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Protected Areas Systems Review of the Indo-Malayan Realm



PROTECTED AREAS SYSTEMS REVIEW

OF THE

INDO-MALAYAN REALM

Prepared on behalf of the World Bank

by

The Asian Bureau for Conservation (ABC)

in collaboration with

The World Conservation Monitoring Centre (WCMC)

Edited by John MacKinnon

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FOREWORD

This report documents the growth and changing character of the protected areas systems of the Indo-Malayan Realm over the ten year period 1986 - 1996 and updates the Review of the Protected Areas System in the Indo-Malayan Realm published by the IUCN in 1986. In addition, the report provides specific suggestions on how the present approaches and initiatives relating to protected areas management could be improved throughout the Realm.

The 1986 - 1996 period was a time of uneven change in the level of public awareness and political commitment to biodiversity conservation throughout the countries of the Indo-Malayan Realm. There were many noteworthy initiatives to halt the loss of biodiversity through the establishment of national protected areas systems. Yet, the extinction of species, the conversion and degradation of natural habitats and the disruption of ecological processes continues at a disturbing rate throughout much of Asia. Changes in public awareness and political good will have yet to result in the level, or quality of "on-the-ground" protected areas management required to halt or reverse these negative trends. As the report points out, there is a long way to go towards establishing a truly effective protected areas system for the Indo-Malayan Realm.

During the 1986 - 1996 period, many countries undertook their own national biodiversity reviews or developed detailed national conservation strategies and environmental action plans. These various national efforts -- each varying with respect to style, approach, methodology, and objective -- now make it necessary to synthesize the large pool of new information into a readily accessible format upon which to build for the future.

The report makes specific suggestions at the country and bio-unit levels on priorities for future investments and institutional development. A wide range of national and international interventions are needed. Perhaps most importantly, the report highlights the urgent need to develop the human resources capacity to implement and manage national protected areas systems. Programs to provide practical training and equipment for on the ground managers and scientists are the utmost priority.

We hope this review will be of value to conservation specialists and development practitioners in their quest to conserve Asia's rich biological resources upon which so many people depend.

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TABLE OF CONTENTS

Copyright/Publication details	ii
Foreword	iii
Acknowledgements	iv
Table of Contents	vi
Executive Summary	viii

Part One - GENERAL REVIEW AND PRINCIPAL FINDINGS

1.1	Background for Present Review	1
1.1.1	Aims and Scope of the Present Review	1
1.2	Need for a Protected Areas System	2
1.3	Introduction to the Indo-Malayan Realm	4
1.3.1	Physical Limits	4
1.3.2	Climate and Vegetation	4
1.3.3	Floral Characteristics	7
1.3.4	Faunal Characteristics	8
1.3.5	Biogeographical Units	9
1.3.5.1	Classification of Biounits	9
1.3.5.2	Richness and Endemism in Biounits	10
1.3.6	Threats, Loss of Resources and Trends	12
1.3.7	Efforts to Conserve Biodiversity in the Realm	13
1.3.7.1	Policy Issues	13
1.3.7.2	Development of Protected Areas	13
1.3.7.3	Management Capacity and Training	14
1.3.7.4	Participation in International Programmes	14
1.3.7.5	Transfrontier Issues	17
1.4	Analysis and Findings	18
1.4.1	Practical Aspects of the Review	18
1.4.2	Scoring Methods used in the Review	19
1.4.2.1	Biodiversity Index	19
1.4.2.2	Conservation Index	20
1.4.2.3	Opportunity Index	21
1.4.3	Principal Findings	22
1.4.3.1	Biodiversity Index (BI)	22
1.4.3.2	Conservation Index (CI)	22
1.4.3.3	Opportunity Index (OI)	22
1.4.3.4	Changes since the 1986 Indo-Malayan Review.....	31
1.4.3.5	Overall Conclusions	33
1.4.4	Summary of Country Needs	35

Part Two - CLASSIFICATION AND REVIEW OF BIOUNITS

A.	Indian Subcontinent	39
2.1	Unit I1: Transhimalayan	39
2.2	Unit I2: Himalayas	40
2.3	Unit I3: Thar/Indus	41
2.4	Unit I4: Semi-Arid Zone	42
2.5	Unit I5: Western Coast	42
2.6	Unit I6: Deccan Peninsula	43
2.7	Unit I7: Gangetic Plain	44
2.8	Unit I8: Laccadives and Maldives	45
2.9	Unit I9: Assam	46
2.10	Unit O2: Ceylon Wet Zone	47
2.11	Unit S13: Ceylon Dry Zone	47

B. Indo-Chinese Sub-region	48
2.12 Unit 04: Burmese Coast	48
2.13 Unit 05: Coastal Indochina	49
2.14 Unit 06: South China	50
2.15 Unit -M: Annamese Mountains	51
2.16 Unit 09: Burmese Monsoon Zone	52
2.17 Unit 10: Indochina	53
2.18 Unit 20: Andaman Islands	54
C. Sundaic Sub-region	55
2.19 Unit 07: Peninsular Malesia	55
2.20 Unit 21: Sumatra and Nicobars	56
2.21 Unit 22: Java and Bali	57
2.22 Unit 25: Borneo and Palawan	58
D. Wallacean Sub-region	59
2.23 Unit 23: Lesser Sundas	59
2.24 Unit 24: Sulawesi	61
2.25 Unit 26: Philippines	62
2.26 Unit 13: Moluccas	63
E. Papuasian Sub-region	64
2.27 Unit P3: New Guinea	64

Part Three - COUNTRY REPORTS

3.1 Bangladesh	69
3.2 Bhutan	74
3.3 Brunei	79
3.4 Cambodia	84
3.5 India	91
3.6 Indonesia	98
3.7 Lao P.D.R.	108
3.8 Malaysia	115
3.9 Myanmar	122
3.10 Nepal	129
3.11 Pakistan	135
3.12 Papua New Guinea	141
3.13 Philippines	148
3.14 Singapore	154
3.15 Sri Lanka	158
3.16 Thailand	164
3.17 Vietnam	171
ANNEX 1 Sources of GIS Coverages	178
ANNEX 2 Codes and Acronyms Used in Review	184
BIBLIOGRAPHY	187

MAPS

- Map 1 Original Habitats and Biounits of the Indo-Malayan Realm
Map 2 Remaining Habitat and Protected Areas of the Indo-Malayan Realm
Maps 3 - 18 Country Coverages of Remaining Habitat and Protected Areas

EXECUTIVE SUMMARY

Context

This report summarises the findings of a two year study to revise and update the *Review of the Protected Areas System in the Indo-Malayan Realm*¹ published by IUCN-The World Conservation Union in 1986. The main objective of the study was to examine the changes to the system of protected areas of the Indo-Malayan Realm over a 10-year period with a view to:

- evaluating the representational coverage and conservation importance of the existing protected areas system;
- identifying gaps and shortcomings in the existing system;
- identifying sites of global priority for conservation; and
- monitoring progress on the development of protected areas within the Realm.

The report evaluates protected areas systems in the Realm from a number of viewpoints: how much of each country and its bio-geographical sub-divisions are under protection status; the management effectiveness in individual countries; the coverage in relation to species richness, centres of endemism, and in relation to threats to habitat. The is intended for both development practitioners and biodiversity conservation specialists who require a comprehensive reference guide to the status of the protected areas system of the Realm² and guidance for future actions.

Findings

During the period 1986 - 1996, many notable improvements were made in the protected areas systems throughout the Realm. Almost all countries now accept the importance of establishing nature reserves in the form of national parks, wildlife sanctuaries, or genepool reserves. Since 1986 most countries of the Realm have completed national conservation plans, action plans or strategies. Virtually all countries have made improvements to both the extent and coverage of their protected area systems as well as on their standards of management, legislation and general conservation awareness. Vietnam, Lao PDR, Cambodia, Burma and Thailand, for example, have completely transformed and strengthened their protected area systems.

Region-wide there has been a great increase in both the number and size of protected areas. The area of land accorded protected areas status, for example, has risen by more than 50 per cent since 1986. There have also been several major international initiatives to support the establishment and management of protected areas. Most significant of these has been the signing and ratification of the Convention on Biological Diversity by most of the countries within the Realm. The establishment of the Global Environment Facility as a major international funding mechanism has also achieved considerable

¹ For the purposes of this review, the Indo-Malayan Realm comprises the 18 countries of South Asia, Indo-China, and South East Asia including Papua New Guinea.

² The present report summarises the main findings of the review, but there are a number of other study outputs: *A Review of the Protected Area System of the Indo-Malayan Realm - Marine Component* (Cheung, in press); *Wildlife Trade in the Indo-Malayan Realm* (Nash, in press) and *Endemic Bird Areas in the Indo-Malayan Realm and their Application* (Crosby, in press). Outputs are available in both hard copy format as well as a software package (Biodiversity Information Management System' - BIMS). The software was the major analytical tool for the review and provides a lasting data management tool for the region. BIMS contains all the data and mapped information used in the review and is distributed on CD-ROM by the Asian Bureau for Conservation. Geographic information system techniques were used extensively throughout the study to help identify critical gaps where more action is needed.

progress in the area of biodiversity conservation in countries such as Bhutan, Lao PDR, Philippines, and Nepal.

The report concludes that while there is some room for optimism, there is no room for complacency. There is an overwhelming sense among reserve managers and conservation planners that the current level of effort is insufficient to stabilise rates of habitat loss which continues³ at an unacceptable rate. Indeed, despite apparent success in getting large areas of natural habitat included in protected area systems, the overall situation for biodiversity conservation looks worse than it did 10 years ago.

Since 1986, little has changed with regard to the underlying threats and constraints to effective protected areas management. The large and continuously growing human populations of the region are still heavily dependent on the direct and indirect production of biological resources. The report concludes that over 60% of the Indo-Malayan Realm's original natural vegetation cover has been lost. Much of what remains is degraded to varying degrees as a result of human use with the main threats continuing to stem from both subsistence and commercial use of natural habitats. Threats such as commercial logging, fuelwood collection, overhunting, land conversion, fire, wildlife trade, climate change, desertification, pollution, and spread of exotic species though well understood, have proven difficult to manage.

Recent experience shows that implementing effective and sustainable protected area management systems constitutes an enormous operational challenge. Conflicts between conservation and development goals, especially for communities living within and around protected areas, are still commonplace. Very few models of well-run reserves with stable buffer zones can be identified. The study also finds that while conservation of forest habitat types are at least being addressed, the conservation of aquatic habitats and grasslands still lags far behind. A comprehensive review of marine protected areas - whose the protection status and management of these areas are made more complicated by special problems of ownership, use and control - was carried out as part of this study.

Progress on establishing sound legal and regulatory frameworks for protected areas and biodiversity conservation is generally positive throughout the region. However, stated policy is not always reflected in government action. Government financial allocations to conservation programs are still low with the result that levels of law enforcement are generally poor, and corruption is still rife in several countries. The quality and levels of staffing and training are poor, and there is a clear shortage of suitable training opportunities to remedy this. Levels of awareness and understanding must be further raised among senior leaders and decision-makers before conservation will be treated more seriously, and a broader and deeper constituency of concern has to be generated among the populace.

³ Two key maps are provided in the report. Map 1 shows the classification of biounits and the distribution of original habitats for the entire Realm. Map 2 shows how little habitat still remains and where this is included in the protected area system. The study's analytical approach relies heavily on the development of three complimentary indices developed to help prioritise between competing demands for investment and action. One of these, the Conservation Index, was developed to act as a continuing and dynamic measure of each country's performance in protecting natural habitats in relation to actual conservation needs and obligations. A score above 1.0 indicates a country is doing an adequate job of conserving natural habitats. Countries with a Conservation Index of 1.0 or above are Brunei, Bhutan, Cambodia, Sri Lanka, and Thailand. The lowest-scoring countries are Bangladesh, India, Myanmar, Malaysia, Philippines, Papua New Guinea and Vietnam. It is believed that all countries could reach a score of 1.0 or higher within ten years, and the specific measures by which this could be achieved as detailed. Maps 3 - 18 presents this information in more detail on a country by country basis.

Funding of national protected area programs has increased from the international development assistance community. The study reports, however, that there are concerns that funds often support donor priorities which do not always coincide with local perceptions. Thus, there is a need to ensure that international funds channelled to conservation purposes are more effectively targeted and utilised. Possible mechanisms for improving performance are discussed.

Recommendations

The report makes a number of specific recommendations at the regional, national and biounit levels. For each country and biounit the report identifies significant gaps in protected area coverage. In addition, the report identifies many operational needs which are generic to all countries of the Realm. These include:

- the need for improving the standards of protected areas management;
- the need to provide sufficient operational budgets both for enforcement and pro-active programs at the field level;
- the need to explore and promote opportunities for regional co-operation in the form of trans-boundary protected areas management and scientific data sharing where appropriate;
- the need to focus conservation efforts on a broader range of habitat types such as freshwater and marine systems;
- the need for increased funding and systematic efforts in the area of basic scientific field surveys, monitoring programs, and biodiversity information systems development;
- the need to more aggressively manage inter-sectoral conflicts between activities such as mining, oil exploration, agricultural expansion, highway construction, illegal logging and biodiversity conservation; and
- the need to ensure international development assistance programs co-ordinate their financial and technical assistance for conservation efforts.

While the report frankly addresses the many difficult challenges which remain ahead for protected areas management in the Indo-Malayan Realm, it also maintains that there are ways that interventions can be designed to be more effective and responsive to field management problems. It emphasises that appropriate responses must seek to harmonise international, national and local level initiatives. More efforts to include NGOs and local communities in the formulation and implementation of protected area management plans are urgently required. This will require much closer co-operation and new conservation partnerships across the region. If commitments are made to the recommended interventions then it is believed that all countries of the Indo-Malayan Realm could achieve significantly improved protected areas systems within the next decade.

PART ONE - INTRODUCTION AND PRINCIPAL FINDINGS

1.1 BACKGROUND FOR THE PRESENT REVIEW

In 1986, the IUCN published a review of the protected area systems in the Indo-Malayan Realm (MacKinnon & MacKinnon, 1986). Many of the data used at that time were already several years old. The results and conclusions of the 1986 Review are now more than a decade out of date. In addition, a great deal has happened in the intervening period. Several countries of the Indo-Malayan Realm including Vietnam, Laos, Cambodia, Myanmar and Thailand have completely transformed their protected area systems. Others, like India, have undertaken their own national review of Protected Area coverage (Rogers and Panwar, 1988). All countries of the Indo-Malayan Realm have made improvements to their system of protected areas as well as to their standards of management, legislation and general awareness of conservation needs.

In parallel, several major international initiatives have taken place which provide a better framework for evaluating performance of different countries in the field of biodiversity conservation. Two significant initiatives deserve special mention. First, the signing and ratification of the Convention on Biological Diversity (CBD) by most of the countries of the Realm (see Table 1.5). Second, the establishment of the Global Environment Facility (GEF) as a major international funding mechanism to promote, among other objectives, the conservation of biodiversity.

Moreover, there are now better methods available for conducting such a review and analysing, presenting and disseminating the results than there were a decade ago. For example, there is better quality satellite imagery for evaluating the extent of habitat loss and indicating trends and Geographic Information Systems (GIS) are now more readily available to support analytical work. Thus, there is both an urgent need and timely opportunity to review the state of protected area development and conservation management of the Indo-Malayan Realm.

1.1.1 Aims And Scope Of The Present Review

This document presents the findings of the revised review of protected areas in the Indo-Malayan Realm. It is based primarily on existing in-country biodiversity reviews, national conservation strategies, biodiversity action plans or other types of national reviews. This review will guide protected area development within individual countries and will help international agencies plan programs of assistance. The current review aims to re-examine the existing system of protected areas of the Indo-Malayan Bio-geographical Realm with a view to:

- evaluating the representational coverage and conservation importance of the existing protected areas system of the Realm;
- identifying gaps and shortcomings in the existing system;
- identifying sites of global priority for conservation, both existing and proposed, which should form the focus of international assistance for protected area development;
- monitoring progress on development of PA systems in the various countries over the 10 year period since the previous Indo-Malayan Review (MacKinnon & MacKinnon, 1986).

The review has drawn on country and protected area data sheets, GIS data layers and both species and protected areas databases held by the World Conservation Monitoring Centre (WCMC) in Cambridge, UK. These data in turn have been drawn from and augmented by

many national and other sources. During the course of the review, three sub-regional terrestrial workshops and one regional marine workshop were held with representatives of both governmental and non-governmental organisations of the countries concerned to evaluate, revise and update the existing data pool for the review. Other major sources of information used include the many species action plans developed by the Species Survival Commission of IUCN, studies of endemic bird areas (EBAs) conducted by BirdLife International, and data held on trade by TRAFFIC. The findings of these studies are being published as separate reports. The review has also considered the marine protected areas systems. The findings and conclusions for marine ecosystems are published in a separate report.

The current review evaluates protected area data from a number of different viewpoints:

- the area of each country and bio-geographical sub-division which is protected;
- coverage in relation to species *richness*, centres of high biological distinctiveness or *endemism* and in relation to *threats* to habitat;
- management effectiveness in individual countries; and
- consideration of adjacent land-use and critical habitat requirements.

In evaluating the suitability of protected area systems in the Indo-Malayan Realm, attention has been paid to current theory of protected area design based on island biogeography and species patterns of migration and distribution (including the need for habitat corridors). In addition, the review has considered management and political practicalities, such as potential for transfrontier protected areas connections. The principles involved are outlined in more detail in the IUCN Indo-Malayan Review (MacKinnon and MacKinnon, 1986) and need not be repeated here.

1.2 NEED FOR A PROTECTED AREAS SYSTEM

Protected areas are territories with legally defined boundaries established to afford protection to certain natural characteristics of particular value or interest. The establishment and management of such protected areas are regarded as two of the most important ways of ensuring that the world's biological resources are conserved to meet the material and cultural needs of mankind now and in the future. The World Conservation Strategy, launched jointly by IUCN, WWF and UNEP in 1981, advocated conservation of living resources as essential for sustaining development by:

- maintaining the essential ecological processes and life-support systems on which human survival and development depend;
- preserving genetic diversity on which depend the breeding programmes necessary for the protection and improvement of cultivated plants and domesticated animals, as well as much scientific advance, technical innovation, and the security of the many industries that use living resources; and
- ensuring the sustainable use of species and ecosystems which support millions of human communities as well as major industries. An essential element in any programme attempting to achieve these objectives is the establishment of networks of protected areas for in situ conservation of species and ecosystems.

The need for protected areas has been accepted by all the national governments in the Indo-Malayan Realm. Objective I of the Bali Declaration prepared by IUCN (1984) as an outcome of the Third World National Parks Congress in Bali in 1983 is "to establish, by 1993, a world-wide network of national parks and protected areas, exemplifying all terrestrial ecological regions". It was also agreed at the Congress that a biogeographical approach should be used in selecting additional protected areas. The 1992 Caracas Action Plan calls for the protection of 10% of all biomes by the year 2000.

Building on these initiatives, the Convention on Biological Diversity (CBD) was initiated in 1992. The CBD has three main objectives. First, to conserve biological diversity. Second, to ensure that the use of biological diversity is sustainable. Third, to ensure that the benefits derived from these uses are shared equitably. The CBD requires countries to develop a fully representative system of protected areas (Article 8) that has full ecosystem coverage, buffer zone integration, necessary restoration, control of alien species, and respect of traditional knowledge. Other articles of the Convention require *ex-situ* conservation, international co-operation, monitoring, training and education work. The CBD has been signed by almost all the countries in the Realm and has the power of funds in the form of the Global Environment Facility (GEF) to assist developing countries in its implementation.

Protected areas may be established for several reasons including protection of characteristic or unique examples of ecosystems, species of special interest, landscapes or geophysical features of aesthetic or scientific value, hydrological protective functions, sites of special scientific interest and cultural sites. Many protected areas serve several of these functions at the same time. The objectives of the protected area will determine the type and degree of protective management needed. In practice, most countries have a number of different categories of protected area, each requiring different levels of protection. Each country has its own criteria and terminology for protected areas.

To standardise the monitoring of the world's protected areas network, IUCN has recently revised and redefined their own protected areas management categories based on legally defined management objectives 1.

Category Ia: Strict Nature Reserve - managed to afford full protection to a natural ecosystem/s in unmodified state.

Category Ib: Wilderness Area - managed mainly for wilderness protection.

Category II: National Park/State Park - managed mainly for ecosystem protection and recreation.

Category III: Natural Monument - managed mainly for conservation of specific natural features.

Category IV: Habitat/Species Management Area - managed mainly for conservation through management intervention.

Category V: Natural Landscape/Seascape - managed mainly for landscape/seascape conservation and recreation.

1 For a more detailed description of these categories, their definitions, management and examples, please refer to the document 'Guidelines for Protected Area Management Categories' (IUCN, 1994). Fuller definitions are also contained in the Biodiversity Information Management Software (BIMS) distributed as part of the current review. The codes UA = unassigned and PRO = proposed are used to designate additional sites discussed in this review that do not yet fall into any of the IUCN categories above. For the purposes of this review categories Ia and Ib are not differentiated.

Category VI: Managed Resource Protected Area - managed mainly for the sustainable use of the natural ecosystem.

1.3 INTRODUCTION TO THE INDO-MALAYAN REALM

A brief review of the most pertinent features of the Realm is offered here to put the findings of protected area coverage within countries and biounits into a more current perspective. A more detailed account of the Indo-Malayan Realm is given in the original IUCN Review (MacKinnon & MacKinnon, 1986). Tables 1.1 and 1.2 present a brief overview of the Realm's social, economic and biological conditions.

1.3.1 Physical Limits

The Indo-Malayan Realm has been defined by Udvardy (1975) and described and reviewed by MacKinnon and MacKinnon (1986). The Realm's natural boundaries contain tropical Asia from the Baluchistan mountains of Pakistan eastward to the Indian subcontinent south of the Himalayan crest, including the tropical southern fringe of China with Taiwan, the whole of South East Asia, the Philippines and all lands of Malesia west of Weber's Line which cuts through the Indonesian archipelago to the east of Sulawesi and Timor. It is preferred, for the purposes of this review, to define the area in terms of complete political units since it is at the national level that management actions and responsibilities must be decided.

In addition, while Papua New Guinea was included in the IUCN Review of the protected areas system of Oceania (Dahl, 1986), the important territory of Irian Jaya and some other parts of eastern Indonesia were not covered in either that review or the Indo-Malayan review of MacKinnon and MacKinnon (1986). Accordingly, the whole of Indonesia and Papua New Guinea has been included, i.e. the entire floristic region of Malesia (Whitmore, 1975), has been included in this review. Similarly, this review covers the whole of Pakistan and will omit the marginal area of China included in the 1986 Review. China now has its own Biodiversity and Protected Areas Review (MacKinnon *et al.*, 1996).

As thus defined, the Indo-Malayan Realm comprises the following countries:

- Pakistan, India, Nepal, Bhutan, Maldives, Bangladesh and Sri Lanka comprise the Indian subcontinent sub-region.
- Myanmar, Vietnam, Laos, Cambodia and Thailand constitute the South-East Asian or Indochinese sub-region.
- Malaysia, Philippines, Singapore, Brunei, Indonesia and Papua New Guinea make up the Malesian sub-regions which can be further divided into the Sundaic sub-region west of Wallace's Line, the Sahul sub-region east of Lydekker's line and Wallacea between the two.

1.3.2 Climate And Vegetation

The main physical factors determining climate are altitude, latitude and rainfall. The climate of the Realm is enormously varied: from the dry Thar desert at one extreme to the lush tropical rainforests of Borneo and the torrential rainfall of the Assam hill stations at the other. The Realm also exhibits such a wide range of altitude - from sea level to the Himalayas - that climate cannot be generalised. For every 100 m increase in elevation, the temperature drops about 0.6 degrees Celsius. Thus, as one goes north or climbs in

Table 1.1 National Data (Area, population, natural cover, deforestation, protected areas)

Country	Area (1000km ²)	Popn. (Mill)	% growth (annum)	Density (km ²)	GNP/capita (\$US)	% Cover Forest	% Deforest (/annum)	No. PAs (UN List	Area Pas > 1000	%PA cover ha)
Bangladesh	144	118	2.5	797	220	6	4.9	8	97	0.7
Bhutan	47	0.7	2.1	15	400	60	0.1	9	966	21.0
Brunei	5.8	0.3	2.5	52	14,240	81	0.4	10	115	20.0
Myanmar	677	45	2.0	66	c.200	43	1.4	2	173	1.0
Cambodia	182	8.5	2.2	47	<500	60	1.4	23	3,267	18.0
India	3,288	914	2.1	287	320	16	0.7	339	13,908	4.4
Indonesia	1,905	190	1.8	107	880	57	1.1	268	18,230	9.5
Laos	237	4.7	2.9	20	320	56	1.0	17	2,756	11.6
Malaysia	330	19.7	2.3	597	3,480	53	2.3	51	1,504	4.5
Maldives	0.3	0.2	3.7	664	950	2	0.0	0	0	0.0
Nepal	141	21	2.5	149	200	35	1.1	14	1,457	10.3
Pakistan	796	129	3.0	160	430	2	4.1	57	3,739	4.7
Philippines	300	67	2.3	237	950	26	1.0	38	597	2.0
Singapore	0.6	2.9	1.1	5000	22,500	7	-0.5	1	3	4.5
Sri Lanka	66	18	1.5	276	6400	26	1.5	56	796	12.1
Thailand	513	58	1.4	114	2,410	25	4.0	112	7,939	12.1
Vietnam	332	72	2.1	217	200	25	1.6	59	1,330	4.0
P.N.Guinea	463	4.2	2.7	10	1,240	78	0.3	5	82	0.2

Figures for protected areas are taken from the UN List (1996 draft) (courtesy of WCMC). These include only areas greater than 1000 ha with established management and assigned to IUCN categories I-V. Other data from The World Bank's World Development Report for 1996 and the Far Eastern Economic Review (1994).

Table 1.2 Biological richness, indicators of importance and management standards

Country	Mega-diversity	Hotspots	EBAs	Endangered Spp.*			Priority* "A" Sites	Standards of Protection			Staff/ 1000 km2	Budget \$/km2
				Mamm.	Bird	Plant		Laws	Enforced	Staffing		
Bangladesh			1	24	24	60	1	Med.	Poor	Inad.	207	246
Bhutan		E.Him.	1	24	12	21	3	Med.	Med.	Inad.	8	93
Brunei		N.Borneo	1	17	13	27	2	Med.	Med.	Med.	165	3771
Myanmar			4	29	40	56	7	Med.	Good	Med.	186	69
Cambodia				28	18	15	6	Med.	Nil	Nil	0	0
India	yes	W.Ghats	8	53	69	1802	32	Good	Med.	Med.	nd	nd
Indonesia	yes	N.Borneo	24	77	123	509	58	Good	Poor	Med.	nd	nd
Laos			1	33	23	10	7	Med.	Nil	Inad.	nd	1
Malaysia	yes	W.Malay	2	32	35	510	9	Med.	Med.	Med.	109	500
Maldives				0	1	0	0	Nil	Nil	Nil	0	0
Nepal		E.Him.	2	28	24	133	6	Med.	Poor	Good	58	80
Pakistan			2	17	25	21	5	Good	Poor	Med.	102	6
Philippines		Philipp.	9	31	43	604	6	Med.	Poor	Med.	nd	nd
Singapore				7	5	84	0	Good	Good	Med.	nd	nd
Sri Lanka		Wet Zone	1	9	8	743	7	Med.	Med.	Good	85	1087
Thailand				33	38	454	5	Med.	Med.	Med.	36	667
Vietnam			3	35	40	642	10	Med.	Poor	Inad.	nd	nd
P.N.Guinea	yes		12	38	22	103	10	Weak	Poor	Inad.	14	211

EBAs = Endemic Bird Areas. Numbers of endangered species are taken from IUCN Red Lists/Books. Number of priority "A" sites of global significance is taken as per this review. Data for staff and budgets are taken from James et al.(1996). Med. = Medium
Inad. = Inadequate. nd = no data.

altitude tropical animals and plants are replaced by species more characteristic of temperate zones.

Rainfall must be considered both in terms of annual total as well as seasonal distribution. Equatorial lowland areas that receive at least 6 cm of rain each month can support evergreen rainforest. Areas with marked dry seasons can support deciduous or monsoon forest only if the total annual rainfall is very high. When rain falls more evenly throughout the year, the total precipitation needed to support forest vegetation is less. Where rainfall is too low, or too seasonal, savannah, scrub or even desert are found.

The pattern of rainfall in tropical Asia is determined by two monsoons: a "summer" or dry monsoon (May-October) and a "winter" monsoon (November-April). In "summer", the sun passes directly over northern India and southern China and a belt of low pressure builds up over the hot Asian mainland. Rain-bearing winds blow north from the high pressure zones now existing over Australia and the Indian Ocean. These winds pick up moisture as they pass over wide areas of sea but when they reach the Asian mainland or islands they must rise to cross hills and mountain ranges and, as they climb, the air cools and drops the moisture as rain. Heavy monsoon rains fall on India, southern China and most of South-East Asia but the Lesser Sunda Islands and southern Sulawesi, lying in the Australian rainshadow, receive little rain.

From October-November the sun lies south of the equator, central Asia is very cold and now lying in a high pressure zone. Monsoon winds blow southwards towards the hot, low pressure zone over Australia. These cool winds are met by warmer winds blowing northwards up towards the equator from another low pressure zone in the southern Indian Ocean. Where the hot and cold air meet heavy rains fall over the Malesian archipelago and north Australia.

Tropical 'ever-wet' forests are found on the mountains of south west Sri Lanka, the Western Ghats of India, Assam and the west coast of Burma, the Malay peninsula south of Kra, parts of Indo-China and on many of the islands of the Malesian archipelago. These forests can be divided into lowland and montane. The division between the two lies at about 1000 metres altitude at the equator but becomes progressively lower as one moves north. The subtropical rainforests resemble tropical lower montane forests both in structure and species composition and the two vegetation types are classed together by some authors (e.g., Whitmore, 1975).

A belt of montane 'ever-wet' forest stretches along the foothills of the Himalayas into the mountains of Indo-China and similar forest occurs in isolated patches on the highest equatorial mountains. Most of the remaining land of the Realm was originally covered in forests of varying degrees of deciduousness, culminating in the extremely arid thorn desert and scrub vegetation of north west India and Pakistan.

The fine details of vegetation are determined by such other features as land-form, soil-type, drainage, aspect and the history of human disturbance. Man has had a long and profound impact on the vegetation of tropical Asia and it is here that human populations live at the highest densities. Most of the grasslands, bamboo brakes and scrub forests of the Realm are the result of past human land-use and the degraded condition of the forests of peninsular India and the present extent of the Thar desert are secondary features brought about by Man.

1.3.3 Floral Characteristics

The Indo-Malayan Realm includes three main floristic regions: the Indian sub-continent; Indo-China; and Malesia which includes the lowlands of New Guinea.

Indian sub-continent

The flora of the Indian sub-continent region is estimated at about 15,000 species. The original flora was probably much richer having suffered from severe degradation of natural habitats due to human activity. Mani (1974) estimates that less than 1% of India can be regarded as primary forest. The Indian flora is closely related to the Indo-Chinese and has been largely derived from that region through the Assam corridor which lies in a transition zone between the two regions. Following the drying up of much of India, however, some Ethiopian species have spread into the drier areas from the west.

Indo-China

The flora of Indo-China is incompletely known. Vidal (1960) lists only 1447 species in 754 genera for Laos but the flora of Vietnam is estimated at about 10,000 species, of which 7000 have been described and the flora of Thailand is estimated at 11,000 (WCMC, 1994). The total flora of the region is probably about 15,000 species. At least one third of these species are endemic to the region. Endemism at generic level is rather less.

Malesia (Sunda, Wallacea, Papuanian).

The Malesian flora is conservatively estimated to contain 25,000 species of flowering plants (van Steenis, 1971), about 10% of the world's total. Peninsular Malaysia alone contains nearly 8000 species from 1500 genera (Whitmore, 1975). Floristically, Malesia is the richest and most important region. Malesia contains one of the largest blocks of tropical rainforest in the world: second only to the Amazon region. The northern limits of the region are clearly marked by 'demarcation knots' at the Kra isthmus and between the Philippines and Taiwan which form the limits of many Indochinese and Malesian genera. About 40% of the genera found in Malesia, and even more of the species, are endemic to the region. The biggest family is Orchidaceae with 3000-4000 species. Some 500 species of trees of the family Dipterocarpaceae are found in the region. The flora of lowland New Guinea is Malesian although the fauna is like the mountain flora derived from Australasia.

1.3.4 Faunal Characteristics

The characteristics of the Indo-Malayan fauna that distinguish it from that of other Realms are of relatively recent origin. There are few endemic families. Only four endemic mammal families are present, and include the tarsiers and tree shrews, spiny dormice and the flying lemurs. The latter constitutes an endemic order Dermoptera of uncertain affinities. The only endemic bird family is the fairy bluebirds (Irenidae). The Realm has a rich reptilian fauna with many species of lizards, snakes and turtles. There is an endemic family of slender-nosed, fish-eating crocodiles, the gharials.

Tailed amphibia are present only in the northern transition zones of the Realm but anurans are common. The tree frogs of the Indo-Malayan Realm belong to the polypedatid family, as do the African tree frogs. The freshwater fish of the Realm are dominated by the carp and catfish families and although the Realm has few endemic families it has many endemic genera and species. Having derived its original fauna from the Palaearctic, Africa and, to a lesser extent, from Australia and the drifting Indian continental plate, the Realm has been a recent and dynamic centre for evolution. A history of relatively stable equatorial conditions, combined with dynamic geological changes in which land connections have been repeatedly formed and broken, has allowed isolated populations to radiate. These events have led to the enormous species richness and the high levels of local endemism characteristic of the Realm. For example, Indonesia alone has more species of birds and trees than the whole continent of Africa.

1.3.5 Biogeographical Units

1.3.5.1 Classification Of Biounits

The Indo-Malayan Realm is divided by Udvardy (1975) into 27 units. These were further subdivided into a finer classification of 70 biounits grouped in three sub-regions in the IUCN Indo-Malayan review (MacKinnon & MacKinnon, 1986). For this review, the Realm has been divided into five sub-regions, namely Indian sub-continent, Indo-Chinese, Sundaic, Wallacean and Papuasian (Sahul). An alternative classification of the Ecofloristic zones scheme developed by FAO (1989) was examined but not adopted. This scheme is designed to help the exchange and comparison of vegetation mapping and is based on climate and vegetational formations. However, it does not adequately reflect biogeographical divisions between vegetation formations of the same type and the units are too large and imprecisely defined for the level of analysis being undertaken for this present review.

On the basis of the respective levels of similarity and distinctiveness in species communities, the different sub-regions have been classified into a total of 90 biogeographic sub-units, classed into 24 major biounits. These units have been kept as close as possible to those used in the IUCN 1986 Review which retained the numbering system of Udvardy (1975). Each biounit is given a three character code: the first two characters refer to the major unit it belongs to and the third character the sub-unit.²

The following revisions have been made since the 1986 Review.

- At the sub-unit level, Unit 05 Indochinese coasts have been split into four (05a-05d) instead of two sub-units and an extra transition unit 09c has been added along the Indian, Burmese border to reflect the floral similarity of that area to Indo-China rather than the Indian sub-continent;
- two montane sub-units (-Ma, -Mb) have been split from unit 05 in recognition of the distinctiveness of the Central Annam Mountains and Dalat Plateau;
- the Eastern Himalayan unit I2d has been extended into northern Burma.

The biogeographical classification of India has been the subject of considerable study, including the detailed mapping of the vegetation by Champion (1936), a major work by Mani (1974) and, more recently, biogeographical classification by Rodgers and Panwar (1988). The most recent study (Panwar, 1990) divides India into 10 biogeographical zones which are, in some cases, subdivided into a total of 25 biotic provinces. This classification has been adopted for use in this review since this system is already well-known in India and the database at the Wildlife Institute of India (WII) is using these units for analysis.

The numbering system of Panwar (1990) (note: numbers are different from Rogers and Panwar 1988) has been preceded with the letter "I" to distinguish these numbers from the other numbers in the review which follow Udvardy (1975) and MacKinnon and MacKinnon (1986). The system has been extended to cover Pakistan, Nepal, Bhutan and Bangladesh. Only the Rogers and Panwar units 09a Andamans and 09b Nicobars are not followed as these are related to the Indo-Chinese and Sundaic sub-regions, respectively and given the same coding as in the IUCN 1986 Review. The units used for this review are in some cases different from the units followed for the 1986 Review which were based on the preliminary classification of Rogers (1983), considerably revised for Rogers and Panwar (1988) and

² Table 1.3 lists the major biounits; Annex 2.2 gives a complete list of all biounits and sub-units with their codes; map 1 shows the extent of the biounits as classified in the review.

Panwar (1990). In addition, the Ceylon dry zone, which was unit 13 under Udvardy (1975) and MacKinnon and MacKinnon 1986, has been renumbered S13 to avoid confusion with the Moluccan unit 13 (from Udvardy's Oceania numbering system).

The fauna of Indo-China is a mixture of Himalayan Palaearctic species which have come into the mountainous northern parts of the sub-region, Chinese Palaearctic species which have spread along the coast of southern China, Sundaic species that have come up the Malay peninsula and a larger number of species shared with northern India through the extensive Burma-Assam transition zone. Some endemism is found, (Table 1.3) and a number of biogeographical divisions can be recognised in the unit.

Sundaic affinities are largely confined to a southern and eastern coastal unit (unit 05) which is climatically wetter than the rest of Indo-China and which is partly isolated by the Cardamom Mountains, Dalat Plateau and Annamite chain. To the east of this latter chain of mountains there are also a number of distinct species and subspecies. The Red/Black river gorges and delta form an effective barrier to many species in northern Vietnam such that unit 06 is closely related to southern China. Udvardy (1975) has used a single zone for all of Indo-China and Thailand. The main central domain of Indo-China (unit 10) is fairly uniform bio-geographically but with marked changes with altitude and latitude and is divided by most authors, e.g. Vidal (1960), Gressitt (1970), on the basis of altitude. Accordingly, the unit has been divided into three subdivisions being basically tropical lowlands, tropical montane and sub-tropical transition zone. Unit 04 is a moist coastal zone of 'ever-wet' rainforest with as close a relationship with Bengal and the Himalayas as with the rest of Indo-China. The very dry Irrawaddy plain constitutes a fairly distinct Burmese unit with again a northern transition zone with the mountains of the Tibet-Yunnan plateau.

1.3.5.2 Richness And Endemism In Biounits

Table 1.3 gives levels of species richness and endemism for various groups in the different biounits. It will be seen that species richness in the Wallacean units tends to be moderate to low but that levels of endemism are very high. In the Sundaic units, however, species richness is very high whilst endemism is relatively low. This is because the units of the Sundaic sub-region were linked by land several times during the Pleistocene and share many species. This pattern is clearly shown in Figure 1.1. As a sub-region, however, Sunda is very distinct with over 400 species of birds endemic to the whole sub-region and similar levels of endemism are found in other groups.

The Indo-Chinese sub-region is of comparable faunal richness, lower plant richness and far lower levels of endemism. The floral affinities of Indo-China are closer to India (44%) and China (32%) than to Malesia, though for some individual families, e.g. ferns and Lauraceae the affinities are closer to China (Palaearctic) than to India. The Indo-Malayan Realm is characterised by high human density and high human dependence on natural resources gathered directly or indirectly from the vast array of natural habitats and ecosystems. It is impossible to add up these benefits in a precise way but it is possible to estimate the scale by estimating how many people are involved and the amount of biological resources they are consuming.

Most people in the region derive significant proportions of their fuel, the materials for their homes, fodder for livestock, medicines, and at least half of their protein intake from the natural environment. They are also indirectly dependent on the natural environment for the quality of water supply, soil protection, climatic regulation and the basic resources from which all future improvements to their crops and domestic animals are dependent. In many cases, the value of these benefits often exceeds the actual monetary income of the local people. For the Indo-Malayan Realm as a whole, monetary benefits derived from

Table 1.3 Biological Importance of Indo-Malayan Biounits
(adapted from MacKinnon & MacKinnon, 1986)

Unit Name	Plant		Mammals		Birds	
	spp.	%end.	spp.	%end.	spp.	%end.
Indian Sub-region						
I1 Transhimal	low	mod.	15	8	30	3
I2 Himalayas	mod.	high	48	2	124	6
I3 West Arid	low	low	26	-	64	5
I4 Central-West India	mod.	low	40	-	62	-
I5 South West India	high	high	32	12	57	9
I6 Deccan Plateau	mod.	low	28	-	47	4
I7 Gangetic Plain	low	mod.	30	-	65	-
I9 North East India	high	high	55	2	112	1
O2 Ceylon Wet Zone	high	v.high	20	10	39	15
S13 Ceylon Dry Zone	low	low	20	10	41	3
Indo-Chinese Sub-region						
O4 Burmese Coast	mod.	low	50	2	89	-
O5 Indochinese Coast	mod.	high	59	3	113	-
-M Annam Mountains	low	high	30	2	85	2
O6 South China	low	mod.	35	10	95	1
O9 Central Burma	high	mod.	55	2	144	3
10 Indochina	high	mod.	65	2	152	3
20 Andamans	mod.	c.10	-	-	29	10

Sundaic Sub-region						
O7 Malay Peninsula	820	15	208	3	480	1
21 Sumatra/Nicobars	820	11	221	12	466	6
22 Java/Bali	630	5	133	12	362	10
25 Borneo/Palawan	900	34	221	19	440	10
Wallacean Sub-region						
23 Lesser Sundas	510	1	41	12	242	30
24 Sulawesi/Sula	530	7	114	60	268	32
26 Philippines	700	27	127	66	367	39
13 Moluccas	380	6	69	17	210	33
Papuasian						
P3 New Guinea/Aru	1030	55	125	58	602	52

Note: Relative scoring of different biological indicators. Figures above the line (Indian and Indo-Chinese sub-regions) are not directly comparable with scores below line. Below the line data for birds and mammals are taken from total fauna, data for plants is taken from selected 118 plant families revised in Flora Malesiana. Above the line plant data is qualitative, data for mammals is taken only for ungulates and primates and data for birds is taken from Passerine families only.

nature in the order of hundreds of billions of dollars per year are not unrealistic. Thus, in biodiversity conservation lies the very survival of mankind in the region.

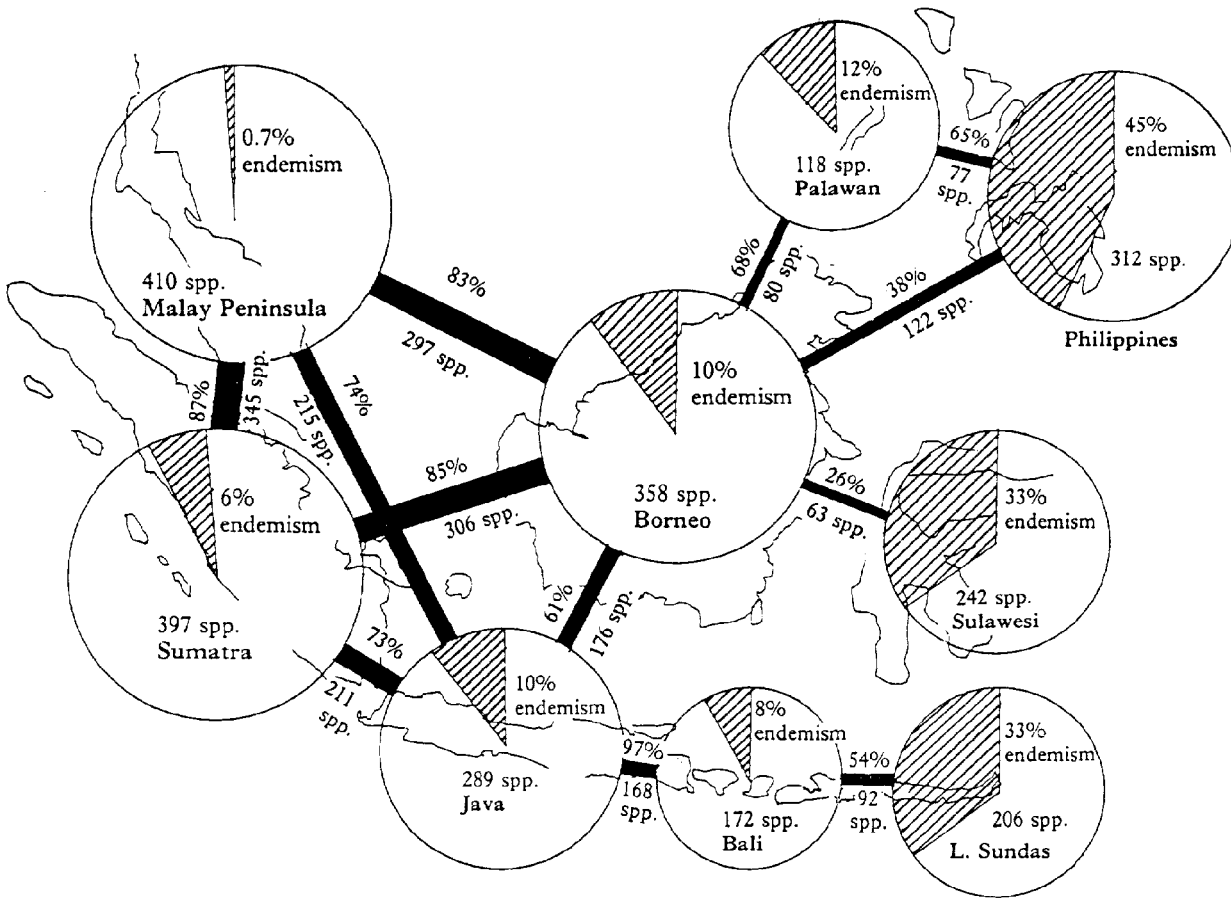


Figure 1.1 Relationships between resident land bird faunas of the Sundaic region.
(MacKinnon & Phillipps, 1993)

1.3.6 Threats, Loss Of Resources And Trends

A vast multitude of threats stem from human overpopulation and a high level of dependence upon biodiversity. The main threats are loss of habitat and living species and unsustainable levels of utilisation of renewable resources. Though described in many publications, the principle threats of uncontrolled logging, fuel-wood collection, excessive hunting, land conversion, fire, climate change, desertification, pollution, spread of exotic species have proven difficult to manage effectively. In many industrialised parts of the region, pollution and acid rain are seriously threatening natural habitats. Wildlife trade is also a growing problem which is proving very difficult to control.

There are many conflicting and imprecise estimates of the rates of decline of the resource base. Nevertheless, all the projections make bad reading. Biodiversity is being lost on all fronts and at an unprecedented rate. This region is losing biodiversity faster than any

other part of the globe. The statement of Braatz (1992) is no exaggeration "Unless immediate, decisive steps are taken to counter the effects of deforestation and other forms of natural resource destruction in the Asia-Pacific region, much of Asia's biodiversity will be irreversibly lost within this generation".

The seas are being over fished and poisoned, coral reefs destroyed, mangroves cleared, forests destroyed and at best replaced by sterile, fire-prone plantations, wetlands encroached upon, polluted and developed, grasslands fenced and farmed. Although efforts to set up nature reserves have shown spectacular spatial gains, it is hard to point to a single sustainable protected area model in the entire region. Domesticated varieties of grain, fruits and vegetables that have taken hundreds of years to adapt to local conditions are being cast aside overnight to make way for modern high-yield varieties without concern for their long-term suitability.

1.3.7 Efforts To Conserve Biodiversity In The Realm

During the last 20 years, the Indo-Malayan Realm has been the site of considerable activity aimed at conserving biodiversity. In particular, the impressive growth in number and size of protected areas indicates that the need for such conservation is well accepted among government's who are demonstrating considerable responsibility. Forest conservation has been most active. Protection of wetlands, grasslands and marine areas has lagged somewhat but now shows signs of catching up with the establishment of forest protected areas.

However, standards of conservation management remain generally low with shortages of funds, training and supervision as the main problems. No country has found a completely satisfactory way for enrolling the support of local people in conserving forests and other critical ecosystems. Various ideas for "buffer zone" development remain vague, under-managed and untried. As this is a region of very high human density and population growth a solution to stabilising land-use practices in buffer zones around protected areas is considered crucial to the success of *in situ* conservation efforts.

Countries clearly understand the long-term value of genetic resources but still have no clear idea of how to sustainably develop such resources. At the present time, the best perceived function of forest is water catchment protection with tourism a very poor second.

Most of the countries in the Realm have ratified the Convention on Biological Diversity and most of the other countries are signatories or in the process of ratification. Progress on the development of national conservation plans, strategies, biodiversity action plans and country studies continues to underpin actions in favour of biodiversity conservation (Table 1.5) though there is much overlap and duplication of efforts.

1.3.7.1 Policy Issues

Every country in the region has adopted policies of protecting ecosystems and natural habitats and species. Most countries have adequate legislation to back-up such policies. These policy statements show good intention and form a sound foundation for action but in many cases, failure to achieve policy objectives results from weak law enforcement rather than lack of intent.

1.3.7.2 Development Of Protected Areas

Most safeguarding of the region's biodiversity relies on the development of protected habitats selected to protect viable examples of all major ecosystems and hence conserve populations of most of the region's living species. Progress in this direction is generally good. It is clear that most countries in the region accept the importance of establishing natural terrestrial and aquatic areas as protected areas in the form of national parks,

wildlife sanctuaries, genepool reserves etc. In addition, a great deal of natural habitat is also conserved through the protection vegetation cover in critical watersheds.

The Bali Declaration (1983) and Caracas Declaration (1992) recommend that each country aim to achieve at least 10% coverage of its territory under a system of protected areas. This figure is based partly on biogeographic theory and also on pragmatic estimates of what countries can afford to devote to conservation of biodiversity. Table 1.1 shows the actual percentage coverage so far achieved by the different countries of the region. A few countries have passed the 10% benchmark, many are getting close and a few are still far off.

Figures 1.2 and 1.3 show the pattern of growth in protected area coverage in the Realm. The major growth of the 1975 - 1990 period has now levelled off and there has been a tendency for protected areas to increase in size. The average size of a protected area in 1990 is double what it was in 1970. The total area protected in the IUCN categories I to IV totals over 62,000 sq km. or about 7% of the Realm.

1.3.7.3 Management Capacity And Training

Most countries in the region have severe shortages of suitably trained staff to establish and manage their biodiversity and protected areas. Personnel shortage is particularly acute in countries which are just developing their national protected areas systems such as Vietnam, Laos, Cambodia, Myanmar and Bhutan. In countries with a long history of protected area management such as Indonesia, Philippines and India, these staff shortages are largely a reflection of inadequate national budget allocations for conservation. They are also a result of lack of training facilities or suitable course development.

Standards of protected area management across the region are generally poor - invariably the result of shortages in numbers and calibre of staff and lack of operational budgets. Other chronic problems include low government salaries leading to inevitable corruption, absenteeism, low staff morale, and poor motivation. Development of a cadre of properly trained, funded and motivated staff is an absolute priority if conservation is going to be a healthy domestic sector. Table 1.4 attempts to evaluate the effectiveness of management through the use of management index scores representing the actual effective protection afforded by each country. Because the sum of money expended per unit area is not an adequate reflection of management standard, a more objective method of monitoring management capacity is urgently required.

1.3.7.4 Participation In International Programmes

The countries of the Indo-Malayan realm vary greatly in their involvement in international programmes. Table 1.5 shows the degree of country participation in some of the major international conservation programmes. As of March 1996, 13 out of the 18 countries of the Realm had ratified the Convention on Biological Diversity. Efforts should be made to ensure complete participation as several countries are missing opportunities for co-operation and assistance by not participating as fully as they should. In addition, the Global Environmental Facility (GEF) provides a powerful funding mechanism to assist developing countries acquire and maintain high standards in biodiversity protection and information management.

All countries of the region should be encouraged to become members of Convention on International Trade in Endangered Species (CITES) if they are to control wildlife trade. Currently, a small number of countries act as conduits for extensive un-controlled and un-monitored trade. Controlling trade will not lead to a loss of national revenue. Rather, it safeguards long-term sustainability of legitimate trade and helps limit national losses of

Fig 1.2

Growth of Protected Areas Indo-Malayan Realm

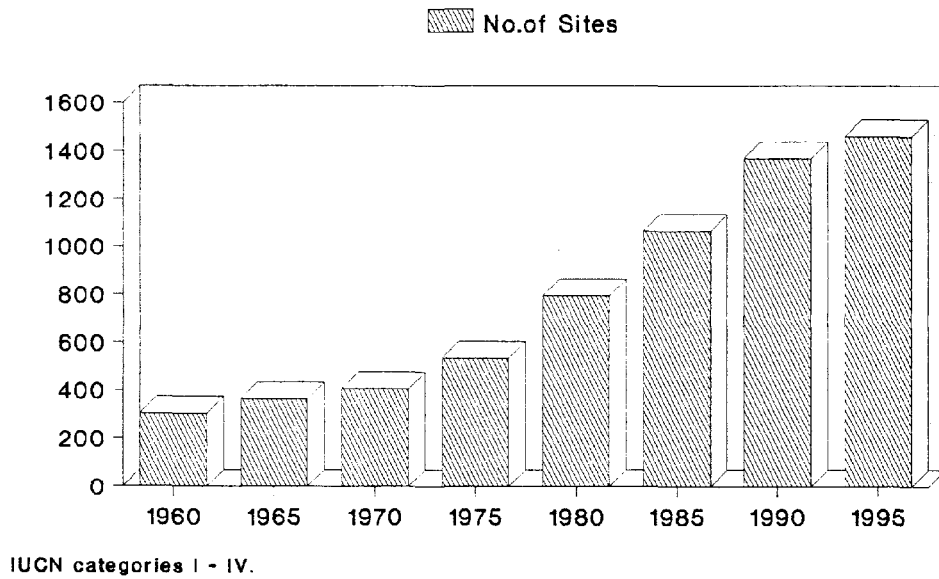


Fig 1.3

Growth of Protected Areas Indo-Malayan Realm

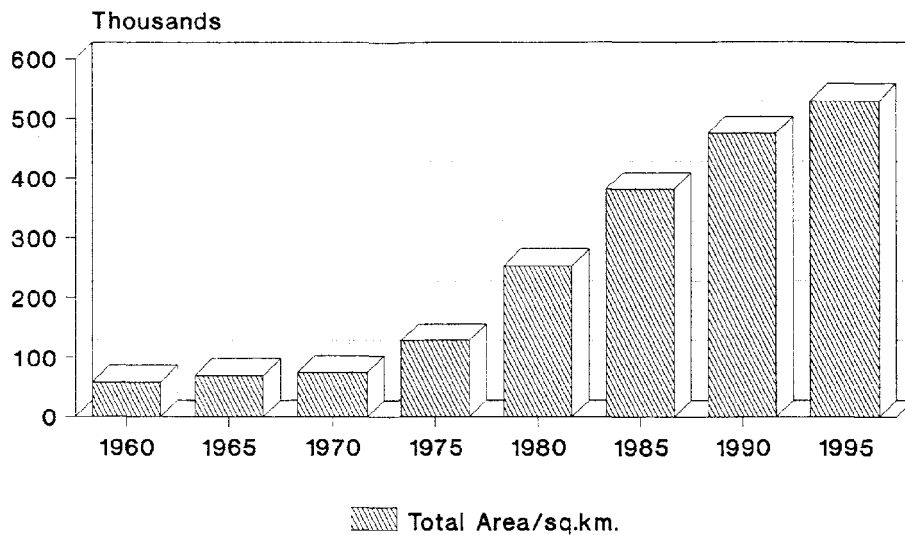


Table 1.4 Scoring of Management Effectiveness by Country

Country	BGD	BRN	BTN	IND	IDN	KHM	LAO	LKA	MAL	MMR
%PA Good	50	30	30	30	20	10	10	50	50	10
%PA Medium	30	60	30	40	40	10	10	30	50	40
%PA Poor	20	10	40	30	40	80	80	20	0	50
Management Index	82.5	80.0	72.5	75.0	70.0	57.5	57.5	82.5	87.5	65.5

Country	MYS	NEP	PAK	PHL	PNG	SGP	THA	VNM
%PA Good	50	50	10	30	40	80	20	20
%PA Medium	50	20	20	30	40	20	50	30
%PA Poor	0	30	70	40	20	0	30	50
Management Index	87.5	77.5	60.0	72.5	80.0	95.0	72.5	67.5

See section 1.4.2 for method of scoring management effectiveness.

Table 1.5 International Participation & Convention on Biological Diversity

Country	CBD Party	Articles of CBD most relevant																		MAB	CITES	GEF (\$M)	BAP	NCS	WH	RAMSAR
		5	6	7	8	9	10	11	12	13	14	16	17	18	20											
Bangladesh	R	*	*	*			*	**	**	**	*	*	*	*	*	*	*	*	R				NCS			1
Bhutan	R		*	**	**		*	*	*	*	*	*	*	*	*	*	*	*	-	10	plan		NES	-		
Brunei		*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	S							yes
Myanmar	R	**	*	**	**	*	*	*	**	*	*	*	*	*	*	*	*	*	-	3.9					-	
Cambodia	R	**	*	**	**	*	*	**	**	*	*	*	*	*	*	*	*	*	8	S					R	
India	R	*	*	*	**	*	**	*	*	*	*	*	*	*	*	*	*	*	R	12	plan				5	6
Indonesia	R	*	*	*	**	*	**	*	*	*	**	*	**	*	*	*	*	*	6	S	13.6	yes	NCP	2		1
Laos		*	**	**	**		**	*	**	**	*	*	*	*	*	*	*	*	-	5.5			NCS	R		
Malaysia		*	*	**	*		*	*	*	*	*	*	*	*	*	*	*	*	R				NCS	R		
Maldives	R	*	**	*	**		*	*	*	*	*	*	*	*	*	*	*	*						R		
Nepal	R			**	**	*	**	*	*	*	*	*	*	*	*	*	*	*	R	3.8	plan		NCS	2		1
Pakistan		*	*	**	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1	R			NCS	R		9
Philippines	R	*	*	*	**	*	*	*	*	**	*	*	*	*	*	*	*	**	2	R	20		NCS	R		
Singapore	R	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	R							
Sri Lanka	R	*		**	**	*	*	*	*	*	*	*	*	*	*	*	*	**	2	R	4.1	plan	NCS	1		1
Thailand		*		**	**	*	*	*	*	*	*	*	*	*	*	*	*	*	3	R	20	plan			1	
Vietnam	R	*	**	**	**	*	*	*	**	**	*	*	*	*	*	*	*	**	1	R	3.0	yes	NEAP	R		1
P.N.Guinea	R	*	**	**	**		**	**	**	**	*	*	*	*	*	*	*	**		5.0	plan			-		

CBD = Convention on Biological Diversity; MAB = Man and Biosphere; GEF = Global Environmental Facility; BAP = Biodiversity Action Plan; NCS = National Conservation Strategy; NES = National Environmental Strategy; NEAP = National Environmental Action Plan; WH = World Heritage Convention; R = ratified; S = signatory; figures under MAB, WH and RAMSAR refer to number of sites. "Yes" under BAP means already drafted, "plan" means BAP is planned.

List of CBD article headings: 5 - Co-operation, 6 - General Measures, 7 - Identification & Monitoring, 8 - In situ Conservation, 9 - Ex situ Conservation, 10 - Sustainable Use, 11 - Incentive Measures, 12 - Research & Training, 13 - Public Education & Awareness, 14 - Impact Assessment, 16 - Access & Transfer of Technology, 17 - Exchange of Information, 18 - Technical & Scientific Co-operation, 18 - Funding.

valuable biological resources through illegal channels. A special study of the trade issues affecting the Realm conducted under the current review is being published by the World Bank as a special report (Nash, in press).

Support for the Man and Biosphere (MAB) programme of UNESCO has been weak, largely because the programme lacks assistance funding. Interest in other conventions such as the wetlands and migratory species programmes has been encouraging and participation continues to grow.

1.3.7.5 Transfrontier Issues And Regional co-operation

Participants in sub-regional workshops held during the past four years consistently stressed the need for greater attention to transfrontier issues and facilitating greater levels of regional co-operation on a number of issues. A regional UNDP Project (RAS/93/102) is helping to promote such co-operation among Vietnam, Laos, Thailand and Cambodia. More programmes of this type are needed, and this section suggests a few options.

- **Transfrontier Reserves**

Many of the international frontiers follow water catchments. These are often selected as sites for protected areas and should in most cases be protected for maintaining ecosystem functions. There are great advantages in neighbouring countries' planning adjacent transfrontier protected areas as they constitute larger coverage of habitat which are ecologically more viable and permit free movement of animal populations. Such arrangements have management advantages in that levels of patrolling and protection of the national boundary can be reduced and levels of poaching, fires and other problems of "poor neighbours" avoided.

Notable examples of important transfrontier reserve arrangements in the region include protected areas along the Indonesian/Malaysian frontier in Borneo, Indian/Bhutan border, Pakistan/China border, Vietnam/Lao and Vietnam/Lao/Cambodia borders, Lao/China border, and Vietnam/China border. The Thai/Myanmar border offers good opportunity for a transfrontier reserve in the Kaeng Krachan region. The proposed "Peace Park" linking Vietnam, Laos and Cambodia has been the subject of a recent book (Westing, 1994); although the respective governments have not embraced the idea each has declared a protected area in this zone.

- **Technical sharing**

Many countries lack experts and technicians in some critical fields and depend heavily on foreign experts provided by aid projects and other co-operative mechanisms. However, such expertise is extremely expensive, often inappropriate and can hinder development of technical self-sufficiency. Accordingly, countries should be encouraged to develop their own technology at levels commensurate with their economic capacity and in keeping with cultural norms. If countries are to escape dependence on technologically more advanced countries, they must invest in domestic research. One good example is Vietnam, which has developed its own outstanding Geographic Information System (GIS).

- **Sharing of information**

Data held by one country may be extremely helpful for a neighbouring country to decide upon its conservation priorities. At present, much information is collected from national sources by international agencies such as World Conservation Monitoring Centre (WCMC) then repackaged and redistributed to the host and neighbouring countries. More direct data linkages between countries or to sub-regional data bases should be encouraged to ensure greater efficiency.

- **Monitoring and data management**

Database initiatives are underway in most countries of the region and regional and global databases are being maintained by various international agencies such as World Conservation Monitoring Centre (WCMC), Asian Bureau for Conservation (ABC), World Wildlife Fund (WWF-US), BirdLife International, and others. Alternative systems to aid countries to develop their own data management systems are also available (The Nature Conservancy, ABC's BIMS, WCMC's PA database, etc.). These are laudable exercises but a greater degree of conformity between the different systems being developed is needed especially in terms of country, biounit and habitat coding, field structures, taxonomy and geographical referencing of data. Improvements must also be made to data availability and free exchange of data. The co-ordinating role of WCMC is crucial in achieving accepted standards and protocols of data exchange. However, such co-ordination is probably only possible by means of a proactive programme to help the different national initiatives, narrow the number of different software systems being used, and increase the degree of data compatibility between existing systems without trying to impose any specific system on individual countries.

1.4 ANALYSIS AND FINDINGS

1.4.1 Practical Aspects Of The Review

This section outlines the methodology used in the review to examine changes in the protected areas system of the Realm. Specifically, to evaluate the representational coverage and conservation importance of the existing protected area system, identify gaps and shortcomings, and identify sites of global priority for conservation.

The first task was to decide on suitable biogeographical sub-divisions or biounits for the Realm. Vegetation maps were prepared, dividing each biogeographic division into its major principal habitats. Maps were made showing both the original or potential extent of each habitat type and also the areas of intact habitat remaining in a natural condition as identified by remote sensed interpretation of satellite imagery and the latest available forest land-use maps of the various countries of the Realm. Four coverages - biounits, national boundaries, original habitat and remaining habitat - were prepared at a scale of 1:1,000,000 as map layers (coverages) under ArcInfo GIS software using the Operations Navigation Charts (ONC) chart series as base maps and world digital charts taken therefrom. The GIS software is able to measure the original and remaining extent of each vegetation type within each biogeographical unit (biounit) and country, the degree of habitat loss thus revealed being taken as one index of threat. Sources used in preparation of the GIS coverages are given in Annex 1.

The boundaries of existing and proposed protected areas have been plotted over these maps and set up as another ArcInfo map layer. The different coverages have been overlaid and combined (unioned) to form a complete mosaic of land units (polygons). Consequently, the original vegetation, remaining vegetation, biounit, country and whether or not it falls within an existing or proposed protected area is known for each unit of land.

Simply presenting figures of how much of a country or region is protected as a percentage of territory included within protected areas can be misleading if a large proportion of the protected habitat is secondary or degraded. The review, therefore uses an index of 'equivalent protected' wherein remaining natural habitat is fully scored and areas of degraded or secondary habitat contained within protected area boundaries are scored as contributing only 25% by area as protected. Such areas are of almost no biodiversity value for plants, invertebrates and small animals but have a potential for ecological recovery and provide habitat for many larger animals as well as valuable corridors for species dispersal.

Artificial wetlands are scored in full as new wildlife habitat. It is important to keep this procedure in mind when evaluating the results of the analysis, as it explains why the proportions of certain countries evaluated and protected is often less than the official percentage cover by protected areas based purely on a total legal area as a proportion of the country surface. In addition, official statistics of percentage of a country that is protected are usually inflated by any marine areas protected. The review results excludes marine areas when expressing the percentage of terrestrial area protected.

Other practical problems with such GIS analysis is that the data are only as good as the maps upon which they are based. For many countries, excellent data of the boundaries of protected areas and vegetation cover. For some countries, the data were of lower quality and some protected areas for which no spatial data could be obtained have had to be omitted from the analysis. In other cases, an approximation has been made by using a circle of the area of the reserve centred on its known centre point.

Some of the protected areas are mapped from data available but the measured areas from the resultant maps do not agree with their legally listed areas. In large countries with extensive protected areas, sites of less than 1000 ha were omitted from the analysis as having a negligible impact on the results although many of these sites are, nevertheless, valuable conservation areas. For the most part, the data were adequate for a regional level review and were an improvement upon those available for the IUCN 1986 Review.

Areas of high local endemism and high species richness have been identified from species distribution data of selected groups and available site-specific survey reports. A special species database has been set up to hold distributional data on all species listed in IUCN Red Data lists and all species listed on CITES schedules. This list of species of immediate conservation concern is also used a measure of biodiversity importance of different countries and biounits. WCMC (1994) have also published a Biodiversity Data Sourcebook giving total estimates of most taxa for each country with numbers of endemics. With some revisions, these figures, these have been used to evaluate biodiversity importance of each country.

1.4.2 Scoring Methods Used In The Review

Three scoring indices are used to help evaluate the findings of the review:

- **Biodiversity Index (BI):** provides a more objective evaluation of the biodiversity importance of individual countries and biogeographical units;
- **Conservation Index (CI):** evaluates the effective conservation effort being applied currently in relation to what should be done; and
- **Opportunity Index (OI):** determines the priority for further action in different countries.

1.4.2.1 Biodiversity Index (BI)

This index reflects the relative importance for biodiversity conservation by taking the total number of species of a taxa, inflating the score with a weighting for endemics and narrow range species and compensating for the area of the unit to remove bias for large areas. The score of all countries or biounits under consideration is relative and finally adjusted around a set mean of 10 for the Realm.

Slightly different scoring methods are used for biounits and countries. For countries, the score reflects a combined score for higher plants, mammals and birds. In each case, the biological richness component to BI is the total number of species x (number of endemic species) times w (the endemism weighting). The resulting richness score is divided by the area of country (in 1000 sq. km) raised to the power 0.3. This log results in a doubling of expected species number for a tenfold increase in area following the principles of island biodiversity. The two indices for plants and animals are expressed as a percentage of the total scores for the Realm, summed and the final score scaled up or down around the Realm mean of 10.

In the case of biounits, a slightly different method was used because precise totals of species and endemics were available. Richness is taken as the total number of species coded for the biunit in the BIMS database (watch.dbf file). This database lists all bird and mammal species listed under IUCN Red Lists plus all birds and mammals listed on CITES Schedules for the Realm. The number of species per biunit has been weighted for endemics and distinctiveness by dividing the raw species score by the mean number of biounits coded for all species in that biunit. This 'similarity index' is high for biounits whose species are generally shared with many other units and low for biounits with many endemics or narrow ranging species. The resultant biodiversity richness score is again divided by area of biunit raised to the power of 0.3 to give the final BI score. Biounits have only been scored for vertebrates. However, a view of the country data shows a very good correlation between vertebrate diversity and plant diversity.

1.4.2.2 Conservation Index (CI)

The Conservation Index (CI) is the ratio of **Equivalent Area Protected/Expected Area Needed for Protection**. It is a dynamic score that assesses the degree to which a country or biunit is meeting international conservation standards.

The percentage covered by protected areas is a very crude statistic of the effectiveness of coverage by a given country. A country can have a large area of deserts and high mountains protected but completely fail to provide coverage to its most important lowland habitats. In addition, there is no consistency in the way in which uncut forests are scored as protected or non-protected. Inclusion of hydrological protection forests would boost many countries totals to well over 10%. In many cases, protected areas exist only on paper. To address this concern, MacKinnon & MacKinnon (1986) applied a matrix of management objectives against management effectiveness to get a more realistic figure of how much habitat area or area equivalent is really protected in different units. A similar but simplified scoring system to determine the **Actual** level of effective protection is applied in the current review.

The **Actual Equivalent Area Protected** is taken to be the percentage of a unit or country still under natural habitat inside protected areas plus one quarter of any secondary habitat contained inside protected habitat times the score of **management effectiveness**.

The **Expected Area Needed for Protection** is averaged around the Realm mean of 10% (the Bali Declaration goal for the Realm) times the mean score for management effectiveness of 75% but weighted for biological importance and urgency for protection. The key to this score determining a target which should ultimately be protected. Myers (1980) has proposed a protected area average target of 10% for each country. A more realistic target might range from 20% in areas of very high biological richness down to 5% in areas with reduced biological significance. Accordingly, the biological index (**BI**) is already scaled up to a mean of 10% to determine our ultimate targets. To reduce the weighting of the raw **BI** scores we have set targets with the following formula:

$$\text{Target} = 10 \text{ times } \text{Log}_{10} \text{ BI.}$$

In practice this weighting results in a range of targets from under 8% up to a maximum of about 15% of country area. These ultimate targets can be taken further to determine what is immediately expected of each country in relation to how much remaining natural habitat is left. Countries which still have plenty of remaining natural habitat are not under such urgency to reach their theoretical targets as countries already reaching the point where all remaining habitat must be protected to achieve these targets. The expected need is therefore lower in cases where more original habitat remains. Accordingly, the following formula has been used to calculate **Expected (E)**:

$$E = \text{Target}/2 + ((\text{Target}/2) \text{ times } (100 - \text{remaining percent}) / (100 - \text{Target}))$$

for **remaining** original habitat still greater than **Target** and **Expected = Remaining** percent otherwise.

Because perfect protective management of protected areas systems may not be expected an index to distinguish score levels of effectiveness is needed. A simple scoring system has been devised. Each country's protected area system is gauged crudely into proportions that are well managed, given average management or poor management such that the percentage well managed score 100%, medium management scores 75% and poor management scores only 50% for the area under protection. This management index is a relative score and as Realm standards rise, the management must also rise to maintain the same level of scoring.

$$\text{Conservation Index (CI)} = \text{Actual/Expected.}$$

CI places a heavier burden on those countries that have to protect very rich biodiversity, but provides a dynamic measure of how they are coping. Expected needs will vary as more original habitat becomes lost. Actual protection varies as more land comes under protection and as management effectiveness varies. A system which scores 1.0 will not maintain that score over time if more original habitat continues to be lost unless these losses are balanced by a further increase in the area of land protected or by increased standards of management. The index can be plotted over time to show a country's performance, rather like a financial index.

1.4.2.3 Opportunity Index (OI)

The biological importance and need to do more protection are only part of identifying priorities for action. There is also potential for raising conservation efforts to the level required and the resultant conservation gain. The opportunity index is a score taken from the product of biodiversity index, need to achieve more conservation and the potential (**scope**) for doing so. This indicates where more effort will pay real dividends. **OI** is a quasi-biological index and is still not an investment index. To identify more precisely where investments of funds, time and personnel should be concentrated, this index needs to be further weighted to include such parameters as political stability, keenness of government to co-operate, willingness of local people and NGOs to co-operate, local costs, alternative land-use options and resource demands, prior land rights and other factors beyond the scope of this review and beyond the wisdom of the reviewers to develop a satisfactory scoring system.

Opportunity index (OI) is scored as:

$$OI = \text{need times natural log of scope times BI (biodiversity index) ,}$$

where **need** (to improve protection) = $1 + \text{Expected} - \text{Actual}$ if actual < expected or 1.0 if actual is greater than expected; and **scope** (for reaching that need) is the potential for

increasing the area of protection plus the potential of improving management efficiency. **Scope** is scored as a percentage of remaining unprotected natural habitat + (percentage protected natural habitat times (100 - **management index**)/100).

1.4.3 Principal Findings

The results of the scoring of biounit and country coverages are given in Tables 1.4-1.8 and the principle findings of this analysis may be reported as follows:

1.4.3.1 Biodiversity Index (BI):

Table 1.6 presents the pertinent data for the scoring of BI for biounits of the Realm and Table 1.7 presents the scoring for countries. Figs. 1.4 and 1.5 show the **BI** scores for biounits and countries respectively in map form. The resulting biounit scores reveal a range of values from a high of 25.5 for New Guinea (unit P3) (due to its very high level of endemism combined with high richness) down to a low of 2.0 for Maldives and Laccadives (unit I8), and 4.1 for both Deccan Peninsula (unit I6) and Indian Desert (unit I3) biounits. Other high scoring biounits were 19.3 for the Moluccas (unit I3); 17.8 for the Philippines (unit 26); 13.7 for Northeast India (unit I9); 13.4 for Sulawesi (unit 24) and 12.1 for the Himalayas (unit I2). The other units were all fairly close to the average of 10.0 for this score. By and large these findings correspond with other efforts to identify areas of biological importance such as the "hot spots" of Myers (1985) and the Endemic Bird Areas of Birdlife International (ICBP, 1992) (see Table 1.2).

Regarding biological importance at the national level, Indonesia scores highest at 26.8 going down to Pakistan scoring only 4.0. Other high scoring countries include the Philippines 14.0; Malaysia 13.7; and Papua New Guinea 13.3. Again these correspond with well-recognised biodiversity hot spots and reflect the add-on richness of those countries spanning several biounits.

