrier** *10368* **(Bombacaceae)**
		K *10368*	Madagascar *10368*
	R		***Adansonia za*** **Baillon var.** ***za*** *10368* **(Bombacaceae)**
		R	Madagascar
	K		***Adenia epigea*** **H. Perrier** *10368* **(Passifloraceae)**
		K *10368*	Madagascar *10368*
	K		***Adenia firingalavensis*** **(Drake) Harms** *10368* **(Passifloraceae)**
		K *10368*	Madagascar *10368*
	K		***Adenia olaboensis*** **Claverie** *10368* **(Passifloraceae)**
		K *10368*	Madagascar *10368*
	K		***Adenia peltata*** **Schinz** *10368* **(Passifloraceae)**
		K *10368*	Madagascar *10368*
	K		***Adenia refracta*** **Schinz** *10368* **(Passifloraceae)**
		K *10368*	Madagascar *10368*
herb.	?		***Aerva lanata*** **(L.) Juss. ex Schultes, Roemer & Schultes** *17617* **(Amaranthaceae)**
		common name: eigaab	
		V *16168*	Egypt (Gebel Elba massive, Eastern desert) *16168*
		?	Saudi Arabia *16168*
		?	Iran *16168*
		?	East Timor *7730*
		?	Indonesia (Madura, Banka, Aru) *16168*
		?	Irian Jaya *7730*
		?	Java *7730*
		?	Sumatra *7730*
		?	?Malaysia *16168*
		?	P.N.G. *16168*
		?	Philippines *16168*
		?	Madagascar *16168*

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			?		Sudan (Gebel Elba) *10269*
					[distribution possibly incomplete]
herb.		?	***Aeschynomene uniflora* E. Meyer** *7926* **(Leguminosae)**		
			?		Comoro Islands *7926*
			?		Madagascar *7926*
			?		Tropical Africa *7926*
			I	*6072*	Ghana *6072*
			?		Nigeria *7926*
			?		Senegal *7926*
			?		Natal *7926*
					[distribution incomplete]
		?	***Agauria buxifolia* (Lam.) Cordem.** *8764* **(Ericaceae)**		
			?		Reunion *8764*
			?		Madagascar *8764*
herb.	II	V	***Agrostophyllum occidentale* Schltr.** *14296* **(Orchidaceae)**		
			Ex/E	*19182*	Madagascar *10246*
			V	*19182*	Seychelles: Gra *14296*
	II	K	***Alluaudia ascendens* (Drake) Drake** *10368* **(Didiereaceae)**		
			K	*10368*	Madagascar *10368*
	II	K	***Alluaudia comosa* Drake** *10368* **(Didiereaceae)**		
			K	*10368*	Madagascar *10368*
	II	K	***Alluaudia dumosa* Drake** *10368* **(Didiereaceae)**		
			K	*10368*	Madagascar *10368*
	II	K	***Alluaudia humbertii* Choux** *10368* **(Didiereaceae)**		
			K	*10368*	Madagascar *10368*
	II	K	***Alluaudia montagnacii* Rauh** *10368* **(Didiereaceae)**		
			K	*10368*	Madagascar *10368*
	II	nt	***Alluaudia procera* Drake** *10368* **(Didiereaceae)**		
			nt	*10368*	Madagascar *10368*
	II	R	***Alluaudiopsis fiherenensis* Humbert & Choux** *10368* **(Didiereaceae)**		
			R	*10368*	Madagascar *10368*
	II	R	***Alluaudiopsis marnieriana* Rauh** *10368* **(Didiereaceae)**		
			R	*10368*	Madagascar *10368*
succ.	II	nt	***Aloe acutissima* H. Perrier var. *acutissima*** **(Liliaceae)**		
			nt	*10368*	Madagascar *10368*
succ.	II	K	***Aloe acutissima* H. Perrier var. *antanimorensis* G. Reyn.** *10368* **(Liliaceae)**		
			K	*10368*	Madagascar *10368*
succ.	II	V	***Aloe albiflora* Guillaumin** *10368* **(Liliaceae)**		
			V	*18294*	Madagascar *10368*
succ.	II	K	***Aloe andringitrensis* H. Perrier** *10368* **(Liliaceae)**		
			K	*10368*	Madagascar *10368*
succ.	II	R	***Aloe antandroi* (Decary) H. Perrier** *18295* **(Liliaceae)**		
			R	*18295*	Madagascar *18295*
succ.	II	V	***Aloe bakeri* Scott Elliot** *10368* **(Liliaceae)**		
			V	*18294*	Madagascar *10368*
succ.	II	V	***Aloe bellatula* G. Reynolds** *10368* **(Liliaceae)**		
			V	*18294*	Madagascar *10368*
succ.	II	R	***Aloe betsileensis* H. Perrier** **(Liliaceae)**		
			R	*18295*	Madagascar *18295*
succ.	II	?	***Aloe boiteaui* Guillaumin** **(Liliaceae)**		
			?		Madagascar
succ.	II	?	***Aloe buchlohii* Rauh** **(Liliaceae)**		
			?		Madagascar
succ.	II	R	***Aloe bulbillifera* H. Perrier var. *bulbillifera*** **(Liliaceae)**		
			R	*18295*	Madagascar *18295*
succ.	II	R	***Aloe bulbillifera* H. Perrier var. *pauliana* G. Reyn.** **(Liliaceae)**		
			R	*18295*	Madagascar *18295*
succ.	II	V	***Aloe calcairophila* G. Reyn.** *18294* **(Liliaceae)**		
			V	*18294*	Madagascar *18294*

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succ. II nt *Aloe capitata* Baker var. *capitata* (Liliaceae)
nt Madagascar
succ. II ? *Aloe capitata* Baker var. *cipolinicola* H. Perrier (Liliaceae)
? Madagascar
succ. II ? *Aloe capitata* Baker var. *gneissicola* H. Perrier (Liliaceae)
? Madagascar
succ. II ? *Aloe capitata* Baker var. *quartziticola* H. Perrier (Liliaceae)
? Madagascar
succ. II ? *Aloe capitata* Baker var. *silvicola* H. Perrier (Liliaceae)
? Madagascar
succ. II V *Aloe compressa* H. Perrier var. *compressa* *18294* (Liliaceae)
V *18294* Madagascar *18294*
succ. II V *Aloe compressa* H. Perrier var. *rugosquamosa* H. Perrier *18294* (Liliaceae)
V *18294* Madagascar *18294*
succ. II V *Aloe compressa* H. Perrier var. *schistophila* H. Perrier *18294* (Liliaceae)
V *18294* Madagascar *18294*
succ. II R *Aloe conifera* H. Perrier (Liliaceae)
R Madagascar
succ. II ? *Aloe cremersii* Lavranos (Liliaceae)
? Madagascar
succ. II ? *Aloe cryptoflora* G. Reyn. (Liliaceae)
? Madagascar
succ. II R *Aloe decaryi* Guillaumin *18295* (Liliaceae)
R *18295* Madagascar *18295*
succ. II ? *Aloe decorsei* H. Perrier (Liliaceae)
? Madagascar
succ. II ? *Aloe deltoideodonta* Baker var. *brevifolia* H. Perrier (Liliaceae)
? Madagascar
succ. II ? *Aloe deltoideodonta* Baker var. *candicans* H. Perrier (Liliaceae)
? Madagascar
succ. II nt *Aloe deltoideodonta* Baker var. *deltoideodonta* (Liliaceae)
nt Madagascar
succ. II V *Aloe descoingsii* G. Reyn. *18294* (Liliaceae)
V *18294* Madagascar *18294*
succ. II nt *Aloe divaricata* A. Berger var. *divaricata* (Liliaceae)
nt Madagascar
succ. II ? *Aloe divaricata* A. Berger var. *rosea* (Decary) G. Reyn. (Liliaceae)
? Madagascar
succ. II ? *Aloe ericetorum* Bosser (Liliaceae)
? Madagascar
succ. II ? *Aloe erythrophylla* Bosser (Liliaceae)
? Madagascar
succ. II ? *Aloe fievetii* G. Reyn. (Liliaceae)
? Madagascar
succ. II ? *Aloe guillaumetii* Cremers (Liliaceae)
? Madagascar
succ. II V *Aloe haworthioides* Baker var. *aurantiaca* H. Perrier *18294* (Liliaceae)
V *18294* Madagascar *18294*
succ. II V *Aloe haworthioides* Baker var. *haworthioides* *18294* (Liliaceae)
V *18294* Madagascar *18294*
succ. II E *Aloe helenae* Danguy *18294* (Liliaceae)
E *18294* Madagascar *18294*
succ. II ? *Aloe humbertii* H. Perrier (Liliaceae)
? Madagascar
succ. II ? *Aloe ibitiensis* H. Perrier (Liliaceae)
? Madagascar
succ. II I *Aloe imalotensis* G. Reyn. (Liliaceae)
I Madagascar
succ. II R *Aloe isaloensis* H. Perrier *18295* (Liliaceae)

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			?		Madagascar
succ.		II	?	*Aloe itremensis* G. Reyn. (Liliaceae)	
			?		Madagascar
succ.		II	I	*Aloe laeta* A. Berger var. *laeta* (Liliaceae)	
			I		Madagascar
succ.		II	?	*Aloe laeta* A. Berger var. *maniaensis* H. Perrier (Liliaceae)	
			?		Madagascar
succ.		II	?	*Aloe leandrii* Bosser (Liliaceae)	
			?		Madagascar
succ.		II	R	*Aloe macroclada* Baker *18295* (Liliaceae)	
			?		Madagascar
succ.		II	?	*Aloe madecassa* H. Perrier var. *lutea* Guillaumin (Liliaceae)	
			?		Madagascar
succ.		II	?	*Aloe madecassa* H. Perrier var. *madecassa* (Liliaceae)	
			?		Madagascar
succ.		II	?	*Aloe mayottensis* A. Berger (Liliaceae)	
			?		Madagascar
succ.		II	V	*Aloe millotii* G. Reynolds *18294* (Liliaceae)	
			V	*18294*	Madagascar *18294*
succ.		II	V	*Aloe parallelifolia* H. Perrier *18294* (Liliaceae)	
			V	*18294*	Madagascar *18294*
succ.		II	V	*Aloe parvula* A. Berger *18294* (Liliaceae)	
			V	*18294*	Madagascar *18294*
succ.		II	V	*Aloe perrieri* G. Reynolds *18294* (Liliaceae)	
			V	*18294*	Madagascar *18294*
succ.		II	?	*Aloe peyrierasii* Cremers (Liliaceae)	
			?		Madagascar *17668*
succ.		II	V	*Aloe rauhii* G. Reynolds *18294* (Liliaceae)	
			V	*18294*	Madagascar *18294*
succ.		II	?	*Aloe schomeri* Rauh (Liliaceae)	
			?		Madagascar
succ.		II	?	*Aloe silicicola* H. Perrier (Liliaceae)	
			?		Madagascar
succ.		II	nt	*Aloe suarezensis* H. Perrier (Liliaceae)	
			nt		Madagascar
succ.		II	?	*Aloe subacutissima* G. Rowley (Liliaceae)	
			?		Madagascar
succ.		II	E	*Aloe suzannae* Decary *18294* (Liliaceae)	
			E	*18294*	Madagascar *18294*
succ.		II	?	*Aloe trachyticola* (H. Perrier) G. Reyn. (Liliaceae)	
			?		Madagascar
succ.		II	?	*Aloe vaombe* Decorse & L. Poisson var. *poissonii* Decary (Liliaceae)	
			?		Madagascar
succ.		II	nt	*Aloe vaombe* Decorse & L. Poisson var. *vaombe* (Liliaceae)	
			nt		Madagascar
succ.		II	nt	*Aloe vaotsanda* Decary (Liliaceae)	
			nt		Madagascar
succ.		II	V	*Aloe versicolor* Guillaumin *18294* (Liliaceae)	
			V	*18294*	Madagascar *18294*
succ.		II	R	*Aloe viguieri* H. Perrier (Liliaceae)	
			R		Madagascar
tree	timber		nt	*Androstachys johnsonii* Prain *18289* (Euphorbiaceae)	
				common names: cimbirre, lebombo ironwood, mecrusse, nsimbitsi	
			?		Madagascar *18289*
			V	*6088*	Zimbabwe *6088*
			nt	*18289*	South Africa *18289*
herb.	med./pharm.	II	?	*Angraecum eburneum* *19183* (Orchidaceae)	
			?		Madagascar *19183*
					[distribution possibly incomplete]

? ***Antidesma madagascariense*** **Lam. (Euphorbiaceae)**

?		Reunion *10710*
?		Madagascar *10710*
E	*12249*	Mauritius *10710*
		[distribution possibly incomplete]

tree med./pharm. **nt** ***Aphloia theiformis*** **(Vahl) Benn. & Brown** *14296* **(Flacourtiaceae)**

common name: FANDAMANE

?		Reunion *5852*
?		Madagascar *5852*
nt		Mauritius (uplands) *5852*
Ex	*5852*	Rodrigues (last seen 1949) *5852*
R	*19182*	Seychelles: Gra *14296*
?		Tropical Africa (south-west) *5852*

? ***Asplenium affine*** **Sw.** *5852* **(Aspleniaceae)**

?		Madagascar *5852*
?		Mauritius *5852*
Ex	*5852*	Rodrigues *5852*
		[distribution possibly incomplete]

tree ethnobot. **nt** ***Avicennia marina*** **(Forsskal) Vierh.** *8021* **(Avicenniaceae)**

common names: api, api-api, shora

V	*16168*	Egypt (Red Sea coast) *16168*
?		Saudi Arabia *16168*
nt	*19218*	Maharashtra *18341*
nt	*19218*	Orissa *18341*
nt	*19218*	Tamil Nadu *18341*
nt	*19218*	West Bengal *18341*
?		Iran *16168*
?		Japan (Yaeyama Is)
?		Pakistan *16168*
E		Taiwan (west coast)
nt	*15733*	Vietnam *15733*
?		Pen. Malaysia (west coast region) *19209*
E	*14965*	Sarawak *14965*
nt	*19591*	P.N.G. *16168*
?		Australia *16168*
?		Pacific Is.
?		Madagascar *16168*
?		Sri Lanka *8021*
?		Tropical Africa
?		Ethiopia *16168*
?		Kenya *16168*
?		Mozambique *16168*
?		Somalia *16168*
?		Sudan *16168*
		[distribution incomplete]

? ***Bakerella hoyifolia*** **(Baker) S. Balle var.** ***richardii*** **(Van Tieghem) Danser** *10936* **(Loranthaceae)**

?		Reunion *10936*
?		Madagascar *10936*
E		Mauritius *10936*

? ***Balanophora abbreviata*** **Blume** *17798* **(Balanophoraceae)**

?		China (south)
?		Hainan Island
?		India
?		Kampuchea
I		Thailand
?		Java
?		Society Is. (Tahiti)
?		Comoros

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			?	Andamans
			?	Madagascar
			?	Tropical Africa
				[distribution incomplete]
tree		nt	***Barringtonia asiatica* (L.) Kurz** *8021* **(Lecythidaceae)**	
			common name: butum	
			E	Taiwan (south-east; Lan Yu)
			nt	Pacific Is. (incl. Polynesia) *8006*
			nt	American Samoa *8006*
			R *19104*	Cocos Is. *19104*
			?	Madagascar *8006*
			nt	Sri Lanka *8021*
			nt	Old World *8021*
				[distribution possibly incomplete]
tree		E	***Beccariophoenix madagascariensis* Jumelle & H. Perrier** *11813* **(Palmae)**	
			E *2014*	Madagascar *6165*
tree		nt	***Bismarckia nobilis* Hildebr. & H. Wendl.** *10246* **(Palmae)**	
			nt	Madagascar *10246*
herb.		?	***Boerhavia africana* Lour.** *16168* **(Nyctaginaceae)**	
			common name: dowinaat el far	
			?	Europe (south west) *16168*
			?	N. Afr. & Mid. E. *16168*
			V *16168*	Egypt (Gebel Elba) *16168*
			?	Saudi Arabia *16168*
			?	Madagascar *16168*
			?	Tropical Africa *16168*
			?	Southern Africa *16168*
				[distribution incomplete]
		V	***Borassus madagascariensis* Bojer** *10246* **(Palmae)**	
			V *17951*	Madagascar *10246*
		E	***Borassus sambiranensis* Jumelle & H. Perrier** *10246* **(Palmae)**	
			E *17951*	Madagascar *10246*
herb.	II	?	***Bulbophyllum incurvum* Thouars** *5852* **(Orchidaceae)**	
			?	Reunion *5852*
			?	Madagascar *5852*
			E *5852*	Mauritius *10936*
			Ex *5852*	Rodrigues (last seen 1874) *5852*
shrub		nt	***Carissa edulis* Vahl** *16168* **(Apocynaceae)**	
			E *16168*	Egypt (Gebel Elba) *16168*
			?	Saudi Arabia *16168*
			?	Madagascar *16168*
			nt	Tropical Africa *19500*
			?	Angola *19500*
			?	Ethiopia *16168*
			?	Kenya *16168*
			?	Somalia *16168*
			?	Sudan *16168*
			?	Tanzania *16168*
			nt *19007*	Uganda *16168*
			?	Zimbabwe *16168*
			?	Namibia *19500*
				[distribution incomplete]
		?	***Cassipourea lanceolata* Tul.** *14981* **(Rhizophoraceae)**	
			?	Comoro Islands *14981*
			?	Madagascar *14981*
			E *14981*	Seychelles *14981*
				[distribution possibly incomplete]
		E	***Catharanthus coriaceus* Markgraf (Apocynaceae)**	
			E	Madagascar

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herb. med./pharm. ? ***Catharanthus roseus*** **(L.) G. Don** *15213* **(Apocynaceae)**
common names: cangrejera, catharanthus, desbarata casamiento, flor de todo el año, jazmín del mar, periwinkle, playera, vinca
? Java (Ujung Kulon) *15213*
? Madagascar *19183*
? Puerto Rico *17833*
[distribution possibly incomplete]

tree timber ? ***Celtis gomphophylla*** **Bak. (Ulmaceae)**
common names: ba, celtis (g), odou
? Comoros
? Madagascar
? Cameroon
[distribution incomplete]

succ. II I ***Ceropegia albisepta*** **Jum. & H. Perrier var.** ***albisepta*** *10368* **(Asclepiadaceae)**
I Madagascar

succ. II I ***Ceropegia albisepta*** **Jum. & H. Perrier var.** ***truncata*** **H. Huber** *10368* **(Asclepiadaceae)**
I Madagascar

succ. II I ***Ceropegia albisepta*** **Jum. & H. Perrier var.** ***viridis*** **(Choux) H. Huber** *10368* **(Asclepiadaceae)**
I Madagascar

succ. II K ***Ceropegia ampliata*** **E. Meyer ssp.** ***madagascariensis*** **Lavranos** *10368* **(Asclepiadaceae)**
K *10368* Madagascar *10368*

succ. II V ***Ceropegia armandii*** **Rauh** *10368* **(Asclepiadaceae)**
V *18294* Madagascar *18294*

succ. II V ***Ceropegia bosseri*** **Rauh & Buchloh** *10368* **(Asclepiadaceae)**
V *18294* Madagascar *18294*

succ. II V ***Ceropegia dimorpha*** **Humbert** *10368* **(Asclepiadaceae)**
V *18294* Madagascar *18294*

succ. II V ***Ceropegia leroyi*** **Rauh & Marn.-Lap.** *10368* **(Asclepiadaceae)**
V *18294* Madagascar *18294*

succ. II I ***Ceropegia racemosa*** **N.E. Br. ssp.** ***glabra*** **H. Huber** *10368* **(Asclepiadaceae)**
I Madagascar

succ. II I ***Ceropegia racemosa*** **N.E. Br. ssp.** ***racemosa*** *10368* **(Asclepiadaceae)**
I Madagascar

tree timber ? ***Chloroxylon swietenia*** **DC.** *8021* **(Rutaceae)**
common name: East Indian satinwood
V *18228* Andhra Pradesh *18341*
V *18228* Kerala *18341*
V *18228* Tamil Nadu *18341*
? Madagascar *8021*
? Sri Lanka *8021*

tree Ex/E ***Chrysalidocarpus acuminum*** **Jumelle** *10246* **(Palmae)**
Ex/E *17951* Madagascar *10246*

tree Ex/E ***Chrysalidocarpus ankaizinensis*** **Jumelle** *10246* **(Palmae)**
Ex/E *17951* Madagascar *10246*

tree E ***Chrysalidocarpus arenarum*** **Jumelle** *10246* **(Palmae)**
E *17951* Madagascar *10246*

tree I ***Chrysalidocarpus auriculatus*** **Jumelle** *10246* **(Palmae)**
I *17951* Madagascar *10246*

tree Ex/E ***Chrysalidocarpus brevinodis*** **H. Perrier** *10246* **(Palmae)**
Ex/E *17951* Madagascar *10246*

tree Ex/E ***Chrysalidocarpus canescens*** **Jumelle & H. Perrier** *10246* **(Palmae)**
Ex/E *17951* Madagascar *10246*

tree II E ***Chrysalidocarpus decipiens*** **Becc.** *10246* **(Palmae)**
E *17951* Madagascar *10246*

tree V ***Chrysalidocarpus fibrosus*** **Jumelle** *10246* **(Palmae)**
V *17951* Madagascar *10246*

tree R ***Chrysalidocarpus lutescens*** **H. Wendl.** *10246* **(Palmae)**

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R 17951 Madagascar 10246

tree R *Chrysalidocarpus madagascariensis* Becc. var. *lucubensis* Becc. 10246 (Palmae)
R 17951 Madagascar 10246

tree R *Chrysalidocarpus madagascariensis* Becc. var. *madagascariensis* 10246 (Palmae)
R 17951 Madagascar 10246

tree R *Chrysalidocarpus madagascariensis* Becc. var. *oleraceus* Jumelle & H. Perrier 10246 (Palmae)
R 17951 Madagascar 10246

tree Ex/E *Chrysalidocarpus mananjarensis* Jumelle & H. Perrier 10246 (Palmae)
Ex/E 17951 Madagascar 10246

tree Ex/E *Chrysalidocarpus midongensis* Jumelle 10246 (Palmae)
Ex/E 17951 Madagascar 10246

tree V *Chrysalidocarpus onilahensis* Jumelle & H. Perrier 10246 (Palmae)
V 17951 Madagascar 10246

tree E *Chrysalidocarpus paucifolius* Jumelle 10246 (Palmae)
E 17951 Madagascar 10246

tree E/V *Chrysalidocarpus pilulifera* Becc. 10246 (Palmae)
E/V 17951 Madagascar 10246

tree Ex/E *Chrysalidocarpus rivularis* Jumelle & H. Perrier 10246 (Palmae)
Ex/E 17951 Madagascar 10246

tree I *Chrysalidocarpus ruber* Jumelle 10246 (Palmae)
I 17951 Madagascar 10246

tree Ex/E *Chrysalidocarpus sahanofensis* Jumelle 10246 (Palmae)
Ex/E 17951 Madagascar 10246

? *Cissus quadrangularis* L. (Vitaceae)
K 10368 Madagascar 10368
[distribution incomplete]

nt *Claoxylon parviflorum* Adr. Juss. 5852 (Euphorbiaceae)
nt 14233 Reunion (mid-altitude forests) 5852
? Madagascar 5852
Ex 5852 Mauritius (last seen 1889) 5852
Ex 5852 Rodrigues (last seen 1874) 5852

? *Clematis mauritiana* Lam. (Ranunculaceae)
? Reunion
? Madagascar
R Mauritius 10710

? *Clitoria heterophylla* Lam. 10082 (Leguminosae)
? Reunion 10082
? Madagascar 10082
? Mauritius 10082
[distribution possibly incomplete]

K *Coleus spicatus* Benth. 10368 (Labiatae)
K 10368 Madagascar 10368

nt *Commicarpus plumbagineus* (Cav.) Standley 10778 (Nyctaginaceae)
R Spain
? N. Afr. & Mid. E. (southern Arabia) 10778
? Israel 10778
? Madagascar 10778
? Angola 10778
? Burundi 10778
? Cameroon (east) 10778
? Chad 10778
? Ethiopia 10778
? Kenya 10778
? Malawi 10778
? Mozambique 10778
? Nigeria (north) 10778
? Rwanda 10778
R Senegal 10778

			?		Somalia *10778*
			?		Sudan *10778*
			?		Tanzania *10778*
			nt	*19007*	Uganda *10778*
			?		Zaire *10778*
			?		Zambia *10778*
			?		Zimbabwe *10778*
			?		Botswana *10778*
			?		Namibia *10778*
			?		South Africa (Natal and Transvaal) *10778*
		K	***Commiphora madagascariensis* Jacq.** *10368* **(Burseraceae)**		
			K	*10368*	Madagascar *10368*
succ.		K	***Crassula cordifolia* Baker** *10368* **(Crassulaceae)**		
			K	*10368*	Madagascar *10368*
succ.		K	***Crassula fragilis* Baker** *10368* **(Crassulaceae)**		
			K	*10368*	Madagascar *10368*
succ.		K	***Crassula humbertii* Descoings** *10368* **(Crassulaceae)**		
			K	*10368*	Madagascar *10368*
succ.		K	***Crassula micans* Vahl ex Baillon** *10368* **(Crassulaceae)**		
			K	*10368*	Madagascar *10368*
succ.		K	***Crassula nummulariifolia* Baker** *10368* **(Crassulaceae)**		
			K	*10368*	Madagascar *10368*
herb.		nt	***Crotalaria ononoides* Benth.** *7926* **(Leguminosae)**		
			?		Madagascar *7926*
			I	*6072*	Ghana *6072*
			?		Nigeria *7926*
			nt		Sierra Leone *7926*
			?		Sudan *7926*
			?		Zaire *7926*
			?		Zimbabwe *7926*
					[distribution incomplete]
		?	***Cryptocarya louvelii*** *6963* **(Lauraceae)**		
			R	*6963*	Madagascar *6963*
					[distribution possibly incomplete]
tree	II	?	***Cyathea albida* Tard.** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea alticola* (Tard.) Tindale** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea appendiculata* Baker** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea approximata* Bonap. var. *approximata*** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea approximata* Bonap. var. *sorisquamata* Tardieu** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea auriculata* Tard.** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea ballardii* Tard.** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea bellisquamata* Bonap. var. *basilobata* C. Chr.** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea bellisquamata* Bonap. var. *bellisquamata*** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea boivini* Mett. var. *boivini*** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea boivini* Mett. var. *concava* Tard.** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea boivini* Mett. var. *humblotii* C. Chr.** **(Cyatheaceae)**		
			?		Madagascar
tree	II	?	***Cyathea borbonica* Desv. var. *borbonica*** **(Cyatheaceae)**		

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			?	Reunion
			?	Madagascar
			V	Mauritius *10936*
				[distribution possibly incomplete]
tree	II	?	***Cyathea borbonica* Desv. var. *laevigata* Bonap. (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea borbonica* Desv. var. *madagascariensis* Bonap. (Cyatheaceae)**	
			?	Reunion
			?	Madagascar
			?	Mauritius
tree	II	?	***Cyathea borbonica* Desv. var. *pesvilleana* C. Chr. (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea borbonica* Desv. var. *simulans* (Baker) C. Chr. (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea costularis* Bonap. (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea decrescens* Mett. var. *decrescens* (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea decrescens* Mett. var. *hirsutifolia* C. Chr. (Cyatheaceae)**	
			?	Madagascar
tree	II	nt	***Cyathea dregei* Kunze var. *dregei* (Cyatheaceae)**	
			?	Madagascar
			?	Burkina Faso
			V	Burundi
			V	Cameroon
			V	Ethiopia
			?	Guinea
			E	Kenya
			?	Malawi
			?	Mozambique
			?	Nigeria
			V	Rwanda
			R	Sierra Leone
			V	Tanzania
			?	Zambia
			V	Zimbabwe
			nt	South Africa
				[distribution possibly incomplete]
tree	II	?	***Cyathea dregei* Kunze var. *polyphlebia* C. Chr. (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea dregei* Kunze var. *segregata* C. Chr. (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea hildebrandtii* Kuhn (Cyatheaceae)**	
			?	Comoros
			?	Madagascar
tree	II	?	***Cyathea humbertiana* Domin (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea isaloensis* C. Chr. (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea lastii* Baker (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea leptochlamys* Baker (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea ligulata* Baker (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea longipinnata* Bonap. (Cyatheaceae)**	
			?	Madagascar
tree	II	?	***Cyathea madagascarica* Bonap. (Cyatheaceae)**	
			?	Madagascar

tree	II	?	*Cyathea marattioides* Willd. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea melanocaula* Desv. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea melleri* (Baker) Domin (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea orthogonalis* Bonap. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea perrieriana* C. Chr. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea pilosula* Tard. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea quadrata* Baker (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea quadrata* Baker var. *ivohibensis* C. Chr. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea quadrata* Baker var. *quadrata* (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea serratifolia* Baker (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea similis* C. Chr. (Cyatheaceae)		
			?		Madagascar
	II	?	*Cyathea spp.* *6963* (Cyatheaceae)		
			E	*6963*	Madagascar *6963*
					[distribution possibly incomplete]
tree	II	?	*Cyathea subincisa* C. Chr. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea tsaratananensis* Tard. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea tsilotsilensis* Tard. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea viguieri* Tard. (Cyatheaceae)		
			?		Madagascar
tree	II	?	*Cyathea zakamenensis* Tard. (Cyatheaceae)		
			?		Madagascar
	II	?	*Cycas circinalis* L. *19100* (Cycadaceae)		
			common name: pitago		
			?		India
			V		Orissa *7771*
			?		Myanmar
			R		Thailand
			?		Java *7771*
			?		Sumatra *7771*
			?		P.N.G. *19361*
			?	*19100*	Mindanao (Siargo island) *19100*
			?		Madagascar *7771*
			I	*16162*	Sri Lanka *16162*
					[distribution incomplete]
	II	?	*Cycas thouarsii* Gaudich. (Cycadaceae)		
			?		Comoros
			?		Madagascar
			R	*19109*	Kenya *19109*
			?		Mozambique
			V		Tanzania
			I		Pemba I.
			?		Zanzibar
					[distribution possibly incomplete]
		K	*Cynanchum ampanihense* Jum. & H. Perrier *10368* (Asclepiadaceae)		
			K	*10368*	Madagascar *10368*

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	K	*Cynanchum aphyllum* (Thunb.) Schltr. *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum compactum* Choux var. *compactum* *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum compactum* Choux var. *imerinse* Descoings *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
succ.	K	*Cynanchum cucullatum* N.E. Br. *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum decaisnianum* Descoings *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum helicoideum* Choux *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum implicatum* (Jum. & Perr.) Jum. & Perr. *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum luteifluens* (Jum. & H. Perrier) Descoings *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
succ.	K	*Cynanchum macrolobum* Jum. & H. Perrier *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum madecassum* Descoings *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
succ.	K	*Cynanchum mahafalense* Jum. & H. Perrier *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
succ.	K	*Cynanchum marnieranum* Rauh *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum messeri* (Buchenau) Jum. & H. Perrier *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	K	*Cynanchum napiforme* Choux *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
succ.	K	*Cynanchum nodosum* (Jum. & Perr.) Descoings *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
succ.	K	*Cynanchum pachylobum* Choux *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
succ.	nt	*Cynanchum perrieri* Choux *10368* (Asclepiadaceae) nt Madagascar
	K	*Cynanchum pycnoneuroides* Choux *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
succ.	K	*Cynanchum rauhianum* Descoings *10368* (Asclepiadaceae) K *10368* Madagascar *10368*
	V	*Cynanchum rossii* Rauh *10368* (Asclepiadaceae) V *10368* Madagascar *10368*
	K	*Cyphostemma cornigerum* Descoings *10368* (Vitaceae) K *10368* Madagascar *10368*
	K	*Cyphostemma coursii* Descoings *10368* (Vitaceae) K *10368* Madagascar *10368*
	K	*Cyphostemma echinocarpum* Descoings *10368* (Vitaceae) K *10368* Madagascar *10368*
	K	*Cyphostemma elephantopus* Descoings *10368* (Vitaceae) K *10368* Madagascar *10368*
	I	*Cyphostemma laza* Descoings var. *laza* *10368* (Vitaceae) I Madagascar
	I	*Cyphostemma laza* Descoings var. *parviflora* Descoings *10368* (Vitaceae) I Madagascar
	K	*Cyphostemma montagnacii* Descoings *10368* (Vitaceae) K *10368* Madagascar *10368*
	K	*Cyphostemma roseiglandulosa* Descoings *10368* (Vitaceae) K *10368* Madagascar *10368*
	K	*Cyphostemma sakalavense* Descoings *10368* (Vitaceae) K *10368* Madagascar *10368*
tree timber	?	*Dalbergia baronii* *17685* (Leguminosae)

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common name: palissandre voamboana
? Madagascar (Eastern) *17685*
[distribution possibly incomplete]

tree timber ? ***Dalbergia greveana*** *17685* **(Leguminosae)**
common name: palissandre violet
? Madagascar (Western) *17685*
[distribution possibly incomplete]

climbemed./pharm. ? ***Danais fragrans*** **(Lam.) Pers.** *10082* **(Rubiaceae)**
common name: liane jaune
? Reunion *10082*
? Madagascar *11082*
? Mauritius *10082*

II K ***Decaryia madagascariensis*** **Choux** *10368* **(Didiereaceae)**
K *10368* Madagascar *10368*

? ***Dicoryphe sp.*** *6963* **(Hamamelidaceae)**
R *6963* Madagascar *6963*
[distribution possibly incomplete]

II K ***Didierea madagascariensis*** **Baillon** *10368* **(Didiereaceae)**
K *10368* Madagascar *10368*

II K ***Didierea trollii*** **Capuron & Rauh** *10368* **(Didiereaceae)**
K *10368* Madagascar *10368*

? ***Dioscorea bemarivensis*** **Jum. & Perr.** *14981* **(Dioscoreaceae)**
? Madagascar *14981*
E *14981* Seychelles *14981*
[distribution possibly incomplete]

tree timber nt ***Diospyros ferrea*** **(Willd.) Bakh.** *8021* **(Ebenaceae)**
common name: kitenyek (pp)
nt *19218* India *8021*
? Ryukyu Is.
? Kampuchea *16285*
? Laos *16285*
? Myanmar (Tenasserim) *8021*
V Taiwan (Heng-ch'un Pen.; Lan Yu)
? Thailand *16285*
? Indonesia *16285*
? Malaysia
? Pen. Malaysia (widely distributed) *19209*
? P.N.G. *16433*
? Philippines *16285*
? Australia
? Fiji
? Madagascar *13102*
? Sri Lanka *8021*
? Angola *13102*
? Benin *7926*
nt Cameroon *7926*
? C. African Rep. *13102*
V *15969* Côte d'Ivoire *13102*
? Ghana *7926*
? Guinea *13102*
? Guinea-Bissau *7926*
? Mali *7926*
? Nigeria *7926*
? Senegal *7926*
? Sierra Leone *7926*
R *6088* Zimbabwe *6088*
[distribution incomplete]

herb. II ? ***Disperis tripetaloides*** **(Thouars) Lindley** *5852* **(Orchidaceae)**
? Reunion *5852*

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		?		Madagascar *5852*
		R		Mauritius *5852*
		V	*5852*	Rodrigues *5852*
		?		Seychelles *14296*
		V	*19182*	Seychelles: Gra *14296*
	K	***Dorstenia cuspidata* Hochst.** *10368* **(Moraceae)**		
		K	*10368*	Madagascar *10368*
	?	***Dracaena reflexa* Lam. var. *linearifolia* Ayres ex Baker** *10082* **(Liliaceae)**		
		?		Reunion *10082*
		?		Madagascar *10082*
		?		Mauritius *10082*
	?	***Dracaena reflexa* Lam. var. *reflexa*** *10082* **(Liliaceae)**		
		?		Reunion *19196*
		?		Madagascar *19196*
		?		Mauritius *19196*
		?		Seychelles: Cor (Aldabra) *19196*
				[distribution possibly incomplete]
tree	Ex/E	***Dypsis angusta* Jumelle** *10246* **(Palmae)**		
		Ex/E	*17951*	Madagascar *10246*
tree	V	***Dypsis boiviniana* Becc.** *10246* **(Palmae)**		
		V	*17951*	Madagascar *10246*
tree	E	***Dypsis fasciculata* Jumelle** *10246* **(Palmae)**		
		E	*17951*	Madagascar *10246*
tree	R	***Dypsis forficifolia* Mart. var. *forficifolia*** *10246* **(Palmae)**		
		R	*17951*	Madagascar *10246*
tree	R	***Dypsis forficifolia* Mart. var. *reducta* Jumelle & H. Perrier** *10246* **(Palmae)**		
		R	*17951*	Madagascar *10246*
tree	Ex/E	***Dypsis glabrescens* Becc.** *10246* **(Palmae)**		
		Ex/E	*17951*	Madagascar *10246*
tree	I	***Dypsis gracilis* Bory ex Mart.** *10246* **(Palmae)**		
		I	*17951*	Madagascar *10246*
tree	R	***Dypsis hildebrandtii* Becc.** *10246* **(Palmae)**		
		R	*17951*	Madagascar *10246*
tree	Ex/E	***Dypsis hirtula* Mart.** *10246* **(Palmae)**		
		Ex/E	*17951*	Madagascar *10246*
tree	R	***Dypsis humbertii* H. Perrier var. *angustifolia* H. Perrier** *10246* **(Palmae)**		
		R	*17951*	Madagascar *10246*
tree	R	***Dypsis humbertii* H. Perrier var. *humbertii*** *10246* **(Palmae)**		
		R	*17951*	Madagascar *10246*
tree	V	***Dypsis lantzeana* Baill.** *10246* **(Palmae)**		
		V	*17951*	Madagascar *10246*
tree	Ex/E	***Dypsis linearis* Jumelle** *10246* **(Palmae)**		
		Ex/E	*17951*	Madagascar *10246*
tree	E	***Dypsis littoralis* Jumelle** *10246* **(Palmae)**		
		E	*17951*	Madagascar *10246*
tree	Ex/E	***Dypsis longipes* Jumelle** *10246* **(Palmae)**		
		Ex/E	*17951*	Madagascar *10246*
tree	R	***Dypsis louvelii* Jumelle & H. Perrier** *11813* **(Palmae)**		
		R	*17951*	Madagascar *10246*
tree	V	***Dypsis mananarensis* Jumelle** *10246* **(Palmae)**		
		V	*17951*	Madagascar *10246*
tree	Ex/E	***Dypsis masoalensis* Jumelle** *10246* **(Palmae)**		
		Ex/E	*17951*	Madagascar *10246*
tree	V	***Dypsis mocquerysiana* Becc.** *11813* **(Palmae)**		
		V	*17951*	Madagascar *10246*
tree	Ex/E	***Dypsis monostachya* Jumelle** *10246* **(Palmae)**		
		Ex/E	*17951*	Madagascar *10246*
tree	Ex/E	***Dypsis plurisecta* Jumelle** *10246* **(Palmae)**		
		Ex/E	*17951*	Madagascar *10246*

tree — V — ***Dypsis procera*** **Jumelle** *10246* **(Palmae)**
V *17951* Madagascar *10246*

tree — Ex/E — ***Dypsis sambiranensis*** **Jumelle** *10246* **(Palmae)**
Ex/E *17951* Madagascar *10246*

tree — E — ***Dypsis viridis*** **Jumelle** *10246* **(Palmae)**
E *17951* Madagascar *10246*

? — ***Ehretia corymbosa*** **DC.** *14981* **(Boraginaceae)**
? Comoro Islands *14981*
? Madagascar *14981*
E *14981* Seychelles *14981*
[distribution possibly incomplete]

tree timber — nt — ***Elaeis guineensis*** **Jacq.** *10238* **(Palmae)**
common name: abe
nt *17951* Madagascar *17951*
nt Angola (also Cabinda) *11628*
? Benin *7926*
? Burundi
? Cameroon *7926*
? C. African Rep. *7926*
? Congo *7926*
? Côte d'Ivoire *7926*
? Gambia *7926*
? Ghana *7926*
? Guinea *7926*
nt *15159* Guinea-Bissau *7926*
? Liberia *7926*
? Malawi
? Nigeria *7926*
? Senegal *7926*
? Sierra Leone *7926*
? Sudan
? Tanzania
? Togo *7926*
R *19007* Uganda *7926*
? Zaire *7926*
[distribution possibly incomplete]

tree timber — nt — ***Erythrophleum suaveolens*** **(Guill. & Perr.) Brenan** *19532* **(Leguminosae)**
synonym: ***Erythrophleum guineense*** G. Don
common names: odom, potrodom, sasswood, tali
? Madagascar
nt *13924* Cameroon *7926*
? C. African Rep. *12346*
? Chad *12346*
nt *13925* Congo *18310*
? Côte d'Ivoire *7926*
? Gabon *18323*
? Gambia *7926*
? Ghana *15970*
? Guinea *7926*
? Guinea-Bissau *7926*
? Kenya *12346*
? Liberia *16029*
? Malawi *12346*
? Mali *7926*
? Mozambique *19532*
? Nigeria *18326*
? Senegal *7926*
? Sierra Leone *7926*
? Sudan *18307*

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? Tanzania *12346*
? Togo *7926*
? Uganda *14519*
? Zaire *18332*
? Zambia *12346*
? Zimbabwe *19532*
[distribution incomplete]

succ. II K ***Euphorbia alcicornis*** **Baker** *17672* **(Euphorbiaceae)**
K *10368* Madagascar *17672*

succ. II nt ***Euphorbia alluaudii*** **Drake ssp.** ***alluaudii*** *17672* **(Euphorbiaceae)**
synonym: *Euphorbia leucodendron* Drake
nt *17672* Madagascar *17672*

succ. II K ***Euphorbia alluaudii*** **Drake ssp.** ***oncoclada*** **(Drake) Friedm. & Cremers** *17672* **(Euphorbiaceae)**
K *10368* Madagascar *17672*

succ. II ? ***Euphorbia ambatofinandranae*** **(Leandri) Cremers** *17672* **(Euphorbiaceae)**
synonym: *Euphorbia stenoclada* Baillon ssp. *ambatofinandranae* (Leandri) Cremers
? *17672* Madagascar *17672*
[distribution possibly incomplete]

I E ***Euphorbia ambovombensis*** **Rauh & Razaf.** *15658* **(Euphorbiaceae)**
E *17672* Madagascar *17672*

succ. II ? ***Euphorbia analalavensis*** **Leandri** *17672* **(Euphorbiaceae)**
? *17672* Madagascar *17672*

succ. II I ***Euphorbia ankarensis*** **Boit.** *17672* **(Euphorbiaceae)**
I *17672* Madagascar *17672*

succ. II ? ***Euphorbia arahaka*** **H. Poisson ex Humbert & Leandri** *17672* **(Euphorbiaceae)**
? *17672* Madagascar *17672*

succ. II ? ***Euphorbia beharensis*** **Leandri** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II ? ***Euphorbia biaculeata*** **Denis** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II ? ***Euphorbia boinensis*** **Denis ex Humbert & Leandri** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II ? ***Euphorbia boissieri*** **Baillon** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II ? ***Euphorbia boiteaui*** **Leandri** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II ? ***Euphorbia bosseri*** **Leandri** *17672* **(Euphorbiaceae)**
? Madagascar (east central) *15926*

succ. II ? ***Euphorbia brachyphylla*** **Denis** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II ? ***Euphorbia capsaintemariensis*** **Rauh var.** ***capsaintemariensis*** *17672* **(Euphorbiaceae)**
? Madagascar

succ. II E ***Euphorbia capsaintemariensis*** **Rauh var.** ***tulearensis*** **Rauh** *15926* **(Euphorbiaceae)**
synonym: *Euphorbia tulearensis* (Rauh) Rauh
E *17672* Madagascar (southernmost area)

succ. II nt ***Euphorbia capuronii*** **Ursch & Leandri** *17672* **(Euphorbiaceae)**
nt Madagascar

succ. II ? ***Euphorbia caputaureum*** **Denis** *17672* **(Euphorbiaceae)**
? Madagascar

succ. II ? ***Euphorbia commersonii*** **Baillon** *17672* **(Euphorbiaceae)**
? Madagascar

succ. II ? ***Euphorbia croizatii*** **Leandri** *17672* **(Euphorbiaceae)**
? Madagascar

succ. I ? ***Euphorbia cylindrifolia*** **Marn.-Lap. & Rauh ssp.** ***cylindrifolia*** *17672* **(Euphorbiaceae)**
? Madagascar

succ. I I ***Euphorbia cylindrifolia*** **Marn.-Lap. & Rauh ssp.** ***tuberifera*** **Rauh** *17672*

(Euphorbiaceae)
I Madagascar

succ. I I *Euphorbia decaryi* Guillaumin *15658* (Euphorbiaceae)
I Madagascar

succ. II ? *Euphorbia decorsei* Drake *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia delphinensis* Ursch & Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia denisiana* Guillaumin *17672* (Euphorbiaceae)
? Madagascar

succ. II I *Euphorbia didiereoides* Denis ex Leandri *17672* (Euphorbiaceae)
I Madagascar

succ. II ? *Euphorbia duranii* Ursch & Leandri var. *ankaratrae* Ursch & Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II nt *Euphorbia duranii* Ursch & Leandri var. *duranii* *17672* (Euphorbiaceae)
nt Madagascar

succ. II ? *Euphorbia enterophora* Drake ssp. *crassa* Cremers *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia enterophora* Drake ssp. *enterophora* *15926* (Euphorbiaceae)
? Madagascar *15926*

succ. II ? *Euphorbia famatamboay* Friedm. & Cremers ssp. *famatamboay* *17672* (Euphorbiacea
? Madagascar

succ. II ? *Euphorbia famatamboay* Friedm. & Cremers ssp. *itampolensis* Friedm. & Cremers *1*
(Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia fianarantsoae* Ursch & Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia fiherenensis* Poiss. *17672* (Euphorbiaceae)
? Madagascar

succ. I nt *Euphorbia francoisii* Leandri *15658* (Euphorbiaceae)
nt Madagascar

succ. II ? *Euphorbia genoudiana* Ursch & Leandri *15926* (Euphorbiaceae)
? Madagascar (south-western) *15926*

succ. II ? *Euphorbia guillauminiana* Boit. *17672* (Euphorbiaceae)
? Madagascar

succ. II nt *Euphorbia guillemetii* Ursch & Leandri *17672* (Euphorbiaceae)
nt Madagascar

II ? *Euphorbia hedyotoides* N.E. Br. *17672* (Euphorbiaceae)
? Madagascar

succ. II nt *Euphorbia horombensis* Ursch & Leandri *17672* (Euphorbiaceae)
nt Madagascar

succ. II nt *Euphorbia intisy* Drake *17672* (Euphorbiaceae)
nt Madagascar

succ. II syn. *Euphorbia intisy* Drake var. *maintyi* (Decorse) L. Poiss. *17672* (Euphorbiaceae)
see *Euphorbia mainty* Denis ex Leandri

succ. II ? *Euphorbia isaloensis* Drake *17672* (Euphorbiaceae)
? Madagascar

succ. II nt *Euphorbia lactea* Haw. *15926* (Euphorbiaceae)
nt *15926* India (peninsular) *15926*
? Reunion *17672*
? Madagascar *17672*
? Sri Lanka *17672*

II syn. *Euphorbia laro* Drake (Euphorbiaceae)
see *Euphorbia tirucalli* L.

succ. II ? *Euphorbia leandriana* Boit. *17672* (Euphorbiaceae)
? Madagascar

succ. II syn. *Euphorbia leucodendron* Drake *17672* (Euphorbiaceae)
see *Euphorbia alluaudii* Drake ssp. *alluaudii*

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succ. II ? *Euphorbia leuconeura* Boiss. *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia lophogona* Lam. *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia mahafalensis* Denis var. *mahafalensis* *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia mahafalensis* Denis var. *xanthadenia* (Denis) Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia mainty* Denis ex Leandri *17672* (Euphorbiaceae)
synonym: *Euphorbia intisy* Drake var. *maintyi* (Decorse) L. Poiss.
? Madagascar

succ. II ? *Euphorbia mangokyensis* Denis *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *betsiliana* Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *bevilaniensis* (Croizat) Ursch & Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II syn. *Euphorbia milii* Des Moul. var. *bosseri* Rauh *15926* (Euphorbiaceae)
see *Euphorbia neobosseri* Rauh

succ. II ? *Euphorbia milii* Des Moul. var. *breonii* (Nois.) Ursch & Leandri *15926* (Euphorbiaceae)
? Madagascar *15926*

succ. II ? *Euphorbia milii* Des Moul. var. *hislopii* (N.E. Br.) Ursch & Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *imperatae* (Leandri) Ursch & Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *longifolia* Rauh *15926* (Euphorbiaceae)
? Madagascar *15926*

succ. II ? *Euphorbia milii* Des Moul. var. *milii* *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *roseana* Marn.-Lap. *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *splendens* (Bojer ex Hook.) Ursch & Lean. *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *tananarivae* Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *tulearensis* Ursch & Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II ? *Euphorbia milii* Des Moul. var. *vulcanii* Leandri *17672* (Euphorbiaceae)
? Madagascar

succ. II I *Euphorbia millotii* Ursch & Leandri *17672* (Euphorbiaceae)
I *18294* Madagascar *18294*

succ. I R *Euphorbia moratii* Rauh *15658* (Euphorbiaceae)
R Madagascar *15926*

succ. II ? *Euphorbia neobosseri* Rauh *17672* (Euphorbiaceae)
synonym: *Euphorbia milii* Des Moul. var. *bosseri* Rauh
? *17672* Madagascar *17672*
[distribution possibly incomplete]

succ. II I *Euphorbia neohumbertii* Rauh var. *aureo-viridiflora* Rauh *17672* (Euphorbiaceae)
I Madagascar

succ. II nt *Euphorbia neohumbertii* Boit. var. *neohumbertii* *17672* (Euphorbiaceae)
nt Madagascar

II ? *Euphorbia orthoclada* Baker ssp. *orthoclada* *17672* (Euphorbiaceae)
? *17672* Madagascar *17672*

II ? ***Euphorbia orthoclada*** **Baker ssp.** ***vepretorum*** **(Drake) Leandri** *17672* **(Euphorbiaceae)**
? *17672* Madagascar *17672*

succ. II I ***Euphorbia pachypodioides*** **Boit.** *17672* **(Euphorbiaceae)**
I *17672* Madagascar *17672*

succ. I R ***Euphorbia parvicyathophora*** **Rauch** *15658* **(Euphorbiaceae)**
R *17672* Madagascar *17672*

succ. II R ***Euphorbia pauliani*** **Ursch & Leandri** *17672* **(Euphorbiaceae)**
R *17672* Madagascar *17672*

succ. II R ***Euphorbia pedilanthoides*** **Denis** *15926* **(Euphorbiaceae)**
R *17672* Madagascar *15926*

succ. II I ***Euphorbia perrieri*** **Drake var.** ***elongata*** **Denis** *17672* **(Euphorbiaceae)**
I *18294* Madagascar *17672*

succ. II R ***Euphorbia perrieri*** **Drake var.** ***perrieri*** *17672* **(Euphorbiaceae)**
R *17672* Madagascar *17672*

II nt ***Euphorbia plagiantha*** **Drake** *17672* **(Euphorbiaceae)**
nt *17672* Madagascar *17672*

succ. II ? ***Euphorbia platyclada*** **Rauh var.** ***hardyi*** **Rauh** *15926* **(Euphorbiaceae)**
? Madagascar (Tulear) *15926*

succ. II ? ***Euphorbia platyclada*** **Rauh var.** ***platyclada*** *17672* **(Euphorbiaceae)**
? *17672* Madagascar *17672*

succ. I I ***Euphorbia primulifolia*** **Baker** *15658* **(Euphorbiaceae)**
I *17672* Madagascar *15926*

II ? ***Euphorbia pyrifolia*** **Lam.** *17672* **(Euphorbiaceae)**
? Reunion *17672*
K *10368* Madagascar *17672*
R *17672* Mauritius *10936*
R *19182* Seychelles: Cor *17672*
R *19182* Seychelles: Gra *14296*
[distribution possibly incomplete]

succ. I R ***Euphorbia quartziticola*** **Leandri** *15658* **(Euphorbiaceae)**
R *17672* Madagascar *15926*

succ. II ? ***Euphorbia razafinjohanii*** **Ursch & Leandri** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II V ***Euphorbia rossii*** **Rauh & Buchloh** *17672* **(Euphorbiaceae)**
V *17672* Madagascar *17672*

II ? ***Euphorbia salota*** **Leandri** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II syn. ***Euphorbia stenoclada*** **Baillon ssp.** ***ambatofinandranae*** **(Leandri) Cremers** *17672* **(Euphorbiaceae)**
see ***Euphorbia ambatofinandranae*** **(Leandri) Cremers**

succ. II ? ***Euphorbia stenoclada*** **Baillon ssp.** ***stenoclada*** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. II ? ***Euphorbia tardieuana*** **Leandri** *17672* **(Euphorbiaceae)**
? Madagascar *17672*

succ. med./pharm. II nt ***Euphorbia tirucalli*** **L.** *18136* **(Euphorbiaceae)**
synonym: ***Euphorbia laro*** **Drake**
common name: patah tulang
? Saudi Arabia *19525*
nt *18228* Andhra Pradesh *18341*
nt *18228* Tamil Nadu *18341*
? *17672* S.E. Asia to PNG *17672*
[?] [introd.] Sumatra (Gunung Leuser National Park) *18136*
? Madagascar *19525*
? *17672* Tropical Africa *17672*
nt *17672* Angola *17672*
nt *17672* Ethiopia *17672*
nt *17672* Kenya *17672*
nt *17672* Tanzania *15951*
nt *17672* Uganda *17672*

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			nt *17672* Zimbabwe *15940*
succ.	II	?	***Euphorbia tsimbazazae*** **Leandri** *17672* **(Euphorbiaceae)**
			? *17672* Madagascar *17672*
succ.	I	syn.	***Euphorbia tulearensis*** **(Rauh) Rauh** *15658* **(Euphorbiaceae)**
			see ***Euphorbia capsaintemariensis*** **Rauh var.** ***tulearensis*** **Rauh**
succ.	II	?	***Euphorbia viguieri*** **Denis var.** ***ankarafantsiensis*** **Ursch & Leandri** *17672* **(Euphorbiaceae)**
			? Madagascar *17672*
succ.	II	nt	***Euphorbia viguieri*** **Denis var.** ***capuroniana*** **Ursch & Leandri** *17672* **(Euphorbiaceae)**
			nt *17672* Madagascar *17672*
succ.	II	?	***Euphorbia viguieri*** **Denis var.** ***tsimbazazae*** **Ursch & Leandri** *17672* **(Euphorbiaceae)**
			? Madagascar *17672*
succ.	II	nt	***Euphorbia viguieri*** **Denis var.** ***viguieri*** *17672* **(Euphorbiaceae)**
			nt *17672* Madagascar *17672*
succ.	II	?	***Euphorbia viguieri*** **Denis var.** ***vilanandrensis*** **Ursch & Leandri** *17672* **(Euphorbiaceae)**
			? Madagascar *17672*
succ.	II	nt	***Euphorbia xylophylloides*** **Brongn. ex Lemaire** *17672* **(Euphorbiaceae)**
			nt *17672* Madagascar *17672*
	II	?	***Euphorbia zakamenae*** **Leandri** *17672* **(Euphorbiaceae)**
			? Madagascar *17672*
shrub med./pharm.		?	***Faujasia flexuosa*** **Benth.** *19420* **(Compositae)**
			common name: bois cassant
			? Reunion *10710*
			? Madagascar *10710*
			? Mauritius *10710*
		nt	***Ficus reflexa*** **Thunb.** *5852* **(Moraceae)**
			? Reunion *10082*
			? Madagascar *10082*
			? Mauritius *10082*
			nt Rodrigues *5852*
succ.		K	***Folotsia aculeatum*** **(Descoings) Descoings** *10368* **(Asclepiadaceae)**
			K *10368* Madagascar *10368*
succ.		K	***Folotsia floribundum*** **Descoings** *10368* **(Asclepiadaceae)**
			K *10368* Madagascar *10368*
succ.		K	***Folotsia grandiflorum*** **(Jum. & Perr.) Jum. & Perr.** *10368* **(Asclepiadaceae)**
			K *10368* Madagascar *10368*
succ.		K	***Folotsia madagascariense*** **(Jum. & H. Perrier) Descoings** *10368* **(Asclepiadaceae)**
			K *10368* Madagascar *10368*
succ.		K	***Folotsia sarcostemmoides*** **Costantin & Bois** *10368* **(Asclepiadaceae)**
			K *10368* Madagascar *10368*
		?	***Gagnebina pterocarpa*** **(Lam.) Baillon** *10082* **(Leguminosae)**
			common names: bois chèvre, goat wood
			? Comoros *10082*
			? Madagascar *10082*
			R *15963* Mauritius (incl. Round Is.) *10082*
		?	***Gladiolus luteus*** **Lam.** *14233* **(Iridaceae)**
			E *14233* Reunion *14233*
			? Madagascar *14233*
			[distribution possibly incomplete]
		?	***Grewia glandulosa*** **Vahl** *14981* **(Tiliaceae)**
			? Madagascar *14981*
			E *14981* Seychelles (Aldabra) *14981*
			[distribution possibly incomplete]
		?	***Grewia picta*** **Baillon** *14981* **(Tiliaceae)**
			? Madagascar *14981*
			E *14981* Seychelles *14981*
			[distribution possibly incomplete]
herb.	II	nt	***Habenaria cirrhata*** **(Lindley) Reichb. f.** *7926* **(Orchidaceae)**

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		?		Madagascar *7926*
		?		Cameroon *7926*
		?		Congo *7926*
		?		Ethiopia *7926*
		?		Ghana *7926*
		?		Guinea *7926*
		?		Malawi *7926*
		?		Nigeria *7926*
		I	*5908*	Sudan *7926*
		?		Tanzania *7926*
		nt	*19007*	Uganda *7926*
		?		Zambia *7926*
				[distribution possibly incomplete]
tree	E	***Halmoorea trispatha* J. Dransf. & N. Uhl.** *11813* **(Palmae)**		
		E	*17951*	Madagascar *17951*
	nt	***Hibiscus calyphyllus* Cav.** *14209* **(Malvaceae)**		
		synonym: *Hibiscus rockii* Degener & I. Degener		
		nt	*14209*	Hawaii (Kaua`i) *14209*
		nt	*14209*	Madagascar *14209*
				[distribution incomplete]
	?	***Humbertia madagascariensis*** *6963* **(Convolvulaceae)**		
		R	*6963*	Madagascar *6963*
				[distribution possibly incomplete]
tree	nt	***Hyphaene coriacea* Gaertner** *10238* **(Palmae)**		
		nt	*17951*	Madagascar *10238*
		?		Tropical Africa *10238*
		?		Southern Africa *10238*
				[distribution incomplete]
herb.	?	***Hypoxis angustifolia* Lam.** *7926* **(Hypoxidaceae)**		
		?		Madagascar *7926*
		?		Cameroon *7926*
		?		Ethiopia *7926*
		R	*6072*	Ghana *6072*
		?		Guinea *7926*
		?		Nigeria *7926*
		?		Sierra Leone *7926*
				[distribution incomplete]
herb.	K	***Impatiens tuberosa* H. Perrier** *10368* **(Balsaminaceae)**		
		K	*10368*	Madagascar *10368*
tree timber	nt	***Intsia bijuga* (Colebr.) Kuntze** *19593* **(Leguminosae)**		
		common names: ajar, Borneo teak, go nuoc, ifi-lele, ifil, ipil, kwila, lumpaw, lumpho thale, merbau, Moluccan ironwood, praduu thale, u'ula, vesi		
		?		India (south) *19593*
		?		Ryukyu Is. *19284*
		?		Kampuchea
		?		Myanmar (south)
		?		Thailand (southeastern & peninsular) *19284*
		I	*15734*	Vietnam (south) *15734*
		I	*16019*	Indonesia *12983*
		?		Irian Jaya *19593*
		?		Malaysia *8618*
		?		Pen. Malaysia (widely distributed) *19209*
		nt	*19093*	P.N.G. *16433*
		?		Bismarck Arch. *19593*
		E/V	*15960*	Philippines *19593*
		?		Australia (north)
		?		Pacific Is. *8006*
		?		Solomon Is. *19593*
		?		American Samoa *8006*

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nt *19602* Vanuatu *19602*
? Indian Ocean Is *19593*
? Madagascar *8006*
? Seychelles *19284*
? Pemba I. *19593*
? Zanzibar *19593*
[distribution incomplete]

? ***Isaloa lepida*** *6963* **(Scrophulariaceae)**
R *6963* Madagascar *6963*
[distribution possibly incomplete]

herb. II ? ***Jumellea recta*** **(Thouars) Schltr.** *5852* **(Orchidaceae)**
? Reunion *5852*
? Madagascar *5852*
V Mauritius *5852*
E *5852* Rodrigues (Mont Cimetiere) *5852*

? ***Justicia congestiflora*** **Benoist var.** ***humilior*** **R. Ben.** *14981* **(Acanthaceae)**
? Madagascar *14981*
E *14981* Seychelles *14981*
[distribution possibly incomplete]

succ. K ***Kalanchoe adolphi-engleri*** **Raym.-Hamet** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe ambolensis*** **Humbert** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe arborescens*** **Humbert** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe aromatica*** **H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe beauverdii*** **Raym.-Hamet var.** ***beauverdii*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe beauverdii*** **Raym.-Hamet var.** ***guignardii*** **Raym.-Hamet** *10368* **(Crassulac**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe beauverdii*** **Raym.-Hamet var.** ***parviflora*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. R ***Kalanchoe beharensis*** **Drake var.** ***aureo-aeneus*** **H.J. Jacobsen** *10368* **(Crassulaceae)**
R Madagascar

succ. K ***Kalanchoe beharensis*** **Drake var.** ***beharensis*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. R ***Kalanchoe beharensis*** **Drake var.** ***subnuda*** **H.J. Jacobsen** *10368* **(Crassulaceae)**
R Madagascar

succ. K ***Kalanchoe bergeri*** **Raym.-Hamet var.** ***bergeri*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe bergeri*** **Raym.-Hamet var.** ***glabra*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. I ***Kalanchoe bitteri*** **Raym.-Hamet** *10368* **(Crassulaceae)**
I Madagascar

succ. K ***Kalanchoe blossfeldiana*** **Poelln.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe boissii*** **Raym.-Hamet & H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe bouvetii*** **Raym.-Hamet & H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe bracteata*** **Scott Elliott** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe campanulata*** **(Baker) Baillon var.** ***campanulata*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe campanulata*** **(Baker) Baillon var.** ***orthostyla*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

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succ. K *Kalanchoe daigremontiana* Raym.-Hamet & H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe ebracteata* Scott Elliott *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe eriophylla* Hils. & Bojer *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe fedtschenkoi* Raym.-Hamet & H. Perrier var. *fedtschenkoi* *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe fedtschenkoi* Raym.-Hamet & H. Perrier var. *isalensis* Manning & Boit. *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe gastonis-bonnieri* Raym.-Hamet & H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe gentyi* Raym.-Hamet & H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe globulifera* H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe gracilipes* (Baker) Baillon *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe grandidieri* Baillon *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe heckelii* Raym.-Hamet & H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe hildebrandtii* Baillon *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe integrifolia* Baker *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe jongmansii* Raym.-Hamet & H. Perrier var. *ivohibensis* Humbert *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe jongmansii* Raym.-Hamet & H. Perrier var. *jongmansii* *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe laxiflora* Baker var. *laxiflora* *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe laxiflora* Baker var. *stipitata* Manning & Boit. *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe laxiflora* Baker var. *subpeltata* Manning & Boit. *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe laxiflora* Baker var. *violacea* Manning & Boit. *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe linearifolia* Drake *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe macrochlamys* H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe manginii* Raym.-Hamet & H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe marnierana* H.J. Jacobsen *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe millotii* Raym.-Hamet & H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe miniata* Hils. & Bojer var. *andringitrensis* H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe miniata* Hils. & Bojer var. *anjirensis* H. Perrier *10368* (Crassulaceae)
K *10368* Madagascar *10368*

succ. K *Kalanchoe miniata* Hils. & Bojer var. *confertifolia* H. Perrier *10368* (Crassulaceae)

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K *10368* Madagascar *10368*

succ. K ***Kalanchoe miniata*** **Hils. & Bojer var.** ***miniata*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe miniata*** **Hils. & Bojer var.** ***peltata*** **Baker** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe miniata*** **Hils. & Bojer var.** ***sicaformis*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe miniata*** **Hils. & Bojer var.** ***subsessilis*** **H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe mortagei*** **Raym.-Hamet & H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe nadyae*** **Raym.-Hamet** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe orgyalis*** **Baker** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe peltata*** **(Baker) Baillon var.** ***mandrakensis*** **H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe peltata*** **(Baker) Baillon var.** ***peltata*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe peltata*** **(Baker) Baillon var.** ***stapfii*** **(Perr.) Raym.-Hamet & H. Perr.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe poincarei*** **Raym.-Hamet** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe porphyrocalyx*** **(Baker) Baillon var.** ***porphyrocalyx*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe porphyrocalyx*** **(Baker) Baillon var.** ***sambiranensis*** **Humbert** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe porphyrocalyx*** **(Baker) Baillon var.** ***sulphurea*** **Baker** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe prolifera*** **(Bowie) Raym.-Hamet** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pseudocampanulata*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pubescens*** **Baker var.** ***alexiana*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pubescens*** **Baker var.** ***brevicalyx*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pubescens*** **Baker var.** ***decolorata*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pubescens*** **Baker var.** ***grandiflora*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pubescens*** **Baker var.** ***pubescens*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pubescens*** **Baker var.** ***subglabrata*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pubescens*** **Baker var.** ***subsessilis*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe pumila*** **Baker** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe rhombopilosa*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe rolandi-bonapartei*** **Raym.-Hamet & H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe rosei*** **Raym.-Hamet & H. Perrier var.** ***rosei*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe rosei*** **Raym.-Hamet & H. Perrier var.** ***seyrigii*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe rosei*** **Raym.-Hamet & H. Perrier var.** ***varifolia*** **Guill. & Humbert** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe rubella*** **(Baker) Raym.-Hamet** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe schizophylla*** **(Baker) Baillon** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe serrata*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe streptantha*** **Baker** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe suarezensis*** **H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe synsepala*** **Baker** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe tetraphylla*** **H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe tomentosa*** **Baker** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe trichantha*** **Baker** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe tuberosa*** **H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. nt ***Kalanchoe tubiflora*** **(Harvey) Raym.-Hamet** *10368* **(Crassulaceae)**
nt Madagascar

succ. K ***Kalanchoe uniflora*** **(Stapf) Raym.-Hamet var.** ***brachycalyx*** **Manning & Boit.** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Kalanchoe uniflora*** **(Stapf) Raym.-Hamet var.** ***uniflora*** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. R ***Kalanchoe viguieri*** **Raym.-Hamet & H. Perrier** *10368* **(Crassulaceae)**
R *10368* Madagascar *10368*

succ. K ***Kalanchoe waldheimii*** **Raym.-Hamet & H. Perrier** *10368* **(Crassulaceae)**
K *10368* Madagascar *10368*

succ. K ***Karimbolea verrucosa*** **Descoings** *10368* **(Asclepiadaceae)**
K *10368* Madagascar *10368*

tree E ***Lemurophoenix halleuxii*** **J. Dransfield** *14788* **(Palmae)**
common name: red-lemur palm
E *17951* Madagascar (valley near Sahavary) *14788*

? ***Lemuropisum edule*** *6963* **(Leguminosae)**
R *6963* Madagascar *6963*
[distribution possibly incomplete]

herb. II nt ***Liparis caespitosa*** **(Thouars) Lindley** *9272* **(Orchidaceae)**
? China *8309*
I Sikkim
I Uttar Pradesh
nt Java *8309*
? Lesser Sunda Is (Bali)
? Pen. Malaysia *9272*
? Philippines
K American Samoa *8006*
? Indian Ocean Is (Mascarenes) *9272*
? Madagascar *9272*
R Sri Lanka *8021*
? Tropical Africa (east) *8309*
[distribution incomplete]

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	K	***Lomatophyllum antsingyense*** **Leandri** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Lomatophyllum citreum*** **Guillaumin** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Lomatophyllum occidentale*** **H. Perrier** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Lomatophyllum oligophyllum*** **(Baker) H. Perrier** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Lomatophyllum orientale*** **H. Perrier** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Lomatophyllum prostratum*** **H. Perrier** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Lomatophyllum roseum*** **H. Perrier** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Lomatophyllum sociale*** **H. Perrier** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Lomatophyllum viviparum*** **H. Perrier** *10368* **(Liliaceae)**		
		K	*10368*	Madagascar *10368*
herb.	nt	***Lonchitis occidentalis*** **Baker** *7749* **(Dennstaedtiaceae)**		
		?		Madagascar *7749*
		?		Angola
		nt		Cameroon
		nt		Eq. Guinea
		?		Gabon
		R	*6072*	Ghana *6072*
		?		Guinea
		?		Liberia
		E		Nigeria
		?		Sao Tome
		?		Sierra Leone
		?		Tanzania
		?		Zaire
		?		Zambia *7749*
				[distribution possibly incomplete]
tree	E	***Louvelia albicans*** **Jumelle** *10246* **(Palmae)**		
		E	*17951*	Madagascar *10246*
tree	E	***Louvelia lakatra*** **Jumelle** *10246* **(Palmae)**		
		E	*17951*	Madagascar *10246*
tree	E	***Louvelia madagascariensis*** **Jumelle & H. Perrier** *10246* **(Palmae)**		
		E	*17951*	Madagascar *10246*
	nt	***Ludia mauritiana*** **J. Gmelin** *12259* **(Flacourtiaceae)**		
		common name: BOIS MOZAMBIQUE		
		?		Madagascar
		nt	*10598*	Mauritius *10598*
		?		Seychelles: Cor (Aldabra itself) *14296*
		V	*19182*	Seychelles: Gra *14296*
				[distribution incomplete]
shrub	?	***Maesa lanceolata*** **Forssk.** *7926* **(Myrsinaceae)**		
		?		N. Afr. & Mid. E. *7926*
		?		Madagascar *7926*
		?		Tropical Africa *7926*
		?		Cameroon *7926*
		?		Côte d'Ivoire *7926*
		?		Bioko *7926*
		I	*6072*	Ghana *6072*
		?		Guinea *7926*
		?		Nigeria *7926*
		?		Southern Africa *7926*
				[distribution incomplete]

tree E *Malagasia alticola* (Capuron) L. Johnson & B. Briggs *19140* (Proteaceae)
E *19140* Madagascar (Ambohitantely Special Reserve) *19140*
? *Malleastrum depauperatum* (Baill.) Leroy *14981* (Meliaceae)
? Madagascar *14981*
E *14981* Seychelles (Aldabra) *14981*
[distribution possibly incomplete]
tree E *Marojejya darianii* J. Dransf. & N. Uhl. *10779* (Palmae)
E *17951* Madagascar *10779*
tree V *Marojejya insignis* Humbert *11813* (Palmae)
V *17951* Madagascar *6165*
tree V *Masoala madagascariensis* Jumelle *11813* (Palmae)
V *17951* Madagascar *10246*
shrub ? *Mimosa pigra* L. *16168* (Leguminosae)
common name: habaab
E *16168* Egypt (Aswan province and Eastern Desert) *16168*
? Middle Asia (Asia) *16168*
? Pen. Malaysia (widely distribution) *19209*
? Madagascar *16168*
? Mauritius *16168*
[distribution possibly incomplete]
R *Moringa drouhardii* Jum. *10368* (Moringaceae)
R *10368* Madagascar *10368*
? *Moringa hildebrandtii* Engl. (Moringaceae)
R *10368* Madagascar *10368*
? Tropical Africa
nt *Mussaenda arcuata* Poiret *10082* (Rubiaceae)
nt *14220* Reunion *10082*
? Madagascar *10082*
R Mauritius *10082*
? Tropical Africa *10082*
? Southern Africa *10082*
[distribution incomplete]
shrub ? *Myrothamnus moschata* Baill. *18289* (Myrothamnaceae)
? Madagascar *18289*
tree R *Neodypsis baronii* Jumelle *10246* (Palmae)
R *17951* Madagascar *10246*
tree Ex/E *Neodypsis basilongus* Jumelle & H. Perrier *10246* (Palmae)
Ex/E *17951* Madagascar *10246*
tree I *Neodypsis canaliculatus* Jumelle *10246* (Palmae)
I *17951* Madagascar *10246*
tree Ex/E *Neodypsis ceraceus* Jumelle *10246* (Palmae)
Ex/E *17951* Madagascar *10246*
tree Ex/E *Neodypsis compactus* Jumelle *10246* (Palmae)
Ex/E *17951* Madagascar *10246*
tree II V *Neodypsis decaryi* Jumelle *10246* (Palmae)
V *17951* Madagascar *10246*
tree V *Neodypsis heteromorphus* Jumelle *10246* (Palmae)
V *17951* Madagascar *10246*
tree R *Neodypsis lastelliana* Baillon *10246* (Palmae)
R *17951* Madagascar *10246*
tree Ex/E *Neodypsis ligulatus* Jumelle *10246* (Palmae)
Ex/E *17951* Madagascar *10246*
tree V *Neodypsis lobatus* Jumelle *10246* (Palmae)
V *17951* Madagascar *10246*
tree E *Neodypsis loucoubensis* Jumelle *10246* (Palmae)
E *17951* Madagascar *10246*
tree E *Neodypsis nauseosus* Jumelle & H. Perrier *10246* (Palmae)
E *17951* Madagascar *10246*
tree E *Neodypsis tanalensis* Jumelle & H. Perrier *10246* (Palmae)

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		E *17951* Madagascar *10246*
tree	V	***Neodypsis tsaratananensis*** **Jumelle** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	E	***Neophloga affinis*** **Becc.** *10246* **(Palmae)**
		E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga bernieriana*** **Becc.** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga betamponensis*** **Jumelle** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	E	***Neophloga brevicaulis*** **Guillaumet** *10521* **(Palmae)**
		E *17951* Madagascar *10521*
shrub	nt	***Neophloga catatiana*** **Becc.** *10246* **(Palmae)**
		nt *17951* Madagascar *10246*
shrub	syn.	***Neophloga commersoniana*** **Baillon** *10246* **(Palmae)**
		see *Neophloga pygmaea* Pichi-Serm.
shrub	V	***Neophloga concinna*** **Becc. var.** ***concinna*** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	V	***Neophloga concinna*** **Becc. var.** ***triangularis*** **Jumelle** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga corniculata*** **Becc.** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga curtisii*** **Becc.** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga digitata*** **Becc.** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga heterophylla*** **Becc.** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga humbertii*** **Jumelle** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga integra*** **Jumelle** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	V	***Neophloga lanceolata*** **Jumelle** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	V	***Neophloga linearis*** **Becc. var.** ***distachya*** **Jumelle** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	V	***Neophloga linearis*** **Becc. var.** ***linearis*** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga littoralis*** **Jumelle** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga lucens*** **Jumelle** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	V	***Neophloga lutea*** **Jumelle var.** ***lutea*** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	V	***Neophloga lutea*** **Jumelle var.** ***transiens*** **H. Perrier** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga majorana*** **Becc.** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	E	***Neophloga mananjarensis*** **Jumelle & H. Perrier** *10246* **(Palmae)**
		E *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga mangorensis*** **Jumelle** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	V	***Neophloga montana*** **Jumelle** *10246* **(Palmae)**
		V *17951* Madagascar *10246*
shrub	Ex/E	***Neophloga occidentalis*** **Jumelle** *10246* **(Palmae)**
		Ex/E *17951* Madagascar *10246*
shrub	E	***Neophloga oligostachya*** **(Becc.) H. Perrier** *10246* **(Palmae)**
		E *17951* Madagascar *10246*
shrub	E	***Neophloga pervillei*** **Becc.** *10246* **(Palmae)**
		E *17951* Madagascar *10246*

shrub E *Neophloga poivreana* Becc. *10246* (Palmae)
E *17951* Madagascar *10246*

shrub Ex/E *Neophloga procumbens* Jumelle & H. Perrier *10246* (Palmae)
Ex/E *17951* Madagascar *10246*

shrub Ex/E *Neophloga pygmaea* Pichi-Serm. *17951* (Palmae)
synonym: *Neophloga commersoniana* Baillon
Ex/E *17951* Madagascar *17951*

shrub R *Neophloga rhodotricha* (Baker) Becc. *10246* (Palmae)
R *17951* Madagascar *10246*

shrub E *Neophloga scottiana* Becc. *10246* (Palmae)
E *17951* Madagascar *10246*

shrub V *Neophloga simianensis* Jumelle *10246* (Palmae)
V *17951* Madagascar *10246*

shrub R *Neophloga thiryana* Becc. *10246* (Palmae)
R *17951* Madagascar *10246*

II V *Nepenthes madagascariensis* Poiret *8316* (Nepenthaceae)
V Madagascar *8316*

II R *Nepenthes masaolensis* Schmid-Hollinger *8316* (Nepenthaceae)
R Madagascar *8316*

? *Nesaea crassicaulis* (Guill. & Perr.) Koehne *7926* (Lythraceae)
? Madagascar
? Angola
R *6086* Benin *6086*
? Chad
? Gabon
? Guinea
? Mali
? Niger
? Senegal
? Tanzania

herb. ? *Nesaea erecta* Guill. & Perr. *7926* (Lythraceae)
? Madagascar *7926*
? Tropical Africa *7926*
? Gambia *7926*
R *6072* Ghana *6072*
? Nigeria *7926*
? Senegal *7926*
[distribution incomplete]

? *Nesogordonia abrahamii* L. Barnett *11039* (Sterculiaceae)
? Madagascar (eastern) *11039*

? *Nesogordonia pachyneura* Capuron ex L. Barnett *11039* (Sterculiaceae)
? Madagascar *11039*

herb. II ? *Oberonia disticha* (Lam.) Schltr. *5852* (Orchidaceae)
? Reunion *5852*
? Madagascar *5852*
R Mauritius *5852*
Ex *5852* Rodrigues (last seen 1874) *5852*

? *Olea lancea* Lam. *10082* (Oleaceae)
? Reunion *10082*
? Madagascar *10082*
? Mauritius *10082*
? Rodrigues *5852*

nt *Ophioglossum pendulum* L. *8006* (Ophioglossaceae)
R *11163* Japan *11163*
? Pacific Is. (Polynesia) *8006*
? American Samoa *8006*
nt *18338* Guam *18338*
? Madagascar *8006*
Ex *5852* Rodrigues (Grande Montagne, last seen 1955.) *5852*

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[distribution incomplete]

tree V *Orania longisquama* (Jumelle) J. Dransf. & N. Uhl. *11813* (Palmae)
V *17951* Madagascar *2014*

II K *Pachypodium ambongense* L. Poisson *10368* (Apocynaceae)
K *10368* Madagascar *10368*

I I *Pachypodium baronii* Costantin & Bois var. *baronii* *10368* (Apocynaceae)
I Madagascar

I E *Pachypodium baronii* Costantin & Bois var. *windsori* (L. Poisson) Pichon *10368* (Apocynaceae)
E Madagascar

I V *Pachypodium brevicaule* Baker *10368* (Apocynaceae)
V Madagascar

I E *Pachypodium decaryi* L. Poisson *10368* (Apocynaceae)
E Madagascar

II I *Pachypodium densiflorum* Baker var. *brevicalyx* H. Perrier *10368* (Apocynaceae)
I Madagascar

II R *Pachypodium densiflorum* Baker var. *densiflorum* *10368* (Apocynaceae)
R Madagascar

II K *Pachypodium geayi* Costantin & Bois *10368* (Apocynaceae)
K *10368* Madagascar *10368*

II R *Pachypodium horombense* Pichon *10368* (Apocynaceae)
R Madagascar

II K *Pachypodium lamerei* Drake var. *lamerei* *10368* (Apocynaceae)
K *10368* Madagascar *10368*

II R *Pachypodium lamerei* Drake var. *ramosum* (Costantin & Bois) Pichon *10368* (Apocynaceae)
R Madagascar

II I *Pachypodium rosulatum* Baker var. *drakei* (Costantin & Bois) Markgraf *10368* (Apocynaceae)
I Madagascar

II R *Pachypodium rosulatum* Baker var. *gracilius* H. Perrier *10368* (Apocynaceae)
R Madagascar

II I *Pachypodium rosulatum* Baker var. *rosulatum* *10368* (Apocynaceae)
I Madagascar

II K *Pachypodium rutenbergianum* Vatke var. *meridionale* (M. Pichon) H. Perrier *10368* (Apocynaceae)
K *10368* Madagascar *10368*

II K *Pachypodium rutenbergianum* Vatke var. *rutenbergianum* *10368* (Apocynaceae)
K *10368* Madagascar *10368*

II K *Pachypodium sofiense* (L. Poisson) H. Perrier *10368* (Apocynaceae)
K *10368* Madagascar *10368*

? *Pedalium murex* L. *10269* (Pedaliaceae)
K *10368* Madagascar *10368*
R Sudan (Gebel Elba) *10269*
[distribution incomplete]

K *Pelargonium caylae* Humbert *10368* (Geraniaceae)
K *10368* Madagascar *10368*

? *Perriera madagascariensis* *6963* (Simaroubaceae)
R *6963* Madagascar *6963*
[distribution possibly incomplete]