1.4.3.2 Conservation Index (CI):

Table 1.6 presents the details for the scoring of CI for biounits and Table 1.8 presents the relevant data for countries. Figures. 1.6 and 1.7 present these data for biounits and countries respectively in map form. The results of the CI analysis show that for major biounits, those where protection seems adequate include Transhimalayan (unit I1), Indian Desert (unit I3), Ceylon Dry Zone (unit S13), Indochina coastal (unit O5) and Sulawesi (unit 24). A few others come close to scoring 1.0 but most are well short with the least well protected biounits being Indian Semi-arid zone (unit I4), Northeast India (unit I9), Gangetic Plain (unit I7), Burmese monsoon zone (unit O9), South Chinese (unit O6), Burmese coast (unit O4), Lesser Sundas (unit 23) and Philippines (unit 26).

At the country level, those above 1.0 include Brunei (1.4), Bhutan (4.1), Cambodia (1.5), Sri Lanka (1.0), and Thailand (1.0). Again other countries come close but the lowest scoring countries remain Bangladesh (0.1), India (0.3), Myanmar (0.1), Malaysia (0.3), the Philippines (0.1), Papua New Guinea (0.1) and Vietnam (0.2). It appears that all countries could reach a score of CI = 1.0 or higher within ten years and the specific measures needed by each to do this are listed under a summary of country needs.

1.4.3.3 Opportunity Index (OI):

Table 1.8 presents the details of the scoring of OI for the countries of the Realm. Figure 1.8 presents these findings in map form. The results of the Opportunity Index (OI) are a range of scores with Indonesia (408), Papua New Guinea (328), Malaysia (273), the Philippines (202) and India (162) as the countries where the best rate of biodiversity return can be expected for further new input. Countries scoring lowest on this scale are Sri Lanka

Table 1.6 Biounit scores of Biodiversity Importance (BI) and Conservation Index (CI)

	Biounit	Area	Remarea	Rem%	Prot%	Protori%	Prop%	Richness	Similar	Bi	Target	Expect	Actual	Ci
I1	Transhimal	162706	162706	100.0	9.4	9.4	0.1	43	14	5.3	7.7	3.9	9.4	2.4
I2	Himalayas	423206	269212	63.6	8.0	6.7	6.3	158	17	12.1	11.1	7.8	7.0	0.9
I3	West Arid	1149762	524425	45.6	7.1	6.9	0.2	86	20	4.1	7.1	5.6	7.0	1.3
I4	CW India	679468	80387	11.8	2.0	0.9	0.2	96	21	5.2	7.6	7.4	1.2	0.2
I5	SW India	162139	40643	25.1	7.4	3.9	1.1	83	23	6.1	8.1	7.4	4.8	0.6
I6	Deccan Plateau	1411320	307688	21.8	3.1	1.6	0.4	103	23	4.1	7.1	6.5	2.0	0.3
I7	Gangetic Plain	534922	26227	4.9	1.8	0.8	0.2	41	21	8.0	9.0	4.9	1.1	0.2
I8	Maldive/Laccadive	3	1	20.0	3.0	2.0	2.0	20	26	2.0	6.0	5.6	2.3	0.4
I9	NE India	124127	33406	26.9	3.5	1.5	0.6	145	20	13.7	11.9	10.9	2.0	0.2
S13	Ceylon Dry Zone	51166	11388	22.3	15.7	7.3	0.0	54	28	4.6	7.3	6.7	9.4	1.4
O2	Ceylon Wet Zone	15633	1742	11.1	4.8	1.4	0.0	57	25	8.0	9.0	8.9	2.3	0.3
O9	Central Burma	401486	211923	52.8	1.4	1.0	3.7	159	20	10.5	10.3	7.9	1.1	0.1
10	Indochina	928039	318988	34.4	7.1	4.5	1.0	161	20	8.3	9.2	7.9	5.2	0.7
O6	South China	61178	8253	13.5	1.0	0.7	1.5	90	22	9.5	9.8	9.6	0.8	0.1
O5	Indochin. coast	376208	106874	28.4	10.3	8.9	0.5	155	20	10.5	10.3	9.3	9.3	1.0
O4	Burmese coast	116077	43158	37.2	0.3	0.1	4.4	121	24	9.6	9.8	8.3	0.2	0.1
20	Andamans	5791	5447	94.1	3.4	3.4	0.0	28	12	10.8	10.4	5.5	3.4	0.6
-M	Annam Mts	36615	14566	39.8	10.3	8.0	8.4	97	22	12.0	11.0	9.2	8.6	0.9
O7	Malay Peninsula	228933	57494	25.1	5.0	3.6	1.5	146	20	11.4	10.7	9.8	4.0	0.4
21	Sumatra/Nicobars	476482	170711	35.8	7.0	5.2	6.1	151	18	10.5	10.3	8.8	5.7	0.6
22	Java/Bali	139521	13886	10.0	4.1	2.6	4.3	101	20	9.2	9.6	9.6	3.0	0.3
25	Borneo/Palawan	758262	427804	56.4	5.7	4.6	7.0	145	18	8.7	9.4	7.0	4.9	0.7
23	Lesser Sundas	90138	36931	41.0	1.9	1.1	8.4	55	11	10.3	10.2	8.5	1.3	0.2
24	Sulawesi/Sula	189701	114862	60.5	9.5	8.3	4.6	82	10	13.5	11.8	8.5	8.6	1.0
26	Philippines	280746	22852	8.1	2.6	0.4	1.6	133	11	17.8	13.9	8.1	1.0	0.1
13	Moluccas	56276	45691	81.2	4.2	3.8	13.1	130	16	19.3	14.7	9.0	3.9	0.4
P3	New Guinea/Aru	890596	696723	78.2	7.7	5.5	8.4	196	8	25.5	17.8	11.3	6.1	0.5

Note: Area and Remaining Natural habitat (remarea) in km²; rem% = remaining as a %age of country; Prot% and Prop% are the %ages protected and proposed for protection in IUCN categories I - IV; protori% counts only the protected %age if habitat is classed as remaining natural habitat; richness is the number of vertebrates in the watch.dbf; similar = the mean number of biounits in which relevant species occur; see section 1.7 for scoring methods for biodiversity index (BI), ultimate target for protection (target); current expected target for protection (expect), actual current effective protection (actual) and conservation index (CI)

Table 1.7 Scoring of Biodiversity Index (BI) and Targets for Indo-Malayan Countries

ISO3	COUNTRY	AREA	ARSCORE	MAMBIRD	MBEND	VINDEX	PLANTS	PLEND	PLINDEX	BI	MBRANK	PLRANK	CRANK	TARGET
BGD	Bangladesh	144.0	4.44	793	1	180	5000	0	1126	5.9	13	16	16	8.5
BRN	Brunei	5.8	1.69	595	0	352	3000	7	1792	10.7	4	13	6	10.2
BTN	Bhutan	47.0	3.17	800	0	252	5446	75	1813	8.6	5	12	9	9.5
IDN	India	1919.0	9.66	1970	580	444	27500	17500	10093	26.8	1	1	1	13.4
IND	Indonesia	3167.0	11.23	1535	99	172	15000	5000	3117	9.0	15	6	8	9.7
KHM	Cambodia	182.0	4.76	667	1	141	7571	1175	2578	7.5	17	9	13	9.2
LAO	Lao PDR	237.0	5.16	851	2	166	8286	1457	2735	8.3	16	7	11	9.4
LKA	Sri Lanka	66.0	3.51	516	36	188	3214	890	1930	7.4	8	11	14	9.1
MAL	Maldives	0.3	0.70	128	0	183	500	0	714	5.2	11	18	17	8.2
MMR	Myanmar	677.0	7.07	1274	10	186	7000	1071	1596	6.8	10	15	15	8.9
MYS	Malaysia	330.0	5.70	1122	38	224	15000	3600	5158	13.7	7	3	3	11.0
NPL	Nepal	141.0	4.41	991	3	227	6500	315	1760	7.9	6	14	12	9.3
PAK	Pakistan	804.0	7.44	822	4	113	5000	372	872	4.0	18	17	18	7.6
PHL	Philippines	300.0	5.54	713	280	331	8000	3500	3971	14.0	3	4	2	11.0
PNG	P.N.G.	463.0	6.30	779	85	178	11000	6050	5587	13.3	14	2	4	10.9
SGP	Singapore	0.6	0.86	340	1	400	2000	2	2335	12.7	2	10	5	10.7
THA	Thailand	514.0	6.51	1180	10	187	11000	2742	3375	9.8	9	5	7	9.9
VNM	Vietnam	332.0	5.71	974	18	183	10000	1260	2634	8.5	11	8	10	9.5

Note: Area in km²; arscore = $\log_{0.3} \text{Area}$; Mambird = total known mammals plus birds; mbend = number of mammal and bird endemics; vindex = vertebrate index; plants = total number of known plants; plend = number of endemic plants; plindex = plantindex; mbrank is the rank of mammal plus bird richness; plrank = rank of plant richness and crank = combined richness rank for plants and vertebrates; see section 1.7 for scoring methods for biodiversity index (BI) and ultimate target for protection (target).

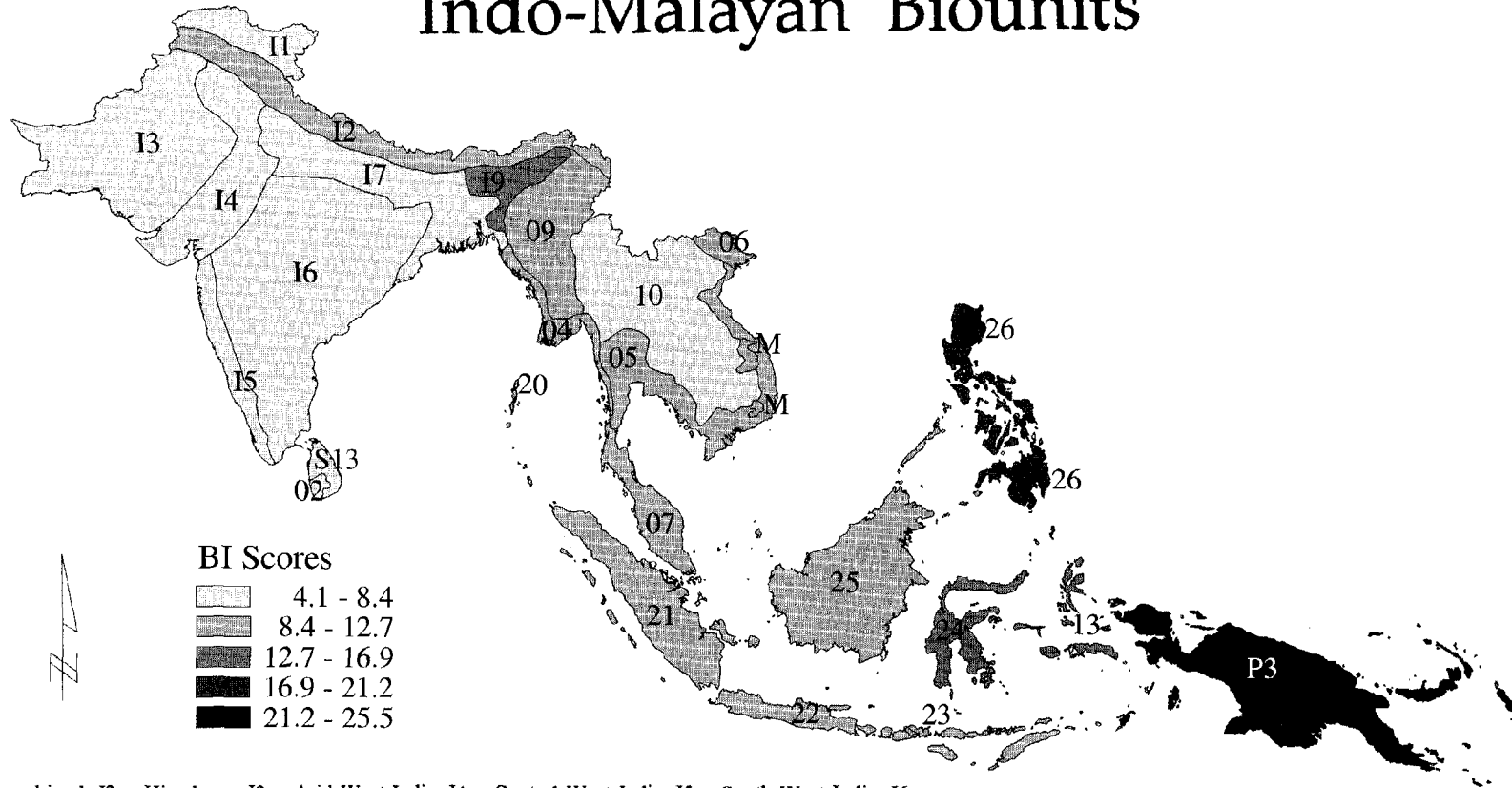
Table 1.8 Scoring of Conservation Index (CI) and Opportunity Index (OI) by country

ISO3	COUNTRY	REM%	PROT%	PROTOR%	PROP%	MANAGEMENT	EXPECT	ACTUAL	CI	POTENTIAL	NEED	OI
BGD	Bangladesh	9.9	0.6	0.4	0.2	82.5	6.3	0.4	0.1	9.6	6.9	92.1
BRN	Brunei	66.8	16.3	16.1	0.0	80.0	5.3	12.9	2.4	59.3	1.0	43.7
BTN	Bhutan	75.8	26.9	25.3	0.0	72.5	4.5	18.6	4.1	57.5	1.0	34.8
IDN	India	54.5	8.3	6.4	7.2	70.0	7.7	4.8	0.6	50.0	3.9	408.9
IND	Indonesia	30.4	3.8	2.5	0.7	75.0	6.5	2.1	0.3	28.5	5.4	162.8
KHM	Cambodia	62.5	14.4	12.7	0.0	57.5	4.9	7.5	1.5	55.2	1.0	30.1
LAO	Lao PDR	17.5	12.1	4.7	4.6	57.5	6.8	3.8	0.6	14.8	4.0	89.5
LKA	Sri Lanka	19.7	13.2	5.9	0.0	82.5	6.5	6.4	1.0	14.8	1.1	21.9
MAL	Maldives	16.7	3.0	2.0	0.0	87.5	5.9	2.0	0.6	12.3	4.9	64.0
MMR	Myanmar	50.9	0.8	0.6	4.1	65.0	5.1	0.5	0.1	50.5	5.6	149.3
MYS	Malaysia	39.6	3.4	2.4	2.8	87.5	6.9	2.4	0.3	37.5	5.5	273.1
NPL	Nepal	45.5	8.3	6.0	6.2	77.5	5.6	5.1	0.9	40.9	1.5	44.0
PAK	Pakistan	32.1	6.9	6.9	0.0	60.0	5.0	4.1	0.8	28.0	1.9	25.3
PHL	Philippines	9.3	2.5	0.5	1.1	72.5	6.5	0.7	0.1	8.4	6.8	202.6
PNG	P.N.G.	76.0	1.3	0.4	9.0	80.0	5.2	0.5	0.1	75.7	5.7	328.0
SGP	Singapore	3.3	5.7	0.3	0.0	95.0	2.5	1.6	0.6	3.0	1.9	26.5
THA	Thailand	25.6	12.4	9.5	0.3	72.5	6.5	7.4	1.1	26.0	1.0	31.9
VNM	Vietnam	16.1	2.4	1.9	1.2	67.5	6.9	1.4	0.2	14.8	6.5	148.9

NOTE: Rem% = remaining a protection in IUCN categories I - IV; protori% counts only the protected %age if habitat is classed as remaining natural habitat; see section 1.7 for scoring methods for current expected target for protection (expect), actual equivalent currently protected (actual) and conservation index (CI). See section 1.7 for scoring method for potential for improvement (scope), need for improvement (need) and resultant opportunity index (OI).

Fig. 1.4

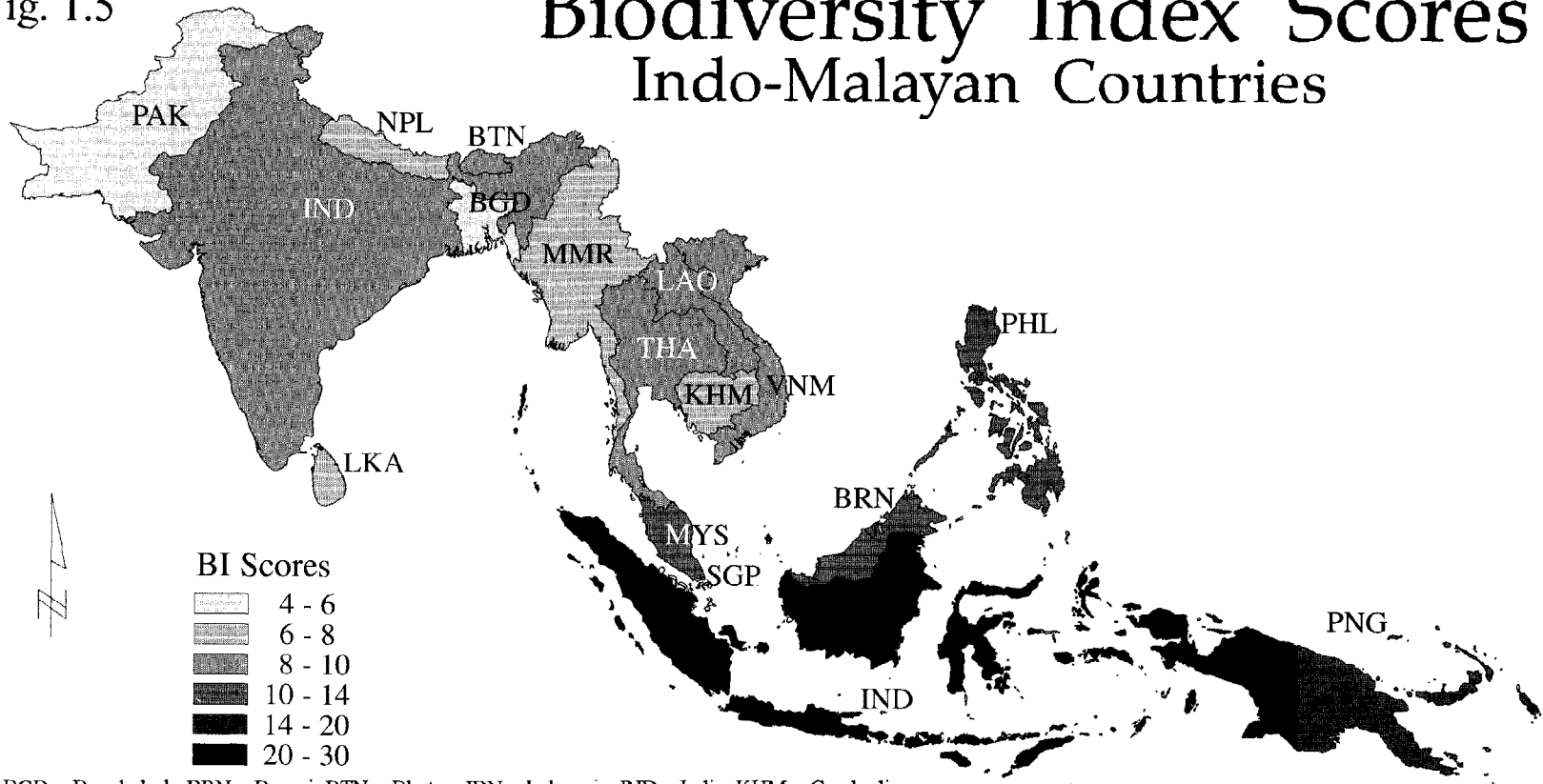
Biodiversity Index Scores Indo-Malayan Biounits



I1 = Transhimal, I2 = Himalayas, I3 = Arid West India, I4 = Central West India, I5 = South West India, I6 = Central India, I7 = Gangetic Plain, I9 = North East India, 09 = Irrawaddy, 04 = Burmese Coast, 05 = Coastal Indochina, 06 = South China, 10 = Indochina, -M = Annamese Mts., 07 = Malaya, 20 = Andamans, 21 = Sumatra, 22 = Java/Bali, 25 = Borneo/Palawan, 23 = Lesser Sundas, 24 = Sulawesi, 26 = Philippines, 13 = Moluccas, P3 = New Guinea. (See section 1.4.2 for Scoring Methods).

Fig. 1.5

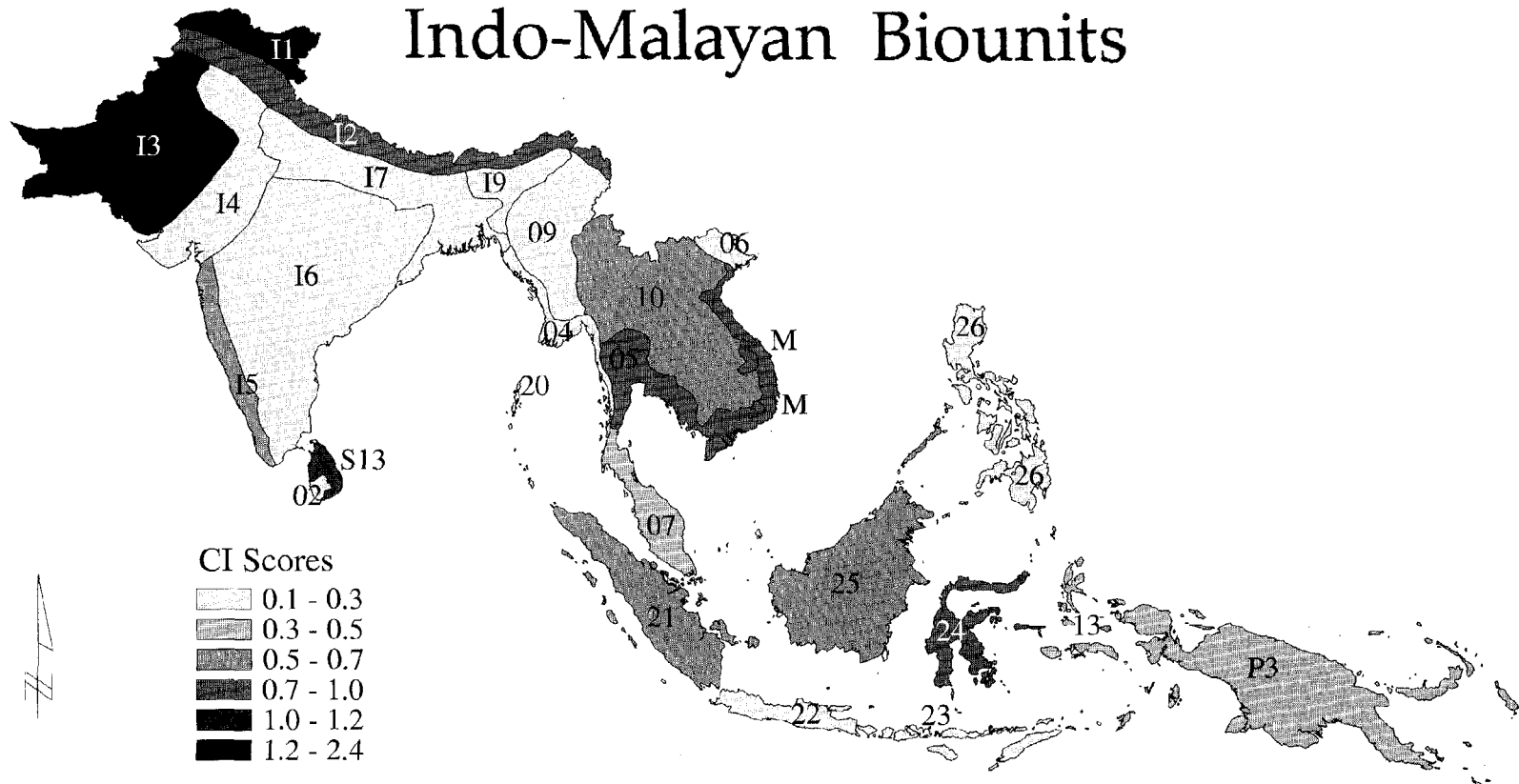
Biodiversity Index Scores Indo-Malayan Countries



BGD = Bangladesh, BRN = Brunei, BTN = Bhutan, IDN = Indonesia, IND = India, KHM = Cambodia,
LAO = Laos, LKA = Sri Lanka, MMR = Myanmar, MYS = Malaysia, NPL = Nepal, PAK = Pakistan,
PHL = Philippines, PNG = Papua New Guinea, SGP = Singapore, THA = Thailand, VNM = Vietnam.
(See section 1.4.2 for Scoring Methods).

Fig. 1.6

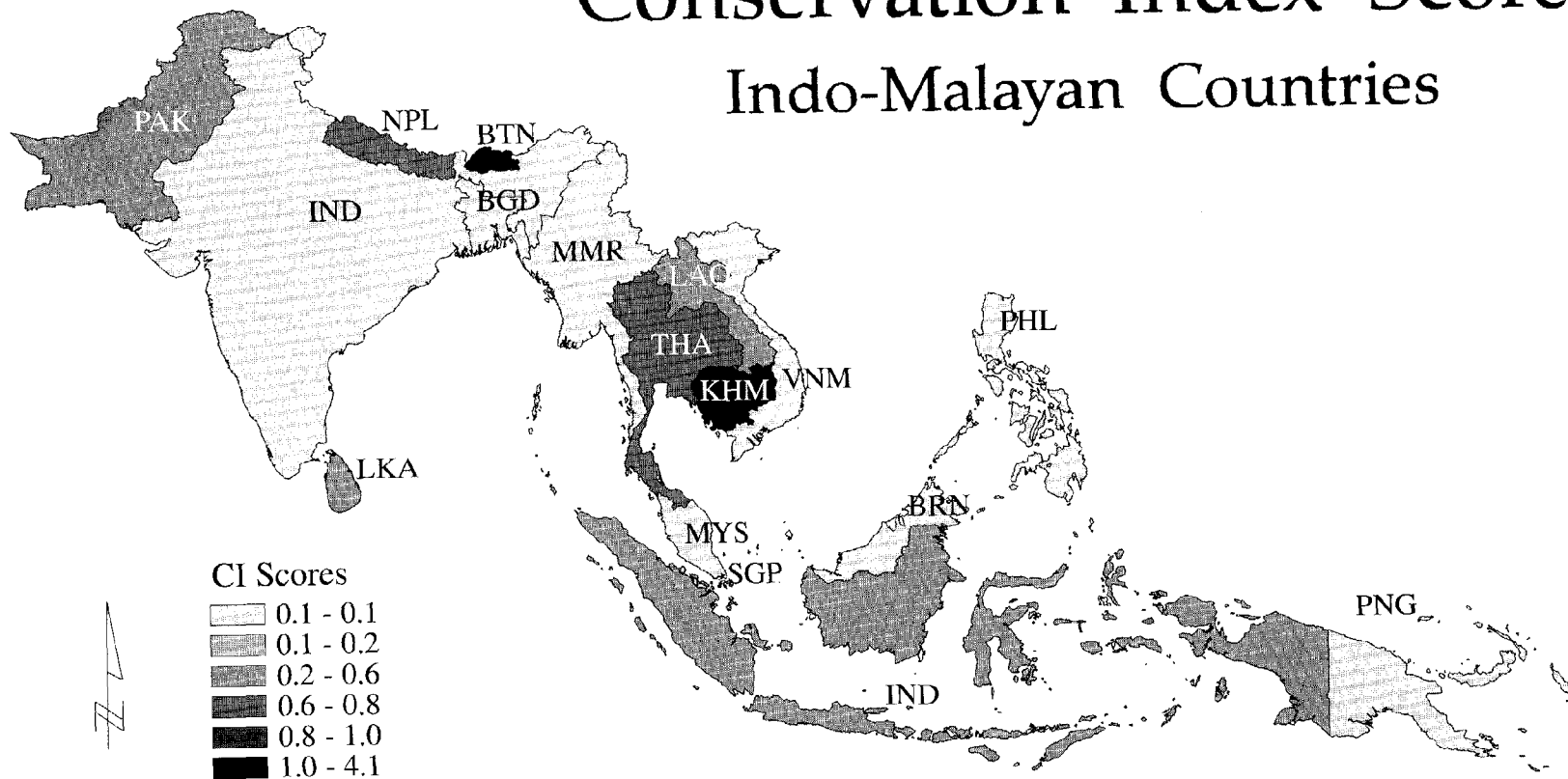
Conservation Index Scores Indo-Malayan Biounits



I1 = Transhimal, I2 = Himalayas, I3 = Arid West India, I4 = Central West India, I5 = South West India, I6 = Central India, I7 = Gangetic Plain, I9 = North East India, 09 = Irrawaddy, 04 = Burmese Coast, 05 = Coastal Indochina, 06 = South China, 10 = Indochina, -M = Annamese Mts., 07 = Malaya, 20 = Andamans, 21 = Sumatra, 22 = Java/Bali, 25 = Bornco/Palawan, 23 = Lesser Sundas, 24 = Sulawesi, 26 = Philippines, 13 = Moluccas, P3 = New Guinea. (See section 1.4.2 for Scoring Methods).

Fig. 1.7

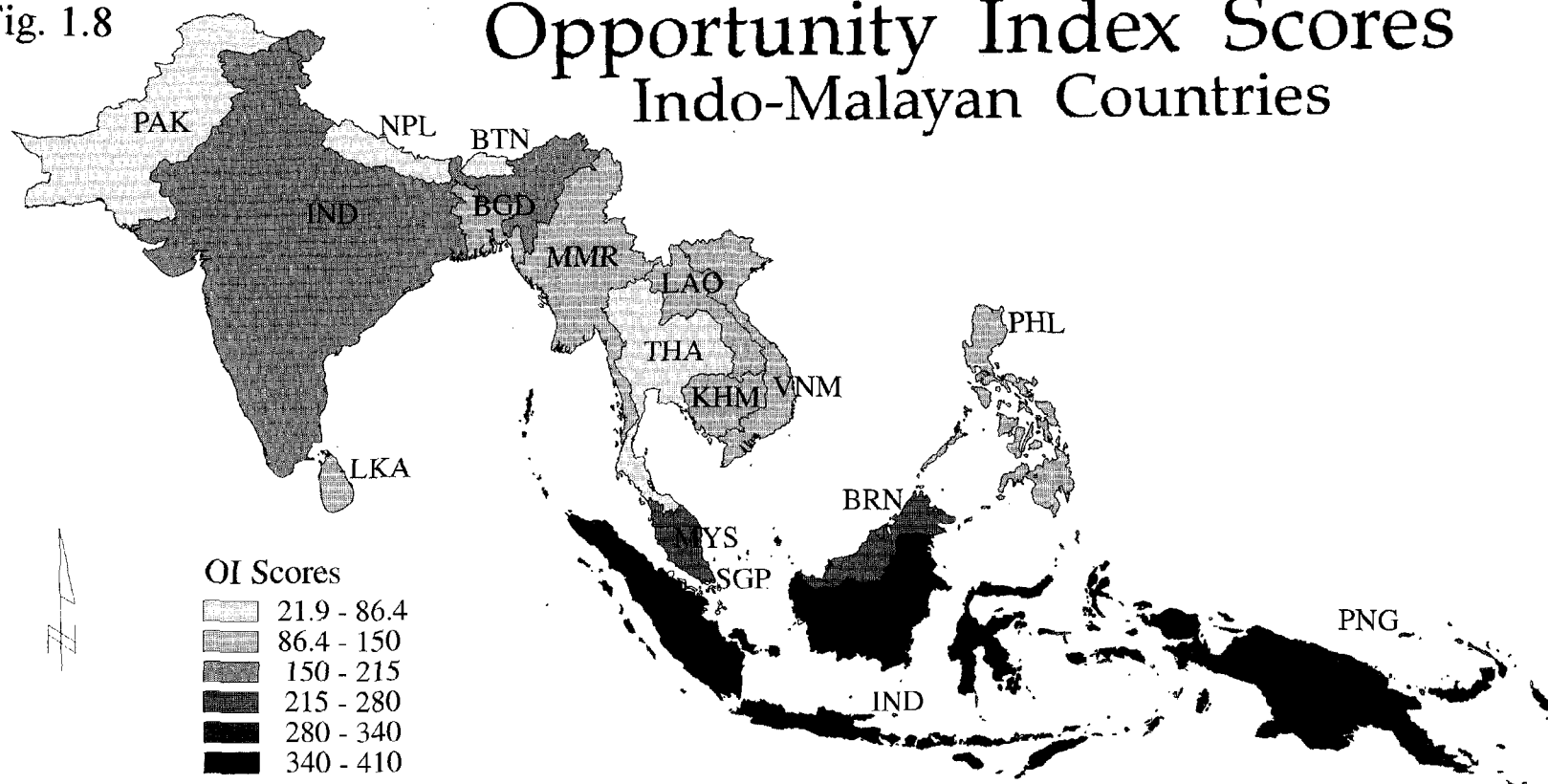
Conservation Index Scores Indo-Malayan Countries



BGD = Bangladesh, BRN = Brunei, BTN = Bhutan, IDN = Indonesia, IND = India, KHM = Cambodia,
LAO = Laos, LKA = Sri Lanka, MMR = Myanmar, MYS = Malaysia, NPL = Nepal, PAK = Pakistan,
PHL = Philippines, PNG = Papua New Guinea, SGP = Singapore, THA = Thailand, VNM = Vietnam.
(See section 1.4.2 for Scoring Methods)

Fig. 1.8

Opportunity Index Scores Indo-Malayan Countries



BGD = Bangladesh, BRN = Brunei, BTN = Bhutan, IDN = Indonesia, IND = India, KHM = Cambodia,

LAO = Laos, LKA = Sri Lanka, MMR = Myanmar, MYS = Malaysia, NPL = Nepal, PAK = Pakistan,

PHL = Philippines, PNG = Papua New Guinea, SGP = Singapore, THA = Thailand, VNM = Vietnam.

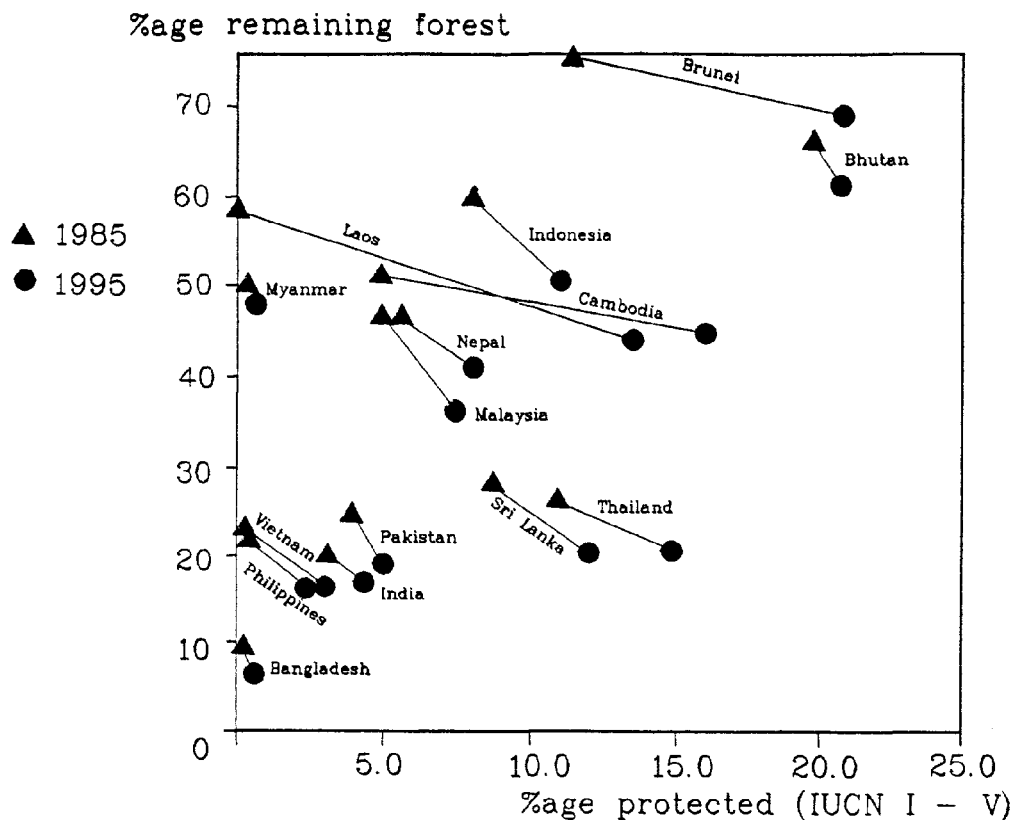
(See section 1.4.2 for Scoring Methods).

(21), Pakistan (25), Singapore (26), Cambodia (30), Bhutan (35) and Thailand (38). These countries will, however, require enough input to maintain their favourable *status quo*.

1.4.3.4 Changes since the 1986 Indo-Malayan Review

Figure 1.9 presents a histogram comparing how much natural habitat remains in each country according to the 1986 Review and current review. There are some discrepancies that need some explanation. Because only large patches of habitat were mapped and measured in the 1986 Review, the 1986 figures tend to be generally low and some apparent slight increases in habitat cover are in all cases misleading. Major increases in apparent habitat in Cambodia (KHM), Myanmar (MMR) and India (IND) are the result of desert, alpine areas and naturally bare areas and open woodland habitats being better mapped and they are included in the current review. The apparent increase of habitat in Bhutan is because the present review included the whole country whilst the 1986 Review only included up to the treeline. Almost all habitat above the treeline is scored as remaining natural habitat in the current review. The same holds true for Nepal and parts of Pakistan and India. The figures for Indonesia and Pakistan are not totally comparable because parts of these countries - Baluchistan, Molluccas and Irian Jaya were not included in the 1986 Review. The added portions of Indonesia have a high proportion of remaining habitat.

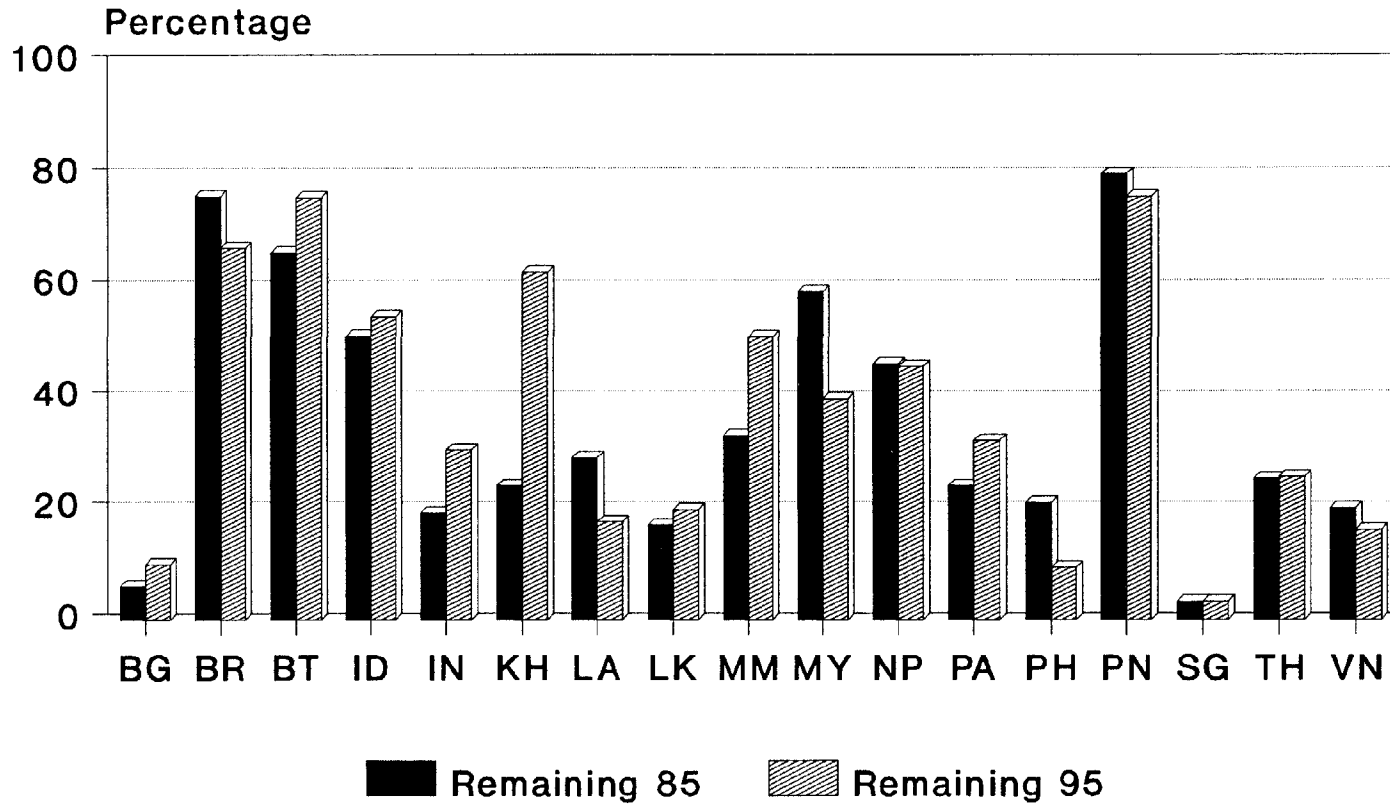
Figure 1.11 Changes in PA coverage over 10 year period



Sources: FAO, WCMC.

Fig 1.9

Remaining Natural Habitat IM Countries 1985 - 1995



1985 data from MacKinnon & MacKinnon (1986). 1995 data from GIS coverages of this review.

BG = Bangladesh, BR = Brunei, BT = Bhutan, ID = Indonesia, IN = India, KH = Cambodia, LA = Laos, LK = Sri Lanka, MM = Myanmar, MY = Malaysia, NP = Nepal, PA = Pakistan, PH = Philippines, PN = Papua New Guinea, SG = Singapore, TH = Thailand, VN = Vietnam.

Figure 1.10 presents a comparison of the proportion of each country scored as protected in the 1986 Review and current review. There has been a general and significant increase in the area of protection in the Realm. Very dramatic increases have been achieved in Bhutan (BTN), Cambodia (KHM), Laos (LAO), Nepal (NPL) and Vietnam (VNM). A few apparent decreases in area protected need explanation. Many areas were included as protected areas in Brunei in the earlier review are now classed as forest reserves of IUCN category "UA" and are not included in the current analysis. The 1986 Review excluded the Baluchistan area of Pakistan from analysis so figures are not comparable. Some areas listed as existing for West Malaysia in the 1986 Review were actually only proposed and remain only proposed whilst one large protected area (Endau Kota Tinggi) is not included because, although it has not been degazetted, it is not a managed protected area. Some localities that were scored fully as protected natural habitat in the 1986 Review have been scored lower where satellite imagery reveals areas of secondary and cleared habitat inside protected areas boundaries.

A clearer picture of change over the last 10 years is gained by simply plotting the official FAO estimates for forest cover of each country against the WCMC database figures for percentage of each country protected in IUCN categories I - V for the dates 1985 and 1995. A large shift across the graph indicates a major increase in protected areas, whilst a sharp drop down the graph indicates a significant loss of forest. The resulting picture (Figure 1.11) shows a dynamic situation. The situation for Bhutan, which appears rather stable, is less so as almost half of the pre-existing protected area system was degazetted to make way for the revised system. Most countries have been gradually losing natural habitat since 1986. In a few countries such as the Philippines (PHL), Malaysia (MYS), Laos (LAO), and Nepal (NPL), the rate of loss has been rather high and gives cause for concern.

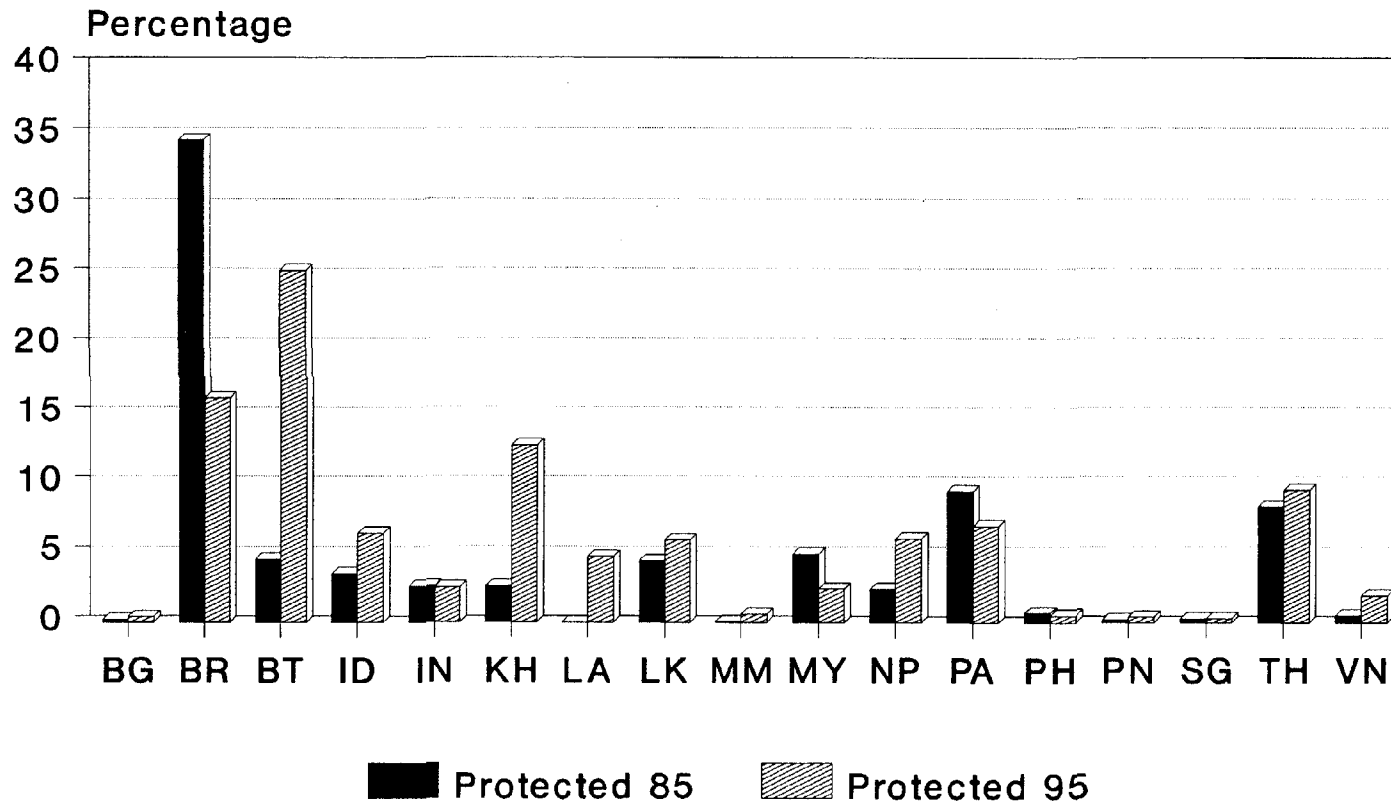
1.4.3.5 Overall Conclusions

Despite a 50% increase of the size of the protected areas system of the Indo-Malayan Realm since 1986, the state of the system is still far from adequate. There are still some major geographical and habitat gaps. Most countries still fall short of the goal of 10% terrestrial protection. Standards of management and protection, though improving, are generally low and staff recruitment has not kept pace with the territorial expansion of the system. National budgets allocated to development and management of the Protected Areas system are inadequate and international funding is only adequate to raise the standards of a few selected priority areas.

Meanwhile, as human populations increase rapidly; natural habitats shrink and ever greater pressure is placed on production from remaining naturally vegetated lands. Lists of species labelled as endangered grow every year as do lists of species which need trade protection. New challenges such as pollution, acid rain and global warming add further long-term threats. Even where blocks of apparently good habitat do remain, ground inspection often reveals that the larger birds and mammals have been completely lost to hunting. The overall situation for biodiversity conservation looks much worse than it looked ten years ago and unless there is a radical change in attitude and investment in conserving the biological richness of our planet, very large-scale losses will continue in the Indo-Malayan Realm.

Fig 1.10

Protected Natural Habitat IM Countries 1985 - 1995



1985 data from MacKinnon & MacKinnon (1986). 1995 data from GIS coverages of this review

BG = Bangladesh, BR = Brunei, BT = Bhutan, ID = Indonesia, IN = India, KH = Cambodia, LA = Laos, LK = Sri Lanka, MM = Myanmar, MY = Malaysia, NP = Nepal, PA = Pakistan, PH = Philippines, PN = Papua New Guinea, SG = Singapore, TH = Thailand, VN = Vietnam.

1.4.4 Summary Of Country Needs

The following section contains only the overview of needs per country if they are to reach a Conservation Index score of 1.0. The Country chapters in Part Three of this review present fuller details of the situation and more detailed recommendations.

1. **Bangladesh** currently scores very low on protected areas. There is little option to acquire large new areas and Bangladesh has reached the point where all remaining original vegetation should be brought under protection. Further improvements are required to make management more effective
2. **Bhutan** already has a CI score of more than 1.0 with a large proportion of the country already protected while plenty more natural habitat remains. The country does not need new reserves but must gradually pick up on management of the resources already assigned for protection.
3. **Brunei** also is already well over the CI = 1.0 mark. There are a few habitat gaps in the Protected Area coverage and some improvements can be made to management. Opening up some of the excellent reserves to visitors and scientists would also help to promote the further development of the protected areas system.
4. **Cambodia** is above CI = 1.0 by virtue of the enormous protected areas system recently declared. However, there is virtually no effective management yet applied on the ground. Priority must focus on manpower development and management planning. A greater area of freshwater swamp and lakes should be transferred from category VI to category IV.
5. **India** would achieve the 40% increase in CI required if it gazettes the many outstanding proposals of Rogers and Panwar (1988) and if it raises its standards of management. Areas of particular importance are the Himalayan forests and forests of North-east India.
6. **Indonesia** faces the most challenging task. It is by far the most important country in the Realm for biodiversity conservation and will need to protect a high proportion of its area to reach a CI of 1. However, the target is easily within range. There are many excellent proposed sites reserved for conservation on government land-use maps but never gazetted. In addition, the country has an extensive system of hydrological protection forests, many of which could be considered as Category IV reserves. Emphasis on new gazetteement should focus on the Mollucas and Lesser Sundas with several important revisions to be made to boundaries of some Irian Jaya reserves. A phase of new gazetteement by the government should be rewarded by substantial external assistance to help develop and manage the extensive reserve system of the country.
7. **Laos** has just declared a huge system of protected areas and still has many large proposals on the table. However, these sites are currently unmanaged and many overlap with production forests, hydro projects etc. They are largely classed as category VI. It is recommended that about half the system where competing land-use is minimal be declared as category IV reserves and a major investment is made in manpower development to manage an excellent PA system. More emphasis should be paid to transfrontier reserve linkages.
8. **Sri Lanka** is already doing a good job in conserving its biodiversity. However, most of the reserves are in the less diverse dry zone. All remaining lowland forest patches in the wet zone should now come under protection.

9. **Maldives** has little terrestrial biodiversity of value (a few endemic pandanus). A minimal terrestrial reserve system is adequate. However, the marine resources of the country are remarkable and a large protected area system is needed in the sea. The marine section of this review gives more details.
10. **Malaysia** still has a lot to do. Protected area networks in Sabah and Sarawak have been growing steadily although forest area has also shrunk rather fast over the past decade. Peninsular Malaysia has a very inadequate system of reserves with many large proposals outstanding and ungazetted for many years. The country has the wealth and personnel to do a good job of management but it is essential to get more land into the PA system in this biologically very rich part of the Realm.
11. **Myanmar** is still very slow in developing a PA system. The total area protected is small and contains a lot of secondary habitat. Large and important proposals remain on the table after many years. Under the new policy of the Forestry Department a major increase in the area of protected areas is planned. A more concerted programme of assistance from international agencies could have enormous dividends.
12. **Nepal** has an adequate area of PA system but there is a bias towards high mountain reserves and tropical terai reserves and a gap in the temperate middle hills. Many reserves are category VI and therefore scored quite low in the CI index. In many cases the percentage of area used for tourism and other uses is very small and with a zoning system most of the PA system could be upgraded to category IV.
13. **Pakistan** scores low on richness so is not looking for a large total area of protected areas. Size it has already achieved by adding huge areas of desert and wasteland to the PA system. What is needed is a more strategic central approach to development of the PA system and a major increase in management standards.
14. **Philippines** is at the same time one of the most biologically important countries of the Realm but also the most seriously degraded and under-protected. As a result of the NIPAS project a new system of Conservation areas is being developed. A few of these priority areas have already been gazetted but it is urgent to get on with this important job. Major improvements in management of protected areas and law enforcement are also needed. A period of political stability is required so that technical work can be completed.
15. **Papua New Guinea** is one half of the single most important biogeographical unit in the whole Realm, yet it has only 1.3 % protection. Huge opportunities remain to develop an excellent PA system. The government must sort its way through a baffling and contradictory pile of proposed areas. The system of sites recommended in this review would certainly provide very complete and good coverage of habitats and biounits. The second problem is to find a formula whereby the government can invest in major conservation areas with co-operation of local communities who by tradition retain all land ownership. Poor communications, high operational costs and severe manpower shortages are a serious constraint.
16. **Singapore** has lost almost all its natural habitat. Tiny remnant forest patches are already protected together with a large area of secondary forest. The most useful improvements to be made are to process the proposed additional reserves which will add important mangrove forests and wetlands to the system.
17. **Thailand** has already protected almost all available natural habitats. There remain a few key habitat gaps such as mangroves and freshwater swamps, but the priority must be on law enforcement and improving management.

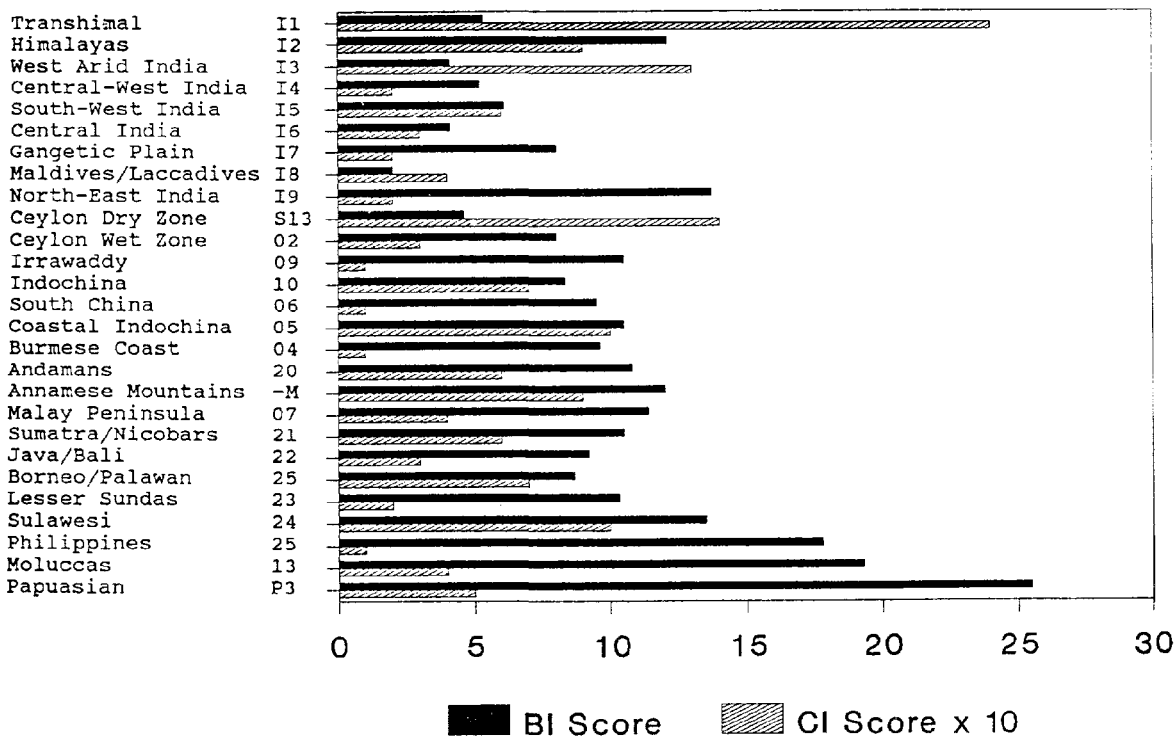
18. **Vietnam** has achieved a well-balanced PA system but it is far too limited in area. The government has agreed to double the size of the existing PA network and excellent proposals have been made to do this. The country already has so little original forest left that this should all be taken into the protected area system. Production forestry should become based on secondary forests and plantations. Poverty among the population and inability to buy imported timber forces the continuing policy of exploiting the dwindling resource of original forests. More attention needs to be paid to freshwater and wetland systems currently neglected in the PA system. Big increases in management effectiveness are possible.

PART-TWO - - CLASSIFICATION AND REVIEW OF BIOUNITS

This section describes the limits and sub-divisions of the biounits used in the present review. Where these units have been revised since the 1986 IUCN review, or were not included in that review (Moluccas and New Guinea), details are given about the biological importance, fauna, flora and current land-use. For units that remain unchanged, such information has been edited down to the minimum needed to leave this document a stand-alone report. Readers wishing to see the full descriptions of these biounits are referred to the earlier publication or to the BIMS software distributed with this review³.

The overview findings of the biounit review and gives tables scoring each major biounit for it's Biological Index (BI) and Conservation Index (CI) are shown in Section 1.4.3. The former index is a measure of overall biological importance whilst the latter indicates how adequately the biounit is currently protected in relation to its importance and need for protection. Figure 2.1 below presents these data in the form of histograms for easier comparison between biounits. See section 1.4.2 for details of the scoring of these indices.

Figure 2.1 Biological Index (BI) scores and Conservation Index (CI) Scores for Major Biounits of the Indo-Malayan Realm.



See Section 1.4.2 for Scoring Method

³ Footnote: The BIMS programme files are available on the FTP site utopia.knoware.nl. Log onto site as 'anonymous' and give full email address as password. Change to /users/lewie/bims and use 'get' command to download (get) files. A complete copy of the maps and data of this review can be obtained on CD-ROM from Asian Bureau for Conservation, 88 Wincheap, Canterbury, Kent CT1 3RS. UK.

A. Indian Sub-continent

The classification of biounits of the Indian Sub-continent used in this review has been revised since the 1986 IUCN Review. It follows the system developed for India by Rogers & Panwar (1988) and Panwar (1990) and used in the biodiversity database maintained by the Wildlife Institute of India at Dehra Dun. This classification system has been extended to cover the other countries of this sub-region. The numbering of these biounits follows that used by Panwar and Rogers but each is preceded by the letter "I" to denote Indian numbering system. This helps distinguish it from the other biunit numbers which are adapted from Udvardy (1975). An exception is made in the case of Andaman and Nicobar units. The numbering of the 1986 review has been retained to reflect biological affinities with the other southeast Asian units.

2.1 Unit 11: Trans-Himalayan

a. Extent of Unit

The unit consists of small areas of Bhutan, Sikkim and Northwest India and north Pakistan which lie north of the main crest of the Himalayas. These areas are much colder and more arid than the southern facies. The unit contains many points of international boundary dispute. The unit as included within this review has a total area of about 162,706 sq. km.

b. Administrative Divisions

The unit extends across the northern portions of the Indian state of Jammu and Kashmir, with a small portion of the Lahul-Spiti district of Himachal Pradesh. Some 83,808 sq. km of this zone claimed by India is occupied by Pakistan and another 41,500 sq. km occupied by China in accordance with current cease-fire lines. The unit includes the northern portions of the North-west Frontier District and Northern Area provinces of Pakistan. In the east portions of northern Sikkim and north-west Bhutan also extend over the Himalayas crest.

c. Natural Vegetation

The unit is very barren. The only vegetation is a sparse alpine steppe. There are some lakes, some of these are saline. Extensive areas consist of bare rock and glaciers.

d. Current Land Use

The area is in a rather natural condition, though it is used for summer grazing of yaks and goats.

e. Biological Richness and Endemism

The unit is very poor in species but the alpine flora does contain a high proportion of endemics. The faunal groups best represented here are wild sheep, marmots and picas. The biodiversity index of the unit is calculated at only 5.3 (see section 1.4.3.1 above), resulting in an ultimate protection target of 7.7%.

f. Distinct Sub-units

Rogers and Panwar (1992) divide the unit into two sub-units. Sub-unit 11a consists of the mountains of Ladakh. The rest of the Tibetan Plateau is included in Sub-unit 11b. The latter unit extends over a vast area of China.

g. State of PA Development

Current level of PA coverage is 9.4% which is a major increase since the 1986 IUCN Review (MacKinnon & MacKinnon, 1986). As the expected target for protection is only 3.9 this gives a healthy conservation index score of 2.4 (see scoring in section 1.7).

2.2 Unit I2: Himalayas

a. Extent of Unit

The unit consists of the forested southern slopes of the Himalayas which form a long belt of land stretching from Kashmir to Arunachal Pradesh and north Myanmar for a length of over 3000 km. The unit has a total area of 423,206 sq. km. The unit excludes the forests of the Siwaliks which are more closely related to the Gangetic Plains.

b. Administrative Divisions

The unit extends across the Indian states of Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh (marginally), Sikkim, Arunachal Pradesh, parts of Northern Pakistan, most of Nepal and Bhutan and extends marginally into Myanmar and China (not covered under this review).

c. Natural Vegetation

Most of the area was originally clothed in dense forests. These forests were arranged in altitudinal strata with sub-tropical pine forests (STP) at lower elevations being replaced by Himalayan moist forest (HMT) (west only), montane wet temperate forest (MWT) (east only) and Himalayan dry forest at higher elevations (HDT). Sub-alpine conifer forests (SAC), sometimes topped in the west by a narrow birch zone (BIR), occur on the highest forested slopes. Small areas of sub-montane dry evergreen forest (SDE) were found in sheltered valleys.

d. Current Land Use

Much of the original vegetation has been destroyed or modified by human activities. The good timber trees have been felled from many of the slopes. In some areas, hill farmers have cleared forests to cultivate and graze slopes, resulting in severe land degradation and erosion. The degree of damage varies. In Bhutan, for example, the upper forests remain in good condition though logging is now making inroads. In Nepal most of the forest has already been lost. Some hill tribes practise slash and burn agriculture in the mountains. About 63% of the unit remains under natural vegetation, including large areas of bare rock and ice.

e. Biological Richness and Endemism

The unit is extremely rich in species. It is an important mixing ground of flora and fauna, where elements derived from Indo-China have spread westwards to mix with temperate forest forms from the Palaearctic, spreading mostly from the west. Botanically, these lush forests are among the richest in the sub-continent and they also support the greatest levels of endemism. Species richness is high in mammals and very high in birds. The bird fauna shows a moderate level of endemism (6%). The unit contains 2 EBAs (ICBP, 1992). The biodiversity index of the unit is calculated at 12.1 (see section 1.4.3.1 above), resulting in an ultimate protection target of 11.1%.

f. Distinct Sub-units

This unit is divided into four distinct sub-units. Sub-unit I2a is the Northwest Himalayas which are predominantly Palaearctic in their species composition. Sub-unit I2b is the sub-unit of West Nepal. Sub-unit I2c comprises the Central Himalayas through western Nepal where the Himalayan moist temperate forests are replaced by montane wet temperate forests. Sub-unit I2d is the sub-unit of the Eastern Himalayas, the richest and wettest of the sub-units. Sub-unit I2d shows a close relationship with Assam.

g. State of PA Development

The current level of Protected Area coverage is about 8.0%. However, some of this is degraded habitat and the actual effective protection of the unit is scored as only 7.0%. This represents a major increase since the 1986 IUCN Review in which the unit was

scored as 3.7% protected. Current expected target for protection is 7.8 resulting in a conservation index score of 0.9 (see section 1.4.2 for scoring details).

2.3 Unit I3: Thar/Indus

a. Extent of Unit

The unit consists of the dry, rugged, western limits of the realm from the Thar desert to the Baluchistan mountains and western borders of Pakistan. The unit has a total area of 1,149,762 sq.km.

b. Administrative Divisions

The unit falls within India, extending into the states of Rajasthan and Gujarat and covers most of southern Pakistan in Sind, Baluchistan, Punjab and the south of Northwest Frontier provinces.

c. Natural Vegetation

Most of the area was originally clothed in tropical thorn forest (TSF) and tropical dry deciduous forests (DDF). The hills of Baluchistan were mostly arid subtropical forest (ASF) with some dry conifer forest (HDC). On the highest peaks some alpine dry steppe (ADS) were present. The driest parts are covered in sandy desert (SDV) with some seasonal salt marshes (SSM). Mangroves are found in the main estuaries.

d. Current Land Use

About 20% of the unit is still covered with natural vegetation. Much has been destroyed or modified by the high density of human inhabitants and over-grazing by domestic animals. The unit supports impoverished farmlands and some forest plantations. The Thar was not always desert. Two thousand years ago it was jungle but man's poor agricultural practices, cutting of vegetation and overgrazing have turned the region into an arid plain. This process has accelerated within the last century so that the Thar desert is currently extending around its perimeter by 8 km every decade.

e. Biological Richness and Endemism

The unit is of rather low species diversity, low botanical endemism, low mammalian endemism but moderate bird endemism. The unit does, however, have a quite distinctive combination of species derived from the Indian sub-continent and Palaeartic and Afro-tropical realms with some specialised desert wildlife. Wetlands in such an arid region are of great importance to wildlife and especially wetland birds. The unit contains one and part of a second EBA (ICBP, 1992). The biodiversity index of the unit is calculated at only 4.1 (see section 1.4.3.1 above), resulting in an ultimate protection target of 7.1%.

f. Distinct Sub-units

There are four major divisions in this rather heterogeneous unit: Sub-unit I3a is the Thar desert; Sub-unit I3b the salt flats of the Runn of Kutch; Sub-unit I3c the Indus valley; and Sub-unit I3d the Baluchistan Mountains.

g. State of PA Development

Current level of PA coverage is 7.1%. However a small area of this is degraded habitat and the actual effective protection of the unit is scored as only 7.0%. This is a major increase since the 1986 IUCN Review in which the unit was scored as 4.8% protected with slight revision of bio-unit boundaries. Current expected target for protection is 5.6 resulting in a healthy conservation index score of 1.3 (see section 1.4.2 for scoring details).

2.4 Unit I4: Semi Arid Zone

a. Extent of Unit

The unit consists of the semi-arid regions in the west of India surrounding the arid desert areas of Thar and Rajasthan extending to the Gulfs of Kutch and Cambay with the whole Kathiawar Peninsula. The unit has a total area of 679468 sq. km.

b. Administrative Divisions

The unit falls within the Indian states of Punjab, Haryana, Rajasthan, Gujarat and western Madhya Pradesh and extends into Pakistan's Punjab Province.

c. Natural Vegetation

Most of the area was originally clothed in tropical thorn forest (TSF) and tropical dry deciduous forests (DDF). Moisture forests are only found in the extreme north of the unit where it meets the Himalayan foothills. Mangroves are found in the main estuaries.

d. Current Land Use

Much of the original vegetation has been destroyed or modified by the high density of human inhabitants and particularly grazing animals. The unit supports impoverished farmlands and wasteland. Some natural and artificial wetlands have become of very great importance to waterfowl. About 12% of the unit is still covered in natural vegetation, though much of this is highly modified by man.

e. Biological Richness and Endemism

The unit is of rather low species diversity, low botanical endemism, low mammalian endemism and moderate bird endemism. The unit does, however, have a quite distinctive combination of species derived from the Indian Subcontinent and Afro-tropical realms including such genera as *Acacia*, *Anogeissus*, *Balanites*, *Grewia* and *Capparis*. The grasslands within reserves, however, support some of the highest biomass of ungulates in all of Asia. Wetlands in such an arid region are of great importance to wildlife and especially wetland birds. The biodiversity index of the unit is calculated at only 5.2 (see section 1.4.3.1 above), resulting in an ultimate protection target of 7.6%.

f. Distinct Sub-units

There are two major divisions in this large unit. Sub-unit I4a consists of the undulating plains of the upper Ganges and upper Indus. This unit contains some forested patches in the boulder Bhabar tracts of the Himalayan foothills and some important wetland sites. Sub-unit I4b consists of the Aravalli Mountains, Malwa plateau and the Kathiawar peninsula.

g. State of PA Development

Current level of PA coverage is 2.0%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 1.2% a minor increase since the IUCN Review (MacKinnon & MacKinnon, 1986). Current expected target for protection is 7.4 resulting in an inadequate conservation index score of 0.2 (see section 1.4.2 for scoring details).

2.5 Unit I5: Western Coast

a. Extent of unit

The unit consists of the climatically moist, south western coastal hills of India, which extend from the extreme southern tip of the peninsula, northwards some 1700 km to the Gulf of Khambhat. The unit has a total area of 162,139 sq. km.

b. Administrative Divisions

The entire unit falls within India in the states of Kerala, Karnataka, Goa, Maharashtra and marginal parts of Tamil Nadu and Gujarat.

c. Natural Vegetation

Most of the area was originally clothed in tropical moist deciduous forest (TMD). The wetter parts of the Western Ghats supported lowland everwet rainforest (TWE) which graded through semi-evergreen forests (SER) to the surrounding deciduous forests. The higher mountains were clothed in sub-tropical broad-leaved hill forests (SBH), topped by montane wet temperate forest (TME) on the highest peaks.

d. Current land Use

Much of the original vegetation has been destroyed or modified by the high density of human inhabitants. Lowland areas are under extensive rice fields, farms and coconut plantations. Hilly areas support tea, coffee, rubber, cardamom, cinchona and other crops and the mountains are partly under secondary forest. Many areas logged for timber have been replanted with exotic *Eucalyptus* or silver oak. About 33% of the unit is still covered by natural vegetation cover, mostly in the hills and mountains. There are sparse populations of semi-nomadic, hunter-gatherer tribals, such as the Kadar and Pandaram, living in parts of the unit, harvesting many minor forest products.

e. Biological Richness and Endemism

The area is very rich in species diversity and shows very high levels of endemism. Plant endemism in the unit is very high with an estimated 1500 endemic plant species. Endemism in the selected mammal groups (primates, ungulates and carnivores) runs at 12% and in passerine bird families at 9%. In some groups it is much higher than this. For instance about 150 endemic species of amphibians and reptiles (almost all species found in the unit) have been described. The unit contains one EBA (ICBP, 1992). The biodiversity index of the unit is calculated at 6.1 (see section 1.4.3.1 above), resulting in an ultimate protection target of 8.1%.

f. Distinct Sub-units

We follow Rogers and Panwar (1988,1992) in dividing the unit into two biotic provinces - the coastal deciduous Malabar Plains (I5a) separated from the moister Western Ghat Mountains (I5b). The 1986 review did not split the unit.

g. State of PA Development

Current level of PA coverage is 7.4%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 4.8% a minor decrease since the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the unit as 5.6% protected. Current expected target for protection is 7.4 resulting in a conservation index score of 0.6 (see section 1.4.2 for scoring details).

2.6 Unit I6: Deccan Peninsula

a. Extent of Unit

The unit consists of the dry central and eastern portions of southern India, from the Satpura and Eastern Ghats to the southernmost tip of the peninsula. It has a total area of 1,411,320 sq. km.

b. Administrative Divisions

The entire unit falls within India, in the states of Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra, Madhya Pradesh and the southern portion of Bihar and Orissa.

c. Natural Vegetation

Most of the area was originally clothed in tropical dry deciduous forests (DDF) and Tropical moist deciduous forest (TMD). Teak *Tectona grandis* is a major component of the deciduous forests in the south of the unit and Sal *Shorea robusta* is dominant in the northeast. Small patches of tropical moist deciduous forest intrude along the border with the Western Ghats (unit I5). Drier parts of the unit are covered by tropical thorn forest (TSF) and the moister coastline of Coromandel has some tropical dry evergreen forest (TDE). Coastal estuaries support small areas of mangroves (MNV) and the Godavari delta formerly supported freshwater swamp vegetation (FSV).

d. Current Land Use

Most of the original vegetation has been destroyed or modified by the high density of human inhabitants. The unit supports extensive farms and coconut plantations and extensive teak plantations. About 22% of the unit is still covered in natural vegetation cover, though most of this is modified by man and his activities. Many degraded areas are heavily eroded and now virtually useless for both humans and wildlife.

e. Biological Richness and Endemism

The unit is of moderate species richness and shows rather low levels of endemism. The biodiversity index of the unit is calculated at only 4.1 (see section 1.4.3.1 above), resulting in an ultimate protection target of 7.1%.

f. Distinct Sub-units

We follow Rogers and Panwar (1992) in dividing the unit into five sub-units - I6a Central highlands, I6b Chotta-Nagpur, I6c Eastern highlands, I6d Central plateau and I6e Deccan south. In fact the distinctions between these units are largely geographical and less biological. The Godavari river, however, does seem to act as an important barrier to some species and races.

g. State of PA Development

Current level of PA coverage is 3.1%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 2.0% a large increase since the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the unit as less than 1.0% protected. Current expected target for protection is 6.5 resulting in a conservation index score of 0.3 (see section 1.4.2 for scoring details).

2.7 Unit I7: Gangetic Plain

a. Extent of Unit

The unit of the moist lowlands and swamp forests of the Ganges valley and delta, the lowlands of the Brahmaputra river and most of Bangladesh. The unit has a coastline of about 1,200 km and a total area of 534,922 km.

b. Administrative Divisions

The unit falls in the India states of Uttar Pradesh, West Bengal, Bihar and coastal Orissa plus almost the whole of Bangladesh.

c. Natural Vegetation

Most of the area was originally clothed in dense tropical forests (SER) with a coastal block of mangroves (MNV) backed by swamp forests (FSV) and a broad plain of tropical moist deciduous forest (TMD). In the moister hilly areas and in the coastal hills of Orissa were found tropical semi-evergreen rainforest (SER).

d. Current Land Use

The original vegetation has been mostly destroyed or modified by man. There are extensive rice fields and farmland with plantations of bananas and sugarcane in coastal areas. The lowlands are some of the most densely inhabited areas on the planet with over 200 persons per sq. km. Only 4.9% of the unit remains under natural vegetation, almost entirely in the Sunderbans mangroves and Siwalik foothills.

e. Biological Richness and Endemism

The unit was probably rich in species, being an important transition zone between Indo-China, the Himalayas and the rest of the Indian sub-continent. Rhino, elephant, swamp deer and buffalo used to roam the plains with tigers and leopards and other large game. However, the area is now almost totally transformed by man. Only the Sunderbans mangroves which are still the largest block of mangroves in Asia are of high conservation value. Wetland sites are of great importance to a wide range of wetland birds. The biodiversity index of the unit is calculated at 8.0 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.0%.

f. Distinct Sub-units

We follow Rogers and Panwar (1992) in dividing the unit into two distinct sub-units. Sub-unit 17a covers the Siwalik hills and upper Gangetic Plain and enjoys direct contact and faunal exchange with southern India. Sub-unit 17b covers the rich lowland areas of the delta to the east of the Ganges river and includes the lower Brahmaputra valley and Sunderbans.

g. State of PA Development

Current level of PA coverage is 3.1%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 2.0% a small increase since the IUCN Review (MacKinnon & MacKinnon, 1986). Current expected target for protection is 4.9 resulting in a low conservation index score of 0.2 (see section 1.4.2 for scoring details).

2.8 Unit 18: Laccadives and Maldives

a. Extent of Unit

This unit consists of two chains of coral atolls each about 750 km long and consisting of over two thousand small islets.

b. Administrative Divisions

The Laccadives is part of India in the state of Lakshadweep. The Maldives is an independent sultanate.

c. Natural Vegetation

Most of the archipelagos consists of sand bars and raised coral atolls. There are mangroves (MNV) in the lagoons and *Pandanus* forests and beach scrub (BFV) on the land.

d. Current Land Use

Most of the islands are uninhabited. About 300 islands are inhabited only by fishermen. There are extensive coconut plantations and groves. Some islands are being developed as tourist destinations (particularly Maldives).

e. Biological Richness and Endemism

The units are rather poor in terrestrial species, but have rich marine life. There are over 100 species of birds reported from the units but very few native mammals (only two bats are native to the Maldives). A few mice and shrews have been introduced by Man. Laccadive species are closely related to mainland India but the Maldives show some local

endemism, including 5 endemic species of *Pandanus* (Adams, 1983), two endemic sub-species of bat and a few endemic sub-species of birds.

f. Distinct Sub-units

The unit can be divided into two with the Laccadives showing closer floral and faunal relationships to mainland India, but they are so small and almost unmappable at the scale of this analysis that they do not merit further subdivision for the purposes of this review.

g. State of PA Development

Current level of PA coverage is 3.0%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 2.3% an increase since the IUCN Review (MacKinnon & MacKinnon, 1986). Current expected target for protection is 5.6 resulting in a conservation index score of 0.4 (see section 1.4.2 for scoring details).

2.9 Unit I9: Assam

a. Extent of Unit

This unit consists of the moist upper Brahmaputra valley up to the Duar foothills of the Eastern Himalayas, together with the deciduous forest zone of the Khasi Hills and Cachar-Tripura tracts. The unit totals 124,127 sq. km.

b. Administrative Divisions

The unit consists of most of Assam state, most of Tripura and small portions of Nagaland and Mizoram plus a small fringe of Bangladesh.

c. Natural Vegetation

Low-lying forests are tropical evergreen (TWE) and semi-evergreen (SER) whilst hills are mostly tropical moist deciduous (TMD) with some sub-tropical broadleaf hill forest (SBH) and subtropical pines (SPF).

d. Current Land Use

Most of the natural vegetation in the Brahmaputra valley has been destroyed and forests remain only on mountains and hill tracts. In total 27% of the unit is still under natural vegetation.

e. Biological Richness and Endemism

The unit is rich in both plants and animals with moderate levels of endemism in most groups. The unit is biologically the richest in the Indian sub-region. The unit contains one EBA (ICBP, 1992). The biodiversity index of the unit is calculated at 13.7 (see section 1.4.3.1 above), resulting in an ultimate protection target of 11.9%.

f. Distinct Sub-units

The unit can be divided into two with I9a consisting of the moist Brahmaputra valley with evergreen systems related to the Eastern Himalayas and sub-unit I9b consisting of the drier hill tracts of the unit, biologically more related to Northern India.

g. State of PA Development

Current level of PA coverage is 3.5%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 2.0% which is a small increase since the IUCN Review (MacKinnon & MacKinnon, 1986). Current expected target for protection is 10.9 resulting in a low and inadequate conservation index score of only 0.2 (see section 1.4.2 for scoring details).

2.10 Unit 02: Ceylon Wet Zone

a. Extent of Unit

The unit consists of the south western corner of the island of Sri Lanka which enjoys everwet climatic conditions. The unit has a total area of 15,633 sq km.

b. Administrative Divisions

The entire unit falls within Sri Lanka.

c. Natural Vegetation

Most of the area was originally clothed in lowland rainforest (TWE). Montane areas were covered in sub-tropical broadleaf hill-forest (SBH) and the highest peaks in montane wet temperate forests (TME).

d. Current Land Use

Most of the original vegetation has been destroyed or modified by the high density of human inhabitants. Lowland areas are under extensive rice fields, farms and coconut plantations. Hilly areas support tea, teak and other crops and the mountains are mostly under secondary forest. About 11% of the unit still supports natural vegetation cover and that is mostly in the mountains.

e. Biological Richness and Endemism

The unit is less rich in species than comparable areas of mainland India, as one would expect for an island, but is quite rich in species and very rich in endemic forms, particularly among rainforest trees and other plants. For instance all but one of the primitive dipterocarp trees on Sri Lanka are endemic (Kostermans, 1983). Endemism among selected mammal groups (primates, ungulates, carnivores and pangolins) runs at 10% whilst the endemism among selected bird groups (passerine families) runs at 15%. The unit contains one EBA (ICBP, 1992). The biodiversity index of the unit is calculated at 8.0 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.0%.

f. Distinct Sub-units

We have recognised no distinct sub-units within this small unit.

g. State of PA Development

Current level of PA coverage is 4.8%. However, much of this is degraded habitat and the actual effective protection of the unit is scored as only 2.3% which is a large increase since the IUCN Review (MacKinnon & MacKinnon, 1986) which scores the unit as only 0.8% protected. Current expected target for protection is 8.9 resulting in a rather inadequate conservation index score of only 0.3 (see section 1.4.2 for scoring details).

2.11 Unit S13 Ceylon Dry Zone

a. Extent of Unit

The unit consists of the northern and eastern parts of the island of Sri Lanka which enjoys seasonally moist to dry climatic conditions. The unit has a total area of 51,166 sq km.

b. Administrative Divisions

The entire unit falls within Sri Lanka.

c. Natural Vegetation

Most of the area was originally clothed in tropical dry evergreen forest (TDE) in the moister areas and tropical thorn forest (TSF) in the drier north and south-eastern corner of the island. There is a belt of tropical semi-evergreen forests around the division with unit 02 (Ceylon Wet Zone).

d. Current Land Use

Most of the original vegetation has been destroyed or modified by the high density of human inhabitants. Moist lowland areas are under extensive farms and coconut plantations. Hilly areas support tea, teak and other crops. The driest areas are mostly under secondary thorn scrub. 22% of the unit is still covered in natural vegetation.

e. Biological Richness and Endemism

The unit is less rich in species than comparable areas of mainland India, as one would expect of an island, but is nevertheless moderately rich in both species diversity and endemism. Endemism among selected mammal groups (primates, ungulate, carnivores and pangolins) runs at 10% whilst the endemism among selected bird groups (passerine families) runs at 2.5%. Plant endemism is relatively low. The unit contains part of one EBA (ICBP, 1992). The biodiversity index of the unit is calculated at 4.6 (see section 1.4.3.1 above), resulting in an ultimate protection target of 6.7%.

f. Distinct Sub-units

We have recognised no sub-unit within this small unit.

g. State of PA Development

Current level of PA coverage is 15.7%. However much of this is degraded habitat and the actual effective protection of the unit is scored as only 9.4% which is a large increase since the IUCN Review (MacKinnon & MacKinnon, 1986) which scores the unit as only 5.9% protected. Current expected target for protection is 6.7 resulting in a satisfactory conservation index score of 1.4 (see section 1.4.2 for scoring details).

B. Indo-Chinese Sub-region

2.12 Unit 04: Burmese coast

a. Extent of Unit

The unit consists of the coastal rainforests of Burma, including the Deltas and estuaries of the Irrawaddy and Salween rivers. The unit corresponds with the subdivisions of Arakan, Irrawaddy Delta and northern Tenasserim described by Blower (1982). The unit has a total area of 116,077 sq km.

b. Administrative Division

The entire unit falls within Burma except for a marginal extension into Bangladesh.

c. Natural Vegetation

The unit receives regular rainfall from the winds off the Indian Ocean and supports very lush vegetation. Most of the area was originally lowland evergreen rainforest (TWE), with some montane evergreen forest (TME), a large area of freshwater swamp (FSV) in the Irrawaddy delta and some semi-evergreen forests (SER). Small areas of the unit were clothed originally in mangrove (MNV) forest along the coast and there is a small patch of deciduous dipterocarp forest (DDF) near the mouth of the Salween river.

d. Current Land Use

Although population density is only moderate for tropical Asia, most of the rainforest and almost all of the freshwater swamp has been cleared for agriculture. Much of the cleared rainforest on hilly terrain has been replaced by creeping bamboo *Melocanna bambusoides*. Flat areas are irrigated for paddy rice; hill farms grow hill rice, cassava, yams and vegetables for local consumption. Few cash crops are grown. Some forest area are exploited for timber.

e. Biological Richness and Endemism

The unit is fairly rich in fauna and flora due to the lushness of the vegetation cover, the extensive range of habitats from coastal mangroves to mountains and the unit's position as a corridor for faunal and floral exchange between the Sundaic, Indochinese and Indian sub-regions. The unit has only low endemism. The biodiversity index of the unit is calculated at 9.6 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.8%.

f. Distinct Sub-units

Although some differences exist from north to south, for the purposes of this broad review we have not recognised any sub-divisions.

g. State of PA Development

Current level of PA coverage is 0.3%. However much of this is degraded habitat and the actual effective protection of the unit is scored as only 0.2% which is the same as the unit was scored in the IUCN Review (MacKinnon & MacKinnon, 1986). Current expected target for protection is 8.3 resulting in a very inadequate conservation index score of only 0.1 (see section 1.4.2 for scoring details).

2.13 Unit 05: Coastal Indochina

a. Extent of Unit

The unit consists of the coastal regions of SE Asia from the Red River in the north to the Indian Ocean coast of southern Burma in the south. The unit extends inland to include the Cardamom mountains. The total area of the unit is 376,208 sq km.

b. Administrative Divisions

The unit consists of most of Vietnam, marginal areas of Laos, southern Cambodia, the south coast of Thailand and a small part of Myanmar.

c. Natural Vegetation

The unit has a wide range of vegetation types from mangroves and freshwater swamps (FSV) in the Mekong and Chao Phraya deltas to montane pine forests (TPF) and everwet forests (TME) on the mountains. Most of the area is classed as semi-evergreen forest (SER) but parts of the Cardamom mountains and a few small areas north of Danang in Vietnam have true everwet rainforest (TWE). Other lowland forest types include mixed deciduous forest (TMD), and very small areas of dry dipterocarp forest (DDF) and forest on limestone (LIM). Extensive parts of the Mekong delta are on peat and used to support *Melaleuca* peat swamp forests (PSV). Montane formations include tropical montane deciduous forest (MDF), montane evergreen forest (TME), tropical pine forests (TPF and SPF) of both *Pinus merkusii* and *Pinus kesiya* and sub-montane dry evergreen forest (SDE).

d. Current Land Use

Population density is very high in the unit and most of the lowland forest has been cleared but since much of the unit is mountainous some 28% of the unit is still clothed in closed forest. Military activities in the long Vietnamese wars caused about 2 million hectares of forest to be destroyed. The mangroves and *Melaleuca* forests of the Mekong delta were the most seriously affected but have partly recovered with the aid of replanting programmes. Extensive areas of peaty delta are acid sulphate and have been abandoned after initial cultivation to form large reed beds. The Mekong delta is a valuable fishery with prawns the most valuable export item.

e. Biological Richness and Endemism

The unit is rather rich in species and shows moderately high levels of endemism, especially in the Annam lowlands. The unit contains two EBAs (ICBP, 1992). The biodiversity index of the unit is calculated at 10.5 (see section 1.4.3.1 above), resulting in an ultimate protection target of 10.3%.

f. Distinct Sub-units

The unit is divided into four main sub-divisions: the eastern coast (Annam) sections 05c and 05b are divided by the Haivan Pass with predominantly tropical conditions to the south and predominantly sub-tropical to the north. The southern sectors are made up of the distinct flattish Mekong Delta unit 05a with its special annual flood regime and the more mountainous unit 05d Cardamom Mountains which also extends into the moist lower Chao Phraya valley region. The latter unit is a transition zone which has quite a lot of Sundaic species mixed with the Indo-Chinese elements. The eastern two units 05c and 05d are a rather distinct area which has been isolated from the rest of Indo-China by the Annam Trung Son mountain chain; in the north it shares several species with the Himalayan units.

g. State of PA Development

Current level of PA coverage is 10.3%. However, some of this is degraded habitat and the actual effective protection of the unit is scored as only 9.3% which is a major increase since the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the unit as only 2.7% protected. Current expected target for protection is 9.3 resulting in a satisfactory conservation index score of 1.0 (see section 1.4.2 for scoring details).

2.14 Unit 06: South China

a. Extent of Unit

The unit consists of a narrow fringe of land along the south coast of mainland China and including the island of Hainan, broadening westwards as far as the Red River in Vietnam. Only this Vietnamese portion is considered under this review. The unit has a total land area of 61,178 sq km.

b. Administrative Divisions

The portion of the unit under consideration constitutes all of northern Vietnam east of the Red River.

c. Natural Vegetation

Originally the southern parts of the unit were covered in tropical semi-evergreen rainforest (SER), and subtropical lowland moist forest (SLM), whilst to the north-west of the unit the hills were clothed originally in sub-montane dry evergreen forest (SDE). Small areas of the unit were covered by forest on limestone (LIM), mangroves (MNV), freshwater swamp (FSV) (Red River Delta only), subtropical broadleaf hill forest (SBH), subtropical pine forest (SPF), and montane deciduous forest (MDF).

d. Current Land Use

The unit is very heavily populated and almost all lowland forests have been cleared. Only 13.5% of the unit remains under natural vegetation and even much of that is rather disturbed, and in mountainous and hilly areas or on the limestone karst formations much of the vegetation is secondary bamboo.

e. Biological Richness and Endemism

The unit is of moderate biological richness and has some local endemic species. There are several mammals and birds endemic to the unit. The biodiversity index of the unit is

calculated at 9.5 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.8%.

f. Distinct Sub-units

Due to its isolation and island endemism, Hainan island should be treated as a distinct sub-unit, 06b, but not considered under this review. The Vietnamese portion falls entirely within sub-unit 06a.

g. State of PA Development

Current level of PA coverage is 1.0%. However, some of this is degraded habitat and the actual effective protection of the unit is scored as only 0.8% which is a small increase since the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the unit as only 0.1% protected. Current expected target for protection is 9.6 resulting in a very inadequate conservation index score of 0.1 (see section 1.4.2 for scoring details).

2.15 Unit -M: Annamese Mountains

a. Extent of Unit

The unit consists of two mountain blocks adjacent to biounit 05 on the Dalat Plateau and in the central Annam zone around Ngoc Linh Mountain. The total area of the unit is 36615 sq. km.

b. Administrative Divisions

The unit is almost totally within Vietnam but extends marginally into Cambodia and southern Laos.

c. Natural Vegetation

The unit is moist and montane. The main vegetation type is montane evergreen forest (TME) but lower slopes contain small areas of tropical wet evergreen and semi-evergreen forests (TWE and SER) and there are small patches of natural conifer forest (TPF) and moss forest on the highest peaks.

d. Current Land Use

Population density is moderate due to the high elevations and generally steep slopes but some flatter areas such as Danang are rather heavily populated. Much of the deforested parts of the unit are reforested in pines or secondary bamboo. About 40% of the unit is still under natural forest cover, although most is to some extent disturbed by fuel and charcoal collection.

e. Biological Richness and Endemism

The unit is moderately rich in species and shows moderately high levels of endemism of birds and conifers, especially on the Dalat Plateau. The unit contains one EBA (ICBP, 1992). The biodiversity index of the unit is calculated at 12.0 (see section 1.4.3.1 above), resulting in an ultimate protection target of 11.0%.

f. Distinct Sub-units

The unit is divided into two sub-divisions: the Central Annam Mountains constitute biounit -Ma and the Dalat or Lang Bian plateau constitutes unit -Mb.

g. State of PA Development

Current level of PA coverage is 10.3%. However, some of this is degraded habitat and the actual effective protection of the unit is scored as only 8.6% which is a major increase since the IUCN Review (MacKinnon & MacKinnon, 1986) which included this unit within unit 05 but included almost no protected areas at that time. Current expected target is 9.2

resulting in a satisfactory conservation index score of 0.9 (see section 1.4.2 for scoring details).

2.16 Unit 09: Burmese Monsoon Zone

a. Extent of Unit

The unit consists of the Irrawaddy catchment between the Chin Hills to the west, extends north through the evergreen forests of Mizoram, Manipur and Nagaland and to the Shan plateau to the east. The unit includes the dry central zone of Myanmar, the Chindwin and the Kachin regions and the northern hills leading up into the Himalayan mountains. It has a total area of 401,486 sq km.

b. Administrative Divisions

The unit lies almost entirely within Burma except for marginal portions of China (not covered under this review), Bangladesh and northeast India.

c. Natural Vegetation

The unit consists of a great range of vegetation types from thorn scrub (TSF) in the dry rainshadow of central Myanmar to lush semi-evergreen lowland (SER) and tropical montane evergreen forests (TME) of the Chin hills. The unit extends from almost sea-level tropical conditions in the south to sub-alpine, temperate conditions in the extreme north.

Most of the central Irrawaddy valley was clothed in mixed deciduous forests (TMD) (very important for the production of teak *Tectona grandis*) interspersed with patches of dry (deciduous) dipterocarp forest (DDF) locally called "indaing" in which *Dipterocarpus* spp. dominate. Edaphic and mainly secondary thorn scrub (TSF) is found in the driest areas.

Around the dry zone is a narrow belt of semi-evergreen forests as a transition to the moister montane forests (TME) on the Chin and Shan hills. A broader belt of semi-evergreen forests (SER) occurs to the north of the dry zone, where it merges gradually with rather similar, but more temperate, forests classed as subtropical moist lowland forests (SLF). On the hills these interdigitate with the sub-tropical montane forests (SBH) of the upper Chindwin and Irrawaddy valleys. The highest peaks in the north of the unit rise above the tree-line and support sub-alpine vegetation (ALP).

d. Current Land Use

Our GIS coverages show 52% of the area as natural vegetation but much of this is logged over, fallow or intensively managed forests. Extensive areas of the Irrawaddy plain are developed as farmland, although much of this can only be planted for part of the year. Other large areas are extensively managed semi-natural teak plantations. Much of the moister hill forests have been destroyed through shifting agriculture and have become lalang grasslands.

e. Biological Richness and Endemism of the Unit

The unit has rather high species richness, due more to the wide range of habitat types included than to high richness per unit area. The unit has a few endemic species vertebrates but overall the endemism is fairly low. The unit contains three EBAs (ICBP, 1992). The biodiversity index of the unit is calculated at 10.5 (see section 1.4.3.1 above), resulting in an ultimate protection target of 10.3%.

f. Distinct Sub-units

We have recognised three biogeographical sub-units - 09a South Irrawaddy, consisting of Peguyoma, dry zone and Lower Chindwin; 09b North Irrawaddy comprising the Kachin and Upper Chindwin divisions; and 09c the Burma transition zone which includes the evergreen forests of Mizoram, Manipur and Nagaland.

South Irrawaddy is essentially a mosaic of dry seasonal tropical habitats whilst North Irrawaddy is a mosaic of moist, sub-tropical and temperate habitats. The two sub-units consequently share few species and their biological relationships are quite different. Sub-unit 09c is faunally closely related to the neighbouring evergreen forests of Assam but remains floristically part of the Burmese evergreen forest formations (P. Ashton pers. comm.).

g. State of PA Development

Current level of PA coverage is only 1.4%. However, some of this is degraded habitat and the actual effective protection of the unit is scored as only 1.1% which is nevertheless a major increase since the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the unit as 0% protected. Current expected target for protection is 7.9 resulting in a still very inadequate conservation index score of 0.1 (see section 1.4.2 for scoring details).

2.17 Unit 10: Indochina

a. Extent of Unit

The unit consists of large inland plains and valleys of the Mekong and the upper catchments of the Chao Phraya and Salween rivers. The unit extends up into the Himalayan foothills of southern China and has a total area of 928,039 sq km.

b. Administrative Divisions

The unit extends over almost all of central and northern Thailand, and all but the southern fringe of Cambodia and the eastern edge of Laos. It also includes small parts of Vietnam, the Shan plateau of Burma and the southern portions of the Yunnan province of China (not included in the current review).

c. Natural Vegetation

The unit consists of a great range of vegetation types from dry dipterocarp forests (DDF) of the plains of Thailand and Cambodia to the lush semi-evergreen lowland (SER) and tropical montane evergreen forests (TME) of the Shan hills. The unit extends from almost sea-level tropical conditions in the south to sub-alpine, temperate conditions at the extreme north. True everwet rainforest (TWE) is found only along the Salween valley. Pine forests (TPF and SPF) are found on some of the hills in the unit and there are some specialised forests on the limestone outcrops (LIM). Hills in the north of the unit dry evergreen forest (SDE) with montane deciduous forest (MDF) on the hills. In the extreme north sub-division of the unit we find sub-tropical moist lowland forest (SML) and sub-tropical montane forests (SMF).

d. Current Land Use

Parts of the unit, support high human densities and here all natural vegetation has long been cleared for agricultural use. In other parts of the unit such as Cambodia, population is relatively low and extensive forest areas remain. In the northern parts of the unit, population density is not very high but pattern of land use by the migrating ethnic minorities is very destructive to natural vegetation and the hilly catchments of the major rivers have suffered from very extensive shifting agriculture. In all, 34% of the unit remains under natural vegetation.

e. Biological Richness and Endemism

The unit is rich in fauna and flora (due to the wide range of habitats represented, large size of the unit and high species richness) and has a moderate level of endemism. About one third of all plants in the Indo-Chinese sub-region are endemic to the sub-region (Vidal, 1960). Most of these endemics are found within unit 10 and many are confined to this biounit. The north of the unit contains part of one EBA (ICBP, 1992). The biodiversity

index of the unit is calculated at 8.3 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.2%.

f. Distinct Sub-units

We have followed Vidal in dividing the unit into three sub-divisions basically corresponding with the tropical lowland plains (10a Central Indochina), hilly sub-tropical sector (10b North Indochina) and montane temperate sector (10c Indochina transition zone). There are major changes in species composition between these different sub-divisions but also considerable overlap because altitudinal changes approximate longitudinal changes and forests similar to those found on mountains in the tropical region occur at lower altitude in the sub-tropical and temperate sectors.

g. State of PA Development

Current level of PA coverage is 7.1%. However, some of this is degraded habitat and the actual effective protection of the unit is scored as only 5.2% which is a large increase since the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the unit as only 2.5% protected. Current expected target for protection is 7.9 resulting in a conservation index score of 0.7 (see section 1.4.2 for scoring details).

2.18 Unit 20: Andaman Islands

a. Extent of Unit

The unit consists of the whole chain of the Andaman islands off the coast of Myanmar. The unit has a total area of only about 6000 sq km.

b. Administrative Divisions

The entire unit is administrated by India together with the Nicobar islands further south as the Union Territories.

c. Natural Vegetation

The unit was originally covered in very dense lowland evergreen rainforest (TWE), only slightly less grand in stature and rich in species than the mainland evergreen forests. The dominant species is *Dipterocarpus grandis* in hilly areas. Some parts of the south are dominated by *Dipterocarpus kerrii*. Valley bottoms are characterised by an abundance of tree-ferns, wild bananas and climbing bamboo *Dinochloa*.

On some coastal areas on fast draining soils, there are some semi-evergreen forests (SER) that are an edaphic pre-climax of the everwet forests. These are dominated by *Pterocarpus dalbergoides* and *Terminalia* spp.

d. Current Land Use

Human population density is low and most of the unit remains forested. Forestry exploitation has destroyed or disturbed much of the coastal lowland areas but the interior of the islands remain relatively undeveloped.

e. Biological Richness and Endemism

As expected for such remote islands, species richness is rather low but there are several interesting endemic species and many endemic sub-species on the islands. The unit shows closest relationships with unit 04 (Burmese coasts) and is quite different from the Nicobar islands to the south. The unit is one EBA (ICBP, 1992). The biodiversity index of the unit is calculated at 10.8 (see section 1.4.3.1 above), resulting in an ultimate protection target of 10.4%.

f. **Distinct Sub-units**

There are several differences between the northern islands of the Andamans and Little Andaman island in the south but not enough to warrant further subdivision of the unit for the purposes of this review.

g. **State of PA Development**

As mapped, current level of PA coverage is 3.4%, less than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the unit as 5.4% protected. Current expected target for protection is 5.5 resulting in a conservation index score of 0.6 (see section 1.4.2 for scoring details).

C. Sundaic Sub-region

2.19 Unit 07: Peninsular Malesia

a. **Extent of Unit**

The unit consists of the whole of West Malaysia, Singapore, a few small islands off the coast of Indonesia, the peninsular portion of southern Thailand and the southern tip of Tenasserim, Myanmar. The unit has a total area of 228,933 sq km.

b. **Administrative Divisions**

Most of the unit falls within the Federation of Malaysia, with a smaller area within Thailand, a coastal strip of Myanmar, Singapore and a few of the smaller islands of Indonesia.

c. **Natural Vegetation**

The vegetation of the unit is predominantly tropical everwet rainforest (TWE) in the south and semi-evergreen rainforest (SER) in the north. In addition there are quite large areas of freshwater swamp (FSV) and of montane forest (TME) and small areas of forest on limestone (LIM), heath forest (HFV), peat swamp (PSV) and mangroves (MNV).

The rainforests of this unit are exceptionally rich in species and very tall in structure. They are among the richest in the whole Sundaic sub-region.

d. **Current Land Use**

Only 25% of the unit is still covered in natural vegetation, mostly as forest reserves for hydrological or production forestry purposes. The unit has a moderately high human population, subsisting on rather intensive agriculture of irrigated rice and some upland farming. Extensive areas of the unit are developed as plantations for economic crops; the most important are oil palm, pine, rubber, cocoa, coffee and coconuts.

e. **Biological Richness and Endemism**

The unit is biologically very rich having similar numbers of species of plants, birds and mammals as does Sumatra although the Peninsula unit is less than half as big as the Sumatran unit. The unit shows moderately high endemism among plant species (15%) but endemism is low among mammals (3%) and birds (1%) even though most of the unit's fauna is endemic to the Sundaic sub-region. The unit has part of one EBA (ICBP, 1992). Biodiversity index is calculated as 11.4 resulting in an ultimate protection target of 10.7%.

f. **Distinct Sub-units**

The unit can be divided into two distinct two sub-units - 07a Malay Peninsula and 07b Malay transition zone. Most of the unit lies truly within the Malesian Floral Region (Whitmore, 1975, van Steenis, 1950) the limits of which extend to the Kra isthmus. This is the sharpest transition in floral composition which van Steenis (1950) terms a 'demarcation knot' where 375 Malesian genera reach their northern limits and where 200 Indochinese genera reach their southern limits. This division corresponds to the

vegetation change from everwet to semi-evergreen rainforest. This boundary is slightly south of the sharpest change in avifaunal composition as shown by Wells (1974). The northern part of the peninsula is in fact a transition zone in which both Sundaic and Indochinese species are found. The southern part of the transition zone, which is more Sundaic than Indochinese in species composition, is therefore included as sub-unit 07b.

g. State of PA Development

Current level of PA coverage is 5.0%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 4.0% which is a reduction since the IUCN Review (MacKinnon & MacKinnon, 1986) which over-generously scored the unit as 11.5% protected by including several Forest Reserves that were only proposed as protected areas. Current expected target for protection is 9.8 resulting in a conservation index score of 0.4 (see section 1.4.2 for scoring details).

2.20 Unit 21: Sumatra and Nicobars

a. Extent of Unit

The unit consists of the entire major island of Sumatra, together with its satellite islands: the Nicobars; the western Sumatran islands, including the Mentawai group; the Lingga and Riau archipelagos; and the two larger islands of Bangka and Belitung. The unit has a total land area of 476,482 sq km.

b. Administrative Divisions

The unit lies within the Republic of Indonesia except the Nicobar islands which are administered as part of India. The Indonesian part of the unit is divided into eight different provinces-Aceh, North Sumatra, Riau, West Sumatra, Jambi, South Sumatra, Bengkulu and Lampung.

c. Natural Vegetation

Sumatra enjoys an equatorial climate with high rainfall which supports extensive areas of very lush tropical rainforests (TWE). Sumatra also has a wide range of other forest types from montane (TME), Limestone forests (LIM) and a small area of ironwood forest (IFV). Some of the drier mountain areas in the north of the island support the only natural tropical pine forests (TPF) in Indonesia. The peat swamps (PSV) of the east coast show characteristic forest formations of great commercial importance and botanical interest. On the islands of Bangka and Belitung, rare heath forests (HFV) grow. The east coast has extensive areas of mangrove (MNV) and some areas of non-peaty swamp forest (FSV).

d. Current Land Use

Human population density in Sumatra is already very high (over 100 per sq km). The unit has already lost a great deal of its original forest (42% forest remaining in 1975, now estimated at only 36%) and continues to lose natural forest faster than any other part of Indonesia. Forests remain mostly on mountains, limestone and acid swamps. In the north there are large plantations of rubber, oil palm, tobacco, coffee, tea and fruit. Cloves are being increasingly planted as a valuable cash crop.

e. Biological Richness and Endemism

Sumatra is faunally one of the richest units in the sub-region. It has 195 mammals and 580 birds (including 465 resident species) and is also rich in reptiles (217 species) and plants. Levels of endemism, however, are less high than on the other Greater Sunda Islands with only 2% endemism in birds, 10% in mammals and 11% in both reptiles and plants.

Within the unit, the highest levels of mammalian endemism are found in the small group of islands off the west coast of Sumatra, known collectively as the Mentawai islands, which account for half the unit's endemic mammals. The unit contains 3 EBA's (ICBP, 1992). Biodiversity index is calculated as 10.5 resulting in an ultimate protection target of 10.3%.

f. Distinct Sub-units

Sumatra can be divided into eight distinct biological sub-units. The main island has a major biological discontinuity just south of Lake Toba where the Barisan mountain chain is broken and there is also a break in the forest cover. Other major biogeographical divisions within the unit separate the Mentawai islands from the main island and also the Nicobars. The Mentawai islands have ten endemic mammals including four endemic primates. They also have one endemic bird *Otus mentawi*. The Nicobar Islands have four endemic mammals, one endemic bird and many endemic subspecies of birds. Less distinct divisions separate the other western islands from the main island of Sumatra and separate the eastern islands from the main island.

g. State of PA Development

Current level of PA coverage is 7.0%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 5.7% with almost no change since the IUCN Review (MacKinnon & MacKinnon, 1986). Current expected target for protection is 8.8 resulting in a conservation index score of 0.6 (see section 1.4.2 for scoring details).

2.21 Unit 22: Java and Bali

a. Extent of Unit

The unit consists of the major island of Java, together with Madura, Bali and a number of small satellite islands in the Java sea - Bawean, Karimata and Kangean. The total land area of the unit is 139,521 sq km.

b. Administrative Divisions

The entire unit is part of the Republic of Indonesia but is administered under four different provinces - West Java, Central Java, East Java and Bali.

c. Natural Vegetation

The vegetation of the unit is largely affected by climate with a cline from lush, tall rainforest (TWE) in the west to deciduous monsoon forests (TMD) in the north-east. The vegetation has also been disturbed by repeated volcanic activity so that many mountains never attain advanced seral succession stages of vegetation. The extensive areas of montane *Casuarina* forest (MDF) are in this category. Where mountains have remained stable for a long time they exhibit a rich montane forest flora (TME).

d. Current Land Use

Java is one of the most densely populated islands in the world. The whole unit has a human population of about 100 million. It is perhaps not surprising that there is not very much natural habitat remaining. About 10% of the island is under nearly natural vegetation and that mostly on mountains. The northern plains of Java were formerly swamp forests but are now vistas of rice and sugarcane and villages shaded with fruit trees. On the higher ground the fertile volcanic soils support intensive mixed gardens and extensive plantations of rubber, oil palm, tea, cloves and coffee. Large forestry plantations have been planted with pine, teak and some *Agathis*.

e. Biological Richness and Endemism

The unit is of high to moderate richness in its flora with little floristic endemism (5%). This includes 10 endemic genera in West Java (van Steenis, 1950). The bird fauna is quite rich (362 residents) with 8% endemism. There are 133 mammals with 12% endemism and 173 reptiles showing 8% endemism. Richness is much higher at the wetter western end of the

unit than in the east. The unit contain two EBAs (ICBP, 1992). Biodiversity index is calculated as 9.2 resulting in an ultimate protection target of 9.6%.

f. Distinct Sub-units

The unit can be divided into three main sub-units. Western Java is distinct because of its wetter climate. This gives it far richer forests both florally and faunally. Many plant species, together with such striking fauna as the rhinoceros, Javan leaf-monkey, slow loris and numerous birds are confined to this sub-unit. Bali is closely related to eastern Java, but does have one endemic bird, Rothschild's starling *Leucopsar rothschildi* and a few Lesser Sunda forms such as the honeyeater *Lichmera indistincta* and lesser sulphur-crested cockatoo *Cacatua sulphurea*.

g. State of PA Development

Current level of PA coverage is 4.1%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 3.0% a slight increase since the IUCN Review (MacKinnon & MacKinnon, 1986). Current expected target for protection is 8.8 resulting in a conservation index score of 0.6 (see section 1.4.2 for scoring details).

2.22 Unit 25: Borneo and Palawan

a. Extent of Unit

The unit consists of the whole of the large island of Borneo together with Palawan, the Calamian islands and the outlying Natuna and Anambas islands of the South China Sea. The total land area of the unit is 758,262 sq km.

b. Administrative Divisions

The unit is divided into a number of different administrative units. The Palawan and Calamian islands are part of the Philippines. Sarawak and Sabah on the north coast of Borneo are states of the Federation of Malaysia. The small double enclave of the Sultanate of Brunei Darussalam also lies on the north coast of Borneo. The rest of the unit falls within the Republic of Indonesia but is administered by five different provincial governments. The islands of Natuna and Anambas are part of the Sumatran province of Riau. The Indonesian portion of Borneo is called Kalimantan and is divided into four provinces - West, Central, South and East Kalimantan.

c. Natural Vegetation

The climate of Borneo is everwet and the unit supports the largest expanse of tropical rainforest in the Sunda region. Forest types include mangrove forests (MNV), large areas of peat swamps (PSV) and freshwater non-peaty swamp (FSV), the most extensive heath forests or "kerangas" forest (HFV) in the realm, large tracts of lowland dipterocarp forest (TWE), ironwood forests (IFV), hill dipterocarp forests (TWE), forests on limestone (LIM) and various montane forest formations (TME). Alpine vegetation is found on the slopes of Mt. Kinabalu in Sabah, which at 4101 m. is the highest peak in SE Asia.

d. Current Land Use

Due to the relative infertility of the Bornean soils, related to the island's lack of volcanism, the island has not been as heavily colonised by Man as other islands in the region. Human density is only about 90 people per sq km and 56% of the land surface is still under natural forest. A long history of slash and burn agriculture has created a patchwork of secondary forests of different age in some valleys. In the Kelabit highlands along the Sarawak-Kalimantan border there are extensive highland secondary grasslands. Some of the cleared hillsides have become *lalang* grasslands (*Imperata cylindrica*).

Logging has made a heavy impact on the lowland forests over the last 20 years, particularly in Sabah and East Kalimantan. Further forest loss was caused by the extensive fires that swept over much of eastern Kalimantan in the freak dry spell of

1982/3 and again in 1994. Mining and oil exploitation have also resulted in considerable scarring of the landscape in the northern and eastern parts of the island.

e. Biological Richness and Endemism

Borneo is very rich in both flora and fauna. The island is the richest unit of the Sundaic sub-region with small plot tree diversity as high as found anywhere in New Guinea or South America. Borneo is the centre of distribution for the tree family Dipterocarpaceae which dominates many of the forest formations of the realm as well as being the most important group of commercial timbers in SE Asia. 262 species of dipterocarp trees are known from the unit.

Endemism runs at high levels through the whole flora with about 34% of all plant species and 59 genera unique to the unit. By comparison Sumatra has only 12% endemism at species level and only 17 endemic genera.

Moderately high levels of endemism are also found in the fauna. The island of Borneo has 31 species of endemic bird and Palawan adds another 14 endemics to the unit. Similarly Borneo has 39 endemic land mammals and Palawan adds a further 14 endemic species to the unit. The unit contain two EBAs (ICBP, 1992). Biodiversity index is calculated as 8.7 resulting in an ultimate protection target of 9.4%.

f. Distinct Sub-units

By far the most distinctive sub-unit is the Palawan-Calamian group of islands which, whilst sharing most of their fauna with Borneo and slightly less with the Philippine unit 26, have a high level of endemism of their own as illustrated by the 14 endemic birds and 14 endemic mammals. The isolated islands of Natuna and the Anambas in the South China Sea have a few distinct bird subspecies shared with Sumatra and not Borneo. Within Borneo itself it is possible to recognise a number of subdivisions. Some of the major rivers have acted as faunal boundaries to lowland species unable to cross the narrow headwaters because of altitude limits. In addition the central montane unit is quite distinct. 23 of the island's 31 endemic bird species and 23 of the island's 39 endemic mammal species are montane.

g. State of PA Development

Current level of PA coverage is 5.7%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 4.9% a slight increase since the IUCN Review (MacKinnon & MacKinnon, 1986) in which the unit was scored as 3.1% protected. Current expected target for protection is 7.0 resulting in a conservation index score of 0.7 (see section 1.4.2 for scoring details).

D. Wallacean Sub-region

2.23 Unit 23: Lesser Sundas

a. Extent of Unit

The unit consists of the chain of Lesser Sunda Islands from Lombok to Tanimbar, including the two southern islands of Sumba and Timor. It has a total land area of 90,138 sq km.

b. Administrative Divisions

The entire unit lies within the Republic of Indonesia, although some countries have still not accepted Indonesian sovereignty over the territory of East Timor. The administration of forests and protected areas is carried out by four different provinces: Nusa Tenggara Barat (Lombok to Sumbawa), Nusa Tenggara Timur (Sumba and Flores to the western half of Timor), East Timor which is governed as a separate province, and the island of Wetar, Banda and Tanimbar fall within the province of Maluku.

c. **Natural Vegetation**

Because of the seasonal climate and low total rainfall over most of the unit, the forests of the Lesser Sundas are far less lush than in most of the Malesian archipelago. Pockets of everwet forest (TWE) do occur on moister mountains and in poorly drained sites. These are the tallest and richest forests of the unit. Monsoon forests (TMD) are extensive in the more seasonal parts of the unit. The extensive savannahs found in the Lesser Sundas are the result of artificial burning of the original vegetation. Montane forests (TME) in the Lesser Sundas are not luxuriant.

d. **Current Land Use**

Although the population of the Lesser Sundas (80 people per sq km) is not as high as in other parts of the archipelago, the forests are so vulnerable to fire that Man has had a very great impact. Much of the Lesser Sundas now consists of grassy hills with forest only surviving in steep valleys, along watercourses, and on the highest peaks.

The islands of Nusa Tenggara (Lesser Sundas) are mostly agriculture-orientated. The main foodcrops are maize, rice, soya bean and manioc (particularly productive in Lombok and western Flores). Timber exports and livestock production are only of secondary importance. Logging activities are mostly concentrated on Lombok and Sumbawa.

e. **Biological Richness and Endemism**

Because of the seasonal climate and the high degree of isolation of the Lesser Sundas, the flora is very poor in species compared to the forested islands of the Sunda and Sahul continental shelves. The flora is Malesian in composition and shows low levels of endemism (only 3%). The vertebrate fauna of the Lesser Sundas is generally rather low in species number but groups with good dispersal have been better able to colonise the islands so that we find, for instance, quite a rich and diverse bird fauna (242 resident species). Moreover, as a result of the high degree of isolation, the area exhibits a high level of faunal endemism with 66 endemic bird species (30%), 8 endemic mammals (12%) and 17 endemic reptiles (22%). The unit contains 3 EBAs (ICBP, 1992). Biodiversity index is calculated as 10.3 resulting in an ultimate protection target of 10.2%.

f. **Distinct Sub-units**

The unit can be divided into four distinct sub-units. The islands of Timor and Wetar, unit 23c, are closely related in their fauna and have a total of 25 bird species not found elsewhere. The Lombok-Alor chain of islands, unit 23a, shows a gradual cline of species changes along its length but no major faunal divisions and in total has 16 bird species not found anywhere else. The island of Sumba, unit 23b, is somewhat distinct, having 8 endemic birds of its own. The islands of Banda and Tanimbar, unit 23d, are very distinct but more closely related both faunally and florally to the Lesser Sundas than to the Moluccas.

g. **State of PA Development**

Current level of PA coverage is 1.9%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 1.3% a slight decrease since the IUCN Review (MacKinnon & MacKinnon, 1986) in which the unit was scored as 1.8% protected. Current expected target for protection is 8.5 resulting in a rather inadequate conservation index score of 0.2 (see section 1.4.2 for scoring details).

2.24 Unit 24: Sulawesi

a. Extent of Unit

The unit consists of the main Indonesian island of Sulawesi (Celebes) together with a number of satellite islands, including Sangihe, Talaud, Togians, Banggai, Selayar, Tukangbesi and the Sula islands. The total land area of the unit is 189,701 sq km.

b. Administrative Divisions

The entire unit lies within the Republic of Indonesia but its administration falls into 5 different provinces. The Sula islands are in Maluku province and Sulawesi itself consists of four provinces - Sulawesi utara (north), Sulawesi Tengah (central), Sulawesi Selatan (south) and Sulawesi Tenggara (south-east).

c. Natural Vegetation

Lush forests (TWE) grow on the moist volcanoes and highlands (TME), highly specialised forests grow on the extensive limestone (LIM) and ultrabasic rocks (FUB) and rather impoverished semi-evergreen forests (SER) occur on granite and sandy soils or where the climate is more seasonal. In addition there are specialised coastal mangroves (MNV), *Casuarina* and *Barringtonia* formations (BFV), and some interesting swamp and lakeside vegetation types (FSV).

d. Current Land Use

The unit has a moderate human density of over 80 people per sq km; but this is not evenly distributed. Most of the natural forest has been cleared around the population centres of south Sulawesi, Palu, Gorontalo, Kendari and in Minahassa district near Manado but much of the rest of the unit is relatively undisturbed apart from villages along the roads and the opening up of forests for logging.

In total, 60 percent of the unit is still under natural vegetation cover. Principal land cover on the cleared land is coconuts in the north, some coffee and cloves in moister hilly areas, irrigated rice where feasible and rather destructive hill farms in many regions which have left large areas of *lalang* grassland (*Imperata cylindrica*).

e. Biological Richness and Endemism

The Sulawesi unit is of only modest richness in terms of species diversity of both plants and animals, being about half as rich as Borneo and slightly less rich than Java. Its flora shows rather low levels of endemism at 7% but its fauna shows remarkably high endemism as a result of the island's long isolation from both the Asian and Australian continents from which its fauna is derived.

86 (32%) of the unit's 268 resident bird species are endemic. 71 (60%) of the unit's 116 mammal species are endemic and 30 (26%) of the unit's 117 reptiles are endemic.

Endemism is strong also at the generic level with 15 genera of mammals endemic to the unit. 15 genera of birds are also endemic to the unit. The unit contains 3 EBAs (ICBP, 1992). Biodiversity index is calculated as 13.5 resulting in an ultimate protection target of 11.8%.

f. Distinct Sub-units

Sulawesi has a complex shape and is of complex origin. Its wildlife does not form a continuum but each arm of the island harbours a somewhat different combination of species. The distribution of the four species (7 races) of monkeys shows the main faunal boundaries which are also marked by limits of many of the island's bird species and different sub-species of tarsiers.

The main island is divided into five sub-units 24a - 24e. In addition two small units comprise 24f the Sangihe and Talaud islands, which have four endemic birds as well as

being the only part of the unit to share several species with the Philippines, and 24g the Sula islands which have another 6 endemic birds and are the only part of the unit to share two Moluccan species.

g. State of PA Development

Current level of PA coverage is 9.5%. However some of this is degraded habitat and the actual effective protection of the unit is scored as only 8.6% a large increase since the IUCN Review (MacKinnon & MacKinnon, 1986) in which the unit was scored as 3.2% protected. Current expected target for protection is 8.5 resulting in an adequate conservation index score of 1.0 (see section 1.4.2 for scoring details).

2.25 Unit 26: Philippines

a. Extent of Unit

The unit consists of the entire archipelago of the Philippines with the exception of the Palawan and Calamian islands which are biologically classed as part of the Sundaic sub-region. The total land area of the unit is 280,746 sq km.

b. Administrative Divisions

The unit lies entirely within the Philippines. Protected areas are administered by the Bureau of Forest Development, Ministry of Natural Resources.

c. Natural Vegetation

The natural vegetation of the Philippines consists of rainforests (TWE and SER) on the eastern side of the archipelago and monsoon forests (TMD) on the western side of the archipelago. Mangrove forests (MNV) grow as a fringe in some coastal bays on the western side of the unit. Montane forests grow (TME and MDF) on the older volcanoes and along the main mountain chains. Extensive areas of the higher land are under natural tropical pine forests (TPF) on Luzon and Mindoro, mainly *Pinus merkusii* in the south and *Pinus kesiya* in the north. Freshwater swamps (FSV) were found on Luzon and Mindanao.

Lowland forests on the eastern seaboard are regularly raked by cyclones and these forests are characterised by being lower and denser than unaffected forest with an uneven canopy.

d. Current Land Use

Over 90% of the natural vegetation has been cleared for agricultural development, logging and mining. Some of the cleared lands are now irrigated for rice cultivation, more is used for rain-fed agriculture. Large areas are under coconuts and other cash crops but there are very extensive areas of *lalang* grassland *Imperata cylindrica* and some secondary forests. Due to the extensive annual land burning, very little of the cleared forest land can ever return to a natural condition.

e. Biological richness and Endemism

The Philippines unit shows considerable richness in its flora and a remarkably high level of endemism in both. Plant endemism is estimated at about 27% including 33 endemic genera. 145 (39%) of the 367 resident bird species are endemic and a total of 84 endemic mammals including 15 endemic genera are known from the unit. The biounit contains 8 EBAs (ICBP, 1992). The biodiversity index is calculated at a very high 17.8 resulting in an ultimate protected target of 13.9% which is now impossible to achieve.

f. Distinct Sub-units

The unit can be divided into six sub-units, each showing high levels of local endemism and distinctiveness. Related units 26a and 26f consist respectively of Luzon and Mindoro and their satellite islets. Unit 26b consists of the central cluster of islands - Panay, Negros,

Cebu, Bohol, whilst related unit 26e consists of Leyte and Samar. Unit 26c consists of Mindanao and unit 26d the Sulu archipelago.

g. State of PA Development

Current level of PA coverage is 2.6%. However, most of this is degraded habitat and the actual effective protection of the unit is scored as only 1.0% a slight increase since the IUCN Review (MacKinnon & MacKinnon, 1986) in which the unit was scored as 0.5% protected. Current expected target for protection is 8.1 resulting in a rather inadequate conservation index score of 0.1 (see section 1.4.2 for scoring details).

2.26 Unit 13: Moluccas

a. Extent of Unit

The archipelago is not a single biogeographic unit. It is a collection of hundreds of very different islands straddling the gap between the Papuan unit to the east and the Sulawesi unit of Wallacea to the west.

The islands are scattered up to as much as 1300 km apart from one another between 30N - 8030'S in latitude and 1260-1340E in longitude with a total land area of 56,276 sq km. They vary in size from Seram and Halmahera at about 20,000 sq. km. to the smallest inhabited islands of only a few hundred ha.

b. Administrative Divisions

The entire unit falls within the Indonesian province of Maluku.

c. Natural Vegetation

Climate varies from everwet to dry monsoon and geology and topography also vary greatly creating a wide range of vegetation types across the unit.

Vegetation types include mangroves (MNV) and freshwater swamps (FSV), generally dominated by sago palms *Metroxylon sago*. *Barringtonia* and *Casuarina* form stands along coastlines but are largely replaced by coconuts. On dry sandy soils monsoon forests (TMD) of *Melaleuca leucodendron* form fire resistant forests. On the northern islands taller semi-evergreen (SER) and evergreen forests (TWE) occur.

The marine environment contains some magnificent coral reefs and important island seabird nesting stacks.

d. Current Land Use

The unit has a human population of about 2 million people with a growth rate of about 2.9% per annum. Density is about 30 persons per sq. km., low by national standards. Much of the unit is forest or cleared land with only small areas under permanent cultivation. Main crops are sago and rice. Plantations of cloves and other spices are common on some of the islands. Coconuts are widespread in coastal areas. Melaleuca oil is tapped from natural and planted stands. Timber is logged over much of the northern islands of the group.

e. Biological Richness and Endemism

The Moluccas unit is poor in its mammal fauna and botanically, as is typical of remote islands. However there is a high level of local endemism among the species that do occur. Florally the unit is related to the west or Oriental region whilst faunally the unit is related to the Papuan region.

The bird fauna is rather rich in terms of such a small area and consists of 323 species with 30% endemism. Mammals are even less able to cross sea barriers and the total mammal

list is only 61 species. The biounit contains 4 EBAs (ICBP, 1992). The biodiversity index is calculated at a very high 19.3 resulting in an ultimate protected target of 14.7%.

f. Distinct Sub-units

Differences in species composition across the unit are as great as across the whole Indonesian archipelago but relationships of shared species enable us to classify the islands into the following biological sub-units:- 13a. N.Maluku; 13b Obi; 13c Buru; 10d Seram and Ambon and 13e Kai Islands.

Excluded from the Moluccan unit are the following island groups of the administrative province Maluku. Aru is botanically and faunally a satellite of New Guinea and is included in biounit P3. The Sula islands are more closely related to Sulawesi than to any other Moluccan islands and therefore included in biounit 24. Tanimbar, Wetar and the Banda Islands are botanically closely related to the Lesser Sundas unit 23 and faunally more closely related to Timor than any other island.

g. State of PA Development

Current level of PA coverage is 4.2%. However, some of this is degraded habitat and the actual effective protection of the unit is scored as only 3.9%. The unit was not included in the IUCN Review (Mackinnon & Mackinnon, 1986). Current expected target for protection is 9.0 resulting in a rather inadequate conservation index score of 0.4 (see section 1.4.2 for scoring details).

E. Papuan Sub-region

2. 27 Unit P3: New Guinea

a. Extent of Unit

The area covered extends from the equator to 120 south latitude, and 1290 to 1550 east longitude in all some 2800 km long by 750 km wide, including the largest expanse of undisturbed humid forest in the Old World Tropics. The unit consists of the entire island of New Guinea together with its satellite islands - Western Papuan Islands, Geelvink Bay Islands, Aru, Bismark Archipelago, New Britain, Dolok and the Eastern Papuan Islands.

New Guinea is the second largest island in the world and has huge forests swamps and mountains rising to the glacier clad peak of Gunung Jaya at 5031 metres.

b. Administrative Divisions

The unit is made up politically of two portions. The easternmost province - Irian Jaya - of Indonesia and the entire sovereign state of Papua New Guinea. In addition the island group of Aru falls within the Indonesian province of Maluku.

c. Natural Vegetation

The lowland forests of New Guinea differ markedly from lowland rainforests elsewhere in Malesia because of the paucity of Dipterocarps which dominate the forests of the other islands. Only three genera and 8 species of dipterocarp occur in New Guinea compared with 9 genera and 262 species on Borneo. This difference is reflected in the commercial value of the timber extracted. The main New Guinea timber trees are *Dracontomelum*, *Pterocarpus*, *Intsia*, *Dialium*, *Palaquin* and *Pometia*.

New Guinea's mangrove (MNV) and beach forests (BFV) share most of the same species as similar habitats elsewhere in the Malesian archipelago but the mangroves of New Guinea are more extensive and better developed than elsewhere in Asia. Freshwater swamp forests (FSV) are also more extensive than anywhere else and contain several endemic

species. Sago palm *Metoxylon sago* is the most characteristic swamp tree occurring in near pure stands, in mixed clumps or as an understorey to taller trees in seasonal swamps. *Camptosperma* and *Terminalia* are also common swamp dominants and in the drier seasonal swamps with peaty soil *Melaleuca* may dominate. Open swamps are covered in grasses and *Pandanus*. Mixed tropical rainforests (TWE) occur on the drained lowlands with *Eucalyptus* and *Melaleuca* woodlands in the more arid regions of the south. On poorer soils of limestone (LIM) or ultrabasic substrate (FUB), *Casuarina papuana*, *Aphitonia*, *Myrtella* and *Stypholia* often dominate the stunted canopy of the forest; ridges are often dominated by *Araucaria* and *Agathis*.

The montane succession passes from *Castanopsis* forest (TME) through the southern beech *Notophagus* to coniferous forest. The latter is dominated by such genera as *Podocarpus*, *Dacrycarpus*, *Papuacedrus* and *Phyllocladus*. Fire-shaped grassy montane valleys often retain a light tree cover of *Cyathea* tree-ferns. *Araucaria* and *Agathis* are sometimes common on ridges. The upper montane forests (UMF) become stunted and mossy. Common species are *Vaccinium*, *Rhododendron*, *Rapanea*, *Coprosma*, *Olearia*, *Pittosporum* and *Drimys*. Above the tree-line, a hardy alpine flora continues up to the glaciers of the highest peaks. With increasing altitude the species richness of the flora decreases but the proportion of endemics in the flora increases.

The flora of the lowland forests is related to the Malesian flora to the west whilst the montane flora is related to the Australian flora.

d. Current Land Use

78% of the unit is still covered in natural vegetation. The human population density is very low, though much higher in Papua New Guinea than in Irian Jaya. Agricultural clearance is extensive in the Snow Mountains and central highlands, northern lowlands and areas with a more seasonal rainfall such as the east side of the Arfak mountains, Enarotali, Dolok island and the coastal reaches of the southeast peninsula. Elsewhere population density is very low and human settlements are small and scattered in small clearings.

Communications are poor. There are few roads and the most extensive means of travel is light aircraft and the hundreds of small runways across the unit or small boats on the larger rivers.

Staple crops of New Guinea are sago and tubers. Potatoes are grown in the highlands. Very few industrial crops are planted such as coconuts and chocolate.

e. Biological Richness and Endemism

New Guinea is one of the world's great genetic storehouses of floral diversity, rich not only in variety but in endemism. Richness is retained at the small plot level where plant diversity can be shown to be comparable to the richest forests of Borneo and South America. The total species list for New Guinea probably comes to about 10,000 species representing more than 1,100 genera of which 124 are endemic (compared to 59 endemic genera for Borneo, 17 on Sumatra and 10 on Java). Lowland plants show Malesian affinities whilst Montane plants show Australasian affinities.

Faunally New Guinea is also justly famous. Over 650 species of birds occur of which 545 are resident and 312 are endemic (57%). 125 mammal species occur with large numbers of rats, bats and marsupials. Faunally New Guinea is related to Australasia. This is a land known for its dazzling birds of paradise, bowerbirds, parrots, cassowaries, tree kangaroos, cuscuses, spiny echidnas and great swamps full of crocodiles to make up for its lack of mammalian carnivores.

The biounit contains 9 EBAs (ICBP, 1992). The biodiversity index is calculated at a very high 25.5 resulting in an ultimate protected target of 17.8%.

f. Distinct Sub-units

The sub-units used in the review are based on those developed by Beehler et al 1986 on the basis of bird distributions and the limits of local endemics. Birds are by far the best known biological taxon of the unit. The following sub-units are therefore used:-

P3a Aru Islands; P3b Western Islands; P3c Geelvink Bay Islands; P3d Vogelkop; P3e Northwest; P3f Southwest; P3g Snow Mountains; P3h Star Mountains; P3i Central Highlands; P3j Sepik/Ramu; P3k Huon Peninsula; P3l Trans Fly; P3m Purari/Kikori; P3n Southeast; P3o East Papuan Islands; P3p New Britain; P3q Bismark Archipelago.

g. State of PA Development

Current level of PA coverage is 7.7%. However, some of this is degraded habitat and the actual effective protection of the unit is scored as only 6.1%. Most of these reserves are on the Indonesian side of the border. The unit was not included in the IUCN Review (MacKinnon & MacKinnon, 1986). Current expected target for protection is 11.3% resulting in a conservation index score of 0.5 (see section 1.4.2 for scoring details).

PART THREE -- COUNTRY REPORTS

Overview of Country Reports.

Each country report begins with a brief presentation of basic socio-economic, forest cover, and protected areas information. These data come from official national and international sources⁴. Following the basic data section, there is a list of **Decade Milestones** highlighting the major conservation and protected areas achievements in each country during the period 1986-1996. Short sections are included on the **Physical Geography, Natural Vegetation, Biogeographic Units, Biological Richness, Threats to Biodiversity and Protected Areas System**. These sections are not intended to be exhaustive. Rather, they are intended to provide a brief context for the analysis. Much of this information has been derived from country sheets maintained and previously published by WCMC. These paragraphs have been adapted to the habitat and biounit classification being used in this review. They have been edited and, where necessary, updated during the regional workshops⁵.

The Review's GIS results are presented in the **Analysis of Protected Area Coverage** section. A habitat coverage table lists all the habitat types in each country. Figures are presented for the original area of each habitat type, the current coverage of each habitat type, the amount of each habitat type included within existing protected areas of IUCN categories I-IV and Other Protected Area categories. The 'Other' category includes Protected Areas of IUCN Categories V and VI plus major proposals and sites for which a category has not yet been assigned (UA). The percentage figures always relate to the original area of each habitat type. Thus, secondary habitats have generally increased in size and most primary types have decreased. The term 'Original' refers to the potential vegetation before the influence of humans. Where the original area of a habitat type is zero (e.g. cultivation), no percentages can be calculated and three asterisks are shown. The percentage loss of a given habitat type is an indicator of the degree of species loss expected since the original species equilibrium of the habitat type was established. Any type reduced to less than 10% of its original area will be expected to incur a loss of about half of its original species depending on its degree of isolation.

Following the detailed habitat table is a summary table expressing how much of the country's original habitat has been lost or converted, how much remains forested, and how much remains under protection of various categories. An estimate of the proportion of protected area that can be considered as 'remaining natural habitat' is provided. This statistic is important in calculating the conservation index (CI) which is used to evaluate whether a country is doing enough to conserve its biodiversity. The resulting figures are

⁴ Sources for information in these boxes is primarily the Protected Areas Unit (PAU) of WCMC for Protected Areas data and the World Bank's World Development Report for 1996 for data on population, GNP, growth rate, forest cover and rate of forest loss. Where more recent official figures and estimates are available these have been used.

⁵ The BIMS software contains additional fields on the history of Protected Areas development, international participation, management of Protected Areas systems, legislation, and NGO activities in each country. Within BIMS, much fuller details of the results of the GIS analysis are available. Data can be examined for each vegetation type (indicated in brackets e.g., TMD) within each biounit and each type of habitat or biounit selected can be viewed on a screen mapper to see map-wise how much originally existed, how much remains today and where it falls within the protected area system. These fields are not original material and are provided as further accessible information. They can be edited, updated and maintained at a national level. Lists are given of protected sites that were rated by the reviewers and regional workshop delegates as being of global significance for conservation.

also compared with the results of the 1986 IUCN Review to determine the degree of change that has occurred in the past decade ⁶.

The data from the habitat tables are presented in histograms form which indicate graphically the original, remaining, protected (I-IV) and others (V,VI,UA or PRO) area for each country. A second histogram shows the same data on a biounit basis. In some case, gaps are regional rather than by habitat type, or by habitat type within a biotic region. For example, Indonesia protects a high enough proportion of its lowland rainforest overall but shows a serious gap of this type in the geographical unit of Maluku.

The section **Identification of Gaps in System** points out the conclusions of the analysis in terms of major gaps noticed in the habitat and biounit coverage of the Protected Areas system of each country. The gaps lead towards recommendations in the next section for plugging the gaps and extending the Protected Areas system. A section on **Other Issues** may be included to add additional important points not covered under the headings above.

The **Recommendations** section lists the general and specific recommendations that emerge from the analysis. These recommendations were largely drafted during the sub-regional workshops with the help of national participants. Some of these recommendations are obvious and simplistic and will need to be developed into more detailed plans of action within the countries concerned. A final section lists **Key Documents** on the state of biodiversity conservation and protected areas development for each country.

⁶ Note well, in a number of cases, there are discrepancies between the figures provided in the Basic Data section and those revealed by the Review's GIS analysis. For example, the protected area coverage of Bhutan is calculated as 21% using the Protected Area figures from the WCMC database and the official size of the country. However, our GIS analysis gives a figure of over 27%. Such discrepancies can usually be explained. In the case of Bhutan, the country as mapped is not as large as its stated official area. In addition, the protected areas as individually mapped are frequently larger than their legal gazettelement figures. Similar discrepancies are encountered when estimating total forest cover.

3.1 BANGLADESH

Basic Data

- Area 144,000 sq. km.
- Population 118 million (1993) = 797/sq. km
- Natural increase 2.5% per annum
- Economic Indicators GNP: US\$ 220 per capita
- Forest Cover 6% (1993)
- Annual Loss of Forest 4.9% per annum
- Protected Area Coverage 0.7% (WCMC)

Decade Milestones

- Endorsement of National Conservation Strategy
- Ratification of Ramsar Convention
- Ratification of Convention on Biological Diversity

Physical Geography

Some 80% of Bangladesh is lowland, comprising an alluvial plain cut by the three great river systems (Ganges-Padma, Brahmaputra-Jamuna and Meghna) that flow into the Bay of Bengal. Typically, at least one-half of the land is inundated annually, with one-tenth subject to severe flooding. The entire flood plain was well-vegetated, but much of the forest has been replaced by cultivation and plantations in recent decades due to mounting pressure from dense human populations. Here, the only extensive tract of forest remaining is the Sundarbans. Hills are confined chiefly to the east and South-East, notably the Chittagong Hills where forest cover is among the most extensive in the country.

Natural Vegetation

The major forest types are mangrove (MNV), tropical moist deciduous (TMD) or sal *Shorea robusta*, restricted to the Madhupur Tract and northern frontier with Meghalaya, and evergreen forests (TWE and SER) found in the eastern districts of Sylhet, Chittagong and Chittagong Hill Tracts. A small amount of freshwater swamp (FSV) occupies the basins of the north-east region. Wetlands, variously estimated as covering between seven and eight million hectares or nearly 50% of total land area, support a variety of wildlife, as well as being of enormous economic importance (Scott, 1989). Actual forest cover has been estimated to be 1 million hectares or 6.9% of total land area, a reduction of more than 50% over the past 20 years (WRI/CIDE, 1990). Our own mapping indicates 10% forest cover but this includes some secondary forests.

Biogeographic Units

Most of the country falls within biunit I7b (Lower Gangetic Plain) but a narrow fringe of forests along the northeast border falls within unit I9b (northeast hills), The Chittagong Hills fall within unit 09c (Burma transition zone) and the coastal forests in the extreme South-East of the country fall within unit 04- (Indochinese coasts).

Biological Richness

Although small and largely deforested, the country is of moderate biological richness with the largest mangrove system in Asia, some very important wetlands and rich forests in the Chittagong Hills and extreme southeast. The country has reportedly 125 mammals, 684

birds, 29 amphibians, 129 reptiles, 94 freshwater fish, 10 swallowtails and about 5000 higher plants (WCMC, 1994; Dinerstein & Wikramanayake, 1993; H.M. Rashid, pers comm). WCMC list 24 endangered mammals, 24 endangered birds and 60 endangered plants and the country covers part of one endemic bird area (EBA). Of particular interest are the many commercially important fish and turtle species dependent on the wetlands of the country, some 150 species of wetland birds that winter here and other aquatic species as Gangetic dolphins. The biodiversity index is calculated at 5.9 (see section 1.4.3.1 above), resulting in an ultimate protection target of 8.5%.

Threats to Biodiversity

The major threat is the extremely high human density combined with poverty and annual floods which place an enormous pressure on all available dry land resources. Despite extensive forest losses the small remaining forest area is relatively well protected.

Protected Area System

The current protected area system consists of 4 small national parks, 7 wildlife sanctuaries and one game reserve. Total area is only 1 million ha. Only Pabakh-ali WS and Chunati WS have been gazetted since the IUCN Indo-Malayan Review (MacKinnon & MacKinnon, 1986). The only protected areas rated as of global significance are the three protected portions of the Sunderbans. There are however 22 proposed reserves including several wetland and marine sites currently being processed by the government. Reserves are managed by the Wildlife Division under the Forest Department of the Ministry of Environment and Forests. Map 3 shows the distribution of remaining wildlife habitat in Bangladesh together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The proportion of the country inside protected areas is necessarily rather small (1%) as so little natural habitat remains. There are some opportunities to enlarge this in the Sunderbans, Chittagong Hills and along the Meghalaya border plus a few key wetland sites. The figures and table and indicate the state of habitat and biounit coverage.

Habitat Details for Bangladesh

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)		
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%	
Cleared	0	123745	***	106	***	376	***	
Freshwater swamp	14260	59	0	0	0.0	0	0.0	
Mangroves	8751	4403	50	364	4.2	0	0.0	
Semi-evergreen	1446	1296	90	0	0.0	0	0.0	
Tropical Moist Deciduous	108989	5911	5	265	0.2	8	0.0	
Tropical Semi-evergreen	1727	1417	82	14	0.8	0	0.0	
Tropical Wet Evergreen	1458	483	33	0	0.0	54	0.0	
Totals:								
	Natural	136631	13569	9.9	643	0.5	62	0.0
	Non-natural		123745	(90.1)	106	0.1	376	0.0

*** = over 10x more current area than original

Summary

Total loss of original natural habitat	90.1 %
Original forest cover	100.0 %
Current forest cover	9.9 %
(Natural forest cover)	not determined
(Secondary forest cover)	not determined
Total area protected	0.9 %
(Area protected IUCN I-IV)	(0.6 %)
(Area protected IUCN V-VI, PRO)	(0.3 %)

As mapped, the current level remaining habitat protected is 0.5%, slightly more than was calculated in the 1986 IUCN Review which scored the country as 0.2% protected. Current expected target for protection is 6.3% resulting in a very low conservation index score of 0.1 (see section 1.4.2 for scoring details).

Identification of Gaps in System

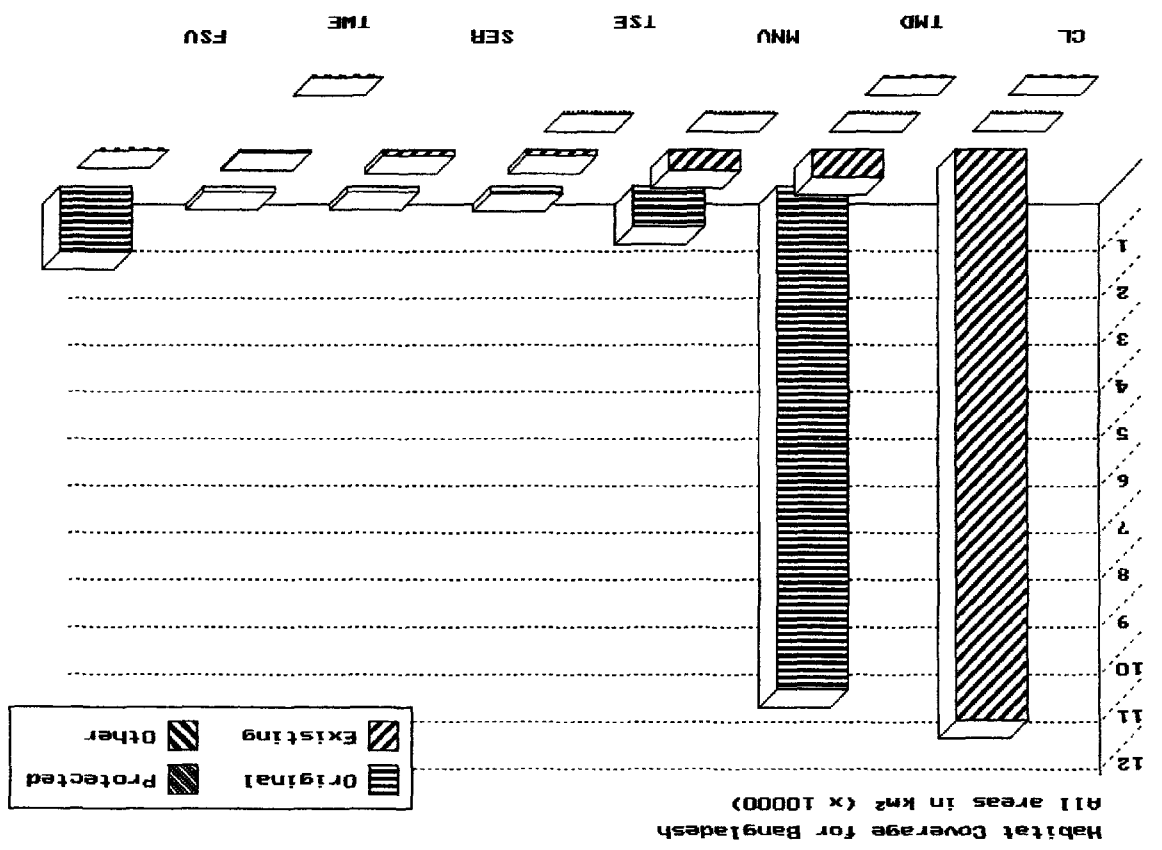
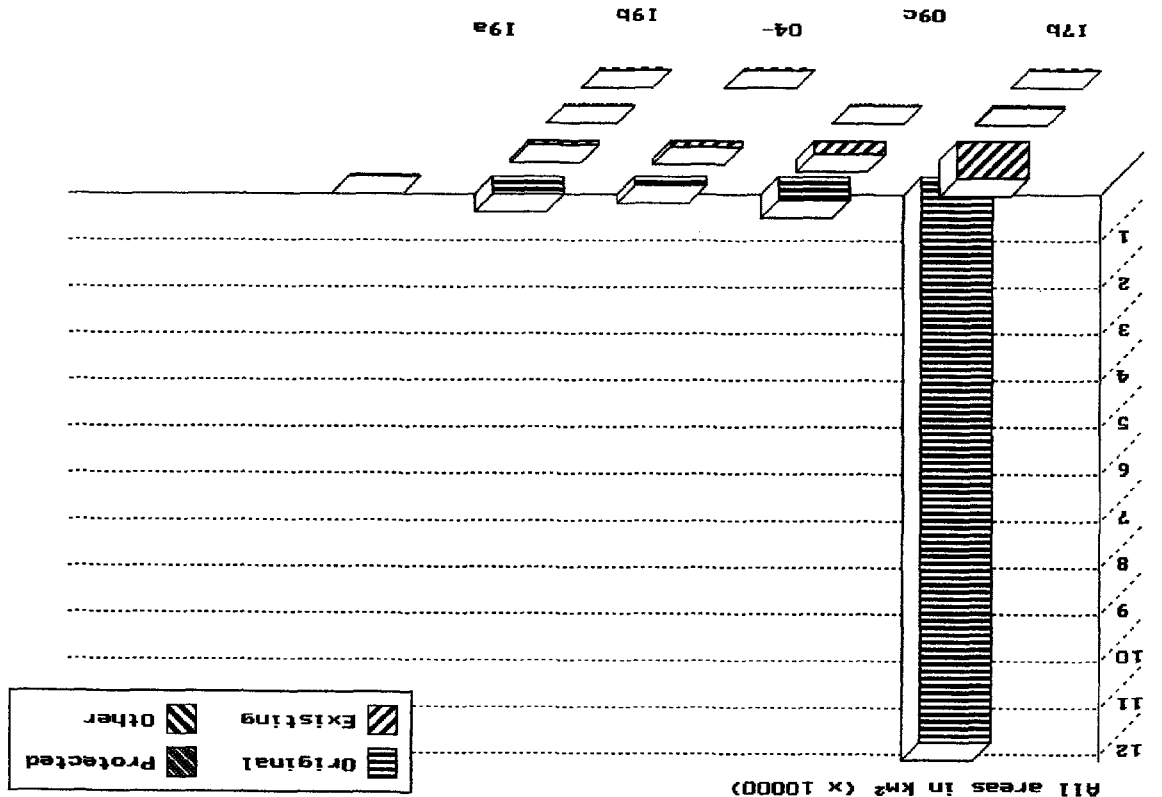
Although very small in area the current Protected Areas system does at least include examples of all major vegetation forest types in the country and all biounits of the country. Freshwater swamp, coastal char lands, and the country's only coral reefs are not protected.

Other Issues

Marine conservation issues are dealt with in the marine report of this review.

Recommendations

1. New protected areas need to be established to give fuller protection to different ecosystems. These should include St. Martins's Island as a national marine park; examples of freshwater swamps, all remaining forests outside the Chittagong Hills tract, including Rajkandi and West Bhanugach, Sangu-Matamuhur as a large sanctuary in the Chittagong Hills tract, a national park at Lawachara Forest, wildlife sanctuaries on coastal chars such as Jiryiradwip and in Barisal and Chittagong districts, protection of turtle nesting areas during the laying season, a sanctuary for either Bogakine or Rainkhyongkine Lakes.
2. Strengthen protection of remaining forests in the Chittagong Hills and Cox's Bazaar tracts where the forests are of high biodiversity value.
3. Place emphasis on protecting wetland habitats of wintering bird populations. Public awareness and education work is more important in this respect than establishing specific protected areas since about 50% of the country is involved.
4. The officially protected portion of the Sunderbans is quite small. Efforts should be made to extend this, especially to include some of the freshwater sundri ecosystem. In addition the area should be gazetted as a national park and have a designated buffer zone to include Block 8. Tourism development should be planned and interpreted.
5. A number of management improvements should be made to improve public participation in management of protected areas and buffer zones; legal changes to allow a new category of recreational park and drop the category Game Reserve (Teknaf should be made a sanctuary). Allow some transfer of forest lands to private



owners. Encourage public and NGO reforestation schemes using mixed species. Prepare management plans and refine boundaries and zones for all protected areas.

6. Complete surveys of flora and fauna using BARC surveys of Chunati as a model and develop a national biodiversity database to analyse results.
7. Bangladesh needs further international assistance in taking these important steps before environmental conditions in the country degrade further.

Key Documents

BARC. (1987) *National conservation strategy for Bangladesh. Draft prospectus (Phase I)*. Bangladesh Agricultural Research Council/IUCN, Gland, Switzerland. 154 pp.

Green, M.J.B. (1989) *Bangladesh: an overview of its protected areas system*. World Conservation Monitoring Centre, Cambridge, UK. 63 pp.

MoEF (1995). *National Environmental Management Action Plan*, Dhaka

Rahman, S.A. and Akonda, A.W. (1987) *Bangladesh national conservation strategy: wildlife and protected areas*. Department of Forestry, Ministry of Agriculture and Forestry, Dhaka. Unpublished report. 33 pp.