K *Perrierastrum oreophilum* Guillaumin *10368* (Labiatae)
K *10368* Madagascar *10368*

shrub Ex/E *Phloga gracilis* (Jumelle) H. Perrier *10246* (Palmae)
Ex/E *17951* Madagascar *10246*

shrub nt *Phloga nodifera* (Becc.) Pichi-Serm. *9996* (Palmae)
synonym: *Phloga polystachya* Noronha ex Mart.
nt *17951* Madagascar *10246*

shrub syn. *Phloga polystachya* Noronha ex Mart. (Palmae)
see *Phloga nodifera* (Becc.) Pichi-Serm.

tree — nt — ***Phoenix reclinata*** **Jacq.** *7926* **(Palmae)**

?		N. Yemen *10290*
?		Comoro Islands *10246*
nt	*17951*	Madagascar *10246*
nt		Angola (widespread) *11628*
?		Cameroon *7926*
?		Côte d'Ivoire *7926*
?		Ethiopia *10254*
?		Gambia *7926*
?		Ghana *7926*
?		Guinea *7926*
?		Guinea-Bissau *7926*
?		Kenya *7926*
?		Liberia *7926*
?		Malawi *7848*
?		Mozambique *7848*
?		Nigeria *7926*
?		Rwanda *7953*
?		Senegal *7926*
?		Sierra Leone *7926*
?		Somalia *10254*
?		Sudan *10245*
?		Tanzania
V	*19007*	Uganda *7926*
?		Zaire
nt	*19487*	Zambia *7848*
?		Cape Prov. *10485*
?		Natal *10485*
		[distribution incomplete]

shrub — ? — ***Phyllanthus reticulatus*** **Poir.** *15204* **(Euphorbiaceae)**

common name: congcong belut

E	*16168*	Egypt (Gebel Elba) *16168*
?		Australia *16168*
?		Madagascar *16168*
?		Cameroon *16168*
?		Somalia *16168*
?		Sudan *16168*
		[distribution possibly incomplete]

liane med./pharm. — nt — ***Piper nigrum*** **L.** *17914* **(Piperaceae)**

common names: merica, pepper

nt	*18228*	Kerala *18341*
nt	*18228*	Tamil Nadu *18341*
[?]		[introd.] Sumatra (Gunung Leuser National Park) *18136*
?		Pen. Malaysia (widely distributed) *19209*
?		Madagascar *14010*
?		Sri Lanka *14010*

liane — ? — ***Pisonia aculeata*** **L.** *11631* **(Nyctaginaceae)**

common name: ar.gerang

?		Madagascar *14981*
?		Seychelles *14981*
E		Côte d'Ivoire *11631*
		[distribution possibly incomplete]

II — ? — ***Platylepis occulta*** **(Thou.) Reichb.f.** *19446* **(Orchidaceae)**

?		Madagascar *19446*
?		Mauritius *19446*
R	*19446*	Seychelles: Gra (incl. Cousin Is.) *19446*
		[distribution possibly incomplete]

V — ***Podocarpus capuronii*** **Laubenfels** *18270* **(Podocarpaceae)**

V	*18270*	Madagascar (Mt. Ambatomenaloha) *18270*

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			V			***Podocarpus humbertii*** **de Laubenfels** *18270* **(Podocarpaceae)**
				V	*18270*	Madagascar *18270*
			?			***Podocarpus madagascariensis*** **Baker** *6963* **(Podocarpaceae)**
				R	*6963*	Madagascar *6963*
						[distribution possibly incomplete]
			V			***Podocarpus madagascariensis*** **Baker var.** ***procerus*** **Laubenfels** *18270* **(Podocarpaceae)**
				V	*18270*	Madagascar (Fort Dauphin) *18270*
			V			***Podocarpus rostratus*** **Laurent** *18270* **(Podocarpaceae)**
				V	*18270*	Madagascar *18270*
herb.		II	nt			***Polystachya fusiformis*** **(Thouin) Lindley** *7926* **(Orchidaceae)**
				?		Reunion *7926*
				?		Madagascar *7926*
				?		Cameroon *7926*
				?		Congo *7926*
				?		Bioko *7926*
				I	*6072*	Ghana *6072*
				?		Kenya *7926*
				?		Tanzania *7926*
				nt	*19007*	Uganda *7926*
				?		Zambia *7926*
						[distribution possibly incomplete]
tree	timber		nt			***Prunus africana*** **(Hook. f.) Kalkm.** *15013* **(Rosaceae)**
						synonym: *Pygeum africanum* Hook. f.
						common names: alumty, iluo, kirah, mkomohoyo, mseneo, mueri, ntasesa, tenduet, vla, wotangue, yazangomaelimnyama
				?		Madagascar *18267*
				?		Angola *7926*
				V	*13924*	Cameroon (NW, on volcanic soils in Afromontane forests) *18267*
				?		Bioko *7926*
				nt		Kenya *7926*
				?		Sao Tome *18267*
				?		Tanzania *7926*
				nt	*19007*	Uganda *7926*
				?		Zaire *7926*
				I	*15013*	Natal *15013*
				?		Transkei *7926*
			?			***Psychotria obtusifolia*** **Poiret** *10082* **(Rubiaceae)**
				?		Madagascar *10082*
				?		Mauritius *10082*
tree			nt			***Raphia farinifera*** **(Gaertner) Hylander** *7926* **(Palmae)**
				nt	*17951*	Madagascar *10253*
				?		Cameroon *7926*
				?		Kenya *15141*
				?		Nigeria *7926*
				?		Tanzania *15141*
				V	*19007*	Uganda *15141*
				V	*6088*	Zimbabwe *6088*
tree			I			***Ravenea amara*** **Jumelle** *10246* **(Palmae)**
				I		Madagascar *10246*
tree			V			***Ravenea glauca*** **Jumelle & H. Perrier** *10246* **(Palmae)**
				V	*17951*	Madagascar *10246*
tree			E			***Ravenea latisecta*** **Jumelle** *10246* **(Palmae)**
				E	*2014*	Madagascar *10246*
tree			R			***Ravenea madagascariensis*** **Becc. var.** ***madagascariensis*** *11813* **(Palmae)**
				R	*17951*	Madagascar *10246*
tree			R			***Ravenea madagascariensis*** **Becc. var.** ***monticola*** **Jumelle & H. Perrier** *10246* **(Palmae)**
				R	*17951*	Madagascar *10246*
tree			V			***Ravenea rivularis*** **Jumelle & H. Perrier** *10246* **(Palmae)**
				V	*17951*	Madagascar *10246*

tree		V			***Ravenea robustior*** **Jumelle & H. Perrier var.** ***kona*** **Jumelle** *10246* **(Palmae)**
			V	*17951*	Madagascar *10246*
tree		V			***Ravenea robustior*** **Jumelle & H. Perrier var.** ***robustior*** *11813* **(Palmae)**
			V	*17951*	Madagascar *10246*
tree		V			***Ravenea sambiranensis*** **Jumelle & H. Perrier** *10246* **(Palmae)**
			V	*17951*	Madagascar *10246*
tree		V			***Ravenea xerophila*** **Jumelle** *10246* **(Palmae)**
			V	*17951*	Madagascar *10246*
succ.	II	?			***Rhipsalis baccifera*** **(J. Miller) Stearn** *8058* **(Cactaceae)**
			common name: Mistletoe cactus		
			K	*10368*	Madagascar *8058*
			?	*19002*	Sri Lanka *8058*
			?		Tropical Africa *8058*
			Ex/E	*19002*	Florida *8058*
			?		Caribbean Is. *8058*
			?		Central America *8058*
			?	*19002*	Mexico *8058*
			?		South America *8058*
			?	*19002*	Country unknown *19002*
succ.	II	K			***Rhipsalis fasciculata*** **(Willd.) Haw.** *10368* **(Cactaceae)**
			K	*10368*	Madagascar *10368*
succ.	II	K			***Rhipsalis horrida*** **Baker** *10368* **(Cactaceae)**
			K	*10368*	Madagascar *10368*
tree timber		nt			***Rhizophora mucronata*** **Lam.** *16168* **(Rhizophoraceae)**
			common names: bakau gandul, kong kaang bai yai		
			E	*16168*	Egypt (southern lagoons of the Red Sea coast) *16168*
			?		Kampuchea *17938*
			Ex		Taiwan
			?		Thailand (southeastern & peninsular regions) *19257*
			nt	*15733*	Vietnam *15733*
			?		Indonesia *12983*
			?		Pen. Malaysia (widely distributed) *12983*
			?		Sabah *12983*
			?		Sarawak *12983*
			V		Philippines
			E	*5713*	Guam *5713*
			?		Madagascar *16168*
			?		Seychelles *16168*
			?		Sri Lanka *8021*
			?		Old World
					[distribution incomplete]
herb.		?			***Rhynchospora holoschoenoides*** **(Rich.) Herter** *7926* **(Cyperaceae)**
			?		Madagascar *7926*
			?		Côte d'Ivoire *7926*
			I	*6072*	Ghana *6072*
			?		Guinea *7926*
			?		Liberia *7926*
			?		Nigeria *7926*
			?		Senegal *7926*
			?		Sierra Leone *7926*
			?		Southern Africa *7926*
					[distribution incomplete]
		I			***Rorippa insularis*** **Jonsell (Cruciferae)**
			I		Madagascar *10936*
			I		Mauritius
		nt			***Rorippa madagascariensis*** **(DC.) H. Hara (Cruciferae)**
			?		Madagascar
			?		Angola
			I		Côte d'Ivoire *11631*

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			?	Ghana
			?	Nigeria
			nt	Senegal
			R *19007*	Uganda *19007*
			?	Zaire
				[distribution possibly incomplete]
	?	***Ruellia monanthos*** **(Nees) Anders** *14981* **(Acanthaceae)**		
			?	Madagascar *14981*
			E *14981*	Seychelles *14981*
				[distribution possibly incomplete]
	?	***Salvadora angustifolia*** **Turrill** *14981* **(Salvadoraceae)**		
			?	Madagascar *14981*
			E *14981*	Seychelles *14981*
				[distribution possibly incomplete]
	?	***Sansevieria canaliculata*** **Carriere (Liliaceae)**		
			K *10368*	Madagascar *10368*
			?	Tropical Africa
succ.	K	***Sarcostemma decorsei*** **Costantin & Gallaud** *10368* **(Asclepiadaceae)**		
			K *10368*	Madagascar *10368*
succ.	K	***Sarcostemma insigne*** **(N.E. Br.) Descoings** *10368* **(Asclepiadaceae)**		
			K *10368*	Madagascar *10368*
succ.	K	***Sarcostemma madagascariense*** **Descoings** *10368* **(Asclepiadaceae)**		
			K *10368*	Madagascar *10368*
med./pharm.	?	***Schizaea dichotoma*** **(L.) Smith** *8006* **(Schizaeaceae)**		
			R *11163*	Japan *11163*
			?	Pen. Malaysia (widely distributed) *19209*
			I	N. Island (NZ) (N. Auckland; Roturoa-Taupo) *10794*
			?	Pacific Is. (Polynesia) *8006*
			?	Marquesas
			?	American Samoa *8006*
			?	Madagascar *8006*
				[distribution possibly incomplete]
succ.	K	***Sedum madagascariense*** **H. Perrier** *10368* **(Crassulaceae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio antandroi*** **Scott Elliot** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio antitensis*** **Baker** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio baronii*** **Humbert** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio barorum*** **Humbert** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio boiteaui*** **Humbert** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	I	***Senecio canaliculatus*** **Bojer ex DC.** *10368* **(Compositae)**		
			I	Madagascar
	K	***Senecio capuronii*** **Humbert** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio cedrorum*** **Raynal** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio crassissimus*** **Humbert** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio decaryi*** **Humbert** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio descoingsii*** **(Humbert) H.J. Jacobsen** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio hildebrandtii*** **Baker** *10368* **(Compositae)**		
			K *10368*	Madagascar *10368*
	K	***Senecio hirto-crassus*** **Humbert** *10368* **(Compositae)**		

K *10368* Madagascar *10368*

K *Senecio kalambatitrensis* Humbert *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio leandrii* Humbert *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio longiflorus* (DC.) Schultz-Bip. var. *longiflorus* *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio longiflorus* (DC.) Schultz-Bip. var. *madagascariensis* (Humbert) Rowley *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio madagascariensis* Poir. *10368* (Compositae)
K *10368* Madagascar *10368*

I *Senecio marnieri* Humbert *10368* (Compositae)
I Madagascar

K *Senecio melastomaefolius* Baker var. *longibracteatus* Bojer ex DC. *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio melastomaefolius* Baker var. *melastomaefolius* *10368* (Compositae)
K *10368* Madagascar *10368*

I *Senecio mesembryanthemoides* Bojer ex DC. *10368* (Compositae)
I Madagascar

I *Senecio meuselii* Rauh *10368* (Compositae)
I Madagascar

K *Senecio navicularis* Humbert *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio neobakeri* Humbert *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio neohumbertii* Rowley *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio quartziticolus* Humbert *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio saboureaui* Humbert *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio sakalavorus* Humbert *10368* (Compositae)
K *10368* Madagascar *10368*

K *Senecio sakamaliensis* (Humbert) Humbert *10368* (Compositae)
K *10368* Madagascar *10368*

K *Seyrigia bosseri* Keraudren *10368* (Cucurbitaceae)
K *10368* Madagascar *10368*

K *Seyrigia gracilis* Keraudren *10368* (Cucurbitaceae)
K *10368* Madagascar *10368*

K *Seyrigia humbertii* Keraudren *10368* (Cucurbitaceae)
K *10368* Madagascar *10368*

K *Seyrigia multiflora* Keraudren *10368* (Cucurbitaceae)
K *10368* Madagascar *10368*

nt *Sphenomeris chinensis* (L.) Maxon *3822* (Dennstaedtiaceae)
? India *9354*
? S.E. Asia to PNG *9354*
nt Pacific Is. *8006*
R American Samoa *8006*
nt Hawaii *3822*
? Madagascar *8006*

? *Stadmannia oppositifolia* Poiret ssp. *oppositifolia* (Sapindaceae)
Ex Reunion
? Madagascar
R Mauritius
? Kenya
? Tanzania
? Zanzibar

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succ. E *Stapelianthus arenarius* Bosser & Morat *10368* (Asclepiadaceae)
E *18294* Madagascar *10368*

succ. E *Stapelianthus decaryi* Choux *10368* (Asclepiadaceae)
E *18294* Madagascar *18294*

succ. E *Stapelianthus hardyi* Lavranos *10368* (Asclepiadaceae)
E *18294* Madagascar *10368*

succ. E *Stapelianthus insignis* Descoings *10368* (Asclepiadaceae)
E *18294* Madagascar *18294*

succ. E *Stapelianthus keraudrenae* Bosser & Morat *10368* (Asclepiadaceae)
E *18294* Madagascar *10368*

succ. E *Stapelianthus madagascariensis* (Choux) Choux *10368* (Asclepiadaceae)
E *18294* Madagascar *18294*

succ. E *Stapelianthus montagnacii* (Boiteau) Boiteau & A. Bertrand *10368* (Asclepiadaceae)
E *18294* Madagascar *18294*

succ. E *Stapelianthus pilosus* (Choux) Lavranos & Hardy *10368* (Asclepiadaceae)
E *18294* Madagascar *18294*

tree timber nt *Symphonia globulifera* L. f. *17754* (Guttiferae)
common names: ahoke, anani, anany, azufre, barillo, boar wood hog gum, brea amarilla, brea caspi, cerillo, chewstick, ehureke, laurel de monte, machare, mani, manil, manni, mataki, nom-ouie, okilolo, ossol, paramán, peramancillo, perman, tomento, yellow mangur, zaputi

?		Madagascar *9492*
?		Tropical Africa *9492*
?		Angola *7926*
E	*6086*	Benin *6086*
I	*13924*	Cameroon *7926*
nt	*13925*	Congo *13925*
V		Côte d'Ivoire *7926*
?		Gabon *7926*
?		Ghana *7926*
?		Liberia *7926*
?		Nigeria *7926*
?		Sao Tome *7926*
?		Sierra Leone *7926*
nt	*19007*	Uganda *7926*
?		Zaire *7926*
?		Caribbean Is. *9492*
?		Trinidad/Tobago *17750*
nt	*9492*	Central America *9492*
?		Honduras *17750*
nt	*9492*	South America *9492*
?		Brazil *17462*
?		Colombia *17750*
?		Ecuador *17750*
?		French Guiana *17754*
?		Guyana *17750*
?		Peru *17750*
?		Suriname *17750*
?		Venezuela *17750*
		[distribution incomplete]

? *Tabernaemontana coffeoides* Boj. ex A. DC. *14981* (Apocynaceae)

?		Comoro Islands *14981*
?		Madagascar *14981*
E	*14981*	Seychelles *14981*
		[distribution possibly incomplete]

? *Tachiadenus antaisaka* Humbert *11010* (Gentianaceae)
? Madagascar (Beampingaratra mts) *11010*

? *Tachiadenus boivinii* Humbert ex Klack. *11010* (Gentianaceae)
? Madagascar (north-west) *11010*

? *Tachiadenus carinatus* (Desr.) Griseb. *11010* (Gentianaceae)

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? Madagascar (eastern coast) *11010*

? ***Tachiadenus gracilis*** **Griseb.** ***11010*** **(Gentianaceae)**
? Madagascar (eastern coast) *11010*

? ***Tachiadenus longiflorus*** **Bojer ex Griseb.** ***11010*** **(Gentianaceae)**
? Madagascar (central Mt range) *11010*

? ***Tachiadenus longifolius*** **Scott Elliot** ***11010*** **(Gentianaceae)**
? Madagascar (near Fort-Dauphin) *11010*

? ***Tachiadenus pervillei*** **Humbert ex Klack.** ***11010*** **(Gentianaceae)**
? Madagascar (Nossi Be I.) *11010*

? ***Tachiadenus platypterus*** **Baker** ***11010*** **(Gentianaceae)**
? Madagascar (central Mt range) *11010*

? ***Tachiadenus platypterus*** **Baker ssp.** ***angustialatus*** **(Humbert) Klack.** ***11010*** **(Gentianaceae)**
? Madagascar (Ivakoany and Kalambatitra) *11010*

? ***Tachiadenus platypterus*** **Baker ssp.** ***platypterus*** ***11010*** **(Gentianaceae)**
? Madagascar (Itremo to Kalambatitra mts) *11010*

? ***Tachiadenus tubiflorus*** **(Roem. & Schutt.) Griseb.** ***11010*** **(Gentianaceae)**
? Madagascar (eastern coast) *11010*

? ***Tachiadenus umbellatus*** **Klack.** ***11010*** **(Gentianaceae)**
? Madagascar (Massif du Midongy) *11010*

? ***Tachiadenus vohimavensis*** **Humbert** ***11010*** **(Gentianaceae)**
? Madagascar (Vohimavo peak at 308m) *11010*

? ***Telfairia pedata*** **(Smith) Hook.f.** ***10082*** **(Cucurbitaceae)**
K *10368* Madagascar *10082*
? Tropical Africa

tree timber nt ***Terminalia catappa*** **L.** ***12983*** **(Combretaceae)**
common names: almendro, almond, amanda, amandier, amendoeira, castana, dat mue, hu kwaang, Indian c
wood, ketapang, khon, lumpang, taa pang, taa-pae, talisay, tat mue
? India *19271*
? Taiwan *19271*
? Thailand (Krung Thep, Trat, Chon Buri, Chanthaburi, Prachaup Khiri Khan, Kancha
Surat Thani, Narathiwat, Trang) *19271*
? Indonesia *12983*
nt *13926* Pen. Malaysia *12983*
? Sabah *12983*
V *15960* Philippines *12983*
? Australia (northern) *19271*
? Fiji *19427*
? Niue *19427*
? Solomon Is. *8836*
? Tonga *19427*
? American Samoa *19427*
? Madagascar *19271*
? Brazil *17462*
? Colombia *17462*
? Ecuador *17462*
? French Guiana *17462*
? Guyana *17462*
? Peru *17462*
? Suriname *17462*
[distribution possibly incomplete]

tree timber nt ***Trachylobium verrucosum*** **(Gaertn.) Oliv.** ***19532*** **(Leguminosae)**
synonym: *Hymenaea verrucosa* Gaertner
? Madagascar *19532*
? Mauritius *19532*
? Seychelles *19532*
nt Kenya (Kilifi) *19532*
? Mozambique *19532*
? Tanzania (Tanga, Rufiji and Newala) *19532*

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		?		Zanzibar *19532*
				[distribution possibly incomplete]
	K	***Uncarina abbreviata*** **(Baillon) Ihlenf. & Straka** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Uncarina decaryii*** **Humbert** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Uncarina grandidieri*** **(Baillon) Stapf** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Uncarina leandrii*** **Humbert** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Uncarina leptocarpa*** **(Decne.) Ihlenf. & Straka** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Uncarina peltata*** **(Baker) Stapf** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Uncarina perrieri*** **Humbert** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Uncarina sakalava*** **Humbert** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Uncarina stellulifera*** **Humbert** *10368* **(Pedaliaceae)**		
		K	*10368*	Madagascar *10368*
	?	***Vittaria scolopendria*** **(Bory) Thouars** *8006* **(Vittariaceae)**		
		?		Pacific Is. *8006*
		R		American Samoa *8006*
		?		Madagascar *8006*
				[distribution possibly incomplete]
tree	**E**	***Voanioala gerardii*** **J. Dransf.** *14792* **(Palmae)**		
		common name: voanio-ala		
		E	*17951*	Madagascar *14792*
tree	**E**	***Vonitra crinita*** **Jumelle & H. Perrier** *10246* **(Palmae)**		
		E	*17951*	Madagascar *10246*
tree	**nt**	***Vonitra fibrosa*** **(C.H. Wright) Becc.** *11813* **(Palmae)**		
		nt	*17951*	Madagascar *6165*
tree	**E**	***Vonitra nossibensis*** **(Becc.) H. Perrier** *10246* **(Palmae)**		
		E	*17951*	Madagascar *10246*
tree	**V**	***Vonitra utilis*** **Jumelle** *11813* **(Palmae)**		
		V	*17951*	Madagascar *10246*
	?	***Wielandia elegans*** **Baillon** *14981* **(Euphorbiaceae)**		
		?		Madagascar *14981*
		E	*14981*	Seychelles *14981*
				[distribution possibly incomplete]
	nt	***Xerosicyos danguyi*** **Humbert** *10368* **(Cucurbitaceae)**		
		nt		Madagascar
	K	***Xerosicyos decaryi*** **Guillaumin & Keraudren** *10368* **(Cucurbitaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Xerosicyos perrieri*** **Humbert** *10368* **(Cucurbitaceae)**		
		K	*10368*	Madagascar *10368*
	K	***Xerosicyos pubescens*** **Keraudren** *10368* **(Cucurbitaceae)**		
		K	*10368*	Madagascar *10368*

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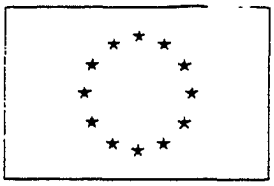
Appendix D: Report on the status of biodiversity in Madagascar

This report was produced in French by the Protected Areas Data Unit at the World Conservation Monitoring Centre in 1989. Figure 3 of this report presents the current status of rare species in Madagascar. Figure 4 presents the distribution of protected areas.

MADAGASCAR

La Conservation de la Diversité Biologique

Un rapport financé sur les crédits de la
Commission des Communautés Européennes



Préparé par le Centre Mondial de Surveillance
Continue de la Conservation de la Nature
Cambridge, UK

Le Centre Mondial de Surveillance Continue de la Conservation de la Nature est une organisation composée de divers membres, et soutenue par l'Alliance Mondiale pour la Nature (UICN), le Fond Mondial pour la Nature (WWF), et le Programme des Nations-Unies pour l'Environnement (PNUE).

Juillet 1989

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RECOMMANDATIONS

Les recommandations suivantes regroupent les principaux points influençant directement sur la conservation de la diversité biologique de Madagascar.

1. Amélioration de la législation protectant les espèces vulnérables

Il est nécéssaire que le statut des espèces et sous-espèces importantes soit révisé et qu'une protection efficace leur soit apportée. Les espèces et sous-espèces des vertébrés qui ne fréquentent pas actuellement les aires protégées et qui risquent de nécessiter une protection sont: la Tortue Geochelone yniphora, le Grèbe de Delacour Tachybaptus rufolavatus, le Fuligule de Madagascar Aythya innotata, la Monias de Bensch Monias benschi, le Rollier terrestre à longue queue Uratelornis chimaera, le Bulbul d'Appert Phyllastrephus apperti, les tenrecs Limnogale mergulus et Microgale occidentalis, le carnivore Eupleres goudotii major, le Dugong Dugong dugong, les primates suivants: Allocebus trichotus, Propithecus diadema sp. nov., le Lemur fauve Lemur fulvus albocollaris, et le Propithèque de Verreaux Propithecus verreauxi coronatus.

2. Amélioration des connaissances de la flore et de l'ethnobotanie de l'île

Il est nécéssaire d'avoir plus d'informations sur plusieurs groupes de plantes, y compris les espèces localisées et en particulier les plantes succulentes et les palmiers, les espèces localisées fortement exploitées, les Orchidées, les Catacées, et les fougères. Un effort tout particulier devrait être mis sur l'amélioration des connaissances des plantes médicinales où de valeurs économiques. Pour arriver à cette fin, un inventaire complet sur les connaissances ethnobotaniques des groupes ethniques de Madagascar doit être fait en priorité. La revue de Plotkin sur l'existance botanique nous donne une base importante pour des travaux futurs dans ce domaine.

3. Amélioration des programmes d'élevages en captivité

Des programmes d'élevages en captivité sont nécéssaires pour aider à la conservation de certaines espèces en voie de disparition, et pour cela nous devrions améliorer leur facilités. Cela concerne tout particulièrement le Parc zoologique de Tsimbazaza ou le programme d'élevage en captivité serait la clé pour le developpement des espèces en voie de disparition . Le parc de Tsimbazaza est un endroit idéal pour se concentrer sur les efforts de l'élevage en captivité et pourrait être l'un des principaux sites pour établir une colonie en captivité dans ce pays.

4. Prise de conscience de la conservation à travers des programmes éducatif

Il est très important d'introduire la conservation dans le système éducatif et de faire réaliser le public de sa nécésité. Le programme éducationnel de l'environnement de WWF comprend l'introduction de matériel de plan d'études dans les écoles primaires, de professseurs specialisés, de la production de livres en Malgache et de l'établissement de centres specialisés dans ce sujet dans des régions sélectionnées. Cet important programme a déjà fait des progrés considérables, mais les activités dans ce secteur vital ont besoin d'être continuées.

5. **Amélioration de l'intégrité des aires protegées**

L'agriculture du brûlis ainsi que d'autres styles de déforestation doivent être arrêtés au sein des aires protégées. Une meilleure protection légale de telles aires sont nécessaires ainsi qu'une équipe de surveillance formée de façon adéquate.

Les suggestions suivantes ont été faites par WWF (WWF, 1988) pour conserver les différentes régions du pays:

6. **Actions dans le Domaine du Sud**

a. Les initiatives actuelles pour la conservation et le développement d'Andohahela et de Beza Mahafaly sont les premières de ce genre à Madagascar. Elles devraient être poursuivies conformément à leur programme actuel pour obtenir l'adhésion des populations locales et pour éviter la poursuite de la perte d'habitat et du braconnage.

b. Le programme de conservation et de développement de Beza Mahafaly pourrait être étendu afin d'intégrer, avec l'accord des populations locales, les secteurs environnants qui ont une grande valeur pour la conservation. A l'avenir, ce programme pourrait inclure la gestion de la Réserve Naturelle Intégrale du Tsimanampetsotsa.

c. De nouvelles aires protégées seraient souhaitables, en particulier entre Toliara et Morombe afin de protéger les fourrés épineux près de la limite nord-ouest du Domaine du Sud, la Monias de Bensch et le Rollier terrestre à longue queue. Une autre aire protégée serait souhaitable pour les dunes littorales.

7. **Actions dans le Domaine de l'Ouest.**

a. Il serait nécéssaire que les nouvelles aires protégées couvrent le tiers méridional du Domaine. Pour cela, on suggère l'intégration du lac Ihotry, la forêt de Kirindy, de Zombitse et de Vohibiasa dans le réseau des aires protégées.

b. Au nord de Morondava, la conservation serait améliorée si certains secteurs étaient transformés en réserve incluant les grands blocs de forêts qui subsistent. La forêt de Tsimembo constitue un site prioritaire, car elle comprend en même temps les lacs environnants comme Bemamba et Masama. L'étude de cette région pour l'inclure dans le World Heritage Site est en cours. Si ce projet est réalisé, la conservation des lacs et de Tsimembo devrait être gérée conjointement avec celle de la réserve Naturelle Intégrale de Bemaraha. Le projet SAF dont l'objectif est de protéger la forêt entre les fleuves Andranomena et Tsiribihina devrait également être prioritaire. Les forêts au nord de la Tsiribihina mériteraient de faire l'objet d'un plan d'aménagement pour une exploitation durable.

c. Il est indispensable d'améliorer la protection de toutes les réserves existantes. Seules quelques-unes d'entre elles bénéficient d'une protection qui est à peine concrète.

d. Une réserve pour l'Angonoka <u>Geochelone yniphora</u> devrait être créée dans la région de la baie de Soalala/Baly.

e. Une action de conservation portant sur Propithecus verreauxi coronatus, grand lémurien absent de toutes les aires protégées, devrait être prise en considération.

8. Actions dans le Domaine de l'Est

Le programme WWF-Aires Protégées, le Centre Universitaire de Duke des primates et le Jardin Botanique du Missouri, en coordination avec le MPAEF, ont identifié plusieurs priorités dans les aires de conservation qui necessitent des actions immédiates. Une extension du réseau des aires protégées de la Région de l'Est est souhaitable pour assurer une couverture totale de la biodiversité subsistante. Si les recommandations du programme des aires protegées de WWF sont mises en action, cela complèterait le champs d'application.

MADAGASCAR

Conservation de la Diversité Biologique et des Ecosystèmes Forestiers

Une étude brève préparée par le Programme des Forêts Tropicales de l'UICN

Madagascar, la quatrième île la plus grande du monde, est située approximativement à 300 km à l'est du continent africain. L'île s'est détachée de l'Afrique il y a au moins 100 millions d'années et, pendant ces dernières 40-60 millions d'années, elle a échangé peu, sinon aucune, espèces animales ou de plantes avec le continent. Jusqu'à l'arrivée des humains, il y a 1500-2000 ans, la faune et la flore de Madagascar ont évolué indépendammemt au cours de l'histoire. De ce fait, cette faune et cette flore sont uniques et diverses et sont caracterisées par un haut niveau d'endémisme ainsi qu'un niveau de taxon plus élevé. La flore de Madagascare est l'une des plus riches du monde avec au moins 10 000 espèces de plantes dont presque 80 % sont endémiques. Sa faune s'est comparativement appauvrie, mais le degré endémique est encore très élevé. Beaucoup de ces mammifères et de ces oiseaux de l'île sont considérés comme menacés, la plupart résultant de la destruction de l'habitat.

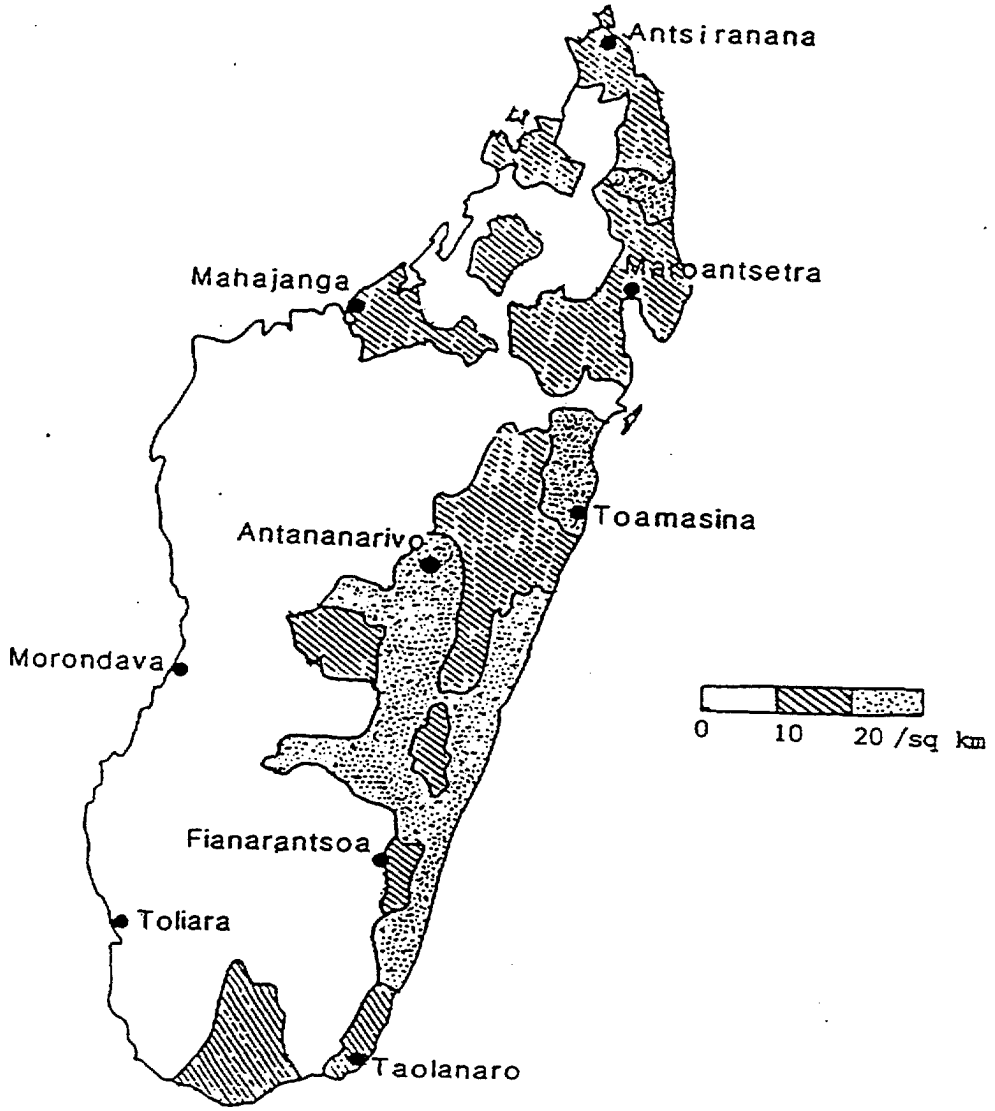
Il n'existe pas de statistiques précises concernant ce qu'il reste de forêts à Madagascar. Cependant 20 % de l'île au maximum est encore couverte de forêts et celles-ci décroîent chaque année, dû principalement à l'agriculture sur brûlis, mais aussi à cause de la mise à feu des pâturages en période de sécheresse. Seulement 1.76 % du terrain a un status de protection et celui-ci est pour la plupart insuffisamment surveillé, dû à un manque de fonds pour employer du personnel et pour acquérir de l'équipement. Les principales recommendations pour ces régions comprennent la préparation d'une carte à jour de la végétation, à partir de photos prises par satellite et de relevés de terrains, du développement de nouvelles régions protégées et de l'agrandissement de plusieurs d'entre elles déjà existantes.

INTRODUCTION

Madagascar, d'une longueur de 1,600 Km et d'une largeur de 580 km à ses points extrêmes, avec une superficie de 587 000 sq. km, est la quatrième île la plus grande du monde, surpassée seulement par le Groenland, la Nouvelle Guinée et Bornéo. Elle est située dans le Sud de l'Océan Indien, séparée de la côte est de l'Afrique par le Canal de Mozambique, qui est d'une largeur de 300 km à son point le plus étroit. L'île est pratiquement située sous la zone tropicale, s'étendant entre la latitude 11° 57'S à 25° 35'S et entre la longitude 43° 14'E à 50° 27'E. A cause de sa grande taille et de son climat variés, de sa géologie et de sa végétation, on s'y référe souvent en tant que microcontinent.

La population humaine de l'île, estimée à 10 605 000 en 1987 (World Resources, 1987), est distribuée inégalement (Figure 1), avec les plus grandes densités concentrées sur le plateau central et sur la plaine côtière est. La population est encore largement rurale, avec seulement

Figure 1: La Densité de la Population à Madagascar



20 % habitant en régions urbaines. La densité moyenne est d'environ 18 habitants au sq. km. Le taux de natalité est élevé, calculé à 2.9 % entre 1985 et 1990, s'élevant à 2.95 % entre 1995 et l'an 2000. Son taux de croissance de la population est classé 24ème en Afrique et 40ème du monde. La population estimée pour l'an 2000 est de 15 550 000 (World Resources, 1987).

L'occupation de Madagascar a commencé relativement récemment, il n'y a probablement pas plus de 2000 ans. Cependant les origines du peuple Malgache sont complexes et ne sont pas complétement connues. Elles semblent basées sur des vagues successives de migration venues de l'Indonésie et de l'Afrique, mais plus particulièrement d'Indonésie. Le Malgache est une langue Malaiso-Polynésienne avec de proches affinités avec la langue parlée de nos jours en Indonésie. A l'intérieur même de Madagascar aujourd'hui, il y a plusieurs dialectes compris et parlés réciproquement par les 18 tribus différentes (Figure 2). Les groupes principaux sont les Mérinas (30 %) du plateau central, les Betsimisaraka (15 %) de la côte est et les Betsilea (14 %) du plateau méridional. Les communautés étrangères comprennent des Européens, la plupart français, des Indiens, des Chinois, des Comoriens et des Arabes. Le pays est divisé en six provinces (Figure 2), bien que celles-ci n'aient peu, sinon aucune relation avec les groupes ethniques. Les provinces sont divisées en 18 préfectures, qui sont à leur tour divisées en 92 sous-préfectures et finalement en 11 000 fokontany (les divisions communautaires traditionnelles). Chaque niveau est gouverné par un conseil élu.

BIODIVERSITE

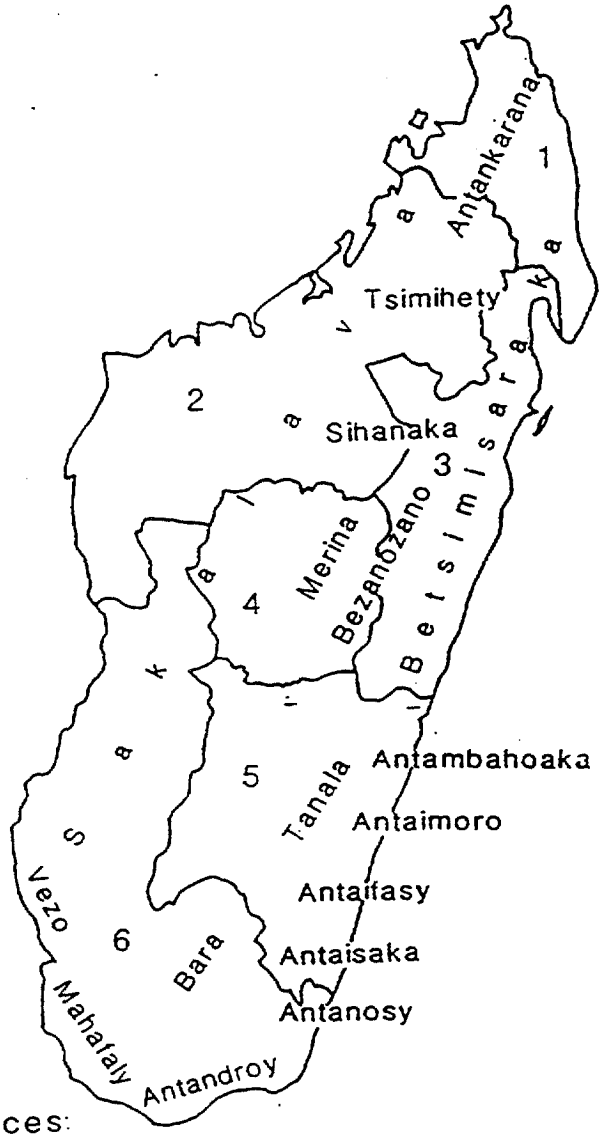
Diversité des Espèces

Madagascar est unique au point de vue biologique et évolutif. La longue séparation de l'île (il y a probablement au moins 100 millions d'années) du continent Africain, sa topographie et ses climats variés y ont fait développer une richesse de plantes exceptionnelles ainsi q'un nombre élevé d'endémisme en flore et en faune.

Les évaluations concernant l'importance de la flore de Madagascar varient entre 7370 et 12 000 espèces (IUCN/UNEP/WWF, 1987). Quelles que soient les figures actuelles (probablement autour de 10 000 avec 80 % endémiques), Madagascar est au point de vue botanique l'une des régions les plus riches du monde. En Afrique, seulement le Zaire et la Tanzanie sont considérés posséder un tel nombre d'espèces de plantes, tandis que l'Afrique du Sud est considérablement plus diversifiée, avec 23 000 espèces répertoriées (IUCN, 1986). Cependant, aucun autre pays d'Afrique n'a un tel pourcentage de plantes endémiques. Le programme de Plantes du WWF-USA considère Madagascar comme un pays de "mégadiversité", ainsi que le Brésil, la Colombie, l'Indonésie, le Mexique et le Zaire.