3.2 BHUTAN

Basic Data

- Area 46,600 sq. km (claimed)
- Population 0.7 million (1993) = 15/sq. km
- Natural increase 2.1% per annum
- Economic Indicators GNP: US\$ 400 per capita
- Forest Cover 60%
- Annual Loss of Forest 0.1% per annum
- Protected Area Coverage 20% (WCMC)

Decade Milestones

- Publication of Forestry Master Plan, including a National Conservation Plan
- Complete revision of Protected Areas System
- Restructuring of Wildlife Division
- New forestry law drafted
- Ratification of Convention on Biological Diversity
- Establishment of UNDP administered Trust Fund for conservation activity
- Preparation of National Biodiversity Status Report
- Preparation of first national park management plan.

Physical Geography

Bhutan is a small kingdom in the Eastern Himalayas similar in size to Switzerland, but with a much wider altitudinal range (200m to over 7,500m) and only one-fifth of the population density. The official area of the country is 46,600 sq km but recent efforts to map the country more accurately suggest the true area is only about 40,000 sq km. There has been almost no industrial development in the country: about 95% of the population is primarily dependent on agriculture and animal husbandry. The Himalayan chain runs along the northern border and the interior of the country is made up of a series of six major north- south-aligned mountain ranges. The largest of these, the Black Mountains, rise to nearly 5,000m and form a substantial physical barrier between eastern and western Bhutan. Four of the seven river valleys merge to form the Manas and all of them flow southwards across the plains of West Bengal and Assam into the Brahmaputra.

Natural Vegetation

The enormous altitudinal range and varied climatic conditions are reflected in the country's great ecological diversity, ranging from tropical moist deciduous forest along the southern foothills, through extensive temperate broad-leaved and coniferous forests across the middle of the country, to alpine scrub and meadows up to the permanent snow-line to the north.

There is a narrow lowland tropical fringe below about 500 m along the southern boundary which has a range of tropical vegetation types including flood-plain grasslands, monsoon forest, sal forest and tropical semi-evergreen forest. Subtropical evergreen broadleaf forests occur between 500 m and 2000 m with a narrow zone of mixed hardwood and conifer forests before the subalpine conifer zone occurs up to the treeline at about 4000 m. The upper fringe of forest is usually fir. Subtropical chirpine forests are found in drier valleys at moderate altitude and blue pine forests occur as a secondary coloniser in broad valleys between 2000 and 3400 m. The conservation importance of major rivers (Torsa/ Ammo Chu, Paidak/Wong Chu, Sankosh/Mo Chu and Manas) is reviewed by Scott (1989). Rivers

are generally rocky and fast-flowing, with marshes restricted to flat valley bottoms in the inner valleys. Most marshes have been drained for agricultural purposes but some of those remaining are internationally important for black-necked crane.

Biogeographic Units

The northern fringe of the country falls into the Transhimalayan unit I1b. Most of the country falls within the Himalayan units I2c (central) and I2d (eastern) whilst the tropical fringe in the south falls marginally into the Lower Gangetic unit I7b and mostly in the Assam Plains unit I9a. The boundaries of these units are not clearcut and rather arbitrary.

Biological Richness

Bhutan is well recognised as biologically very rich, especially in relation to its small size. It falls within the biodiversity "hotspot" of the eastern Himalayas (Myers, 1975). Preliminary estimates list 160 mammals, over 700 birds and over 5000 plant species in the small kingdom. Plant richness in the Himalayas increases towards the wetter eastern end. The rhododendrons show this pattern of richness well. There are 7 spp in west Nepal, 10 in central Nepal, 29 in eastern Nepal and no less than 50 species in Bhutan. Bhutan contains important populations of a number of endangered bird species with the black-necked crane especially appreciated in the country and for which several wintering areas are especially protected. The Eastern Himalayas is an important endemic bird area (EBA) and the country contains 24 endangered mammals, 12 endangered birds and 21 endangered plants. Biodiversity index is calculated at 8.6 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.5%.

Threats to Biodiversity

The current level of threat to Bhutan's natural resources is low but increasing. While less pronounced than in other parts of the Himalaya, the uplands in Bhutan are being degraded at accelerating rates. The main conservation problem is the conversion of forests to other forms of land use as a result of human settlement, high domestic consumption of fuelwood and timber, shifting cultivation, overgrazing and encroachment, all of which reflect the rising human population. The southernmost forest belt has been almost completely cleared for human settlement. People are concentrated in the fertile valleys and, in the south-western foothills, at densities approaching an upper limit given present production methods, which are unlikely to change in the near future. Apart from the southern areas, hunting is not a major problem in Bhutan due to a religious taboo. Herdsmen shoot tigers and leave poison on killed yaks which has reduced the populations of large carnivores and dhole. Resultant increases in wild pig populations is causing major problems in some agricultural areas.

Review of Protected Area System

The original Bhutan reserve system consisted of a huge reserve on the north side consisting mostly of rock and ice and a fringe of small reserves along the southern tropical border with India. The central temperate parts of Bhutan were not protected (MacKinnon & MacKinnon, 1986). A major review of the Protected Areas system prepared in 1991 proposed as complete redesign. As a result a new system of reserves was declared in 1994 comprising 9 main reserves and a number of small sites of conservation interest. Two reserves cover the northern high altitude zone, four reserves span the temperate zone from east to west and another three reserves remain along the tropical fringe. Three national parks are rated as being of global significance - Jigme Dorji which is the largest and richest protected example of mountain systems in the eastern Himalayas; the Black Mountains which offers the fullest representation of habitats in the temperate zone of the eastern Himalayas and Royal Manas which is a vital tropical link between the Black

Mountains and the Indian Manas Tiger Reserve (a recognised World Heritage Site). The black-necked crane refuge of Popjikah is a significant wetland. Map 4 shows the distribution of remaining wildlife habitat in Bhutan and the location of the existing protected areas system. Details of the individual reserves are contained in the BIMS database software.

Analysis of Protected Area Coverage

Protected area coverage is excellent, more than 10% of all major habitat types are included and the total reserve coverage is 27%. The following table and figures show how much of each habitat and biounit remain and how much is protected.

Habitat Details for Bhutan

Habitat (Code)	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Alpine pasture	4229	4229	100	630	38.5	0	0.0
Alpine scrub	2238	2211	99	849	37.9	0	0.0
Alpine Bare rock	2669	2692	101	1027	38.5	0	0.0
Blue pine	0	332	***	11	***	3	***
Cleared	0	3817	***	170	***	13	***
Degraded Forest	0	5481	***	445	***	3	***
Glaciers	146	146	100	59	40.4	0	0.0
Grassland	27	27	100	19	70.4	0	0.0
Lower Hardwood	3405	1712	50	497	14.6	0	0.0
Riverine	20	20	100	0	0.0	0	0.0
Subalpine conifer	9239	8680	94	3683	39.9	0	0.0
Subtropical pine	1278	675	53	70	5.5	0	0.0
Tropical Moist deciduous	202	39	19	39	19.3	0	0.0
Upper Hardwood	16307	9699	59	2182	13.4	0	0.0
Total:							
Natural	39760	30130	75.8	10346	26.0	6	0.0
Non-natural		9630	24.2	642	01.6	19	0.0

*** = over 10x more current area than original

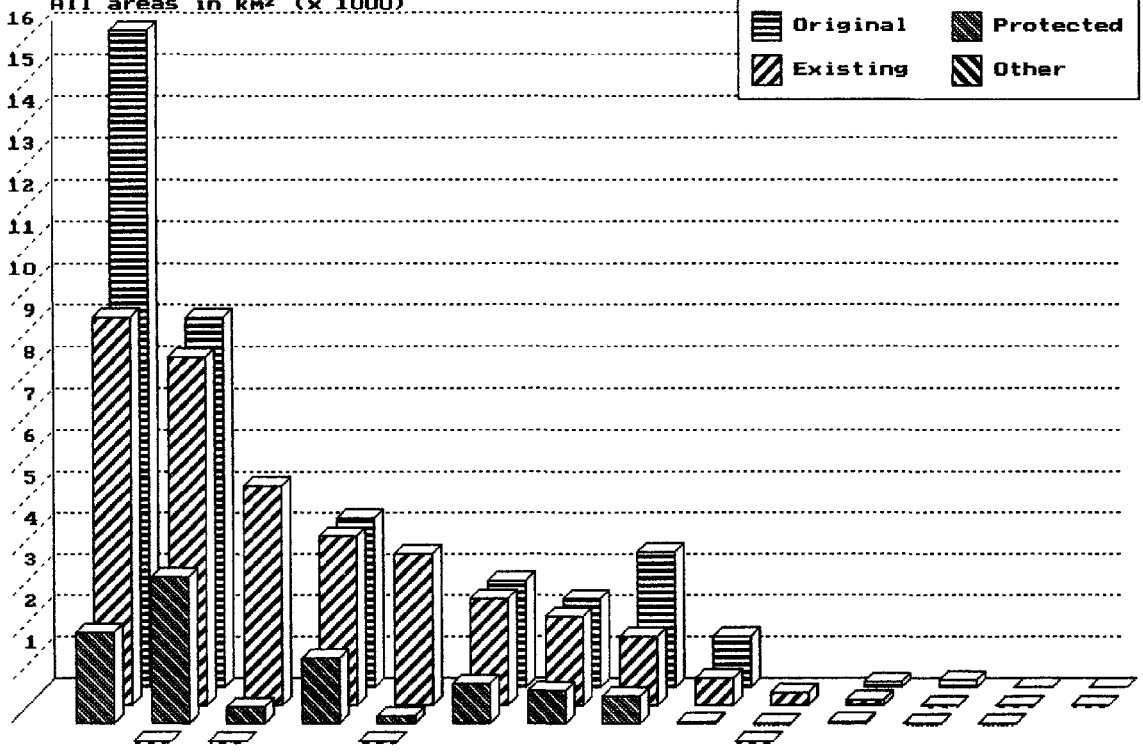
Summary

Total loss of original natural habitat	24.2 %
Original forest cover	76.5 %
Current forest cover	66.9 %
(Natural forest cover)	(52.3 %)
(Secondary forest cover)	(14.6 %)
Total area protected	27.6 %
(Area protected IUCN I-IV)	(27.6 %)
(Area protected IUCN V-VI, PRO)	(<0.1 %)

As mapped, the current level of habitat protection is 25.3%, much more than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 4.5% protected but excluded the largely protected zone above the treeline from the realm analysis. Current expected target for protection is only 4.5% resulting in a very high conservation index score of 4.1 (see section 1.4.2 for scoring details).

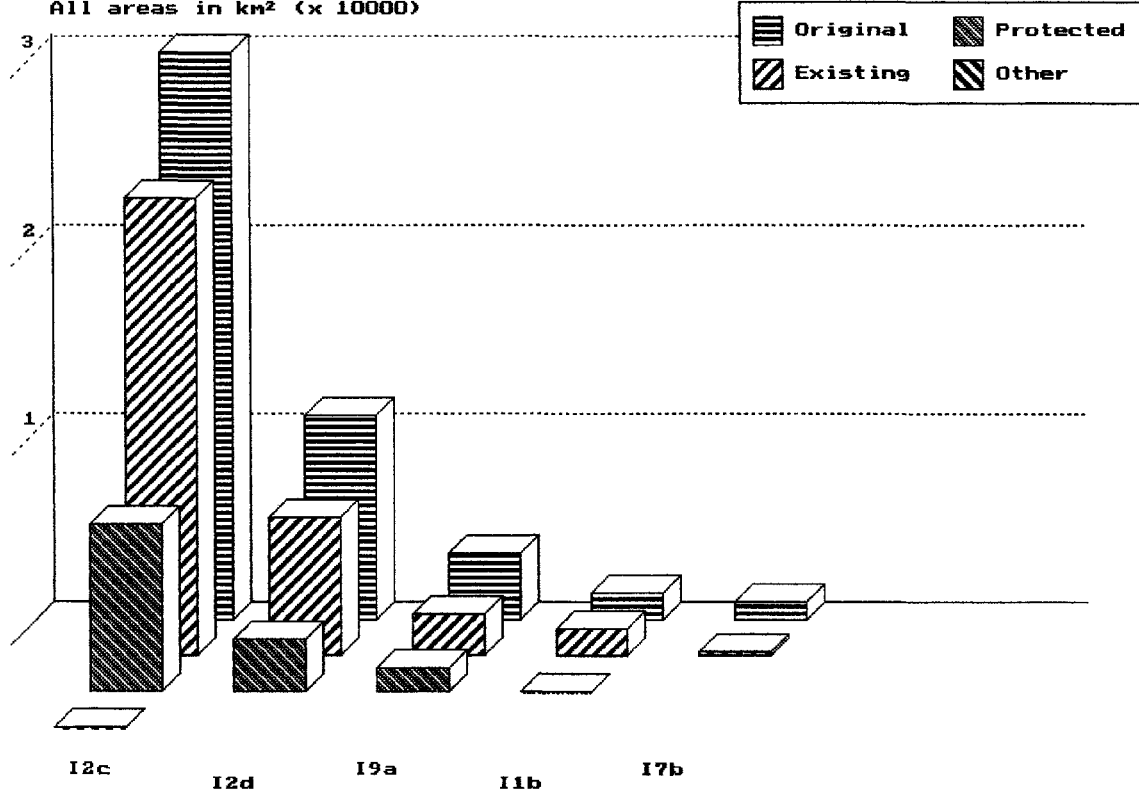
Habitat Coverage for Bhutan

All areas in km² (x 1000)



Biounit Coverage for Bhutan

All areas in km² (x 10000)



Identification of Gaps in System

There are no recognised gaps in the current ambitious reserve system.

Recommendations

1. Following the notification of a revised system of nine Protected Area's it is necessary to prioritise the order of management. It is not feasible to develop all nine at once given staff and funding constraints. Priority reserves need management plans and development as models but a minimal protective management should be applied to the others to maintain the status quo until such time as resources can be devoted to their full development.
2. Those priority reserves that are developed should have Integrated Conservation Development Programs (ICDP) to ensure the proper involvement of local people. These programs can be combined with park extension services.
3. A national database should be developed to hold essential data on habitats, reserves and species distributions as well as socio-economic data on villages around the reserves and management data on staff, visitors and other details.
4. Major efforts should be made in manpower development and training for the Wildlife Conservation Division which also should be given the respect due to its high responsibilities. This will require a major program of public awareness and education.
5. Efforts should be made to co-operate with India and China concerning the protection of border reserves especially Manas and Jigme Dorji national parks.
6. When the time is suitable, several of the Bhutan parks can be developed for tourism with careful precautions to ensure that such developments do not damage the resource base.
7. The revised Forestry Law should be passed as soon as possible.

Key Documents

MacKinnon, J. (1991) *National Conservation Plan for Bhutan*. Annexe 1, Forestry Masterplan for Bhutan. ADB/Royal Govt. Bhutan. 1200 pp.

NCS (1995). *Royal Manas National Park, Bhutan: Conservation Management Plan, 1995 - 2000*. Nature Conservation Section, Forestry Services Division, Ministry of Agriculture, Royal Government of Bhutan. Thimphu.

NESPC (1992). *Bhutan - Towards Sustainable Development in a Unique Environment*. National Environment Secretariat Planning Commission, Thimphu. 71 pp.

3.3 BRUNEI

Basic Data

- Area 5,765 sq. km
- Population 0.3 million (1993) = 52/sq. km
- Natural increase 2.5% per annum
- Economic Indicators GNP: US \$14,240 per cap.
- Forest Cover 81% (1993)
- Annual Loss of Forest 0.4% per annum
- Protected Area Coverage 20% (WCMC)

Decade Milestones

- Adoption of new National Forestry Policy
- Brunei Darussalam Master Plan proposed a Wildlife Conservation and Management Programme
- Establishment of Field Studies Centre in Temburong NP.
- Development of several Protected Areas

Physical Geography

Brunei Darussalam is a state on the northwest coast of the island of Borneo with a coastline of 130 km between 114° 23' and 115° 23'E by 4° 00' and 5° 05'N. The country is bordered on three sides by Sarawak, a state of Malaysia. The country is physically divided into two portions, the eastern of which, Temburong, is separated by the Limbang river valley of Sarawak from the larger western portion. Temburong district is rugged and mountainous rising to over 1,850 m with a wide margin of coastal swamp and narrow alluvial valleys along the main rivers. The western part of the country has a narrow mangrove fringe but is predominantly hilly lowlands below 90 m rising to an escarpment and hills of about 300 m near the Sarawak border. The climate is moist equatorial with little seasonality but rain comes from the northeast monsoon from November to March and from the southwest monsoon between April and October. Rainfall is about 2800 mm in the lowlands and up to 4000 mm in the inland mountains. Humidity is high all year round and mean annual temperature is about 27.50 C.

Natural Vegetation

The country is still about 59% covered in primary forest. Mostly this is lowland evergreen (TWE) with small areas of heath forest (HFV) and some peat swamps (PSV) in the west. There are small areas of montane forest (TME) and a coastal fringe of mangroves. Secondary forests and plantations also occur. The main areas of peat swamp forest are along the basin of the Belait River in western Brunei. Substantial areas of seasonally flooded peat swamp forest occur in the middle reaches of the Tutong River. All of these swamp forests are still in almost pristine condition (Scott, 1989). The dipterocarp forest, which covers most of the country, gives way to montane forest from about 700m upwards. In the upper Temburong area, where the land rises above 1,500m, this in turn gives way to montane vegetation with stunted, gnarled trees covered with mosses (Bennett, 1991). The mangroves on the Brunei coast probably represent the largest remaining intact mangroves in northern Borneo. Together with those in neighbouring Malaysia in Brunei Bay, they comprise one of the largest tracts of relatively undisturbed mangroves in the region.

Biogeographic Units

Almost the entire country falls within the biounit 25a - North-west Borneo, with a very small montane portion falling in biounit 25e - Bornean Mountains.

Biological Richness

The country lies in the North Borneo biodiversity "hotspot" and the lowland forests show remarkable diversity of trees, especially of the dominant family Dipterocarpaceae. Orchids and pitcher plants are two plant groups that also show extreme diversity. The area contains part of one endemic bird area (EBA). Preliminary estimates list 155 mammals, about 500 birds, 76 amphibia, 44 reptiles and 35 swallowtail butterfly species (adapted from Dinerstein and Wikramanayake, 1993). Brunei is the home to most of the endemic lowland animals of Borneo including the proboscis monkey, Bulwer's pheasant, Bornean Bristlehead, yellow muntjac, Bornean gibbon and many endemic plants. The biodiversity index (BI) is calculated at 10.7 (see section 1.4.3.1 above), resulting in an ultimate protection target of 10.2%.

Threats to Biodiversity

There is not much threat to the biodiversity of Brunei. The country enjoys one of the highest living standards in Asia with 80% of its GNP coming from oil. Pressure on forest resources is very low. No timber export occurs and limited logging activities harvest only about 200,000 cu m per annum to meet local needs. Most timber needs are met from imports. Firearms have been strictly prohibited since 1962 and hunting is limited to traditional methods (e.g. by spears, dogs, nets, blowpipes etc.) by inland indigenous groups with negligible impact. It should be noted, however, that orang-utan, rhino and elephant were all probably exterminated from Brunei at an early date by just this type of hunting. The greatest threats to biodiversity are the disturbance to habitat and occasional spillages and pollution from the oil exploration. This only affects the shoreline and swampy lowlands.

Review of Protected Area System

Brunei has one large national park, 3 small marine wildlife sanctuaries and a large number of forest reserves some of which are managed specifically for protection, conservation or recreation. In total these categories total about 20% of the country. The recreation forests and several of the conservation forests are all less than 1000 ha and could not be plotted or included in the GIS analysis. Fourteen largest reserves were analysed. The status of some of these is unclear. It appears that the significant reserve Ulu Mendaram (6,170 ha) has been de-gazetted. The important mangrove and peat swamp area of Selirong (2,566 ha) is accorded a category of UA or unallocated and the important area of Tasek Merimbun remains only a proposal after many years. The two main inland reserves protect a total of 10% of the country. Few changes have been made over the last 10 years to the protected area system which was already extensive at the time of the IUCN review (MacKinnon & MacKinnon 1986). The peat swamp reserves of Belait have been established but remain of uncertain conservation status. The Batu Apoi reserve was raised to National Park status in 1991 under the name Ulu Temburong; some revisions have been made to the blocks of the Labi and Ladan Hills and a few small sites and marine reserves have been added. Two sites - the National Park of Ulu Temburong and the conservation forests of Selirong and rated as globally significant.

Map 5 shows the distribution of remaining wildlife habitat in Brunei together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The table and figures below show how much each habitat type survives and is protected in the country. Habitat coverage is generally good with over 10% protected.

Habitat Details for Brunei Darussalam

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Cleared	0	1175	***	10	***	49	***
Degraded forest	0	778	***	0	0.0	19	***
Freshwater swamp	92	74	80	0	0.0	0	0.0
Heath forest	87	76	87	6	6.9	0	0.0
Mangroves	250	200	80	0	0.0	76	30.4
Peat swamp	1643	1236	75	44	2.7	58	3.5
Tropical montane evergreen	74	74	100	74	100.0	0	0.0
Tropical wet evergreen	3723	2255	61	823	22.1	0	0.0
Totals:							
Natural	5869	3915	67.0	947	16.1	202	3.4
Non-Natural		1953	33.0	10	00.2	0	0.0

*** = 10x or more current area than original

Summary

Total loss of original natural habitat	33.2 %
Original forest cover	100.0 %
Current forest cover	80.0 %
(Natural forest cover)	(66.8 %)
(Secondary forest cover)	(13.2 %)
Total area protected	19.7
(Area protected IUCN I-IV)	(16.3 %)
(Area IUCN V-VI, PRO)	(03.4 %)

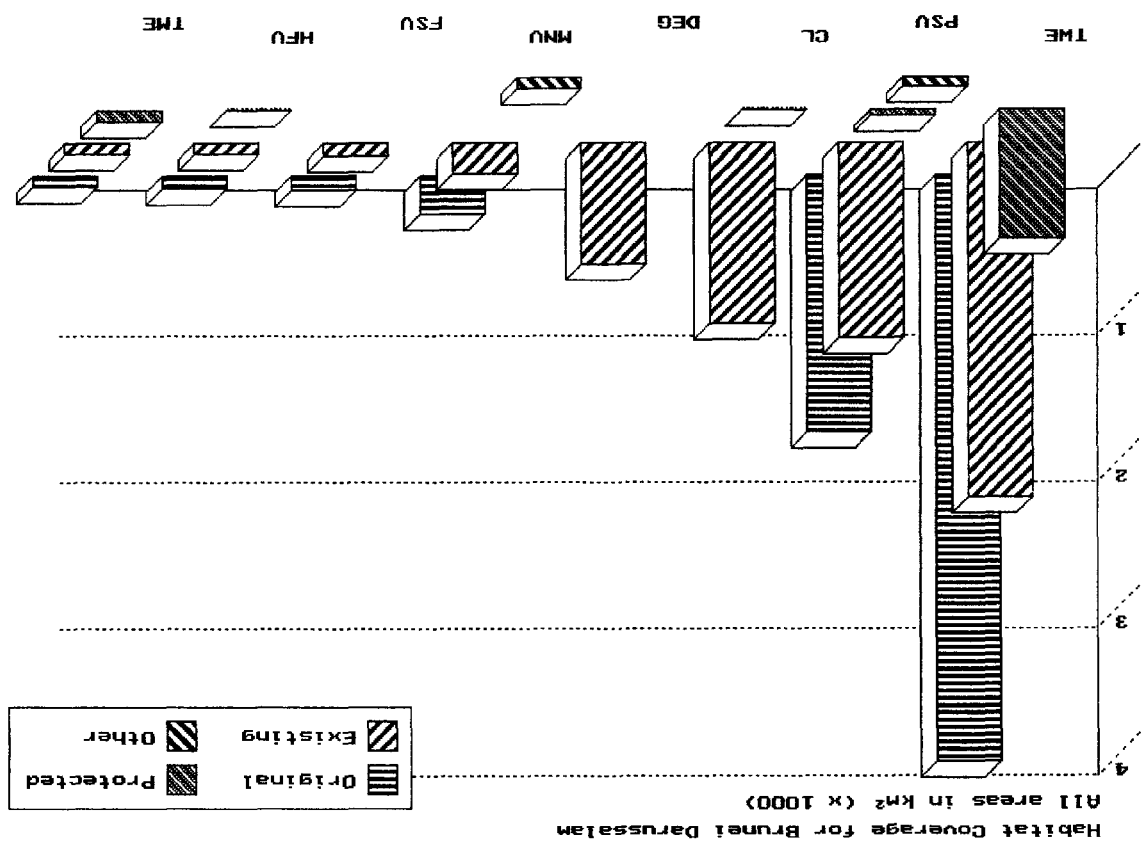
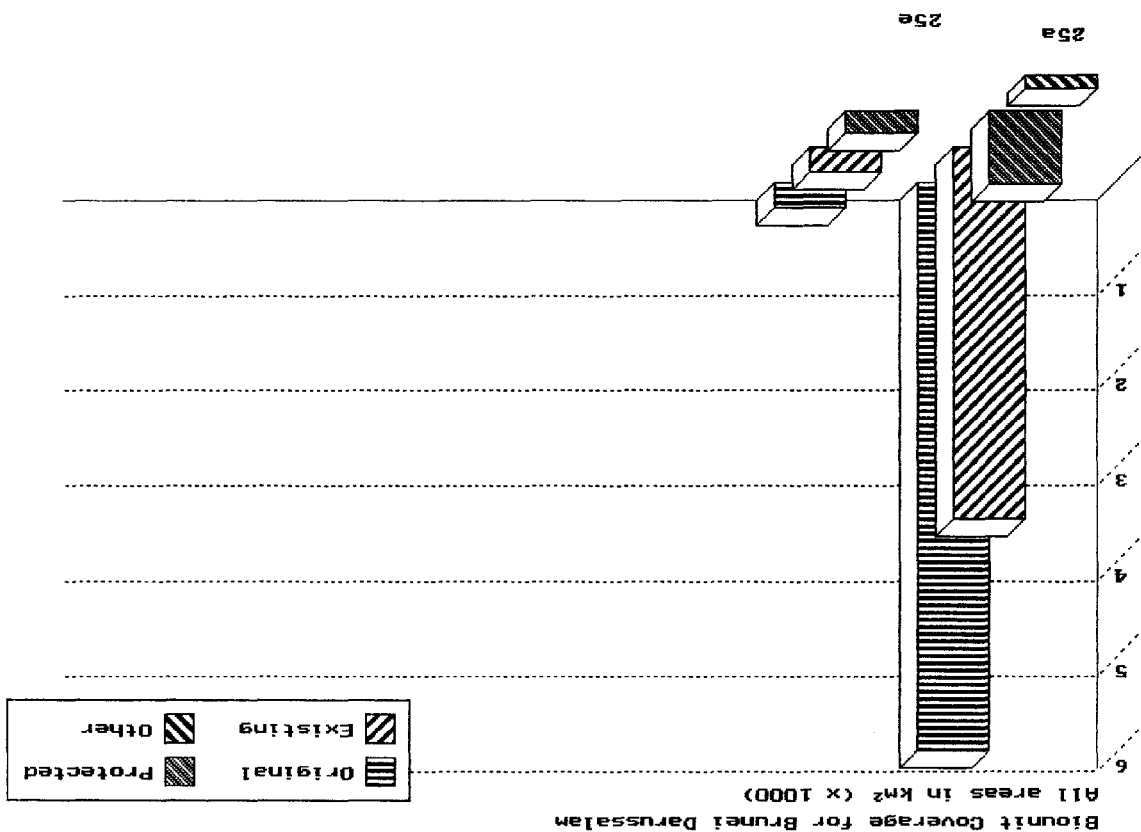
As mapped, the current level of habitat coverage is 16%, rather less than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 34.6% protected by scoring several forest reserves now not regarded as being in IUCN categories I-IV. Conservation index score (CI) is calculated at a healthy 2.4 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

Main gaps in the system continue to be freshwater swamp forests. In fact freshwater forest will be included when Tasek Merimbun reserve is added to the system. Mangroves are protected in several small reserves designated to protect proboscis monkeys and flying foxes but is only included significantly in the Selirong reserve. It is therefore very important to confirm the status of this site as a conservation area.

Recommendations

1. It has been recommended that the forest reserve network be developed, with boundaries of certain reserves altered and new reserves established (Anderson and Marsden, 1988). This job is only partly completed.



2. Additional recommendations include the development of Batu Apoi Forest Reserve as a national park (Bennett *et al.*, 1984; Farmer *et al.*, 1986; IUCN, 1985). Six key critical sites merit priority attention and continued protection: the primary inland forests of Ulu Temburong (Batu Apoi); the peat swamp forests of the Belait River system (Ulu Mendaram); the mangroves of Brunei Bay (incl. Selirong); Tasek Merimbun (an area of freshwater and peat swamps); the Bukit Batu-Sungei Ingei area, which is contiguous with Gunung Mulu National Park in Sarawak; and the coastal kerangas forests (Bennett, 1991). If the Ulu Mendaram area has indeed been de-gazetted then there is need of an alternative large peat swamp reserve.

Key Documents

Bennett, E.L., J.D. Caldecott & G.W.H. Davison (1984) *A wildlife study of Ulu Temburong, Brunei*. Forest Department, Kuching and University of Malaysia. Unpublished report. 61 pp.

Brunei Darussalam Ministry of Industry and Primary Resources, Department of Fisheries (1992) *The integrated management plan for the coastal zone of Brunei Darussalam*. ICLARM Contribution. xviii + 122pp.

de Silva, M.W.R.N. (1988) The coastal environmental profile of Brunei Darussalam. *Tropical Coastal Area Management* 3: 1-4

Farmer, A.S.D., Caldecott, J.O., Phillips, A., Prince, G. and Thomson, N. (1986) *Negara Brunei Darussalam Masterplan*. Special report: wildlife conservation and management. 4 volumes. Huszar Brammah and Associates/Department of Town and Country Planning, Bandar Seri Begawan.

3.4 CAMBODIA

Basic Data

- Area 181,035 sq. km
- Population 8.5 million (1993) = 47/sq km
- Natural increase 2.2% per annum
- Economic Indicators GNP: US\$ 500 per capita (1993)
- Forest Cover 60% (1993)
- Annual Loss of Forest 1.0% per annum
- Protected Area Coverage 18% (WCMC)

Decade Milestones

- Declaration of extensive Protected Areas System
- Ratification of Convention on Biological Diversity (1995)
- Establishment of Technical Advisory Panel for environment
- Revisions of wildlife protection and hunting laws
- Buffer zone management policy developed
- Enactment of Environment and Natural Resource Management Law (1997)

Physical Geography

Cambodia is situated in south-east Indochina between 10° 24' and 14° 41'N and 102° 21' and 107° 22'E with a total land area of 181,035 sq. km bordered to the north by Thailand and Laos and to the east by Vietnam. The country has a short coastline of only 435 km. The climate is dominated by the south-west and north-east monsoons. The south-west monsoon lasts from May to October and the north-east monsoon from November to March. The mean annual rainfall is 1200 mm-1875 mm, but rainfall of up to 3000-4000 mm may be experienced in the south-west.

The landscape of the country is centred around the shallow Tonlé Sap (Great Lake) and the surrounding swamp forests. The Tonlé Sap river draining the lake, flows into the Mekong River which cuts through the country from north to south. During the summer high water level period the Mekong floods extensive areas of swampy grasslands and water flows up the Tonlé Sap to fill the lake and swamp forests. During the dry season this water flows back out into the Mekong with the swamp acting as a huge sponge and reducing high level flooding.

The Cardamom Mountain range dominates the south-west of the country, rising to 1,563m. In the south and south-east are low plains bordering the Mekong River, extensive areas of which are seasonally flooded. North of Tonlé Sap, the area leading to the border with Laos and Thailand consists of rolling savannah country with some open grassland areas and deciduous forest.

Natural Vegetation

Evergreen forests (TWE and TME) grow on the mountains to the southwest and semi-evergreen forests (SER) occur on much of the hilly country but the most extensive forest type is the deciduous 'forêt claire' or Dry Dipterocarp Forests (DDF) which occupies most of the open plains.

Rather unique swamp forest vegetation (FSV) occurs around the Tonlé Sap Lake and grassy or reedy savannah swamps (SWG) occur in much of the flooded zone of the lake and

Mekong river. These are the most extensive freshwater swamps in Southeast Asia. Some areas of *Melaleuca* forest (PSV) on acid sulphate soils have been largely replaced by extensive reedbeds.

Where evergreen forests have been cut and burned as a result of shifting cultivation or forest operations, secondary forests, swidden or mixed deciduous forest (SEC, ASW and MDF) or bamboo (BMB) have replaced the original vegetation. In areas with regular burning this has been reduced to grasslands (GRA and ALA) of *Imperata cylindrica* or the grasslike bamboo *Arundinaria*.

Along the south coast there are some sheltered islands and bays with good mangrove forests (MNV). The extensive area of freshwater lakes (FWL) including the unique Tonlé Sap lake system are an important wildlife habitat. A review of wetlands important for conservation is given in Scott (1989).

In the 1960's forest cover extended over 13 million ha but today this is reduced to about 11 million ha or 60% of which about 5 million ha are evergreen formations. Not only is forest being reduced in area but it is being reduced in biomass as a result of fires and extraction of timber and fuelwood.

Biogeographic Units

Most of the country falling within the Mekong drainage lies within biounit 10a - Central Indochina; the extreme south-east of the country lies within the unit 05a - Mekong Delta; the mountains of the south-west form a distinct moist biounit 05d - Cardamom Mountains and the hills in the extreme north-east are part of unit -Ma - Central Annam Mountains.

Biological Richness

The country exhibits typically rich tropical biodiversity of the Indo-China sub-region but is not regarded as a biodiversity hot-spot and has only moderate levels of endemism with no endemic bird areas (EBA's) identified (ICBP, 1992).

There are an estimated 123 mammals, 545 birds, 28 amphibia, 88 reptiles and 22 swallowtail butterfly species recorded for the country (WCMC, 1994; Dinerstein and Wikramanayake, 1993). 215 species of freshwater species are recorded (Kottelat, 1985).

The country scores as slightly less than average biodiversity richness for the realm when area and levels of endemism are weighted. The country may score higher if fuller inventories are completed. The biodiversity index (BI) is calculated at 7.5 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.2%. The single species that has aroused the most interest is the national animal the Kouprey *Bos sauveli*, a wild ox endemic to Cambodia and marginal areas of southern Laos, Vietnam and formerly southern Thailand. A second bovid *Pseudonovibos spiralis* has now been described which remains an enigma of which only a few sets of horns exist.

Wetlands are the most critical habitat type in Cambodia. The Tonlé Sap (Great Lake) area remains a tremendously important site for nesting and feeding large water birds including Eastern Sarus crane, Great Adjutant and Asiatic Black Stork. In addition the Mekong river and Tonlé Sap Lake are important reservoirs of freshwater fish species with many endemic forms and several endangered species. Several endemic species occur around the rapids area where the Mekong is fanned into many stream at the border area with Laos. Probably the most valuable biodiversity resources are in fact the plant species and notably the plants of the evergreen formations of the southwest of the country.

Threats to Biodiversity

Civil war has resulted in considerable levels of chaos, lack of control and law enforcement, unplanned logging, clearance, poaching and mining operations. Uncontrolled forest fires erode forest borders in most areas each year and thin out the fire tolerant dry dipterocarp forests. Minefields threaten wildlife as well as human life in many parts of the northern portions of the country. Drainage of swamplands for agriculture has resulted in loss of wetland habitat and spread of acid sulphate conditions. The queue of international logging companies wishing to exploit Cambodia's forests for timber is a serious long-term threat. Cutting of forests around the Tonlé Sap Lake combined with increased siltation of the entire Mekong system are endangering the freshwater ecosystems of the country. The depth of the Tonlé Sap Lake continues to decrease with sedimentation and the life cycles of many fish species require movements from spawning areas in the swamp forests or upstream tributaries back into the main river system.

Review of Protected Area System

A series of large reserves and proposed reserves totalling 5% of the country were established prior to the Pol Pot regime. These were nominally retained after the defeat of the Khmer Rouge faction in 1978 but in reality were unprotected during the long period of internal civil war and conflict. After the restoration of monarchy, however, a completely new and ambitious system of reserves has now been declared. In total the Protected Areas total 3,267,200 ha or about 18% (as mapped only 14%) of the land area being 7 National Parks totalling 732,250 ha, 10 Wildlife Sanctuaries totalling 2,030,000 ha; 3 Protected Landscapes totalling 97,000 ha and 3 Multiple Use Areas totalling 403,950 ha.

The following reserves have been identified as being of global significance.

Name	Ecosystem	Cat	Year Gazetted	Size/(km ²)
Phnom Bokor	Elephant Mts. Forests	2	1993	1400
Kulen Promtep	Northern Forest Mosaic	4	1960	4025
Tonle Sap Great Lake	Freshwater and swamps	6	1993	3163
Lomphat	Eastern Dry Dipterocarp	4	1960	2500
Phnom Samkos	Cardamom Mts. Forests	4	1993	3338
Phnom Prich	Eastern Dry Dipterocarp	4	1960	2225

Map 6 shows the distribution of remaining wildlife habitat in Cambodia together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The table and figures below gives habitat details of the extent and Protected Areas coverage of the country.

Habitat Details for Cambodia

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Swidden fields	0	16336	***	987	***	409	***
Bamboo	0	3900	***	1138	***	0	0.0
Cultivated	0	29783	***	364	***	224	***
Dry Dipterocarp	72218	57936	80	10114	14.0	619	0.9
Freshwater swamp	12530	4239	34	0	0.0	1665	13.3
Freshwater lake	3307	3218	97	1	0.0	127	3.8
Rivers	1465	1463	100	12	0.8	1	0.1
Grassland	405	1838	454	330	81.5	0	0.0
Mangroves	1007	467	46	222	22.1	89	8.8
Plantations	0	769	***	0	***	0	***
Peat swamp	15189	0	0	0	0.0	0	0.0
Secondary	0	2524	***	216	***	59	***
Semi-evergreen forest	48639	27608	57	8948	18.4	30	0.1
Seasonal flooded	0	6733	***	0	*	19	***
Swamp grasses	0	5806	***	0	***	1014	***
Tropical moist deciduous	1715	0	0	0	0	0	0.0
Tropical montane evergreen	731	731	100	341	46.6	0	0.0
Tropical pine forest	98	0	0	0	0.0	0	0.0
Tropical wet evergreen	24909	18222	73	5438	21.8	575	2.3
Totals:							
Natural	182213	115099	63.2	25406	13.9	3106	1.7
Non-natural		66474	36.5	2705	01.5	1725	0.9

*** = over 10x more current area than original

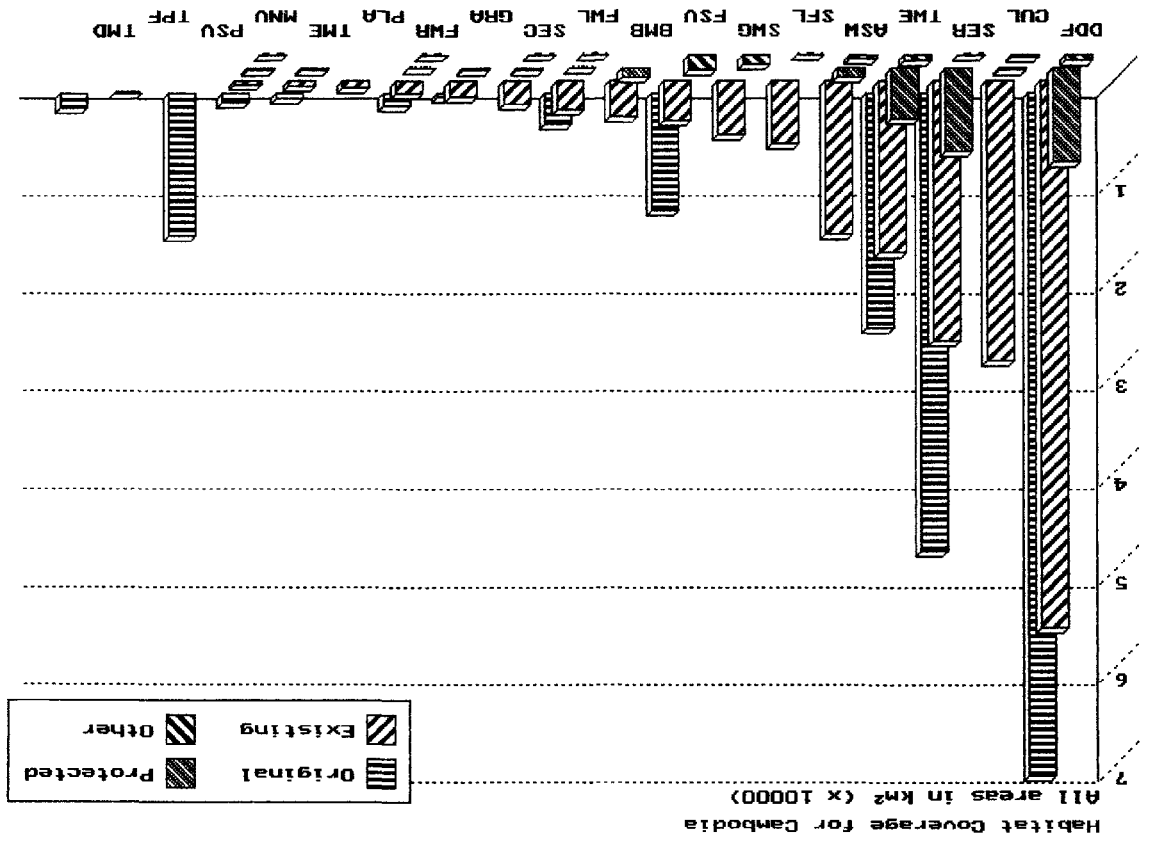
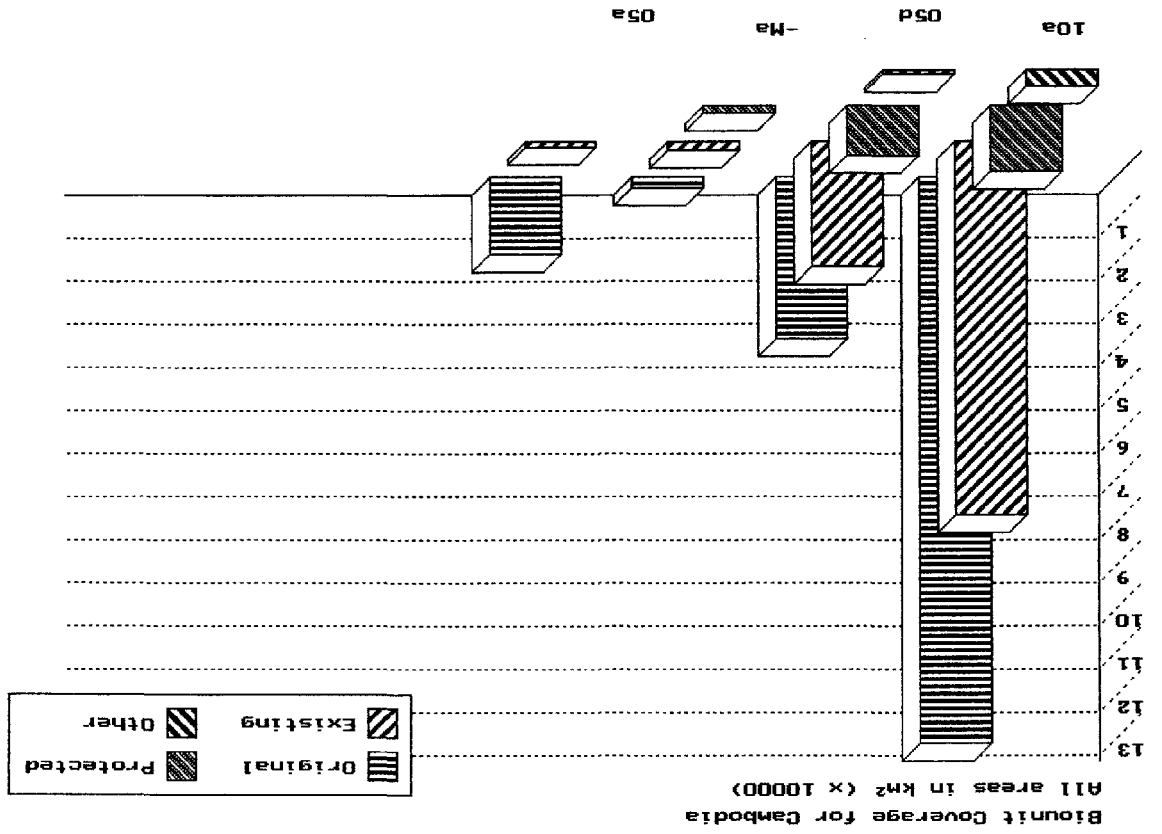
Summary

Total Loss of original natural habitat	36.8 %
Original forest cover	97.2 %
Current forest cover	61.5 %
(Natural forest cover)	(60.1 %)
(Secondary forest cover)	(01.4 %)
Total area protected	18.1
(Area protected IUCN I-IV)	(15.4 %)
(Area protected IUCN V-VI, PRO)	(02.7 %)

As mapped, current habitat protection is 12.7%, a major increase since the 1986 IUCN Review which scored the country as 2.6% protected. Current conservation index score (CI) is calculated as a satisfactory 1.5 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

The Biounit analysis above reveals no gaps in terms of habitat coverage but a gap of Protected Areas coverage for the Mekong Delta biounit (05a). However more than 85% of the natural habitat of this unit has already been destroyed or modified. The only gap which could be filled would be to protect some of the remaining reed/grass swamps which are important winter feeding area for Sarus Cranes and other wetland birds (including Bengal Florican).



Other Issues

The continuation of civil war activity in some areas continues to impede any form of on the ground management. Reliance must be made on remote sensing, GIS and aerial surveys. The immediate period should be used to build up the technical skills of staff and skills in data management (databases, remote sensing, taxonomy etc.) and planning. Safe areas can be used as models to develop land management and ground survey capacity.

Marine conservation issues are dealt with under the marine section of this review.

Recommendations

1. Major increases are needed in manpower, training and management budgets to meet the needs of surveying planning and developing this ambitious system of Protected Areas. This will require concurrent increases in public and government awareness.
2. Three areas are proposed to be submitted to the RAMSAR Convention as wetland sites of international significance, namely 1) Boeung Chhma and associated river system and floodplains (28,000 ha). This area is included in the Tonlé Sap Multiple-use area. The area is important for fish and wetland birds and includes in important breeding colony of Milky Storks *Mycteria cinerea*. 2) Koh Kapik and associated islets (12,000 ha). This is a coastal wetland with a diverse range of habitat including extensive mangroves and important prawn spawning areas. 3) Middle stretches of Mekong River north of Stung Treng. This unique part of the river system has over 100 species of fish and freshwater dolphin *Orcaella brevirostris*. It is important that these sites are recognised so as to draw national attention to these important areas as well as raise international concern and assistance to Cambodia.
3. Greater emphasis should be placed on transfrontier issues. There is great potential for the establishment of transfrontier reserves with Laos in the Mekong river and Virachey areas and with Vietnam in the Virachey and Phnom Nyam Lyr areas. Several reserves border Thailand and face heavy threats of exploitation as well being security problem areas. In addition as Cambodia is in such need of international assistance in developing its own Protected Areas system and developing its own manpower and data management systems it makes sense to develop co-operation with its neighbours, rather than becoming dependent on wider international aid. The UN regional biodiversity project RAS/93/102 can facilitate much of the needed co-operation.
4. The Tonlé Sap reserve is currently only a multiple use area. This does not provide enough protection to this area of supreme biodiversity importance. At least part of the swamp forests and lake area should be given full protected status.

Key Documents

Anon. (1993). *Creation and Designation of Protected Areas*. A royal decree declared on 1 November 1993 by His Majesty, King of Cambodia. 4 pp.

Desai, A. & Lic, V. (1996) *Status and Distribution of Large Mammals in Eastern Cambodia: results of the first foot surveys in Mondulakiri and Rattanakiri provinces*. IUCN/FFI/WWF Large Mammal Conservation Project Phnom Penh, Cambodia. xv + 54pp

Mundkur, T., P. Carr, Sun Hean & Chhim Somean. (1995). *Surveys of Large Waterbirds in Cambodia, March-April 1994*. National Wildlife Federation/IUCN. Cambridge. 80 pp.

3.5 INDIA

Basic Data

- Area 3,288,000 sq. km
- Population 914 million = 287/sq km
- Natural increase 2.1% per annum
- Economic Indicators GNP: <US\$ 320 per capita
- Forest Cover 16 %
- Annual Loss of Forest 0.7% per annum
- Protected Area Coverage 4.4% (WCMC)

Decade Milestones

- 34% increase in Protected Areas System
- Publication of Biodiversity Action Plan
- Revisions of policy and legislation
- Ratification of Ramsar Convention
- Ratification of Convention on Biological Diversity
- Opening of Indira Gandhi Conservation Monitoring Centre

Physical Geography

India is a nation of extraordinary diversity, the seventh largest and second most populous in the world. Its relief can be conceptualised in terms of three well-defined regions: the Himalayan mountain system along its northern margin; the Gangetic Plain, which extends some 2,400km from Assam in the east to the Punjab in the west and southwards to the Rann of Kutch in Gujarat; and the Deccan Plateau which is flanked on either side by the Western Ghats and Eastern Ghats (Mani, 1974). Its rich diversity of ecosystems, which range from tropical rain forests to deserts, and from marine and coastal systems to high mountains, support an estimated 5-8% of the world's known flowering plant and animal species, of which a significant proportion are endemic (Gadgil and Meher-Homji, 1986a). Important centres of biological diversity, particularly for plants, are the Western Ghats, north-eastern India and the Andaman and Nicobar Islands (Nayar, 1989).

Natural Vegetation

Forest once covered most of India but much of it has been destroyed or severely degraded as a result of human population pressures, particularly in the fertile lowlands which are among the most densely populated areas in the world. For example, 4.1 million hectares of forest were cleared mainly for agriculture between 1951 and 1980 (Singh, 1986; Vedant, 1986). Probably less than 1% of the total land area is covered by primary forest (Mani, 1974). Forests are estimated to have covered 64.01 million hectares in 1985-1987, or 19.5% of total land area comprising 11.5% dense forest (at least 40% crown density), 7.8% open forest (at least 10% crown density) and 0.1% mangrove forest (FSI, 1989).

The total area of wetlands (excluding rivers) in India is 58,286,000ha, or 18.4% of the country, 70% of which comprises areas under paddy cultivation. A total of 1,193 wetlands, covering an area of 3,904,543ha, were recorded in a preliminary inventory coordinated by the Department of Science and Technology, of which 572 were natural. In a recent review of India's wetlands, 93 are identified as being of conservation importance (Scott, 1989).

Coral reefs occur along only a few sections of the mainland, principally the Gulf of Kutch, off the southern mainland coast, and around a number of islands opposite Sri Lanka. This general absence is due largely to the presence of major river systems and the sedimentary

regime on the continental shelf. Elsewhere, corals are also found in the Andaman, Nicobar and Lakshadweep groups, although their diversity is reported to be lower than in south-east India (UNEP/IUCN, 1988).

Evergreen forest types include tropical wet evergreen (TWE) and semi-evergreen forests (SER) in the Western ghats, Andaman and Nicobar islands and northeast India, Himalayan wet and moist temperate forests (HWT and HMT) and subtropical broadleaf hill forests (SBH) of the Peninsula and Himalayas. Evergreen subalpine, subtropical and Blue pine conifer forests (SAC, SPF and BFP) occur in the Himalayas. A small area of dry evergreen forest (TDE) occurred on the Coromandel coast but has largely been destroyed. Mangroves are found in the Sunderbans, Andamans and Nicobar islands and in some estuaries around the coast of India

Deciduous forests include tropical moist deciduous and dry deciduous forests (TMD and DDF), dominated by sal *Shorea robusta* in the north and by teak *Tectona grandis* in the south, thorn scrub forest (TSF) occurs over large areas that were probably formerly more moist and sand desert vegetation occurs and is spreading in the Thar desert of Rajasthan.

Biogeographic Units

Rogers and Panwar (1988) present a national classification of biogeographical units for India. These differ slightly from the biounits used in the 1986 review of MacKinnon and MacKinnon who tried to adapt an earlier draft of the Rogers, Panwar Units into the system of Udvardy 1975. The following Table clarifies the relationship of these classifications.

Rogers & Panwar Bio. zones	Rogers & Panwar Biotic Province	1986 Biounits	This Review
1 Trans-Himalayan	1a Tibetan	-	I1a
2 Himalayan	2a Northwest Himalaya	-Ha	I2a
	2b West Himalaya	-Hb	I2b
	2c Central Himalaya	-Hc	I2c
	2d East Himalaya	-Hd	I2d
3 Desert	3a Kutch	15b	I3a
	3b Thar	15a	I3b
4 Semi-arid	4a Punjab	15c	I4a
	4b Gujarat-Rajwara	15d	I4b
5 Western Ghats	5a Malabar Coast	01-	I5a
	5b Western Ghat Mountains		I5b
6 Deccan Peninsula	6a Deccan Plateau South	14- 12-	I6a
	6b Central Plateau	08c (part)	I6b
	6c Eastern Plateau	08c (part)	I6c
		11-	
	6d Chhota-Nagpur	08b	I6d
	6e Central Highlands	08c (part)	I6e
7 Gangetic Plain	7a Upper Gangetic Plain	08a	I7a
	7b Lower Gangetic Plain	03a	I7b
8 North-East India	8a Brahmaputra Valley	03b	I8a
	8b Assam Hills	09c	I8b
9 Islands	9b Andaman Islands	20-	20-
	9b Nicobar Islands	21h	21h
	9c Lakshadweep Islands	18-	18-

Biological Richness

As a large tropical country, India ranks high in terms of Asian species richness. Dinerstein and Wikramanayake (1993) list 350 mammals, 1200 birds, 182 amphibia, 453 reptiles and 91 swallowtail butterfly species and some 15000 plants as recorded in the country. However, it should be noted that the open country of the Indian subcontinent is not rich in biodiversity. The presence of such large game animals as tiger, leopard, elephant and gaur with large herds of chital certainly represent good 'game' country and the open vegetation makes birdlife easy to see. However the number of species associated with such habitats is not high. The truly species-rich parts of India are quite small and scattered namely in the moist sub-tropical and temperate forests of northeast India, the moist Himalayan foothills, particularly eastward and the relict patches of moist forest in the Western Ghats. The Andaman and Nicobar islands have high levels of local endemism but like other small islands are comparatively poor in species. Endemism is very high in the Western Ghats. The country has 8 EBA's (ICBP, 1992). The biodiversity index is calculated at 9.0 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.7%.

Threats to Biodiversity

Wildlife conservation in India has met with tremendous success but protected areas management is beset with problems of inadequate fund allocation, a reluctance on the part of the states to establish national parks and sanctuaries because the land is lost forever for other uses (moreover, industries are not permitted within 30km of the boundary of a sanctuary), insufficient magisterial powers for wildlife staff to deal with poachers, difficulties of communication in often remote areas, and lack of trained manpower at lower levels (Chandha, 1989).

Major threats to wildlife and habitats are caused by the huge population density, land hunger and shortages of fuel and pasture. Forest fire is a problem in many areas as is overgrazing by a huge population of cattle that cannot be killed under Hindu beliefs. Hunting is a problem in areas where indigenous tribals still live which happen to be the wilder and moister parts of the country where most biodiversity resides. Grazing of wildlife in reserves and conflicts between reserve authorities and local people e.g. tiger and lion kills and grazing rights, are routine issues. These problems are ameliorated by a deep tradition of tolerance and respect for wildlife and a growing popular sympathy for conservation efforts.

Review of Protected Area System

The protected area system has been growing fast. In particular many of the proposals of Rogers and Panwar (1988) are being processed so that any statistics given are only momentary. At the current time there are 75 national parks and 428 wildlife sanctuaries covering about 1.4 million sq km which is 4.2 % of the country. In addition there are 23 project tiger reserves which largely overlap the formal Protected Areas system but add 9375 sq km of habitat managed for sustainable use. 8 biosphere reserves (not internationally designated) cover 32413 sq km of which only 6575 sq km are included within the Protected Areas system. It has proved extremely difficult to map all these reserves. Many small areas (<1000ha) have been omitted from the current analysis. In some cases boundaries of larger reserves have been approximated by circles of correct area centred upon their given centroids. In other cases the mapped areas diverge markedly from the listed areas and we have no way of checking the mapped accuracy. However as mapped, the Protected Areas system also totals 4% of the country and an analysis of habitat covered is given below.

The following reserves are identified as being of global significance.

Name	Ecosystem	Cat	Gazetted (year)	Size (km²)
Bandipur	Southern Moist Deciduous Forest	2	1974	874
Nagarahole	Southern Moist Deciduous Forest	2	1988	643
Silent Valley	West Ghats Rainforest	2	1980	90
Cauvery	Southern Dry Deciduous Forest	4	1987	511
Eturnagaram	Central Moist Deciduous Forest	4	1953	806
Periyar	S. Western Ghats Forest Mosaic	4	1950	472
Sharavathi Valley	N. Western Ghats Forest Mosaic	4	1974	431
Nagarjunasagar	Southern Dry Deciduous Forest	P		1200
Khangchendzonga	E. Himalayan Subalpine/Alpine	2	1977	850
Dibang Valley	E. Himalayan Forest Systems	4	1991	4149
Intanki	Assam Tropical Moist Forest	4	1975	202
Itanagar	Assam Duars and Moist Forests	4	1978	140
Manas	Assam Duars and Deciduous Forest	4	1928	391
Sajnakhali	Sunderbans mangroves	4	1976	362
Satkosia Gorge	Rivers and E. Moist Deciduous	4	1976	796
Simlipal	Eastern Moist Deciduous	4	1979	2200
Moiling	E. Himalayas Forest Systems	P		700
Indravati	Central Moist Deciduous Forests	2	1978	1258
Kanha	Northern Moist Deciduous Forest	2	1955	940
Sanjay	Northern Dry Deciduous Forest	2	1981	1938
Gir	Gir Peninsular Dry Deciduous	4	1965	1153
Great Indian Bustard	Central Thorn Forest	4	1979	8496
Melghat	Central Dry Deciduous Forest	4	1985	1597
Wild Ass	Western Deserts and Salt Pans	4	1973	4954
Dandeli	N. Western Ghats Evergreen	U	1987	843
Corbett	C. Himalayan Foothills	2	1936	521
Hemis	W. Himalayan Alpine	2	1981	4100
Pin Valley	W. Himalayan Alpine	2	1987	807
Kachchh Desert	Western Salt Pans and Desert	4	1986	7506
Kaimur	Northern Dry Deciduous Forest	4	1978	1342
Karakoram	Transhimalayan alpine	4		1800
Mount Harriet Island	Andaman Rain Forest	2	1979	46

Category codes:

1 - 6 Corresponding IUCN Category

P Proposed

U Unassigned

Moiling and Nagarjunasagar still need to be gazetted.

Maps 7a, b and c show the distribution of remaining wildlife habitat in India together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The details of remaining and protected habitats for India are given in the table and figures below.

Habitat Details for India

Habitat	Original	Current	Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²) %	(km ²)	%	(km ²)	%
Alpine pasture	108000	108000 100	11033	10.2	129	0.1
Alpine scrub	13529	13529 100	1083	8.0	1539	11.4
Barren	623	623 100	184	29.5	135	21.7
Cleared land	0	2255126***	43611	***	5976	**
Dry deciduous forest	1152543	264740(21)	16896	1.5	4076	0.3
Degraded forest	0	28714 ***	594	***	338	***
Freshwater swamp	12889	67 1	0	0.0	0	0.0
Glaciers	37143	37143 100	5095	13.7	211	0.6
Himalayan dry temperate	1845	1052 57	183	9.9	0	0.0
Himalayan moist temperate	34617	11970 35	485	1.4	3	0.0
Mangroves	14007	3035 22	1506	10.8	0	0.0
Montane wet temperate	31378	24711 79	759	2.4	4513	14.4
Subalpine conifer	18621	12000 64	600	3.2	956	5.1
Subtropical broadleaf hill	7724	2471 32	197	2.6	131	1.6
Subtropical dry evergreen	5411	899 17	0	0.0	0	0.0
Sand desert	153358	321622(100)	2991	2.0	0	0.0
Semi-evergreen forest	89419	25511 25	1545	1.7	120	0.1
Subtropical pine forest	70935	31695 45	1647	2.3	2490	3.5
Seasonal salt marsh	23524	23985 100	18813	80.0	0	0.0
Tropical dry evergreen	25530	1001 4	24	0.1	0	0.0
Tropical moist deciduous	732071	129222 18	14625	2.0	453	0.1
Thorn scrub	551049	29942 5	1182	0.2	138	0.0
Tropical wet evergreen	70463	22514 32	2368	3.4	637	0.9
Totals:						
Natural	3526376	1071251 27.6	81224	2.6	15531	0.5
Non-natural		2456245 72.4	44205	1.4	6314	0.2

*** = over 10x more current area than original

Summary

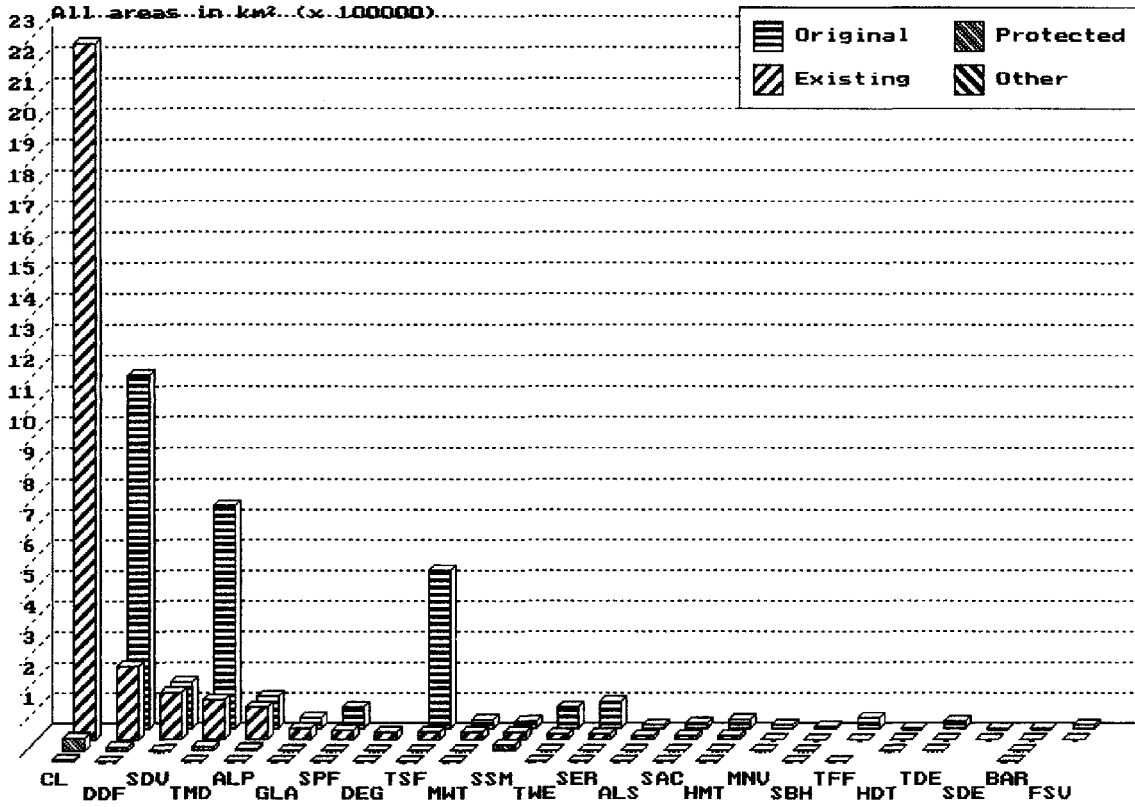
Total loss of original natural habitat	72.4 %
Original forest cover	73.0 %
Current forest cover	17.0 %
(Natural forest cover)	(16.1 %)
(Secondary forest cover)	(00.9 %)
Total area protected	4.7 %
(Area protected IUCN V-VI, PRO)	(4.0 %)
(Area protected IUCN I-IV)	(0.7 %)

As mapped, current habitat protection is 2.6%, a slight decrease since the 1986 IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 2.9% protected. Current conservation index score (CI) is calculated as only 0.3 (see table 1.8 and section 1.4.2 for scoring details).

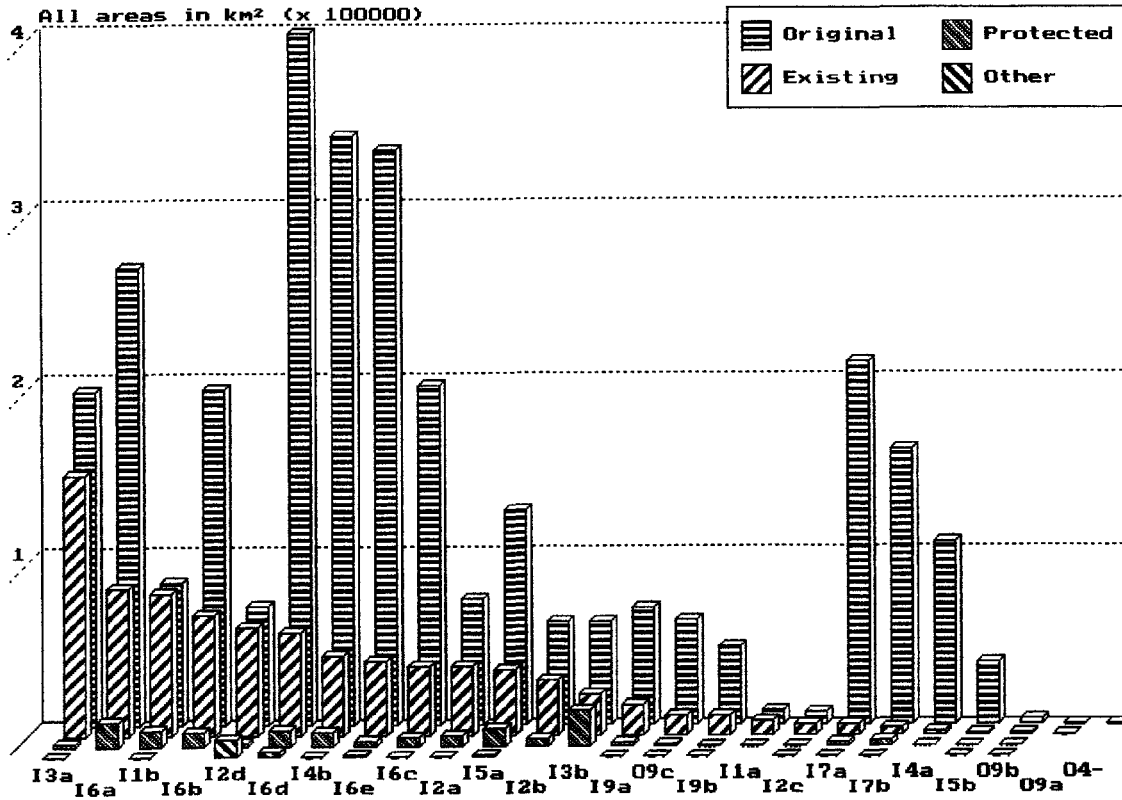
Identification of Gaps in System

There are no major gaps in the Protected Areas system but the proportions of protected habitats are in some cases rather small. The Himalayan moist forest systems are rather

Habitat Coverage for India



Biounit Coverage for India



under-represented. freshwater swamps are almost all destroyed so any remaining patches should be protected as a priority.

Recommendations

1. Increase the area of protection in the Himalayas, NE India and all moist forest systems of the Western Ghats and Eastern Ghats.
2. Continue to follow the recommendations for Protected Areas extensions, linkages and new reserves well outlined the excellent report of Rogers and Panwar (1988).
3. Concentrate energies on finding solutions to the man-reserve friction that occur in buffer zones by extending the eco-development zone programme around priority reserves. this will need additional support from international donor agencies.
4. A greater level of biological and socio-economic inventory and study is needed at protected area level across the country including a basic assessment of characteristic flora and fauna in all Protected Areas.
5. It is important to develop greater formal co-ordination between the different biodiversity databases in the country in particular the relationship between the Indira Gandhi Monitoring Centre, the World Conservation Monitoring Centre and government data centres.

Key Documents

Department of Environment. (nod.) *National Wildlife Action Plan*. Government of India, New Delhi. 28 pp.

FSI. (1989) *The state of forest report 1989*. Forest Survey of India, Dehra Dun. 50 pp.
Government of India. (1988) *National Forest Policy 1988*. Ministry of Environment and Forests, Government of India, New Delhi. 13 pp.

Kothari, A., Pande, P., Singh, S., Variava, D. (1989) *Management of national parks and sanctuaries in India: a status report*. Environmental Studies Division, Indian Institute of Public Administration, New Delhi. 298 pp.

Rodgers, W.A. and Panwar, H.S. (1988) *Planning a wildlife protected area network in India*. 2 vols. Project FO: IND/82/003. FAO, Dehra Dun. 606 pp.

3.6 INDONESIA

Basic Data

- Area 1,919,663 sq. km
- Population 190 million = 100/sq. km
- Natural increase 1.8% per annum
- Economic Indicators GNP: US\$ 880 per capita
- Forest Cover 57% (1993)
- Annual Loss of Forest 1.1% per annum
- Protected Area Coverage 9.5% (WCMC)

Decade Milestones

- 48% increase in Protected Areas including large marine system
- Publication of Biodiversity Action Plan
- Revisions of conservation policy and regulations
- Ratification of Ramsar Convention
- Ratification of Convention on Biological Diversity
- Major international co-operation programmes to support biodiversity conservation

Physical Geography

The Indonesian archipelago comprises approximately 17,000 islands stretching in an east-west direction for 5,200km across the Sunda and Sahul continental shelves. Characterised by an enormously varied physical structure of high mountain ranges, volcanoes, alluvial plains, lakes, swamps and shallow coastal waters, the archipelago exhibits a biological diversity and richness which is without comparison in South-East Asia (FAO, 1981-82; MacKinnon et al., 1996; Monk et al. 1997; Petocz, 1989; Scott, 1989; Whitten and Whitten 1992; Whitten et al., 1984, 1987, 1996).

Natural Vegetation

With the exception of the Lesser Sunda Islands, the natural vegetation of the "outer" islands of Sumatra, Kalimantan, Sulawesi, Moluccas and Irian Jaya consists primarily of tropical evergreen forests (TWE, TME, IFV and TSE) of which Indonesia holds approximately 10% of the world total (Davies *et al.*, 1986). Deciduous monsoon (TMD) forests occurs in seasonally dry areas, particularly in southern and eastern islands such as the Lesser Sundas and the southern part of Irian Jaya. Edaphic variants grow on acid peat (Heath Forest (HFV) and Peaty Swamp Forest (PSV); Freshwater Swamp Forest (FSV); Forest on Limestone (LIM) and Forest on Ultrabasic (FUB).

The vegetation types are divided by a biogeographic boundary, Wallace's Line, that extends from north to south along the Sunda Shelf. Forests on the islands of the shelf itself are Malesian and dominated by the commercially important Dipterocarpaceae, while those found to the east, though also made up of Malesian genera, lack dipterocarps and have increasing affinities with the Australo-Pacific flora. Extensive natural wetlands, including many of international importance, are found in the low-lying alluvial plains and basins, flat-bottomed valleys and grassy savannahs are found in the south of Irian Jaya (GRA). Mangrove estuaries (MNV) are extensive in Sumatra, Kalimantan and Irian Jaya and limited on other islands. In addition, Indonesia contains some of the largest artificial wetlands in the world, including millions of hectares of rice paddies and nearly 200,000 ha

of fish ponds (Scott, 1989). Indonesia is widely recognized as having very high marine biodiversity (Bleakley and Wells, 1995) (see marine report of this review).

Over 50% of Indonesia is still under natural forest but forest clearance is continuing at a fast pace and forest cover is far from even across the country but follows the pattern of human expansion. Historically, human settlement has concentrated on the so-called "inner islands" with fertile volcanic soils, particularly Java and Bali and to a lesser extent Lombok. Although the population in Java in 1817 was estimated by Sir Stamford Raffles to be only about four million, a tradition of intensive cultivation, with high population densities, has been in evidence for several generations. Introduction of estate crops, especially coffee, tobacco and tea, during the 19th century contributed to the expansion of cultivation into the uplands, destroying the natural forests in these areas. During the last half of this century, increasing population pressure as well as changing economic circumstances have led to the cultivation of many of these former plantations, and the clearance of large areas of forest for oil palm, rubber, and industrial timber plantations. Today these islands contain more than 64% of the population and produce some 70% of the national food supply.

Percentage forest cover for different Indonesian units as mapped in our GIS is as follows: - Java and Bali 10%, Sumatra 35%, Kalimantan 59%, Lesser Sundas 41%, Sulawesi 61%, Maluku 79%, Irian Jaya 76%. Some of these figures are fairly out of date (mid-1980's) and figures for Maluku and Lesser Sundas include extensive secondary forest of limited biodiversity value. Maps 8a - 8g show the distribution of remaining habitats in the country.

Biogeographic Units

Indonesia straddles two of the globe's major biogeographical realms - The Indo-Malayan Realm and the Australasian Realm. In addition the overlap zone between these two realms is itself often regarded as a distinct biological sub-region - Wallacea. The country contains the whole of Sumatran biounits 21a-g; all of the biounits of units 22 (Java and Bali), 23 (Sulawesi) and 24 (Lesser Sundas); the larger part of the Bornean biounits - namely 25a-c and e-i, plus units of Maluku and Irian Jaya 13a - g and P3a - h, j and l. Units 21, 22 and 25 lie on the Sunda continental shelf and are within the Sundaic sub-region. Unit P3 lies on the Sahul or Australasian continental plate and fall within the Australasian sub-region whilst units 23, 24 and 13 lie in the Wallacean sub-region between the two continents.

Biological Richness

Indonesia is one of the five most species diverse countries in the world. It is a recognised mega-diversity country and contains parts of the Borneo "biodiversity hotspot". The following table presents some of the figures indicating this great richness. It must be remembered that neither the Indonesian nor global lists of species are complete so proportions are only indicative. Indonesia scores as the richest country in the realm for every group for which comparable data are available. The country has no less than 24 EBA's (ICBP, 1992). The biodiversity index is calculated at 26.8 (see section 1.4.3.1 above), resulting in an ultimate protection target of 13.4%.

Taxon group	Indonesia spp.	World spp.	% global total	Realm rank
Mammals	500	4,170	12	1
Birds	1,500	9,200	16	1
Reptiles	2,000	6,300	32	1
Amphibians	1,000	4,200	24	1
Fish	8,500	19,000	45	1
Molluscs	20,000	50,000	40	?
Insects	250,000	750,000	33	1
Higher Plants	25,000	250,000	10	1
Fungi	12,000	47,000	24	?