Par contraste, Madagascar est relativement pauvre en mammifères. En effet il ya moins d'espèces de mammifères non-marins (108) que dans aucun autre pays africain de taille comparable. Ces espèces sont cependant, la plupart uniques à Madagascar. Les mammifères originaires de l'île appartiennent à cinq ordres: les Primates, les Chiroptères, les Insectivores, les Carnivores et les Rongeurs. Il y a une sorte d'espèce, des Artiodactyla, un cochon de brousse, Potamochoerus larvatus, mais celui-ci fut probablement introduit par l'homme. Une espèce de l'ordre

Figure 2: Carte Regroupant les Provinces et la Répartition des Différentes Tributs



Provinces:

1 Antseranana 2 Mahajanga 3 Toamasina

4 Antananarivo 5 Fianarantsoa 6 Toliara

Sirenia, le Dugong dugon vit dans les eaux côtières. Les plus connus du monde extérieur sont probablement les primates de Madagascar (tous des Lémurs) et cependdant le status et la distribution de ces espèces ne sont pas bien connus et il y a peu d'étude au sujet de leur histoire naturelle. En effet, une nouvelle espèce de lémur (Hapalemur aureus) vient juste d'être découverte dans la forêt équatoriale du sud-est de Madagascar (Meier et al, 1987). Cela rend Madagascar troisième pays du monde pour le nombre d'espèces de primates (Mittermeier and Oates, 1985). Le Brésil vient en tête avec 51 espèces, puis le Zaire avec 29-32 espèces et ensuite Madagascar (29) et le Cameroun (28-29). On peut cependant noter que Madagascar a perdu au moins 14 de ses espèces de primates depuis l'arrivée de l'homme sur l'île (Sussman et al, 1985). Le nombre d'espèces de mammifères, leur degré d'endémisme, et le nombre d'espèces considérées comme menacées d'extinction sur la liste Rouge de 1988 (Annexe 1) sont répertoriés dans le tableau n° 1.

Comme pour les mammifères, le nombre d'espéces d'oiseaux rencontrés à Madagascar est faible mais la plupart sont endémiques dans l'île, et un pourcentage élevé sont menacées (voir Tableau 1). Les espèces en danger citées dans la Liste rouge de l'IUCN sont montrées dans l'Annexe 1. L'une d'entre elles, le coua mangeur d'escargot (Coua delalandei) pourrait déjà avoir disparue.

Tableau 1: Nombre d'Espèces de Flore et de Faune Rencontrées à Madagascar, Nombre d'Espèces Endémiques et Espèces Citées comme Menacées par l'IUCN. (Les poissons et invertébrés, autres que les papillons, ne sont pas inclus)

Taxon	No. d'Espèces	No. Endémiques	No. menacés d'extinction
Plantes	ca 10 000	79 %	1
Mammifères*	108	84 (78 %)	51 (47 %)
Primates	29	27 (93 %)	24 (82 %)
Carnivores	8	8 (100 %)	7 (88 %)
Insectivores	32	30 (94 %)	18 (56 %)
Chiroptères	28	9 (32 %)	1 (4 %)
Rongeurs	10	10 (100 %)	0
Sirenia	1	0	1 (100 %)
Oiseaux	250 total		
	197 en élevage	106 (54 %)	28 (14 %)
Reptiles	256	231 (90 %)	12 (5 %)
Amphibiens	144	142 (99 %)	1 (1 %)
Papillons	260	182 (70 %)	18 (considerant seulement 2 familles

*Mammifères non-marins

Pour sa taille, Madagascar est relativement riche en reptiles et en amphibiens et plus de 95 % de ceux-ci sont endémiques. Toutes les 144 espèces d'amphibiens sont des grenouilles; on ne trouve pas de caecilians,

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de tritons ou de crapauds. La plupart des grenouilles sont des espèces vivant sur les arbres des forêts et sont sensibles à la destruction de leur habitat. Seule, une espèce est actuellement considerée comme menacée par l'IUCN, mais il y a peu d'information à leur sujet. Madagascar a plus d'amphibiens qu'aucun autre pays d'afrique. Il y a environ 260 espèces de reptiles actuellement répertoriées: 1 de crocodile, 13 espèces de tortues de terre et tortues de mer; environ 180 lézards comprenant deux tiers des espèces de caméléons existant au monde; et environ 60 espèces de serpents, toutes sont sans danger pour l'homme. Les espèces sont citées dans l'Annexe 1 et leur nombre montré dans le Tableau 1.

On a peu d'information sur le poisson natif de Madagascar et on connait peu de choses à son sujet et sur sa répartition. Il y a environ 40 espèces endémiques. Celles considérées comme menacées (bien qu'elles ne soient pas sur les listes officielles de l'IUCN) sont citées dans l'Annexe 1.

De la même façon, bien que certain groupes d'invertébrés aient été étudié en détail, la vaste majorité est relativement peu connue. On estime qu'il y a plus de 100 000 espèces. Les papillons et les mites sont parmi les insectes les plus connus et il y a plus de 3000 espèces de celles décrites à présent. Relativement peu d'espèces sont considérées comme menacées (voir Annexe 1) mais probablement parce qu'elles n'ont pas été étudiées. Les chiffres donnés dans le tableau 1 pour le nombre d'espèces de papillons comprennent seulement six familles. Il n'y a aucune trace d'information sur les Hesperiidae.

LA VEGETATION

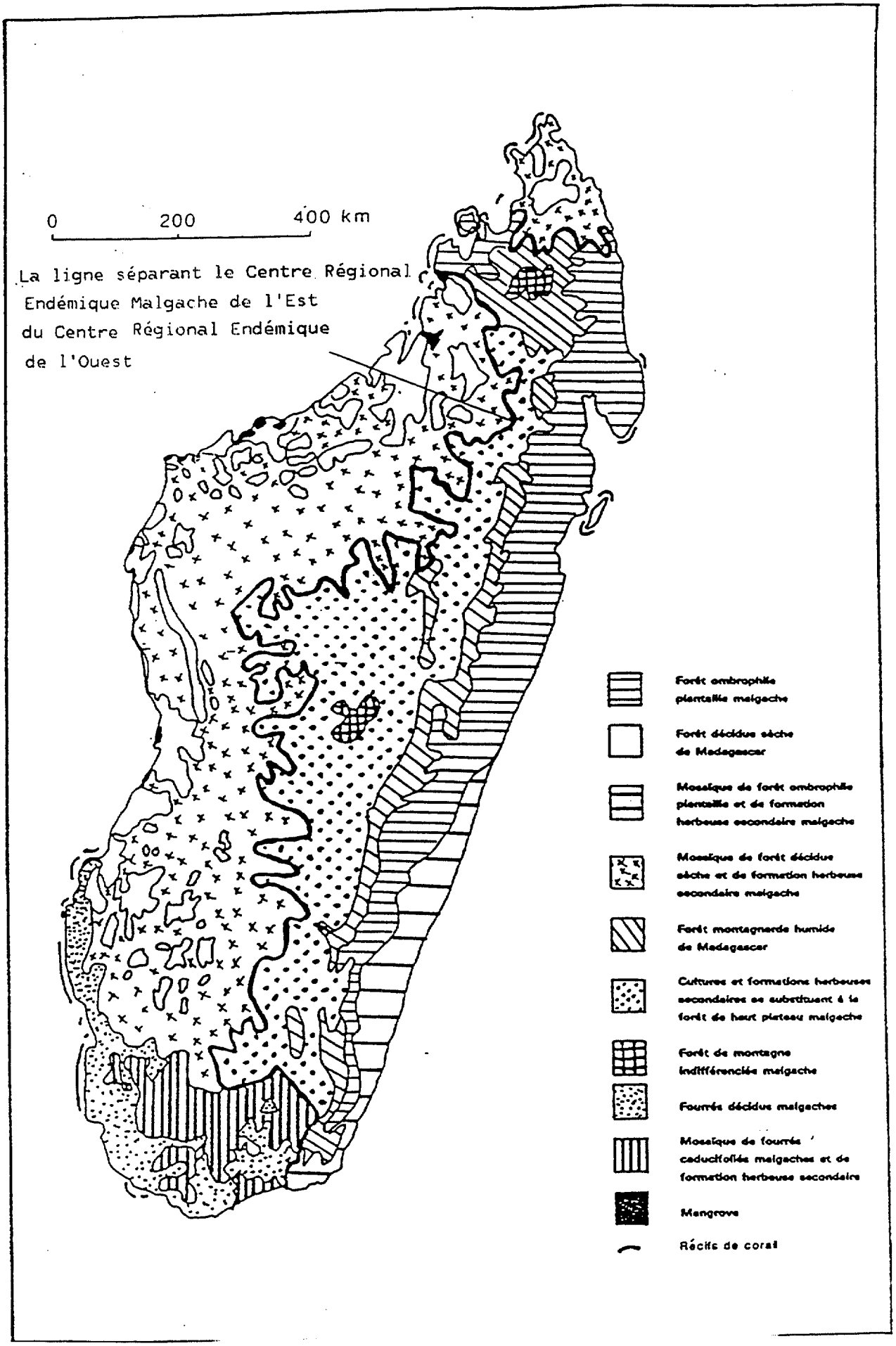
Topographiquement, Madagascar se divise en trois zones principales: une plaine étroite orientale et un raide escarpement qui la démarque à l'ouest; un haut plateau central accidenté; et une immense plaine sédimentaire à l'ouest et au Nord-Ouest. Résultant d'un relief varié, nous trouvons à travers l'île, une diversité de climat et de végétation.

La végétation de Madagascar est tellement différente de celle du continent africain qu'on lui a attribué deux "phytochoria" différents: le Centre Régional Endémique Malgache de l'Est et le Centre Régional Endémique Malgache de l'Ouest (Figure 3). A l'intérieur de ces vastes régions biogéographiques, se trouve un vaste éventail d'habitats.

La région Malgache couvre juste la moitié de l'île, s'étendant à l'ouest à partir de la côte en comprenant le plateau central. Cette partie fut probablement entièrement couverte de forêts à l'origine. Il y aurait eu (et il y en a encore dans certains endroits) une forêt équatoriale riche et variée de basse altitude (en dessous de 800 m), à la fois humide et "sclérophylle", une forêt de montagne sur les flancs orientaux et des forêts "tapia" (Uapaca bojeri) sur les flancs occidentaux. Beaucoup de cette forêt d'origine a été remplacée par une mosaïque de cultures et de formations secondaires.

Dans la région occidentale, des variantes distinctes de forêts de caduques secs Malgaches croîent sur des argiles latéritiques, des sols sableux et des plateaux calcaires. Des forêts plus luxuriantes croîent en habitat

Figure 3: Principaux Types de Végétation



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riverain, le long des rivières principales. Les Baobabs sont répandus dans les forêts occidentales, sept sortes d'espèces y poussent, contrairement à une seule sorte trouvée en Afrique continentale. Dans le Sud et le Sud-Ouest semi arides, la forêt est xérophytique, dominée par les Euphorbiaceae et la famille endémique des Didiereaceae. Il y a 18 sortes de plantes endémiques dans cette région.

LES TERRES HUMIDES

La majorité des lacs à Madagascar sont petits, moins de 100 ha, seulement 18 excèdent 1000 ha . Des cinq plus grands lacs, deux (Alaotra et Itasy) sont sur le plateau central et trois (Kinkony, Tsimanampetsotsa et Ihotry) sont à l'Ouest. Ces cinq lacs sont d'une profondeur de moins de 6.50 m. Il a été conseillé que le lac Alaotra et les terres l'entourant soient protégés car ils sont le territoire du pochard Malgache et de la grébe du lac Alaotra, aussi bien que d'une sub-espèce peu commune: le lémur gris (Hapalemur griseus alaotrensis). De même façon, il a été proposé de protéger les lacs Ihotry et Kinkony. Tous deux sont des réserves importantes d'oiseaux, et la tortue (Erymnochelys madagascariensis) habite le lac Kinkony. Le lac Tsimanampetsotsa est déjà une réserve. Deux autres lacs, importants pour leur réserve d'oiseaux, ont été proposés pour faire partie d'une zone protégée: les lacs Benamba et Masama. Il a été proposé d'élargir la réserve de Tsingy de Bemahara afin de les inclur dans une même réserve.
(Les locations de ces lacs sont montrées en Figure 4 et 5).

LES MANGROVES

Madagascar posséde les plus grandes régions de mangroves de l'Océan Indien occidental. Elles recouvrent une superficies de 330 000 ha. La plupart se trouvent le long de la côte ouest, dans 29 endroits mais on trouve également des petites mangroves sur la côte est dans 11 emplacements dont la plus grande se trouve dans la Baie d'Irodo. Aucune de celles-ci ne se trouvent dans une zone protégée. Les mangroves sont importantes pour l'industrie de la pêche à la crevette qui a produit 4300 tonnes par an en 1974 (MacNae, 1974).

LES RECIFS DE CORAIL

On trouve d'importants récifs au large de Madagascar. Ceux de la côte est sont rudimentaires, bien qu'importants; ce sont des récifs qui bordent la côte, à l'intérieur desquels se trouvent une série de lagons peu profonds. La plupart des récifs se trouvent le long de la côte ouest ou ils couvrent une distance de plus de 1000 km. La partie centrale de la côte ouest a peu de récifs, le plus grand et le plus connu étant le Grand Récif du Toliara qui a été proposé deux fois déjà comme réserve marine. On a également suggéré que le récif de corail au large de la petite île de Nosy Bé, au Nord-Ouest, soit protégé. Cependant jusqu'à présent aucun de ces récifs n'a une protection légale.

DESTRUCTION DES FORETS

Il y encore beaucoup de débats au sujet de savoir combien de forêts recouvraient Madagascar à l'origine. Même à présent, il n'y a pas de figures précises consernant l'étendue de ce qu'il reste de forêts, le maximum serait 20 % de l'île. Les estimations de 1980 ont compté qu'il reste 2 900 000 ha de forêts ouvertes et 10 300 000 ha de forêts fermées. Le déboisement des forêts fermées, entre 1981 et 1985 a été estimé à 128 000 ha par an (ie 1.2 %) avec des reboisements de 12 000 ha par an, toutes avec des espèces de pins exotiques et d'eucalytus.

Le chiffre de FAO/UNEP (1981) de 6 955 000 ha de forêt restante dans la région orientale peut-être décomposée de façon suivante:

Forêts Primaires	1 200 000 ha
Forêts Exploitées	3 570 000 ha
Régions inaccessibles	1 650 000 ha
Réserves	535 000 ha

Le principal agent de la destruction forestière dans cette région est l'agriculture sur brûlis ("tavy").

Les chiffres de FAO/UNEP (1981) pour les régions de forêts restantes dans la partie occidentale de Madagascar sont plus élevés que ceux estimés en 1960 (ainsi que pour les chiffres concernant les forêts orientales). Ils considèrent que 3 145 000 ha restent, composés de:

Forêts Vierges	500 000 ha
Forêts Exploitées	1 500 000 ha
Massifs dégradés	650 000 ha
Réserves	495 000 ha

La plupart des forêts restantes à l'ouest sont des parcelles relativement petites et isolées dans des terrains inaccessibles ou impropres au défforestage, en général à cause du sol trop pauvre.

Le plus grand danger pour les forêts occidentales est le feu, qui est la plupart du temps allumé délibérement afin d'encourager la poussée d'herbe nouvelle pour le pâturage. L'agriculture sur brûlis détruit également ces forêts.

Les forêts méridionales, qu'on estime recouvrir 2 900 000 ha (FAO/UNEP, 1981) sont générallement considérées les mieux préservées des formations culminantes de l'île. Les populations humaines sont faibles et la végétation est relativement résistante au feu. Le ramassage de bois pour en faire du charbon est probablement la menace la plus importante pour les forêts méridionales, bien que l'agriculture nomade pose également des problèmes. Les forêts du plateau central ont toutes déjà disparues. Celles restantes disparaissent rapidement, la plupart à cause de feux d'herbes qui érodent leurs abords.

Les forêts de montagne, au dessus de 2000 m, sur les grands massifs isolés tels que Tsaratanana, Marojejy, Ankaratra et Andringitra sont estimées couvrir une surface d'environ 600 000 ha (FAO/UNEP, 1981). Bien que relativement à l'abris des indigènes, ces régions sont très suceptibles aux dégâts causés par le feu.

REGIONS PROTEGEES*

Cinq différentes catégories d'aires protégées sont officiellement reconnues (Tableau 2 et Figure 4):

1) Réserves Naturelles Intégrales
2) Parcs Nationaux
3) Réserves Spéciales
4) Forêts Classées
5) Périmètres de Reboisement et de Restauration.

Il y a en plus, deux réserves privées qui appartiennent à la famille de Heaulme.

1) La législation qui réglement les Réserves Naturelles Intégrales a été fixée essentiellement par le Décret 66-242 (01.06.66); le réseau de réserves fut à l'origine, institué en 1927. Ces réserves font partie du domaine forestier de l'Etat. Leur accès est strictement défendu autre que pour buts scientifiques (qui doivent être autorisés par le Ministère chargé de la Direction des Eaux et Forêts). Il existe à présent 11 Réserves Naturelles Intégrales; une douzième, la RNI N° 2 sur la Péninsule de Masoala, a été officiellement re-désignée en Forêt Classée par le Décret 64-381 du 16.09.64.

2) La législation qui réglement les Parcs Nationaux a été fixée par les Décrets 58-07 (28/10/58) et 62-371 (19/7/62). L'accès aux Parcs est contrôlé. Certains produits forestiers peuvent être exploités par les villageois avoisinnants qui en contrepartie sont tenus à certaines obligations. Il existe à présent deux Parcs Nationaux.

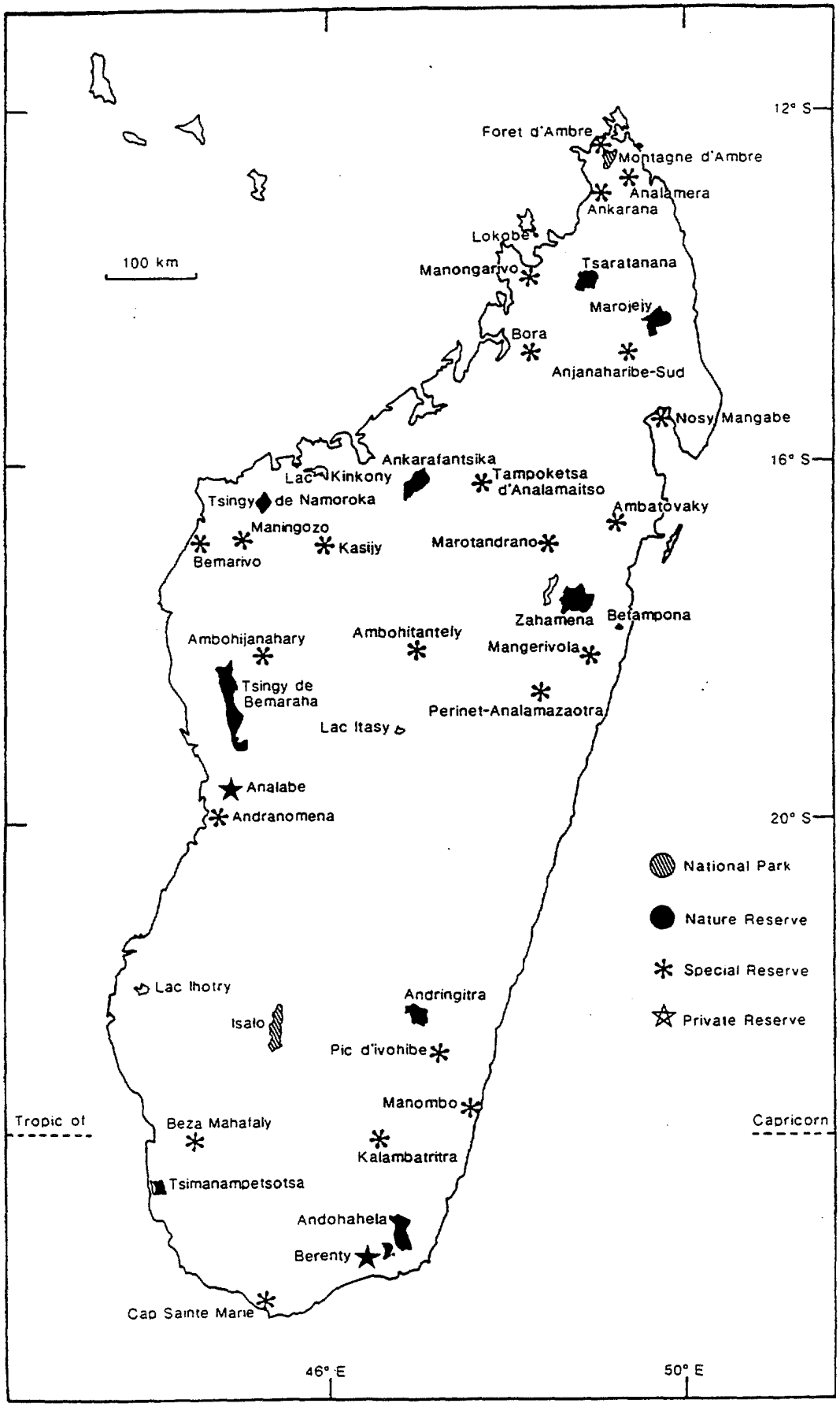
3) Les Réserves Spéciales ont été instituées par une série de décrets dans le but de protéger certaines espèces particulières de la faune et de la flore. Leur accès est libre mais il y est interdit de chasser, de pêcher, de laisser pâturer les animaux, d'y faire la cueillette de produits et d'y introduire de nouvelles vegetations ou d'animaux. Cependant, ces aires ne sont pas surveillées. IL y a 23 Réserves Spéciales.

4) Les Forêts Classées font l'objet de décrets ministériels particuliers. Elles ont été créées sous l'initiative du Ministère en charge de la Direction des Eaux et Forêts sur le conseil d'une commissions composée de représentants de l'administration et des habitants locaux. Elles ont été créées avec l'intention de constituer des "Réserves Forestières " au sens économique du terme. L'exploitation est interdite, bien que les habitants locaux peuvent y exercer certains droits d'usages traditionnels tels que le ramassage de miel ou de raphia. La protection de ces terrains n'est pas pour autant permanente.

5) Les Périmètres de Reboisement et de Restauration sont organisés sur les modèles des Forêts Classées. Leur objectif principal et de stabiliser et de protéger les bassins-versants et de lutter contre l'érosion.. L'exploitation des terres y est contolée et une politique de gestion appropriée y est appliquée.

Les parcs et les réserves, à l'origine, ont été définis par la Convention de Londres de 1933 (adoptée par la loi Malgache le 25/1/37). La

Figure 4: Localisations des Aires Protégées



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Convention Africaine pour la Conservation de la Nature et des Ressources Naturelles (1968) est invoquée pour la protection et la conservation de ces aires.

Les aires protégées couvrent une superficie totale d'environ 10 350 m^2 (à l'exclusion des forêts classées et des zones de reboisement), ce qui représente 1.76 % de la superficie du pays. Il ya deux problèmes majeurs avec les aires protégées existantes à Madagascar. L'un est un manque de fonds chroniques, le budget total pour le support matériel pour le réseau des réserves est de $ 1 100 par an. Par conséquent , il n'y a pas assez d'equipement et de personnel pour protéger les réserves d'une façon efficace. Le deuxième problème est la taille des réserves. De nombreuses recherches théoriques et pratiques ont montré qu'à long terme, une réserve de grande taille est un facteur essentiel pour ralentir l'extinction des espèces. La plus petite réserve officielle à Madagascar (à l'exclusion de Nosy Mangabe qui ne peut être agrandie) est de 740 ha, et il n'y a pas moins de 12 autres qui sont en dessous de 10 000 ha. Seulement sept sont au dessus du minimum "idéal" de 50 000 ha généralement recommandé. Ces sept réserves recouvrent une superficie de 563 440 ha (0.96 % de Madagascar) et la plus grande, Tsingy de Bemaraha représente plus d'un cinquième de cette aire.

Tableau 2: Superficie Totale Protégées

	Hectares
Parcs Nationaux	
Isalo (No 2)	81 540
Montagne d'Ambre (No 1)	18 200
Total	99 740
Réserves Naturelles	
Tsingy de Bemaraha (No 9)	152 000
Andohahela (No 11)	76 020
Zahamena (No 3)	73 160
Ankarafantsika (No 7)	60 520
Marojejy (No 12)	60 150
Tsaratanana (No 4)	48 622
Tsimanampetsotsa (No 10)	43 200
Andringitra (No 5)	31 160
Tsingy de Namoroka (No 8)	21 742
Betampona (No 1)	2 228
Lokobe (No 6)	740
Total	569 542

Tableau 2: cont'd

Réserves Spéciales	
Ambatovaky (Tomasina Province)	60 050
Marotandrano (Mahajanga)	42 200
Manongarivo (Antsiranana)	35 250
Analamera (Antsiranana)	34 700
Anjanahatibe-Sud (Antsiranana)	32 100
Kalambatritra (Fianarantsoa)	28 250
Ambohijanahary (Mahajanga)	24 750
Kasijy (Mahajanga)	18 800
Ankarana (Antsiranana)	18 220
Tampoketsa d'Analamaitso (Mahajanga)	17 150
Bemarivo (Mahajanga)	11 570
Maningoza (Antsiranana)	7 900
Anfranomena (Toliara)	6 420
Ambohitantely (Antananarivo)	5 600
Manombo (Fianarantsoa)	5 020
Forêt d'Ambre (Antseranana)	4 810
Bora (Mahajanga)	4 780
Pic d'Ivohibe (Fianarantsoa)	3 450
Cap Sainte Marie (Toliara)	1 750
Perinet-Analamazaotra (Tomasina)	810
Mangerivola (Toamasina)	800
Beza Mahafaly (Toliara)	600
Nosy Mangabe (Toamasina)	520
Total	365 500
Réserves privées:	
Berenty	250-265
Analabe	Plus de 2000
Forêts classées:	
Il y en a 158, Superficie totale	ca 2 671 000
Périmètres de Reboisement et de Restauration:	
Il y en a 77 couvrant	ca 823 978

Parc National de la Montagne d'Ambre

Il a été établi le 28/10/58 par le Décret n° 58-07. Ce parc, à la pointe nord de Madagascar, repose sur un massif volcanique à une altitude de 850-1474 m. La végétation est composée principalement de forêt tropicale humide, avec des arbres atteignant 30 m de hauteur. Les palmiers et les fougères géantes abondent dans les sous-bois et on y trouve une flore épiphyte variée, comprenant des fougères et de nombreuses variétés d'orchidées. La région est un important centre de collection de pluies pour Antsiranana. C'est l'une des seules zones protégées dans laquelle on y trouve le lémur couronné (Lemur coronatus). Plusieurs espèces de reptiles et une d'amphibien sont supposées être uniques dans ce parc.

La gestion du parc est sous la responsabilité de la Circonscription Forestière d'Antsiranana. En général, le parc n'est pas gardé de façon

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adéquate. Il n'y a qu'une seule personne qui s'en occupe, c'est un agent des Eaux et Forêts. Dans le sud plus particulièrement s'opére une exploitation forestière illégale. Le bétail pâture dans le parc, mais, plus grave, sont les feux allumés pour brûler les pâturages qui menacent les bords du parc. La cueillette de plantes ornementales et le braconnage, en particulier du lémur (L. fulvus et L. coronatus) et de l'ibis huppé (Cophotibis cristata), est un problème. L'un des projets actuels du WWF est d'aider à la gestion de la Montagne d'Ambre.

Parc National de l'Isalo (no 2)

Il a été établie le 19/07/62 par le Décret n° 62-371. Le parc de l'Isalo situé au sud du centre de Madagascar, renferme la totalité du massif gréseux. S'élevant à une altitude dépassant 514-1268 m, la végétation est pour la plupart dégradée. Environ 20 % du parc au Nord-Ouest est couvert de forêts caduques. Les nombreux canyons de 100-200 m de profondeur sont recouverts par des forêts à feuilles persistantes. La végétation de rochers est abondante, deux des espèces les plus communes, Pachypodium rosalatum et Aloe isaloensis sont endémiques au massif.

Le brûlis incontrolé annuel des pâturages bordant le parc constitue la plus grande menace pour Isalo. Ces feux s'étendent dans la forêt à l'interieur du parc. Les habitants de Ranohira sont autorisés à faire la cueillette de cocons de vers à soie (Bocerus sp) et Tapia Uapaca bojeri dans le parc. Cependant, il y a beaucoup de braconnage de lémurs (L. catta), de cochon de brousse (Potamochoerus larvatus), de pintade (Numida meleagris), de chauve-souris à fruit (Pteropus rufus et Eidolon helvum), d'anguilles et de miel. De plus, le bétail broute à l'intérieur du parc et le bois de chauffage ou de reconstruction est récolté.

Réserve Naturelle Intégrale de Betampona (n° 1)

Elle a été établie le 31/12/27, et sa superficie a été fixée par le Décret n°66-242 en Juin 1966. Cette réserve, à altitude basse de 275-650 m, est un exemple du biotope naturel de basse altitude de la région orientale de Madagascar. Betampona est le seul massif boisé dans une vaste aire déboisée. La végétation non dégradée est composée de forêts denses équatoriales à feuilles persistantes qui est extrémement riche au niveau de la flore et est le lien prototype de beaucoup d'espèces de plantes. Il existe au moins neuf espèces de lémurs dans cette région, en comprenant l'aye-aye (Daubentonia madagascariensis), et probablement cinq des sept espèces de carnivores. La forêt dans le parc de Betampona recouvre seulement 1000 ha car il y a une large zone dégradée de 1000-1500 m de large à l'intérieur des limites de la réserve. La forêt d'origine a été probablement abattue avant que la zone ne soit complètement mise sous protection totale en 1949. La régénération s'y développe mais principalement le palmier voyageur, Ravenala madagascariensis. Il y a de nombreux villages dans une aire de un km à l'intérieur de la réserve, ce qui explique les incursions fréquentes.

Réserve Naturelle Intégrale de Zahamena (n° 3)

Elle a été établie le 31/12/27. La végétation de cette réserve est en général caractéristique de la falaise orientale avec forêts primaires et secondaires tropicales à feuilles persistantes typique des basses altitudes entre 800 et 1300 m. Au dessus se trouvent des bois de montagne et des zones de bambou. C'est une autre région riche en primates et également particulièrement importante pour les oiseaux, dont plus de 60 espèces ont été répertoriées.

La plupart de la moitié occidentale et du sud-est de la réserve sont bien boisées. Cependant, il y a des problèmes au nord-est ou le bétail pâture, ou l'on éclaircit le terrain pour la culture et ou le braconnage y est pratiqué.

Réserve Naturelle Intégrale de Tsaratanana (n° 4)

Elle a été établie en décembre 1927. Tsaratanana, au nord de Madagascar, protége la végétation hautement spécifique d'un massif qui inclus le Mont Maromokotra, le pic le plus élevé de l'île (2876 m). La réserve varie en altitude, de 700 m jusqu'à plus de 2800 m et contient des forêts primaires et secondaires à feuilles persistantes de basses et hautes altitude. La flore est riche en espèces endémiques, surtout en altitude. De 2000 à 2200 m d'altitude se trouve une zone à bambous géants. Au dessus de 2200 m d'altitude, c'est la forêt à mousse. Les épiphytes y sont très abondantes. La végétation au sommet a été presque entièrement détruite par le feu. Cette réserve est la plus importante de Madagascar pour les mollusques, pour plusieurs espèces de reptiles et d'amphibiens qui sont également originaires de la région . La nouvelle espèce répertoriée de mangouste à rayures (Galidictis grandidiensis) a été reportée vivant dans cette région (Wozencraft, 1986).

A part les sommets brûlés, la réserve est quasiment intacte car les températures hivernales très froids et la raideur du terrain sont un obstacle à l'extension des cultures.

Réserve Naturelle Intégrale de l'Andringitra (n° 5)

Elle a été établie le 31/12/27. Les présentes limites ont été fixées par le Décret 66-242 en juin 1966. Cette réserve protége la flore du deuxième pic le plus élevé de l'île, le Pic Bobu, à 2658 m d'altitude. La chaine de montagnes qui constitue la réserve est un massif granitique très valloné, possédant le climat le plus froid de Madagascar. Il y a plusieurs types de végétation: à 700-800 m d'altitude, il y a des zones de forêt humide de basse altitude du domaine orientale; entre 800 et 1600 m d'altitude, forêt humide de moyenne altitude; au dessus, jusqu'à 2000 m d'altitude, forêt de montagne sclérophylle et sylve à lichens et de brousse ericoïde. Toute la région est riche en espèces endémiques: 80 % de la flore des dépressions humides et des rochers est endémiques au massif. La végétation naturelle à l'ouest du massif a été détruite par le feu. Il y a au moins sept espèces de grenouilles endémiques dans cette zone.

Les incendies sont la principale menace pour la réserve. Le bétail broute dans la région et cause des dégâts, particulièrement en ce qui concerne la flore des rochers. Le lémur Masqué (L. Catta) est capturé vivant pour être revendu. Le projet de gestion Mamoly, désigné à améliorer l'irrigation et la production du riz, a construit un barrage et un canal de trois km de long dans la réserve. Cela a endommagé la beauté de Riantahy et les chutes d'eau de Rianvavy.

Réserve Naturelle Intégrale de Lokobe (n° 6)

Elle a été établie en Décembre 1927, bien que la Forêt de Lokobé ait acquis le statut de réserve 14 ans auparavant. Cette réserve est sur l'île de Nosy Bé, au large de la côte nord-ouest de Madagascar. Beaucoup de ce qu'il reste de cette forêt, qui est dense et humide, appartient à la réserve et joue donc un rôle important pour l'hydrographie. La plupart de ses plantes sont endémiques. Nosy Bé est sur le point de devenir l'un des principaux centre d'attraction touristique et c'est l'un des endroits ou

l'on peut voir aisément le lémur noir, (L. macao). Il existe au moins sept espèces de reptiles endémiques à Nosy Bé.

La réserve est vulnérable à cause de sa petite taille. La zone tampon qui n'est pas protégée officiellement, est défrichée afin de pouvoir y cultiver le riz et le manioc. Le braconnage de lémurs est également un problème.

Réserve Naturelle Intégrale de l'Ankarafantiska (n° 7)
Elle a été établie en décembre 1927 et mise à jour par le Décret 66-242 du 30/06/66. La réserve abrite une variété d'habitats typiques des sols arénacés du domaine occidental de Madagascar, est aussi le bassin de reception des eaux, et, est l'une des régions de riziculture les plus importantes de Madagascar. La réserve est encore largement recouverte d'une végétation de forêts caduques secs. On y trouve beaucoup de légumineuses et de Myrtacae, de nombreuses lianes mais peu d'épiphytes. Ankarafantiska est probablement la plus importante zone protégée de la forêt occidentale. Au moins deux espèces d'oiseaux, le mesite à poitrine blanche (Mesitornis variegata) et le vanga de Van Dam (Xenopirogstris damii), et trois espèces de reptiles (Chamaleo angeli, Brooksia decaryi et Pygomeles petteri) sont connues seulement à Ankarfantsika. C'est également la seule région protégée dans laquelle on peut y trouver le lémur mangouste (L. mougoz). La station de la forêt d'Ampijoroa, qui couvre environ 20 000 ha, se trouve sur la frontière ouest de la réserve. La tortue anfonoka (Geochelone yniphora), extrêmement rare est trouvée près de cette réserve et un programme pour la reproduction en captivité de cette tortue, qui est probablement la plus menacée d'extinction du monde, a commencé à Ampijoroa.

Ankarafantiska et la station forestière sont défrichées pour la création de pâturages et pour l'installation de cultures. Le brûlage de charbons est un problème. La réserve a six zones tampons autour d'elle mais celles-ci ont souffert des dégâts dans la forêt et les abords sont repoussés dans la réserve, particulièrement au nord et à l'est. Le feu a affecté la partie ouest en 1983. Il y a du bétail à l'intérieur de la station forestière, ainsi que dans la réserve. Le braconnage n'est pas une menace jusqu'à présent.

Réserve Naturelle Intégrale du Tsingy de Namoroka (n° 8)
Elle a été établie en décembre 1927. La réserve est une mosaïque de forêts denses et sèches, de savanes et de végétation adaptée aux Karsts calcaires trouvés dans la région. La taille moyenne des arbres est de 12-15 m. Les baobabs, en particulier Akdansonia rubrostipa, sont communs, de même que les plantes grasses et autres plantes xérophilliques. Certains des derniers bois d'ébéne sont trouvés dans cet endroit. La région a un courant d'eau alimenté par une source, avec une remarquable flore aquatique. Il y a beaucoup d'autres sources, de caves et de falaises dans la réserve. La réserve, comme beaucoup d'autres, n'est pas gardée de façon adéquate et les habitants locaux sont largement indifférents aux lois protégeant cette région. Des plantations de chanvre ont été trouvées à l'intérieur de la réserve et le bétail y broute librement. Les feux sont fréquents pendant la saison sèche.

Réserve Naturelle Intégrale du Tsingy de Bemaraha (n° 9)
Elle a été établie en décembre 1927. Bemaraha est la plus grande réserve des aires protégées de Madagascar. Comme à Namoroka, la végétation est caractéristique de la région de Karst calcairee de l'ouest, avec plusieurs

espèces uniques. La taille et l'altitude de cette réserve (jusqu'à 700 m) font que la végétation y est plus riche que dans la RNI n°8. On connait relativement peu de choses sur les espèces de cette réserve, mais elle est considérée être d'une importance particulière et a été récemment élue en tant que Site d'Héritage mondial.

On a reporté des installations et du bétail illégal dans la réserve. Cependant, elle est en général plutôt difficile d'accès et donc protégée naturellement. La pratique du braconnage y est courante.

Réserve Naturelle Intégrale de Tsimanampetsotsa (n° 10)
Elle a été établie le 31/12/27. Cette réserve comprend tout le lac Tsimanampetsostà aux eaux peu profondes et saumâtres, aussi bien que la zone couverte par la végétaion naturelle du plateau Mahafaly. On y trouve des fourrés à xérophytes sur le plateau calcaire et des formations arbustives sur sol arénacé typique du sud-ouest. La végétation est un mélange remarquable de Didieracéae, une plante endémique de la famille des arbres et arbustes qui ressemble aux cactus. La région est particulièrement importante pour son avifaune.

La réserve semble être peu dégradé et est en bonne condition. Elle est protégée du feu par ses buissons ininflamables et les collines rocheuses qui l'entourent. Il n'y a pas de bétail étant donné qu'il y a peu, sinon pas d'eau fraîche dans la région. Un tabou local éloigne les villageois de la réserve.

Réserve Naturelle Intégrale d'Andohaela (n° 11)
Elle a été établie le 11 juin 1939 et fut agrandie de 30 000 ha le 1/06/66 par le Décret 66-242. Cette réserve est découpée en trois parcelles non contigües: la superficie de la parcelle n° 1 est de 63 100 ha, la superficie de la parcelle n° 2 est de 12 420 ha et la superficie de la parcelle n° 3 est de 500 ha. La parcelle n° 1 varie en altitude de 100 a 1956 m (Pic d'Adndohahela) et est un important abri pour l'eau, contenant la source de plus de dix rivières. Chaque parcelle a un type distinct de végétation. La végétation de la parcelle n° 1 est typique de la forêt tropicale humide d'altitude dont elle marque la limite la plus méridionale à Madagascar. La famille de plante endémique des Humbertaceae se reproduit dans cette réserve; les épiphytes sont communs, ainsi que les mousses et les lichens trouvés à des altitudes plus élevées. La parcelle n° 2 comprend principalement une forêt d'épineux avec des broussailles et du chiendent et également des forêts galeries le long de la rivière Mnanara dans la partie nord de la réserve. Les genres endémiques Allaudia et Didiera sont bien représentés comprenant une espèces d'allandia (A. ascendens) qui n'est trouvée que dans la région Mandtare. Le baobab Adansoniaza est également endémique à cette région. La parcelle n° 3 a été ouverte à l'origine afin de protéger le palmier endémique Neodypsis decaryi. De plus, elle possède une ceinture végétale qui fait la transition entre la forêt humide du domaine et la forêt d'epineux. Il en résulte de cette végétation variée que cette réserve est très riche en flore et en faune, avec plus de 100 espèces d'oiseaux répertoriés et 14 espèces de lémurs ce qui est plus que dans aucune autre région protégée de Madagascar.

Toutes les parcelles ont des zones déboisées dues au feu et à la coupe de bois. Il y a des habitations dans la réserve et des zones éclaircies pour les pâturages ou pour les cultures. Le L. catta y est chassé pour sa chair.