Richness and endemism are not evenly distributed throughout the country. Small isolated islands have reduced species richness in all groups but generally higher levels of endemism. Fig. 1.1 above presents a picture of this pattern. Species of special significance include long lists of national endemics and many trees and other plants of economic use but the following species are generally recognised as national treasures: - orangutan, tiger, elephant, banteng, anoa, Komodo dragon, birds of paradise, tarsiers, Javan rhino, Sumatran rhino, dugong, marine turtles, marine fisheries, asian tapir, proboscis monkey, cockatoos, *Amorphophallus titanum* and *Rafflesia arnoldi*. Economic plants of great significance include several spices such as cinnamon, cloves and nutmeg, wild rice, wild yams and sweet potatoes, *Dipterocarpus* spp. *Pinus merkusii*, *Agathis*, sago, *Eucalyptus* and *Melaleuca* spp.

Threats to Biodiversity

The greatest threat to biodiversity in Indonesia is the clearance of forest for agriculture (ladang cultivation) which is fuelled by the very high human density and fast rate of population increase. In some cases this opening up of the forest area has been officially sanctioned and sponsored. Loss of forest as a result of logging (both legal and illegal) is less damaging as forests are cut selectively and secondary reforestation is generally fast. More serious problems occur when forestry activity is followed by fire or agricultural settlers. Major fires in Sumatra and Kalimantan have destroyed large forest areas and prehistoric fires were probably responsible for the clearance of forest on much of the Lesser Sundas and southern Irian Jaya.

Hunting is a problem in some areas but is limited by two important factors. The majority of the population is Muslim with little interest in hunting or consuming the meat of wild animals. In addition there is a complete absence of shotguns or other firearms among the rural population. However, important large species such as tigers and Sumatran rhinos are reportedly being poached to supply the demand for animal parts in the Chinese medicine trade. Various destructive fishing methods (use of poisons, explosives and electricity) are threatening some species and wildlife trade for pets (especially parrots) is a growing concern. Raiding nests of turtles and megapodes for their eggs and the netting of

migrant waders for food along the north Java coast are some examples where hunting is endangering some species. Pollution of lakes and waterways is also serious in some areas. In Jakarta Bay serious pollution extends well into the sea. In the long-term, climate change and sea-level rise will be a serious problem.

Review of Protected Area System

Since 1949, by which time over 100 sites had been established under the colonial regime, the network has expanded considerably, and now covers 19 million ha, some 10% of the total land area (Hadisepuro and Wardojo, 1990). During this period, a number of systems reviews have been published with recommendations for the further development of the protected areas system.

The first of these, the National Conservation Plan for Indonesia (FAO, 1981-82), outlined a programme for the development of a comprehensive protected areas network covering over 20 million ha of the terrestrial area. This subsequently formed the basis for the Indonesian section of the IUCN Systems Review of the Indo-Malayan Realm (MacKinnon and MacKinnon, 1986) and all subsequent reviews. An expanded and updated conservation strategy for Irian Jaya has since been produced by WWF/IUCN (Petocz, 1984, 1989). National priorities have been highlighted in the Biodiversity Action Plan for Indonesia (1993).

The current system of Protected Areas (all categories) totals 356 sites with a total area of 19.5 million ha or 10% of the country. 1.5% of this figure is made up of marine area. In addition another 30 million ha is classified as protection forest and may with only slight reaffirmation of management objective warrant inclusion as IUCN categories IV or VI. The table below lists areas of global significance only. Although little advance has been made since the IUCN review (MacKinnon & MacKinnon, 1986) in further developing the protected area network, there are signs of a renewed interest in following up on the many outstanding recommendations for new reserves.

As the richest biodiversity country in the realm, it is not surprising that Indonesia has the longest list of sites rated as of global significance. These are listed below with some indication of their current status and main significance.

Name	Ecosystem	Cat	Gazetted (Year)	Size (km ²)
Irian Jaya				
Gunung Lorentz	Lowland - montane evergreen	1	1978	21500
Pulau Supriori	Lowland evergreen insular	1	1982	420
Laut Cendrawasih	Marine	2	1990	14530
Wasur	Deciduous forest savannah	2	1990	3080
Jayawijaya	Montane evergreen	4	1981	8000
Mamberamo-Peg. Foja	Lowland - montane evergreen	4	1982	14425
Peg. Arfak	Montane evergreen, semi-ever.	4	1992	450
Peg. Tamrau Selatan	Montane evergreen	P		2479
Peg. Tamrau Utara	Montane evergreen	1	1996	2657
Peg. Weyland	Montane evergreen	P		2230
Teluk Bintuni	Mangroves	P		4500
Pulau Kofiau	Lowland evergreen insular	P		100

Kalimantan

Sg. Kayan Sg. Mentarang	Lowland - montane evergreen	1	1980	16000
Bukit Baka - Bukit Raya	Montane evergreen	2	1992	1811
Gunung Bentuang	Lowland - montane evergreen	2	1992	6000
Gunung Palung	Lowland evergreen	2	1990	900
Tanjung Puting	Swamp forest, heath Forest	2	1982	3550
Hutan Kapur Sangkulirang	Limestone	P		2000
Muara Kayan	Mangroves	P		800
Perairan Sungai Mahakam	Freshwater lakes and swamps	P		2000
Ulu Sembakung	Lowland evergreen	P		5000

Nusa Tenggara

Komodo	Monsoon forest, savannah	2	1980	1735
Pulau Moyo	Monsoon forest insular	6	1986	223
Tambora Selatan	Semi-evergreen forest sav.	6	1978	300
Gunung Wanggameti	Evergreen Forest	P		60
Gunung Mutis	Monsoon limestone forest	P		400
Gg. Olet Sangenges	Montane limestone forest	P		350
Gunung Talamailu	Limestone and evergreen	P		200
Tambora Utara	Montane evergreen	P		800

Maluku

Gunung Api	Bird colonies	1	1937	1
Pulau Manuk Woha	Bird colonies, marine	4	1981	1
Manusela	Evergreen lowlands	2	1982	1890
Gunung Arnau	Limestone forest	P		450
Gn. Kelapat Muda	Lowland - montane evergreen	P		1450
Jamdena	Moist deciduous and mangrove.	P		600
Kai Besar	Limestone forest	P		370
Lolabata	Mixed evergreen forests	P		1890
Pulau Kobroor	Evergreen and limestone	P		1700

Sulawesi

Kep. Togian	Semi-evergreen islands	1	1989	1000
Kep. Take Bone Rate	Marine corals	1	1992	5308
Morowali	Lowland - montane evergreen	1	1986	2250
Tangkoko - Dua Saudara	Lowland evergreen, coastal	1	1978	43
Dumoga Bone	Lowland evergreen	2	1982	2871
Lore Lindu	Lowland - montane evergreen	2	1982	2310
Bunaken Menado Tua	Marine corals	2	1989	891
Rawa Aopa Watumohai	Lowland swamps	2	1989	968

Sumatra

Kep. Krakatau	Volcanic island	1	1919	25
Berbak	Peat swamps	2	1935	1627
Bukit Barisan Selatan	Montane evergreen	2	1982	3650
Gunung Leuser	Lowland - montane evergreen	2	1980	7927
Kerinci Seblat	Lowland - montane evergreen	2	1982	14847

Tai-tai Batti	Lowland evergreen insular	4	1976	565
Java and Bali				
Gunung Halimun	Lowland - montane evergreen	1	1992	400
Bali Barat	Monsoon - semi-evergreen	2	1982	777
Baluran	Monsoon savannah	2	1980	250
Gunung Gede	Montane evergreen	2	1980	150
Pangrango				
Meru Betiri	Lowland semi-evergreen	2	1982	580
Ujung Kulon	Lowland evergreen, swamps	2	1992	1229

Categories: 1-6 IUCN categories taken to be:

- 1 = Cagar Alam
- 2 = Taman Nasional
- 4 = Suaka Margasatwa
- P = Proposed

Note that several of these global sites are still only proposals.

Maps 8a - 8g show the distribution of remaining wildlife habitat in Indonesia together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The tables and figures below show how much habitat remains and is protected across the country and by biounit according to the GIS analysis. The overall picture is good with 8.3% as mapped is included in the Protected Areas system and another 7.2% included in proposals or IUCN categories V and VI (mostly proposed).

Identification of Gaps in System

There are no major gaps in terms of habitat coverage at the national level but there are major gaps in terms of biounit coverage and some habitat gaps within biounits. The Protected Areas systems in the Moluccas and Lesser Sundas with their fast vanishing forests and high levels of island endemism constitute major gaps which will result in the extinction of many species if not quickly rectified.

In Kalimantan which has 59% forest cover, 6.6% Protected Areas coverage (IUCN categories I-IV) and 8.5% proposed or in other categories, there are gaps in coverage of heath forest and forest on limestone. Biounit coverage is fairly even.

In Sumatra with 35% forest cover and 6.9% Protected Areas coverage (categories I-IV) with another 6.1% proposed or other categories, there is also a gap in heath forest coverage, freshwater swamp coverage and biounit gaps for sub-units 21d, 21e, 21f and 21g.

In Java and Bali with only 10% forest cover and 4% protection (categories I-IV) plus 4.3% proposed or other categories, there could be more lowland evergreen habitat protected.

Irian's coverage is good for both habitats and biounits. Sulawesi is pretty good with 60% remaining forest and 10% protected in categories I-IV. There is not much coverage of freshwater swamps.

In Maluku with 79% forest and only 3.6% protected, there are habitat gaps for freshwater swamps, forest on ultrabasic and monsoon forest and not enough inclusion of forest on limestone. Even coverage of semi-evergreen forest is too low. There are many proposals for Protected Areas here (14.8%) which would fill these gaps. In terms of biounits the most under-represented are 23c, 13a, 13b, 13c and 13e with 23d also very poor. Only unit 13d has adequate representation.

The Lesser Sundas have only 38% forest cover and 2% Protected Areas cover (categories I-IV). There are another 6.4% of proposals which will be needed to fill the gaps in forest on limestone, forest on ultrabasic rocks, semi-evergreen forest. Only montane forests are adequately protected. Sumba is particularly poorly represented.

Habitat Details for Indonesia

Habitat	Original (km ²)	Current		Protected(I-IV)		Other (V,VI,PRO)	
		(km ²)	%	(km ²)	%	(km ²)	%
Alpine	1881	1213	64	844	44.9	64	3.4
Barren	0	203	***	0	***	203	***
Cleared	0	847859	***	33377	***	35406	***
Freshwater swamp	108329	40492	37	3041	2.8	1424	1.3
Ultrabasic Forest	17550	14885	85	1077	6.1	377	2.1
Rivers/Lakes	5496	2627	48	111	2.0	376	6.8
Grassland	0	3613	***	2262	***	1130	***
Heath Forest	90994	37741	41	1977	2.2	896	1.0
Ironwood Forest	11713	3893	33	276	2.4	0	0.0
Forest on limestone	117094	56837	49	3193	2.7	7432	6.2
Mangroves	53711	24237	45	4156	7.7	4047	7.5
Monsoon forest	5504	363	7	204	3.7	2	0.0
Peat Swamp Forest	196123	106136	54	10649	5.4	9626	4.9
Savannah	8311	20238	244	1134	13.6	898	10.8
Secondary forest	0	439	***	0	***	439	***
Semi-evergreen	210835	82116	39	8850	4.3	7620	3.7
Tropical montane deciduous	9140	7422	81	0	0.0	1414	15.5
Tropical montane evergreen	197405	154734	(78)	37899	20.7	20182	11.0
Tropical montane limestone	7219	16418	85	4855	25.0	1963	10.1
Tropical pine forest	3757	2398	64	648	17.2	222	5.9
Tropical wet evergreen	860388	474995	(55)	41119	4.8	43577	5.1
Upper montane forest	14812	9829	66	3418	23.1	282	1.9
Totals:							
Natural	1920262	1045007	(54.4)	123451	6.4	100503	5.2
Non-natural		852114	(44.4)	37424	1.9	37817	2.0

*** = over 10x more current area than original

Summary

Total loss of original natural habitat	45.6 %
Original forest cover	99.2 %
Current forest cover	53.8%
(Natural forest cover)	not determined
(Secondary forest cover)	not determined
Total area protected	15.6 %
(Area protected IUCN I-IV)	(08.4 %)
(Area protected IUCN V-VI, PRO)	(07.2 %)

As mapped, current habitat protection is 6.4%, more than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 3.5% protected. However the earlier review did not include the rather forested regions of Maluku and Irian Jaya. Current conservation index score (CI) is calculated as 0.6 (see table 1.8 and section 1.4.2 for scoring details).

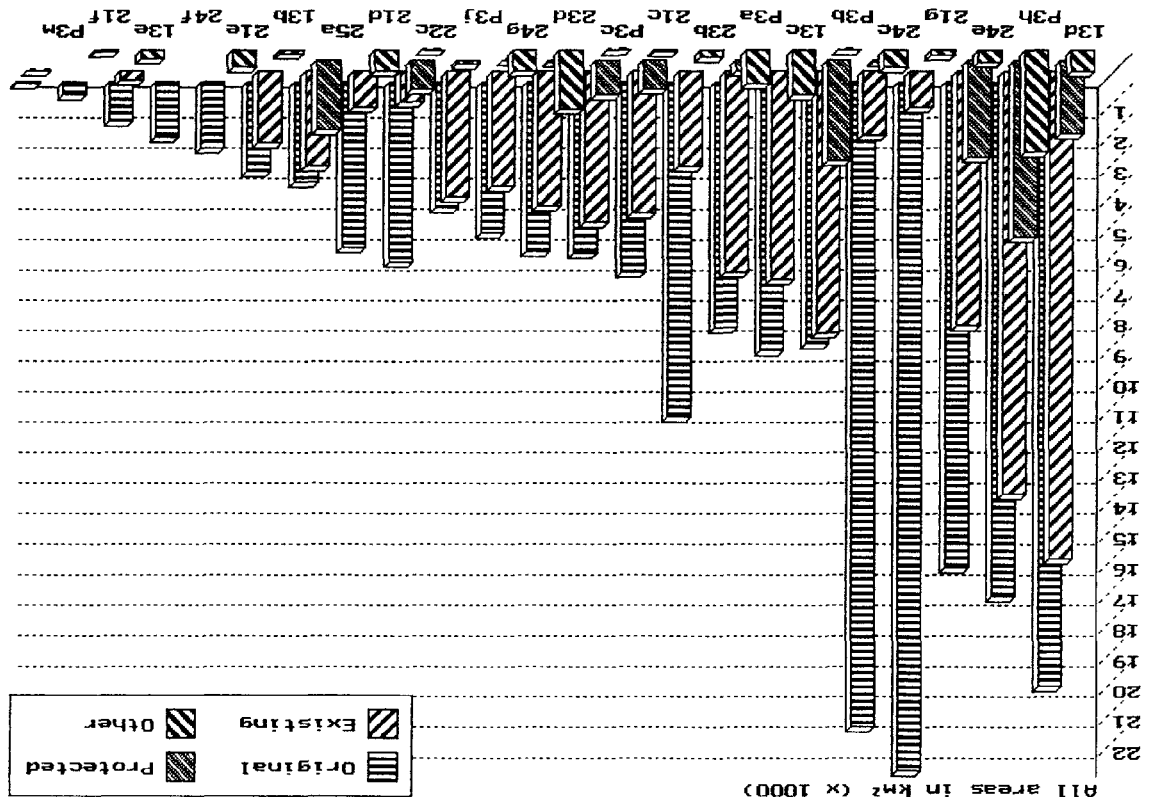
Despite many of the criteria for the design of the protected area system having been met, a number of deficiencies remain. Wetlands in particular have received inadequate coverage in the existing network and are under-represented, partly because of insufficient information regarding their conservation value. A preliminary inventory of wetlands has been compiled by the Asian Wetland Bureau (Silvius *et al.*, 1987; Scott, 1989), in order to identify sites for incorporation into the protected areas network.

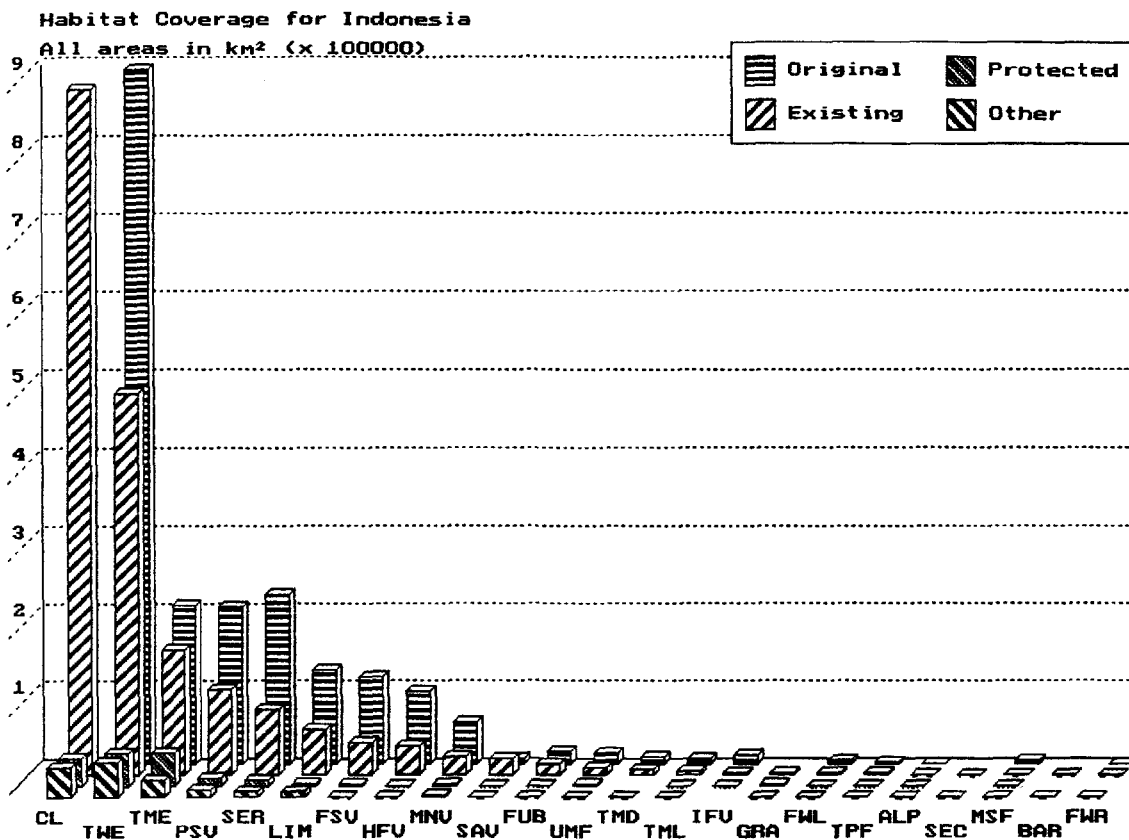
Other Issues

In addition to the official list of protected areas, Indonesia has a very extensive system of protection forests. In many cases these could be accepted as meeting the requirements of IUCN categories IV or VI. If thus scored, Indonesia will be seen to be easily meeting its obligations for *in-situ* conservation.

Recommendations

1. The protection of Indonesia's natural heritage and resources for the benefit of future generations will therefore require innovative conservation measures, possibly outside the existing protected areas network. That these must take account of human needs is increasingly crucial, as many areas of outstanding conservation value are both populated and subject to conflicting land use demands of a growing economy (Leader-Williams *et al.*, 1990).
2. It is easy to be complacent about the protected area system of Indonesia since the total area protected is very large and it is easy for ministers to feel that it is enough. It must be realised, however, that due to its geographical position, tropical moist climate and archipelago formation, Indonesia is simply by far the most important country in the realm for biodiversity conservation and a "good enough" system of reserves is not adequate. Indonesia merits an excellent system of protected areas to which standard it just falls short. Some parts of Indonesia (particularly Maluku) are quite inadequately protected.
3. New protected areas are urgently needed in Maluku province and the Lesser Sundas island of Sumba. Priority areas for gazettelement include :- Lalobata, Aketajawi, Pulau Taliabu, Gunung Kelapatmuda, Kai Besar, Yamdena, Gunung Arnau, Manupeu, Laiwangi-Tabundang-Gunung Wanggameti, Selalu Leginin, Puncak Ngenges (Olet Sangenges), Tambora Utara, Tanjung Karitamese, Egon Iliwuli, Gunung Timo, Gunung Tamailu. The general weakness of the protected areas systems in these parts of Indonesia has been highlighted in many reviews since 1981 but several recent surveys by Birdlife International are quite specific in proposed boundaries and should be followed up as a matter of some urgency.
4. Other global priority sites which still need gazettelement or boundary changes are :- Gunung Sahendaruman, Ulu Sembakung, Sangkulirang Limestone and Danau Sentarum. These must be tackled as a highest priority.
5. Considerable improvements can be achieved in the standards of management and protection within the reserve system. Many reserves are threatened by illegal





logging and illegal agricultural incursion. Other reserves are threatened by intersectoral conflicts such as mining, oil exploration and highway construction.

6. A careful review of the protection forest system could usefully be undertaken to see what forests are also of high biodiversity importance. Many protection forests could be accepted as category IV protected areas under the revised IUCN category definitions.
7. Additional recommendations concerning the marine reserves are given in the marine report of this review.

Key Documents

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PHProtected Areas/BirdLife International (1995) *Recommendations for Additions to the Indonesian Protected Area Network*. BirdLife International, Bogor. 67 pp.

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3.7 LAO P.D.R.

Basic Data

- Area 237,035 sq. km.
- Population 4.7 million = 20/sq km
- Natural increase 2.9% per annum
- Economic Indicators GNP: US\$ 320 per capita
- Forest Cover 56% (1993)
- Annual Loss of Forest 1.0% per annum
- Protected Area Coverage 11.6% (WCMC)

Decade Milestones

- Declaration of 17 proposed protected areas as National Biodiversity Conservation Areas (NBCA)
- Established Center for Protected Areas and Watershed Management (CPAWM)
- Established international programs of co-operation in biodiversity protection and surveys
- Enacted Forestry Law (1997)
- GEF funded project to strengthen management of NBCAs (1996)

Physical Geography

Laos is a tropical and sub-tropical country lying in north-central Indochina between 13° 55'N to 22° 32'N and 100° 06'E to 107° 87'E. Lao P.D.R is a land-locked, mountainous country and extends 1160 km from north to south but only 125 km in width with a very narrow central "waist". The country is bordered to the west by Thailand and Myanmar, to the north by China, to the east by Vietnam and to the south by Cambodia.

The major physical features of Laos are the south-flowing Mekong river with its low-lying plain which is mostly below 200 m altitude; the steep, rugged hills throughout the north of the country; the Annamite Mountains along the Vietnam border to the east; and the Bolovens plateau, an outlying massif in the south of the country, rising to over 1500 m. In the narrow central portion of the country, there are extensive blocks of karst limestone. The highest point in the country is the 2817 m Phou Bia, located 130 km north-east of the capital city, Vientiane. The area of alluvial land is limited and sticky hill rice is the staple cereal.

The climate of Laos is dominated by a monsoon regime - the winter dry season by the northeast winds from the Asiatic continent, and the summer wet season by the southwest winds from the Indian Ocean. Lowland areas are tropical whilst the extreme north and higher mountains are sub-tropical. Rainfall varies from 1000 mm in the Savannakhet region to over 3000 mm in the southern mountains and extreme north-east. The rainy season commences in mid-May. March and April are the months when the land is driest and farmers burn fields in the traditional ray slash and burn agriculture. However, due to heavy fog and occasional thunderstorms in the dry season, the climate permitted evergreen forests to predominate over the entire country.

Natural Vegetation

The original forest cover consisted largely of evergreen and semi-evergreen forests (MacKinnon and MacKinnon, 1986; Salter and Phanthavong, 1989; Berkmuller et al, 1995). These comprised dry evergreen forests (SDE), which covered much of the

mountainous northern part of the country; tropical montane evergreen forests (TME), primarily along the Annamite Mountains and on the Bolovens Plateau; and lowland semi-evergreen dipterocarp forests (SER) over the Mekong Plain. Other original vegetation types were tropical montane deciduous forests (MDF) scattered throughout the north, dry dipterocarp (DDF) and mixed deciduous forests (TMD) in the south and on the Mekong Plain, forest on limestone (LIM) and pine forests (SPF and TPF) in the Annamites and parts of the north, and a small area of subtropical montane forest (SBH) in the extreme north (along the Chinese border).

The most recent data on forest cover (Lao Forest Inventory and Management Office, 1991), based on 1988-89 SPOT imagery, indicate a current forest cover of 111,816 sq. km (47.2% of land area). An additional 88,051 sq. km (37.2% of area) are classified as potential forest, including bamboo and secondary formations; 15,515 sq. km (6.6% of area) as other wooded areas, primarily savannah and scrub forest; 10,083 sq. km (4.3% of area) as permanent agricultural land; and 11,336 sq. km (4.8% of area) as other non-forest land, including barren areas, grasslands, urban areas and wetlands. The best and most extensive forests are now confined primarily to the southern and central parts of the country, deforestation having been most severe in the north and along the densely settled Mekong Plain. The total current forest area represents an approximately 2% decrease in forest cover from 1981/82 estimates.

Different sources of land cover information vary wildly in estimating forest cover for the country. The discrepancy is due to the fact that most of the forest is to some extent degraded by human activities and disputable as to whether it should be classed as original forest cover or secondary habitats. Our own data suggest only 17% is still original forest but there is a large area 36% of the country now classed as degraded forest.

Biogeographic Units

The largest portion of the country falls within biounit 10a - Central Indo-China which includes tropical Mekong drainage. The northern parts of the country fall within unit 10b - whilst the highest northern mountains fall within biounit 10c. The Annamite mountains along the eastern border with Vietnam fall within unit 05c.

Biological Richness

Despite the fast rate of forest loss, large, sparsely populated areas remain, and these continue to support a fauna of approximately 200 mammal species, including tiger, leopard, two bear species, possibly six deer species, elephant, four species of wild cattle, including kouprey *Bos sauveli*, and Javan rhinoceros *Rhinoceros sondaicus*, and more than 600 bird species (FRCP (unpublished data); Interim Mekong Committee, 1978; King *et al.*, 1975; Lekagul and McNeely, 1988).

The country has moderate levels of richness and a few endemic species. Endemism is highest for plants running at about 17%. The following numbers are adapted from Dinerstein and Wikramanayake (1993) - 200 mammals, 609 birds, 37 amphibia, 66 reptiles, and 244 fish with 8286 higher plant species, but these will tend to be underestimates reflecting the incompleteness of inventory in Laos. Botanical inventory is more complete than other groups. Gressitt (1970) was surprised at the richness of longicorn beetles found in Laos (1156 species with a high proportion of apparent endemics).

The WCMC database lists 33 endangered mammals, 23 endangered birds and 10 endangered plant species. The country has one EBA (ICBP, 1992). The biodiversity index is calculated at 8.3 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.4%.

Of particular interest are the two "new" mammals discovered in Annamite mountains between Laos and Vietnam. A primitive bovid has been named the Saola *Pseudoryx nghetinhensis* whilst a large form of barking deer has been named the Giant Muntjac *Megamuntiacus vuquangensis*. Both have recently been added to Appendix I of CITES to prevent endangerment through over-eager collectors or zoos.

Threats to Biodiversity

Shifting cultivation, fires, uncontrolled hunting and fishing, and unsustainable logging practices all represent serious conservation problems in Laos. Probably the major current cause of actual deforestation is some upland shifting cultivation systems which involve conversion of primary forest areas and continuous, intensive cultivation and repeated fires. In addition, the planned system of dams and reservoirs for power and irrigation purposes will result in many currently wild areas being opened up by roads with valuable habitat and animal migration routes submerged by reservoirs. Trade in wildlife has become a serious issue with major routes developing to China both directly and through Vietnam. Monkeys, lorises, pangolins, snakes and chelonians are particularly affected.

Review of Protected Area System

Although some forest reserves have been declared in the past, their total extent has been small (less than 1,300 sq. km) and protection ineffective (FAO/UNEP, 1981). The government has received assistance, through FRCP, in formulating and implementing management plans for the 808 ha Houei Nhang Forest Reserve just outside Vientiane and the 200,000ha Phou Khao Khouay area (Salter and Phanthavong, 1990). Five protected areas had come under management by mid-1995.

A variety of proposed reserves have been listed and surveyed over the past few years but in 1995 the first major batch of gazettements was issued consisting of 15 new reserves totalling 2.6 million ha or 11 % of the country. A further 11 reserves (totalling 1.1 million ha or 4.4% of the country) remain as firm proposals, some of which are already approved at provincial level.

The following 7 localities are regarded as globally significant.

Name	Ecosystem	IUCN. Category	Year	Size/km ²
Dong Ampham	Semi-evergreen Forest	4	1993	2030
Hin Namnu	Limestone Forest	4	1993	865
Khammouane	Limestone Limestone Forest	4	1993	1620
Nakai-Nam Theun	Annam Evergreen and Conifer	4	1993	3710
Xe Pian	South Tropical Evergreen	4	1993	2370
Nam Chuan	Annam Evergreen	P		1610
Nam Theun Ext.	Annam Evergreen	P		645

Category codes:

- 1 - 6 Corresponding IUCN Category
- P Proposed

Map 9 shows the distribution of remaining habitat in Laos and the location of the existing and proposed protected areas. The BIMS database contains detailed descriptions of each protected area.

Analysis of Protected Area Coverage

The table and figures below show how much of each habitat and biounit remain and how much is protected and proposed for protection.

Habitat Details for Lao P.D.R.

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Bamboo	0	7003	***	340	***	15	***
Cleared	0	0	0	0	***	0	***
Cultivated	0	35583	***	1694	***	38	***
Dry dipterocarp	10115	1904	19	261	2.6	0	0.0
Degraded forest	0	83603	***	9538	***	5261	***
Freshwater swamp	659	0	0	0	0.0	0	0.0
Rivers/Lakes	1711	2180	127	70	4.1	0	0.0
Grassland	0	5005	***	629	***	9	***
Forest on limestone	4595	3896	85	1540	33.5	0	0.0
Plantations	0	975	***	217	***	0	***
Subtropical hill forest	32032	730	2	15	0.0	220	0.7
Scrub	0	58669	***	4951	***	1737	***
Sub-tropical dry evergreen	34885	569	2	70	0.2	123	0.4
Semi-evergreen	78316	15418	20	6317	8.1	963	1.2
Subtropical montane forest	4306	88	2	0	0.0	0	0.0
Subtropical pine forest	1573	101	6	3	0.2	0	0.0
Tropical moist deciduous	35321	9203	26	1212	3.4	718	2.0
Tropical montane evergreen	24859	5220	21	1344	5.4	1389	5.6
Tropical pine forest	2517	749	30	3	0.1	238	9.5
Tropical wet evergreen	77	77	100	69	89.6	0	0.0
Totals:							
Natural	230968	40135	17.4	10904	4.7	3651	1.6
Non-natural		190838(82.6)		17369	7.5	7060	3.1

*** = over 10x more current area than original

Summary

Total loss of original natural habitat	82.6 %
Original forest cover	99.3 %
Current Total Forest Cover	52.6 %
(Natural forest cover)	(16.5 %)
(Secondary forest cover)	(36.2 %)
Total area protected	16.6 %
(Area protected IUCN I-IV)	(12.2 %)
(Area IUCN V-VI, PRO)	(04.6 %)

As mapped, current natural habitat protection is 4.7%, a big increase since the 1986 review which scored the country as 0% protected. A higher proportion of remaining habitat may in fact be included in the Protected Areas system in the category "degraded". Current conservation index score (CI) is calculated as 0.6 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

Although the Protected Areas system covers a large percent of the country, there are apparent gaps in the habitat coverage. There is almost no protected examples of tropical and sub-tropical pine forests; very little subtropical broadleaf forest and a general bias towards the moister (admittedly richer) forest types.

Other Issues

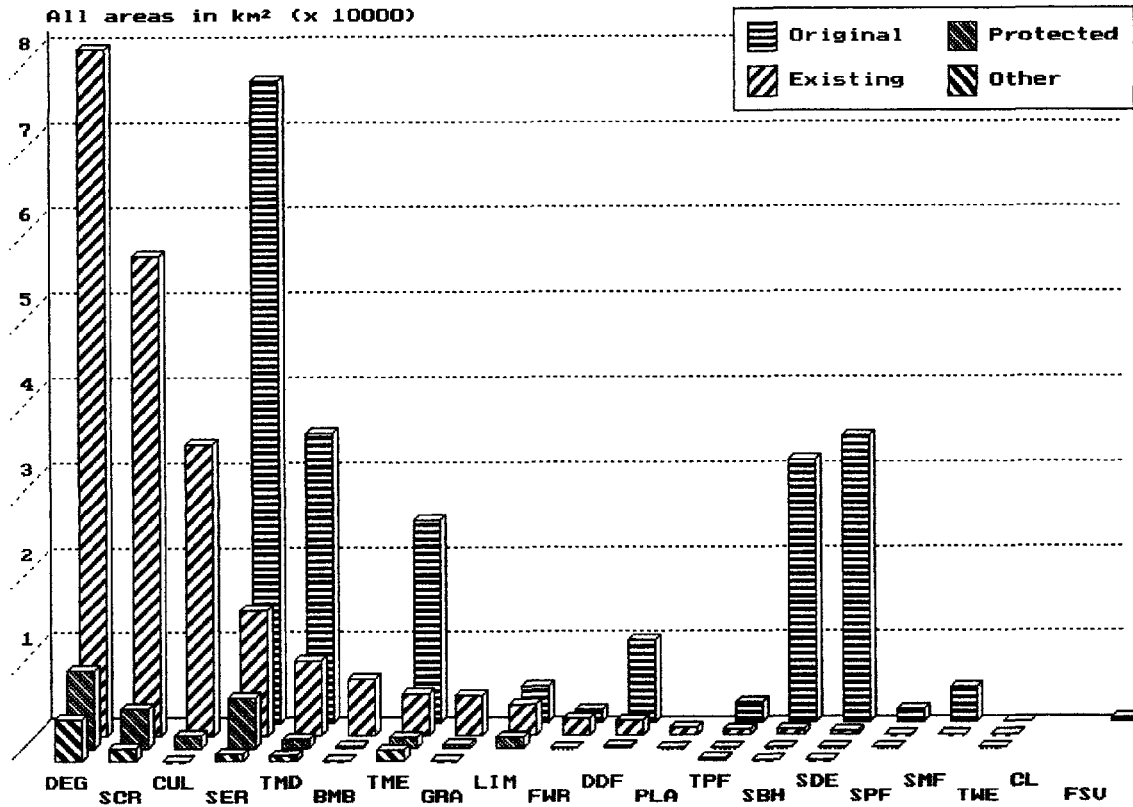
Most of the protected areas are occupied by varying numbers of human residents. It is the policy to elicit the co-operation and participation of these local people in the management of the reserves. However, mechanisms for such participation have still to be developed. It is noted that most problems in reserves come from intrusion by people from outside. It should therefore be possible to align the privileged insiders to help protect what are also their resources from such outside groups. It is anticipated that protected areas in Laos will have a very low staffing level, with most protection functions resting at the district or village level (Salter et al. 1991).

Recommendations

1. The process of identifying and gazetting a representative system of protected areas is well in progress and current methods and approaches are sound. Greater attention should be paid to establishing strong transfrontier linkages when evaluating suitability of new areas for reserves. For instance great opportunities exist to link a new reserve to the Cambodian reserve of Virachey and to link the proposed Nam Ha (West) reserve with the famous Xishuangbanna reserve of Yunnan province, China. The most significant transfrontier links are the Nakai-Nam Theun reserve with Vietnam's famous Vu Quang reserve and Hin Namnu with Vietnam's Dong Phong Nha.
2. The Government should be encouraged and assisted to deploy larger budgetary and staff allocations towards nature conservation. This will require a general increase in awareness among the public and government leaders. Such a commitment to action would greatly encourage further international assistance in this sector. Such assistance is now being mobilised by UNDP, World Bank, Swedish SIDA and other agencies. Nakai-Nam Theun (adjoining areas to be flooded by a large dam), possibly Laos' most important reserve remains without an international sponsor.
3. Laos should participate more freely in international programmes and cooperation with its neighbours. Some important transfrontier areas are currently given no added prioritisation for establishment as reserves. It is recommended that Laos takes full advantage of the UNDP regional project RAS/93/102 which can provide a forum for greater co-operation on transfrontier issues.
4. Laos clearly needs a great deal of training and manpower development in the sector of Protected area management. It would be most economical and more relevant to receive this training in Thailand where there is only minimal language difference and plenty of training opportunities.

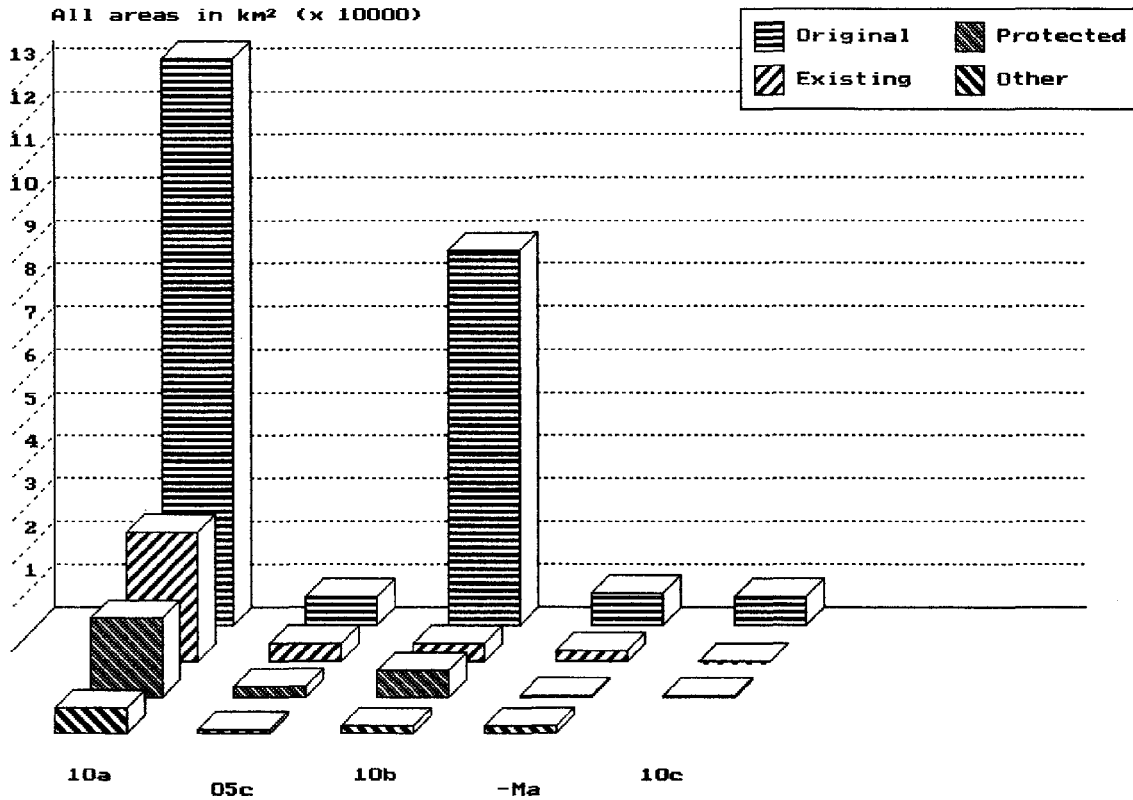
Habitat Coverage for Lao P.D.R.

All areas in km² (x 10000)



Biounit Coverage for Lao P.D.R.

All areas in km² (x 10000)



Key Documents

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IUCN-World Conservation Union (1993) *Wildlife in Lao P.D.R.: A Status Report*, Vientiane

3.8 MALAYSIA

Basic Data

• Area	330,355 sq. km
• Peninsular	(132,750)
• Sarawak	(123,985)
• Sabah	(73,620)
• Population	19.7 million (1991) = 60/sq km
• Peninsular	(16.3 million)
• Sarawak	(1.6 million)
• Sabah	(1.8 million)
• Natural increase	2.3% per annum
• Economic Indicators	GNP: <US\$ 3,480/capita
• Forest Cover	53% (1993)
• Annual Loss of Forest	2.3 % per annum
• Protected Area Coverage	4.5 % (WCMC)

Decade Milestones

- Endorsement of National Conservation Strategy
- Establishment of Endau-Rompin as State Park
- Ratification of Ramsar Convention

Physical Geography

Unlike any other nation in South-east Asia, Malaysia has a substantial land mass on both the Asian mainland and in the Malay Archipelago. It forms a crescent well over 1,600km long between 1° 00'-7° 00'N and 100°-109°E. It occupies two distinct regions, namely the Malay Peninsula, which extends from the Isthmus of Kra to the Singapore Strait comprising West Malaysia, and the north-western part of Borneo comprising the states of Sabah and Sarawak as East Malaysia. The two portions are respectively 133 and 198 thousand sq km. 1990).

Natural Vegetation

Lowland evergreen tropical rain forest (TWE) is the principal original formation in Peninsular Malaysia on dry land at low altitudes. In the extreme north-west this is replaced by semi-evergreen formations (SER). The rain forest is rich in Dipterocarpaceae and may be sub-divided into lowland (below 300m) and hill (300m to 1,000m) forest. Above 1000m is found tropical montane evergreen forests (TME). Along the east coast there remain a few patches of heath forest (HFV) on recent un-consolidated sands, but most have been degraded to open grasslands or scrub. Widely scattered patches of forest on limestone (LIM) occur north of Kuala Lumpur, peat swamp (PSV) and freshwater swamp forests (FSV) are extensive on both east and west coasts, although most of the latter have been cleared for agriculture. About 100 years ago rain forests probably covered 90% of the land area, much of it in the lowlands. In 1966 it was estimated that 68% of land area was naturally forested (Lee, 1973). A figure of 57,090 sq. km (43%) has been estimated for 1990 (FAO, 1987). However, much of this remaining cover is disturbed and in 1985 as little as 13,000 sq. km (9.8%) supported intact forest (Collins *et al.*, 1991).

Both Sabah and Sarawak were originally clothed in forest, including lowland evergreen rain forests (TWE), peat swamps (PSV), heath forests (HFV), forests on limestone (LIM), a floristically distinct formation on the ultrabasic rock (FUB) which forms a mountainous arc

extending from Mount Kinabalu to the east coast and lower and upper montane forests (TME). According to FAO (1987), the forest estate in Sarawak stood at 84,000 sq. km of broad-leaved forest in 1980 (67.5% of land area) and a predicted 79,639 sq. km (64%) in 1990. In Sabah in 1953 natural forest covered 63,725 sq. km (Fox, 1978) or 86% of land area. Thirty years later the forest cover had diminished to 46,646 sq. km (63%) (Sabah Forest Department, 1984). According to an FAO assessment in 1985, forest cover was 33,130 sq. km (45%).

The wetlands of Malaysia may be divided into ten groups, comprising mangroves (MNV), mud-flats, nipa swamps, freshwater swamps (FSV), peat swamp forest (PSV), lakes (FWL), oxbow lakes, river systems, marshes and wet rice paddies. An account of the coral reefs is given in UNEP/IUCN (1988), including a general description, an account of reef resources, disturbances and deficiencies, legislation and management and recommendations for further protection; a number of specific sites are described in more detail.

Biogeographic Units

Almost all of Peninsular Malaysia lies within biounit 07a Malay Peninsula with a tiny northern portion falling in 07b the Malay Transition Zone. Sarawak and Sabah contain the most important parts of the Borneo Mountains unit 25g plus much of the lowland units 25a, 25e and 25d.

Biological Richness

The extraordinary biological richness of the unit is well established. Both Peninsular Malaysia and northern Borneo are recognised biodiversity hotspots. National lists of species for Malaysia are boosted by the fact that it covers both parts of mainland Asia and the Sundaic islands. The following figures are, however, available for comparison. Dinerstein and Wikramanayake (1993) document 293 mammals, 1200 birds, 171 amphibians, 294 reptiles, 449 freshwater fish and 54 swallowtails and 15000 higher plants.

Endemism levels on the peninsula are fairly low but Sarawak and Sabah have many of the Borneo island endemic species. These are not counted as national endemics as they also occur in Indonesian Borneo. The country contains part of two EBA's (ICBP, 1992). The biodiversity index is calculated at 13.7 (see section 1.4.3.1 above), resulting in an ultimate protection target of 11.0%.

Malaysia contains a wealth of species of conservation and economic interests including such high profile mammals as tiger, elephant, orang-utan, siamang and proboscis monkey. Important birds such as Crested argus pheasant, Bulwer's pheasant, Helmeted Hornbill etc. Economic species are mostly plants and include many important medicinal plants and a large proportion of the globally important timber trees of family Dipterocarpaceae for which Borneo is the world distribution centre.

Threats to Biodiversity

Major threats to biodiversity are forest loss due to logging, forest fires and land conversions. Minor threats are hunting, oil pollution and introduced species. Wetland habitats are particularly vulnerable to human development.

A major cause of forest loss in Sarawak is shifting cultivation, covering over 30,000 sq. km, with as many as 1,500 sq. km cleared annually for hill paddy, although some of this may have already been cleared at an earlier date. Encroachment frequently occurs along logging roads, where access is provided into previously inaccessible forest. There is concern that levels of timber extraction may be unsustainable, although measures are

being taken to attempt to improve sustainability (G. Davison, pers. comm., 1991). Shifting cultivation is less of a threat in Sabah, covering only some 15% of total land area, although substantial areas in the lowlands are under threat of conversion. Severe and extensive fires, especially in logged forests, destroyed some 10,000 sq. km of forest in 1983.

Review of Protected Area System

The first comprehensive protected areas plan was contained in the Third Malaysian Plan (TMP) for 1976-1980, in which Taman Negara, 22 other wildlife reserves, game reserves and bird sanctuaries were recognised and a further two national parks and 21 other reserves were proposed. The TMP was designed to include representative ecosystems and the major biological communities suggested by the Malayan Nature Society in its Blueprint for Conservation (MNS, 1974). The present record of conservation falls a little short of that proposed in the TMP, with a total of 8,239 sq. km gazetted against the 8,985 sq. km proposed, and the sites recommended in the TMP do not necessarily correspond to those that have been gazetted.

The official protected area system is usefully augmented by a national system of Virgin Jungle Reserves and amenity forests. These tend to be small but many act as small nature reserves.

Map 10 show the distribution of remaining wildlife habitat in Malaysia together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

The following sites are rated as being of global significance:

Name	Ecosystem	Cat.	Year	Size (km ²)
Taman Negara	Lowland - montane evergreen	2	1939	4344
Endau Rompin	Lowland evergreen	P	1993	874
Crocker Range	Bornean mountains	2	1984	1399
Kinabalu	Unique montane system	2	1964	754
Danum Valley	Bornean lowlands	4	1983	428
Bako	Bornean Lowlands	2	1957	27
Gunung Mulu	Limestone and montane evergreen	2	1974	529
Niah	Limestone formations, caves	2	1974	31
Hose Mountains	Bornean mountains	P		2847

Category codes:

- 1 - 6 Corresponding IUCN Category
- P Proposed

Analysis of Protected Area Coverage

The figures and tables below show how much of each habitat remains in each biounit and how much of this is protected.

Habitat Details for Malaysia

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Cleared	0	175958 (***)		2975	***	1904	***
Degraded forest	0	13690 (***)		475	***	272	***
Freshwater swamp	6905	3160	46	0	0.0	0	0.0
Lakes/Rivers	9	5	56	5	55.6	0	0.0
Heath Forest	1645	739	45	112	6.8	24	1.5
Forest on limestone	486	98	20	70	14.4	0	0.0
Mangroves	8998	2327	26	2	0.0	65	0.7
Peat swamp	13806	5703	41	34	0.2	46	0.3
Semi-evergreen	1956	0	0	0	0.0	0	0.0
Tropical montane evergreen	27047	23651	87	2163	8.0	1550	5.7
Tropical wet evergreen	268524	104670(39)		6170	2.1	6070	2.3
Totals:							
Natural	329376	140353(42.6)		8556	2.6	7755	2.4
Non-natural		189648(57.6)		3450	1.0	2176	0.7

*** = over 10x more current area than original

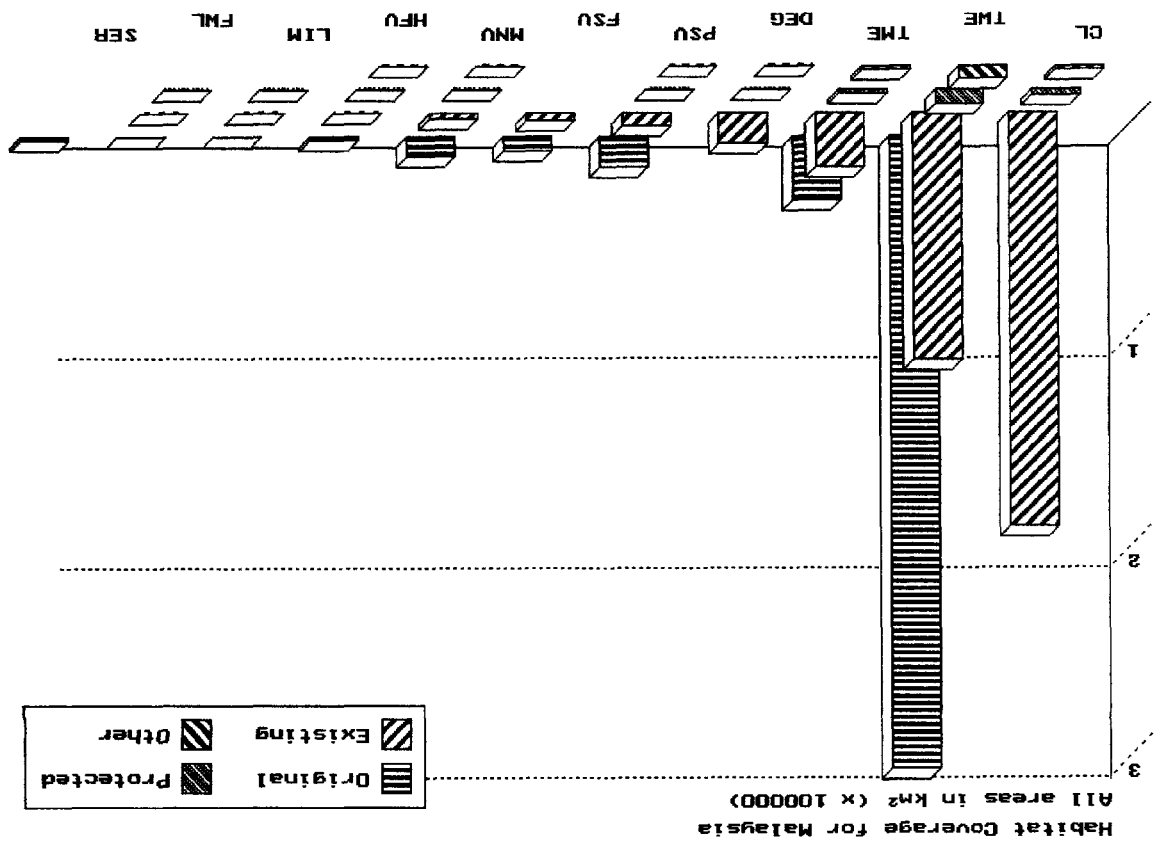
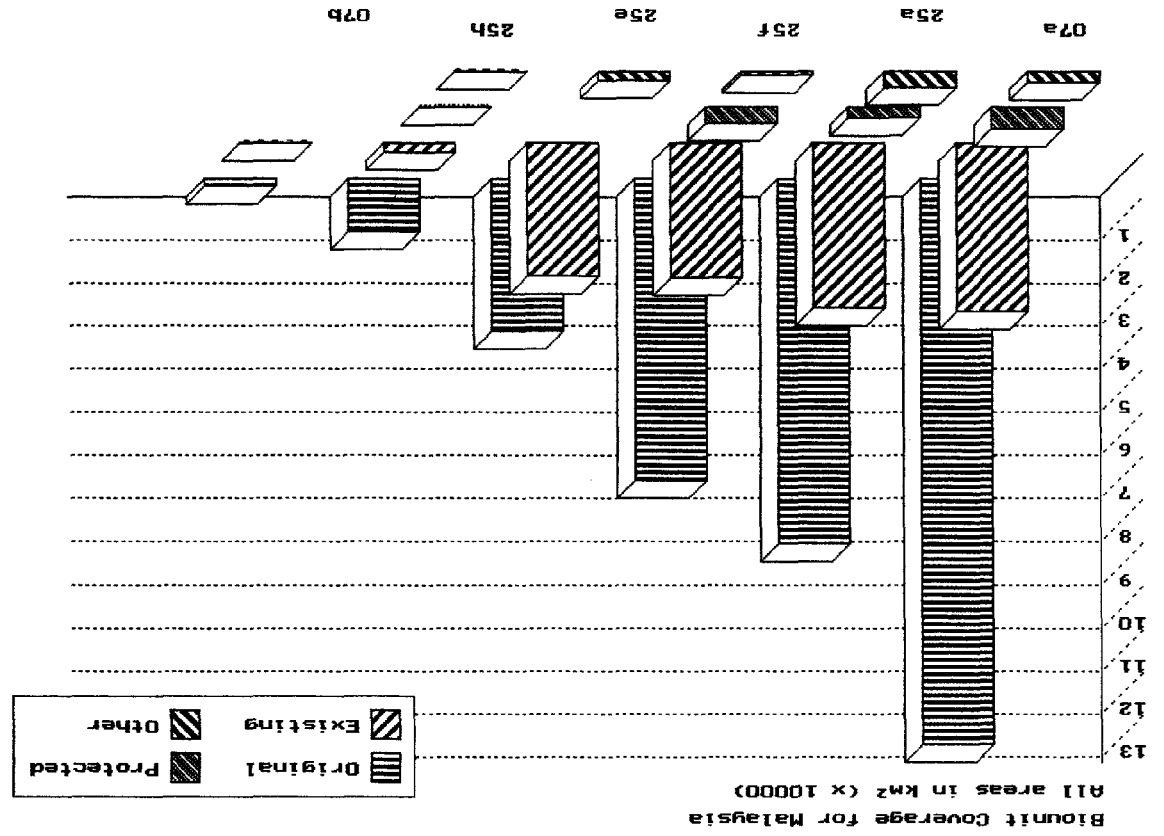
Summary

Total loss of original natural habitat	57.6 %
Original forest cover	100.0 %
Current forest cover	46.6 %
(Natural forest cover)	(42.5 %)
(Secondary forest cover)	(04.1 %)
Total area protected	6.7%
(Area protected IUCN I-IV)	(3.6 %)
(Area IUCN V-VI, PRO)	(3.1 %)

As mapped, current habitat protection is only 2.6%, much less than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 4.9% protected. Some protected habitat is now classes as degraded, some areas have been degazetted and other areas classed as protected in the earlier review are now known to be still only proposals. Current conservation index score (CI) is calculated as 0.3 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

The existing protected areas system in Peninsular Malaysia relies heavily on Taman Negara, one of the largest parks in South-East Asia. However, a number of critical habitats remain under-represented, including peat swamp forests in Pahang and Johor states, mangrove forests and open lake systems. Most importantly, the lowland dipterocarp rain forests are seriously under-represented. Existing "national" parks cover 0.92% and 1.9% of Sarawak and Sabah, respectively. Other categories of existing reserves cover 1.4% in Sarawak, and 4.9% of Sabah. Sarawak has a further 5% in proposed "national" parks and 1.4% in proposed wildlife sanctuaries. In addition, Sabah has 883 sq. km of virgin jungle reserves and about 1,000 sq. km of protection reserved forest that potentially play an important role. Including all categories, 8.3% of Sarawak, and 8.9% of Sabah will be under protection for ecological and biological purposes if all new reserves are gazetted.



The protected areas system in both states covers a good representation of the natural communities present. However, there is concern that few of the areas are under complete protection, and they could be subject to disturbance as pressure for land and timber increase. The main shortcomings are as follows. In Sabah, some of the virgin jungle reserves and other protected areas have been excised, or partially or totally logged, and may be under threat from shifting cultivators and poaching of wildlife. Although the state government passed a bill in 1984 requiring all de-reservations to go to the floor of the State Assembly, areas have still been excised from Kinabalu Park. Wildlife sanctuaries in Sarawak had a dual status as part of the Permanent Forest Estate, which gave less protection to biodiversity; the Wildlife Protection Ordinance (1990) has addressed this shortcoming. In Sarawak, great progress has been made in extending and managing the protected areas system in recent years. The State Conservation Strategy, still a confidential document, identified various new areas for protection and good progress has been made, but until the proposed areas are gazetted important omissions remain (Collins *et al.*, 1991).

Recommendations

1. There is a target to establish 10% of the country as protected areas to include full representation of diversity of natural ecosystems and areas of high species interest. All relevant natural resources agencies at both federal and state level should pursue the establishment of additional protected areas, maintaining of existing reserves and stricter enforcement of conservation legislation.
2. Biological inventory and socio-economic studies should be carried out in all reserves and a national database established to manage and analyse such information, under the umbrella of a national biodiversity centre.
3. Formulation and updating of management plans should be done for all protected areas, virgin jungle reserves and amenity forests. Better educational and interpretative facilities should be included.
4. National parks and state parks should have well-designed tourism outlets to offset protection costs and increase the public support for the conservation policy.
5. Despite its relative wealth, Malaysia should be afforded more international assistance and support in technology transfer, development of a biodiversity and GIS database and management of protected areas.
6. Increase institution capacity building through the employment of technical staff and skill training.
7. Continue to participate fully in international and regional conservation initiatives. For instance Taman Negara could be made a World heritage Site.

Key Documents

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3.9 MYANMAR

Basic Data

- Area 676,577 sq. km
- Population 46 million = 67/sq. km
- Natural increase 2.0% per annum
- Economic Indicators GNP: US\$ 200 per capita
- Forest Cover 43% (1993)
- Annual Loss of Forest 1.4% per annum
- Protected Area Coverage 1.0 % (WCMC)

Decade Milestones

- Gradual increases to Protected Area System
- Ratification of Convention on Biological Diversity
- New legislation for protection of wildlife and protected areas

Physical Geography

The Union of Myanmar (formerly Burma) is situated in the northern part of continental South-East Asia with an elongated north south length of over 2000 km from 10° - 28°N and between 92° and 102° E. The country shows an ecological spectrum of almost unique variety, ranging from tropical rain forests and coral reefs in the south to temperate forests of conifers, oaks and rhododendrons in the far north, where snow-capped mountains up to 5,729m high mark the eastern extremity of the Himalaya. The Salween (Thanlwin) and Irrawaddy (Ayeyarwady) valleys drain southwards. High mountain ranges form a continuous barrier along the western border with India and Bangladesh, extending southward parallel with the coast to the Ayeyarwady (Irrawaddy) Delta. In the north-east, the border with China follows the high crest of the Irrawaddy-Salween divide, then bulges out eastward to enclose the ruggedly mountainous Shan Plateau forming the border with Laos and Thailand. The west Rhakine coast and southern Tenassarim (Thaninthayi) portion of the country consist of narrow coastal plains backed by paralleling mountain ranges of moist forests with an extensive delta and mangrove area around the mouth of the Irrawaddy.

Climate varies greatly from the temperate north and high altitude zones to the equatorial climate in the extreme south. There are extreme differences in annual rainfall between the 5,000 mm or so on the coast and the arid conditions of only 760 mm in the central dry zone in the rain shadow of the Irrawaddy valley. Most rainfall arrives between mid-May and October with a cold season from November to January followed by a hot season from February to mid-May.

Natural Vegetation

Natural vegetation varies with altitude, latitude and climate. The climax vegetation in coastal areas is lowland rain forest (TWE and SER), with mangroves (MNV) and freshwater swamp forest (FSV) in the Ayeyarwady Delta and flood plain. The Ayeyarwady Basin includes a central dry zone of open, stunted dry deciduous woodland (DDF), known as *indaing* and some thorn scrub (TSF). Peripheral to this dry zone are extensive mixed deciduous forests (TMD) which are of great economic importance as the source of Myanmar's teak *Tectona grandis* and other commercial hardwoods. These are in turn surrounded by a fringe of moist, semi-evergreen (SER) and evergreen montane forest (TME) on the semi-circle of higher hills to the west, north and east, merging in the far north with

temperate oak (SLF) and subalpine conifer forests (SAC) and ultimately fir, birch, rhododendron and other sub-alpine vegetation (ALP) (Blower, 1989). The temperate and alpine zones of Myanmar are isolated and sparsely populated. The natural vegetation remains virtually intact.

Results from the UNDP/FAO National Forest Survey and Inventory Project, based on LANDSAT MSS and RBV imagery for the period 1979-1981, indicate that the total area of closed and degraded forest was 51.0% of total land area. Another 23% of the country was classed as forest affected by shifting cultivation. Virtually all forest in the Shan states has been affected by shifting cultivation and there is little intact forest in the Arakan Yoma in the west, with forest on the coastal side degraded to bamboo and only some managed mixed deciduous formations on the eastern side. Conditions in the southern and northern Chin Hills are highly degraded with only small islands of natural forest remaining. The extreme north of the country has some of the most extensive intact forests in the region with a continuum of habitats from glaciers and alpine through subalpine conifer and temperate oak and subtropical evergreen forests.

A summary of wetlands is given in Scott (1989). With a coastline of 2,278 km, several large estuarine and delta systems and numerous offshore islands, Myanmar possesses a considerable diversity of coastal wetland habitats, including coral reefs, sandy beaches and mud-flats. The most extensive wetlands in the interior of the country are the seasonally inundated floodplains of the three main river systems: Ayeyarwady-Chindwin, Sittoung (Sittang) and Salween. These plains have a surface area of some six million hectares during the monsoon season, providing feeding grounds for waterfowl and spawning grounds for fish, notably carp, catfish and perch. The practice of constructing embankments and cultivating flood plains restricts major areas of natural flood plain to the north. Permanent freshwater bodies, including the two main lakes, Inle and Indawngy, cover about 1,300,000ha (Scott, 1989). At least 17 important wetland sites have been identified (Scott, 1989).

Our own GIS coverage was based on more recent (1993) but coarser AVHRR satellite imagery. This can accurately distinguish degraded evergreen forests but sometimes cannot distinguish degraded from intact forests in deciduous types and may boost the forest total. The results give an estimate of 51% forest cover plus 18.6% degraded (affected by shifting cultivation).

Biogeographic Units

Myanmar contains parts of three of the realm's major sub-regions with a narrow fringe of the Indian sub-region in the extreme west (including important Himalayan elements), a significant piece of the Malesian sub-region in the extreme south but mostly falls within the Indochinese sub-region in the rest of the country (including important Chinese elements). The table below shows the area breakdown of the country into the component biounits.

Biounit composition of Myanmar

Code	Biounit	Area km ²	%age
04-	Burmese Coast	113742	17.0
05d	Cardamon Mountains	26628	4.0
07b	Malay Transition	3787	0.6
09a	South Irrawaddy	187945	28.1
09b	North Irrawaddy	102226	15.3
09c	Burma Transition Zone	39955	6.0
10a	C. Indochina	58221	8.7

10b	N. Indochina	123375	18.4
10c	Indochina Transition Zone	4477	0.7
10d	East Himalaya Zone	8358	1.2

Biological Richness

As a result of the extremely wide range of physical conditions, vegetation formations and biogeographical units, the country is rather rich in biological diversity. Myanmar contains nearly 300 known mammal species, about 1,000 birds, 370 reptiles and 7,000 plants. Levels of endemism are moderate with a particular area of local endemism focused around Mt. Victoria (Natma Taung). The country contains 4 EBA's (ICBP, 1992). The mangrove forests are extremely important breeding areas for valuable prawn fisheries. The teak resources of the country are immensely valuable. Corrected for size, the biodiversity index of the country is 6.8 (see section 1.4.3.1 above), resulting in an ultimate protection target of 8.9%.

Threats to Biodiversity

The greatest threat to biodiversity is the gradual loss of natural habitat. Shifting cultivation has caused loss or degradation of extensive forest areas particularly on the Shan Plateau. The switch in logging habitats towards the evergreen dipterocarp forests is threatening moist tropical forests. The intensification of teak production is threatening the ecological richness of the mixed deciduous forest zone. Historical un-sustained management of the dry central zone has led to almost desert conditions spreading through areas that were formerly forested. Protected areas are directly threatened by inadequate size, both individually and in aggregate, and by weak and poorly-enforced legislation (Blower, 1982). There is also extensive encroachment in many of the existing forest reserves. Game sanctuaries only legally protect fauna and not habitat.

Review of Protected Area System

The protected area system has been developed slowly over many years. At the present time there are 17 Wildlife sanctuaries, 4 national parks and the Hlawga Wildlife Park. The total area of these reserves is just over 1% of the country but the policy of the government is to increase this to 5%. In fact it has been recommended that the total should be increased to 10% and given that large areas in the north of the country are well forested and sparsely populated, this target is not unrealistic, though progress to date has been slow.

Progress since the IUCN Indo-Malayan Review (MacKinnon & MacKinnon, 1986) has been slow with only Alaungdaw Kathapa national park and Moyin-gyi wetland site established in the decade. Development of protected areas has been hampered by civil unrest in different regions. It is important to grasp opportunities of peaceful windows to progress with protected area establishment.

The following existing and proposed protected areas of the country are rated as of global significance:

Name	Ecosystem	IUCN cat.	Year	Size km ²
Alaungdaw Kathapa	Monsoon Forest	2	1984	1606
Tamanthi	Northern Semi-evergreen	2	1974	2151
Ka Kabo Razi	Himalayan	P		2000
Pakchan	South tropical evergreen	P		648
Tanlwe-ma-e-chaung	Arakan Yoma system	P		2600
Taungup Pass/ Thandwe-chaung	Arakan Yoma system	P		2600

Lampi Tropical marine system 2 1994 3890

Category codes:

1 - 6 Corresponding IUCN Category
 P Proposed

Myanmar has extensive forests managed on a long-term basis for sustainable management, relying on animals to extract timber. This use of forest is proven to be environmentally benign and economically profitable. This excellent system of management should be retained and not replaced by use of heavier and more mechanical extraction methods. Map 11 show the distribution of remaining wildlife habitat in Myanmar together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The figures and table below show how much habitat is remaining in each biounit and how much of this is protected. As mapped, current habitat protection is only 0.6%, more than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 0% protected. Current conservation index score (CI) is calculated as a very inadequate 0.1 (see table 1.8 and section 1.4.2 for scoring details).

Habitat Details for Myanmar (Burma)

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Alpine	2842	2842	100	0	0.0	2388	84.0
Cleared	0	203903	***	847	***	2014	***
Dry dipterocarp	31388	5407	17	0	0.0	0	0.0
Degraded forest	0	124257	***	445	***	1359	***
Freshwater swamp	16076	572	4	0	0.0	0	0.0
Lakes/river	2188	1576	72	25	1.1	71	3.2
Glaciers	1324	1324	100	0	0.0	1324	100.0
Montane deciduous forest	52821	41389	78	25	0.0	0	0.0
Mangroves	16616	4219	25	107	0.6	182	1.1
Montane wet temperate	27984	26819	96	1	0.0	3337	11.9
Sub-alpine conifer	12239	11670	95	174	1.4	4607	37.6
Sub-tropical hill forest	1758	0	0	0	0.0	0	0.0
Sub-tropical dry evergreen	29149	655	2	0	0.0	0	0.0
Semi-evergreen	151003	88545	59	1752	1.2	5890	3.9
Subtropical montane	53090	25196	47	144	0.3	25	0.0
Subtropical lowland	35109	31388	89	80	0.2	1872	5.3
Tropical moist deciduous	41096	69519	49	1817	1.3	2084	1.5
Tropical montane evergreen	14814	7221	49	4	0.0	358	2.4
Tropical thorn scrub	3674	48	1	0	0.0	0	0.0
Tropical wet evergreen	75543	22171	29	0	0.0	1918	2.5
Totals:							
Natural	668714	340561	(50.9)	4129	0.6	24056	3.6
Non-natural		328160	(49.1)	1292	0.2	3373	0.5

*** = over 10x more current area than original

Summary

Overall Loss of Natural Habitat	49.1 %
Original forest cover	98.5 %
Current forest cover	50.1 %
(Natural forest cover)	not determined
(Secondary forest cover)	not determined
Total area protected	4.9%
(Area protected IUCN I-IV)	(0.8 %)
(Area IUCN V-VI, PRO)	(4.1 %)

Identification of Gaps in System

The existing reserve system is very limited and leaves gaps in almost all habitats and biounits. The proposals currently mapped will remedy many of these gaps such as alpine and subalpine habitats in the north of the country. However, the reserve system will still need new proposals to fill such gaps as the lack of mangroves and freshwater swamps, both lowland and montane deciduous forests.

Recommendations

1. Survey Kakabo Razi and Nam Lang Valley areas as soon as possible to determine suitable boundaries for major protected areas. The Nam Lang reserve should extend as far as the international boundary to create a transfrontier reserve with the Indian Namdapha reserve.
2. Find suitable areas where mangroves and relict patches of freshwater swamp can be protected.
3. Hasten gazettelement of the several long-standing high priority proposed reserves notably Tanlwe-Mae-chaung, Taungup Pass Thandwe chaung, Pegu (Bago) Yomas elephant range and Pakchan.
4. Develop a large transfrontier reserve adjacent to the Thailand Kaeng Krachan reserve and protect the forest corridor linking this to Thung Yai reserve.
5. International donor agencies should be more positive in assisting the government of Myanmar to undertake essential environmental programmes rather than refrain because of political stances. Environmental boycott is not valid.

Key Documents

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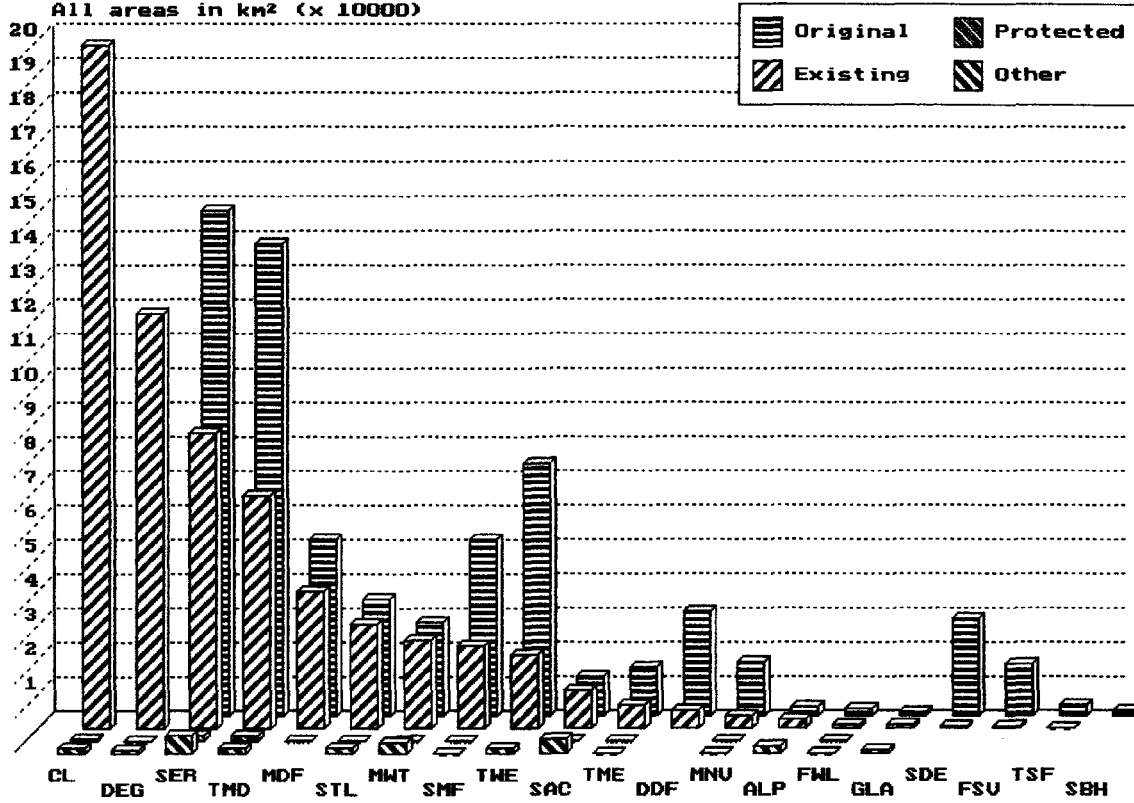
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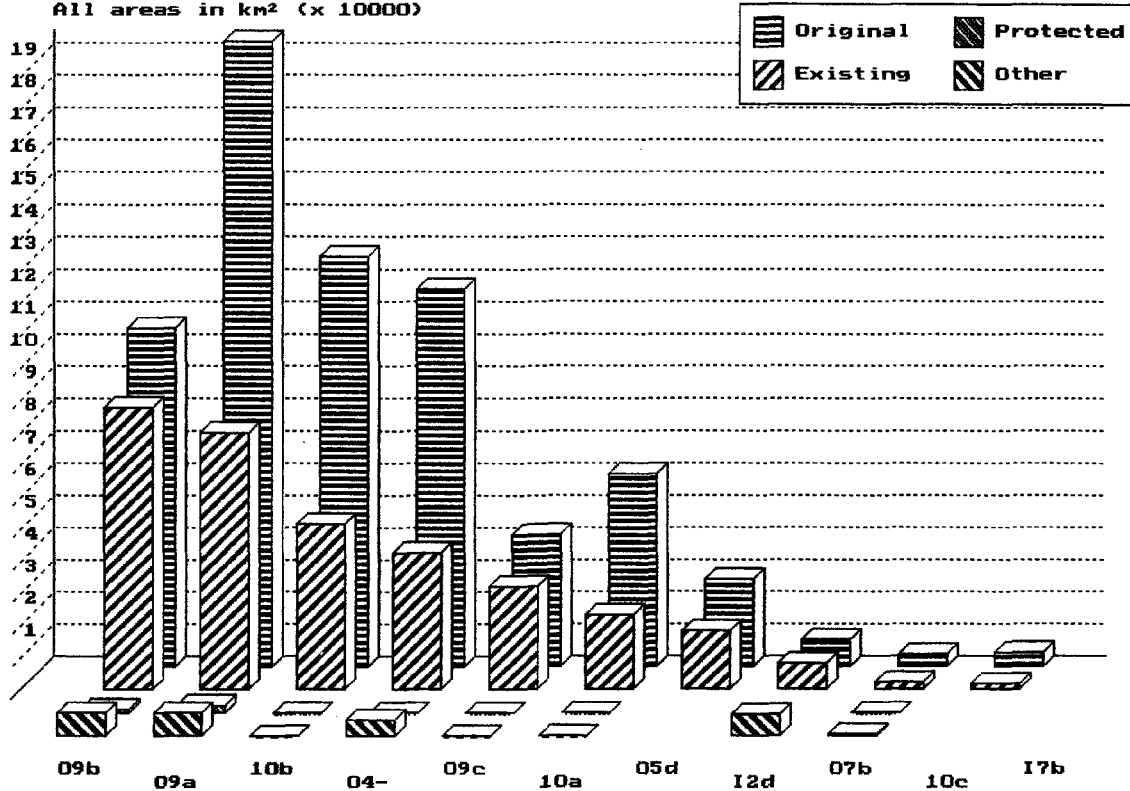
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Habitat Coverage for Myanmar (Burma)
All areas in km² (x 10000)



Biounit Coverage for Myanmar (Burma)
All areas in km² (x 10000)



3.10 NEPAL

Basic Data

- Area 147,181 sq. km
- Population 19.2 million (1994) = 135/sq. km
- Natural increase 2.1% per annum
- Economic Indicators GNP: US\$ 200 per capita
- Forest Cover 35% (1993)
- Annual Loss of Forest 1.1 % per annum
- Protected Area Coverage 10.3% (WCMC)

Decade Milestones

- Increase in Protected Areas
- Endorsement of National Conservation Strategy
- Ratification of Ramsar Convention
- Major changes in Policy and regulations to address management of forest resources, Environmental Areas and buffer zones management
- Ratification of Convention on Biological Diversity
- Publication of the Biodiversity Profile for Nepal

Physical Geography

Nepal is rich in regard to biological diversity and contains spectacular landscapes. The country extends for 800 km along the southern slopes of the Himalaya and separates the arid Tibetan Plateau to the north from the fertile Gangetic Plain to the south. Rugged hills and mountains cover more than 80% of the total area. Nepal's mountains include Sagarmatha (Mount Everest) and another seven of the world's ten highest peaks. Five physiographic zones can be distinguished in Nepal. The *High Himal* (23% total area) comprises alpine meadows, rock and ice between the tree line and Great Himalayan divide plus a tiny area of Transhimal. The *High Mountains* (20%) extend from the heavily populated hills of the Middle Mountains to the tree line. The *Middle Mountains* or Middle Hills (30%) of central Nepal. The *Siwaliks* (13%), represent the first and lowest ridges of the Himalayan system and extend from the Gangetic Plain to the Mahabharat Lekh at the southern edge of the Middle Mountains. The *Terai* (14%), a northern extension of the Indo-Gangetic Plain (Kenting, 1986; MFSC, 1988). The main river systems which originate from the Himalaya, together with other smaller rivers rising in the Mahabharat Lekh and Siwaliks, contribute up to 40% of the annual flow of the Ganges River and 71% of its dry season flow. Other wetlands include numerous small lakes, reservoirs and village tanks, and a number of lakes and reservoirs in the Gandaki, Bagmati and Karnali river basins (Scott, 1989).

Natural Vegetation

Vegetation changes from the drier west to the wetter east and it is convenient to distinguish west, central and eastern regions of Nepal. In all regions sal forests (TMD) predominate in the Terai zone up to about 1000m. In the sub-tropical zone, Chirpine forests (SPF) dominate in the west and central regions up to about 1600m with deciduous *Schima-Castanopsis* forests (HMT) continuing up to 2000m. In the east, sub-tropical broadleaf hill forests dominate the entire sub-tropical zone. In the temperate zone between 2000m and 3000m, the west and central regions are forested by dry oak forests topped by Blue-pine (BPF), whilst the eastern region contains wetter montane wet temperate forests (MWT) of oaks and rhododendrons. The subalpine zone between 3000m and 4000m has fir

and birch forests grading to birch with rhododendrons at the treeline in the west and central regions grading to subtropical mixed conifer forests (SAC) in the east with a fir upper treeline zone. In the alpine zone above the treeline is a narrow zone of juniper and rhododendron scrub which grades into alpine scrub and meadows (ALP). Above 5000m is a barren nival zone. There is a tiny area of dry Tibetan scrub in the Transhimal zone. The Middle Hills and lowlands are densely populated and the vegetation is greatly degraded by land clearance and fuel collection. Secondary forests of thin pines replace some originally broadleaf forests in this zone. Forest loss has been estimated at 4% per year; one of the fastest rates in Asia.

Biogeographic Units

There are four main ecological zones in Nepal. The Trans-Himalaya, the highlands, the subtropical/temperate midlands, and the tropical lowlands or *terai* (HMG Nepal/ IUCN, 1988). However, these altitudinal zones show considerable difference from the drier west of the country to the wetter east. For the purposes of this review, Nepal is divided into four biounits. Unit I2b consists of the western Himalayas as far east as Dorpathan. The Central Himalayan unit I2c continues eastward. Unit I7a Upper Gangetic plains covers the *terai* and subtropical Siwalik zone as far east as Narayani river.

Biological Richness

Considering its small size and high altitude Nepal is surprisingly rich in both plants and animals. Part of the richness is a result of the extreme variability in conditions between the eastern and western zones of the country and the rich tropical zone in the south. WCMC (1994) list the country as having 167 mammals, 824 birds, 80 reptiles, 36 amphibia, some 120 fish and over 6500 higher plants. Levels of endemism are fairly low. Nepal ranks above average for biological richness when weighted for endemism and country size. WCMC list 28 endangered mammals, 24 endangered birds and 133 endangered plants in the kingdom. Nepal protects a wide range of Himalayan species but emphasis is placed on protecting several large and spectacular species such as Indian rhino, elephant and tiger in the *terai* zone; red panda in the temperate forest zone and blue sheep and snow leopard in the high mountain zone and pheasants at all altitudes. The country has 2 EBA's (ICBP, 1992). The biodiversity index is calculated at 7.9 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.3 (see table 1.7).

Threats to Biodiversity

Nepal's natural resources are being exploited above their sustainable capacity to meet the increasing needs of a rising human population that is predominantly agrarian and subsistence in nature. The pressure on land and forest resources to meet daily food, fuelwood and fodder requirements inevitably leads to conflicts at the boundaries of protected areas (Upreti, 1985). Major development projects also threaten the integrity of protected areas, as in the case of irrigation and hydropower projects. The need to integrate conservation and development needs is gradually being addressed through, for example, the national planning process and implementation of the national conservation strategy.

Review of Protected Area System

Nepal has a fairly extensive protected areas network of 15 sites covering 14.5% of the total land area. General recommendations to develop the protected areas network are made by MacKinnon and MacKinnon (1986) and in the *Corbett Action Plan* (IUCN, 1985). A more recent assessment shows that of Nepal's five physiographic zones, the Middle Mountains are poorly represented with only 1.4% protected areas coverage. In contrast, at least 4% of all other zones and 17.1% of the High Himalayan zone are represented. The limited coverage of the Middle Mountains is improved somewhat by the royal forests of Nagarjun

(1,600ha) and Gokarna (250ha), and there are two protected watersheds due to be established in this zone (MFSC, 1988). A more refined review of protected areas coverage of Nepal's forests with respect to breeding birds (Inskipp, 1989) shows that all upper temperate, subalpine and alpine and most tropical forest types are well represented. Tropical evergreen forests, subtropical and lower temperate broad-leaved forests in the far east, and subtropical broad-leaved forests further west are un-represented or poorly represented. A high priority for bird conservation is protection of the species-rich forests of Phulchowki Mountain in Kathmandu Valley, severely threatened by quarrying and removal of fuelwood (Inskipp and Inskipp, 1989), and the Mai Valley in the far east.

The following sites are rated as protected areas of global significance:

Name	Ecosystem	IUCN Cat	Year	Size (km ²)
Langtang	High Himal to upper forests	2	1976	1710
Makalu-Barun	High Himal to middle forests	2	1991	1500
Royal Chitwan	Tropical terai	2	1973	932
Sagarmatha	Globe's highest peak	2	1976	1148
Shey-Phoksundo	High Himal and alpine	2	1984	3555
Annapurna	High Himal to upper forest	6	1992	2660

Category codes:

- 1 - 6 Corresponding IUCN Category
- P Proposed

Map 12 show the distribution of remaining wildlife habitat in Nepal together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The figures and table below show how much habitat is remaining in each biounit and how much of this is protected.

Habitat Details for Nepal

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Alpine	13426	13426	100	2725	20.3	1793	13.4
Birch forest	8045	1932	24	172	2.1	46	0.6
Blue pine	2995	1567	52	76	2.5	0	0.0
Cleared	0	43849	***	1827	***	2658	***
Dry Deciduous	2481	481	19	170	6.9	0	0.0
Degraded Forest	0	36418	***	1576	***	1063	**
Glaciers	15434	15434	100	3269	21.2	3270	21.2
Moist temperate	4892	2707	55	199	4.1	49	1.0
Montane Wet temperate	4040	1596	40	258	6.4	0	0.0
Subalpine conifer	12935	5533	43	377	2.9	31	0.2
Sub-tropical hill forest	13296	3077	23	204	1.5	111	0.8
Semi-evergreen	1266	113	9	13	1.0	0	0.0
Sub-tropical pine	21963	9711	44	56	0.3	66	0.3
Tropical moist deciduous	46554	11509	25	1273	2.7	8	0.0

Totals:							
Natural	147327	67086	46.5	8792	6.0	5374	3.6
Non-natural		80267	54.5	3403	0.3	3721	2.5

*** = over 10x more current area than original

Summary

Total loss of original natural habitat	54.5 %
Original forest cover	80.4 %
Current forest cover	50.7 %
(Natural forest cover)	(25.9 %)
(Secondary forest cover)	(24.7 %)
Total area protected	14.5
Area protected IUCN I-IV	(8.3 %)
Area IUCN V-VI, PRO	(6.2 %)

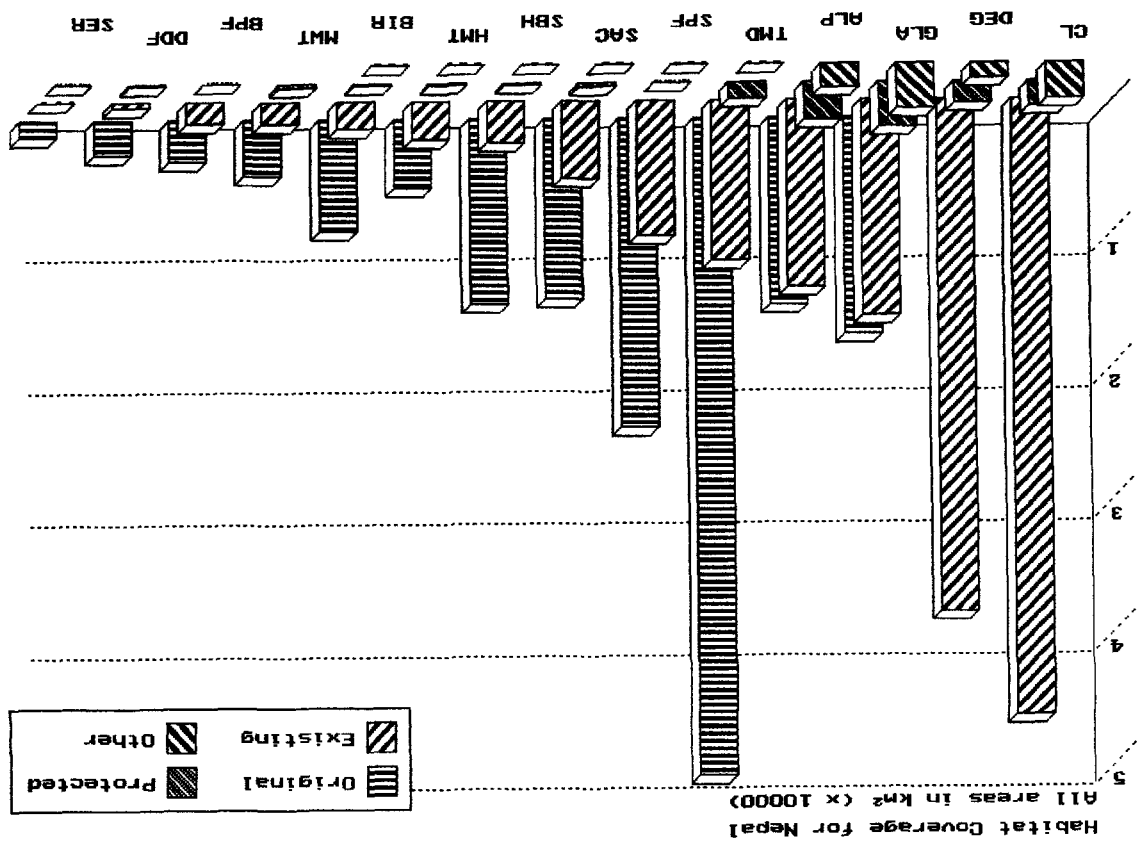
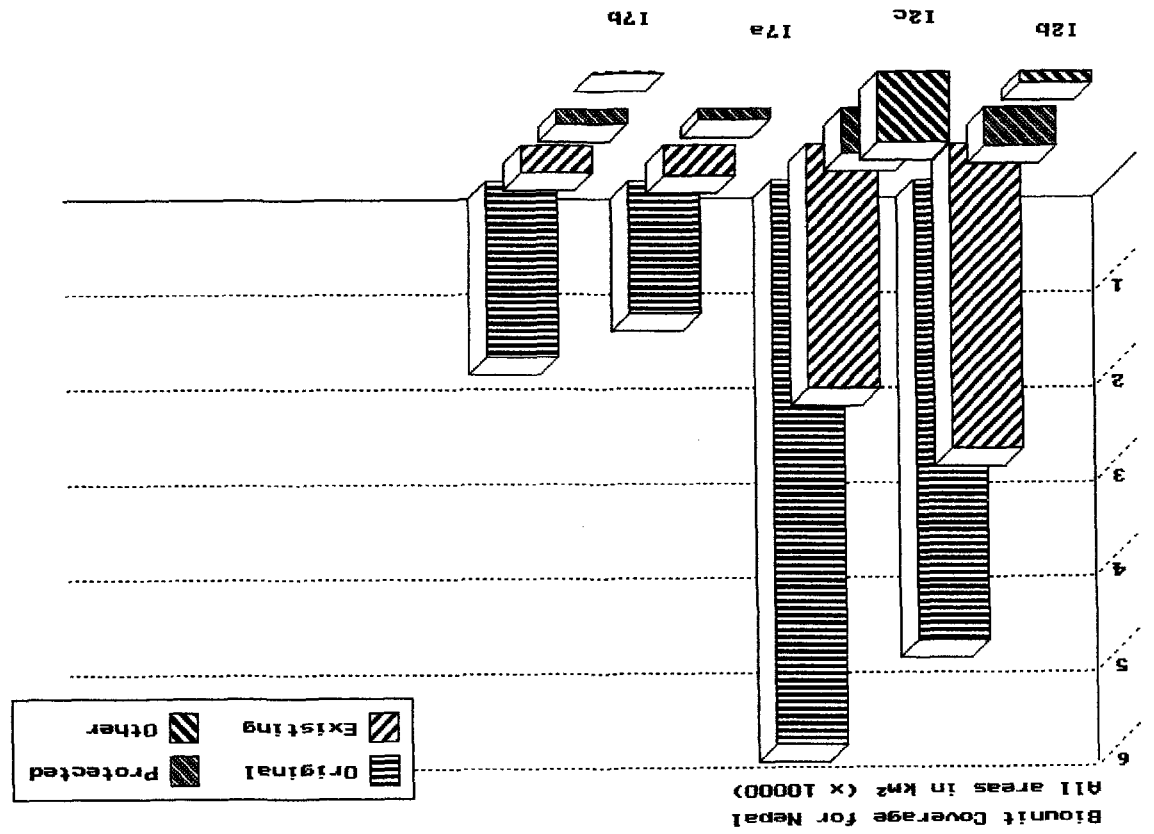
As mapped, current habitat protection is 6.0%, much more than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 2.4% protected. Current conservation index score (CI) is calculated as 0.9 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

All habitat types are represented in the current reserve system but some types are only marginally represented. Two major reserves Annapurna and Dhorpatan are classed as IUCN category VI and therefore not contributing to the first column of protection. However even when these areas are considered the whole reserve system is biased towards the high mountains in the north and the tropical terai zone in the south. There is inadequate coverage of the temperate and subtropical forests of mid latitudes where little forest remains but some increase in protected areas coverage is still possible.

Recommendations

1. Look for forests suitable for protection in the temperate and sub-tropical zones of both east and west Nepal. Other gaps include wetlands and Churia hills.
2. Reduce dependence on army in protecting national parks and develop a competent guard force with law enforcement powers. This will involve training of lower-level field staff capable of conducting surveys.
3. Improve data management by establishing a central database feeding off minimal datasets established and maintained in the different reserves.
4. Develop and implement management plans for all those reserves still lacking them.
5. Tighten up all aspects of wildlife protection including illicit wildlife trade controls.
6. Strengthen co-operation with neighbouring countries especially in the establishment of transfrontier reserves and corridors, data management and training.



Key Documents

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HMGN/IUCN (1988). *Building on success. The National Conservation Strategy for Nepal*. HMG National Planning Commission/NCS for Nepal Secretariat, Kathmandu. 179 pp.

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3.11 PAKISTAN

Basic Data

- Area 796,000 sq. km
- Population 126 million (1993) = 158/sq. km
- Natural increase 3.0% per annum
- Economic Indicators GNP: US\$ 430 per capita
- Forest Cover 4 % (1993)
- Annual Loss of Forest 0.4 % per annum
- Protected Area Coverage 4.7% (WCMC)

Decade Milestones

- Increase in Protected Areas
- Approval of National Conservation Strategy
- Ratification of Ramsar Convention

Physical Geography

The Islamic Republic of Pakistan is a predominantly arid and semi-arid land of great contrasts. Nearly 60% of the country consists of mountainous terrain and elevated plateaux; the rest is lowland, generally below 300m. The highlands comprise: the Himalaya and adjacent mountain ranges to the north, rising to 8,611m at the top of K2, the world's second highest peak; the central Sulaiman Range and its southern extensions (Ras Koh, Siahan and Kirthar ranges); and the western Baluchistan Plateau. The lowlands comprise the Indus River plain and a narrow stretch of coastline bordering the Arabian Sea. Borders in the northeast remain in dispute with India. Current control is delimited by the last cease-fire line giving Pakistan a territorial control of 83,808 sq km claimed by India.

Natural Vegetation

Vegetation types include glaciers and alpine dry steppe (ADS) in the extreme north of the country with Himalayan dry conifer forest (HDC), Himalayan dry temperate forest (HDT) and Himalayan moist temperate forests (HMT) above a zone of subtropical pine forest (SPF) on the southern facies of the Himalayas. Sand desert vegetation predominates over the Cholistan region to the east of the Indus river and in the Thal regions of west Punjab, also over parts of western Baluchistan. Thorn scrub vegetation (TSF) was widespread over most of the arid, low lying parts of the country, being replaced on cooler, higher parts of the west by arid sub-tropical forest (ASF). Seasonal salt marshes (SSM) are found in the Rann of Kutch in southern Sind provinces whilst mangroves occur in the southern estuaries. Moist areas of the Indus valley had a fresh water seasonal swamp forest and grasslands.

Much of the original vegetation has been transformed by cutting and over-grazing. Most thorn scrub forest and arid sub-tropical forest has been lost. Original forests in the Indus valley have largely been replaced by plantation forests. Official figures indicate that 18% of the country is under forest cover. The Review's analysis suggest only 3.4% of the country is under forest cover but it has not been possible to map all the Himalayan dry conifer forest patches in the alpine dry steppe zone.

Pakistan possesses a great variety of wetlands distributed throughout much of the country. Inland waters cover 7.8 million ha, over half of which comprise waterlogged areas, seasonally flooded plains and saline marshes. Coastal mangrove swamps cover at least

260,000ha. Pakistan's wetlands are important for waterfowl, particularly those of the Indus Valley - a major wintering ground for a wide variety of central and northern Asian species, as well as being of socio-economic value (Scott, 1989).

Biogeographic Units

Deserts east of the Indus valley fall into sub-unit I3a, Thar Desert. The Indus valley itself falls mostly into biounit I3c. Small areas of south Sind lie in sub-unit I3b Rann of Kutch and most of Baluchistan falls within sub-unit I3d. The hills between the Indus and Ganges valleys constitute sub-unit I4a. The Himalayan sections of Pakistan are within the north Himalayan sub-unit I2a but the extreme north is in the Transhimalayan sub-unit I1a.

Biological Richness

Much of Pakistan is arid and poor in species diversity. On the whole the country scores low on species richness and numbers of endemics. However, the moist habitats of the Indus valley are rich and add a large number of species to national lists. In addition, the small areas of Himalayan moist temperate forests are very rich in wildlife. The country has two EBAs (ICBP, 1992). Adjusted for geographical area, the country has a biodiversity index of only 4.0 resulting in a calculated protected area target of only 7.6.

Most of Pakistan's remaining wildlife is to be found in the mountainous country west of the Indus, where human pressures have not been as great as in the plains. The two regions of outstanding importance are the Himalayan and Karakoram massifs in the extreme north and the desert in the south-west of the country (Grimwood, 1969). To the east of the Indus, Hazara Division in North-West Frontier Province and several areas in Punjab have a considerable amount of wildlife (M.M. Malik, pers. comm., 1987), as does the Neelum Valley in Azad State of Jammu & Kashmir (G. Duke, pers. comm., 1990). Wildlife resources and their exploitation have been reviewed for Baluchistan (Groombridge, 1988; Mian and O'Gara, 1987; Roberts, 1973) and Sind (Roberts, 1972). In a recent review of critical ecosystems in Pakistan, Roberts (1986) identifies the Indus riverine zone, and the Chaghai Desert and juniper forests of Baluchistan as being of unique ecological interest and international conservation importance. Cheetah and Siberian crane are extinct. Important wildlife include visiting waterbirds, raptors, pheasants, wild sheep and desert fauna.

Threats to Biodiversity

Major threats are created by Pakistan's huge population. Due to its arid climate and long history of cutting trees over much of the country, Pakistan does not have a rich forest resource base. Extensive reforestation schemes and extension programmes have tripled forest coverage since independence to 4.6 million ha (5.2% of total land area) by 1984. Most of this forest is protection forests for watershed protection and is not commercially exploited.

Review of Protected Area System

Prior to 1966, Pakistan had taken no significant steps towards establishing a protected areas network. From that year national parks and other reserves have been steadily established. The network currently comprises 10 national parks, over 80 wildlife sanctuaries and over 80 game reserves, covering 7.2 million ha (9% total land area). The only major changes since the IUCN Indo-Malayan Review of 1986 have been the establishment of Chinji, Dhrun and Hingal National Parks and the establishment of the large Central Karakoram conservation area.

The following protected areas are rated as being of global significance:

Name	Ecosystem	IUCN Cat	Year	Size (km ²)
Khunjerab	Transhimal alpine	2	1975	2269
Kirthar	Tropical Scrub desert	2	1974	3087
Rann of Kutch	Salt pan desert	4	1980	3205
Central Karakoram	Transhimal alpine	U	1993	2000
Cholistan	Sandy desert	U	1975	20327

Category codes:

- 1 - 6 Corresponding IUCN Category
- U Unassigned

Other reserves of very high national importance are the mangrove forests south of Karachi and the Margalla Hills north of Islamabad. Much of the flooded wetlands of the Indus valley is a globally significant wetland site for wintering birds but is not officially protected.

Map 13 show the distribution of remaining wildlife habitat in Pakistan together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The figures and table below show the degree of protection of different habitat types and biounits of the country. Figures for remaining vegetation cover should be taken with caution. These are based on poor quality hard copy land-use maps and not from remote sensing. Moreover the boundaries of the protected area system are also inadequate and in many cases represented by circles.

Habitat Details for Pakistan

Habitat	Original (km ²)	Current		Protected(I-IV)		Other (V,VI,PRO)	
		(km ²)	%	(km ²)	%	(km ²)	%
Alpine dry steppe	83683	83683	100	3915	4.7	0	0.0
Arid subtropical	260382	9571	4	645	0.2	0	0.0
Bare land	1919	1919	100	86	4.5	0	0.0
Cleared	0	597750	***	22780	***	548	***
Freshwater swamp	18227	1601	9	231	1.3	0	0.0
Rivers/lakes	4877	4877	100	580	11.9	0	0.0
Glaciers	25573	25573	100	1888	7.4	0	0.0
Himalayan dry conifer	36534	4071	11	65	0.2	318	0.9
Himalayan dry temperate	428	0	0	0	0.0	0	0.0
Himalayan moist temperate	4519	1599	35	19	0.4	0	0.0
Mangroves	3800	727	19	290	7.6	0	0.0
Sandy desert	124940	124940(100)		50572	40.5	0	0.0
Sub-alpine pine	13607	3987	29	0	0.0	3	0.0
Seasonal salt-marsh	8736	8736	100	1345	15.4	0	0.0
Thorn scrub forest	289825	8065	3	331	0.1	0	0.0
Totals:							
Natural	877050	279349(31.9)		59967	6.8	321	0.0
Non-natural		597750(68.2)		22780	2.6	548	0.1

*** = over 10x more current area than original

Summary

Total loss of original natural habitat	68.1 %
Original forest cover	71.5 %
Current forest cover	3.4%
(Natural forest cover)	not determined
(Secondary forest cover)	not determined
Total area protected	9.5%
(Area protected IUCN I-IV)	(9.4 %)
(Area protected IUCN V-VI, PRO)	(0.1 %)

As mapped, current habitat protection is 6.8%, less than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 9.4% protected but excluded the rather under protected Baluchistan Mountains from the review. Current conservation index score (CI) is calculated as 0.8 (see table 1.8 and section 1.4.2 for scoring details). Protected area coverage is higher than the figures presented by WCMC as we have included many reserves still listed as category UA = unassigned by WCMC.

Identification of Gaps in System

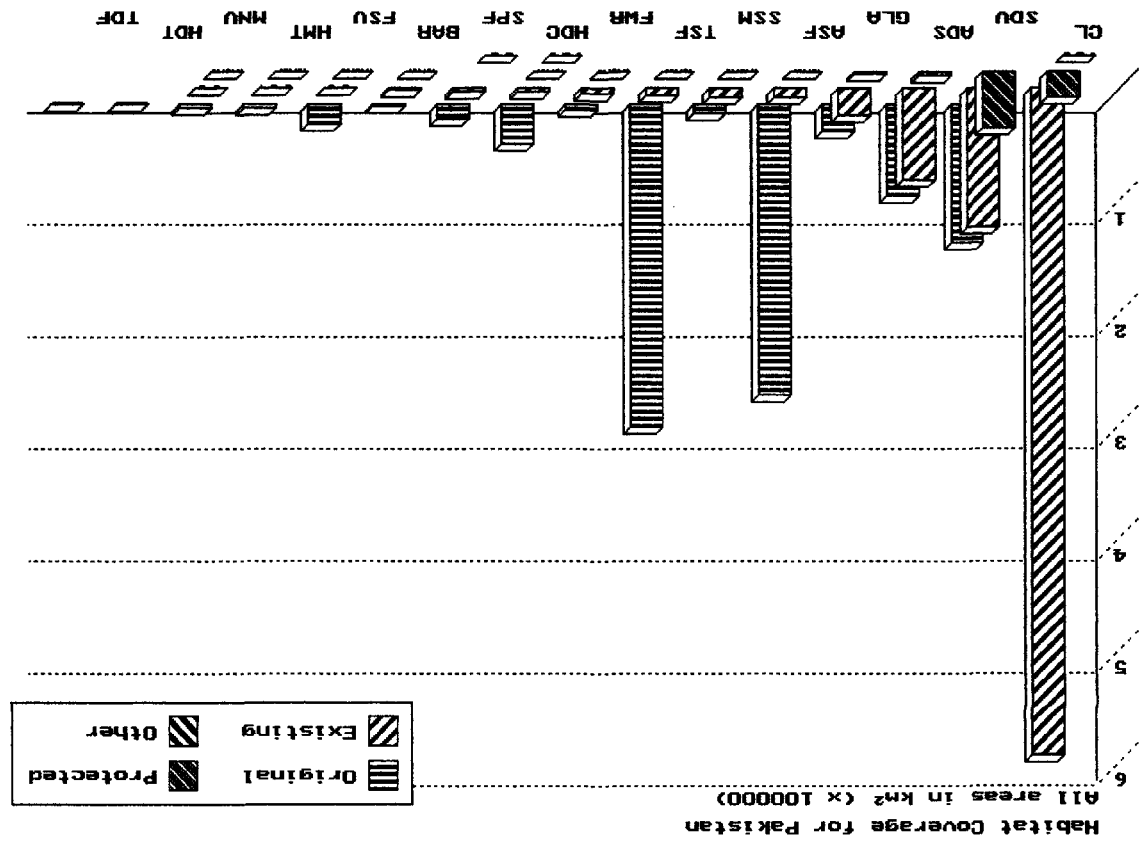
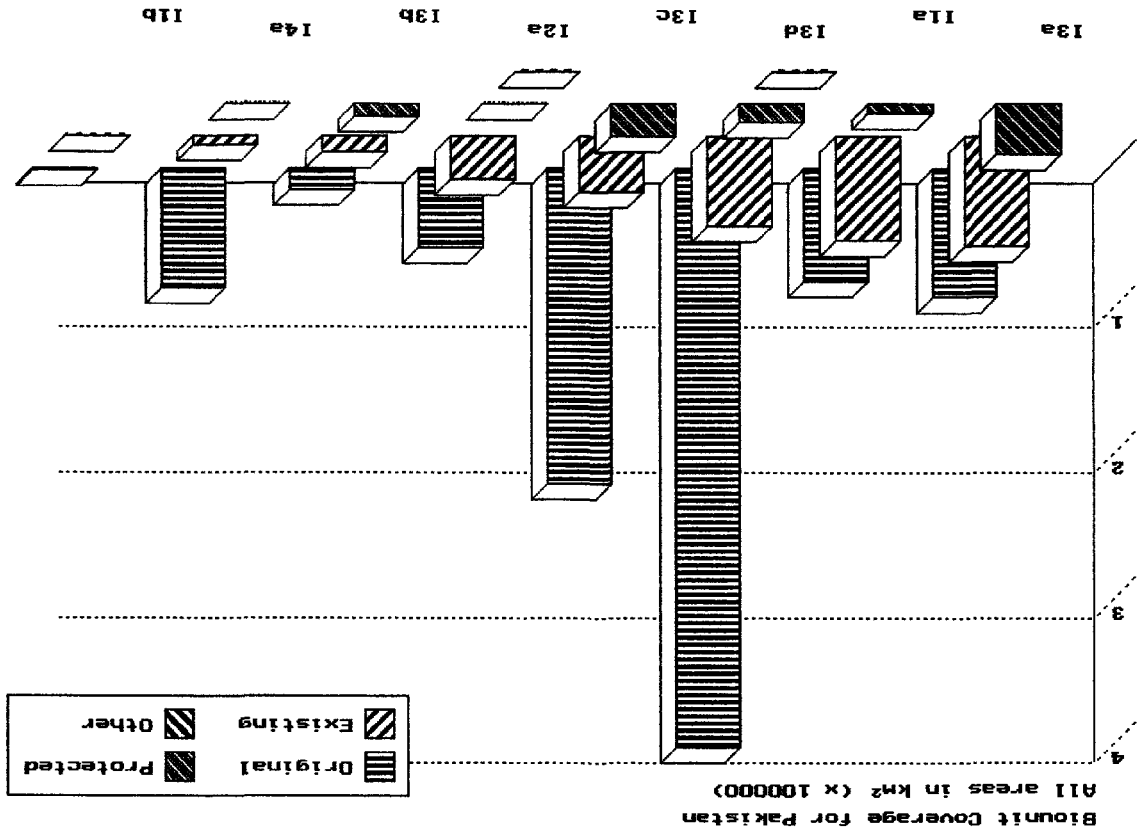
Total area of remaining habitat protected is 9.4% of the country. In terms of habitat coverage, this system includes examples of all vegetation types except as mapped sub-tropical pine forest. In fact, there are small areas of this vegetation type in reserves but more should be added for the sake of completeness of the system. All main biounits are included in the system but coverage in unit I3d (Baluchistan) is inadequate. The largest gap in the system is the rather inadequate coverage of the Himalayan unit I2a which is where the richest variety of bird and plant in the country occur.

Other Issues

Pakistan is a major route for the illegal trade in falcons both to Pakistan itself or to pass on to Arab countries. This trade is causing considerable international concern and efforts must be made to control it.

Recommendations

1. Add new reserves in suitable remaining habitat in the Baluchistan mountains (including the small lakes in the Kakar range) and in the Himalayan section north of Islamabad.
2. Develop Kunjerab and Central Karakoram in co-operation with Chinese authorities as a transfrontier reserve linked to Taxkorgam reserve in Xinjiang.
3. Strengthen management and protection of the many important but currently neglected game reserves and sanctuaries.
4. Improve management of data on biodiversity status at the national level so that strategic planning can be effected more efficiently. It was notable during this review that data for vegetation and protected areas in Pakistan was less readily available than for any other country in the realm.



Key Documents

Anwar, M. (1995) *State of biodiversity in Pakistan: a state-of-the art review paper*. Draft. (Paper prepared for the International Centre for Integrated Mountain Development 19-20 December 1995, Kathmandu, Nepal. International Centre for Integrated Mountain Development, Kathmandu. 34pp.

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3.12 PAPUA NEW GUINEA

Basic Data

- Area 462,842 sq. km
- Population 3.9 million (1989) = 47/sq. km
- Natural increase 2.7% per annum
- Economic Indicators GNP: <US\$ 790 per capita (1988)
- Forest Cover 71% (1993)
- Annual Loss of Forest 1.0% per annum
- Protected Area Coverage 0.2% (WCMC)

Decade Milestones

- Increase in Protected Areas
- Publication of Papua New Guinea Conservation Needs Assessment
- Publication of Review of the Management and Status of Protected Areas & Action Plan
- Ratification of Convention on Biological Diversity

Physical Geography

Papua New Guinea lies between the Equator and latitude 12°S and between longitudes 141°E and 164°E. It comprises the eastern half of New Guinea and includes the Bismarck Archipelago (principally New Britain, New Ireland, New Hanover and Manus), d'Entrecasteaux Islands, the Louisiade Archipelago and the North Solomon islands of Bougainville and Buka. The western half of New Guinea forms the Indonesian province of Irian Jaya.

The country has a total area of over 46 million ha. A central cordillera creates the spine of the country with several peaks rising above 5000m with major rivers draining to form the northern and southern lowlands. Climate is generally moist and extensive areas are covered in evergreen forests but the extreme south of the country is adjacent to the land mass of Australia which acts as a rain shadow and results in a markedly drier climate which impacts on the natural vegetation.

Natural Vegetation

Forest of some sort, including successional forest, covers 71% (328,617 sq. km) of mainland Papua New Guinea. A fringe of mangrove occurs along much of the coastline. Inland, swamps (FSV and PSV) are extensive and covered by high forest with screw "pine" *Pandanus* and sago palm *Metroxylon sagu* forming a lower canopy. On drier land, mixed lowland rain forest (TWE) is widespread and comprises complex communities, with epiphytes, orchids, tree and ground ferns. In contrast to rain forests elsewhere in Malesia, dipterocarp species are poorly represented. Throughout the lowlands, rain forests have been extensively destroyed or modified by shifting agriculture. Specialised formations grow on limestone (LIM) and ultrabasic rocks (FUB). Areas having a markedly seasonal climate support monsoon forest which is characterised by the presence of a number of species that remain leafless for prolonged periods. Savannah vegetation, a degraded form of monsoon forest (TMD), occurs in areas receiving an annual rainfall of less than 1000-1300mm. Dominated by *Eucalyptus* spp., it is quite distinct from lowland alluvial plains vegetation elsewhere in Papua New Guinea and resembles that of northern Australia.

Above 900m coniferous trees appear in the montane rain forest (TME). Various altitudinally overlapping forest types can be distinguished within the montane zone, which usually extends from 900m to 2,700-3,000m. The upper montane forest (UMF), which may extend to 3,300m, is a cloud forest, with 10-25m tall moss-covered trees and a dense understorey. In the subalpine zone, the "high mountain forest" has a closed canopy at about 10m, with moss carpeting the forest floor. Ericaceous shrubs including many species of *Rhododendron* supplant the forest near its upper limit at 3,800-4,100m, and are in turn replaced by alpine grasslands, tarns and bogs (ALP) (Smith, 1982). These are supplanted by tundra, which extends from about 4,400m to 4,700m. With the possible exception of the montane grasslands around Henganofi, all grasslands below 3,000m probably originate from a combination of agriculture and firing. The vegetation of the various island groups is mainly lowland rain forest, and at higher elevation, montane rain forest. The enclaves of grasslands and savannahs are likely to be anthropogenous.

The various types of wetlands are described by Paijmans (1976) and Scott (1989), the latter providing detailed accounts of 33 wetland sites. Among the most extensive are mangrove swamps which occupy large parts of the coastal areas of Papua New Guinea, predominantly along protected bays and near the mouths of rivers. The largest expanses are in the south, notably in the Gulf of Papua with 162,000-200,000ha of mangroves. The north coast is not as rich in mangroves as the south coast.

The coral reefs of Papua New Guinea are virtually pristine compared to those of many countries, although they are coming under increasing threat from higher siltation and effluent loads in coastal areas and from commercial exploitation (UNEP/IUCN, 1988). The total area of reefs and associated shallow water to depths of 30m or less is estimated to be 40,000 sq. km (Wright and Kurtama, 1987; Wright and Richards, 1985), with the greatest concentration (12,870 sq. km) lying off Milne Bay Province (Dalzell and Wright, 1986).

Biogeographic Units

The country is divided into a number of distinct biounits largely on the basis of bird distributions (Beehler, 1985). Being biologically poorly explored, these biounits may need further revision when other taxonomic groups become better studied. Small parts of southwest New Guinea P3f and northwest unit P3e fall marginally in the country. Extensive areas of the dry transFly unit P3l occur in the south with all of the Kibori-Ruvani unit P3m and almost all of the Sepik/Ramu unit P3j on the north coast together with the Huon peninsula P3k. The central cordillera is divided into three units Star Mountains P3h in the west, central highlands P3i and extending into southeast unit P3n. The offshore archipelagos are classed as P3o east Papuan Islands, P3p New Britain and P3q the Bismark Archipelago.

Biological Richness

The island of New Guinea is a recognised biodiversity hotspot and offers very great botanical richness and richness in certain animal groups notably birds, marsupial mammals, bats and birdwing butterflies. In total the country has 214 mammals including 57 endemics, 708 birds including 85 endemics, 280 reptiles, 197 amphibia and over higher 10,000 plants. High levels in endemism in all groups result in Papua New Guinea scoring as 4th richest of the 18 countries in the current review.

The island is famous for its Birds of Paradise but cassowaries, bowerbirds, parrots and others are equally important. Mammalian fauna is largely derived from the Australasian stock and consists of many species of marsupial including tree kangaroos, cuscus and possums.

The country has 12 EBA's (ICBP, 1992). The biodiversity index is calculated at 13.3 well above average for the realm (see section 1.4.3.1 above), resulting in an ultimate protection target of 10.9%.

Threats to Biodiversity

Agricultural conversion is a threat to habitat in some areas but the major threat is logging and, in the south, forest fire. It is easy for foreign timber corporations to buy permission to log near economically disadvantaged communities. Often community leaders who grant permission, do not fully understand the long-term effects of their agreements on biological diversity. Hunting is intense across the island but as population density is still low and hunting methods still rather traditional this does not pose a major threat. Specialised trapping of rare parrots does threaten some species.

The most significant natural resource problems facing Papua New Guinea are forest depletion, soil loss and soil fertility in the mid-montane valley systems, degradation from large-scale mining and agricultural activities, and exploitation of reef fisheries which are among the richest in the world (ADB, 1987; UNEP, 1987; Viner, 1984). Forests are being destroyed at an estimated rate of 80,000ha per year, commercial logging accounting for some 60,000ha yearly, and shifting cultivation 10,000-20,000ha yearly (ADB, 1987; WEI, 1988).

Review of Protected Area System

Because almost all the forest land of the country is owned by tribal communities, only a few protected areas have been established and these tend to be very small. Many are not controlled by government but run by local land-owner communities as wildlife management areas.

An expanded protected areas network proposed by Diamond (1976) was based largely on bird distributions because these have been studied in most detail. Less ambitious and focused principally on conserving birds of paradise and their rain forest habitat throughout New Guinea is a 4,882 sq. km system of eight reserves proposed by Beehler (1985). Similarly, Parsons (1983) has proposed the establishment of a network of 20 reserves to meet the conservation requirements of birdswing butterflies. Many of these proposed sites coincide or overlap with those recommended under the schemes already discussed.

A review of conservation needs undertaken by the Biodiversity Support Programme has resulted in the publication of a map of areas of high and lesser conservation importance. The map colours so much of the country as a conservation priority that it is not very useful in prioritisation but does underline the importance of the whole country for biodiversity conservation. In the course of the present review these priority areas have been narrowed down to realistic areas with good remaining habitat. This proposed system of protected areas should supersede the overwhelming list of over 120 proposed reserves currently being considered by the government.

The following protection sites are rated as being of global significance:

Name	Ecosystem	IUCN Cat	Year	Size (km ²)
Maza (I)	Marine	6	1978	1842
Finisterre	Huon peninsula forests	P		2615
Kikori River	Southern mangroves/wetlands	P		4345
Mt. Bosavi	Southern evergreen system	P		3564
Mt. Capella	Snow Mountains	P		2116
Mt. Menawa	Northern evergreen systems	P		2154
Mt. Michael	Central Mountains	P		1166
Mts. Albert Edward /Victoria	Southeast Mts.	P		1984
Sepik River	Northern riverine swamps	P		3874
Yakopi Nalenk Mts	Northern Mts. and lowlands	P		6264

Category codes:

1 - 6 Corresponding IUCN Category
P Proposed

Map 14 show the distribution of remaining wildlife habitat in Papua New Guinea together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The figures and table below show the degree of habitat loss and protection afforded to all habitats and biounits in the country. Current coverage is very limited but there is plenty of good habitat from which a first class system could be developed. The figures show that the proposed system of reserves put forward in this review would adequately cover all major habitats and biounits.

Habitat Details for Papua New Guinea

Habitat	Original (km ²)	Current		Protected(I-IV)		Other (V,VI,PRO)	
		(km ²)	%	(km ²)	%	(km ²)	%
Alpine	489	333	68	0	0.0	106	21.7
Cleared	0	80859	***	768	***	4076	***
Freshwater swamp	78962	59621	76	4	0.0	6963	8.8
Lakes	1526	1526	100	87	5.7	397	26.0
Rivers	3191	3194	100	0	0.0	1394	43.7
Grasslands	0	13233	***	3401	***	0	0.0
Limestone forest	16666	16422	99	0	0.0	1599	9.6
Mangroves	5031	4627	92	86	1.7	997	19.8
Savannah	20299	7946	25	1211	6.0	32	0.2
Tropical semi-evergreen	5840	2956	51	0	0.0	0	0.0
Tropical moist deciduous	6030	5620	93	0	0.0	0	0.0
Tropical Montane evergreen	78829	64055	81	0	0.0	9934	12.6
Tropical wet evergreen	244175	201701(83)	82	623	0.3	18076	7.4
Upper montane forest	5885	4830	82	0	0.0	1558	26.5
Totals:							
Natural	466923	349994 (79.2)		2011	0.4	41056	8.8
Non-natural		94092 (20.2)		4169	0.9	4076	0.9

*** = 10x or more current area than original

Summary

Total loss of original natural habitat	20.8 %
Original forest cover	94.5 %
Current forest cover	77.5%
(Natural forest cover)	not determined
(Secondary forest cover)	not determined
Total area protected	11.0%
(Area protected IUCN I-IV)	(1.3 %)
(Area protected IUCN V-VI, PRO)	(9.7 %)

As mapped, current habitat protection is only 0.4%, the country was not included in the IUCN Review (MacKinnon & MacKinnon, 1986). Current conservation index score (CI) is calculated as an inadequate 0.1 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

The present protected areas system is very inadequate, particularly for a country of such biological importance as Papua New Guinea. Major gaps occur in almost all regions and vegetation types. These would be almost totally satisfied in the proposed reserves mapped in this review were processed.

Other Issues

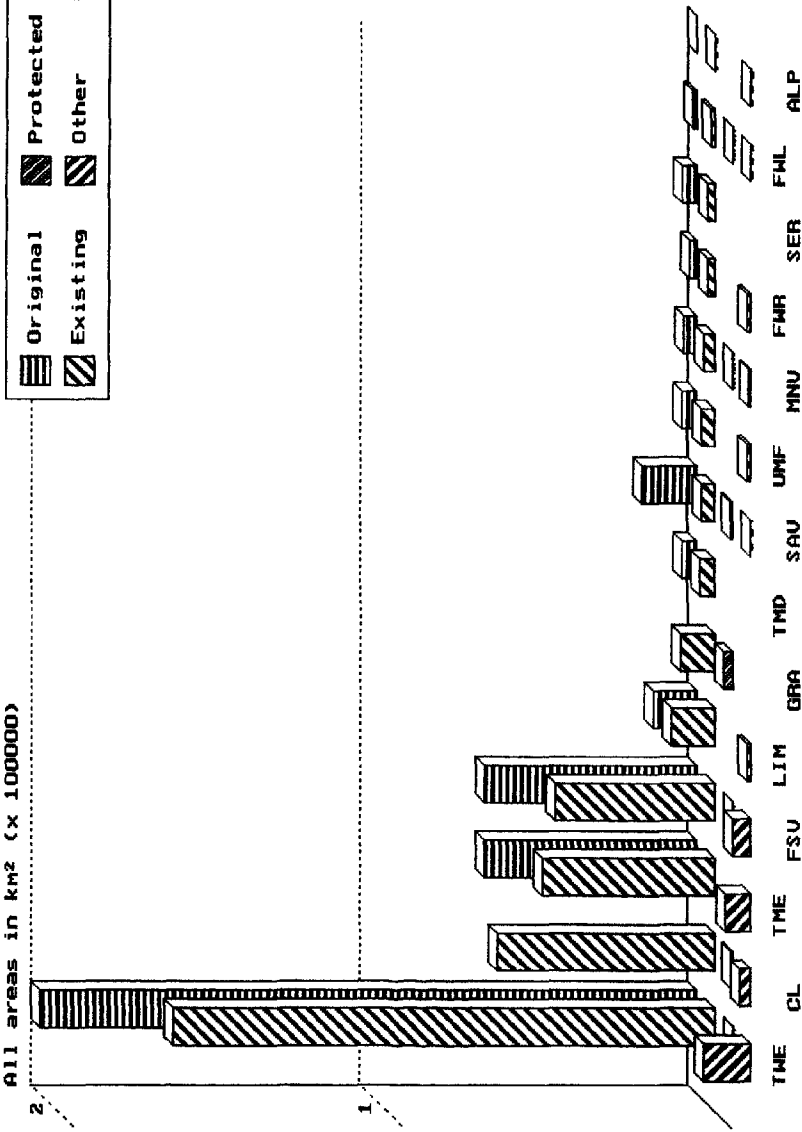
Wildlife trade is very great from Papua New Guinea. No studies have been conducted to evaluate how sustainable such trade in cockatoos, other parrots, birds of paradise and crocodiles and other reptile skins and marine products are. Certainly some species considered endangered are entering this trade. The Government should undertake studies of species status and determine safe quotas and better control mechanisms.

Recommendations

1. A major expansion of the protected area system is urgently needed. Also attention should also be directed towards developing the network on other large islands such as New Britain, New Ireland, Manus, Goodenough, Fergusson and Bougainville. Smaller islands with significant levels of endemism, such as Ninigo Islands and Luf (Hermit) Islands, may require priority action, however, because they may be under greater relative human threat (Dahl, 1986). Similarly, marine sites need to be identified and incorporated within the protected areas network (Dahl, 1986; Genolagani, 1984).
2. Improvements in the existing protected areas network should receive a high priority. Twenty protected areas are identified as suitable for rehabilitation under any TFAP operations (Srivastava and Bützler, 1989).
3. The priority proposal areas should be surveyed for their feasibility as soon as possible and where feasible should be declared as reserves with co-operation of local land-owning communities. There is an urgent need to find ways around land tenure issues e.g. improve the effectiveness of the Wildlife Management Areas model.

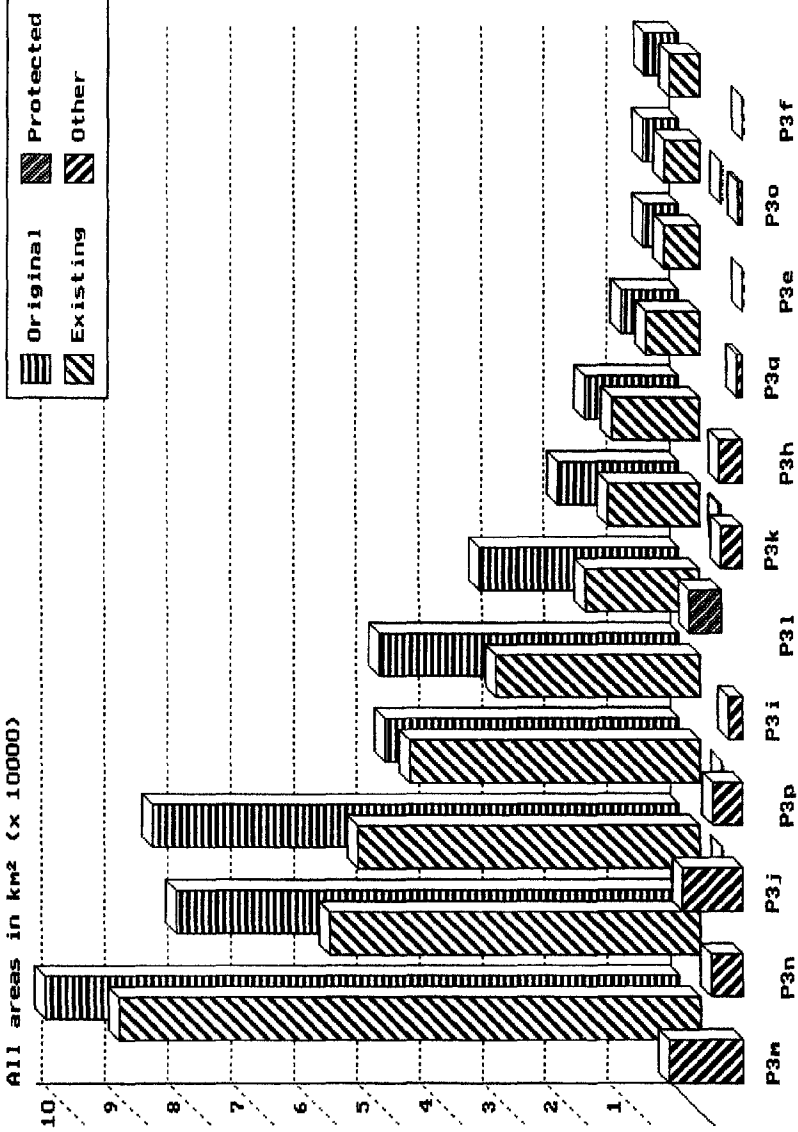
Habitat Coverage for Papua New Guinea

All areas in km² (x 100000)



Biocunit Coverage for Papua New Guinea

All areas in km² (x 10000)



Key Documents

ADB (1987) *Papua New Guinea. Environmental natural resources briefing profile*. Asian Development Bank, Manila. 6 pp.

Beehler, B.M. ed. (1993) *A biodiversity analysis for Papua New Guinea, 2*.

Conservation International, Government of Papua New Guinea & Biodiversity Support Program (1993) *Conservation Needs Assessment*. (map and accompanying text).

Pearl, M.; Beehler, B.; Allison, A. & Taylor, M. (1991) *Conservation and Environment in Papua New Guinea: establishing research priorities*. Proceedings of a symposium held June 3 1991. Government of Papua New Guinea and Wildlife Conservation International, Washington DC USA. viii + 141pp.

TFAP. (1989) *Tropical Forestry Action Plan. Papua New Guinea: forestry sector review*. Draft. Unpublished. 165 pp.

3.13 PHILIPPINES

Basic Data

- Area 299,765 sq. km
- Population 67 million = 223/sq. km
- Natural increase 2.3% per annum
- Economic Indicators GNP: US\$ 950 per capita (1994)
- Forest Cover 26%
- Annual Loss of Forest 1.0 % per annum
- Protected Area Coverage 2% (WCMC)

Decade Milestones

- Increase in Protected Areas
- Publication of Philippines Strategy for Biological Diversity
- Revision of the Philippine Constitution
- Publication of NIPAS plan and passing of NIPAS Act
- Major international programmes currently helping develop new protected areas
- Ratification of Convention on Biological Diversity

Physical Geography

The Philippines is a tropical country that extends from latitudes 4°23'N to 21°25'N and longitudes 116°E to 127°E. It is an archipelago of Southeast Asia with the Bashi Channel to the north, Pacific ocean to the east, Sulu and Celebes Seas to the south and the South China Sea to the west. The country consists of about 7,100 islands with a total area of 30 million ha. The total coastline is about 18,000 km. The islands are mostly of volcanic origin and steep mountains on the larger islands Luzon and Mindanao rise to almost 3000m. The climate is moist tropical, though some rain shadows create seasonal drier areas. The eastern seaboard is regularly buffeted by typhoons.

Natural Vegetation

The natural vegetation of the Philippines consists of rainforests (TWE and SER) on the eastern side of the archipelago and Palawan and monsoon forests (TMD), including extensive deciduous dipterocarp forests which occur nowhere else in Malesia, on the western side of the archipelago. Mangrove forests (MNV) grow as a fringe in some coastal bays on the western side of the unit. Montane forests (TME and MDF) grow on the older volcanoes and along the main mountain chains. Extensive areas of the higher land are under natural tropical pine forests (TPF) on Luzon and Mindoro, mainly *Pinus merkusii* in the south and *Pinus kesiya* in the north. Freshwater swamps (FSV) were found on Luzon and Mindanao. Lowland forests on the eastern seaboard are regularly raked by cyclones and these forests are characterised by being lower and denser than unaffected forest with an uneven canopy.

Tropical forests originally covered almost 280,000 sq km (93%) of the total land area of the Philippines, and still two-thirds in 1950. Figures published by Revilla (1986) indicate that forest with at least 40% crown cover only 22% of total land area. The GIS coverage indicates that current forest cover is as little as 18% of which half is made up of degraded forest.

Forest cover is largely restricted to higher land, as human activities preferentially clear lowland vegetation. Major forest blocks, therefore, are restricted to the Sierra Madre and Cordillera Central in Luzon, Central Samar, the highlands around Mt Ragang and other

areas to the east in Mindanao. The only extensively forested island is Palawan, principally due to low human population density.

Mangroves, which covered some 4,500 sq. km in 1920, have been depleted both by legal and illegal felling over the last 60 years (Alvarez, 1984). Some 1,461 sq. km of mangroves remained in 1978 (Davies *et al.*, 1990), but only 1,190 sq. km remained in 1990 (Penafiel, 1990). A descriptive inventory of wetlands considered to be important for conservation is given by Davies *et al.*, (1990).

Biogeographic Units

The unit can be divided into six sub-units, each showing high levels of local endemism and distinctiveness and corresponding to deep marine divisions between different island clusters. Related units 26a and 26f consist respectively of Luzon and Mindoro and their satellite islets. Unit 26b consists of the central cluster of islands - Panay, Negros, Cebu, Bohol, whilst related unit 26e consists of Leyte and Samar. Unit 26c consists of Mindanao and unit 26d the Sulu archipelago.

Biological Richness

The Philippine fauna is exceptionally rich with some 960 terrestrial vertebrates. Many species are forest obligates and are acutely threatened by forest loss. Endemism collectively amounts to 43% of species, with 59% endemic mammals (100 species out of a total of 167) and as many as 85% of non-volant mammals (79 species) (Heaney, 1986; Petocz, 1988). There are 162 endemic bird species out of a total of 388 resident species (Bruce, 1980). Endemism is also unusually high in the herpetofauna at 63% (160 species) whilst 17% (240 species) of the ichthyofauna is endemic (Petocz, 1988). Plant endemism is estimated at 44% (3,500 species) but only 5% (75 species) in Palawan (Davies *et al.*, 1986).

Endangered mammals include - the Mindanao gymnure *Podogymnura truei*, Forest rat *Batomys grantis*, Calamian deer *Axis calamianensis*, Luzon tamaraw *Bubalus mindorensis* and Philippine tarsier *Tarsius syrichta*. Important birds include :- the Great Philippine eagle *Pithecophaga jefferyi*, Mindoro imperial pigeon *Ducula mindorensis*, Giant Scops owl *Mimizuku gurneyi*, Koch's pitta *Pitta kochi*, ashy ground thrush *Zoothera cinerea* and Cebu black shama *Copsychus cebuensis*. Many more birds and mammals with limited distributions are endangered. 30 mammals and 45 birds are listed on IUCN's red lists. Some may even be extinct already. The country has 9 EBA's (ICBP, 1992). The biodiversity index is calculated at a high 14.0 (see section 1.4.3.1 above), resulting in an ultimate protection target of 11.0%.

Threats to Biodiversity

The country's biodiversity is threatened by the severely degraded natural vegetation, weakness of the existing protected area system, high population and weak law enforcement. Regular burning of bare lands prevents secondary re-colonisation. Hunting pressure on remaining wildlife is high. On top of this many endemic species are extremely vulnerable because they have such limited distributions. Irreversible biodiversity loss is probably higher at the present time in Philippines than any other country of the realm.

Marine biodiversity is equally threatened as a result of mangrove clearance, coral blasting, collecting of rare shells, turtles and other wildlife and "blanket" fishing methods.

Review of Protected Area System

At least 59 national parks have been created since 1900, but they provide little effective protection for the country's terrestrial environment, and in 1986 the Haribon Foundation

(Haribon Foundation, 1986) indicated that none would satisfy international protected areas standards established by IUCN. The integrity of virtually all the reserves in the existing Philippines protected areas system, which includes less than 1.3% of the country's total land surface, is poorly maintained. In 1975, it was reported that approximately 72,000 people were permanently settled in park lands and that 54,000ha of the protected area estate were under some form of cultivation (DAP, 1975). A further 4,000ha were being logged by timber companies. Recent information is not available, but it is likely that these figures now drastically underestimate the current situation. Park boundaries are frequently not demarcated (Basa, 1988), law enforcement is lacking and current staffing and financial provisions are such that the PAWB is unable to deploy an effective corps of forest guards and park rangers.

A systematic attempt to identify an integrated protected areas system (IPAS) was initiated in 1986, supported by WWF-US, Department of Environment and Natural Resources and the Haribon Foundation (Anon., 1988a). This review identified 27 "priority one" potential protected areas and a further 41 "priority two" areas; only 19 existing national parks were included. The report recommended that the remaining sites be excluded from the IPAS programme. Although the specific recommendations of this study were not accepted by the government, the principle of a planned protected areas system became established.

Efforts are currently underway to identify and initiate management for ten priority sites (WWF, 1991) under World Bank funding and other reserves with EU funding. The long term strategy is to place the last adequate, remaining stands of forest, significant marine areas and wetlands under a protected areas regime, with as much as 20% of the country included (Roque, 1991). However, the current funding for the IPAS is short-term, and the full implementation of the system will require both long-term and more substantial funding than is currently available.

The following existing protection sites are rated as being of global significance:

Name	Ecosystem	IUCN Cat	Year	Size (km²)
Mount Apo	Mindanao Mts.	2	1966	728
Mount Kitanglad	Mindanao Mts.	2	1990	741
Mount Malindang	Mindanao Mts.	2	1971	533
Mounts Iglit-Baco	Mindoro Mts.	2	1970	754
Tubbataha Reef	Marine coral reefs	2	1988	800
Baguan Turtle Islands	Coral reefs and islets	4	1982	50

Category codes:

1 - 6 Corresponding IUCN Category

Map 15 shows the distribution of remaining wildlife habitat in Papua New Guinea together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The table and figures below show the degree to which different biounits and habitat types remain and are protected in the country. The severe loss of almost all lowland habitat types is quite clear. The protected area system totals 3% but most of this is secondary habitat.

Habitat Details for Philippines

Habitat	Original	Current	Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²) %	(km ²)	%	(km ²)	%
Cleared	0	239564 ***	5606	***	2799	***
Degraded forest	0	27404 ***	387	**	166	***
Freshwater swamp	14460	802 6	411	2.8	64	0.4
Lakes	1962	1962 100	126	6.4	0	0.0
Rivers	0	181 ***	1	100.0	0	0.0
Montane deciduous	4080	894 22	9	0.2	0	0.0
Mangroves	1354	1093 81	50	3.7	2	0.1
Semi-evergreen for.	140103	4999 4	124	0.1	82	0.1
Tropical moist deciduous	75349	4903 7	33	0.0	0	0.0
Tropical montane evergreen	14040	4461 32	430	3.1	9	0.1
Tropical pine forest	6586	2416 37	27	0.4	78	1.2
Tropical wet evergreen	36834	5886 16	187	0.5	23	0.1
Totals:						
Natural	294768	27416 9.3	1397	0.5	258	0.1
Non-natural		267149(90.6)	5994	2.0	2965	1.0

*** = 10x or more current area than original

Summary

Total loss of original natural habitat	90.7 %
Original forest cover	99.3 %
Current forest cover	17.9 %
(Natural forest cover)	(8.6 %)
(Secondary forest cover)	(9.3 %)
Total area protected	3.6%
(Area protected IUCN I-IV)	(2.5 %)
(Area protected IUCN V-VI, PRO)	(1.1 %)

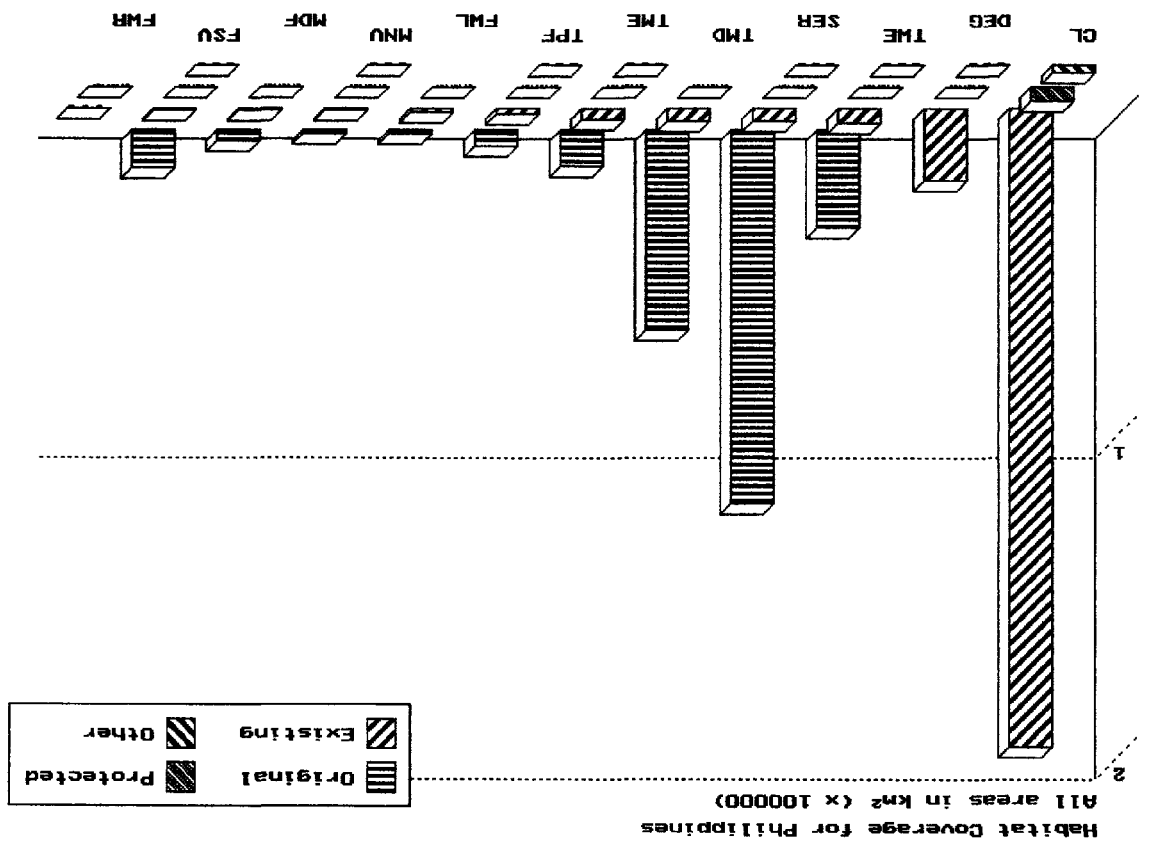
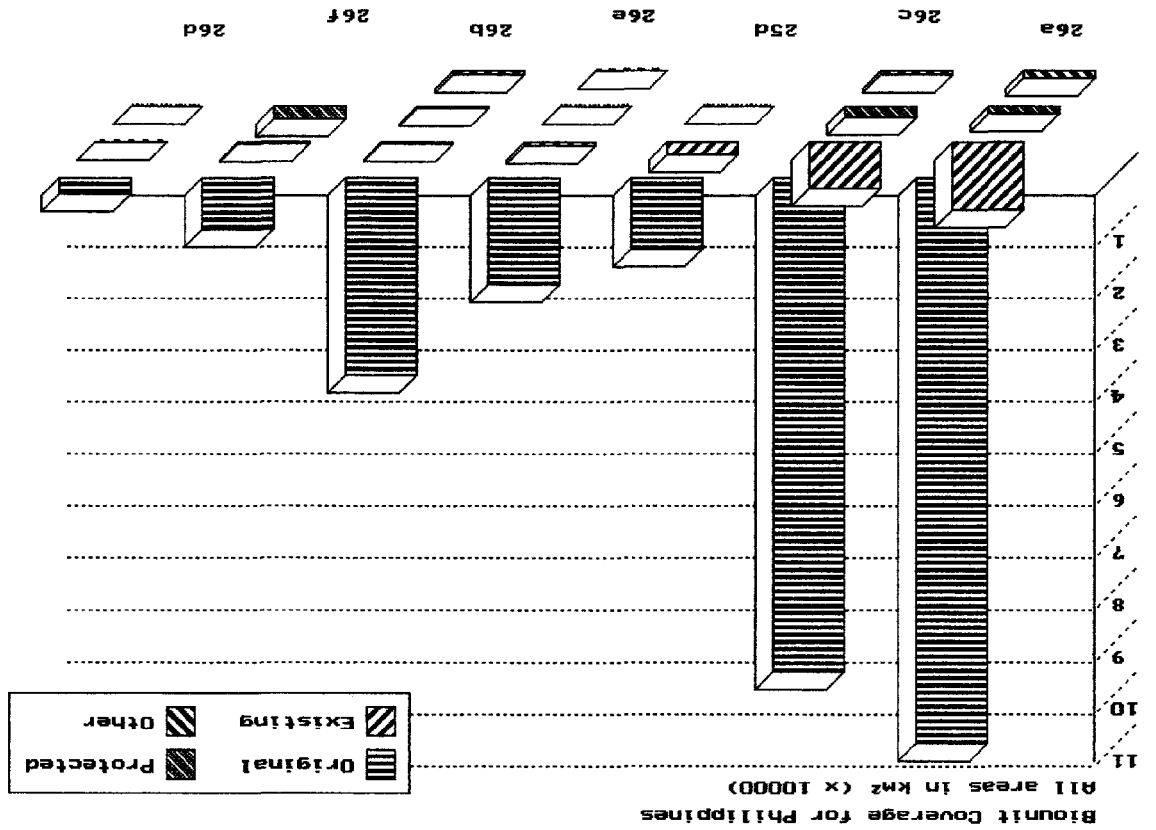
As mapped, current habitat protection is 0.4%, even less than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 0.7% protected. The change, despite an overall increase in Protected Areas area is due to the increasing degradation of habitat even within protected areas. Current conservation index score (CI) is calculated as a very low 0.1 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

While almost all vegetation types and biounits are included in the existing or proposed Protected Areas system, almost all are under-protected. There is little remaining habitat to select additional reserves but if urgent action is taken, valuable gains could be made for almost all vegetation types.

Recommendations

1. It is clear the government is now aware of the urgent needs for biodiversity conservation in Philippines. It is important to protect all remaining primary forests (estimated at 9,840 sq km or 3.3% of the country) plus all steep slopes and identified national parks and reserves. Funds are now available to do this and priorities mostly established. It is hoped that the additional gaps identified in this review will be given appropriate attention.



2. Areas of major biodiversity importance have been identified by the NIPAS project and gazettelement should proceed as proposed.
3. Areas where forest is still "available" and new protected areas are urgently needed are:

Luzon	Sierra Madre range - montane and hills. Central Cordillera - deciduous forests montane and hills. Hills east of Quezon City.
Mindoro	Extent Mts. Iglit-Baco reserve north along the mountain crest.
Panay	Deciduous forest.
Negros	Extend Mt. Canloan northwards.
Leyte	Forested mountains.
Samar	Central Hills
Palawan	Deciduous and evergreen forests.
Mindanao	Diata Mountains SE mountains west of Caraga.

4. It is important to set up a long-term funding mechanism for Protected Areas management.

Key Documents

Davies, J., Magsalay, P.M., Rigor, R., Mapalo, A. and Gonzales, H. (1990) *A Directory of Philippines wetlands*. Two Volumes. Asian Wetland Bureau Philippines Foundation/Haribon Foundation.

DENR. (1991) *Philippine Strategy for Sustainable Development*. Department of Environment and Natural Resources, Quezon City.

PAWB. (1991) *The protected areas and biological diversity of the Philippines*. Protected Areas and Wildlife Bureau, Department of Environment and Natural Resources, Quezon City. 30

WCMC. (1988) *The conservation status of biological resources in the Philippines*. A report by the IUCN Conservation Monitoring Centre prepared for the International Institute for Environment and Development. World Conservation Monitoring Centre, Cambridge, UK. 68 pp.

WWF. (1991) *Inception report: integrated protected areas system of the Philippines*. Feasibility studies, preliminary design and other support components. World Wildlife Fund-US, Washington DC. 31 pp.

3.14 SINGAPORE

Basic Data

- Area 636 sq. km
- Population 2.9 million = 46/sq km
- Natural increase 1.1% per annum
- Economic Indicators GNP: US\$ 22,500/capita (1994)
- Forest Cover 7 % (1994)
- Annual Gain of Forest 0.5 % per annum
- Protected Area Coverage 4.5% (WCMC)

Decade Milestones

- Large increase in Protected Areas with addition of Central Catchment Reserve
- Establishment of Singapore Nature Society
- New national parks legislation
- Ratification of CITES
- Ratification of Convention on Biological Diversity

Physical Geography

Singapore consists of one main island (41.8km long and 23km wide) with 58 islets within its territorial waters. The centre of the island has a series of low hills of granite and other igneous rocks. Bukit Timah, the highest hill, attains 163m and only three others exceed 100m in height. In the west and south-west of the island is a series of low ridges aligned North-West to South-East, formed from sedimentary rocks. The coastline is mostly flat and muddy although 5,400ha of this has now been covered by extensive landfill (Hails, 1989).

Natural Vegetation

Prior to the establishment of the British colony in 1819, the great bulk of the island was covered in pristine forest, comprising 82% lowland evergreen dipterocarp rain forest (TWE), 13% mangrove (MNV) and 5% freshwater swamp (FSV). As early as 1890, as much as 90% of this vegetation had been cleared. Today, more than half the island is urban in character and natural rain forest is restricted to the 81ha Bukit Timah Nature Reserve and scattered patches, totalling 50ha, in the adjacent Central Catchment Area. There are, in addition, some 1,800ha of 50 to 100 year old secondary forest in the catchment area, on land cleared during the last century, which may have growing value for the conservation of biological diversity (Collins *et al.*, 1991).

Biogeographic Units

The whole of Singapore falls within biounit 07a Malay Peninsula.

Biological Richness

As part of the West Malesia biodiversity hotspot, Singapore was biologically very rich. When its small size is taken into account Singapore actually scores as fifth richest of the 18 countries covered under this review. However, it has lost almost all its large mammals

and original habitat. As a measure of its remaining richness, the bird fauna is reduced to 295 species compared to 575 in adjacent Malay Peninsula. Only two mammals and three birds listed in IUCN red lists occur in Singapore: The country has no EBA's (ICBP, 1992). The biodiversity index is calculated at 12.7 (see section 1.4.3.1 above), resulting in an ultimate protection target of 10.7%.

Threats to Biodiversity

Major threats to the protected areas are the possibility of degazettement; increasing recreational use of Bukit Timah (also threatened by quarrying activities) and the MacRitchie Reservoir area; and the small size of the reserves which exacerbates edge effects, isolation and extinction (Collins *et al.*, 1991).

Review of Protected Area System

The Singapore Nature Society has formulated a "Masterplan for the Conservation of Nature in Singapore". Twenty-eight sites have been identified, comprising areas which may already have some form of protected status, as well as unprotected areas of the most important sites. Three are within gazetted nature reserves, while the rest includes four wetland areas (Kranji, Khatib Bongsu, Sungei Buloh and Senoko), two islands (Pulau Tekong and Pulau Ubin) and a mangrove area (Mandai), all of which are to the north of Singapore.

None of Singapore's protected areas are rated as of global importance. Bukit Timah is the most important single site. Map 10a shows the distribution of remaining wildlife habitat in Singapore together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The table below and figure show that almost all original habitat has been transformed with only tiny relics of rainforest and forest on limestone remaining, a much diminished area of mangrove (largely secondary) and a modest area of secondary forest. The protected area system covers what remains fairly adequately.

Habitat Details for Singapore

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Cleared	0	194	***	0.2	0.0	4.4	***
Freshwater	0	12	***	7.6	***	0.1	***
Limestone forest	1	1	100	0.7	70.0	0.0	0.0
Mangroves	55	22	40	0.0	0.0	2.7	5.5
Secondary forest	0	25	***	24.8	***	0.0	0.0
Tropical wet evergreen	540	24	4	0.6	0.2	0.0	0.0
Urban areas	0	319	***	0.0	0.0	0.6	***
Totals:							
Natural	596	47	7.9	2	0.3	2.8	0.5
Non-natural		550	92.3	33	5.5	5.0	0.8

*** = 10x or more current area than original

Summary

Total loss of original natural habitat	92.1 %
Original forest cover	100.0 %
Current forest cover	12.1 %
(Natural forest cover)	not determined
(Secondary forest cover)	not determined
Total area protected	7.2%
(Area protected IUCN I-IV)	(5.9 %)
(Area protected IUCN V-VIII, PRO)	(1.3 %)

As mapped, current habitat protection is 0.3%, slightly more than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 0% protected. Current conservation index score (CI) is calculated as 0.6 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

An apparent gap is mangrove forests but these are in fact represented in several recreational parks. Provided these are managed to preserve habitat, then mangrove is reasonably included in the Protected Areas system.