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Réserve Naturelle Intégrale de Marojejy (n° 12)
Elle a été établie le 03/01/52. La réserve comprend le massif de Marojejy et ses principaux contre forts. Ce massif varie en altitude de 90 à 2137 m sur une courte distance horizontale. La diversité des espèces de plantes est très élevée, avec plus de 100 genres et 2000 espèces enregistrées, dont plusieurs sont apparemment endémiques au massif. Entre 50 et 800 m d'altitude environ on trouve une forêt humide dense, à futaie serrée et haute de 25 a 90 m, occupant la zone inférieure. A 800-900 m d'altitude environ, cette formation est graduellement remplacée par une forêt humide de moyenne altitude. La forêt est en général de basse altitude et les fougères y sont abondantes. La sylve à lichens et de mousse se développe au mieux entre 1450 et 1850 m d'altitude. La futaie est haute de six a dix métres avec des arbres souvent très ramifiés à la base. Il n'existe pas d'étage intermédiaire, mais le tapis végétal est dense et varié. Les épiphytes, comprenant les fougères et les orchidées sont nombreuses. Les bambous Arundinaria marojejyyensis poussent en groupes sur les sols les moins développés. Au-dessus de 1850 m la forêt est composée de broussailles ericoïdes. Il y a des fougères arborescentes à environ 2000 m, ainsi que des petits marais et des dépressions marécageuses avec une flore distinctive. La région est très riche en différentes espèces d'oiseaux, comprenant plusieurs espèces menacées, telles que le Sarothrura watersi, le Brachypteracias leptosomus, le B. Squamiger et l'Atelornis corssleyi. Au moins sept espèces de grenouilles et deux de reptiles trouvées à cet endroit sont endémiques à la réserve.

La réserve manque de personnel et les cultures sur brûlis se font dans les vallées rarement patrouillées par les quatre gardes. Les forêts au sud et à l'ouest de la réserve ont été largement éclaircies. On connait mal l'état des frontières au nord et à l'est. Avant 1952, on cultivait le café à l'intérieur des limites, à des altitudes de 400-500 m mais ces régions sont retournées à leur état naturel de forêts.

Réserve Spéciale Botanique d'Ambohitantely
Cette région contient l'un des derniers vestiges dans la forêt du plateau central. Elle a de proches affinités floristiques avec les forêts pluviales orientales. Cette réserve a été établie assez récemment, en 1982, sur l'initiative de la Direction des Eaux et Forêts avec l'aide du WWF. Sa proximité d'Atananarivo pourrait la rendre particulièrement propice comme terrain de recherche pour les étudiants. La plus grande menace pour cette réserve y est le feu.

Réserve Spéciale de Beza Mahafaly
Cette réserve a été inaugurée en 1985. La végétation consiste en forêts galeries le long de la rivière dominée par le Tamarindus indica, et de forêts d'épineux, particulièrement de Alluaudia procera. On estime que des 5-600 ha de forêts riveraines restant dans le sud de Madagascar, environ 300 ha se trouvent à Beza Mahafaly. L'un des rôles principaux de la réserve est de fournir un lieu de recherche sur la flore et la faune du sud-ouest de Madagascar.

Réserve Spéciale de Nosy Mangabe
Nosy Mangabé est une petite île de 520 ha, située à six km au large de la côte est de Madagascar, dans la Baie d'Antongil. Sa végétation est une forêt typique de la côte est, bien que la plupart y est secondaire. Le lémur Varecia variegata est trouvé sur cette île et les ayes-ayes y ont été introduits en 1966 et y sont toujours présents.

Réserve Spéciale de Perinet-Analamazaotra

Elle a été établie en 1970. Cette petite réserve de 810 ha possède une topographie accidentée. Sa végétation est une forêt tropicale humide de moyenne altitude (930-1040 m). Les épiphytes y sont abondants, et comprennent des mousses, des fougères et des orchidées. Neuf espèces de primates sont connues dans cette réserve, comprenant le aye-aye ainsi que l'Indri qui est le plus large des lémurs. La petite faune de mammifères est également riche avec au moins dix espèces de tenrec et cinq espèces de rongeurs endémiques. La réserve est facile d'accès à partir d'Antananarivo, soit par route, soit par chemin de fer, et, est une région touristique favourite.

La réserve est trop petite pour protéger ce type de forêt. Le tavy représente la principale méthode de culture dans la région, avec l'accroissement de la population, cette méthode devient peu rentable et pose une menace sérieuse à long terme. Le tavy est pratiqué au Sud et à l'Est de la réserve, mais elle est protégé au Nord et à l'Ouest par la forêt autochtone est la forêt de plantation. L'exploitation illicite du bois prend place à travers la région ainsi que celle des arbres qui ne recevraient en aucun cas un permis d'exploitation. Cette exploitation locale de bois dur a l'intérieur de la réserve est utilisé comme combustible ou materiel de construction.

Il y a également un traffic d'orchidées, de produits provenant des fougères arborescentes, de palmiers ornementales ainsi que de reptiles et de lémurs.

Réserve Privée d'Analabe

Analabé est la propriété de M. de Heaulme. Cette réserve est trouvée sur la plaine côtière de Morondava et est située entièrement en dessous de 100 m d'altitude. Le terrain est plat, avec des zones de dépression formant des marais ou des lacs saisonniers ou permanents. Les forêts sèches à feuilles caduques de l'ouest occupent la plupart de la réserve ainsi que le baobab Adansonia grandidieri qui est commun mais on y trouve également des broussailles de plantes grasses et épineuses et du chiendent.

La réserve n'est pas protégée à l'heure actuelle. La culture au tavy y est pratiquée et les feux de brousses allumés chaque année dans la forêt environnante posent une menace pour la réserve. Des sentiers pour l'exploitation du pétrole ont été ouvert à travers la zone; ils rendent la forêt très vulnérable à l'exploitatrion, en particulier celle du bois de chauffage. La chasse en particulier celle de Tenrec ecaudatus et du rongeur Hypogeomys antimena est pratiquée dans la réserve.

Réserve Privée de Berenty

C'est une petite réserve privée d'environ 250 ha et également la propriété de la famille de Heaulme. Elle est située dans une plantation de sisal et est bordée par la Rivière Madrare. La végétation consiste en une forêt galerie pour la plupart composée d'Acacia et de Tamarindus près de la rivière, ainsique d'une foret d'épineux. Le lémur à queue baguée (L. catta), le Sifake (Progithecus verreauxii), et le lémur nocturne (Lepilemur leucopus) sont communs et facilement apercus par les nombreux touristes qui viennent visister cette réserve.

Les problèmes principaux sont les débordements de la rivière et l'érosion de ses bords. La mort d'arbres d'âge mûr et la pauvre régénération de nombreuses parties de la forêt sont dues à l'invasion du caoutchouc Cissus quadrangulus.

(*Information de IUCN/UNEP/WWF, 1987)

SITES CRITIQUES

Les régions suivantes (voir Figure 5) ont toutes été proposées par les représentants de WWF à Madagascar pour leur protection. Il est prévu que les régions déjà protégées soient agrandies et que plusieurs nouvelles régions soient établies.

Nouvelles Régions

1) Proposée comme Parc National: une bande de forêt pluviale orientale près du petit village de **RANOMAFANA** située près de Fianarantsoa est considérée comme l'une des priorités pour la conservation. Les plans pour créer un Parc National dans cette région sont actuelllement en cours. Elle abrite l'une des dernières populations du lémur Hapalemur simus, ainsi que les nouvelles espèces récemment découvertes du lémur Hapalemur aureus. le lémur du bambou doré. De plus, il y a au moins huit autres espèces de lémur dans la région. Celle-ci est également très riche en espèces d'oiseaux, avec un aperçu récent du "Râle de waters" qui est rajouté aux 70, et plus,d'espèces déjà répertoriées. La région est également une source d'eau pour les produits agricoles des terres basses côtière, et posséde une station hydroélectrique qui produit l'électricité de plusieurs villes environnantes.

2) Proposé comme Parc National: **MANANARA**. Située au nord-est de Madagascar, cette région abrite l'une des plus belles forêts côtière à basse altitude. Elle posséde la plus grande densité d'aye-ayes qu'aucune autre forêt, et pourrait également abriter le lémur nain Allocebrus trichotis qui n'est que très peu connu. C'est également une région importante pour les oiseaux.

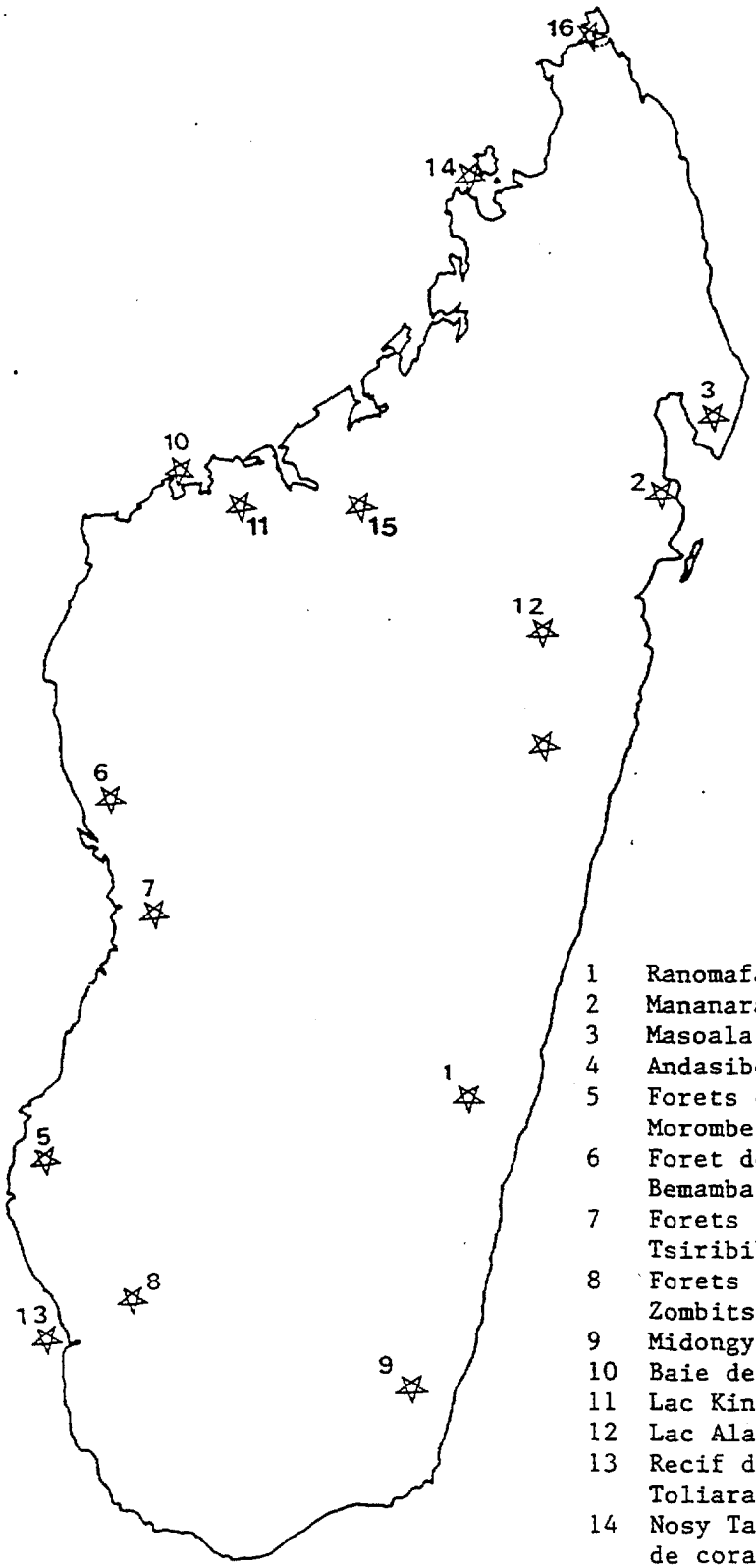
3) Proposé comme Parc National: la Péninsule de **MASOALA**.
Cette région, qui contenait une zone protégée de 30 000 ha (RNI n°2) est particulièrement riche en plantes endémiques, deux nouveaux genres de palmiers ont été découverts en 1986. Un nombre de reptiles et
d'amphibiens ne sont connus que dans cette région et elle contient une population variée d'oiseaux, avec plus de 80 espèces répertoriées.

4) Proposé comme Parc National: **ANDASIBE**. Andasibe (Périnet) est localisée à 135km d'Antananarivo. Il est projeté de constituer en parc national un secteur du bloc forestier dans la forêt de Mantady afin d'assurer un niveau de préservation adéquate d'une partie de ce massif. L'ensemble du projet de conservation d'Andasibe comporte trois entités distinctes; le secteur de Mantady, la Réserve spéciale d'Analamazaotra, et la Station forestière.

5) Proposé comme Parc National: **ANKARAFANTSIKA**. Parmi d'autres developements, l'agrandissement de cette réserve au sud-ouest, afin d'y inclur le lac Ampijoroa, a été suggéré commme étant tout particulièrement important pour la protection des oiseaux.

6) Le lac **IHOTRY** et le désert épineux l'entourant, ainsi que les forêts entre Toliana et Morombe sur la côte sud-ouest de Madagascar. Le désert épineux entourant le lac Ihotry est caractérisé par le Didierea madagascariensis et par le petit baobab Adansonia fony. Au niveau de la flore, cette réserve différe des autres régions protégées et le lac a été classé comme important pour la protection des oiseaux.

Figure 5: Sites Critique



1 Ranomafana
2 Mananara
3 Masoala Peninsula
4 Andasibe
5 Forets entre Toliara et Morombe & Lac Ihotry
6 Foret de Tsimembo & Lacs Bemamba et Masama
7 Forets entre les fleuves Tsiribihina & Andranomena
8 Forets de Vohibasia et Zombitse
9 Midongy Sud
10 Baie de Baly
11 Lac Kintony
12 Lac Alaotra
13 Recif de corail de Toliara
14 Nosy Tanikely et recifs de corail de Nosy Be
15 Ankarafantsika
16 La Montagne des Francais

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7) La forêt de TSIMEMBO et les lacs BEMAMBA et MASAMA. Ces deux lacs sont particulièrement importants pour la conservation des oiseaux et il a été proposé que les deux lacs et la forêt soient inclus dans une extension vers l'ouest de la Réserve et soit nommée Site d'Héritage mondial.

8) Les forêts occidentales entre les rivières Tsiribihina et Andranomena. Les forêts sont d'un intérêt logique fondamental de par la diversité biologique qu'elles abritent et de par son important endémisme local. La forêt de Kirindy est marquée par de remarquables espèces de baobabs; Adansonia grandidieri, A. fony et A. za. L'avifaune est riche et la faune possède une nombre d'espèces qui sont soit localement endémiques soit à la limite de leur espèce.

9) Forêt classée de ZOMBITSE (et forêt de VOHIBASIA). La forêt de Zombitse repose sur le versant occidental d'une dune de grès sur des collines ondulantes. C'est la forêt sèche à feuilles caduques la plus méridionale de l'ouest et forme une transition entre la végétation occidentale et méridionale. Cette région est une importante réserve d'eau pour les rizières extensives qui s'y trouvent. La forêt possède l'une des deux ou trois uniques populations réduites de l'Appert Greenbul (Phyllastrephus apperti)et le Monticola bensoni a été enregistré à cet endroit pendant une période de non-reproduction. Le gecko Phelsuma standingi est endémique à la région.

Le forestage illégal a pris place, utilisant des techniques et un équipement moderne, entre 1974 et 1981 et tout le bois utilisable a été coupé. L'exploitation y a continué utilisant des techniques plus traditionnelles, pour la production de charbon et de materiel de construction.

10) MIDONGY-SUD. Le secteur forestier de Midongy du sud constitue avec la RNI d'Andahalelo un des plus grands refuges pour la faune de la forêt pluviale malgache d'altitude du sud-est de Madagascar. Très peu de prospections ont été menées dans cette zone.

11) La Baie de BALY. La région entourant la Baie de Baly est le seul endroit ou l'on peut y trouver le Geochelone yniphora ou angonoka. Cette tortue est considérée comme étant la plus rare du monde; de récentes estimations suggèrent qu'il n'y aurait plus que de 100 à 400 spécimens dans la nature. La destruction de l'habitat, la plupart du temps par le feu, est la menace la plus sévère pour la survie des espèces. Bien que l'on ait instauré un programme de reproduction en élevage, il est vital que la région de la Baie soit protégée.

12) Le lac ALAOTRA est le plus grand lac de Madagascar. Il est le territoire de deux des oiseaux les plus menacés du pays, le pochard malgache (Aythya innotata) et de la grébe du lac Alaotra (Tachybaptus rufolavatus). le Lac est actuellement menacé par le déboisement et l'érosion à grande échelle dans les régions environnantes.

13) Les récifs de corail de TOLIARA: ce récif a été probablement étudié plus que d'autres récifs de l'Océan Indien (pour les détails voir UNEP/IUCN, 1987). Soixante deux genres de récifs de corail ont été

trouvés à cet endroit. La pêche commerciale de poissons et d'invertébrés y existe. La région a un grand potentiel touristique bien que pas encore réalisé.

La pêche en trop grandes quantités est en train de devenir un problème sérieux dans cette région ainsi que la récolte éxagérée de crustacés.

14) NOSY TANIKELY, les Récifs de corail de Nosy Bé et les îles du nord-est. Nosy Tanikely est déjà protégée pour sa faune terrestre et ses eaux environnantes sont classées Réserve Marine mais son status légal n'est pas établi. Il y a au moins 63 genres de corail dans cette région. Les mangroves sont abondantes dans de nombreuses Baies et estuaires de Nosy Bé. La tortue Eretmochelys imbricata y est représentée et les "couvries" y sont abondants. L'oiseau tropical Phaethon lepturus se reproduit sur les îles environnantes. Nosy Bé est une région touristique importante et les récifs de corail pourraient en faire une attraction principale.

Les plages et les récifs de Nosy Bé ont été affectés par l'envasement causée par le déboisement. Des coquillages ornementaux sont ramassés dans la région.

Plusieurs autres régions ont été suggèrées par Mittermeier (1987) comme étant des sites importants:

Lac KINKONY: c'est un lac de crue de plaine et le deuxième en taille à Madagascar. Il est important pour la protection des oiseaux, particulièrement pour l'aigle-poisson malgache, le "teal" et le héron (Haliaeetus vociferoide, Anas bernieri et Ardea humbloti). La tortue malgache Erymnochelys madagascariensis menacée de disparition, est abondante dans ce lac.

La MONTAGNE DES FRANCAIS: c'est un massif calcaire de 350-450 m d'altitude, situé de l'autre côté de la baie, à partir de la ville d'Antsiranana, à l'extrême nord de Madagascar. Bien que seulement à 50 km de la Montagne d'Ambre, la composition de la flore y est complétement différente, étant une région de forêt sèche contrairement à la forêt humide du Parc National. Les risques y sont le feu et l'abattage illégal des arbres.

Il a été suggèré (Mittermeier, 1987), que les réserves suivantes soient agrandies:

ZAHAMENA devrait être élargie à l'ouest afin d'y inclur la source d'eau du lac Alaotra et au sud, si possible aussi loin que la région de Didy-Fito, à l'ouest de Toamesina. Cette extension méridionale couvrirait une zone de semi-altitude de 500-1300 m connue comme la "forêt de Sihanake" qui a été reconnue comme priorité majeure pour la protection des oiseaux.

MAROJEJY: devrait être élargie vers l'ouest, en direction de Andapa.

threats

MENACES POUR LA BIODIVERSITE

L'Agriculture Nomade

Celle-ci a probablement contribué le plus à la destruction des forêts d'origine de Madagascar, et avec la population croissante, la situation

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s'empire. Des zones de forêts sont abattues, la végétation est assèchée et brûlée quelques mois plus tard. Le sol est ensuite cultivé, la plupart avec du riz de terre sèche, mais également avec du maïs, du manioc et d'autres semences, pendant un an ou deux, et, est ensuite laissé en friche. Une végétation dégénérée pousse sur les champs et après dix ans environ est éclaircie à nouveau. Le cycle se répétant, le sol s'appauvrit jusqu'à ce que finalement la région devienne pâturage ou fougère. Cette culture de "tavy" est souvent pratiquée sur des versants escarpés ou l'érosion s'ajoute à la destruction.

Le Feu

Celui-ci a été une autre cause majeure de la destruction des forêts, particulièrement sur les hauts plateaux et à l'ouest. Les feux sont allumés afin d'encourager l'herbe à pousser sur les pâturages et ceci est fait normalement en période de saison sèche, quand la végétation est particulièrement vulnérable. La forêt tourne rapiement à la broussaille, puis à une savane parsemée de quelques arbres pour former éventuellement un terrain à pâturage stérile, qui couvre déjà la plupart de l'île. Les chiffres de la FAO pour 1981 donnent une estimation de 1000 ha de savane productive qui se dégrade chaque année avec les feux.

La Chasse

Au moins 14 espèces de lémurs, toutes plus grandes que les espèces de lémurs actuelles, deux espèces de tortues géantes, une espèces d'hippopotame pygmée et les énormes oiseaux éléphants comprenant l'Aepyornie maximus, sont déjà éteints (Tableau 3), probablement à cause de la chasse intensive ainsi que par la destruction de l'habitat. Cependant la chasse actuellement n'a certainement qu'un effet local sur la taille de la population de ces animaux. Il est fort possible que des espèces déjà très réduites, pourraient être decimées complétement par la chasse. Par exemple, l'aye-aye est considéré comme porte-malheur et est fréquemment tiré à vue. Certaines tribus ont des tabous et sont réticentes à tuer des espèces bien précises. Le braconnage a lieu, même dans les régions sous protection (voir détails des réserves). Plusieurs espèces d'oiseaux sont menacées par le vol d'oeufs et la chasse aux adultes (par exemple le pochard malgache, le héron, le Sakalawa, le coua mangeur d'escargots, le "Scaly" et les "rollers" à longue queue, ainsi que l'aigle poisson). Plusieurs espèces de tortues et la plupart des tortues de mer sont ramassées pour être domestiquées pour leur carapace ou pour leur chair. Le crocodile du Nile, bien qu'en Annexe II de CITES, est encore considéré comme un parasite à Madagascar et les articles fait de sa peau sont en vente dans la capitale Atananarivo. Madagascar n'a pas de quota de CITES, ce qui fait qu'elle utilise 1000 peaux de crocodiles chaque année. Au moins une des espèces menacée de papillon Papilio morondavana est menacée par les collectionneurs.

Beaucoup d'espèces de palmiers endémiques du pays fournissent des fibres et de la nourriture aux populations locales et certaines espèces sont menacées à cause d'une utilisation trop intensive. Le ramassage de plantes ornementales a lieu dans tout Madagascar et présente des menaces pour certaines espéces locales. Par exemple, les palmiers, les fougères arborescentes et les orchidées dans la forêt pluviale de l'est et les espèces de P. achypodium et d'Aloé au sud sont ramassées trop intensivement.

Le Deboisement

Les forêts de Madagascar sont relativement pauvres au point de vue économique. Les forêts méridionales possèdent peu d'arbres à valeur commerciale, ceux de l'ouest ont une productivite faible, ce qui rend leur abattage peu économique et dans les forêts orientales, de larges zones ne sont pas exploitables commercialement, à cause du terrain accidenté et des problèmes d'accès. La plupart des forêts relativement accessibles ont vu leurs meilleurs arbres abattus systématiquement. Bien que l'exploitation soit souvent lente à cause de méthodes traditionnelles, les régions (e.g. Ranomafna) sont toujours dégradées par le déboisement. Dans de nombreuses forêts qui ont un status de protection, on assiste à un déboisement sélectif illégale. Dans des régions ou des concessions forestières ont été éditées, on coupe cependant des arbres de circonférence illégale ou des arbres d'une catégorie non autorisée. Depuis 1975, aucun bois de valeur en troncs n'a été autorisé pour l'exploitation.

Encore plus importante est la destruction de la forêt pour le combustible. La FAO estime que 6 262 000 cu. m de bois a été abattu dans les forêts entre 1982 et 1984, presque tout le bois (5 455 000 cu. m) a été utilisé par la population locale pour les feux domestiques et le charbon. Seulement 807 000 cu. m a été utilise industriellement. Le brûlage de charbon est une menace majeure aux alentours des grandes villes telles Toloana, Mahejanga, Antsiranana et Toamasina. Dans ces régions, cela conduit à un rapide déboisement. Le brûlage de charbon se produit à plus petite échelle dans toute l'île, afin de subvenir à la demande locale.

Tableau 3: Espèces Animales Disparues à Madagascar

Nom Latin	Nom commun	Taille
Varecia insignis	Lémur	Petite
Varecia jullyi	Lémur	Petite
Hapalemur gallieni	Lémur	Petite
Megaladapis madagascariensis	Lémur	Grande
Megaladapis grandidieri	Lémur	Grande
Megaladapis edwardsi	Lémur	Grande
Mesopropithecus pithecoides	Lémur	Petite
Mesopropithecus globiceps	Lémur	Petite
Palaepropithecus insignia	Lémur	Grande
Archaeoindris fontoynonti	Lémur	Grande
Archaeolemur major	Lémur	Moyenne
Archaeolemur edwardsi	Lémur	Moyenne
Hadropithecus stenognathus	Lémur	Moyenne
Daubentonia robustus	Lémur	Petite
Hippopotamus lemerlei	Hippopotame pygmé	
Mullerornis	Petit oiseau éléphant	
Aepyornis maximus	Oiseau éléphant	
Geochelone (Testudo) grandidieri	Tortue géante	
Geochelone (Testudo) abrupta	Tortue géante	

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Tailles:	Grande: environ la taille d'un chimpanzé ou plus grande, Moyenne: environ la taille d'un petit babouin, Petite: équivalent ou plus grand lemur existant à Madagascar ou un peu plus grand.

PATURAGE DU BETAIL

Le bétail menace la régénération des forêts, modifie les sous-bois et dans certaines réserves cause de sérieux dommages aux espèces de plantes.

COMMERCE

La plupart du commerce concerne les reptiles, les oiseaux et les plantes. Six espèces de Gecko (Phelsuma) ont été exportées en 1985. Bien plus de 1000 de chaque de ces espèces ont été capturées: P. lineata, P. quadrocelata, P. laticaudata, et P. madagascariensis, et 100 de chacune de ces deux espèces: P. serauticauda et P. flavigularis. Plus de 1000 Chamaeleo laterales ont été exportés en 1985 ainsi que 320 C. parsonii. 145 crocodiles vivants ont été également vendus en 1985. Des milliers de perroquets (Agapornis cana, Coracopsos vasa et C. nigra) ont été exportés la même année. Les plantes lesplus exportées sont les aloes, Pachypodium sp et Euphorbia sp.. Plusieurs espèces de Lémurs semblent être exportées chaque année dans des instituts de recherche scientifique, la plupart en France et aux Etats-Unis.

ORGANISATIONS DE LA PROTECTION DE LA NATURE

En octobre 1970, une conférence sur la conservation de la nature et des resources naturelles, organisée par le gouvernement malgache et patronnée par diverses organisations internationales, a été tenues à Antananarivo au cours de laquelle des projets ont été introduits pour conserver la faune et la flore d'intérêt particulier de l'île. Une conférence suivante intitulée "Conférence de Madagascar sur la conservation des ressources naturelles au Service du développement", a été tenue en novembre 1985. Son but principal était de développer des projets pour les ressources internationales, dans le cadre d'une stratégie de conservation nationale. L'accent a été mis sur les régions protégées, en particulier sur la nécessité de faire un inventaire biologique sur la totalité des régions protégées déjà existantes et des recherches concernant la façon dont leur valeur pourrait être reconnue par les indigènes locaux.

Entre ces deux conférences, en juin 1979, un décret a été issus, autorisant l'etablissement d'un représentant de WWF à Madagascar (Mr Barthelemi Vaohita) afin de promouvoir la protection de la nature. Jusqu'en 1986, ce projet a été concentré sur l'education et l'opinion publique et dans une moindre mesure sur l'installation de champs d'activités. Il y a maintenant deux representants de WWF de plus dans le pays, qui sont particulièrement interésés par les régions protégées. Ils sont responsables du projet majeur de WWF qui à commencé en septembre 1986 avec pour objectif d'évaluer le status et les besoins des aires protégées

déjà existantes, et d'identifier plus de sites avec une biologie exceptionnelle ayant une certaine importance pour la création de nouvelles aires.

L'agence gouvernementale principale concernée par la protection de la nature est la Direction des Eaux et Forêts, qui dépend du Ministère de la production animale (élevage et pêche) et des Eaux et Forêts.

Il ya plusieurs agences non-gouvernementales à Madagascar:

L'Association pour la Sauvegarde de l'Environnement, à Antsiranana, qui s'occupe des campagnes concernant la protection du Parc National de la Montagne d'Ambre.

L'Associtation des Amis des Réserves d'Andasibé, rattachée précédemment avec les représentants de WWF à Anatananarivo, afin de protéger Perinet.

L'Association pour la Protection de la Nature à Toamasina.

L'Association pour la Compréhension et la Protection de la Nature à Madagascar.

Plusieurs pays ont fourni de l'aide à Madagascar pour protéger ses forêts. Ceux-ci sont les suivants:

FRANCE	Formation de gestionnaires et de main-d'oeuvre de scieries.
	Projet de recherche forestiere générale
Rép Féd d'Allemagne	Programme de reboisement en préparation.
Suisse	Support aux forêts de l'ESSA.
	Villages de forêts aux sources d'eaux autour d'Antanarivo.
	Assistance au CFPF (Centre de Formation Forestière), Morondava: déboisement, scierie et gestion forestière.
	Protection et gestion de la forêt côtière orientale.
UNDP	Réabilitation/développement de Savoka (phase 2): exécutée par la FAO.
	Etude de la possibilité sylvo-industrielle du Haut Manjoro (Phase 2, exécutée par la FAO)
WFP	Développemnt forestier et régional reboisement, protection de la forêt et maintenance de la réabilitation de Savoka.
Banque Mondiale	assistance de prêts pour l'établissement et la gestion de plantations de pins à Manjoro, comprenant l'utilisation d'engrais.

Jardins Botaniques du Missouri	Supportés par la Fondation W. Alton Jone et travaillant en proche coordination avec le Parc de Tsimbezaza. Le focus du programme est l'exploitation botaniques générale de régions sous-répértoriées et la production d'un inventaire de la flore, l'un des buts pour lequel il aidera le gouvernement à planifer les priorités de protection.
WWF/IUCN	Surveillance continue et formation. WWF à un nombre de projets à Madagascar comprenant:

1) La Protection et la Gestion de la Réserve d'Ankarafantsika.

2) Une Etude et un Inventaire de la flore de la forêt d'Ambohitantelt.

3) L'Etude et la Protection du aye-aye sur l'île de Madagascar.

4) La Gestion du Parc National de la Montagne d'Ambre.

5) Un programme de Conservation de la zone méridionale de Madagascar.

6) Gestion des Régions protégées.

7) Promotion de l'Education et de l'Information de la Protection de la nature.

LEGISLATION

Législation des Espèces

Celle-ci est basée premièrement sur la Convention de Londres de 1933 par Ordonnance n° 60-126 du 03/10/60. La faune a été divisée en trois catégories: (protégée, gibier ou nuisible, voir tableau n°4) et est maintenant sous la contrainte d'une série de dispositions contrôlant la chasse et la pêche. Certaines espèces peuvent être capturées pour but commercial, d'autres seulement sous circonstances "exceptionnelles". Une telle exploitation est contrôlée par des Décrets (surtout le n° 61-093) qui indiquent les moyens, le moment et la région ou la capture peut avoir lieu. La capture à but scientifique est contrôlée par le Décret 71-006 et est généralement autorisée sur payment d'une taxe proportionnelle à la valeur scientifique de l'espèce concernée. Il y a des restrictions concernant les lémurs gardés en captivité (Décret n°62-020). Les papillons sont les seuls invertébrés sous protection. Ceux-ci ne peuvent être collectionnés, vendus ou exportés sans permis (Décret n°69-085)

Aucune plante ou graine ne peuvent être exportées sans autorisation, et ceci est très en vigueur et comprend la collection de graines pour des études botaniques.

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Tableau 4: Liste d'Espèces Protégées et Nuisibles à Madagascar

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Espèces citées comme protégées par le Décret n°61-096

Mammifères:
Tous les Lémurs
Dugong dugon
Fossa fossa
Cervidae (espèces introduites)

Oiseaux:
Egretta gazetta dimorpha (appelé maintenant E. dimorpha)
Egretta alba melanorhynchus
Ardeola (Bubuculus) ibis ibis
Phoenicopterus ruber (appelé maintenant P. roseus)
Phoenicopterus minor
Lophotibis cristata

Serpents:
Testudo yniphora (maintenant Geochelone yniphora)
Testudo radiata (maintenant Geochelone radiata)
Acrantophis dumerii
Acrantophis madagascariensis

Poissons:
Typhleotris pauliani
Typhleotris madagascariensis

Espèces nouvellement introduites, notamment le cerf.

Espèces citées comme nuisibles par Décret n°61-096

Mammifères:
Felis ocreata (Felis libyca)
Galidictis striata
Potamochaerus larvatus (P. porcus)
Pteropus rufus

Oiseaux:
Tous les Faucons, Butors, Astur
Milvus migrans
Foudia madagascariensis
Ardea purpurea
Ardea cinerea
Corvus albus
Coracopsis
Milvus parasitus

Reptiles:
Crocodylus nilotica (C. niloticus)

Tout animal non-cité comme protégé ou nuisible est décrété espèce de gibier.

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Conventions Internationales

Madagascar a signé ou ratifié les traités internationaux suivants et les conventions concernées sur la Protection de la Nature:

1) Convention de l'Héritage mondial ratifié le 06/02/63

2) La Convention de Bonn sur les espèces migratoires, signée mais non ratifiée.

3) La Convention Africaine de 1933 ratifiée le 09/10/69.

4) La Convention sur le Commerce Internationale d'Espèces menacées de Faune et de Flore sauvages(CITES) ratifiée le 18/11/75.

Un nombre de sites ont été proposés comme sites d'Héritage mondial mais seulement l'un d'eux, Tsingu de Bemaratra, a été officiellement nommé et est actuellement sous considération.

La Convention de Bonn ne comprend pas de nombreuses espèces trouvées à Madagascar. Celles trouvées à Madagascar sont le Dujong dugong, les flamants roses, les tortues et tortues de mer.

La faune et la flore suivante qui se reproduit à Madagascar est citée dans les Annexes de CITES

	Annexe I	Annexe II
Mammifères:	Tous les Lémurs Dugong dugon Eupleres major Fossa fossa	Cryptoprocta ferox Eupleres goudotii
Oiseaux:	Tyto soumagnei Tous les Falconformes Tous les Psittaciformes Strigiformes	Anas bernieri
Amphibiens:	Dyscophus antongilii	
Reptiles:	Tous les Cheloniidae Geochelone radiata Geochelene yniphora Acrantophis spp. Acrantophis spp. Sanzinia madagascariensis	Phelsuma spp Chamaeleo spp Testudinidae (sauf ceux en Annexe I) Crocodylus niloticus avec un quota de 1,000 peaux authorisee par an
Plantes:		Pachypodium spp Cactaceae Cyatheaceae Didieraceae Euphorbia spp Aloe spp Orchidaceae Nepenthes spp

Espèces en voie de disparition

(La plupart sont sur la Liste Rouge de l'IUCN de 1988)

Oiseaux:

K	Tachybaptus pelzelnii	Grèbe malgache
E	Tachybaptus rufolavatus	Grèbe roussâtre
K	Ardea humbloti	Héron de Humblot
V	Anas bernieri	Sarcelle de Bernier
E	Aythya innotata	Fuligule de Madagascar
E	Haliaeetus vociferoides	Pygargue malgache
E	Eutriorchis astur	Serpentaire de Madagascar
R	Mesitornis variegata	Mésite variée
R	Mesitornis unicolor	Mésite unicolore
R	Monias benschi	Mésite monias
I	Sarothrura watersi	Râle de waters
K	Amaurornis olivieri	Marouette d'Olivier
R	Charadrius thoracicus	Pluvier à bandeau noir
Ex	Coua delalandei	Coua de Delalande
I	Tyto soumagnei	Effraie jaune
R	Brachypteracias leptosomus	Brachyptérolle leptosome
R	Brachypteracias squamigera	Brachyptérolle écaillé
R	Atelornis crossleyi	Brachyptérolle de Crossley
R	Uratelornis chimaera	Brachyptérolle à longue queue
I	Neodrepanis hypoxantha	Philépitte de Salomonsen
R	Phyllastrephus apperti	Bulbul d'Appert
R	Phyllastrephus tenebrosus	Bulbul obscur
R	Phyllastrephus cinereiceps	Bulbul à tête noire
R	Xenopirostris damii	Vanga de Van Dam
I	Xenopirostris polleni	Vanga de Pollen
K	Monticola bensoni	Merle de roche de Benson
I	Crossleyia xanthophrys	Oxylabe à sourcil jaune
I	Newtonia fanovanae	Gobe-mouches de Fanovana

Mammifères
Primates

R	Mirza coquereli	
E	Allocebus trichotis	Allocèbe
K	Phaner furcifer	Phaner
K	Hapalemur griseus	Hapalémur gris
E	Hapelemur simus	Grand Hapalémur
I	Hapelemur aureus	
K	Lemur catta	Maki catta
K	Lemur coronatus	
E	Lemur macaco flavifrons	
V	Lemur macaco macaco	Lémur macaco
V	Lemur mongoz+	Lémur mongoz
I	Lemur rubriventer	Lémur à ventre roux
K	Lepilemur dorsalis	Lépilémur
K	Lepilemur edwardsi	Lépilemur
K	Lepilemur leucopus	Lépilemur
K	Lepilemur microdon	Lépilémur
K	Lepilemur mustelinus	Lépilémur
K	Lepilemur ruficaudatus	Lépilemur

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K	Lepilemur septentrionalis	Lépilemur
I	Varecia variegata	
K	Avahi laniger	Avahi
E	Indri indri	Indri
V	Propithecus diadema	Propithèque à diadème
K	Propithecus verreauxi	Propithèque de Verreaux
E	Daubentonia madagascariensis	Aye-aye

Carnivores:

K	Cryptoprocta ferox	Fossa
V	Eupleres goudotii	Falanouc
V	Fossa fossana	Genette fossane
I	Galidictis fasciata	Galidie rayée
V	Mungotictis decemlineata	Galidie à bandes étroites
K	Salanoia concolor	Galidie unicolore

Chauves-souris:

K	Myzopoda aurita	

Insectivores:

K	Geogale aurita aurita	Tenrec
I	Geogale aurita orientalis	"
V	Limnogale mergulus	"
K	Microgale brevicaudatus	"
K	Microgale crassipes	
K	Microgale drouhardi	"
K	Microgale longicaudata	"
K	Microgale longirostris	"
K	Microgale majori	"
K	Microgale melanorrhachis	"
I	Microgale occidentalis	Tenrec
K	Microgale parvula	"
K	Microgale principula	"
K	Microgale prolixicaudata	"
K	Microgale sorella	"
K	Microgale taiva	"
K	Microgale thomasi	"
K	Microgale (leptogale) gracilis	"

Sirenia:

V	Dungong dugon*	Dugong

Reptiles:

I	Erymnochelys madagascariensis	Tortue
V	Geochelone radiata	
E	Geochelone yniphora	
I	Pyxis arachnoides	
I	Pyxis planicauda	
K	Acrantophis dumerili	
K	Acrantophis madagascariensis	
V	Crocodylus niloticus*	Crocodile du Nil

V	Caretta caretta*	Tortue
E	Chelonia mydas*	"
E	Eretmochelys imbricata*	"
E	Lepidochelys olivacea*	"

Insectes:

I	Isoma hieroglyphicum	Demoiselle
I	Libellulosoma minuta	Demoiselle
R	Papilio mangoura	Papillon
R	Papilio morondavana	"
R	Amauris nossima+	"
I	Antanartia borbonica*	"
R	Apaturopsis kilusa	"
R	Apaturopsis pauliani	"
R	Charaxes cowani	"
R	Euxanthe madagascariensis	"
I	Hypolimnas dubius drucei*	"
R	Neptis metella gratilla	"
R	Neptis sextilla	"
I	Salamis angustina*	"
I	Salamis angustina angustina*	"
R	Smerina manoro	"
R	Acraea hova	"
R	Acraea sambavae	"

* Trouvé à l'exterieur de Madagascar + Trouvé sur l'Ile de Comores aussi

Poissons identifies comme pouvant être menacés mais non désignés officiellement par l'IUCN:

"Hautement menacés: Ptychochromoides betsileanus	Oxylapia polli
"Rares" Oryzias madagascariensis Pachypanchax playfairi Rheocloides pellegrini Typhleotris madagascariensis Typhleotris pauliani	Acentrogobius therezieni
"Vulnérables" Paratilapia dami Paratilapia kieneri Paratilapia maculatus Paratilapia petiti Ptychochromis oligacanthus	Paratilapia polleni

Plantes:

Catharanthus coriaceus (dans le livre d'information de plantes rouge de l'UICN, 1978).

La forêt primaire humide de basse altitude de l'est de Madagascar recouvrait jadis toute la région située sur la côte jusqu'à une altitude de 800 m. Cette région est caractérisée par une forte pluviométre qui

varie entre 2000 et 3000 m. La futaie est haute de 25 à 30 mètres et elle ne possède pas d'arbres immenses. Les palmiers sont abondants et les bambous sont disséminés dans les divers étages de la forêt. Les épiphytes sont abondantes et leur nombre s'accroît avec l'altitude. Ce type de forêt est très riche en espèces et la composition de ces dernières varie.

La forêt dense humide de montagne recouvre les régions entre 800 et 1300 m d'altitude. La futaie est haute de 20 à 25 mètres. Les épiphytes, en particulier les lichens et les mousses, sont abondantes. La diversité des espèces est aussi riche à cette altitude qu'à une altitude plus basse.

La forêt dense sclérophylle de haute altitude se rencontre entre 1300 et 2300 m d'altitude. La futaie est basse entre dix et 13 m. Les bryophytes et les lichens y sont abondants ainsi que les nombreuses mousses recouvrant le sol de la forêt.

Clef des catégories de la liste Rouge d'Information de l'IUCN

Ex: éteintes

E: en danger. Espèces en voie de disparition et dont la survie n'est pas possible si les facteurs qui causent ce danger continuent.

V: vulnérble; espèces allant sûrement dans la Catégorie en Danger dans le futur proche si les facteurs de destructions ne cessent pas.

R: rare; espèces en petit nombre de populations qui ne sont pas pour le moment en danger ou vulnérables mais qui sont à risque.

I: indéterminé; espèces appartenant à l'une des catégories précédentes mais il n'y a pas assez d'information afin de déterminer quelle catégorie est appropriée.

K: insuffisamment connue, espèce soupçonnée d'appartenir à l'une des catégorie ci-dessus mais sur laquelle on n'a pas assez d'information sur le moment.

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demands than do the villages south of the Ankarana. The natural environment is also significantly different between the two regions. Amber Mountain is covered mostly with rain forest. Ankarana is near dry lowland tropical forest.

We found that in both Ankorefo and Bemanevika (west of Amber Mountain) and Antsambalahy (south of Ankarana), the average number of people per household is 4 to 5. In Ankorefo and Bemanevika, however, each household uses three huts: one as a bedroom, one as a kitchen, and one as a granary. In Antsambalahy, by contrast, most households own 1-2 huts, since they farm less rice and have less of a need for a granary (Antsambalahy produces less than 70% of the rice produced by Ankorefo and Bemanevika).

In terms of population density in 1966, Antsambalahy was more densely populated. There were 5-10 people per square kilometer there, compared with 2-5 in Ankorefo and Bemanevika (see Figure 4). Between 1950 and 1991, Antsambalahy grew significantly. In 1950, only the northern third of the village area of 1991 was inhabited (Antsambalahy has three separate sections, see Figure 14). Ankorefo and Bemanevika grew also, but less dramatically. The population estimates for these villages in 1991 are 1186 for Antsambalahy, 322 for Ankorefo and 350 for Bemanevika.

In this project we investigated the use of remotely-sensed products to give us cultural information. In rural Madagascar, people generally live in small huts. A village may contain from 50 to 200 huts. Hut roofs are generally made of organic thatching (Figure 13A), but are replaced by corrugated "tin" roof when they can be purchased. The number of huts in a village can be counted from aerial photographs. We counted the number of huts in 17 villages in the study area and determined the number of organic and tin roofs present (Table 1). We could also map the size (hectares) of the villages as well as the number of roads running into each village (Figure 14). This information can be compared to population estimates derived by WWF personnel during village visits (Table 1).

We noticed a strong relationship (Figure 14B) between the number of huts and the cleared area encompassing the village. Only two village plot off the main trend. Tsarakibany was unique in its high density of huts and Ambatoranana had a lower density of huts probably due to the presence of more civic buildings. This result is encouraging because village area can probably be measured using SPOT satellite images as well as aerial photographs.

Villagers usually sweep litter from between the huts to prevent the presence of insects and scorpions. Thus the villages show bare ground not usually present in the natural environment and spectrally distinguishable in SPOT multispectral images (Figure 13B). Villagers also plant trees around the village perimeter for food and materials. This ring of trees provides a sharp and high contrast edge between the village and the surrounding terrain. Thus the village can be located and the village size can be determined using satellite images. This preliminary analysis suggests that satellite images can be used as a surrogate measure of population density in rural Madagascar. SPOT panchromatic images may be useful in mapping road networks as well.

We also noted (Figure 14C) a significant drop in the area of a village with the distance to the nearest large city (Antsiranana and Ambilobe). Beyond a distance of 40 km village size seemed to be unaffected by large cities. The number of roads leading into a village similarly increases with proximity to a large city (Figure 14C). Thus fundamental structural elements of a village (Antsambalahy for example) attest to its connection with larger economic structures (national or international) and these connections can be identified through remotely sensed images.

The scatter plot (Figure 14D) has the number of huts in a village plotted against the estimated population. There is a general positive correlation, although some villages fall below the relationship shown (dotted line). A hut's roof material can also be determined from aerial photos and is given in Table 1. The percent "tin" roofed huts is shown on the scatter plot by x-error bars. The larger the bar, the higher the percentage of "tin" huts. Nearly all of those villages falling below the positive relationship have a high percentage of "tin" roofed huts. This may be explained by a process in which organic huts are replaced by tin- roofed ones at a less than one to one ratio. One tin-roofed hut may replace two or more organic roofed ones. The number of roads entering a village can also be determined by photo interpretation and is indicated by y-error bars. The larger the number of roads, the larger the error bar.

ECONOMIC INFORMATION

We found the economic base of a given area to vary widely. The people of Ankorefo and Bemanevika are subsistence rice farmers and cattle herders. They sell some of their rice for cash, but only enough to cover their primary needs (to buy kerosene, soap, salt, sugar). In Antsambalahy, however, people grow much less rice (an average annual production of 93.1 dabas of rice in Antsambalahy--a daba is 30 liters--versus 135.4 dabas in Ankorefo and Bemanevika.). Substituting for rice production is cash crop production. They grow mostly sugar cane, but more people are turning to cotton. Just under 30% of the households in Antsambalahy reported they grow sugar cane as their main cash crop. Only 18% of households never or rarely buy rice. 63% must buy rice during 1 to 4 months of the year, when their stored rice runs out before the next harvest. In Antsambalahy people also herd cattle, but not as many as in Ankorefo and Bemanevika. There is less pasture land available around Antsambalahy than around Ankorefo and Bemanevika.

Because of cash cropping, Antsambalahy is much more connected to the world cash economy than Ankorefo and Bemanevika are. The people of Antsambalahy rely more on cash earnings for the necessities of life. They are more susceptible to national and world market fluctuations (i.e., in the price of sugar and cotton). There is some evidence of socioeconomic differentiation in Antsambalahy. About a third (32.4%) of its households hire seasonal wage laborers to help with cash crops. In Ankorefo and Bemanevika, by contrast, although many peasants are in sharecrop relationships with land owners, none receives a cash wage from the landowner. Therefore, both village areas have social stratification, with a few people owning much more land than others, but there are different modes of production in each. Another indication of social stratification is that our socioeconomic status index showed 20% of the households to be in the lowest socioeconomic category, with only

Appendix E: FAO Forestry Report

Madagascar section of the 1990 FAO Forest Resources Assessment Project Report.

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MADAGASCAR

Les tableaux suivants résument les résultats standardisés qui sont incorporés dans la base de données mondiale.

Tableau 1 • Etat de l'inventaire du couvert forestier

Année de référence	Surface couverte	Classe de fiabilité	Source
1957	Complète	(2)	(1)
1957	Complète	(2)	(2)
1973-76	Complète	(2)	(3)

Classes de fiabilité:

(1) Fiabilité élevée: inventaires forestiers basés sur des images satellite à haute résolution (LANDSAT TM, SPOT) ou des photographies aériennes complétées par des vérifications au sol nombreuses ou par échantillonnage.

(2) Fiabilité moyenne: inventaires forestiers basés sur des images satellite à moyenne résolution (typiquement LANDSAT MSS) avec des enquêtes de terrain limitées.

(3) Fiabilité faible: cartes ou enquêtes forestières basées sur une documentation hétérogène telles que cartes de végétation, enquêtes d'occupation du sol, etc. généralement à faible résolution et très souvent anciens. Cette classe est synonyme d'information insuffisante et implique la nécessité d'une base d'information fiable dans le futur.

Commentaires du tableau 1

(1) "Carte internationale du tapis végétal et des conditions écologiques, Madagascar", 1965, réalisée par l'Institut de la carte internationale du tapis végétal, le Centre national de la recherche scientifique et l'Office de la recherche scientifique et technique outre-mer (ORSTOM). Cette carte a été faite à l'échelle du 1:1 000 000 à partir de photographies aériennes, prises en 1957.

(2) "Carte pour l'évaluation de l'exploitabilié des forêts", 1972, élaborée par la République Malgache, le Programme des Nations Unies pour le développement (PNUD) et l'Organisation des Nations Unies pour l'alimentation et l'agriculture (OAA) dans le cadre du projet " Inventaire et mise en valeur de certaines perimètres forestières". La carte a été faite par l'interprétation de photographies aériennes de 1957.

(3) Faramalala Miadana Harisoa, "Carte des formations végétales de madagascar", 1988. Cette carte a été élaborée à l'échelle du 1:1 000 000 à partir des images LANDSAT MSS prises durant la période 1973-76.

(4) L'année de référence se rapporte à la date d'enregistrement des données de base ou des images satellite utilisées pour l'inventaire, non pas à la date de la compilation des données.

(5) Les cartes/inventaires indiqués en caractères gras ont été utilisés comme données de base dans le processus de modélisation et d'estimation

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Tableau 2 • Données de base du couvert forestier en correspondance avec la classification du Projet d'évaluation des ressources forestières 1990
(surfaces en milliers d'hectares)

Année de référence	Unité sous-nationale	Superficie totale	Surface du couvert forestier	Surface des jachères
1973	Antsiranana	4 376.9	2 431.4	586.4
1973	Mahajanga	15 407.9	4 198.6	637.3
1973	Anatanarivo	5 933.1	1 436.4	21.0
1974	Toamasina	7 388.7	3 186.9	1 510.3
1976	Toliary	16 514.7	4 176.0	1 065.6
1976	Fianarantsoa	10 150.4	2 413.9	1 614.5
	Ensemble du pays	59 771.7	17 843.2	5 435.1

Données de surface ont été prises des cartes/inventaires de base

Tableau 3 • Surface rapportée des plantations forestières
(surfaces en milliers d'hectares)

Surface rapportée des plantations: 1980	Surface rapportée des plantations: 1990	Changement annuel de la surface des plantations: 1981-90	Taux de changement annuel (%) des surfaces des Plantations: 1981-90
266.0	310.0	+4.4	+1.7

La formule de l'intérêt simple a été utilisée pour estimer le taux de changement annuel

Commentaire du tableau 3

Les surfaces rapportées des plantations sont basées sur les estimations par pays issues des Commissions forestières régionales de l'OAA, du 10e Congrés forestier mondial ou d'autres documents se rapportant aux pays. Les estimations sont utilisées sans ajustement quand elles se rapportent aux années 1980 et 1990. Dans le cas contraire les résultats standardisés sont obtenus par une procédure d'ajustement basée sur les tendances des surfaces des plantations dans les pays.

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Tableau 4 • Résultats standardisés
(surfaces en milliers d'hectares)

Surface des terres	Surface estimée du couvert forestier 1980	Surface estimée du couvert forestier 1990	Changement annuel estimé de la surface du couvert forestier: 1981-90	Taux de changement annuel (%) estimé de la surface du couvert forestier: 1981-90	Fiabilité de l'évaluation des changements
58 154	17 128	15 782	-134.6	-0.8	(3)

Classes de fiabilité:
(1) Fiabilité élevée: cette classe est attribuée aux pays pour lesquels deux inventaires forestiers comparables (en termes de classification des types de forêt) ou plus existent et le taux de changement observé du couvert forestier est utilisé pour ajuster le modèle aux conditions locales.

(2) Fiabilité moyenne: cette classe est attribuée aux pays pour lesquels des données multi-date fiables mais incomplètes existent. Les taux de changement observés sont utilisés pour vérifier les estimations issues du modèle.

(3) Fiabilité faible: cette classe est attribuée aux pays pour lesquels il n'existent pas de données multi-date fiables. Les taux de changement sont calculés en utilisant le modèle sans possibilité de vérification préalable.

Commentaires du tableau 4

(1) Les résultats standardisés sont destinés aux estimations au niveau mondial et sont obtenus en utilisant les données de base et une procédure d'ajustement (voir page xvii). Les chiffres seront actualisés régulièrement lorsque de nouvelles données de bases seront disponibles.

(2) Il faut remarquer que les valeurs calculées de surface du couvert forestier et de changement du couvert forestier se rapportent aux forêts d'origine naturelle. La substitution des forêts naturelles par des plantations est calculée en diminuant la surface du couvert forestier naturel par la surface des plantations et en augmentant la surface des plantations par la même quantité. Tenant compte de cette procédure, le taux de déforestation devrait être considéré ensemble avec le taux de changement des surfaces des plantations pour obtenir un idée complète du taux de changement de la surface du couvert forestier.

(3) Surface des terres issue de l'Annuaire de la production de l'OAA, Vol. 45. La surface des terres exclue les surfaces des eaux à l'intérieur des pays. La surface des terres additionnée à la surface des eaux intérieures correspond à la superficie totale.

(4) La formule de l'intérêt simple a été utilisée pour calculer le taux de changement annuel en surface du couvert forestier pour la période: 1981-90

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Appendix F: CIESIN Pilot Project Report

Green, Glen, Lisa Gezon, and Conrad Kottak. 1991. "Deforestation and the Human Role in Environmental Change in the Amber Mountain and Ankarana Regions of Madagascar."

This is a summarized portion from:

Kottak, Conrad P., "Final Report of the CIESIN Pilot Project: An Integrated Approach to Deforestation, Conservation, and Development in Madagascar Using Satellite Images". U. of Michigan.

SUMMARY:

The main goal of this pilot project has been to field test CIESIN's goals of integrating human and natural science methods, using remotely sensed images, in a comprehensive study of deforestation. The focus of our multidisciplinary team (anthropology, remote sensing, geography, biology, natural resources, public health) is the human dimension of environmental change. We are looking at its extent, nature, and causes and seeking suggestions for remedial action.

Today Madagascar is suffering from massive forest degradation. To protect biodiversity, scientists and policy makers must understand why deforestation occurs. To conserve forests and their endangered species, policy makers are supplementing traditional conservation practices (parks, reserves, enforcement and punishment) with measures that systematically consider the needs, wishes, and abilities of the people living in forested habitats.

Our pilot project focused on northern Madagascar, where we found that cash cropping, by placing significant external pressure on the land, has been the major cause of forest depletion. Our project worked in collaboration with a major WWF conservation project focusing on Amber Mountain and Ankarana massif. This region includes a variety of forest types, dynamics of deforestation, and social settings.

Consulting with WWF, we used satellite images and aerial photos to choose four sites (village clusters) for our integrated research. WWF had hired 3 Malagasies to be trained by us, eventually to do socioeconomic interviews in all the village clusters around the protected areas. Our 1991 field work allowed us to test a series of integrated-science hypotheses about the causes of deforestation. Our integrated perspective systematically cross-checked views from above (satellite images and aerial photos) and below (biotic and socioeconomic ground-truthing). We learned that many kinds of human traces and human dimension data are visible in remotely-sensed images of Madagascar. These include settlements of different size and function; subsistence and cultivation patterns; water availability; relative wealth of settlements; quality of infrastructure; links to markets; and migration trends.

Our research paints a varied picture of the causes of deforestation and environmental change and reveals some interesting results. Deforestation for fuel wood and for upland rainfed (slash and burn) subsistence agriculture is minimal in the areas studied. Forest clearing to convert land to irrigated rice subsistence agriculture has destroyed some forest. However the largest causes of deforestation are ultimately external driven, largely by commercial agriculture and commercial timbering. The largest area of forest lost (600 ha) is from riverine forest south of Ankarana and is driven largely by conversion to sugarcane and cotton production to fill external markets. This cutting may have resulted in the sudden migration of the Mananjeba river which formerly flowed through a cave in the Ankarana massif the home to endangered alligators. This cave is now filling with sediment making the alligators accessible to hunting. Severe erosion has also resulted from this recent river migration.

The Amber Mountain rainforests have also been impacted by deforestation but to a lesser amount (200 ha). In this case selective commercial cutting appears to have weakened the structure of the forest sufficiently to allow much of it to be blown down in a cyclone in 1984. These damaged forests have since repeatedly burned and have now converted to secondary grasslands. This past deforestation and commercial selective cutting currently taking place on the west side of Amber Mountain threatens water production in the watersheds of both Ankorefo and Bemanevika.

Invasion of forest and savanna by the exotic Lantana camara has caused the loss of 450 ha., a greater aerial extent than that forest lost to deforestation. This plant may be the largest single threat to the biodiversity of the region.

Loss of forest due to burning of adjacent grassland appears to be minimal, but policies designed to halt burning have alienated and criminilized local people, adversely affecting conservation and developement plans.

Efforts at conservation and development must address the needs and concerns of the local people. Field research, combining integrated qualitative and quantitative methods, is indispensable for a synoptic understanding of environmental change. Decision makers may benefit from future collaboration such as that described here. The knowledge gained by transfers in both directions may help to achieve culturally appropriate goals for sustainable conservation management.

Our links with WWF, IUCN (the International Union for the Conservation of Nature), USAID, the World Bank, and institutions in Madagascar illustrate our continuing impact on policy-makers. For the most effective policy impact, there is need for long-term collaboration between policy-oriented scientists and decision makers. We hope to continue to monitor global change issues in Madagascar and to build on the user-driven data collection arrangement we have established there. Based on this pilot project we make some suggestions regarding the human dimension of global environmental change.

INTRODUCTION

The main goal of this project has been to field test the workability of integrating human and natural science disciplinary methods, using satellite images, in a comprehensive study of the process of deforestation. We also aimed at pinpointing effective means of transferring the knowledge we gained to international, national, and local policy makers. The focus of our multidisciplinary team (anthropology, remote sensing, geography, biology, natural resources, public health) is the human dimension of environmental change. We are looking at its extent, nature, and causes and seeking suggestions for remedial action to guide Malagasy and international policy makers.

In our attempt to integrate research in the human and natural sciences, we combined the study of forest distribution and human socioeconomic characteristics. Mapping vegetation types and the extent of forest change is important for understanding the controls on deforestation as well as determining which species are endangered and which may be spreading. The study of socioeconomic variables is necessary to determine the human uses of forested and deforested land and the indigenous use of forest products. This is important for understanding the human role in biodiversity change and its link to deforestation rates.

Information on local social, political and economic arrangements will facilitate the transmission of knowledge to policy makers concerned with protecting biodiversity. This should increase their sensitivity to local concerns and understand indigenous decision-making processes, incentive structures, environmental awareness, risk perception and aversion.

Field work was begun in the summer of 1991 in collaboration with the staff of the WWF project "Projet Complex des Reserves de la Montagne d'Ambre" (Integrated Project for the Amber Mountain Forest Reserves) located in the northern city of Antsiranana. Together we examined satellite images and aerial photos and mutually agreed on four sites where integrated research on environmental change was needed. These areas included the villages: 1) Ankorefo, 2) Bemanevika, 3)Marovato, and 4) Antsambalahy and their surroundings. We generated a questionnaire to be filled in (by our team, working with the WWF staff and trainees) in these four research areas. We tested it and revised it before conducting our research.

We spent approximately a week in the field conducting research in each village (fokontany). We began by introducing ourselves to the village authorities and explaining our project to them. Green and Gezon worked together in the same village area, sharing our individual results each day. While Gezon spent most time within the villages, Green (accompanied by a Malagasy translator and guide) did ground truthing in the surrounding countryside and forest. Interviews were conducted about changes in forest and agricultural practices when the opportunity arose.

Toward the end of the first week, a three-person team hired by the WWF arrived to be trained by us to collect socioeconomic data for the WWF project and to translate. From then until the end of our research, they joined our team. We thus conducted intensive user-driven research during our entire stay in Madagascar. After completing the first two weeks of research, we

returned to Antsiranana to compile our findings. Our approach to this interdisciplinary research has been to maintain contact between investigators at each important step of the research. We worked together closely during data collection and analysis. We found this to be a highly satisfactory approach to integrated research.

STUDY AREA

The study area comprises the northern tip of the island of Madagascar, with the Indian Ocean to the east and the Mozambique Channel to the west (Figure 1). The villages surveyed lie to the west of the major north-south roadway serving the north of Madagascar--Route National 6. They are located on secondary roads that lead to Antsiranana (Diego Suarez) in the north and Ambilobe in the south; these are the largest cities in the study area. While Route National 6 is paved, these secondary roads are unmaintained dirt. They are impassible throughout much of the wet season (Northern winter months). The villages surveyed are positioned along the secondary roads from 22 to 72 kilometers from the large cities. Because of the bad road conditions they are progressively more isolated from the large urban centers of the north as distance increases (Figure 1A).

Two large protected areas are found in the study area and form the dominant features in two SPOT satellite images (Figures 1B and C) that cover the study area. Amber Mountain National Park to the north is located in predominantly rain forest lands covering the mountain of Ambohitra (Amber Mountain), a basaltic volcanic construct of Quaternary age (Figure 2). At lower elevations near Amber Mountain (Figure 3), continuous rain forest gives way to a mosaic of grasslands and gallery forests (river valley forests). The villages of Ankorefo and Bemanevika are located at the forest-grassland boundary on the western slopes of the mountain along rivers which drain to the west.

To the south, a sedimentary carbonate unit of Middle Jurassic age (Figure 2) has eroded to a massif dominated by pinnacle karst, much of which is included in the Ankarana Special Reserve. While much of the karst is inaccessible to humans, Ankarana is surrounded by a ring of forests, and several valleys running through the massif contain forest. Riverine forest is also located along the Mananjeba river, which flows to the west north of Ambilobe. At one time this river flowed through a cave in the southern portion of the Ankarana massif itself. The Mananjeba has deposited Quaternary alluvium and residual sands along its flood plain (Figure 2). These soils once supported forest but now are used mainly for cash crop agriculture. The village of Antsambalahy is located south of the Ankarana massif, south of the Mananjeba flood plain. While the region surrounding the villages of Ankorefo and Bemanevika has a low population density, that near Antsambalahy has a higher population density. The flat land that surrounds the Mananjeba and other rivers to the south forms a large delta region, now largely converted to agriculture, maintains a high population density (Figure 4). The diversity of the study area allowed us to study deforestation in different environments (rain forests, dry forests). We could also study different socioeconomic processes (cash cropping, selective lumbering, slash and burn agriculture (forest farming), and sustainable indigenous use).

The people in our northern study area, around the Amber Mountain and the Ankarana Reserve, are mixed ethnically. Near Amber Mountain, as many

as ten ethnic groups may live in a single village. There is no longer a dominant ethnic group. It is commonly believed that the region was historically the domain of the Antakarana. Now, however, there may not even be one Antakarana family in any given village. Many immigrants came to this area in precolonial (19th century) and early colonial times, when the French were developing the nearby urban center, Diego Suarez (now Antsiranana), into a major operational base and port. The French needed workers, and people from all over Madagascar responded to the call. The French encouraged the immigrants to settle in the rural areas around Diego Suarez.

There have been more recent migrations, particularly from the South and the southeast coast (Antandroy, Antemoro, Antaisaka). Facing difficult economic and environmental conditions at home, migrants have sought a better life in the North, Madagascar's most prosperous area. The region around the Ankarana Reserve remains the domain of the Antakarana people, and many land use decisions are made within the context of this traditional indigenous authority. There has been considerable migration from the South into the area because of opportunities in cash-cropping. There is a large sugar company in the vicinity (Sirama) plus some tobacco and cotton buyers. Sometimes immigrants are integrated into the Antakarana polity; sometimes they keep their original ethnic affiliation. These immigrants have been arriving especially since the 1950's, when the sugar company expanded under the French. People work either as wage-earners for company plantations, as share-croppers for local land owners, or as individual growers if they have access to land. Cash cropping is significant in the southern Ankarana region.

METHODOLGY

Our first criterion for choosing the study sites was to sample along the gradient of deforestation amount, that is to study areas that have experienced much deforestation as well as those where little forest has been cut. To see deforestation patterns to first order, we first compared a 1990 SPOT multispectral scene of Amber Mountain at 1:100,000 scale to topographic maps of the same area and scale. These maps are based on the 1950 aerial photographs and are an interpretation from the 1949 photographs of the forest boundaries present at that time. The mapped boundaries were traced onto clear acetate, then overlain onto the SPOT color composite. Because these data sets were at the same scale this comparison could proceed rapidly. Areas involving little change were picked (Bemanevika) as well as those exhibiting greater amounts of change (Ankorefo).

Our strategy was to examine those data sets that were the furthest apart in time, and thus probably showed the maximum amount of change detectable. An aerial survey had been taken at 1:25,000 scale by WWF one month prior to our field work. These recent photos were compared with the oldest forest cover data set available--the 1949-50 1:50,000 photos. Unfortunately the two sets of photos were at different scales, which precluded the direct use of clear plastic overlays. Therefore, by visual inspection, changes were drawn on overlays covering the photos, generally those from 1950. Different color permanent pens were used to delineate areas thought to have undergone deforestation, as well as those of woody growth into the savanna. (Many areas of what first appeared to be forest spread were observed around Amber Mountain; after ground truthing these were determined to be an exotic

invader bush). The use of a small stereo viewer made these comparisons more accurate. These photographs were taken into the field so these areas could be examined directly.

Since we would stay near a village for one week only, the first day or two of which were devoted to meetings with the village President or townspeople, a strategy of extensive reconnaissance ground truthing was adopted over that of intensive measurement at only a few locations. The four or five days available were spent covering as much of the area surrounding the village as possible in day long hikes from camp (located in the village). Green was usually accompanied on these ground truthing trips by his assistant (Jim Yount, a senior student at Macalester College), a local guide knowledgeable in the local vegetation (sometimes a WWF-APN) and a translator--usually one member of the Malagasy socioeconomic team (Figure 5D).

These walks were led by the guide, directed in a general way to an area identified from the remotely-sensed images and photos, such as an area of apparent deforestation. The guide would then choose the route, and in this way a degree of objectivity was achieved in the terrain surveyed. What we viewed would not be biased toward only those features we had identified previously. Often the guides would point out sites they thought were of interest but that were not visible in the images. In this way we detected features we would have known nothing about, nor could we have known would be of interest. Many of these areas were fascinating and very important in determining the face of local change. For example, a major canal diverting a river that flowed into the Ankarana Reserve to rice fields was discovered quite unexpectedly. This canal, by providing more water for irrigation, opened up formerly forested lands to rice cultivation.

Our traverses were mapped on the aerial photographs (1991, 1:25,000) by matching objects visible in the field and those visible in the aerial photos, such as trees, huts, rivers and foot paths. When in the savanna, our exact position could be well maintained. However, when in continuous tree cover a count of our paces was kept to estimate our position on the photos. As we progressed we made notes on the clear acetate covering the 1:25,000 aerial photographs. We gathered information from personal observation, by querying our guide, by comparing the recent and 1950 aerial photographs, and by examining the satellite image products (Figure 5A).

During these trips we would often encounter local people working in their fields or in the forest. We interviewed many of these people on the vegetational changes that had taken place locally, such as clearing of forest or exotic invasion. Questions included plant names, dates of changes, irrigation practices, water availability, weed species and dates of exploitation of wood by commercial timber companies. The remotely-sensed images provided a very important asset as we asked questions. With the images providing a time series into the past, we were not asking questions from complete ignorance. The images gave us a check on the local people's responses. For instance, we could tell that large fields had been cleared between these two dates (image acquisition dates), and we could expect that fact to be corroborated by the interviewee. We could also check people's responses about field size and location. This reliability check showed that (at least concerning the checkable information) the local people interviewed in the field were

generally truthful. This observation was in contrast to some of the results of the village surveys, in which a Malagasy member of our team thought many of the answers were fabricated.

From the ground truthing surveys, we compiled a ground truthing map for the regions we visited surrounding each village (Figure 6). These maps were keyed to the 1:25,000 1991 aerial photographs. The maps included areas of forest cleared between 1950 and present (with the date of clearing); logging roads; areas of cyclone damage and fire damage; new forest in former savanna; invasion by exotics; local names of rivers, roads, forests and places; reserve boundaries; cattle grazing areas; rice fields; and our ground truthing path. Also included was the location of any photograph taken and the direction of the camera.

We acquired photographs (many in stereo) of the terrain and local plants. Plant specimens of important species were collected in the field and later pressed and dried, to be identified to species. Malagasy names of the plant specimens were recorded as well as many of their uses and when they first appeared (for the exotics). Tree cores (for use in later dendrochronology studies) were collected to estimate the ages of certain trees, and their location marked. Transect position was also recorded. The transect method first used proved to be too time- consuming, and a new methodology and rationale was developed.

Lisa Gezon and her WWF associates and trainees collected socioeconomic data using three sets of survey questions. There was one set of questions for household information (e.g., how much land each household owns), one for individual information (e.g., age), and one regarding individuals' perceptions of the environment. The first questionnaire had about 150 questions; the second had 30 questions; and the last had 16 questions. Each interview lasted about one-and-a-half hours and was conducted face-to-face either in the person's home, their rice field, or the central public space.

At the start of the project Gezon led every interview, with the help of a translator. As the WWF team became trained, they would each conduct interviews separately. Gezon would oversee one of them at a time. This made the interviews go faster, since there was no need to translate every word. It also allowed the team to conduct 3-4 times as many interviews. In the first two villages, we only collected information for about 20 households, but we have data for over 80 households from the last village. This could happen because of the intensive on-location training our WWF colleagues received and because they were not hired merely as translators, but as socioeconomic researchers in their own right, with the responsibility and motivation to produce quality results.

After two weeks in the field, we returned to the WWF office in Antsiranana to write village reports. We also revised our questionnaire before conducting the second phase of our data collection in the second two villages. After the first phase of research, we drew up a code book, and so were able to code all our surveys while in Madagascar. We then entered our data into the Foxpro database program and trained the three-person socioeconomic team to use the database software.

We integrated our methodologies during data collection to generate synoptic and synergistic results, accomplishing more than we could have singularly. We mainly accomplished this by conducting our research simultaneously in the same area. While Gezon did socioeconomic interviews, Green ground-truthed the surrounding area. Gezon's surveys included questions related to the state and use of the forest that Green would be able to relate to what he saw on the ground. This process served to cross-check the answers to the surveys. Similarly, Green ground-truthed with the help of a local villager and a translator. He also interviewed local people while ground-truthing. This allowed us to develop histories of specific areas of forest use. We would then have a botanical and a socioeconomic story of the state of the forest. After finishing a day's research, we convened at the camp to share our findings. We then incorporated this information into our research, guiding what to look for and what questions to ask.

ENVIRONMENTAL CHANGE 1950-1991

In the four regions surrounding the village areas surveyed we found different vegetation change processes and different driving forces. Our first communication with the local people in the villages regarding the surrounding natural terrain was in the town meeting called by the president of Bemanevika to discuss the activities of the commercial loggers who had arrived just a few days before and were busy felling the largest trees in the area. We saw trees present two days before being dragged away by tractor (Figures 10C and D). The villagers were concerned that the cutting might endanger their water supply, used for subsistence rice production. Green traced the watershed outline of all lands that feed water for their fields from the 1:100,000 scale topographic map. He overlaid this on the 1:100,000 scale SPOT multispectral scene in which current forest boundaries are visible (Figure 7). We then discussed this product with them (Figure 5B).

While Ankorefo has a large watershed that reaches nearly 10 km. into the Amber Mountain rain forest, the watershed of Bemanevika was much smaller, and the forest cover within that watershed smaller still, yet very important for maintaining water flow during dry months. If water from their watershed diminished, the villagers' rice production would go down. The village rice production already seemed to be water limited, and only by diverting other streams outside their watershed (an act that would anger their neighbors) could they maintain rice production if their water supply diminished.

Ground truthing and interviews with the local people on our surveys led to the discovery of large changes in the vegetation since 1950 on the west side of Amber Mountain (near both Ankorefo and Bemanevika) and in the area south of Ankarana near Antsambalahy. Near Ankorefo and Bemanevika much of the forest has been selectively logged. Villagers' accounts and the presence of large stumps cut decades ago attest to selective cutting in the region since the 1960's. Only the straight trunk of the largest trees were taken, but logging roads were put in to transport the logs to a saw mill in Diego Suarez. The trees were dragged to the roads by a tractor.

While only a small percent of logs were probably removed in relation to the whole forest (only trees over 50cm dbh were removed during our visit, and old stumps suggest a similar selectivity in the past), the adverse effects on

2% in the top category. That indicates a situation in which a few people own significantly more resources than most of the population.

HUMAN DIMENSION OF CHANGE

The two village areas share some similar ecological relationships. For example, the villagers in both rely mainly on wood from the forest for the construction of their homes. They use 5-7" diameter trees for posts, and some cut planks from larger trees. It is generally the Betsileo from the South who are skilled at carving boards out of trees with non-mechanized saws. The villagers all prefer hardwoods. They claim that hardwoods extend the life of the structure. They all use dry fallen wood for fuel, not charcoal or butane. Thus, we found that forest clearing for charcoal is not a threat to the forests in the areas we examined.

There are also differences in the way they use the environment. The most evident is that villagers from Antsambalahy and nearby villages have probably cut down some 600 hectares of forest for agricultural fields. Before 1950, approximately 25% of the forest was cleared for rice fields. But since 1950 with the expansion of the sugar company at Ambilobe (the nearest urban center), local people have cleared an additional 50% of the estimated original extent of this riverine forest for sugar cane and cotton cash crops. They have deforested a large portion of the land that is officially located in the protected reserve area.

We can tell from the aerial photos where the cash-cropped fields are located, by their geometrical shapes (Figure 15). Their borders usually have straight lines, as opposed to the curved lines of subsistence rice fields. This is an artifact of the use of tractors, which cultivate in straight lines. Subsistence rice farmers don't use any form of mechanization, and most do not own a plow. As a result, there is nothing to keep their boundaries from following natural contours. Based on this ground truthing, we can affirm that the difference between mechanized and non-mechanized fields are visible in 1:25,000 scale aerial photographs.

The villagers on the west side of Amber Mountain do not seem to have had a large destructive impact on their environment. Their agricultural practices (irrigated rice) would appear to be sustainable, and the population isn't large enough to put a strain on the forest. Their extraction of trees for house construction is thought to have been minimal. Also, cutting for fuel wood and upland rainfed agriculture also appear to be minimal in the areas studied, collecting dead wood from village and nearby forest is sufficient to supply the current demand. The demand for charcoal in Antsiranana, however, is much larger, and cannot be met by local trees. It appears that this fuel wood comes mainly from the French Mountains to the east of the city.

The threat to the forest in this area is a consequence of commercial logging. Ankorefo has undergone selective logging since early colonial times (ca. 1900). Villagers complained that the loggers took out not only the log they wanted, but that they could also killed a dozen more trees just dragging their tree out. We found that about 200 hectares of forest in Ankorefo have been lost since 1950. This area has been completely converted to secondary grass land. With the help of the memories of the villagers, we put together a story of the history of the forests around the village. The forested land had been

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selectively logged prior to having been blown down by a cyclone. It was probably vulnerable primarily because it had been selectively logged along a ridge top. With the logging road located on a ridge, the cyclone winds hit the logged forest particularly hard. Thus, we saw that the harm to the environment may happened in stages. It was neither solely a long-term gradual process, nor was it a single crisis that caused deforestation. Rather, a series of human and random peak natural destructive events led to forest destruction.

This relationship between the local people and the environment is important to study. It allows the observation of dynamics of deforestation that do not directly implicate the indigenous people. This dynamic contrasts with other areas of Madagascar, where the main causes of deforestation are: subsistence cultivation (the eastern rain forest), fuel wood collection (southwest), or commercial agriculture (Ankarana).

It is important to know under what circumstances local people are not driven to destroy natural resources. In our research area, the reasons are multiple. Population density is low on the west side of Amber Mountain. This rather isolated region has no history of cash cropping to encourage the construction of durable roads. Also, the land is flat, with a fair amount of rainfall (though the people say that rainfall is decreasing). Another reason is cultural: most local people don't take advantage of the apparent opportunities to cut into the forests to make upland rainfed fields.

The case of Bemanevika village was instructive, since the logging company employees had arrived there to begin cutting down trees a week before our arrival. The 20 kilometers of road that we drove on from Ankorefo to Bemanevika had been built just days earlier. Before then, the road had been impassible even with four-wheel drive. From what we could tell, this village had been rather isolated from the presence of loggers in the past. We had the chance to observe first hand the reactions of the people to this disruptive event. Everyone worried that the company would cut the trees of their watershed. Opinion on logging activities, however, was split between those who wanted to try to force the company out, and those who wanted to allow the company to cut certain forests in exchange for compensation.

The company's legal right to log this land was questionable; their logging permit may have been falsified. The villagers should have been contacted before if proper legal channels had been followed. The villagers asked us to explain to them what we knew about the forest in their region and about the potential effects of deforestation. We confirmed that their watershed is small and their concerns are valid. This is an example of effective local-level knowledge transfer to active decision makers (see Figure 5B). While we were in Bemanevika, we heard chainsaws daily and saw enormous felled trees carried out on trucks (see Figures 10C and 10D). These trees were going to a sawmill in Antsiranana and would supply the urban market there.

HYPOTHESIS TESTING

We came to this project with several integrated science hypotheses. We have included them in this section and used our figure products to illustrate our findings. This format places our results in the context of current debates in conservation and ecology.

certain forests were far greater. Near Ankorefo, forest recently selectively cut had been cut before, so the cutting may be sustainable if properly managed, but in other areas the consequences were disastrous. For example, near Ankorefo, a region was selectively cut between 1965 and 1984 (Figure 8). The logging road was put in on a ridge crest, and the logs were probably dragged up the slope via tractor. Although trees were removed, the forest may have looked generally similar until the 1984 cyclone. This large windstorm felled many of the remaining trees in this area, probably because the crest road and cutting had weakened the forest's structure (the ridge crests areas being the most susceptible to wind damage). This area has burned subsequently nearly every year. It has converted to secondary grassland, littered with dead trees (Figure 10A). Only forests with ridge logging roads seem to have been so severely affected, yet the majority of the 205 hectares of closed canopy rainforest destroyed on the west side of Amber Mountain since 1950 appear to have been deforested as a consequence of commercial selective logging (Figure 9).

Few forest stands (<10 ha) were identified as having been cleared for upland rainfed (slash and burn) subsistence agriculture. This observation is in marked contrast to the cutting in many parts of the eastern rainforests of Madagascar, where forest farming is the major destroyer of forests. The majority of those forests that were felled for subsistence agriculture were limited in extent (< 50 ha), located near Marovato on the NW corner of Ankarana, and were put into irrigated rice production.

Other selectively-logged forests have been invaded by bamboo (Figure 18). While looking the same in aerial photos and some image products, the biodiversity of these invaded forests has been greatly reduced.

A still larger area of savanna (542 ha) was lost to the exotic plant lantana camara, locally known as kalabera since 1950. Originally from South America, this plant, was introduced locally by a resident of Bemanevika in 1965. Unobserved in the 1950 aerial photos, it has colonized many of the forest-savanna edges, forming vast monospecific stands, possibly restricting forest use by local people. Twice the area of rainforest lost through deforestation has been lost to this exotic (Figure 9). Kalabera has invaded dry land savanna shrub communities as well as fallow agricultural areas. Exotic invasion may be a greater threat to biodiversity than deforestation.

Lantana camara has also invaded large tracts of xerophytic deciduous forests (Figure 17) found on recent basaltic flows on the west side of Amber Mountain near Bemanevika (Figure 16). These unique and restricted forests are located within the National Park yet their open canopy structure has allowed the influx since 1950 of vast amounts of Lantana camara. The consequences to biodiversity of this exotic invasion may be severe.

It is interesting that the effects of commercial selective logging may be compounded substantially at certain crisis points by natural phenomenon occurring randomly like the cyclone of 1984 and the introduction of lantana. A student of Robert Sussman, Ben Freed, has studied the lemurs in the rain forest of Amber Mountain between Ankorefo and Bemanevika. He has discovered that at least one species of lemur (lemur sanfordi) (Figure 10B) now uses kalabera as a primary food. The ecological consequence to the forest from

changes in seed intake and dispersal from this change in diet is unknown but may be significant. Though large changes have been mapped (Figure 9), many of these changes have been caused by external factors (from the city of Antsiranana). The local people of Ankorefo and Bemanevika appear to be living sustainably.