Other Issues

Singapore is the second most densely populated country in the world, and with the great demand for land, conservation has received a low priority. Swamp forest felling and reservoir construction have reduced the wetlands to one small area. Similarly, industrial development and exploitation have reduced the mangroves to 2-3% of the original cover (Hails, 1989).

Recommendations

1. Conservation in Singapore must be concentrated on minimising extinction rates in existing reserves and maximising benefits from man-made habitats. Three measures are the most urgent: protection of the margins of existing reserves, restriction of military training in the reserves and diversion of recreational pressure away from the most sensitive areas. A more ambitious idea would be to accelerate succession in the secondary forests of the catchment area by assisting seed dispersal and planting primary forest species. It may also be possible to reintroduce locally extinct forest vertebrates, particularly birds, from Malaysia, now that hunting and trapping have been greatly reduced (Collins *et al.*, 1991).

Key Documents

Briffett C. (1990) *Master Plan for the Conservation of Nature in Singapore*. Malayan Nature Society, Singapore. 152pp.

Corlett, R.T. (1988). Bukit Timah: the history and significance of a small rain-forest reserve. *Environmental Conservation* 15: 37-44.

Hails, C.J. (1989). Singapore. In: Scott, D.A. (Ed.), *A directory of Asian Wetlands*. IUCN, Gland, Switzerland and Cambridge, UK. Pp. 899-910.

3.15 SRI LANKA

Basic Data

- Area 65,618 sq. km
- Population 18 million (1993) = 276/sq. km
- Natural increase 1.5% per annum
- Economic Indicators GNP: US\$ 640 per capita (1993)
- Forest Cover 26 % (1992)
- Annual Loss of Forest 1.5% per annum
- Protected Area Coverage 12.1% (WCMC)

Decade Milestones

- Increase in Protected Areas System
- Preparation of National Biodiversity Conservation Action Plan
- Publication of Forestry Sector Master Plan
- Ratification of Ramsar Convention
- Ratification of Convention on Biological Diversity
- Completion of National Conservation Review

Physical Geography

The Democratic Socialist Republic of Sri Lanka comprises a large pear-shaped island at the extreme south of the Indian subcontinent between 79°40' to 81°50'E and 5°55' to 9°48'N. The island is 430 km from north to south and 224 km from east to west. Sri Lanka became an island probably in the late Miocene. It consists of a south-central massif, rising to some 2,500m, surrounded by a coastal plain which encompasses about 75% of the total geographic area. The massif has a major influence on the tropical climate, with conditions ranging from wet in the south-west to dry in the north and east. Radiating from this massif is a network of major rivers (Fernando, 1984). These features are largely responsible for the wide variety of ecosystems present in Sri Lanka and the associated rich diversity of plants and animals, many of which occur in the wet zone and are endemic (Wijesinghe *et al.*, 1989).

Natural Vegetation

The main forest types are the tropical wet evergreen forests (TWE) below 1,000 m and subtropical broadleaf hill forest (SBH) and evergreen montane forests (TME) above 1,000 m forests of the wet zone, tropical moist/wet semi-evergreen forests of the intermediate zone, tropical dry mixed evergreen forests (TDE) of the dry zone and semi-evergreen thorn forest (TSF) of the arid zone.

Large tracts of forest have been cleared during the last hundred years to accommodate the growing human population, which has risen from 3.5 million in 1900 through 5 million in 1950 to nearly 20 million today. Natural forest cover has dwindled rapidly from an estimated 84% in 1881 to 46.5% in 1956 and only 24% in 1992 (Legg and Jewell, 1994). The annual rate of deforestation of closed forest (3.5%) was among the highest in the world for the period 1981-1985 (Repetto, 1988).

The wetlands of Sri Lanka comprise a variety of coastal and inland systems, ranging from estuaries, lagoons and mangroves to rivers, villus and tanks (reservoirs). Many of the tanks date back 1,500 years when they formed part of an intricate irrigation system for rice cultivation. In recent decades, several large reservoirs have been constructed as part of large-scale hydro-power and irrigation projects, notably in the Mahaweli catchment area. There are 60 tanks in Sri Lanka, which exceed 300ha in size. The wetlands support a variety of wildlife, as well as being of socio-economic importance, particularly for irrigation purposes (Scott, 1989).

Biogeographic Units

Sri Lanka comprises two complete biounits - S13 (Ceylon Dry Zone) covering most of the island and O2- (Ceylon Wet Zone) in the southwest corner. The Wet Zone in the mountains and southwest of the island is related to the wet forests of India's Western Ghats but contains many endemic species of its own. The Dry Zone is related to adjacent dry areas of SE India with which it has enjoyed recent contact. Very few species are endemic to the Dry Zone.

Biological Richness

Sri Lanka is only moderately rich in species and has fairly high levels of local endemism. Twelve of 89 mammals and 24 of 419 birds are endemic whilst about 870 out of 3368 higher plants are endemic. Endemism runs at 49% in reptiles, 60% in amphibia and 45% in freshwater fishes and 6% in butterflies (FPU,1995). Sri Lanka protects important populations of elephant, leopard and its various endemic species. Some 9 mammals and 8 birds are listed in IUCN red lists of threatened species (1994). In addition many endangered plants in the lowland wet-zone forest fragments need urgent protection measures. The country has 1 EBA (ICBP, 1992). The biodiversity index is calculated at 7.4 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.1.

Threats to Biodiversity

Major threats to biodiversity are the fast expanding land-hungry population and the associated pressure on clearing forest for new farmland and major land development schemes to plant teak, tea, cardamom and other commercial crops. Creation of roads, canals and reservoirs have opened up or destroyed other wild areas but in some cases newly created wetlands have had a positive effect on wildlife. Some parks suffer from excessive pressure of visitors.

Review of Protected Area System

Sri Lanka has a history of establishing protected areas from the 3rd century BC (De Alwis 1969). 19 Protected areas were established in the colonial era and the number and area of sites under protection has grown steadily ever since. Today, 12 National Parks, 3 Strict Nature Reserves, 3 Nature reserves, 52 Sanctuaries, including 3 wetland sites, protect 12.4% of the country, under the purview of the Department of Wildlife and Conservation. Another 17.4% of the country falls within the Forestry Estate of which 1.3% consists of conservation forests areas and National Heritage Wilderness areas. The Forestry Department has recently completed a 'Forestry Master Plan' (1995) and 'Forestry Policy' (1995). Biodiversity Conservation is stressed as the highest priority and good plans and recommendations have been put forward to further strengthen the Protected Areas

system. New legislation is being prepared for the management of 31 newly created 'conservation forests'.

The following conservation areas and complexes are rated as being of global significance:

Name	Ecosystem	IUCN Cat	Year	Size (km ²)
Yala/Ruhuna/Yala East 1519	SE Dry Zone	1/2 1	1938/73	
Gal Oya Valley Complex	Dry Zone Moist Forest	2/4	1954	536
Horton Plains/ Peak Wilderness	Wet Zone Montane	2/4	1988/40	256
Wasgomuwa/ Minneriya-Giritale	Dry Zone Moist Forest	2/4	1938/88	478
Wilpattu 1317	Dry Zone Drier Forest	2	1938/73	
Bundala	Coastal Wetlands	4	1969	62
Sinharaja	Wet Zone Evergreen	4	1988	112
Knuckles	Wet Zone outlier	6	1992	389

Category codes:

1 - 6 Corresponding IUCN Category

Map 16 shows the distribution of remaining wildlife habitat in Sri Lanka together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The table and figure below show the degree of habitat loss and protected area coverage for all habitats and both biounits of the country. In total 14 % of the land area of the country is protected. Most of this is in the dry zone.

Habitat Details for Sri Lanka

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Cleared	0	52521	***	3927	***	892	***
Freshwater swamp	72	17	24	3	4.2	0	0.0
Lakes/rivers	521	692	133	242	46.4	0	0.0
Mangroves	1022	63	6	5	0.5	0	0.0
Semi-evergreen	13595	1514	11	568	4.2	50	0.4
Tropical dry evergreen	31064	9210	30	2532	8.2	309	1.0
Tropical montane evergreen	3194	626	20	146	4.6	117	3.7
Tropical thorn forest	4073	141	3	75	1.8	0	0.0
Tropical wet evergreen	12286	1054	9	109	0.9	0	0.0
Upper montane forest	39	28	72	13	33.3	5	12.8
Totals:							
Natural	65866	13345	20.3	3693	5.6	481	0.7
Non-natural		52521	79.7	3927	6.0	892	1.4

*** = 10x or more current area than original

Summary

Total loss of original natural habitat	79.7 %
Original forest cover	99.2 %
Current forest cover	19.2 %
(Natural Forest Cover)	not determined
(Secondary forest cover)	not determined
Total Area protected	13.7%
(Area protected IUCN I-IV)	(11.6 %)
(Area protected IUCN V-VI, PRO)	(02.1 %)

Although almost 14% of the country lies within protected areas, current habitat protection as mapped is only 5.6%. This is more than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 4.4% protected. Current conservation index score (CI) is calculated as 1.0 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

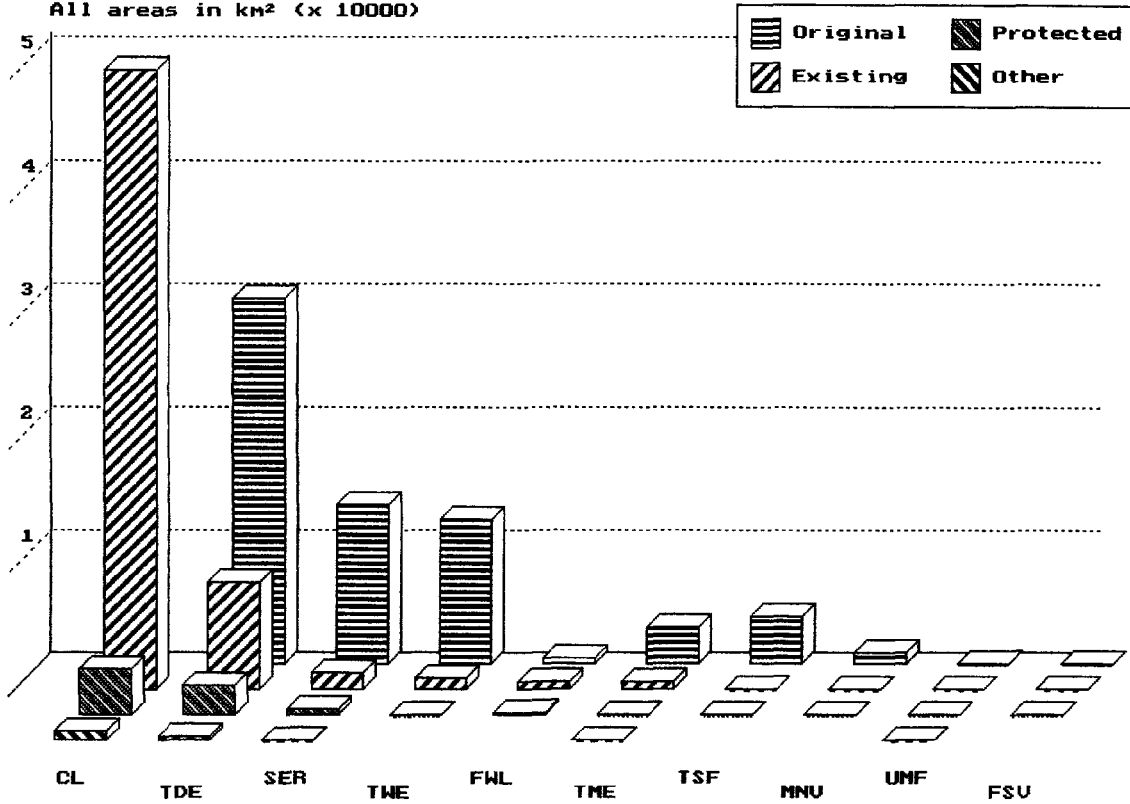
All vegetation types and both biounits are represented in the Protected Areas system but there is an imbalance towards the drier forest types. The major gaps in the system is lowland evergreen forests of the wet zone and mangroves.

The wet zone has a number of floristically important regions, such as the forests of Kottawa, Himidumkanda, Kanneliya and Gilimale, which have not been allocated for conservation (Gunatilleke and Gunatilleke, 1990). Demarcation of protected areas in the wet zone is considered to be a high priority. Other gaps in the network include coastal and marine protected areas, the only one established to date being Hikkaduwa Marine Sanctuary. In the dry zone, important areas with inadequate conservation status include the Samanalawewa area in the Walawe Ganga basin and the core of the Minneriya-Giritale Nature Reserve.

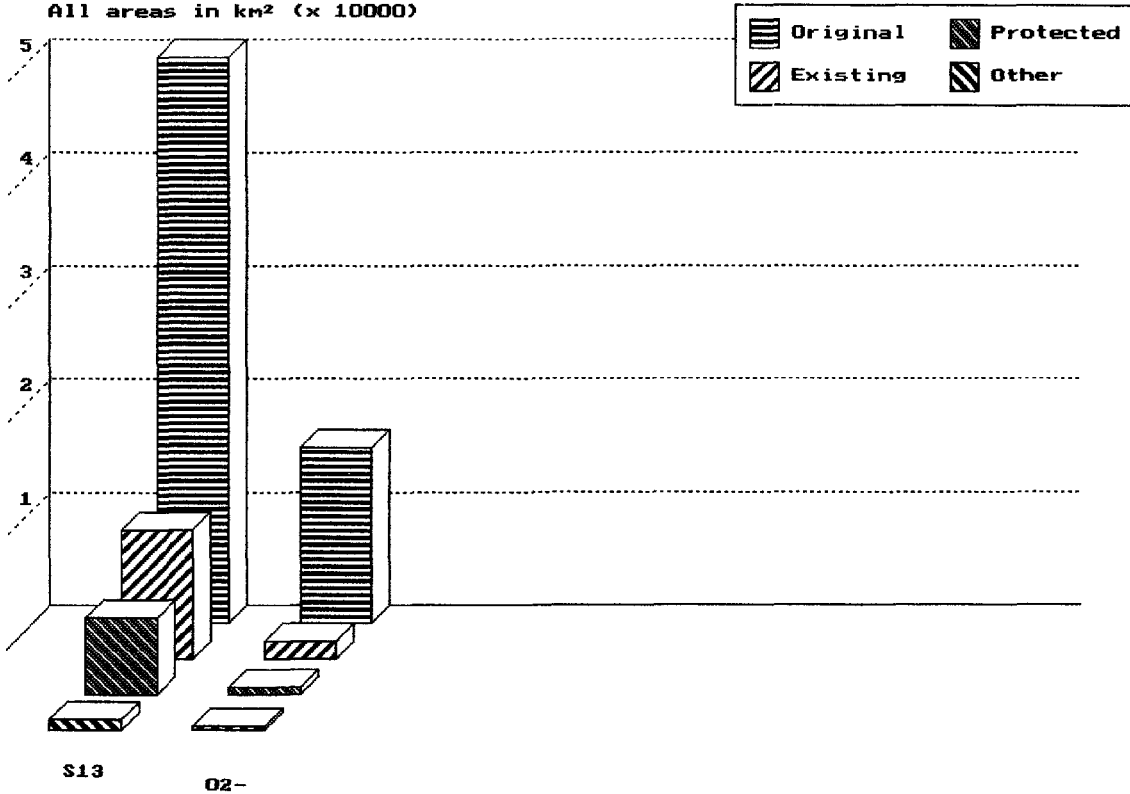
Recommendations

1. So little remains of evergreen vegetation types in the wet zone and these are so rich in endemic species that all remaining fragments should be protected as a matter of urgency. The logging ban introduced in the early 1990s is a good first step. Several forest patches still need official gazettement. Active efforts should then be made to propagate rare trees and recreate corridors between relict patches.
2. Particular attention should be paid to the relatively large forest 'conservation forests', Dellawa (24.5 sq km) and Diyadawa (22.4 sq km). Both are species-rich, harbour several endemics and are important for hydrology and should be managed as extensions to adjacent Sinharadja. Another priority 'conservation forest is Kanneliya forest reserve (60 sq km). This is one of the larger and more species-rich forests remaining in the country.
3. Upgrade Peak Wilderness Sanctuary to National park and prepare a management plan and implement it. This is one of the most species-rich wet zone forests but it is becoming increasingly subject to human-related pressures.
4. Strengthen protection of the newly gazetted Knuckles conservation area. This area is rich in relict species representing several taxonomic groups, but the forest is under intense pressure from cardamom growers.

Habitat Coverage for Sri Lanka
All areas in km² (x 10000)



Biounit Coverage for Sri Lanka
All areas in km² (x 10000)



5. A number of additional marine reserves are needed for coral reef, mangroves and beach systems. A marine report of this project will give more detailed recommendations.
6. A number of management improvements are required such as boundaries of protected areas need to be marked in the field; combined quarters should be provided for officers working in various ranges and national parks.
7. A greater level of community participation and public awareness is needed to reduce such conflicts as elephants versus agriculture.

Key Documents

Baldwin, M.F. (ed.). (1991) *Natural resources of Sri Lanka: conditions and trends*. Keells Business Systems, Colombo. 280

FPU (1995) *Sri Lanka Forestry Sector Master Plan*. Conservation of Biodiversity in Forests. Chapter 3. Forestry Planning Unit, Battaramulla. Pp 32-85.

3.16 THAILAND

Basic Data

- Area 513,517 sq. km
- Population 58 million (1993) = 113/sq. km
- Natural increase 1.4% per annum
- Economic Indicators GNP: US\$ 2,410/ capita (1994)
- Forest Cover 25% (1994)
- Annual Loss of Forest 4.0% per annum
- Protected Area Coverage 12.1% (WCMC)

Decade Milestones

- Increase in Protected Areas
- Total ban on logging of natural forest
- Revisions to organisation of Royal Forest Department divisions responsible for Protected Areas
- Major changes in policy and regulations to address management of forest resources, buffer zone management and wildlife trade

Physical Geography

The Kingdom of Thailand stretches some 1,600 km south to north from 5°34' - 20°30'N and some 780 km east to west from 97°10' to 104°40'E on the western side of the Indochinese peninsula. The country divides naturally into six regions. The Northern Highlands extend from the borders with Myanmar and Laos south to about 18° latitude. They mainly comprise ridges oriented north-east to South-East, reaching an elevation of between 1,500 m and 2,000 m, and separated by wide valleys at between 300 m and 500 m. The Korat Plateau covers the north-east of Thailand. It forms a shallow depression at 100 m and 200 m, rimmed by the Petchabun Range in the west, and the Dangrek Range in the south. These reach 500 m to 1,400 m and meet in the highlands of Khao Yai National Park.

The Central Plain of the Chao Phraya River is an extensive low-lying delta and alluvial plain extending as far north as 16°N. The South-East Uplands are an extension of the Cardamom Mountains from across the Cambodian border. Rainfall approaches 5000 mm in some areas. The land form is highly dissected and mountains rise to over 2000 m. The Tenasserim Hills extend south from about 18°N in the Northern Highlands, along the Myanmar border to the Kra Isthmus, at about 10°N, rising steeply to about 1,000m. The Southern Peninsula extends to the Malaysian border from a line joining Chumphon to Ranong at 10°N. It is an area of heavy rainfall and was originally covered in rain forest.

Natural Vegetation

In the Northern Highlands, the mountains above 1,000 m were originally clad in evergreen montane rain forest (TME and SDE), with mixed deciduous monsoon (TMD) and dry dipterocarp savannah forests (DDF) on their flanks. The valleys, however, have long been wholly cultivated. This region suffers from the steady southward push of hill tribes such as the Hmong and Yao, which cultivate upland rice and, at higher elevations, the opium poppy. Undisturbed forest is now restricted to a few scattered patches in remote areas. The Korat plateau is now largely devoid of forest, but extensive areas still persist on the ranges. Dry monsoon forests (DDF) on the lower slopes grade into evergreen rain forest (SER) on the hills and finally into pine woodlands (SPF) on the ridge tops.

The Central Plain is now almost entirely under intensive rice cultivation and its original swamp (FSV) and monsoon forest (DDF) has completely disappeared. There is a small area of remaining mangrove forest on the coast. Small remnants of the once prevalent tropical rain forest (TWE and SER) of the Southeast Uplands still survive in protected areas. Since the Thai side of the Tenasserim Hills lies in the rain shadow of higher hills on the Burmese side, it is relatively dry, but semi-evergreen rain forest (SER) persists of higher elevations along the border. The upper flanks are often precipitous, with bare rock. The slopes, once clothed in deciduous monsoon forest (TMD) containing some teak and much *Shorea* spp., are now deforested and covered with bamboo (BMB) and grassland (GRA).

Most rainforests (TWE) in the lowlands of the Southern Peninsula has been lost to agriculture. Extensive tracts persist only on the hills (TME), but during the last decade even these have come under assault, principally from rubber plantations, which have often been established with international aid (Collins *et al.*, 1991). In the mid-1940s some 70-80% of Thailand's land area supported closed forest. Despite state ownership of all forests in the form of national parks, wildlife sanctuaries and forest reserves, more recent estimates indicate a severe decline in cover to 33% in 1978 (FAO, 1981), 30% in 1982. Our own estimates put the current forest cover at 26%.

Biogeographic Units

Most of north and eastern Thailand falls within the central Indochina unit 10a with only the extreme north falling within the north Indochina unit 10b. The moister and more tropical forests of the southeast and lower Chao Phraya valley fall within the Cardamom Mountains unit 05d with considerable Malesian influence and the south peninsula falls within the Malay transition zone unit 07b. A very small part of the extreme southern tip of the country south of the Kra isthmus falls within the evergreen forest zone of the Malay peninsula unit 07a.

Biological Richness

Thailand supports an extremely diverse fauna and flora. Situated in the Indo-Chinese peninsula of the Oriental region, the country has been described as a "zoogeographic cross roads". For example, the avifauna comprises Sino-Himalayan, Indo-Burmese, Indo-Chinese and Sundaic elements, to which may be added large numbers of migrant visitors from the Palaearctic region (Round, 1988). Current knowledge of the flora and fauna is not complete, but it is estimated that some 20,000 to 25,000 species of vascular plants are present, including 10,000 to 15,000 flowering species. This includes more than 500 tree species and 1,000 orchid species. Approximately 891 bird species have been recorded, of which roughly 638 breed or formerly bred within the country. In a review of the status and conservation of forest birds, Round (1988) estimates that at least 521 species are present in existing national parks and wildlife sanctuaries, although 106 land birds, and water birds associated with forests are considered threatened and six species are considered to be extinct. Mammals number about 265 species (Lekagul and McNeely, 1977), fish approximately 1,450, reptiles at least 300 and amphibians at least 100 (Taylor, 1965).

25 mammals and 34 birds are listed in IUCN red lists and require special protection. Kouprey, Schomborg's deer, Sumatran rhinoceros, Javan rhinoceros and Eld's deer are already extinct in Thailand and tapir is almost or possibly extinct. Wild buffalo remain in only one small herd. In addition there are 454 endangered plant species. The country has no EBA's (ICBP, 1992). The biodiversity index is calculated at 9.8 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.9%.

Threats to Biodiversity

Permanent agricultural encroachment and swidden agriculture are the principal causes of deforestation, in addition to both previously government sanctioned and illegal logging, the widespread practice of annual burning of forest undergrowth, and developments such as hydroelectric projects and highway construction. Despite a cabinet directive in 1981 that 50% of Thailand's land area should be forested, relatively undisturbed protected areas are increasingly isolated, thus possibly contributing to a decline in diversity. A number of protected areas have been adversely affected by development activities, such as hydroelectric projects and highway construction, whilst mineral extraction, resettlement programmes and recreation increase the pressure on wildlife and forests (Jintanugool *et al.*, 1982; Round, 1985). The 1989 logging ban has relieved some pressure from protected areas by nullifying logging concessions, but many of the fundamental causes of deforestation, such as rural poverty and illegal logging, persist. There is also concern that the ban will have an adverse effect on the poorer countries in the region which will be enticed to increase their own rates of felling to satisfy the demands of Thai sawmills (Round, 1989).

The major threat to protected areas is poaching, and habitat loss due to agricultural encroachment. For this reason, parks and sanctuaries tend to be on higher ground that is less favourable for agriculture and lowland forest is not well represented in the protected area system (Round, 1985).

Review of Protected Area System

The national park system was expanded from 16 sites (9,357 sq. km) in 1979 to 45 sites (24,222 sq. km) in 1985. By May 1995 some 105 national parks had been established, including 24 with a marine component, covering 66,185 sq. km (12.8% of total land area). At the same time there were 38 wildlife sanctuaries, covering 29,185 sq. km (5.7% of total land area).

The existing national parks and wildlife sanctuaries cover 18.5% of the total area of the country but this includes quite a lot of degraded and cleared forest. Only 8.2% of the country consists of protected natural habitat. With a management efficiency score of 72.5 this results in an effective protection score of 6.3%. In relation to the immediate target of 6.5 this figure is adequate and gives Thailand a conservation index of 1.0.

The following conservation areas and complexes are rated as being of global significance:

Name	Ecosystem	IUCN Cat	Year	Size (km ²)
Doi Inthanon	Northern Montane Evergreen	2	1972	482
Kaeng Krachan	Southern Evergreen	2	1981	2915
Khao Yai	SE Evergreen/deciduous	2	1962	2169
Huai Kha Khaeng	Western evergreen/ deciduous	4	1972	2780
Thung Yai Naresuan	Western evergreen/ deciduous	4	1974	3647

Category codes:

- 1 - 6 Corresponding IUCN Category
- P Proposed

Map 17 shows the distribution of remaining wildlife habitat in Thailand together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The table and figures below show to what extent different habitat types and biounits are covered under the Protected Areas system and how much of each remain in a natural condition. Protected Areas coverage totals 10% of the country but with the ban on logging, almost all remaining forest areas are being reclassified as either Wildlife sanctuaries or national parks. Much of this new area is already secondary and even densely inhabited ! The fast expansion of reserves puts severe impacts on staffing budgets as the Royal Forestry Department gets over staffed.

As mapped, current habitat protection is 9.4%, more than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 8.3% protected. Current conservation index score (CI) is calculated as 1.1 (see table 1.8 and section 1.4.2 for scoring details).

Habitat Details for Thailand

Habitat	Original (km ²)	Current (km ²) %	Protected(I-IV) (km ²) %	Other (V,VI,PRO) (km ²) %
Cleared	0	319612***	10927 ***	262 ***
Dry dipterocarp	168398	45506 27	10042 6.0	3 0.0
Freshwater swamp	68514	460 1	0 0.0	36 0.1
Rivers/lakes	458	458 100	0 0.0	0 0.0
Limestone forest	296	65 22	65 22.0	0 0.0
Montane deciduous	3780	809 21	345 9.1	0 0.0
Mangroves	11905	1946 16	261 2.2	0 0.0
Plantations	0	21401 ***	887 ***	183 ***
Scrub	0	38164 ***	3137 ***	336 ***
Sub-montane dry evergreen	3381	1670 49	187 5.5	0 0.0
Semi-evergreen	116870	32398 28	21222 18.2	564 0.5
Subtropical pine forest	3579	1613 45	243 6.8	0 0.0
Tropical moist deciduous	95725	27478 29	9516 9.9	113 0.1
Tropical montane evergreen	19120	12428 65	4297 22.5	0 0.0
Tropical wet evergreen	19734	6729 34	2134 10.8	350 1.8
Totals:				
Natural	511760	131560(25.7)	48312 9.4	1066 0.2
Non-natural		379177(74.3)	14951 2.9	781 0.2

*** = 10x or more current area than original

Summary

Total loss of original natural habitat	74.3 %
Original forest cover	99.9 %
Current forest cover	25.7 %
(Natural forest cover)	not determined
(Secondary forest cover)	not determined
Total area protected	16.8%
(Area protected IUCN I-IV)	12.4 %
(Area protected IUCN V-VI, PRO)	0.4 %

Identification of Gaps in System

Habitat coverage is quite satisfactory and there are no obvious gaps. It would be good to add some additional lowland wet evergreen forest and it is important to add more relict areas of freshwater swamp and mangroves. From a biounit perspective there are gaps in the two marginal units 10b and 07a in the extreme north and south of the country respectively.

Other Issues

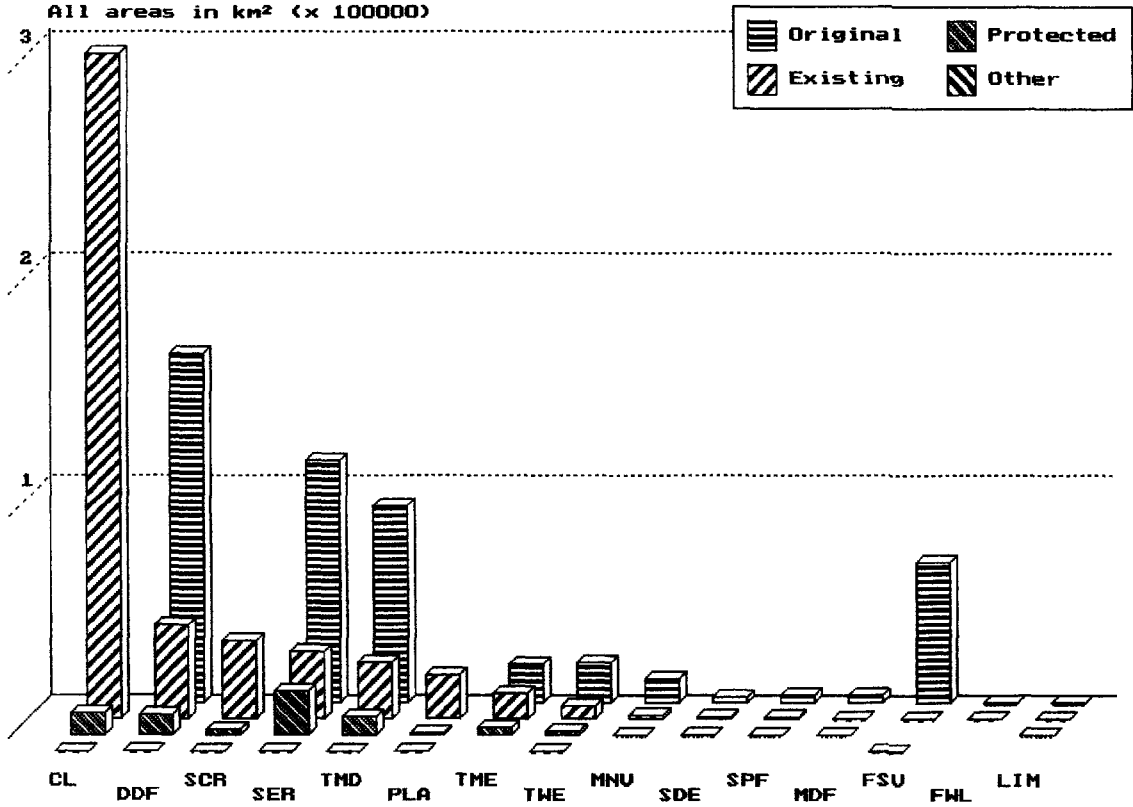
A major issue in Thailand is the many millions of people living inside forestry boundaries including protected areas. Although partly stemming from the lack of a systematic protected area acquisition policy, measures to tackle encroachment were made in 1975. The Cabinet directed that reserved forests that have been heavily degraded by encroachment and settlement be developed into "forest villages". This gives families the right to remain on the land indefinitely which hopefully will prevent further forest destruction.

Another issue that should be tackled is Thailand's position in the international wildlife trade. Thailand was black listed by the CITES secretariat for one year due to its failure to meet required standards of control. There are still many problems in this area.

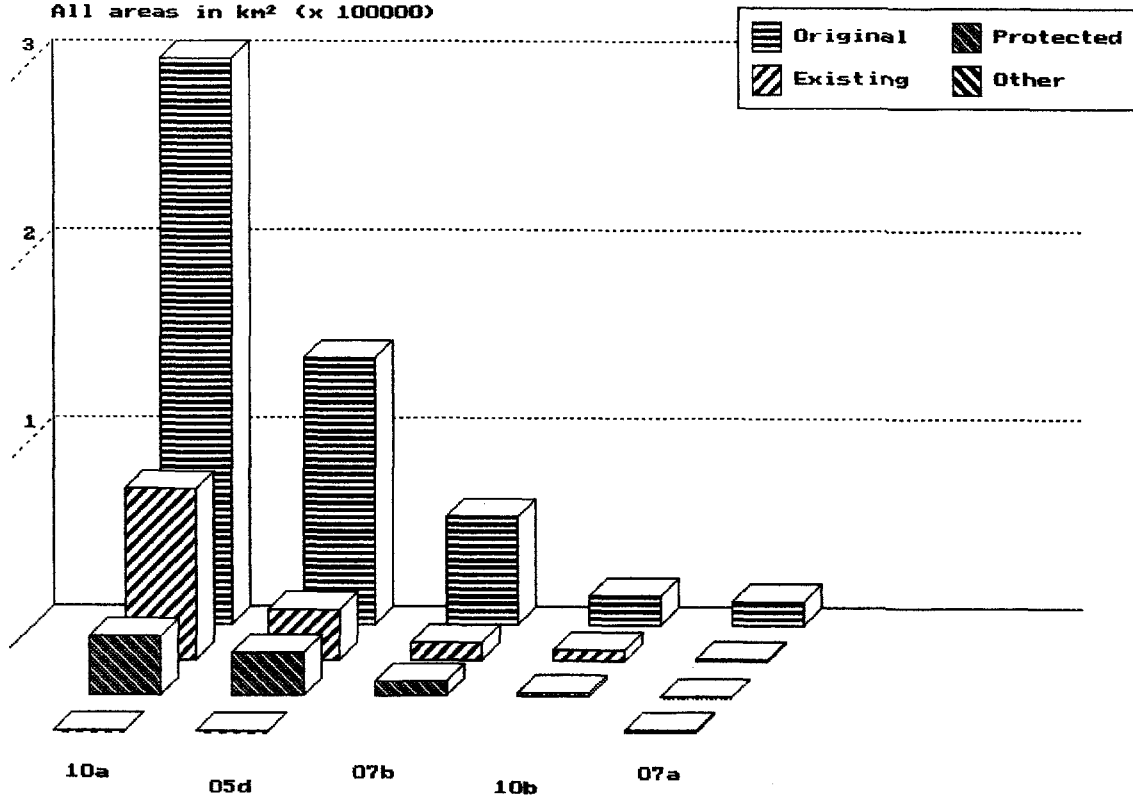
Recommendations

1. All remaining rainforest in the southern unit 07a should be added to the Protected Areas system as soon as possible.
2. Thailand should cooperate closely with neighbouring countries in developing some important transfrontier corridors and forest links. It would be important to persuade the Myanmar government to form a transfrontier reserve adjacent to Kaeng Krachan and thereby establish a forest link with Thung Nai. It is important to maintain the forest corridor between Thap Lan N.P. and the Dangrek Mountains on the Cambodian side of the border. Fuller participation in UNDP project RAS/93/102 will help in the latter case.

Habitat Coverage for Thailand
All areas in km² (x 100000)



Biounit Coverage for Thailand
All areas in km² (x 100000)



Key Documents

Brockelman, W. Y. & V. Baimai, (1993) *Conservation of Biodiversity and Protected Area Management in Thailand*. MIDAS, Bangkok.

Chettamart, Surachet (1987). *Assessment of National Parks, Wildlife Sanctuaries and other preserves in Thailand*. Faculty of Forestry, Kasetsart University, Royal Forest Department and Office of the National Environment Board, Bangkok. 138 pp.

Thailand Ministry of Science Technology and Energy, Office of the National Environment Board, National Biodiversity Unit (1992) *Thailand country study on biodiversity: draft*. National Biodiversity Unit, Thailand. 89pp.

3.17 VIETNAM

Basic Data

- Area 332,000 sq. km
- Population 72 million (1993) = 217/sq. km
- Natural increase 2.1% per annum
- Economic Indicators GNP: US\$ 200 per cap. (1994)
- Forest Cover 25% (1994)
- Annual Loss of Forest 1.6 % per annum
- Protected Area Coverage 4.0% (WCMC)

Decade Milestones

- Major increase and revision of Protected Areas System
- Endorsement of National Environmental Action Plan
- Publication of Tropical Forestry Action Plan
- Establishment of staff training centre at Cuc Phuong
- Ratification of Ramsar Convention
- Major changes in law and regulations to address management of forest resources and wildlife.
- Ratification of Convention on Biological Diversity
- Ratification of CITES
- Publication of the Biodiversity Action Plan for Vietnam

Physical Geography

Vietnam is situated on the eastern seaboard of Southeast Asia. The country has a land area of some 33 million ha with a length of some 1000 km stretching from 8°30'N in the south to 23°N in the north. Three quarters of the country consist of hills and mountains reaching up to over 3000 m.a.s.l. Vietnam is bordered by China to the north, and Laos and Cambodia to the east. The country is S-shaped with broad deltas of the Red river in the north and Mekong in the south linked by a narrow central section. At its narrowest point the country is only 35 km wide. The climate is warm moist tropical in the south and moist sub-tropical in the north. The Hai Van pass between the towns of Danang and the old capital of Hue marks a natural division between these two units. The Hoang Lien Son mountains in the NW of the country are the highest peaks in the country. Phansipan rises to 3143 m. These mountains form an extension of Hengduan mountains of China and are biologically related to SW China. The mountains to the east of the Red river are connected to the limestone ranges of Guangxi and are biologically related to southern China. The narrow east coastal plains and hills are a distinct biological unit endemic to the country.

Natural Vegetation

The discontinuous central mountain chain is very distinctive especially in the plateau around Dalat. Some parts of the central highlands lie on the west side of the Annamite chain and drain into the Mekong. This area is seasonally dry.

The two deltas were formerly occupied by swamp forests. These have been cleared for agriculture but the coastal areas still support mangroves and parts of the Mekong delta support Melaleuca forests. Low lying dryland forests were semi-evergreen but are also largely destroyed. Hill forests remain of both evergreen and semi-evergreen types. In some

areas of the north and centre of the country karst limestone produces spectacular scenery as well as a distinct forest formation. Montane forests grade from oaks and chestnuts mixed with conifers to upper montane forests dominated by conifers and with an understorey of bamboo. The highest peaks of Hoang Lien Son emerge above the cloud layer, receive very high levels of insolation and exhibit a specialised xerophytic montane heath vegetation. The central highlands support extensive areas of dry dipterocarp monsoon forest.

Forest cover was reduced from 44% in 1943 to 23% by 1983. Since 1988 the apparent area of forest cover has increased to just over 9 million ha or 28%. However much of this figure is made up of secondary forest, damaged forest and new plantations. The actual area of good quality forest cover continues to decline. A frightening total of 13 million ha or 40% of the country is currently classed as bare land.

Biogeographic Units

Vietnam is divided into several distinct biounits. Major barriers to species distribution are caused by the Red River and the climatic divide at the Hai Van pass in the centre of the country. The Red river separates lowland units 06a South China to the east from 05c North Annam to the west; whilst the Hai Van pass separates 05c from the south Annam unit 05b. The Mekong delta is a distinct biological zone (05a) and two montane units -Ma Central Annam Mountains and -Mb Dalat Plateau are characterised by high levels of endemism and distinctiveness. Large areas of northwest Vietnam are subtropical in nature and fall within unit 10b North Indochina with a small area of the extreme northwest falling into unit 10c Indochinese transition zone with affinities to the Himalayas. Phu Quoc island, lying west of the Mekong delta is part of biunit 05d Cardamom Mountains.

Biological Richness

Vietnam contains a great wealth of biological diversity in its forests, its waterways and in its marine areas. It also contains a great variety of valuable species and varieties of crops, cultivars and domesticated animals in its agricultural systems. Over a thousand medicinal plants are recognised. Many more certainly await discovery. The table below shows the number of species of different taxa that are already known. In some cases these are still low figures. For instance it is estimated that Vietnam has about 12000 species of higher plants but only 7000 have been identified.

Taxa	Spp. in Vietnam(SV)	Spp. in World (SW)	SV/SW (%)
Mammals	275	4,000	6.8
Birds	800	9,040	8.8
Reptiles	180	6,300	2.9
Amphibians	80	4,184	2.0
Fishes	2,470	19,000	13.0
Plants	7,000*	220,000	3.2

Mean %age of global biodiversity 6.2%

* estimated to be 12,000

Endemism is high in many groups. 33% of the flora of northern Vietnam is endemic (Pocs Tamas, 1965) whilst it is estimated that for the entire national flora the figure is as high as

50% (Thai van Trung, 1970). Endemism is high for freshwater fish with 77 endemic species described out of a known fauna of 203 spp. in northern Vietnam (Yen, 1985).

Some important endemic or near-endemic vertebrates include:-

Sao La *Pseudoryx nghetinhensis*, Giant Muntjac *Megamuntiacus vuquangensis*, Hatinh Langur *Trachypithecus hatinhensis*, Delacour's Langur *Trachypithecus delacouri*, White-headed Langur *Trachypithecus poliocephalus*, Tonkin Snubnose Monkey *Rhinopithecus avunculus*, Vietnam Pheasant *Lophura hatinhensis*, Imperial pheasant *Lophura imperialis*, Edward's Pheasant *Lophura edwardsi*, Orange-necked Partridge *Arborophila davidi*, Grey-crowned Crocias *Crocias langbianis*, Collared Laughingthrush *Garrulax yersini*, White-cheeked Laughingthrush *Garrulax vassali*.

Endemism is not spread evenly throughout the country. The main mountain blocks such as Lang Bien plateau, central mountains and mountains of Hoang Lien Son are those which carry the highest levels of endemism in conifers, other plants and birds. Some groups depart from this pattern (e.g. pheasants are mostly confined to lower altitudes).

In addition, Vietnam contains globally important populations of some of Asia's rarest animals such as Kouprey *Bos sauveli*, Javan Rhinoceros *Rhinoceros sondaicus*, Asian Elephant *Elephas maximus*, Tiger *Panthera tigris*, Eld's Deer *Cervus eldii*, Crested Argus *Rheinartia ocellata*, Green peacock *Pavo muticus*.

In total, 35 mammals and 40 bird species are listed on IUCN red lists. The country contains 3 EBA's (ICBP, 1992). The biodiversity index (BI) is calculated at 8.5 (see section 1.4.3.1 above), resulting in an ultimate protection target of 9.5%.

Threats to Biodiversity

There are many threats to the country's biodiversity but the most important threat has been and remains deforestation. Deforestation is itself caused by several factors - logging, clearance for agriculture, forest fire, war damage, shifting cultivation, collection of firewood, overgrazing.

Apart from loss of forest, many individual species are endangered or eliminated as a result of massive over-utilisation. Collection of rare medicinal plants and rare timbers, overhunting and collecting for the wildlife trade are all common threats to Vietnam's beleaguered biodiversity.

Freshwater habitats are threatened by siltation, industrial and domestic pollution, over fishing, fishing with poisons and explosives, fishing with fine gill nets, electric fishing, pollution from agricultural pesticide run-off, land reclamation, physical disturbance, hunting of waterfowl and introduction of exotic species. Another great threat to biodiversity is the fragmentation effect. As habitat patches become encroached and split, their capacity to support species declines and many larger species or species with low density or wide range requirements are vanishing. Introduction of exotic species is a threat to freshwater systems and to a lesser extent to terrestrial vegetation.

Review of Protected Area System

The National Park of Cuc Phuong was established as early as 1962 but almost all of the 87 other reserves were added in 1986. In total these protected areas total 1.3 million ha or 4 % of the land area of the country. The reserves have been selected to cover representative examples of all major ecosystems as well as about 30 sites of primarily historical (battlefields) or scenic interests.

The system was reviewed during the Tropical Forest Action Plan for Vietnam and it was recognised that many of the protected areas were too small and too damaged to satisfy their biological requirements. The TFAP proposed a doubling of the area of nature reserves by adding 24 new areas to the system. 18 of these are enlargements to existing reserves and creating links between other reserves. This does not include coverage of marine ecosystems which also need protected areas. It was also recommended to transfer management of non-biological reserves to another ministry. The Ministry of Forestry has agreed to these changes and adopted a target of 2 million ha. of nature reserves. The new additions are currently being surveyed and management plans being prepared for the enlargement of the system.

The revised nature reserves will have additional lands around their perimeter designated as buffer zones where intensification of agriculture and agro-forestry will be sponsored to reduce the dependence of local villagers on the forest resources of the reserves.

The following protection sites are rated as being of global significance:

Name	Ecosystem	IUCN Cat	Year	Size (km ²)
Cat Ba	Limestone Island forest	2	1986	152
Nam Bai Cat Tien	Tropical Evergreen	2	1978	379
Yok Don	Dry Deciduous Forest	2	1988	582
Cat Loc	Tropical Evergreen	4	1990	300
Chu Yang Sinh	Tropical Montane Evergreen	4	1986	200
Pu Mat	Annamite Hills and Mountains	4	1994	912
Thuong Da Nihm (Bi Doup)	Dalat Plateau Montane	4	1990	70
Vu Quang	Annamite Hills and Mountains	4	1986	559
Xuan Thuy	Mangrove Wetland	4	1990	30
Bach Ma	Evergreen Hills and Mountains	2	1990	220

Category codes:

1 - 6 Corresponding IUCN Category

Map 18 show the distribution of remaining wildlife habitat in Vietnam together with the location of existing and proposed protected areas. Details of the protected areas are contained in the BIMS database.

Analysis of Protected Area Coverage

The table and figures below show how much of different habitats and biounits remain in a natural condition and how much of each is protected. All vegetation types and biounits are included in the system but the total area remains low across the board.

Habitat Details for Vietnam

Habitat	Original	Current		Protected(I-IV)		Other (V,VI,PRO)	
	(km ²)	(km ²)	%	(km ²)	%	(km ²)	%
Cleared		162646	***	5187	***	3239	***
Cultivated	0	89526	***	694	**	539	***
Dry dipterocarp	7389	3817	52	484	6.6	34	0.5
Freshwater swamp	29877	94	0	43	0.1	0	0.0
Lakes/river	2512	2512	100	5	0.2	2	0.1
Limestone forest	12071	10927	91	855	7.1	591	4.9
Mangroves	16200	734	5	216	1.3	0	0.0
Peat swamp	14819	230	2	44	0.3	0	0.0
Sub-alpine conifer	702	366	52	2	0.3	54	7.7
Sub-tropical hill forest	20493	2467	12	105	0.5	218	1.1
Scrub	0	23798	***	1322	***	921	***
Sub-montane dry evergreen	76702	2992	4	253	0.3	94	0.1
Semi-evergreen	57051	9895	17	659	1.2	374	0.7
Sub-tropical montane	6044	1407	23	244	4.0	242	4.0
Tropical dry evergreen	1682	0	0	0	0.0	0	0.0
Tropical moist deciduous	22115	4974	22	207	0.9	190	0.9
Tropical montane evergreen	11915	4410	37	868	7.3	45	0.4
Tropical pine forest	4644	3759	81	684	14.7	381	8.2
Semi-evergreen<500m	41044	2317	6	728	1.8	65	0.2
Tropical wet evergreen	3599	1986	55	825	22.9	0	0.0
Totals:							
Natural	328859	52887	16.1	6222	1.9	2290	0.7
Non-natural		275970(83.9)		7203	2.2	4699	1.4

*** = over 10x more current area than original

Summary

Total loss of original natural habitat	83.9 %
Original forest cover	99.2 %
Current forest cover	15.3 %
(Natural forest cover)	not determined
(Secondary forest cover)	not determined
Total Area protected	6.2%
(Area protected IUCN I-IV)	(4.1 %)
(Area protected IUCN V-VI, PRO)	(2.1 %)

As mapped, current habitat protection is 1.9%, more than was calculated in the IUCN Review (MacKinnon & MacKinnon, 1986) which scored the country as 0.5% protected. Current conservation index score (CI) is calculated as a still inadequate 0.2 (see table 1.8 and section 1.4.2 for scoring details).

Identification of Gaps in System

There are no real gaps in the system but the area of protected areas tends to be small. A doubling of protected areas is currently under process but an even larger increase is needed if Vietnam is really to achieve a realistically representative system.

Other Issues

Vietnam wishes to benefit from developing better co-operation with its neighbouring countries in four respects - the establishment of transfrontier reserves; technical exchanges; sharing of information; co-operation in tackling shared problems such as poaching, spread of fire etc. These transfrontier issues can be tackled through Vietnam's participation in a number of regional and international programs such as CITES, RAMSAR, IUCN Commissions etc. However a specific project RAS/93/102 under UNDP funding is now in operation, with Vietnam as the focal country, to facilitate greater co-operation between the four SE Asian countries - Vietnam, Laos, Cambodia and Thailand. The project has established a regional forum to discuss regional biodiversity issues and a database is set up to share biodiversity information. Similar transfrontier relationships will be sought with China whose authorities have expressed interest in the idea.

Recommendations

1. Vietnam still harbours some valuable and unique areas of high biodiversity with considerable global significance. Vietnamese scientists and officials have shown a long and laudable concern for these biological resources and have adopted far-sighted policies and regulations in an effort to preserve these resources. International agencies have been rather slow in providing a low level of assistance.
2. If Vietnam can maintain the 2 million ha of proposed reserves, control wildlife trade and hunting and put in place its plans for EIA's as a prerequisite for major developments, then the prospects for conserving the nation's biodiversity are quite good. However it is impossible to over-estimate the problems for nature conservation in Vietnam.
3. The very high and still growing population density combined with poverty and a shortage of fuel, meat and other resources places a tremendous pressure on the last forest and aquatic resources. In addition the weakness of forest protection units and law enforcement in general and the low level of budgeting being allocated to conservation work do not provide an adequate counter measure to this pressure on resources.

Key Documents

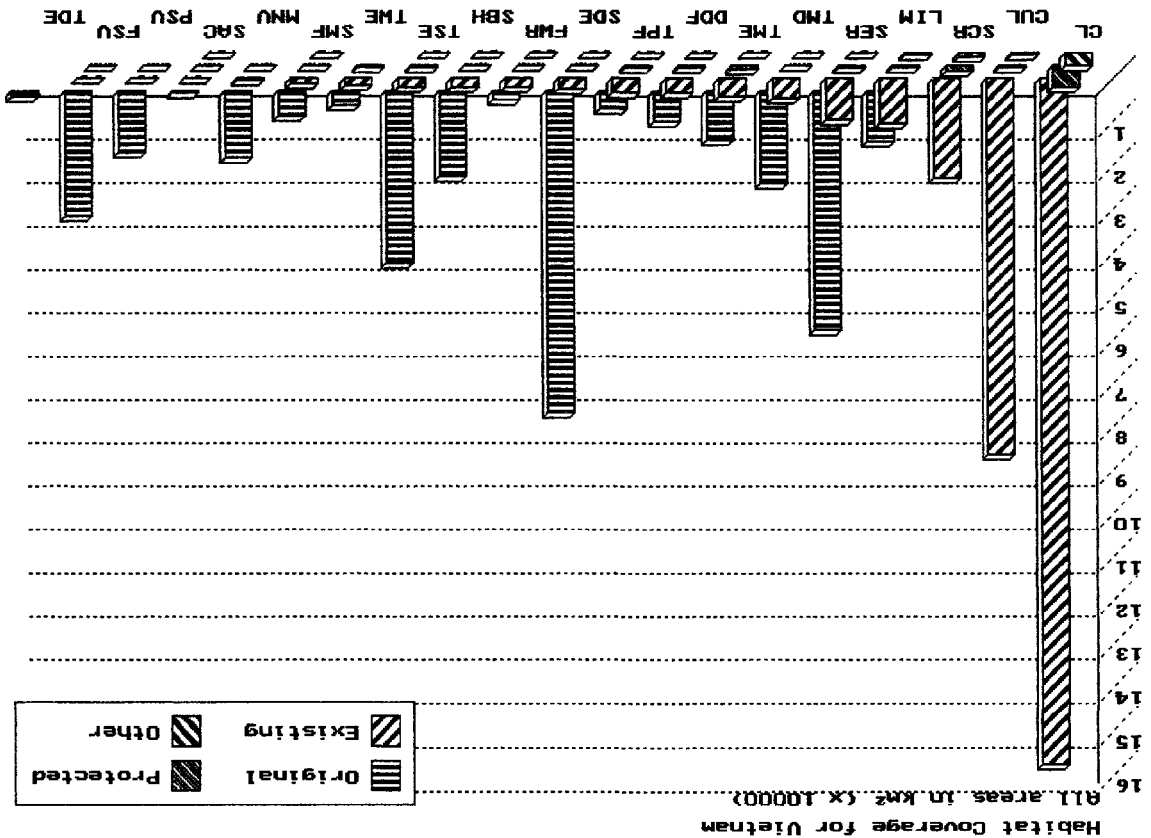
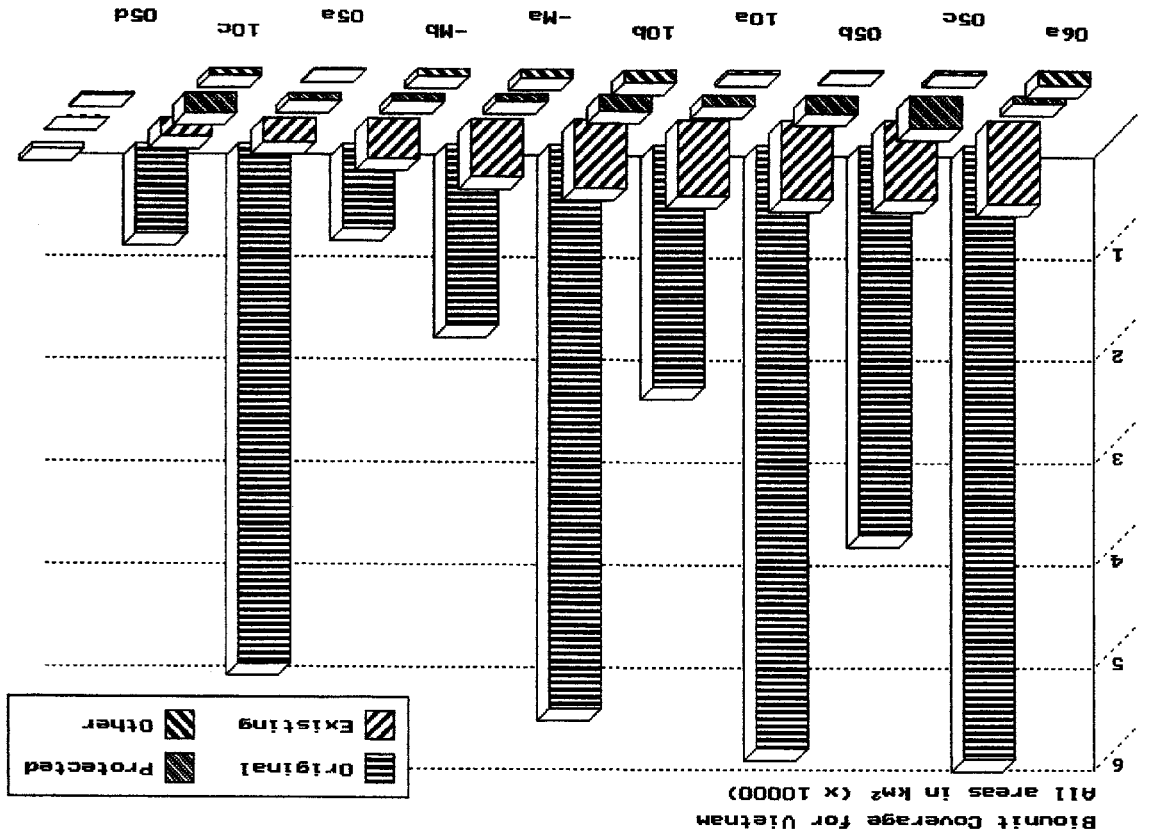
MacKinnon, J. (1990). *The Nature Conservation System, National Parks and Protected Areas*. Technical report No. 3 of project VIE/88/037. 55 pp.

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Vietnam. Ministry of Forestry (1991). *Vietnam: forestry sector review; tropical forestry action programme main report*. Ministry of Forestry, Hanoi. xv + 202pp.



ANNEX 1 SOURCES FOR GIS COVERAGES

INDONESIA

Original Habitats - Digitized from blue dyeline maps National Conservation Plan of MacKinnon & Artha (1981-2). Selected vegetation boundaries were taken, ie forest on alluvia was not distinguished. A 3000 foot contour line extracted from DCW was used to delimit areas of montane vegetation. Original habitat types of Irian Jaya were based on National Conservation Plan but adapted from Atlas Data rather than digitized from scratch.

Remaining Habitats and Protected Areas - Taken from data produced by the Regional Physical Planning Programme for Transmigration (RePPProT) at a scale of 1:2,500,000. The data was compiled over a number of years, commencing in 1984. It was digitized by WCMC in 1989 for The Conservation Atlas of Tropical Forests - Asia and the Pacific¹. Parts of Sumatra, Kalimantan and Irian Jaya were revised on basis of newer plots of classified AVHRR data, provided by the TREES (TRopical Ecosystem Environment observations by Satellite) project.

MALAYSIA

Peninsular Malaysia

Original Habitats - Adapted from existing Atlas (Collins *et al.*, 1991) coverage, based on the maps from the original review.

Remaining Habitats - based on data from the atlas, combined with data digitized from TREES plots. Areas where both data sets indicated forest were classed as having remaining forest cover, whilst areas where only one dataset indicated forest were classified as degraded.

Sabah/Sarawak

Original Habitats - Digitized from tracing paper overlays drawn on ONC charts based on the maps from the 1986 Review.

Remaining Habitats - Digitized from plots of TREES data and edited after comments made by Dr Clive Marsh based on personal aerial reconnaissance of Sabah.

BRUNEI

Original Habitats - Based on Atlas data with areas of non forest reclassified on basis of 1986 Reviews and areas of heath forest and freshwater swamp classed from a map in the national masterplan (Farmer; 1986).

Remaining Habitats - Based on atlas data with areas of degraded forest identified from Chapter 2. Coastal Zone Environment and Resources Utilization.

¹ Edited by N. Mark Collins, Jeffrey A. Sayer and Timothy C. Whitmore. ISBN 0 333 53992-3, 1991. 304 x 237mm (hardback), fully illus., 256pp. Available in the United States from Simon & Schuster, 200 Old Tappan Road, Old Tappan, NJ 07675.

PAPUA NEW GUINEA

Original Habitats - based on atlas data with limestone areas taken from ONC charts and upper montane vegetation taken from vegetation maps of Pajimans (1975) and transferred to plots before digitizing.

Remaining Habitats - Digitized from manual classification lines drawn on TREES data plots only where newer data showed changes to forest distribution in the Tropical Forests Atlas.

Protected Areas - Edits to plots made by participants to 3rd regional workshop, Bogor, Indonesia, 1995.

PHILIPPINES

Original Habitats - Digitized from overlays drawn over ONC charts based on classification of the 1986 Review and Whitmore Malesia map (1984).

Remaining Habitats - based on the data from the Tropical Forests Atlas, reclassified into three classes (FOR, DEG and NON) according to the scheme laid out in the following notes, then reinterpreted on basis of original condition.

Protected Areas - Edits to plots made by participants to 3rd regional workshop, Bogor, Indonesia, 1995; plus a PAWB map at 1:2,000,000 dated 17 May 1989.

BANGLADESH

Note. New coastline digitized from recent air photos as ONC Chart coastline significantly out of date.

Original Habitats - Digitized from overlays on ONC charts based on 1986 Review.

Remaining Habitats - Atlas data modified by manual digitizing from recent Landsat images.

Protected Areas - Digitized from WCMC protected area plots which were edited by Mohammed Nuruzzaman, Assistant Chief Conservator of Forests, Office of the Conservator of Forests, Dhaka, Bangladesh, and Haroun Er Rashid, Bangladesh Poush (NGO).

BHUTAN

Remaining Habitats - Wildlife Habitat classification for Bhutan - Satellite interpretation of TM images (1993) by J MacKinnon for WWF Bhutan, partially ground-truthed. Boundaries partly modified to match WCMC Biodiversity Map Library Botanical Reporting Units

Original Habitats - The original cover map was produced directly from the remaining from map by reclassifying those areas now cleared or degraded according to whether they were above or below a 3000 feet contour line. Some secondary pine formations were similarly reclassified.

Protected Areas - Digitized from edits to plots made by T. B. Mongar, of the Forestry Services Division, Ministry of Agriculture, Bhutan and the WWF Bhutan Programme. Edits based on an A4 map of Protected Areas of Bhutan 1992.

NEPAL

Original Habitats - Contours were taken from DCW and plotted. Some additional arcs, separating valley slopes with markedly different aspects were then added to the plot and digitized. The resulting coverage was classified according to the following scheme which combines altitude with simple geographic divisions based on river catchments and dividing the country into three regions (West, Central and Eastern)

DCW ZONE	Altitudinal range in FEET	Approximate equivalent in METERS	GEOGRAPHIC ZONE		
			West	Central	East
3	< 3000	< 1000	TMD	TMD	TMD
4	3000 - 7000	1000 - 2150	SPF/HMT	SPF/SBH	SBH
5	7000 - 11000	2150 - 3300	SAC	HMT/SAC	MWT
6	11000 - 13000	3300 - 4000	BIR	BIR	BIR/SAC
7	13000 - 16000	4000 - 5000	ALP	ALP	ALP
8	> 16000	> 50000	GLA	GLA	GLA

Remaining Habitats - Data from several different sources have been combined to produce this map. UNEP GRID in Bangkok kindly provided a map derived from 1km resolution AVHRR satellite data and showing landuse in 1992/3. This was combined with a 1:1,000,000 scale A3 map, *Vegetation map of Himalayas Part IV (Nepal)* showing forests (Continuous Canopy) and degraded forests (40 - 60% cover). This map was produced in 1985 from Landsat imagery, bands 5 and 7. The resulting coverage was reclassified into three categories, forest, degraded forest and non-forest according to areas of agreement or disagreement between the two data sources. This coverage was finally overlain with the original habitat types and reclassified according to original condition.

Protected Areas - Digitized from map of National Protected Areas and Protected Areas of Nepal (1986) at 1:1,000,000 made by the Department of National Protected Areas and Wildlife Conservation (DNPCWC) with revisions of recent changes marked on maps during regional workshop I.

INDIA

Original Habitats - Digitized from general lines drawn on the 'Atlas of Forest Resources of India' at 1:2,000,000 in five map sheets (1975).

Glaciers Deserts and Alpine scrub added from Operational Navigation Charts (1:1,000,000 scale).

Remaining Habitats - Data on moist forests from The Conservation Atlas of Tropical Forests was combined with data for arid forests digitized from a diazo map at 1:3,500,000 of vegetation of India from Remote Sensing of the Himalayas (M. A. Kawasa, 1988) and four separate sheets covering the Himalayan region.

Alpine and desert habitats were added from the original habitat map and the forest polygons were reclassified according to their original type.

Protected Areas - Digitised from hand-drawn protected areas maps (1:1,000,000) by Vasumathi Sankaran, Indian Institute of Public Administration, based on protected areas data gathered from State Forest Departments of each State of India. Revised by addition of extra reserves for which polygons were elsewhere available or by circles for other large areas still lacking boundary details.

PAKISTAN

Original Habitats - Drawn on ONC charts and based on Vegetation Map from Birds of Pakistan Vol.I (Roberts, 1992) and a vegetation classification of 1986 Review.

Remaining Habitats - Deserts, alpine and glacier habitats were assumed to be remaining. Remaining forest patches were digitised from two poor quality forestry maps of Pakistan and required transforming to match geographic projection. General reliability of these sources is thought to be poor. Mangroves added from WCMC Mangrove Atlas drafts.

Protected Areas - Some areas taken from edits to plots made by National Council for Conservation of Wildlife, Ministry of Food, Agriculture and Cooperatives. Others from state maps and individual reserve brochures.

SRI LANKA

Remaining Habitats - Although a more up to date and detailed dataset has been prepared by the Forest Department of Sri Lanka, it is rather more detailed than the general scale used for this project, and has not yet been cleared for general use. Therefore the map digitized for the Atlas was used.

Original Habitats - Digitized from tracing over Forest Department Map based on 1986 classification.

Protected Areas - Data taken from edits to plots made by participants to 1st regional workshop, Nepal, November 1994. The boundary for Sinharaja was taken from data provided by the Forest Department.

CAMBODIA

Original Habitats and Remaining Habitats - Originally digitized in AUTOCAD by the Asian Bureau for Conservation. Based on three available maps, Mebray Commission Vegetation Map, FAO study and then pulled into ARC/INFO through DXF format.

Protected Areas - Hand drawn from reserve sheet maps onto Operational Navigation Charts tracing then digitized and checked and edited by David Ashwell, (IUCN Cambodia Programme) at workshop 2, Bangkok, Thailand, January 1995.

LAO PDR

Original Habitats - Originally digitized at ABC. The Coniferous forest, Open deciduous (*Tectona Grandis*) forest and Karst classes were then extracted from the 1987 Lao PDR Forestry Department map. This hand coloured dyeline map at a scale of 1:1,000,000 had previously been digitized at WCMC for use in the Atlas.

The resulting coverages were then reclassified as follows:- Coniferous forests became SPF in northern Lao and TPF in the south of the country. Open deciduous became DDF unless it was previously classed as TMD and Karst was reclassified as LIM or forest on Limestone.

Remaining Habitats - Digitized from tracings of TM interpretations by J. MacKinnon and TREES data with reference to land cover map supplied by UNEP GRID Bangkok. The 'scrub' category was added from data digitized from plots of TREES data. This information was then superimposed on to the original map and deciduous and evergreen types reclassified.

Protected Areas - Boundaries for new reserve system were traced onto plots from a published map at the same scale and projection by Lao Forestry officials attending the 2nd workshop.

MYANMAR

Original Habitats - Originally digitized in AUTOCAD, by Asian Bureau for Conservation from overlays on Operational Navigation chart based on original 1986 Review and recent A4 maps of Forestry Department. The 1000m contour was taken from Digital Chart of the World (digital version of ONC, available from US Defense Mapping Agencies and many resellers).

Remaining Habitats - A map distinguishing between evergreen and monsoon forest, mangrove and cleared land was digitized in AUTO CAD by ABC based on A4 maps of Forestry Department and TREES data. This coverage was then combined with the original habitat map and reclassified. All evergreen forest was given its code from the original map (eg TWE, TME), where it had not been cleared. Monsoon forest types (DDF,TMD,MDF,FSV) were also maintained. However where the original map showed forest as an evergreen type (TWE,TME,SER,FSV) and the remaining code was monsoon, areas were reclassified as degraded.

THAILAND

Original Habitats - Reference made from ONC charts on basis of altitude, TREES data plots and large scale Royal Forest Department (RFD) maps of remaining forest by type.

Remaining Habitats - The RFD Dataset "THFT" (based on 1993 Landsat imagery) was first projected transformed slightly to account for a small misalignment. The RFD coastlines and international boundaries were removed and replaced with the WCMC Botanical Reporting Units border file.

The RFD classification distinguished evergreen forest, mixed deciduous forest, dry dipterocarp forest, pine forest, mangroves, rubber plantations and scrub. Any off shore islands not included in the RFD dataset were also classed as cleared or cultivated land. One polygon classed as mangrove was reclassified as FSV as it was inland. The forest classes were then separated out and combined with the original forest cover map to give the type of forest and recombined with the rest of the remaining cover classes. Those classes found to be present were TMD, DDF, SDE, MDF, SER, LIM and TMD.

Protected Areas - General RFD Digital dataset used to supplement existing WCMC data for recently designated sites.

VIETNAM

Original Habitats - Drawn onto ONC charts following classification of original review, then digitized.

Remaining Habitats - Digitized in AUTOCAD by Asian Bureau for Conservation, converted via DXF to ARC and rubber sheeted to fit the DCW boundary more exactly.

Protected Areas - extensive edits to plots by participants at workshop, later reviewed by John MacKinnon.

ANNEX 2 CODES AND ACRONYMS USED IN REVIEW

The following codes are used to denote countries, biounits and habitat types in the GIS coverages developed under this review and are used as abbreviations in the BIMS database software available with this report. The codes are used as abbreviations in some of the tables and maps presented in this report.