Large changes in the vegetation near Antsambalahy have also been mapped (Figure 11). From 1950 aerial photographs and remnant stands still present, we suspect that large tracts of gallery forest near Antsambalahy, bordering the Mananjeba River, have disappeared. To reconstruct the original extent of that forest we look at the forest present now and the isolated remnant stands present in the 1950 photos. It appears that the gallery forest originally extended from the river channel in a tract 1 - 1.5 km. in width and probably originally covered an area of nearly 800 ha (estimated by filling in between forest patches present in 1950).

About one-quarter of this gallery forest appears to have been cut prior to 1950 (585 ha remained as of 1950), probably for agricultural fields. The topographic maps from the 1950 photos designate this as an area of rice cultivation. More than half of those forests remaining in 1950 have since been cut (Figure 11). As of 1991 approximately 200 ha remain, 25% of the estimated original extent. Much of the forested land and former rice land was converted to commercial sugar cane (Figure 12A) and cotton (Figure 12B) cash crops.

Now, only a small remnant of this gallery forest remains to the west of the Ankarana massif. In 1950 gallery forest was present within the reserve; today the forest that remains is outside the reserve and lacks any formal protection. The consequences of this deforestation may have been far-reaching. In 1950 the Mananjeba formerly flowed through a cave in the Ankarana reserve. It now flows north to the sea through a gap in the karst formation. At present only a small tributary of the river flows through the cave, and a population of unique alligators that live in the caves of Ankarana is threatened. Lack of water flow has caused sediment to start filling up the cave (Figure 12C).

The river changed its course in the mid 1980's in a period of heavy rain. Deforestation of the gallery forest surrounding the river probably made this sudden river migration possible or at least accelerated the process. Erosion of other formerly forested (dry forest) lands to the north has resulted from these changes (Figure 12D). A great deal of land has been damaged, with danger of further degradation.

Similar to the deforestation process near Ankorefo, peak random natural phenomenon (heavy rains) have acted on a system that was put into a metastable condition by a slowly accelerating deforestation process acting over a 50-year period. This deforestation was accelerated by the transition from subsistence to commercial sugar and cotton agriculture.

DEMOGRAPHIC INFORMATION

In the four village areas we surveyed, we found diverse relationships between the local populations and the environment. The villages west of Amber Mountain have different socioeconomic characteristics and resource

1. a. Hypothesis: Raw growth in population leads to deforestation in a linear fashion.

b. Findings: This is not the best model in certain areas. Other, complicating factors include the nature and intensity of technological exploitation. In some areas, a few people with substantial capital destroy a disproportionate amount of forest resources (e.g., lumbering companies, plantations, capital-intensive peasant farmers). Commercial enterprises found in larger cities can reach into rural regions of low population density and exploit forests.

Cultural factors also influence the resources people use and the ways they exploit them. For example, the people on the west side of Amber Mountain did not practice slash-and-burn cultivation, although the forest is suited for it (as is the forest south of Ambilobe, which, by contrast, is undergoing considerable slash-and-burn deforestation).

Still, high population density does stress the environment, leading to abuse of resources. Researchers must not look just at population density figures, but also at the regional social and economic processes that create high population densities and demands on resources.

2. a. Hypothesis: Local people in Madagascar use resources destructively.

b. Findings: In Ankorefo and Bemanevika, most local people use the forest in a sustainable way. This was not true at Antsambalahy, south of the Ankarana, where people cut down the forest for cash crop fields. This is an example of deforestation originating not in raw population pressure, but in capital-intensive peasant farming connected to a larger, global economy.

3. a. Hypothesis: Nonlocal people (immigrants) use resources destructively.

b. Findings: Being an immigrant is not a sufficient indicator of likelihood to deforest. For example, most of the people living on the west side of Amber Mountain were immigrants in colonial times, and none of them deforest. The propensity to deforest is related to a combination of economic and demographic variables. It depends on the dominant mode of production in the region where immigration occurs. It also depends on immigrants' access to tools of exploitation and their ability to pursue destructive environmental practices despite possible local sanctions against it. The volume of immigration could be a relevant variable. Greater numbers will be more forceful or persuasive and also put a greater strain on the environment.

4. a. Hypothesis: Destructive use of resources is linked to world system variables (the world capitalist economy) (e.g., the cost of fuel, coffee production in Brazil, national timber needs.)

b. Findings: This was true for the deforestation dynamics we examined, particularly in the village of Antsambalahy, where a local sugar plantation has encouraged peasants to grow sugar to sell to the refinery. Mass migration to the region during colonial times and deforestation have been responses to this economic dynamic.

5. a. Hypothesis: Perception of the amount of deforestation will correlate positively with extent of deforestation (Figure 19A).

b. Findings: The relationship is much more complicated. People tend to perceive more deforestation when they don't benefit economically from it.

Correspondingly they tend to perceive that deforestation as a problem if they don't benefit from it (see Figure 19C).

We saw this relationship played out at all three village locations. In Ankorefo, half the adult men had worked in their youth for the company logging in the region. They perceived the lumberer's activities as benign and nothing to be concerned about (Figure 19B). By contrast, those who had not worked for the company, and thus had not benefitted economically from the forest destruction, generally condemned logging and feared its consequences on their water supply.

In Bemanevika, everyone saw logging as a serious threat, but those who thought their village could derive some economic benefit from the activities downplayed this threat.

In Antsambalahy, we saw a different aspect of the relationship. At a certain point, when a large enough portion of the land has been deforested, even those benefitting from it must recognize its destructive impact. Here, everyone viewed deforestation as a significant threat.

6. a. Hypothesis: Deforestation is a long-term, cumulative process (See Figure 19D).

b. Findings: For this region of Madagascar, large deforestation episodes can occur in a series of short events after forests have been brought into a metastable regime by a cumulative process. This may be linked to natural peak random phenomenon (e.g., a cyclone or a 50-year rainfall--Figure 19E), to a sudden change in economic-technological intensity (e.g., forest concessions--Figure 19F), or the two combined.

For example, the largest patch of deforested land around Ankorefo had at one time been selectively logged. This may have weakened the vegetation cover to the extent that a cyclone later blew down a significant number of trees (Figure 19E). Also, near Antsambalahy, during a peak period of rain, a river with deforested and easily eroded banks changed its course. In both cases a threshold had been reached. Conditions were metastable, and a particularly intense natural event forced the system into a different regime. The external natural and anthropogenic perturbators (like the cyclone or global economic change) occur unpredictably as far as the local system is concerned, or unpredictably within a certain time period (such as a 10, 50, or 100 year rainfall).

7. a. Hypothesis: With respect to conservation and development: grassroots involvement in a project will enhance the realization of conservation goals.

b. Finding: To answer this requires years of longitudinal research. We hope to continue our project in various sections of the country to monitor these dynamics. One complicating factor we noticed is that often variables external to a conservation project can interfere with this goal. Governmental policy and regulations can interfere, for example, if policy makers don't share the same priorities. This is where knowledge transfer must play a role beyond the local level.

8. a. Hypothesis: Villagers who deforest have a higher socioeconomic standing than those who don't deforest because they derive an economic advantage from accumulating forest products.

b. Findings: The data did not confirm this hypothesis. Instead, a curvilinear relationship: richer people and poorer people are more deforest than people in the middle. The rich deforest because they and market connections at the national and international level.

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remote sensing/GIS systems. An approach in which fifty percent of the information is gathered at one percent the cost of large (ARCINFO type) systems should be stressed. Also these methods are more accessible and resilient for developing countries.

Information has been hidden and twisted to fit the interests of various groups in Madagascar. Here are some examples:

1) Our team discussed hiding data on the location of reserve boundaries from the local people in order to protect reserve forests from exploitation.

2) WWF hid information on decision making (who was in charge) from village elders, greatly increasing their suspicion of the project.

3) Waters and Forests (the Ministry in charge of protecting forests) hid information about reserve boundaries from both local people and WWF.

4) Waters and Forests hid information about permits and cutting laws from locals and WWF. (Many permits are issued without the required map showing permitted cutting areas attached.)

5) U.S. Embassy personnel distorted the results of the Green and Sussman 1990 Science paper to suggest an improving deforestation situation where none in fact exists.

6) Conservation NGOs in Madagascar have focused on some areas where there is little deforestation threat, to show greater successes.

7) Government reports heard over the radio indicated that a road north of Ankarana (which Swiss assistance for work had been previously obtained) had been paved when it was clear that no construction had taken place.

Human Influence is visible in satellite images and aerial photographs, and as such can be used as surrogate measures of important socioeconomic information for rural areas.

1) Settlements: villages, towns and cities can be detected. With some ground truthing (surveys to determine the average number of people per household), one can extrapolate population numbers.

2) Subsistence base: crop land is detectable, as are methods of cultivation. Tractors leave distinct traces: fields cultivated with tractors tend to be larger, planted in rows and more square-shaped. Slash-and-burn cultivation can also be detected, because of the small plots cut into forested areas. Irrigation ditches can be seen and recognized as such with just a bit of ground truthing. Availability of water and fertility of the land may be detectable. Water sources will often be visible (rivers), though not always (wells).

3) Relative wealth of a settlement: settlements with larger buildings are usually wealthier, as are those with more "tin" roofed structures (higher-value construction material). Also, the quantity of arable land around an agricultural community can be used to assess relative wealth of communities.

4) Quality of infrastructure: the quality of the road system and the places it reaches. With some ground truthing, one can find out where local markets and outlets for rural products are, plus modes of transportation. From that information, one can learn how connected an area is to the national or even international market system.

5) Migration can be inferred, with some preliminary information about the region. For example, a sugar refinery provides seasonal jobs for people on plantations and encourages peasants to grow sugar cane to sell. Looking at areas of heavy settlement or intensive production (large villages, big cash crop fields) we can infer that those areas have experienced immigration.

These results indicate that a 1:25,000 scale aerial survey of the entire country is critical to update socio-economic data for the country. The last country wide survey was run in 1950 and is currently more than 40 years out of date.

Multi-referenced ground truthing and cross-checks was accomplished using an interdisciplinary approach. Glen Green interviewed people he met in the field during his reconnaissance treks. He checked their responses against the satellite images and historical aerial photos he had, with respect to past ground cover and land use and deforestation. This provided a check on reliability. As the images raised questions, Green could check, in the field, some of the information that Gezon was obtaining from interviews. They used images to give ground history and to generate questions to ask during ethnography.

The policy of the Ministry of Waters and Forests needs a major external evaluation as we believe some of their policies hinder the adoption of sustainable forestry practices. Through village and field interviews we observed many instances of policies that discourage sustainability and conservation. Here are some examples:

1) Years after a man had planted trees he had to go to Waters and Forests for permission to cut them. He became so frustrated by the steps needed to get permission that he vowed never to plant trees again.

2) Antsambalahy villagers, who need wood for construction, wanted to plant trees now, to be ready in twenty years. However, they did not trust Waters and Forests not to give permission to someone else who might cut those trees meanwhile.

3) A man near Marovato bought forested land; ten years later Waters and Forests gave the rights to cut the trees on his land to a commercial timber company, so that he gained nothing.

4) People near Marovato customarily patrolled the use of the local forest, but when Waters and Forests excluded them from the decision-making process they became frustrated and stopped patrolling.

A regulatory system in which individuals don't benefit from their conservation decisions needs substantive change.

The Ankarana/Amber Mountain region is not experiencing as high a rate of deforestation as other areas of interest to our project (which we hope to add on in 1992). Areas experiencing heavier deforestation include a region we briefly ground-truthed in summer, 1991, south of Ankarana (the Ambilobe-Ambanja region). We emphasize that any efforts at conservation and development must address the needs and concerns of the local people. This conclusion isn't novel, but it is important enough to be restated. It has implications for the kind of knowledge transfer that should be given top priority. Environmental decision-makers must have accurate and detailed knowledge about how the local people actually affect the forest. Local level, field research, comprising a combination of integrated qualitative and quantitative methods, is indispensable for a holistic understanding of deforestation.

deforest because they lack sufficient land to support their families. They either do destructive subsistence cultivation, or they turn to cash cropping, which also contributes to deforestation.

9. a. Hypothesis: The annual burning of grasslands (to provide new-growth pasturage for cattle) leads to deforestation.

b. Findings: We found only a few examples of grass fires' having entered and degraded an intact forest, with damage to just a few hectares. Grass fires don't appear to cause deforestation. However, trying to prevent fires leads to the criminalization of the local population. Since fires are a natural phenomenon in savannas (Figure 18A), a law making burning the savanna illegal creates unnecessary tensions between villagers and conservation groups. Fearing an accusation, villagers run away from natural fires, rather than trying to control them.

10. a. Hypothesis: Establishment of woody plant species on land currently grass covered is inherently good and should be encouraged to replace a forest that existed there prior to human intervention.

b. Findings: Pollen studies by David Burney from lakes near the study area clearly show that significant hectarage of grassland and savanah existed prior to human intervention, therefore these ecosystems are not necessarily secondary as far as human impact is concerned and deserve equal protection and conservation. Dr. Burney's studies also show that fire existed in Madagascar prior to human colonization as would be expected in any grassland or savanah. Our own study has shown significant encroachment of the savanah bordering the west side of the Ankarana massif from 1950 to 1991, tens of hectares of grassland have now been converted to forest especially near Marovato, local people refer to these lands as "new forest", and are distinct from large areas of Lantana camara growth. The cause of this woody expansion is unclear and should be of concern to conservation. If this conversion proceeds much of this ecosystem may be lost in several decades. This growth would also destroy the vistas of the Ankarana massif from the west which is critical for any ecotourist interest. It would appear that this invasion is connected to cattle grazing since the woody colonizers, though native are generally a subset of plants whose fruits are eaten by cattle thereby possibly dispersing their seeds to new sites. Policies that would prevent grass fires, though generally thought to be ineffective may also play a part in accelerating this troubling change.

CONCLUSIONS AND RECOMENDATIONS

Our research paints a varied picture of the causes of deforestation and environmental change and reveals some interesting results. Deforestation for fuel wood and for upland rainfed (slash and burn) subsistence agriculture is minimal in the areas studied. Forest clearing to convert land to irrigated rice subsistence agriculture has destroyed some forest. However the largest causes of deforestation are ultimately external driven largely by commercial agriculture and commercial timbering. The largest area of forest lost (600 ha) is from riverine forest south of Ankarana and is driven largely by conversion

to sugarcane and cotton production to fill external markets. This cutting may have resulted in the sudden migration of the Mananjeba river which formerly flowed through a cave in the Ankarana massif the home to endangered alligators. This cave is now filling with sediment making the alligators accessible to hunting. Severe erosion has also resulted from this recent river migration.

The Amber Mountain rainforests have also been impacted by deforestation but to a lesser amount (200 ha). In this case selective commercial cutting appears to have weakened the structure of the forest sufficiently to allow much of it to be blown down in a cyclone in 1984. These damaged forests have since repeatedly burned and have now converted to secondary grasslands. This deforestation and any subsequent to the commercial selective cutting currently taking place on the west side of Amber Mountain threatens the water production in the watersheds of both Ankorefo and Bemanevika.

Invasion of forest and savanna by the exotic Lantana camara has caused the loss of 450 ha. This plant may be the largest single threat to the biodiversity of the region.

There is a need for: (1) information (with maps and satellite data playing a major role) accessible to a wide array of people and organizations and (2) objective criteria for evaluating conservation priorities and the success or failure of conservation projects. Evaluation should involve satellite-based determination of changes in deforestation rates, linked to an exploitation model like the one described in this report. We need concrete measures to evaluate, for example, a decrease in deforestation rates--compared with what would be expected given no action.

Political boundaries were imprecise or were absent from maps. Many of these boundaries are only known to local political leaders or elders. Such boundaries need to be mapped, possibly with GPS instruments. Often, reserve boundaries (1) were unknown by locals, (2) were poorly-marked or unmarked, (3) don't include very important biodiversity sites, (4) were unknown to WWF, (5) were not disclosed by Waters and Forests, to keep local people in the dark, (6) were lied about by locals to protect resources. This lack of knowledge about boundaries corrupts the reserve system.

People in developing countries like Madagascar often lack database capabilities, in technology and expertise. Their data needs are better addressed by a decentralized, commercial system that is easy to fix, is free of bugs, has low cost, and can be used in situations with little technological infrastructure. A system (remote sensing/GIS) that is low cost and simple (even if it does only 75% of what a larger and much more costly system can do) is desirable. Desk-top publishing hardware and software should be stressed, rather than high end products designed specifically for the remote sensing/GIS market.

We envision a small lab in Madagascar, housed at the Museum of Art and Archeology, where students and researchers can work on remote sensing and GIS-based analysis in tandem with our project. This would be a low-cost, stand-alone, low-tech facility, based on desk-top publishing hardware and software. The desk-top publishing market is very big and as such has driven capabilities up, costs down, and has produced the most bug-free systems, unlike most

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VILLAGE POPULATION STATISTICS 1991

Village:	Pop.:	Tin roofs:	Organic:	huts:	roads:	km to city:
						Antsiranana
Ambohibory	250	21	44	65	3	36
Ankorefo	322	13	109	122	3	44
Andranofan-java	1500	47	68	115	4	53
Ampanangana	250	11	65	76	3	66
Bemanevika	350	25	83	108	2	63
Bobakilandy	492	57	72	129	2	73
						Ambilobe
Mahatsara I	397	NA	3	72		
Tsarakibany	993	47	158	205	2	63
Ampasimbengy	1017	32	64	96	2	62
Marovato	393	18	53	71	2	59
Andranotol-ihigny	250	16	41	57	3	52
Matsabori-manga	280	27	90	117	2	45
Antsatrabonko	860	39	85	124	4	39
Andrafiabe	202	23	51	74	2	36
Ambotoaranana	557	24	120	144	9	30
Antsambalahy	1186	70	241	311	9	22
Mahatsara II	797	26	138	164	6	24

We generated the following IMAGE PRODUCTS

1) Landsat TM Color Composite, 1984, Bands 1,2,3 @ B,G,R. 1:150,000.

2) Landsat TM Color Composite, 1984, Bands 7,5,4 @ B,G,R. 1:150,000.

3) Landsat TM Color Composite, 1984, Bands 2,3,4 @ B,G,R. 1:150,000.

4) Landsat TM Color Composite, 1984, Bands 3,4,5 @ B,G,R. 1:150,000.

5) SPOT Panchromatic print. 1:50,000.

6) SPOT Multispectral Color Composite, 1990. 1:100,000.

7) SPOT Multispectral Color Composite, 1990. 1:50,000.

8) SPOT Multispectral Color Composite, 1990. 1:375,000.

9) TM-SPOT Pan Sharpened Image. 1:100,000.

10) TM-SPOT Pan Sharpened Image. 1:50,000.

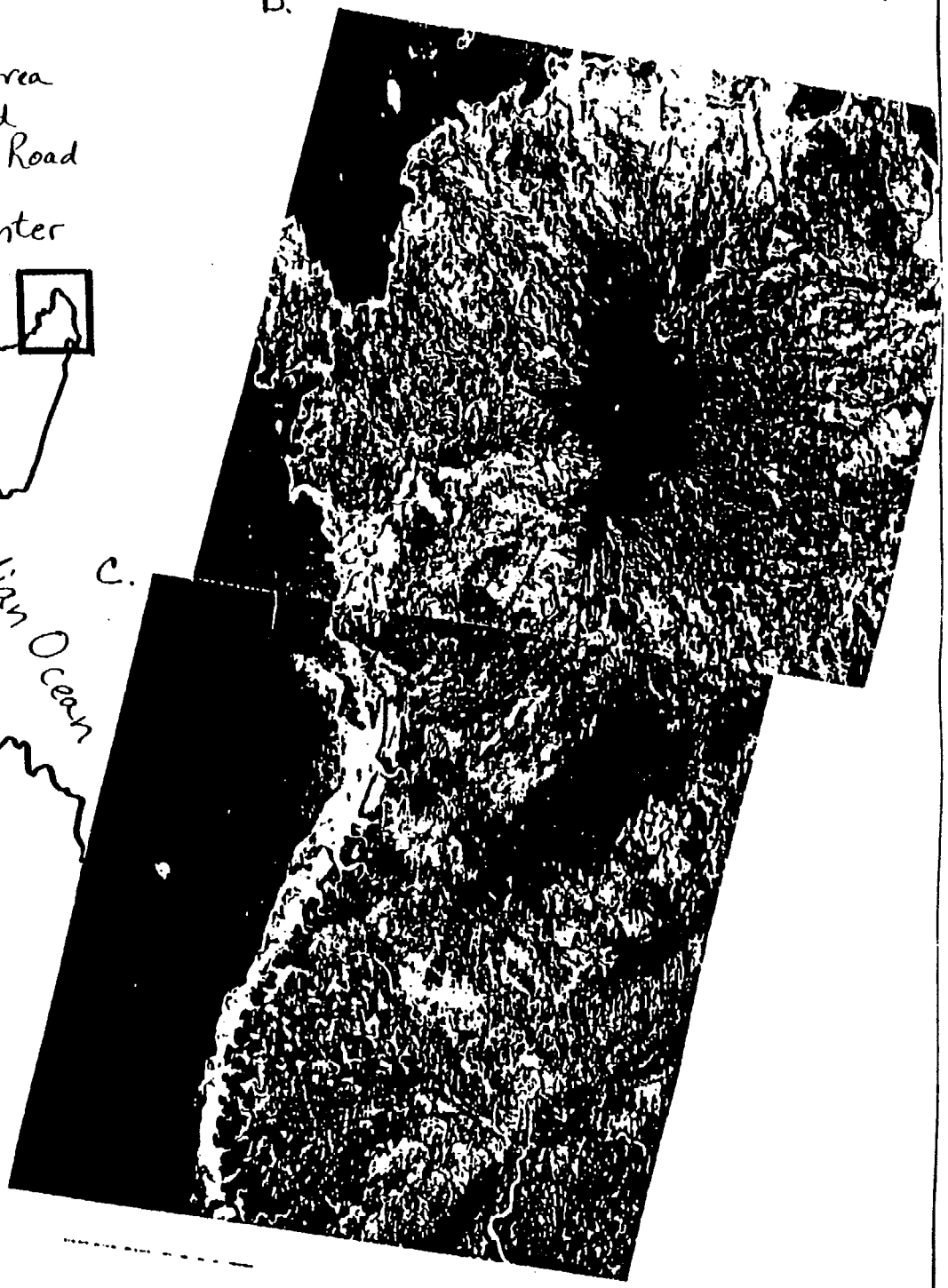
11) Landsat MSS-TM Change Detection Image. MSS-1972 (Blue), TM 1984 (Red) 1:375,000.

12) Landsat MSS-TM Change Detection Image. MSS-1972 (Blue), TM 1984 (Red) 1:100,000.

13) Landsat MSS-TM Change Detection Image. MSS-1972 (Blue), TM 1984 (Red) 1:75,000

A.
N
Protected Area
Major Road
Secondary Road
Village
Urban Center
Antsiranana
(Diego Suarez)
Mozambique Channel
Ambohibory
Ankorefo
Andranofanjava
Ampanangana
Bemanevikabe
Bobakilandy
Amber Mountain
National Park
Indian Ocean
Mahatsara
Isara Kibany
Ampasimbengy
Andranolohiny
Matsaborimanga
Antsatratonko
Andrafiabe
Ambatoaranana
Antsambalahy
Ankarana
Special Reserve
Mahatsara II
Ambilobe

B.



C.

Geologic Map

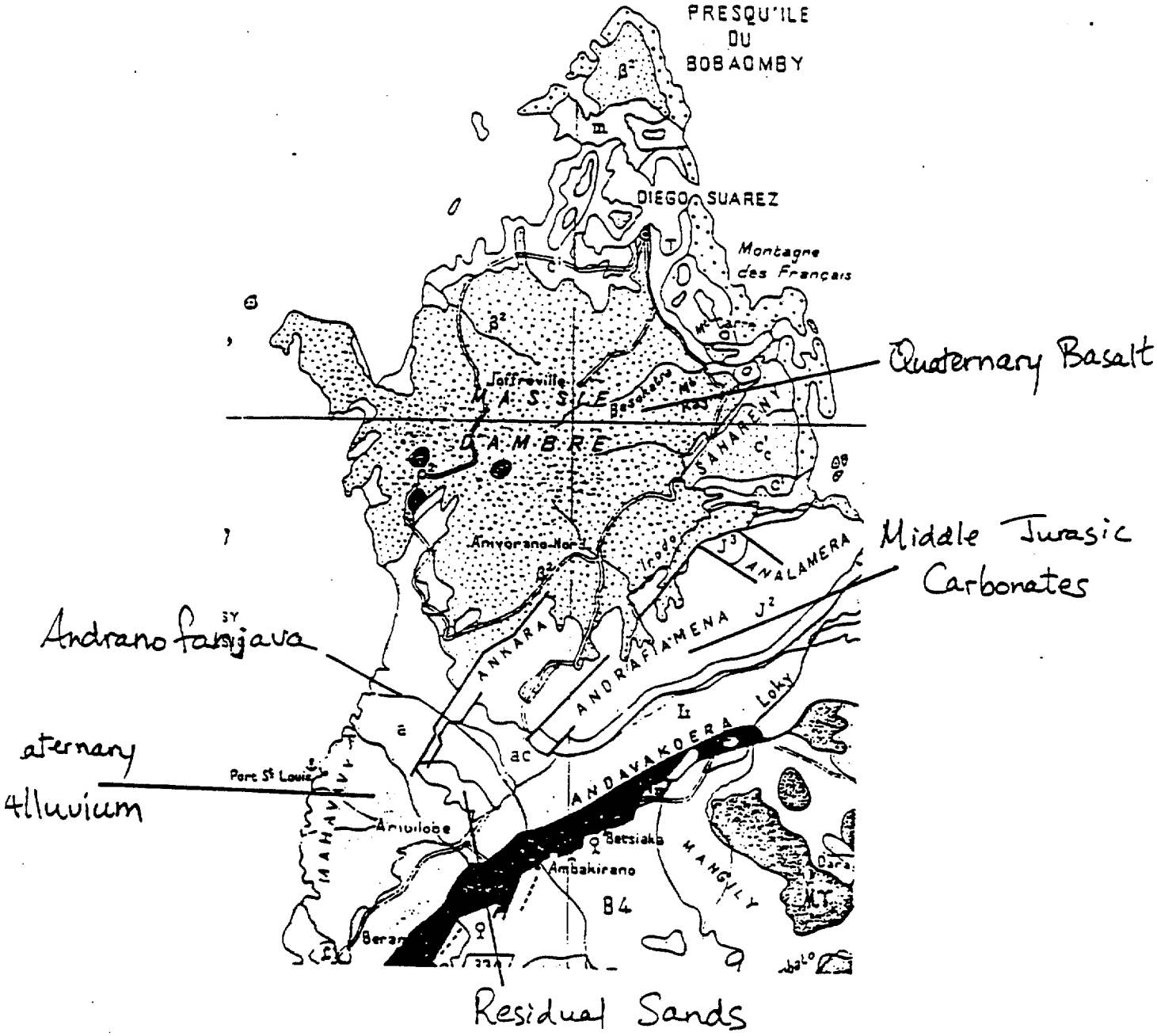


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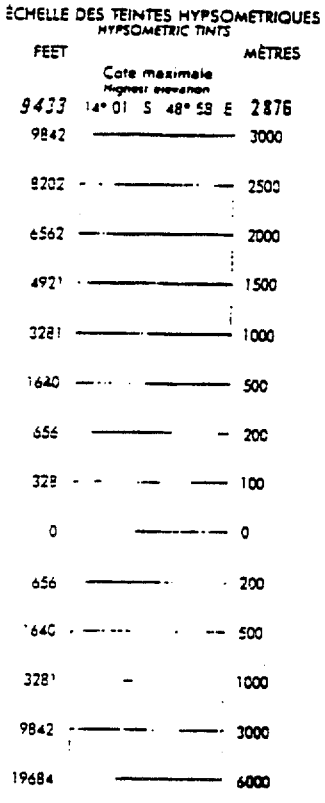
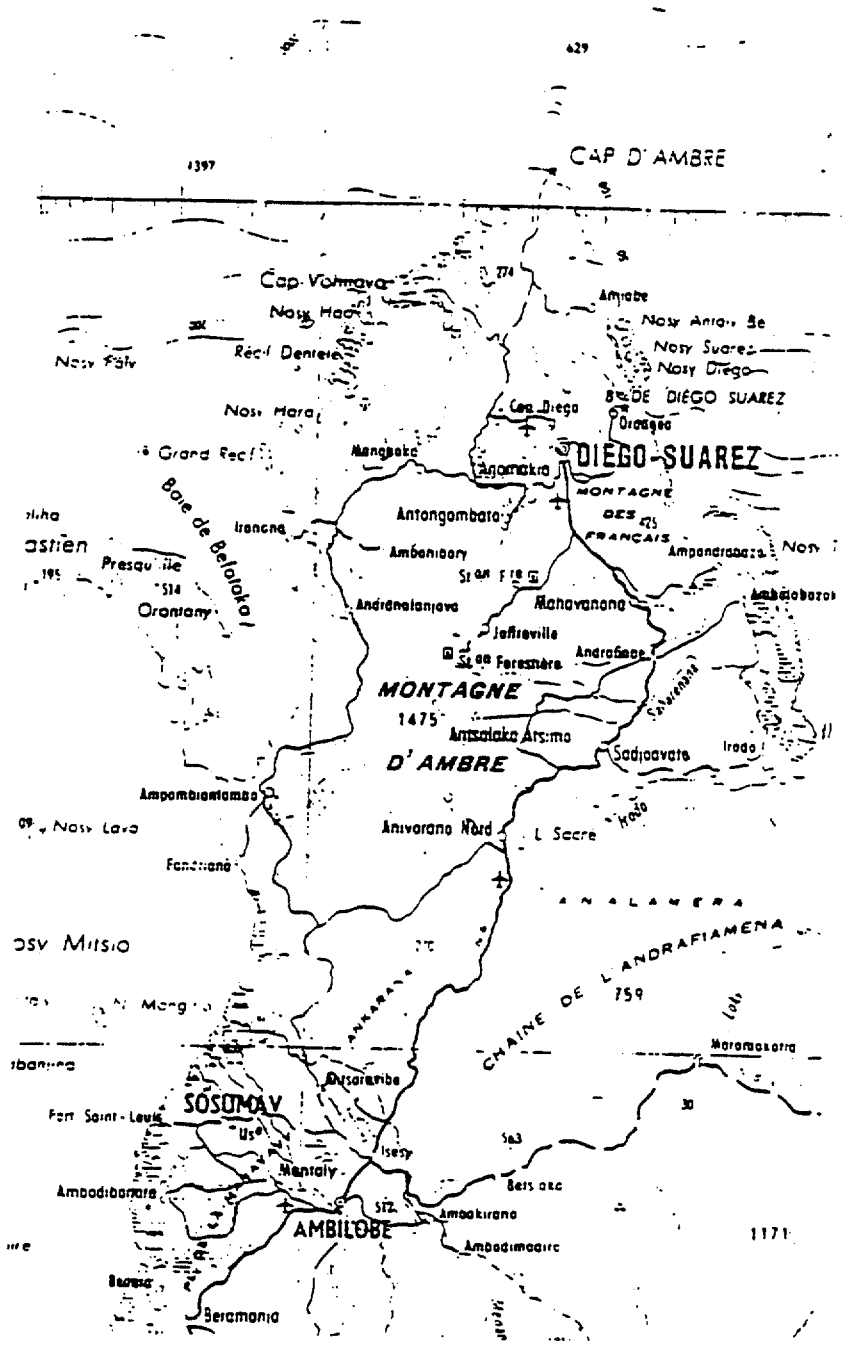
Fig. 2

Relief Map





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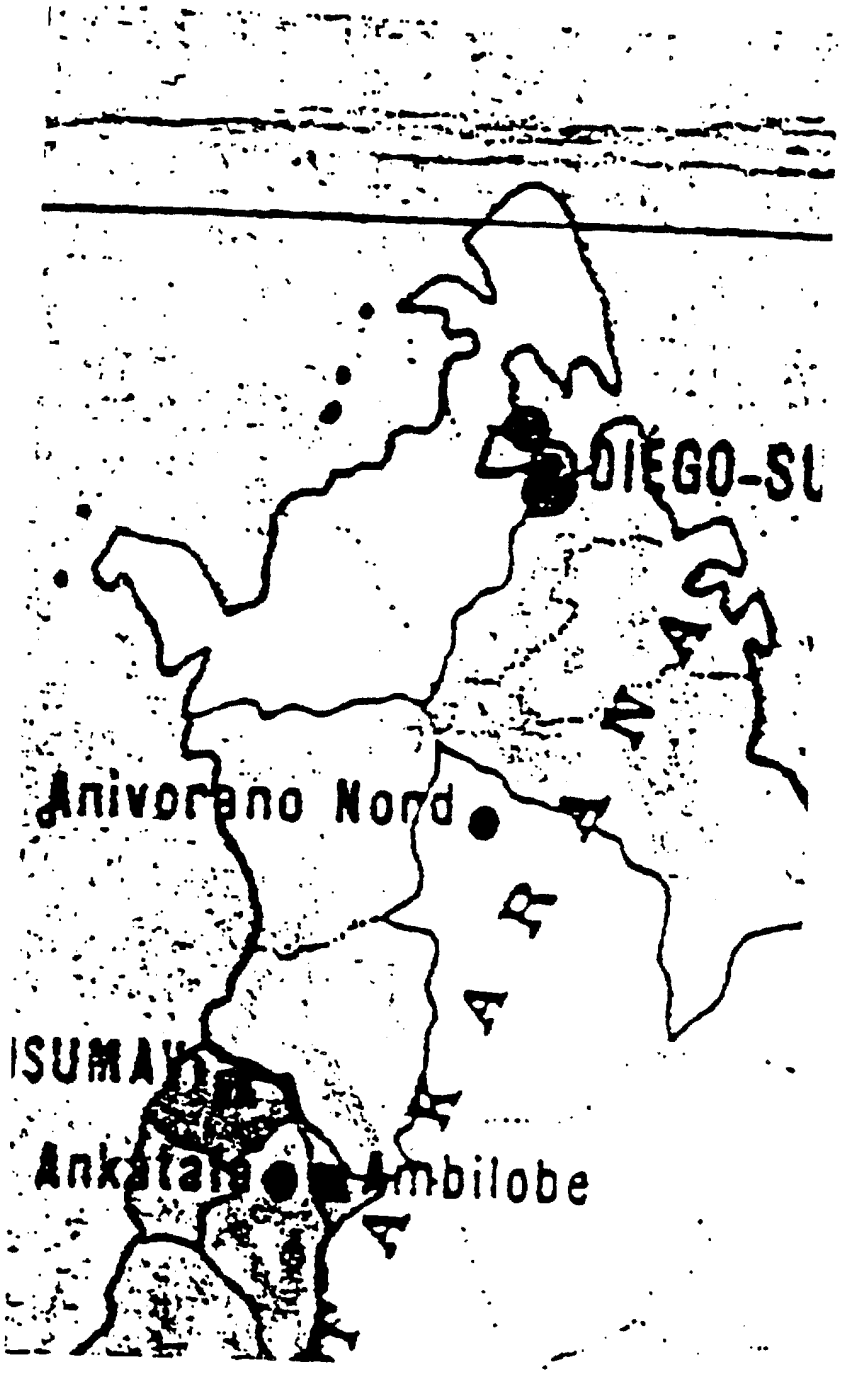
Population Density



pratiquement inhabité	moins de 2 hab.	de 2 à 5 hab.	de 5 à 10 hab.	de 10 à 20 hab.	de 20 à 50 hab.

Population Density (Persons per Square Kilometer) 1966

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Fig. 4.

A.

Ground-Truthing with satellite image

B.

Village Meeting at Bemaneviikabe

C.

Socioeconomic interviews at Ankorefo

D.

Ground-Truthing with village president and WWF park guard.

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Ground-Truthing Map for Ankorefo

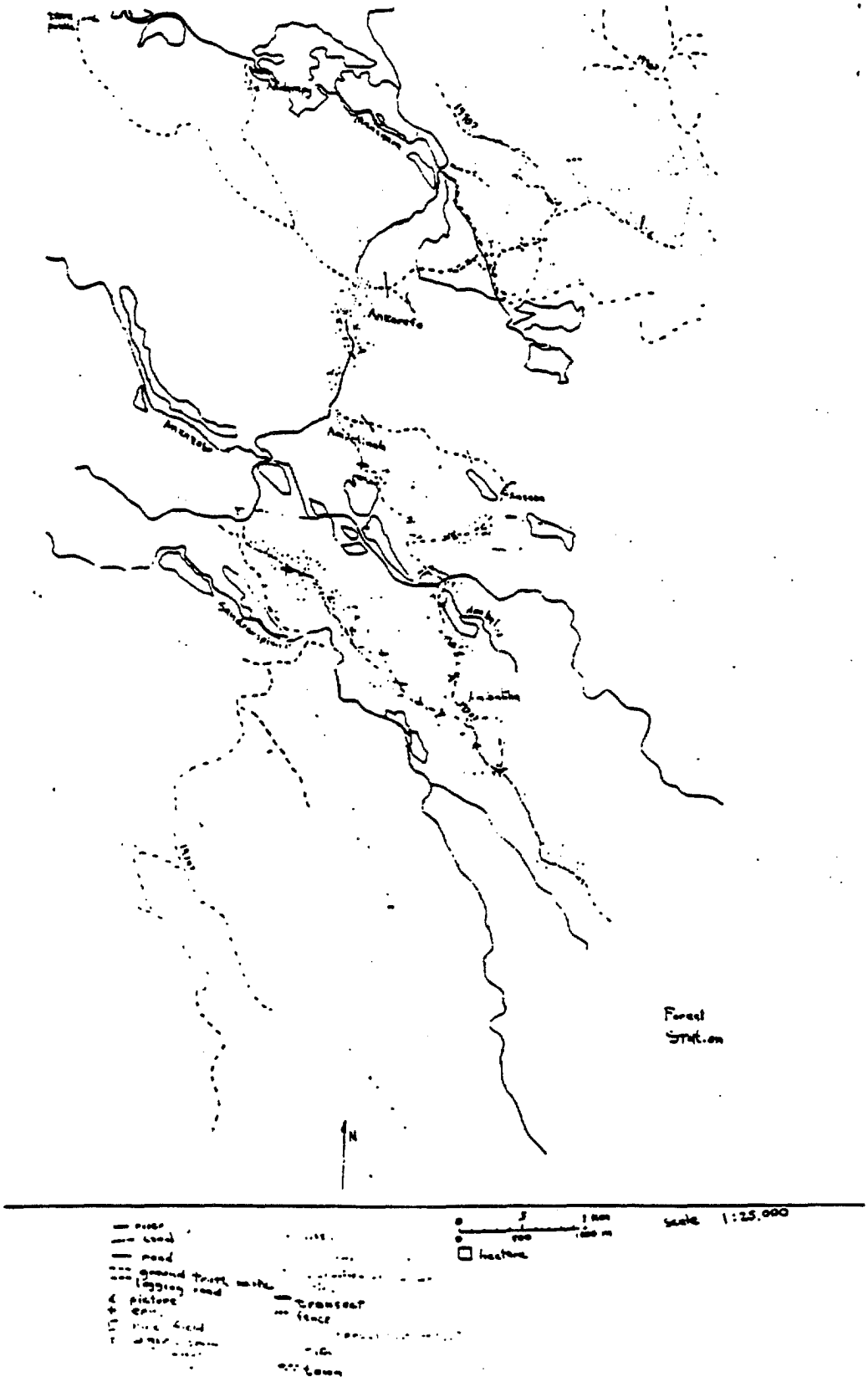

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Fig. 6

Watershed Outline

← Ankorefo

← Bemarevika

10 km

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Vegetational Changes near Ankarana

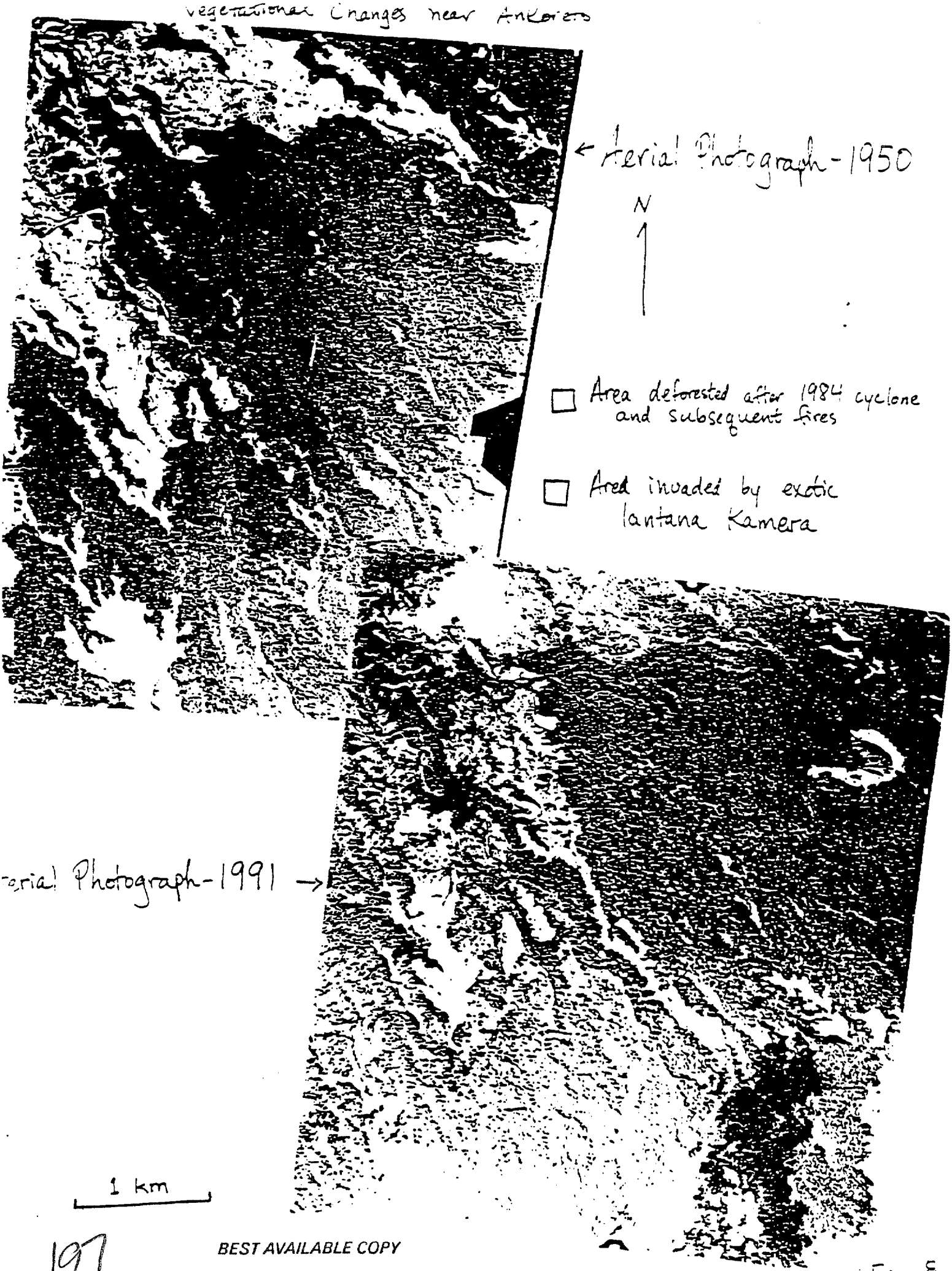

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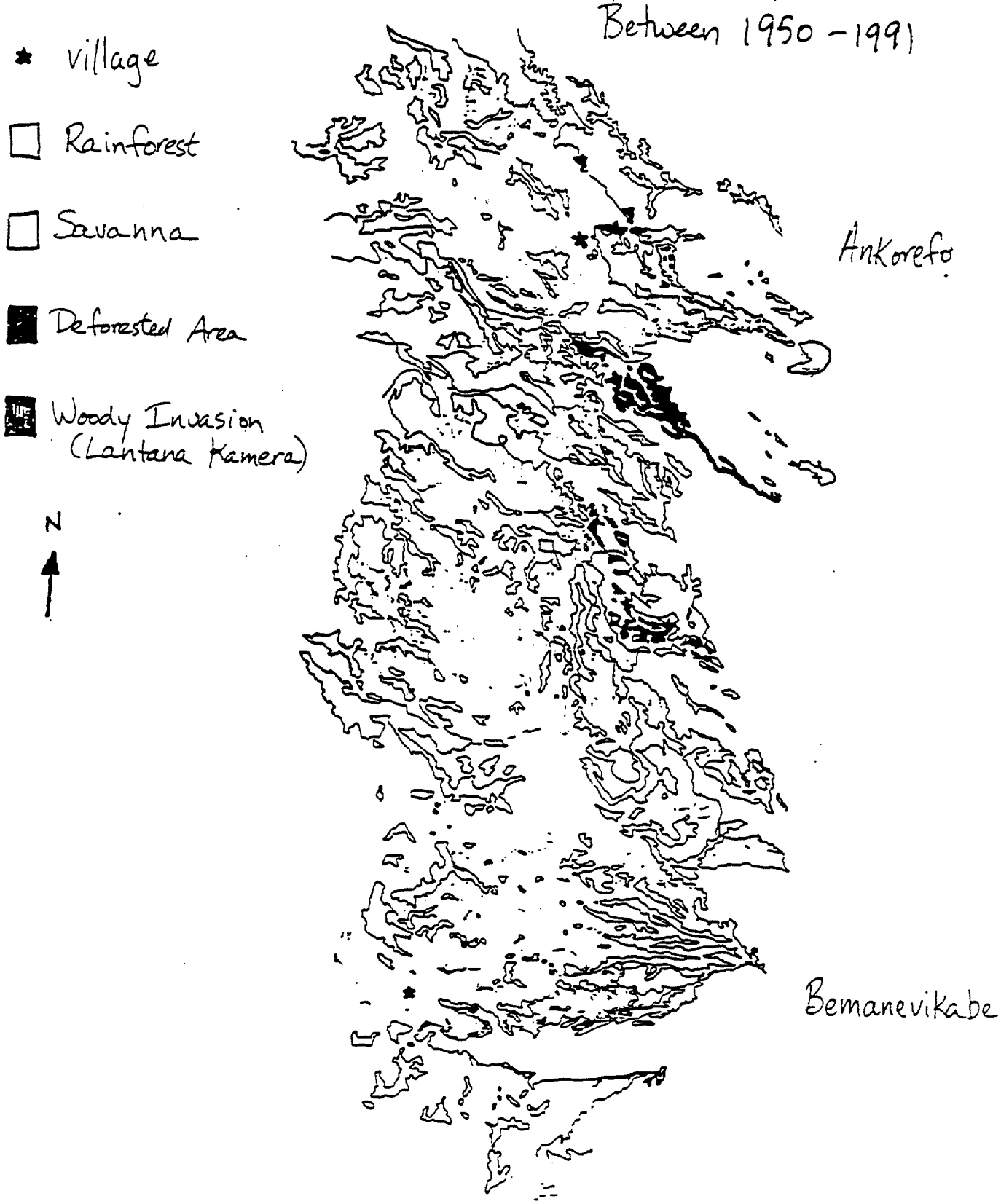
Fig 8

Vegetational Change Map of An/Be Between 1950 - 1991



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A.

Selective Logging, Cyclone & Fire Damage

C.

Selective Logging - Bemanevikabe : Before

B.

Lemur in Lantana Kamera

D.

Selective Logging - Bemanevikabe: 2 Days Later

Fig. 10

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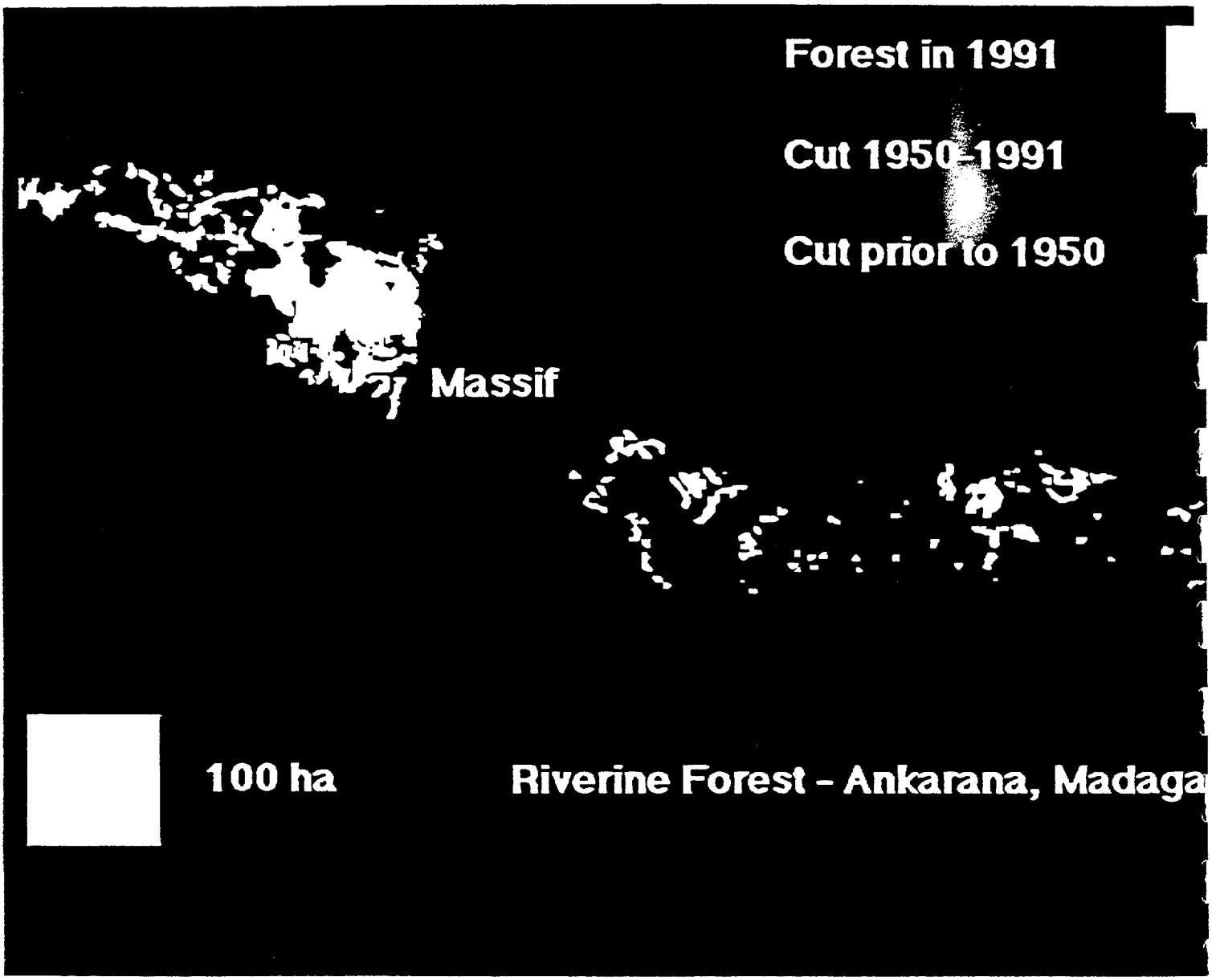

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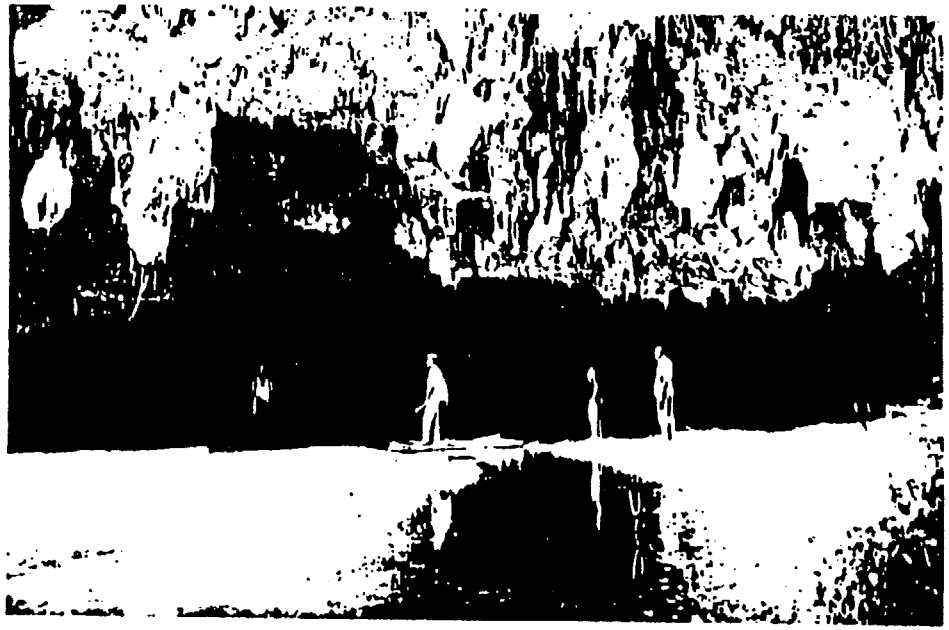
A

Sugar cane replacing gallery forest near Ant.



Former subterrainean river channel of the Andranofanjava

B.

Cotton replacing forest near Ant.

D

Erosion from the Andranofanjava River

A.

Organic Hut

B.

SPOT Multi-Spectral
Color Composite

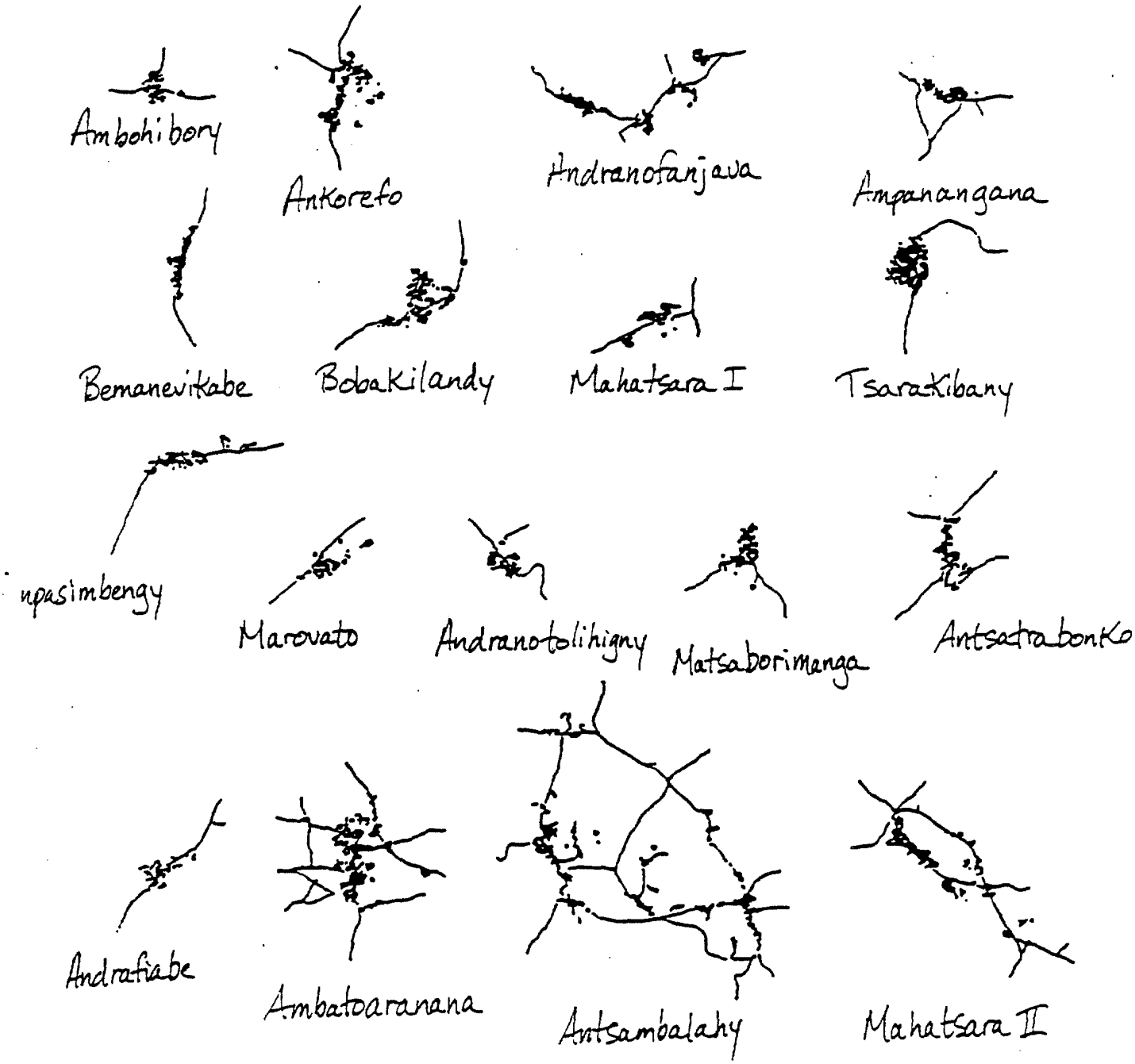


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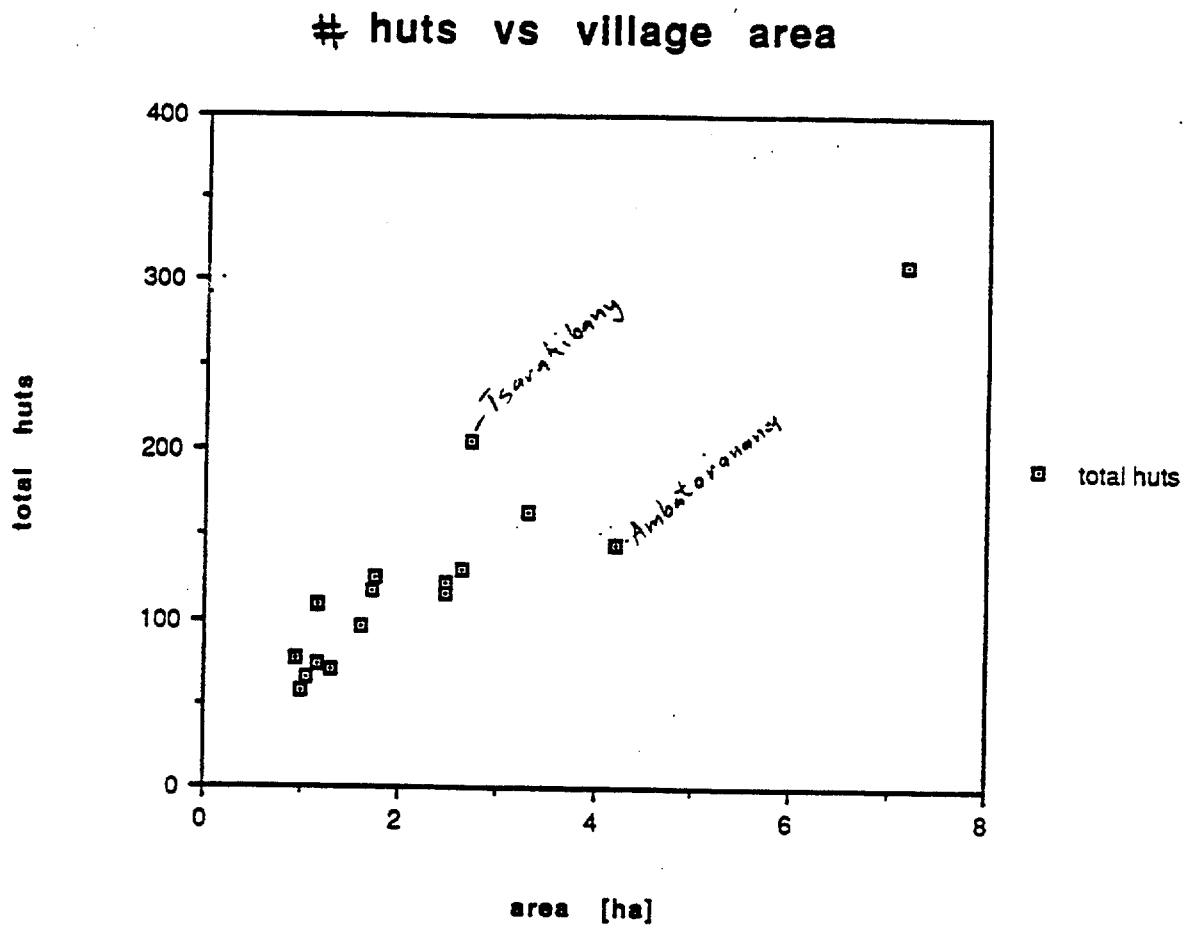
Fig 14 A



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Distance to city vs area of village

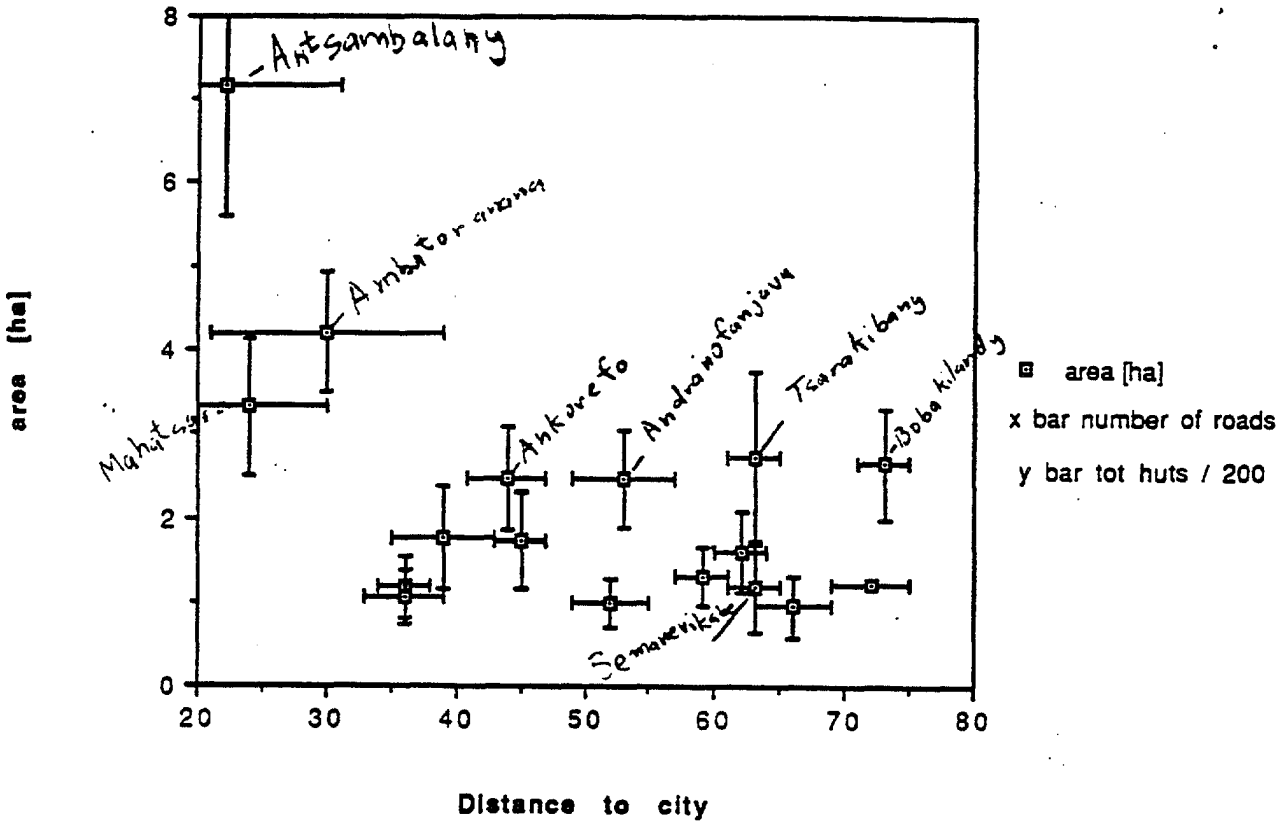

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Figure 14

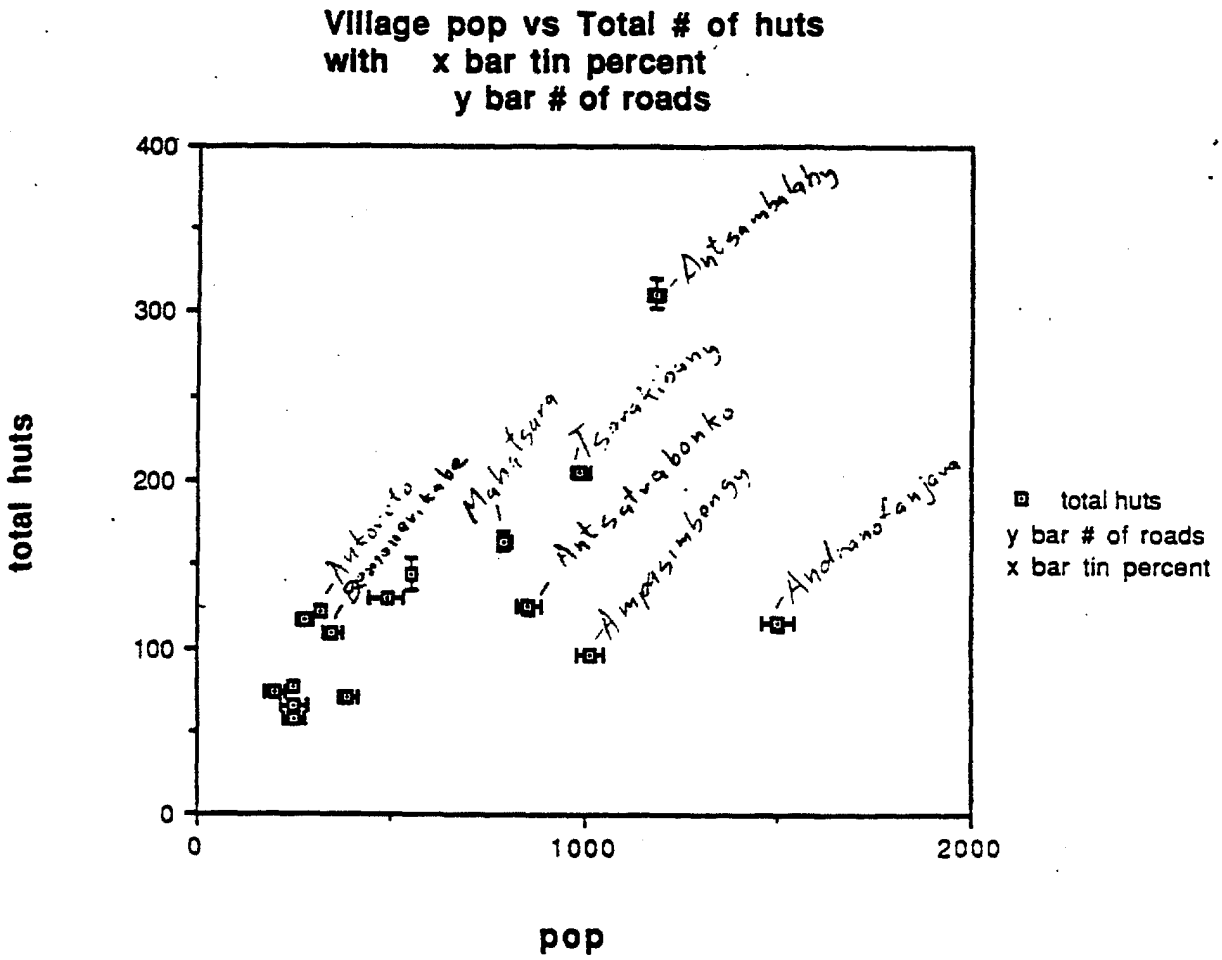

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Figure 14.

Agricultural Field Patterns

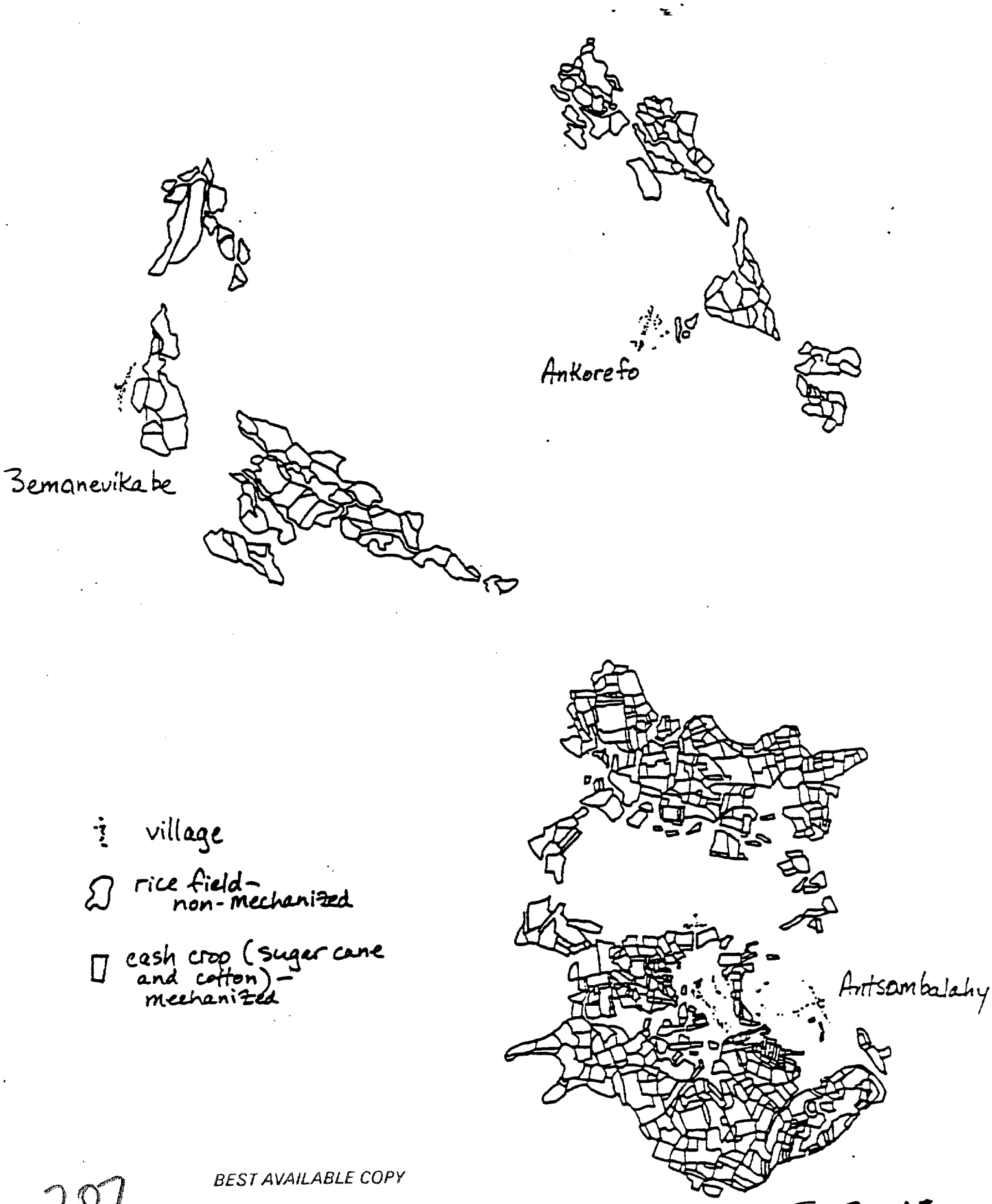

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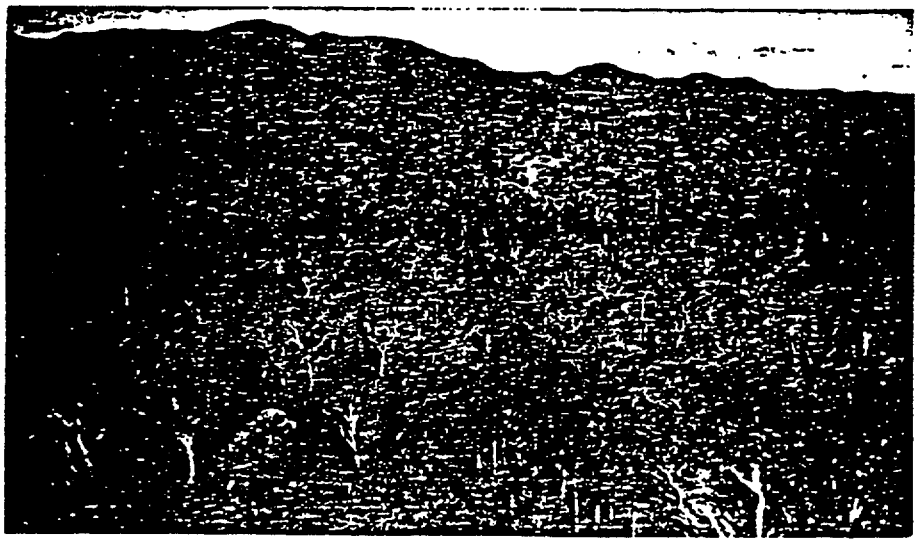
Fig 15

A.

Xeromorphic Tree Growing out of Basalt

B.



Xerophytic Forest on Basalt Flow

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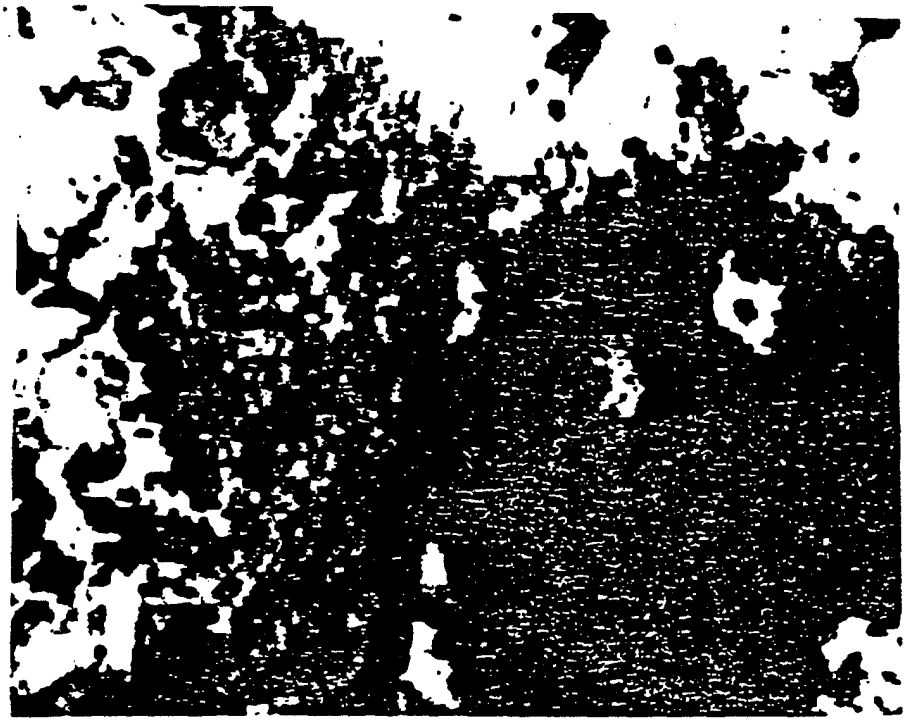
A.



Change Image - 1972 and 1984

Recently Burned Area

B.

Aerial Photograph 1950

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Fig 17

A.

Grassfire in Savanna

B.

Bamboo Invasion In Rainforest near Ankorefo

C.

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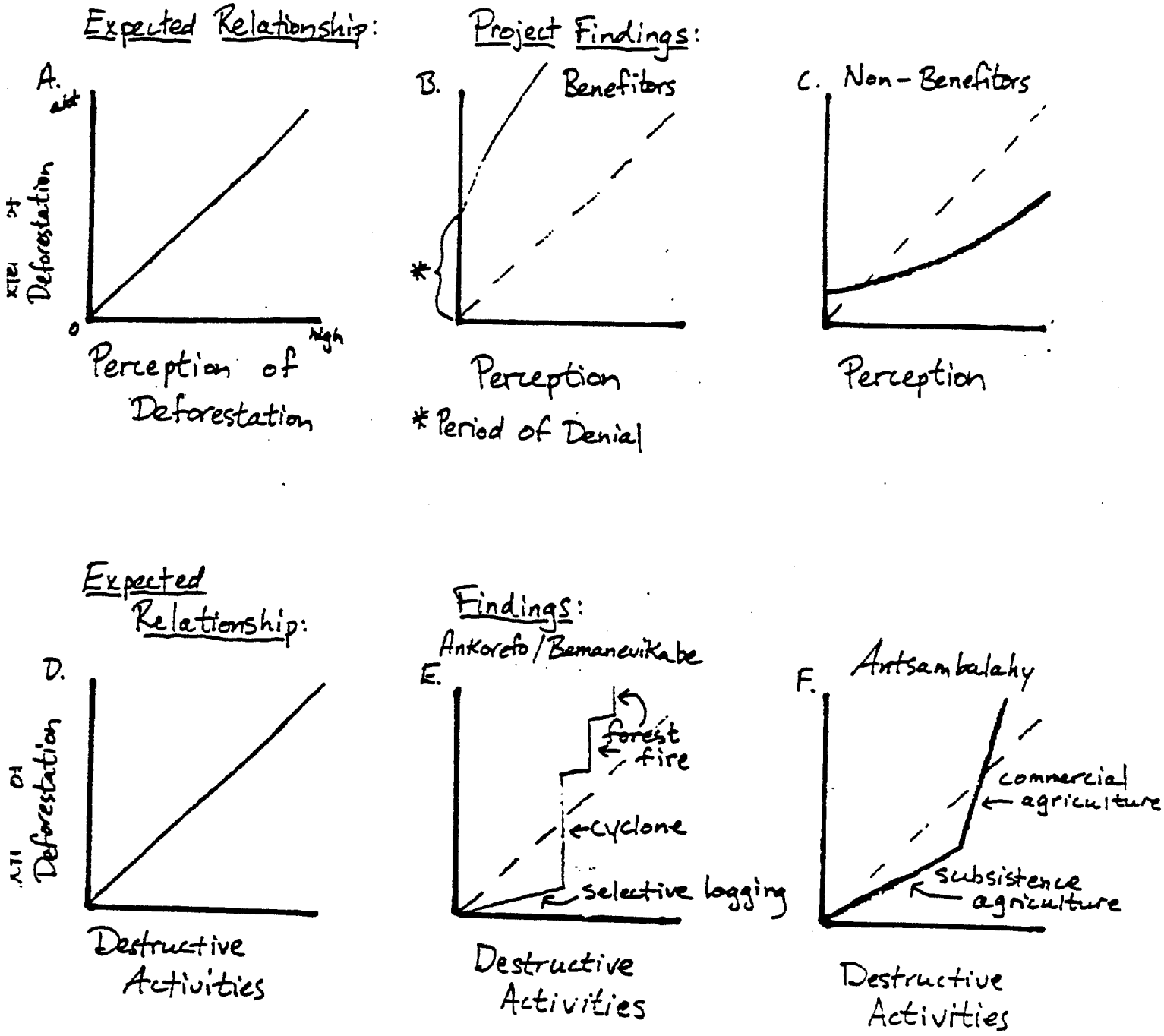

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Fig 19

Appendix G: Deforestation in Madagascar

An important research synthesis of the "on-the-ground" local issues influencing deforestation in the different regions of Madagascar is currently awaiting publication:

Sussman,R.W., G.M. Green, L.K. Sussman. In press: "Satellite Imagery, Human Ecology, Anthropology and Deforestation in Madagascar." *Human Ecology*.

The following five map products, illustrated in this upcoming publication, were produced for this study and are presented here as important modern biodiversity map products for Madagascar. Some of these maps will be available in photographic and in digital formats. Glen Green should be contacted in regard to access to these materials.

Map A

Three maps of deforestation history in eastern Madagascar derived from aerial photographs and satellite images:

* the estimated original forest extent.
* the forest extent as of 1950.
* the forest extent in 1985.

Map B

A shaded image of topographic relief in eastern Madagascar overlain by colors depicting the amount of forest remaining at different times. The three maps in 1) above are combined and the blue areas represent forests cut prior to 1950, the red areas in this map are those cut between 1950 and 1984, and the green areas on this map represent the forest which remained in 1985.

These colors are applied to a computer generated shaded relief image so that areas of higher slope appear as raised regions. This mapping technique permits the display of the relationship between deforestation and slope. The slope image was generated from a digital elevation model produced using maximum change values using 2 minute latitude by 2 minute longitude grid cells from 1:500,000 topographic maps. <u>This map demonstrates that in the southeast part of the island the only remaining forest is located on very steep slopes.</u>

Map C

A computer generated map of the possible future extent of rainforest in Eastern Madagascar. This map is generated based upon the assumption that all forested areas in Eastern Madagascar of slopes < 7° will be destroyed.

Map D

A computer-generated composite map of Eastern Madagascar in which colors relate to forest extent, topographic relief, and protected status. White areas on this map depict forested reserves

located in regions of high slope. Pink areas on this map depict forested reserves in regions of low slope. Only the centrally located Zahamena reserve contains large tracts of forest on low slopes at moderate elevations. This map demonstrates that there is no extant reserve that contains large tracts of rainforest at low elevations.

Map E

This is a representation of a Landsat satellite image of the west coast of Madagascar. Indicated here are the locations of dry forests on limestone formations near Toliara. The dark areas in this image are forest cover while the light area represents a recently deforested area along the road that connects Toliara to Antananarivo. This image is approximately 30 km in extent.

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