1. Country Codes

BGD	Bangladesh	BRN	Brunei Darussalam
BTN	Bhutan	IDN	Indonesia
IND	India	KHM	Cambodia
LAO	Lao P.D.R. (Laos)	LKA	Sri Lanka
MAL	Maldives	MMR	Myanmar (Burma)
MYS	Malaysia	NPL	Nepal
PAK	Pakistan	PHL	Philippines
PNG	Papua New Guinea	SGP	Singapore
THA	Thailand	VNM	Vietnam

2. Biounit Codes

-M	Annam Mountains	-Ma	Central Annam Mountains
-Mb	Dalat Plateau	02-	Ceylon Wet Zone
04-	Burmese Coast	05	Coastal Indo-China
05a	Mekong Delta	05b	South Annam
05c	North Annam	05d	Cardamom Mountains
06-	South China	06a	Tropical Southern China
07-	Malaya	07a	Malay Peninsula
07b	Malay Transition	09-	Irrawaddy
09a	South Irrawaddy	09b	North Irrawaddy
09c	Burma Transition	10	Indochina
10a	C. Indochina	10b	N. Indochina
10c	Indochina Transition	13	Moluccas (Maluku)
13a	N. Maluku Islands	13b	Obi
13c	Buru	13d	Ceram and Ambon
13e	Kai Islands	13f	Tanimbar
20	Andaman Islands	21	Sumatra
21a	Southern Sumatra	21b	Northern Sumatra
21c	Mentawai Islands	21d	Nias & Batu Islands
21e	Simeuleu Island	21f	Enggano Island
21g	Lingga Archipelago	21h	Nicobar Islands
22	Java	22a	West Java
22b	East Java	22c	Bali Island
23	Lesser Sundas (Nusa Tenggara)	23a	North Nusa Tenggara
23b	Sumba Island	23c	Timor and Wetar Islands
23d	Tanimbar	24	Sulawesi
24a	Sulawesi - Central	24b	Sulawesi - North
24c	Sulawesi - South	24d	Sulawesi - Southeast
24e	Sulawesi - Northeast	24f	Sulawesi - Sangihe Talaud Islands
24g	Sulawesi - Sula Isls.	25	Borneo and Palawan
25a	Borneo - North	25b	Borneo - Southwest
25c	Borneo - Natunas	25d	Palawan
25e	Borneo - Central Mts.	25f	Borneo - Northeast
25g	Borneo - East	25h	Borneo - Northwest
25i	Borneo - Southeast	26	Philippines
26a	Philippines - Luzon	26b	Philippines - Central Islands
26c	Philippines - Mindanao	26d	Philippines - Sulu Archipelago
26e	Philippines - Leyte/Samar	26f	Philippines - Mindoro
I	Indian Subcontinent	11	Ladakh and Tibet

I1a Ladakh Mountains
 I2 Himalaya Mountains
 I2b West Himalaya
 I2d East Himalaya
 I3a Thar Desert
 I3c Indus Valley
 I4 Central-West India
 I4b Kathiar/Gir
 I5 South West India
 I5b Western Ghat Mts.
 I6a Central Highlands
 I6c Eastern Highlands
 I6e Deccan South
 I7a Upper Gangetic Plain
 I8 Maldives/Laccadives
 I9a Brahmaputra Valley
 P3 New Guinea
 P3b New Guinea - Western Islands
 P3d Vogelkop
 P3f New Guinea - SW
 P3h Star Mts.
 P3j Sepik/Ramu
 P3l Trans Fly
 P3n New Guinea - SE
 P3p New Britain
 P3r Bougainvillea Islands

I1b Tibetan Plateau
 I2a North-West Himalaya
 I2c Central Himalaya
 I3 West Arid
 I3b Rann of Kutch
 I3d Baluchistan
 I4a Punjab Plains
 I4b Gujarat Rajputana
 I5a Malabar Plains
 I6 Central India
 I6b Chotta-Nagpur
 I6d Central Plateau
 I7 Gangetic Plain
 I7b Lower Gangetic Plain
 I9 North East India
 I9b North-East Hills
 P3a Maluku - Aru Islands
 P3c Geelvink Bay Islands
 P3e New Guinea - Northwest
 P3g Snow Mts.
 P3i New Guinea - Central Highlands
 P3k Huon Peninsula
 P3m Kibori Ruvani
 P3o East Papua Islands
 P3q Bismark Archipelago
 S13 Ceylon Dry Zone

3. Habitat Codes

ADS Alpine Dry Steppe
 ALP Alpine (Pasture)
 ALX Alpine Bare Rock
 ASW Shifting Cultivation
 BFV Beach Vegetation
 BMB Bamboo
 CL Cleared Land
 DDF Dry Dipterocarp Forest
 FIR Fir Zone
 FUB Forest on Ultrabasic
 FWR Freshwater River
 GRA Grassland
 HDT Himalayan Dry Temperate
 HMT Himal Moist Temperate
 LHF Lower Hardwood Forest
 MAR Marine Sea
 MNV Mangroves
 PLA Plantations
 RIV Riverine Vegetation
 SAV Savannah

 SCF Sub-alpine Conifer Forest
 SDE Sub-montane Dry Evergreen
 SEC Secondary Forest
 SFL Seasonally Flooded Agriculture
 SMV Seasonal Marsh
 SSM Seasonal Salt Marsh
 SWG Swamp Grassland
 TMD Tropical Moist Deciduous
 TML Tropical Montane Limestone

ALA Lalang Grassland
 ALS Alpine Scrub
 ASF Arid Sub-Tropical Forest
 BAR Bare Land
 BIR Birch Forest
 BPF Blue Pine Forest
 CUL Cultivated Land
 DEG Degraded Forest
 FSV Freshwater Swamp
 FWL Freshwater Lakes
 GLA Glacier
 HDC Himalayan Dry Conifer
 HFV Heath Forest
 IFV Ironwood Forest
 LIM Limestone Forest
 MDF Montane Deciduous Forest
 MWT Montane Wet Temperate Forest
 PSV Peat Swamp
 SAC Subalpine Conifer Forest
 SBH Sub-tropical Broadleaved
 Hillforest
 SCR Secondary Scrub
 SDV Sand desert vegetation
 SER Semi-Evergreen Rainforest
 SMF Sub-tropical Montane Forest
 SPF Sub-tropical Pine Forest
 STL Sub-tropical Lowland Forest
 TDE Tropical dry Evergreen Forest
 TME Tropical Montane Evergreen
 TPF Tropical Pine Forest

TSE Tropical Semievergreen Forest	TSF Thorn Scrub Forest
TWE Tropical Wet Evergreen Forest	UHF Upper Hardwood Forest
UMF Upper Montane Forest	URB Urban

4. Acronyms and Abbreviations:

ABC	Asian Bureau for Conservation
ADB	Asian Development Bank
ASEAN	Association of South East Asian Nations
AWB	Asian Wetland Bureau
AVHRR	Advanced Very High Resolution Radiometry
BAP	Biodiversity Action Plan
BARC	Bangladesh Agricultural Research Council
BI	Biodiversity Index
BIMS	Biodiversity Information Management System
CI	Conservation Index
CITES	Convention on International Trade in Endangered Species
CBD	Convention on Biological Diversity
CNPPAIUCN	Commission on National Parks and Protected Areas
EBA	Endemic Bird Area
ESRI	Environmental Systems Research Institute
FAO	Food and Agriculture Organisation of the United Nations
FSI	Forest Survey of India
GEF	Global Environment Facility
GEMS	Global Environment Monitoring System
GIS	Geographic Information System
GRID	Global Resources Information Division (UNEP)
ICBP	International Council for Bird Protection (now BirdLife International)
ICIMOD	International Centre for Integrated Mountain Development
ITTO	International Tropical Timber Organisation
IUCN	The World Conservation Union
IWRB	International Waterfowl and Wetlands Research Bureau
MAB	Man and Biosphere Programme
NCS	National Conservation Strategy
NGO	Non-governmental Agency
ODA	Overseas Development Administration (UK)
OI	Opportunity Index
ONC	Operational Navigation Charts
PA	Protected Area
RePPPProt	Regional Physical Planning Programme for Transmigration (Indonesia)
SIDA	Swedish International Development Authority
SPOT	Systeme Probatoire d'Observation de la Terre
SPREP	South Pacific Regional Environment Programme
SSC	Species Survival Commission (IUCN)
TFAP	Tropical Forestry Action Plan
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
Unesco	United Nations Educational, Scientific and Cultural Organisation
US-AID	United States Agency for International Development
WCMC	World Conservation Monitoring Centre
WRI	World Resources Institute
WWF	World Wide Fund for Nature

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Key to Maps

- Bathymetry: 0 - 200m
- Bathymetry: 200 - 2000m
- Bathymetry: over 2000m
- ∩ Coral reefs
- ∩ Major Roads
- ∩ Railways
- ∩ Major Rivers
- ▨ Lakes
- ∩ Coastlines
- ∩ International Boundaries
- Cities
- ∩ Biounits

PROTECTED AREAS

- ▨ IUCN Categories I - V
- ▨ IUCN Category VI and Unassigned
- ▨ Proposed

List of Maps

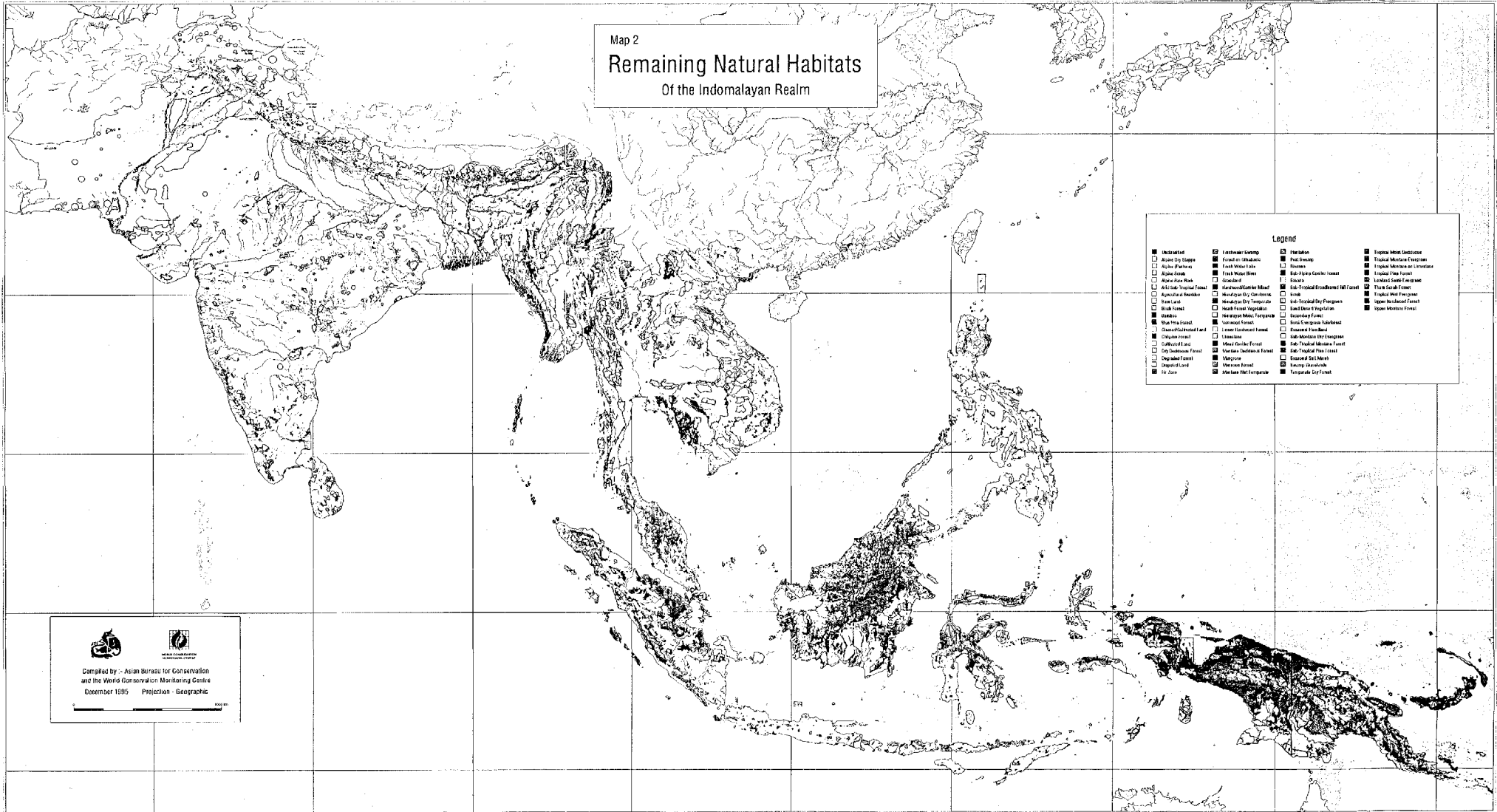
1. Original Habitats and Biounits of the Indo-Malayan Realm
2. Remaining Habitats and Protected Areas of the Indo-Malayan Realm
3. - 18. Country Maps of Remaining Habitat and Protected Areas

3. Bangladesh
4. Bhutan
5. Brunei Darussalam
6. Cambodia
- 7.a. India - North West
- 7.b. India - North East
- 7.c. India - South
- 8.a. Indonesia - Sumatra
- 8.b. Indonesia - Java & Bali
- 8.c. Indonesia - Kalimantan
- 8.d. Indonesia - Sulawesi
- 8.e. Indonesia - Lesser Sundas
- 8.f. Indonesia - Moluccas
- 8.g. Indonesia - Irian Jaya
9. Lao P.D.R.
- 10.a. Malaysia - West (inset Singapore)
- 10.b. Malaysia - Sarawak
- 10.c. Malaysia - Sabah
11. Myanmar
12. Nepal
13. Pakistan
14. Papua New Guinea
15. The Philippines
16. Sri Lanka
17. Thailand
18. Viet Nam





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and the World Conservation Monitoring Centre
Date Printed - 1996 Projection - Geographic

Map 2
Remaining Natural Habitats
 Of the Indomalayan Realm



Legend

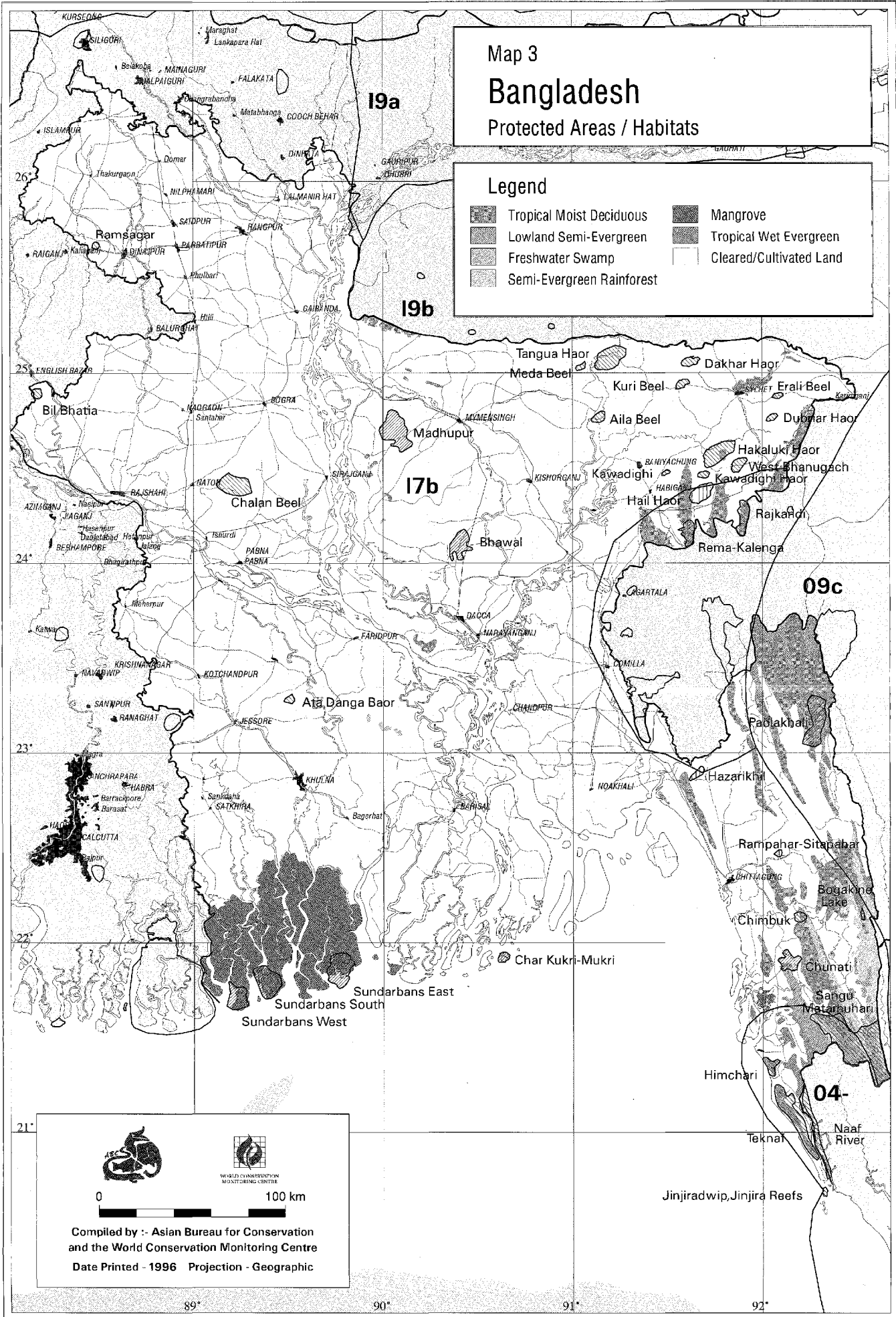
■ Urbanized	■ Freshwater Swamp	■ Mangrove	■ Tropical Almond Deciduous
□ Urban City Centre	■ Forest in Disbalance	■ Pastureland	■ Tropical Mixed Deciduous
■ Urban Park	■ Fresh Water Lake	■ Pasture	■ Tropical Monsoon or Livestock
■ Urban Green	■ Fresh Water River	■ Pasture Center Forest	■ Tropical Pine Forest
■ Urban Green Park	■ Grassland	■ Park	■ Tropical Semi Evergreen
■ Agricultural Forest	■ Mangrove/Coconut Wood	■ Sub-Tropical Broadleaved Hill Forest	■ Tropic Subalpine Forest
■ Agricultural Meadow	■ Mangrove Dry Deciduous	■ Sub-Tropical Dry Forest	■ Tropic Hill Evergreen
■ Bush Forest	■ Mangrove Dry Temperate	■ Sub-Tropical Dry Forest	■ Open Montane Forest
■ Shrub	■ South Coast Scrubland	■ Sub-Tropical Pine Forest	■ Open Montane Forest
■ Shrub Forest	■ New Guinea Hill Evergreen	■ Secondary Forest	
■ Shrub Tree Forest	■ Lowland Forest	■ Sub-Equatorial Submontane	
■ Chaco/Steppe and	■ Lower Montane Forest	■ Submontane Forest	
■ Chaparral Forest	■ Lowland	■ Sub-Montane Dry Evergreen	
■ Subalpine Hill	■ Montane Forest	■ Sub-Tropical Montane Forest	
■ Dry Submontane Forest	■ Montane Deciduous Forest	■ Sub-Tropical Pine Forest	
■ Open Forest	■ Mangrove	■ Savanna of East Africa	
■ Open Land	■ Mangrove Forest	■ Savanna Woodland	
■ Open Land	■ Mangrove Wet Evergreen	■ Temperate Dry Forest	
■ Wet Zone			



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Map 3 Bangladesh Protected Areas / Habitats

Legend

	Tropical Moist Deciduous		Mangrove
	Lowland Semi-Evergreen		Tropical Wet Evergreen
	Freshwater Swamp		Cleared/Cultivated Land
	Semi-Evergreen Rainforest		



Map 4
Bhutan
 Protected Areas / Habitats

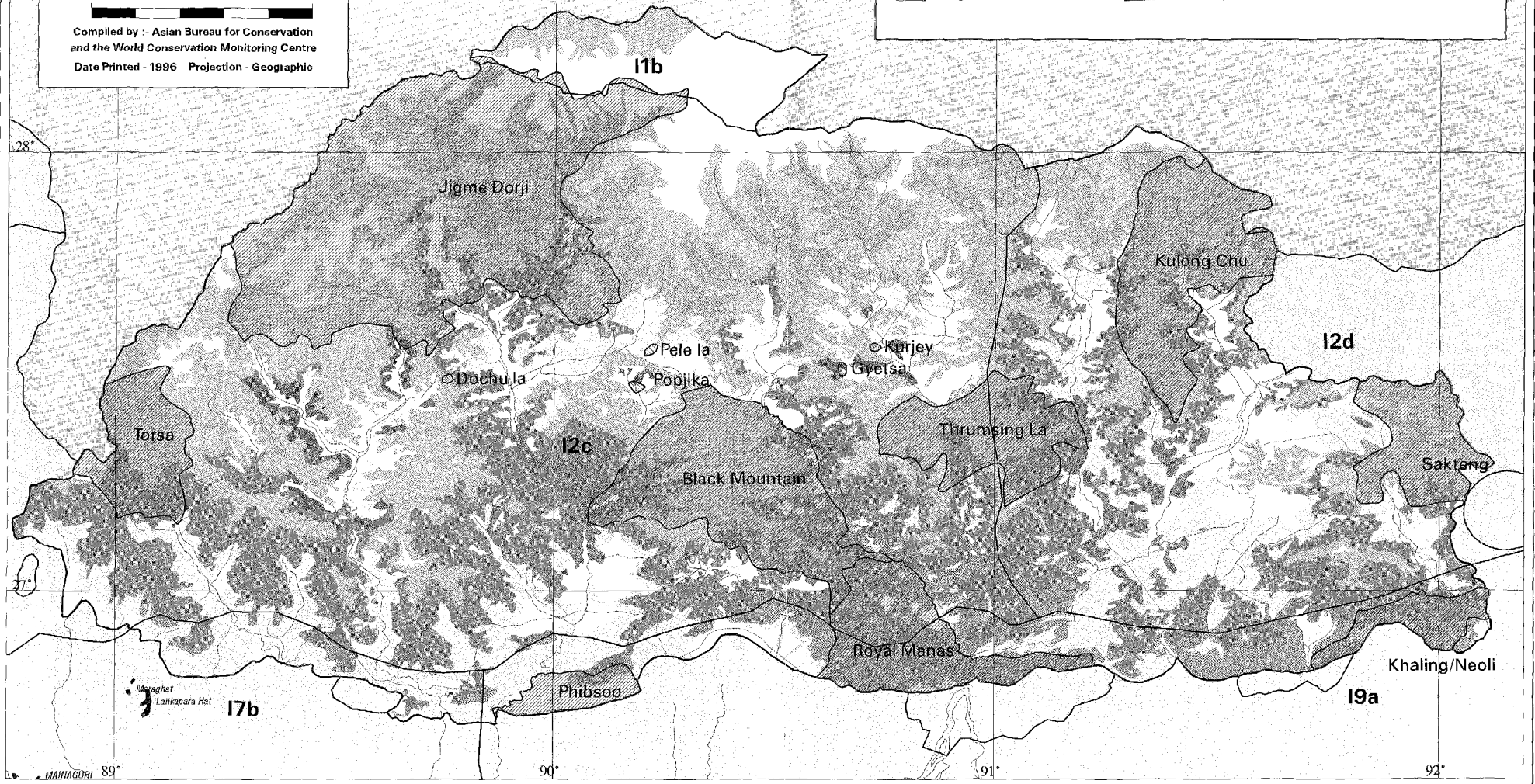


0 50 km

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Legend

- | | | | |
|--|---------------------------|--|--------------------------|
| | Alpine (Pasture) | | Blue Pine Forest |
| | Alpine Bare Rock | | Lower Hardwood Forest |
| | Alpine Scrub | | Riverine |
| | Sub-Alpine Conifer Forest | | Grassland |
| | Cleared/Cultivated Land | | Tropical Moist Deciduous |
| | Upper Hardwood Forest | | Montane Deciduous Forest |
| | Degraded Forest | | Sub-Tropical Pine Forest |



Map 5

Brunei Darussalam

Protected Areas / Habitats

5°00'



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and the World Conservation Monitoring Centre
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PEKAN SERIA

Anduki

Bentuan Catchment

Tasek Merimbun

Bukit Biang

Bukit Bedawan

Ulu Temburong

4°30'

Lutong

Miri

Ulu Tutong

25a

Ulu Mendaram

Bukit Teraja

Sungei Ingei

25f

Legend

- Cleared/Cultivated Land
- Degraded Forest
- Mangrove
- Peat Swamp
- Heath Forest Vegetation
- Tropical Wet Evergreen
- Freshwater Swamp
- Tropical Montane Evergreen

4°00'

114°00'

114°30'

115°00'

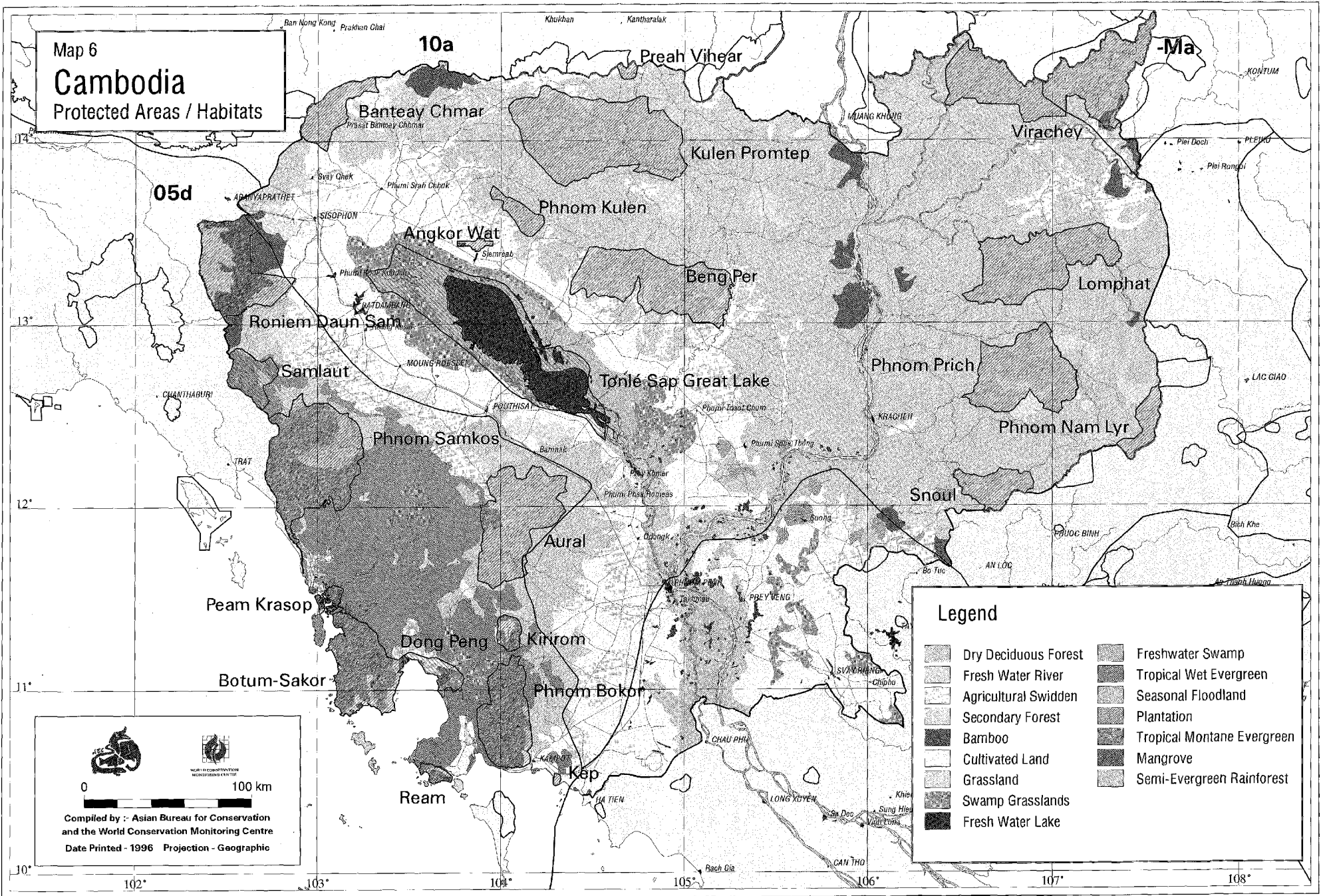
Bukit Batu Patam

BANDAR SERI BEGAWAN

Labu Selirong

Belait Peat Swamp

Map 6
Cambodia
 Protected Areas / Habitats



Legend

	Dry Deciduous Forest		Freshwater Swamp
	Fresh Water River		Tropical Wet Evergreen
	Agricultural Swidden		Seasonal Floodland
	Secondary Forest		Plantation
	Bamboo		Tropical Montane Evergreen
	Cultivated Land		Mangrove
	Grassland		Semi-Evergreen Rainforest
	Swamp Grasslands		
	Fresh Water Lake		

0 100 km
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 and the World Conservation Monitoring Centre
 Date Printed - 1996 Projection - Geographic

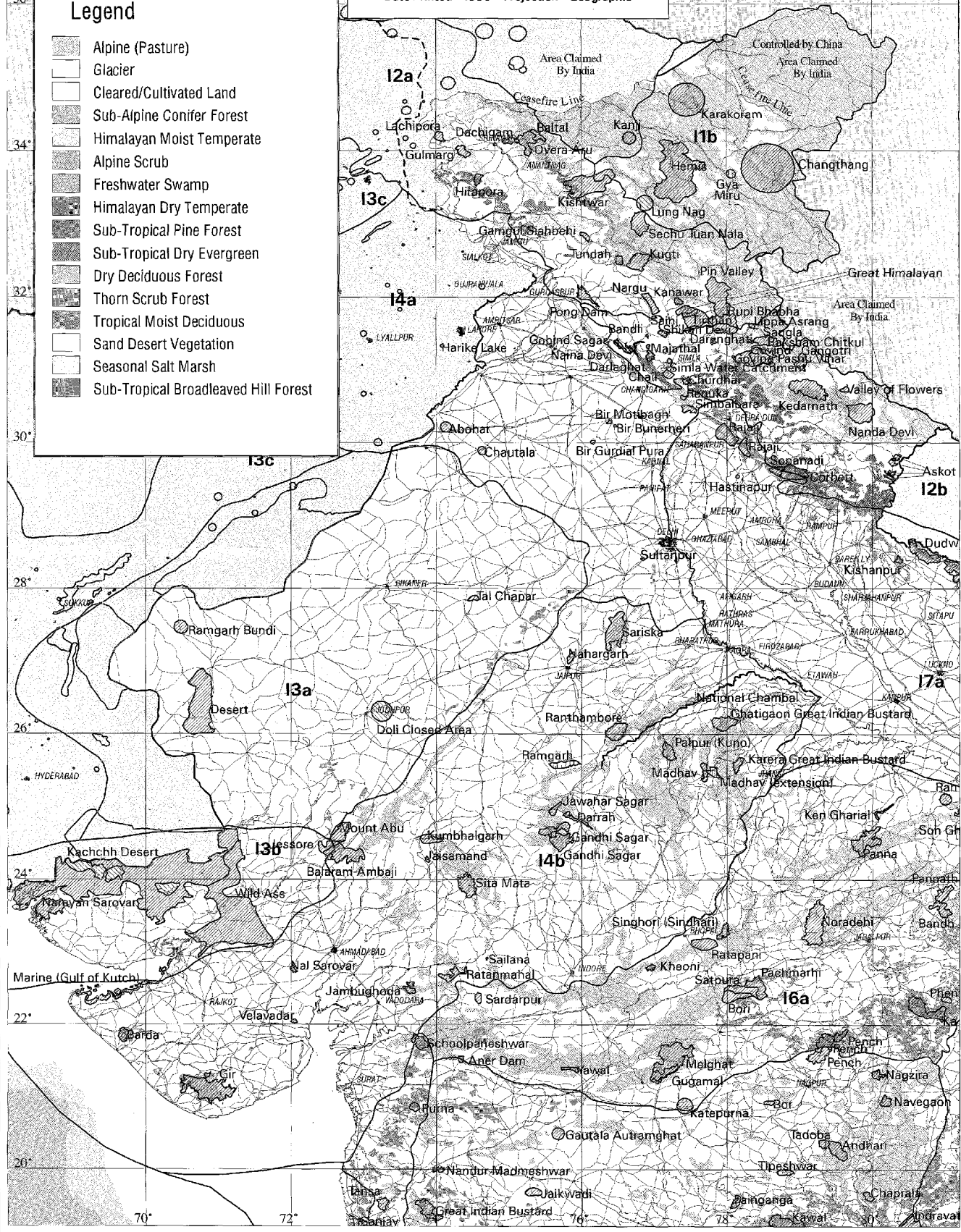
Map 7a India - North West Protected Areas / Habitats



Compiled by :- Asian Bureau for Conservation
and the World Conservation Monitoring Centre
Date Printed - 1996 Projection - Geographic

Legend


- Alpine (Pasture)
- Glacier
- Cleared/Cultivated Land
- Sub-Alpine Conifer Forest
- Himalayan Moist Temperate
- Alpine Scrub
- Freshwater Swamp
- Himalayan Dry Temperate
- Sub-Tropical Pine Forest
- Sub-Tropical Dry Evergreen
- Dry Deciduous Forest
- Thorn Scrub Forest
- Tropical Moist Deciduous
- Sand Desert Vegetation
- Seasonal Salt Marsh
- Sub-Tropical Broadleaved Hill Forest



Map 7b
India - North East
 Protected Areas / Habitats

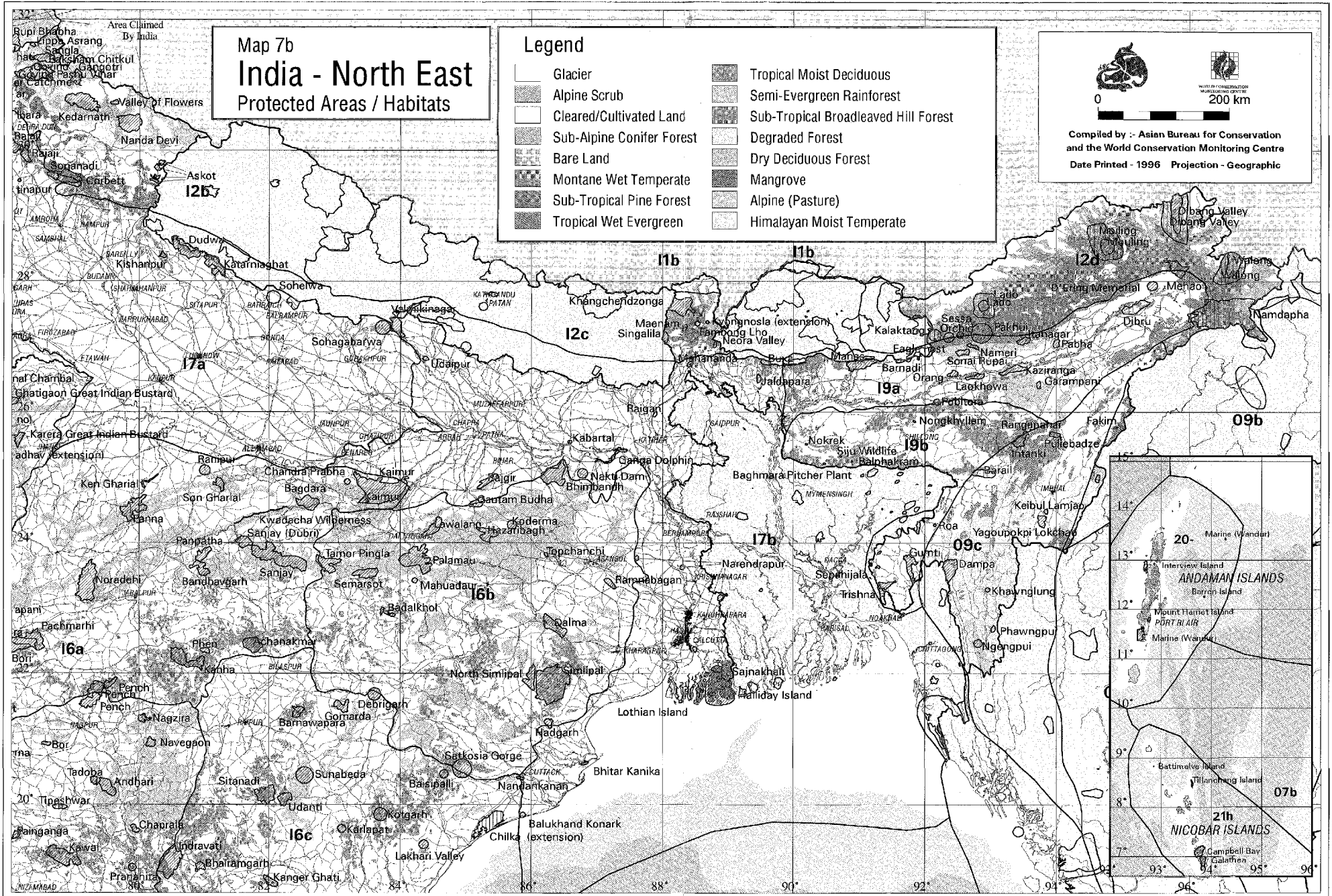
Legend

- | | | | |
|--|---------------------------|--|--------------------------------------|
| | Glacier | | Tropical Moist Deciduous |
| | Alpine Scrub | | Semi-Evergreen Rainforest |
| | Cleared/Cultivated Land | | Sub-Tropical Broadleaved Hill Forest |
| | Sub-Alpine Conifer Forest | | Degraded Forest |
| | Bare Land | | Dry Deciduous Forest |
| | Montane Wet Temperate | | Mangrove |
| | Sub-Tropical Pine Forest | | Alpine (Pasture) |
| | Tropical Wet Evergreen | | Himalayan Moist Temperate |



0 200 km

Compiled by :- Asian Bureau for Conservation
 and the World Conservation Monitoring Centre
 Date Printed - 1996 Projection - Geographic

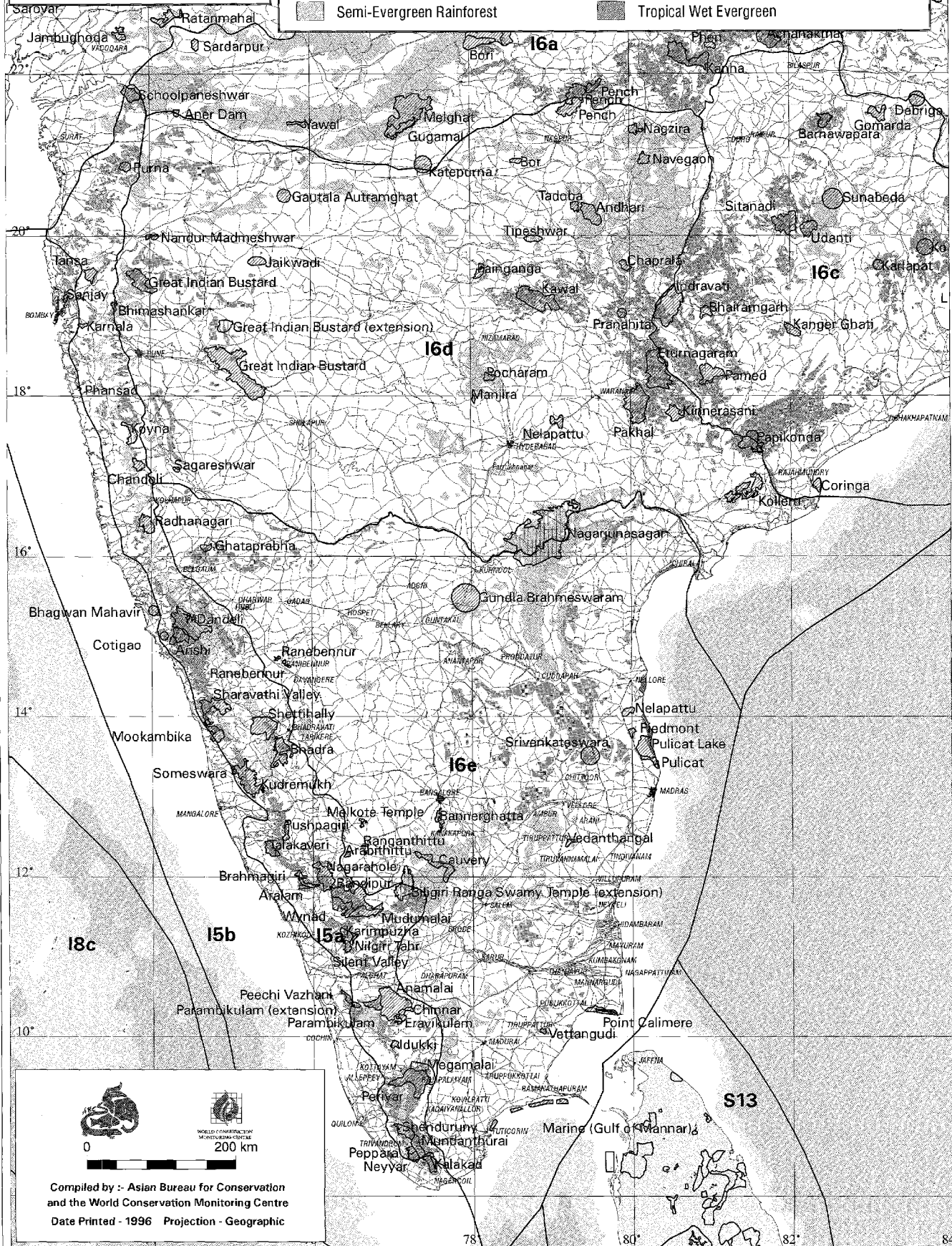


Map 7c

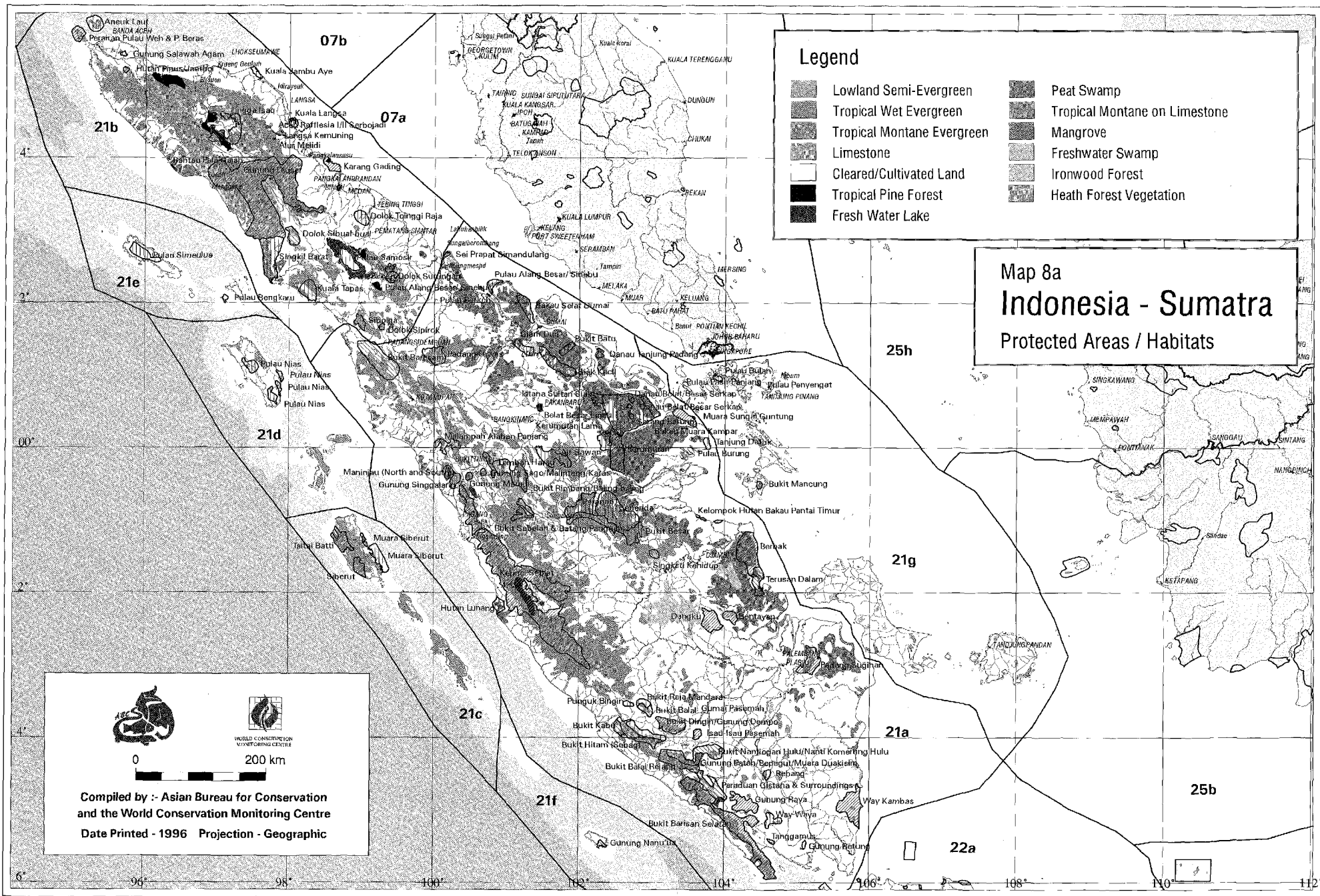
India - South
Protected Areas / Habitats

Legend

- | | | | |
|--|---------------------------|--|--------------------------------------|
| | Cleared/Cultivated Land | | Sub-Tropical Broadleaved Hill Forest |
| | Dry Deciduous Forest | | Thorn Scrub Forest |
| | Mangrove | | Tropical Dry Evergreen |
| | Montane Wet Temperate | | Tropical Moist Deciduous |
| | Semi-Evergreen Rainforest | | Tropical Wet Evergreen |




Compiled by :- Asian Bureau for Conservation
and the World Conservation Monitoring Centre
Date Printed - 1996 Projection - Geographic



Legend

- | | | | |
|--|----------------------------|--|-------------------------------|
| | Lowland Semi-Evergreen | | Peat Swamp |
| | Tropical Wet Evergreen | | Tropical Montane on Limestone |
| | Tropical Montane Evergreen | | Mangrove |
| | Limestone | | Freshwater Swamp |
| | Cleared/Cultivated Land | | Ironwood Forest |
| | Tropical Pine Forest | | Heath Forest Vegetation |
| | Fresh Water Lake | | |

Map 8a
Indonesia - Sumatra
 Protected Areas / Habitats



0 200 km

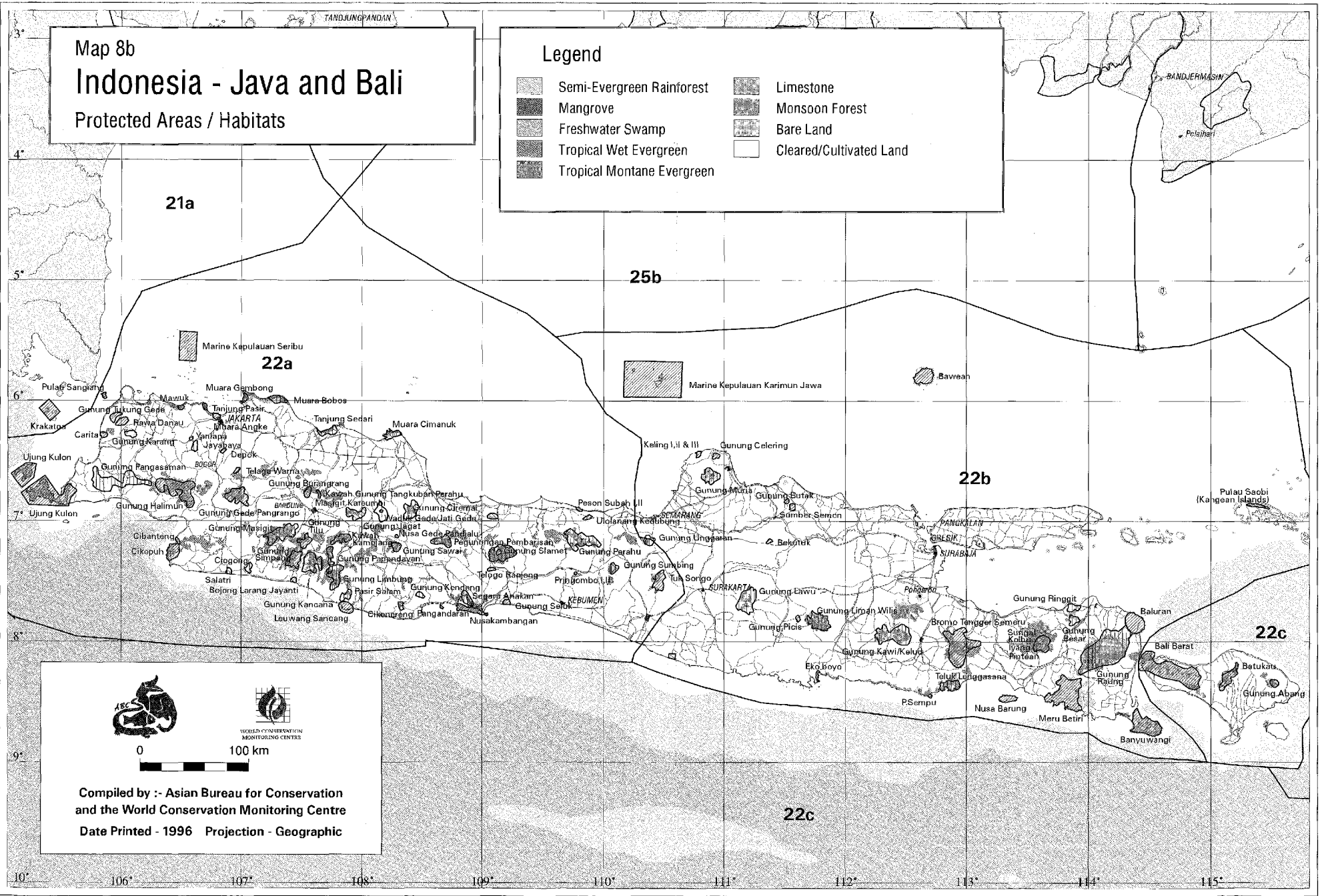
Compiled by :- Asian Bureau for Conservation
 and the World Conservation Monitoring Centre
 Date Printed - 1996 Projection - Geographic

6° 96° 98° 100° 102° 104° 106° 108° 110° 112°

Map 8b
Indonesia - Java and Bali
 Protected Areas / Habitats

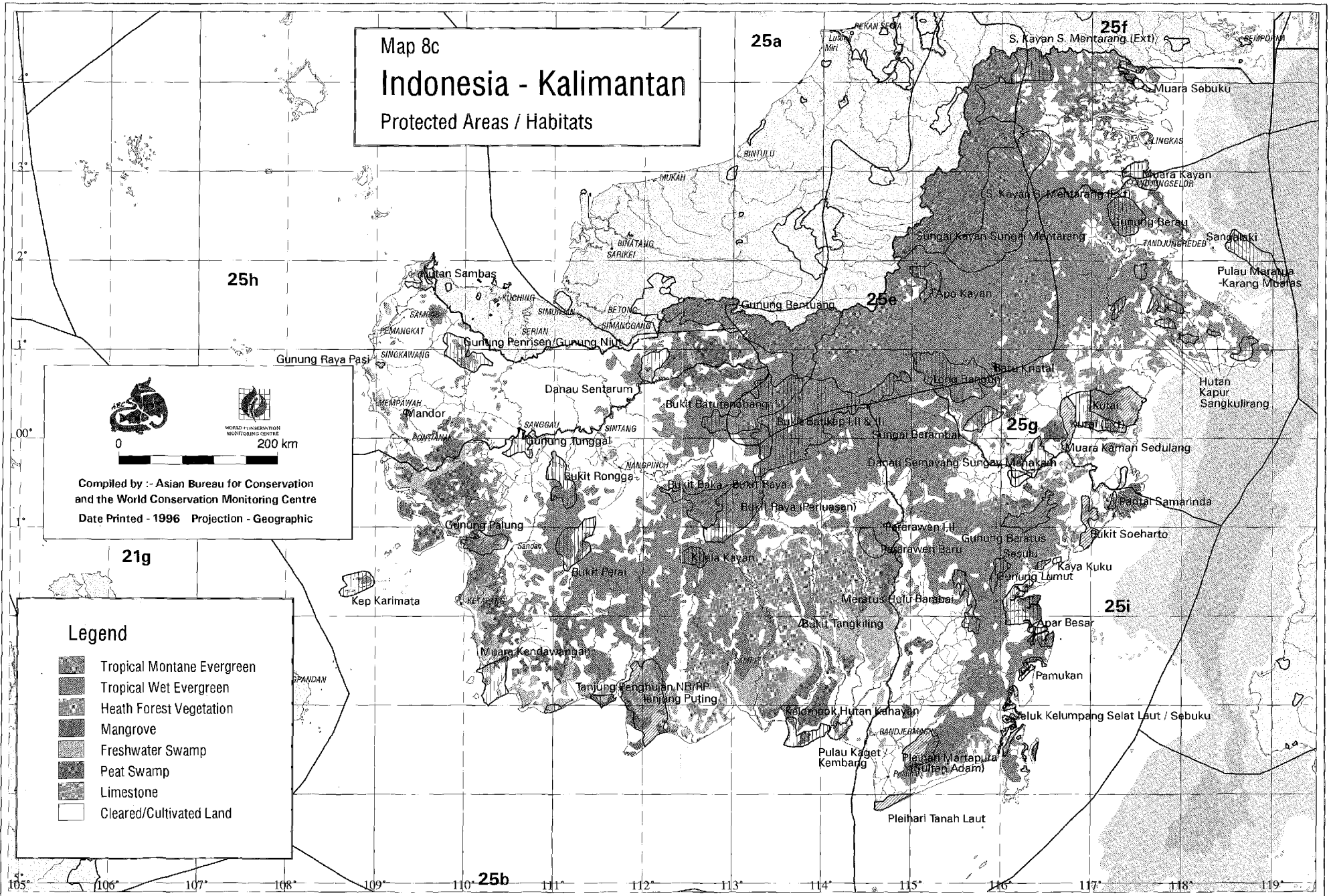
Legend



- | | | | |
|--|----------------------------|--|-------------------------|
| | Semi-Evergreen Rainforest | | Limestone |
| | Mangrove | | Monsoon Forest |
| | Freshwater Swamp | | Bare Land |
| | Tropical Wet Evergreen | | Cleared/Cultivated Land |
| | Tropical Montane Evergreen | | |











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Map 8c
Indonesia - Kalimantan
 Protected Areas / Habitats





 0 200 km
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Legend

-  Tropical Montane Evergreen
-  Tropical Wet Evergreen
-  Heath Forest Vegetation
-  Mangrove
-  Freshwater Swamp
-  Peat Swamp
-  Limestone
-  Cleared/Cultivated Land

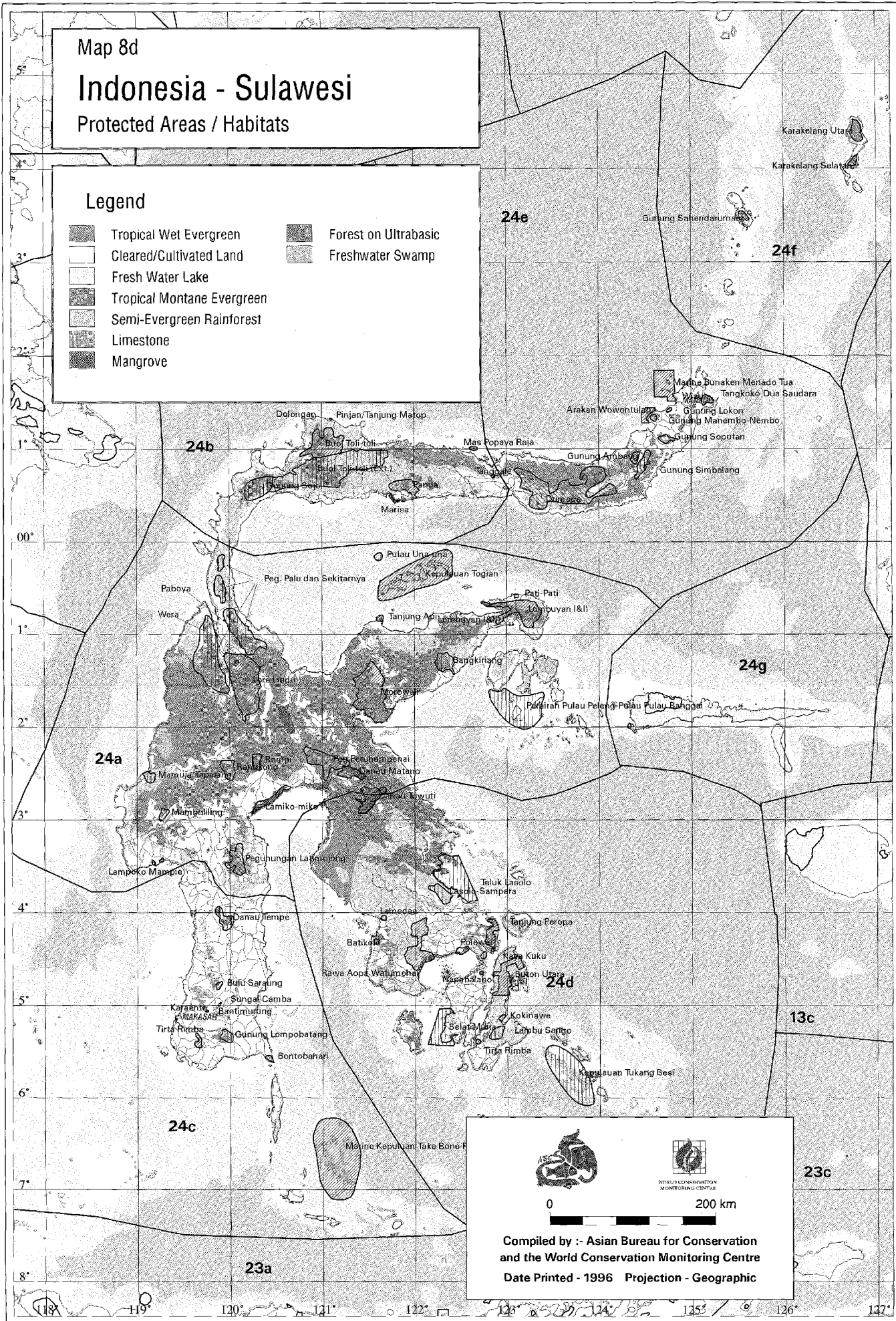
Map 8d

Indonesia - Sulawesi

Protected Areas / Habitats

Legend

- | | | | |
|--|----------------------------|--|----------------------|
| | Tropical Wet Evergreen | | Forest on Ultrabasic |
| | Cleared/Cultivated Land | | Freshwater Swamp |
| | Fresh Water Lake | | |
| | Tropical Montane Evergreen | | |
| | Semi-Evergreen Rainforest | | |
| | Limestone | | |
| | Mangrove | | |



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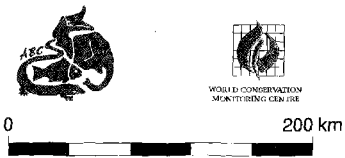
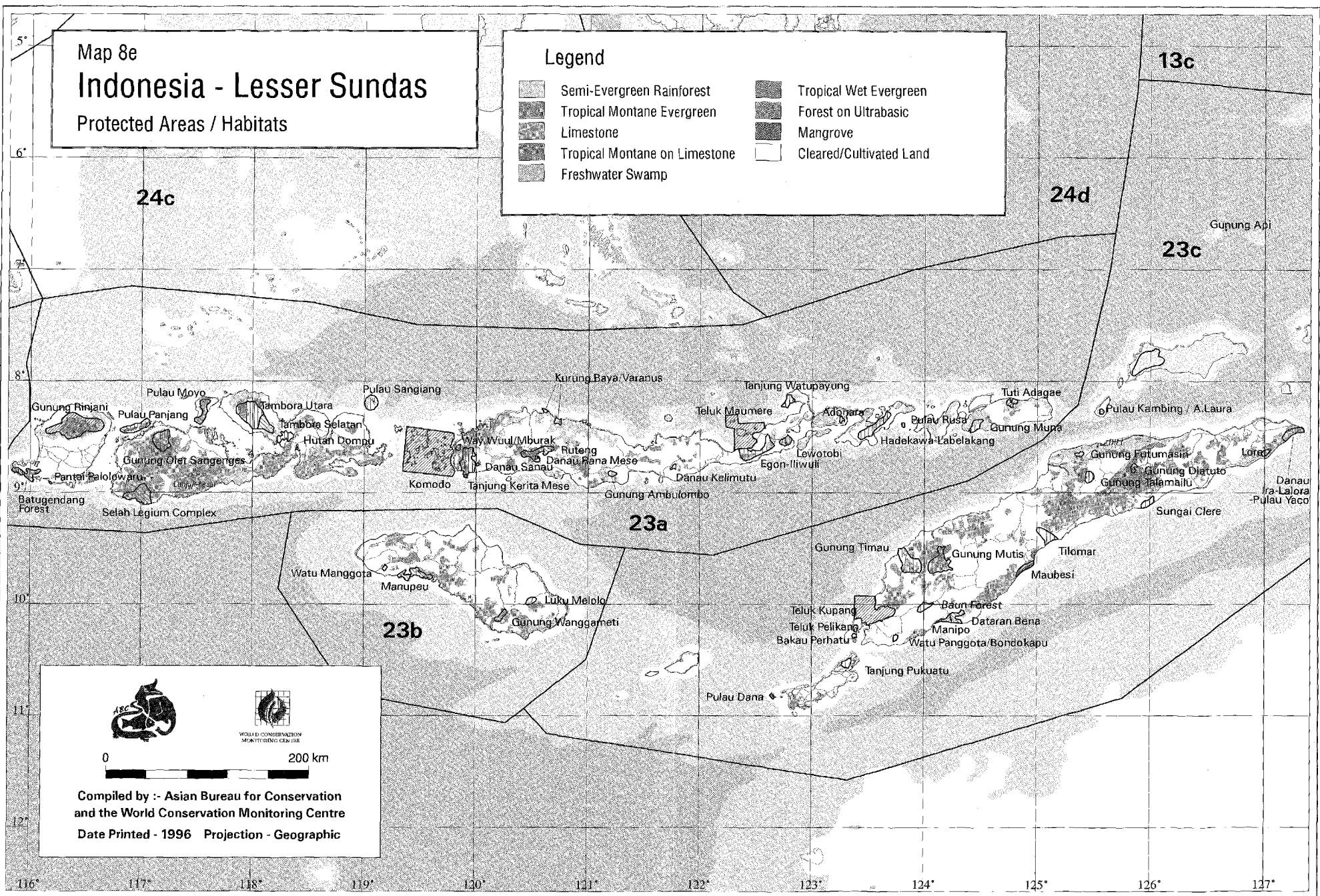
Map 8e

Indonesia - Lesser Sundas

Protected Areas / Habitats

Legend

- | | | | |
|--|-------------------------------|--|-------------------------|
| | Semi-Evergreen Rainforest | | Tropical Wet Evergreen |
| | Tropical Montane Evergreen | | Forest on Ultrabasic |
| | Limestone | | Mangrove |
| | Tropical Montane on Limestone | | Cleared/Cultivated Land |
| | Freshwater Swamp | | |



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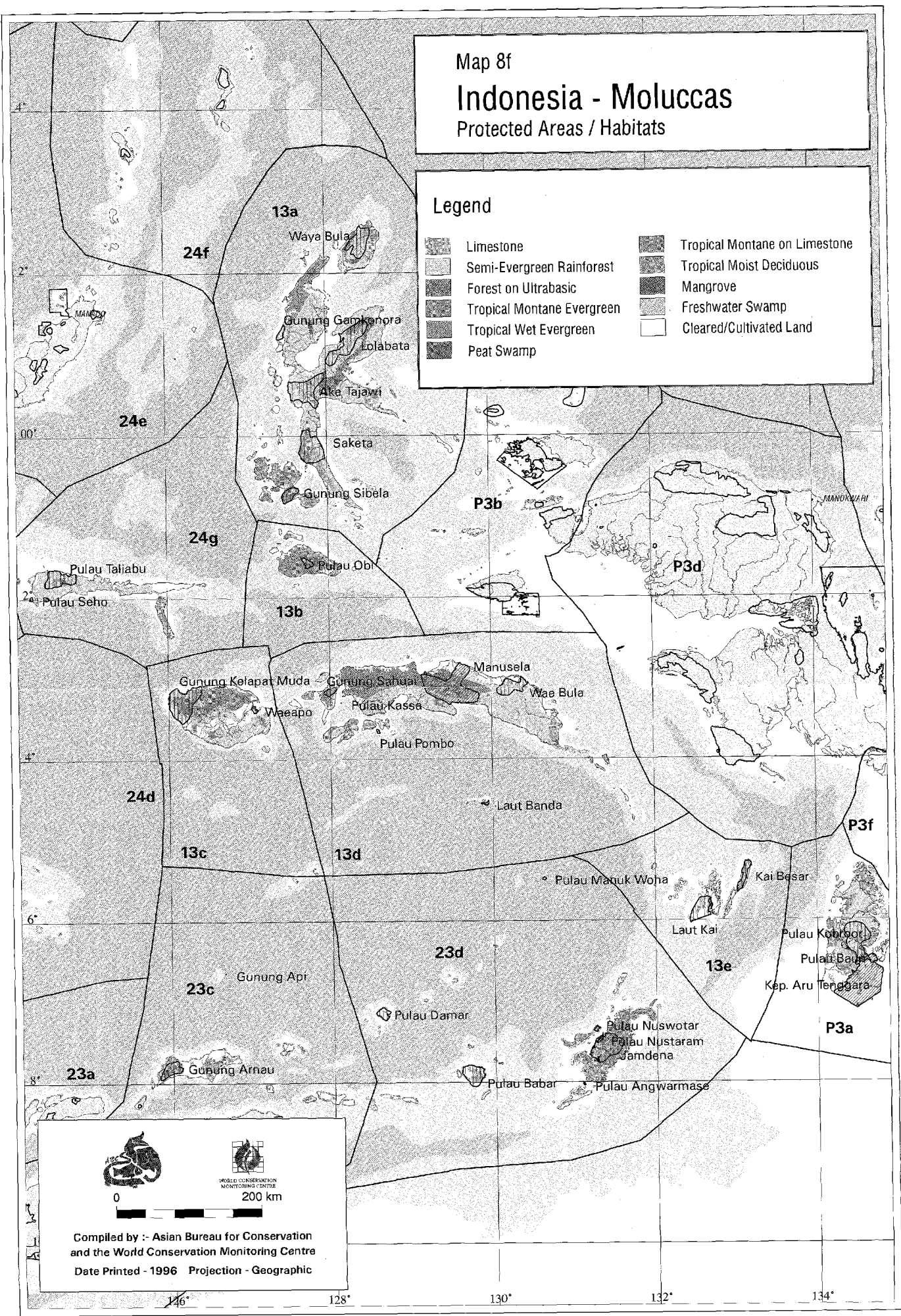
Map 8f

Indonesia - Moluccas

Protected Areas / Habitats

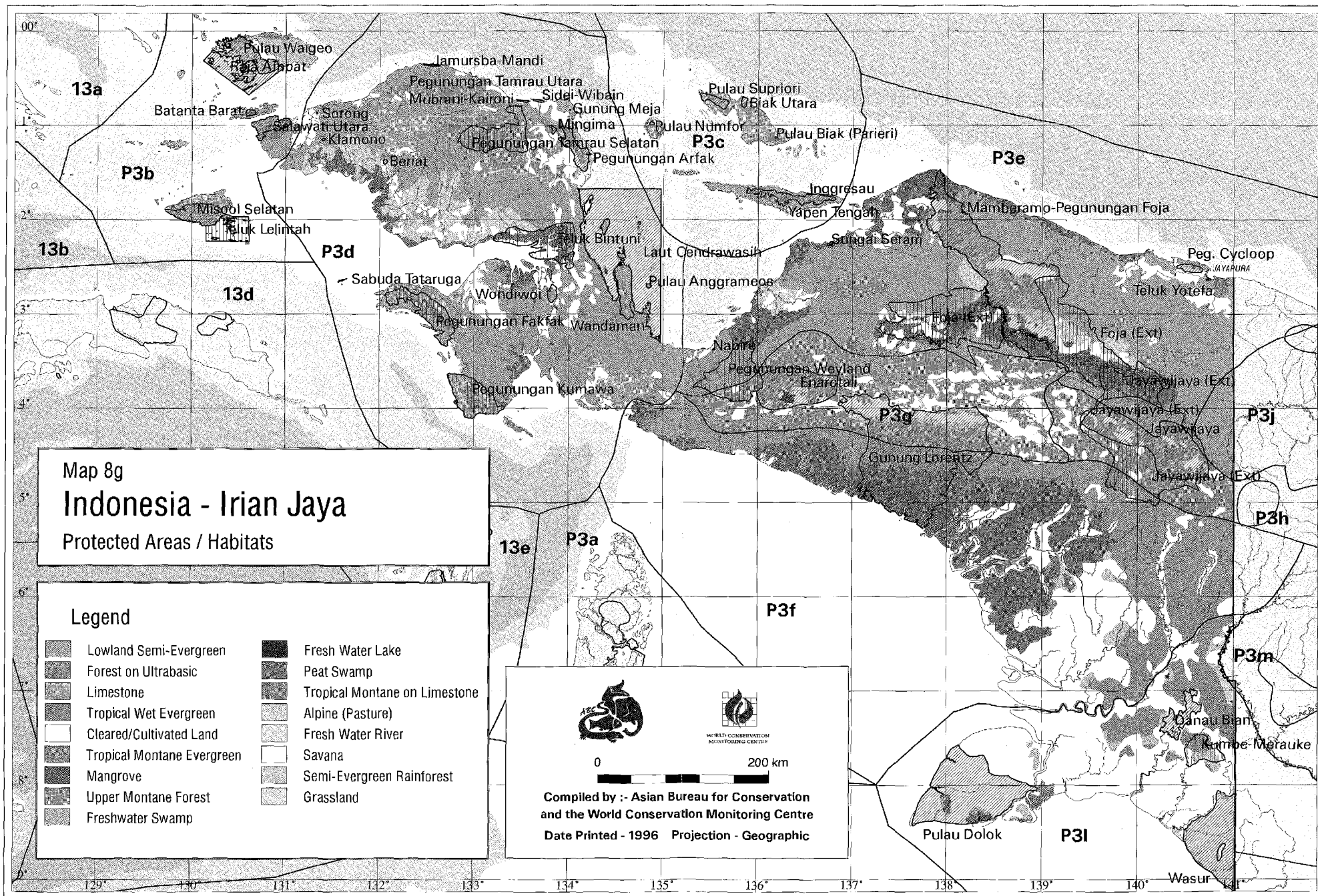
Legend

- | | | | |
|--|----------------------------|--|-------------------------------|
| | Limestone | | Tropical Montane on Limestone |
| | Semi-Evergreen Rainforest | | Tropical Moist Deciduous |
| | Forest on Ultrabasic | | Mangrove |
| | Tropical Montane Evergreen | | Freshwater Swamp |
| | Tropical Wet Evergreen | | Cleared/Cultivated Land |
| | Peat Swamp | | |

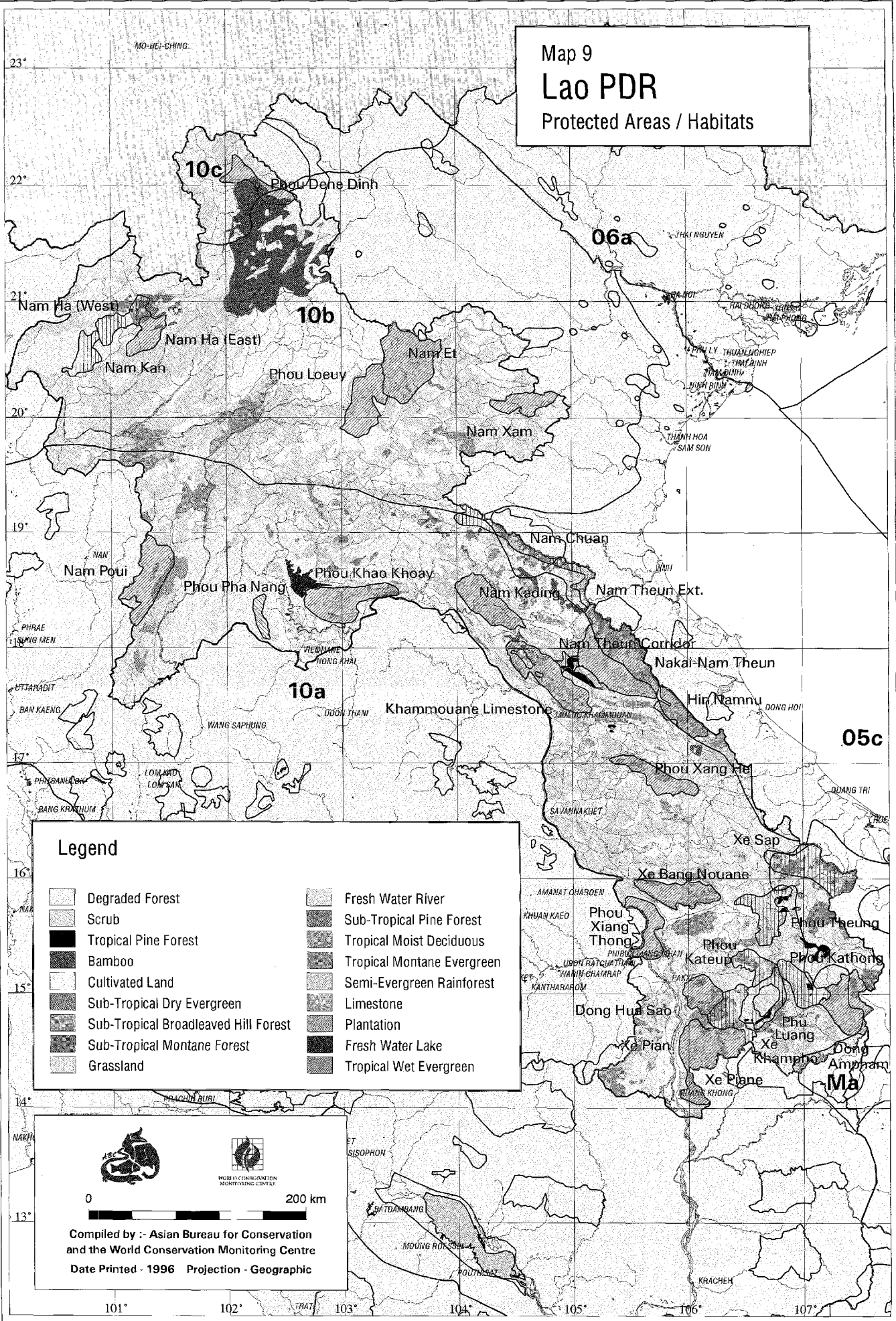


0 200 km

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Map 9
Lao PDR
 Protected Areas / Habitats











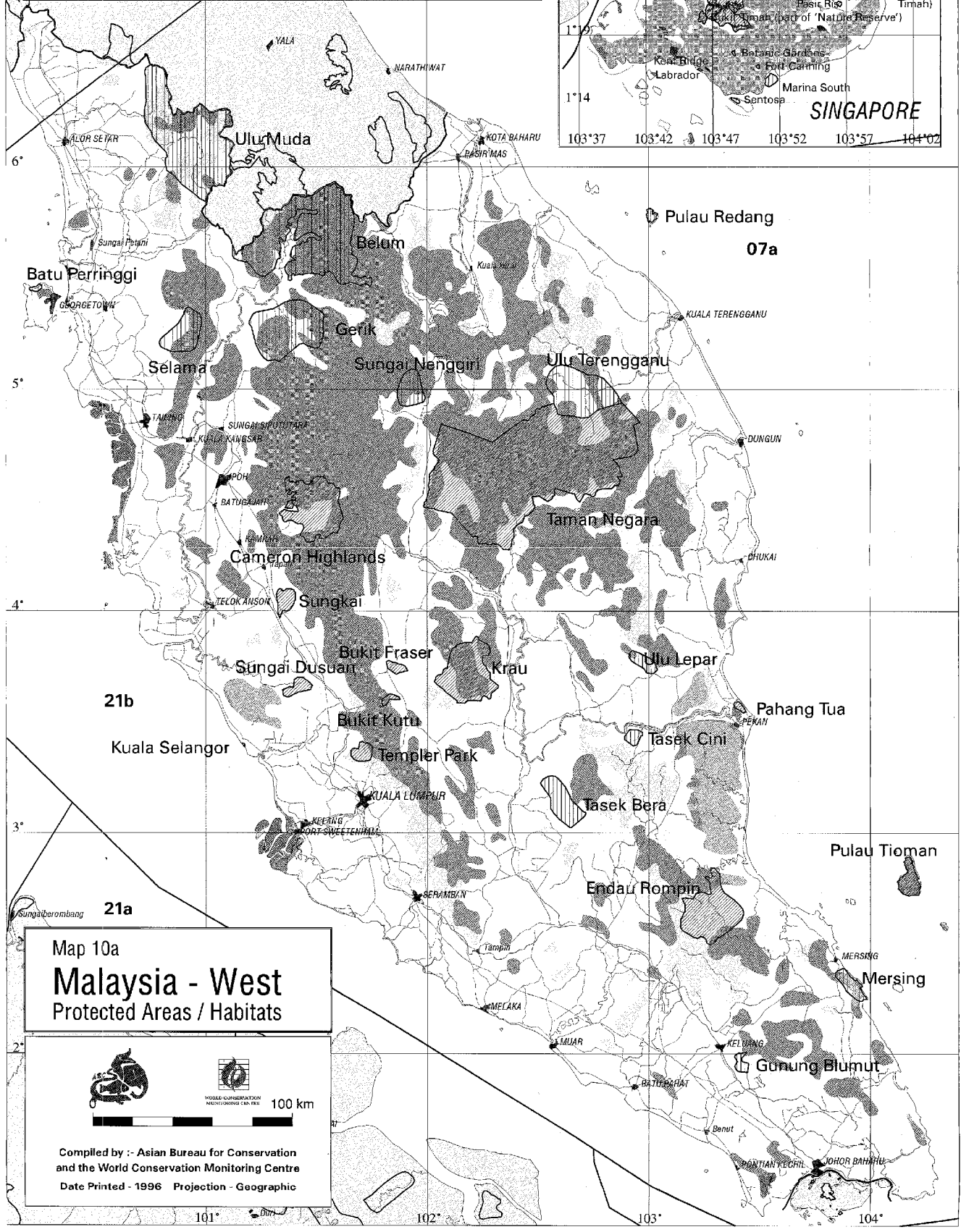
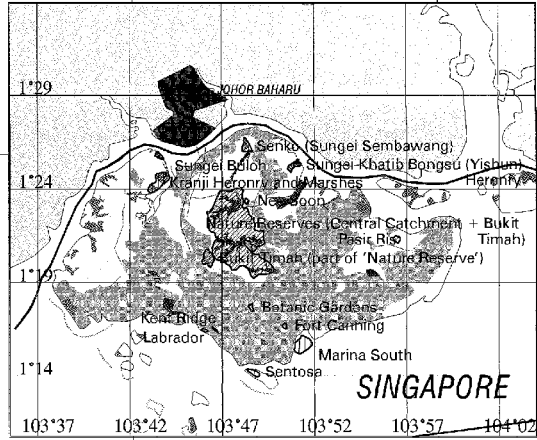
Legend			
	Degraded Forest		Fresh Water River
	Scrub		Sub-Tropical Pine Forest
	Tropical Pine Forest		Tropical Moist Deciduous
	Bamboo		Tropical Montane Evergreen
	Cultivated Land		Semi-Evergreen Rainforest
	Sub-Tropical Dry Evergreen		Limestone
	Sub-Tropical Broadleaved Hill Forest		Plantation
	Sub-Tropical Montane Forest		Fresh Water Lake
	Grassland		Tropical Wet Evergreen

0 200 km


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Legend

- | | |
|---|--|
|  Degraded Forest |  Tropical Montane Evergreen |
|  Cleared/Cultivated Land |  Freshwater Swamp |
|  Tropical Wet Evergreen |  Secondary Forest |
|  Mangrove |  Urban Areas |



Map 10a
Malaysia - West
 Protected Areas / Habitats












100 km

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Map 10b

Malaysia - Sarawak Protected Areas / Habitats

Legend

-  Cleared/Cultivated Land
-  Tropical Wet Evergreen
-  Mangrove
-  Tropical Montane Evergreen
-  Heath Forest Vegetation
-  Peat Swamp
-  Limestone
-  Fresh Water Lake
-  Freshwater Swamp

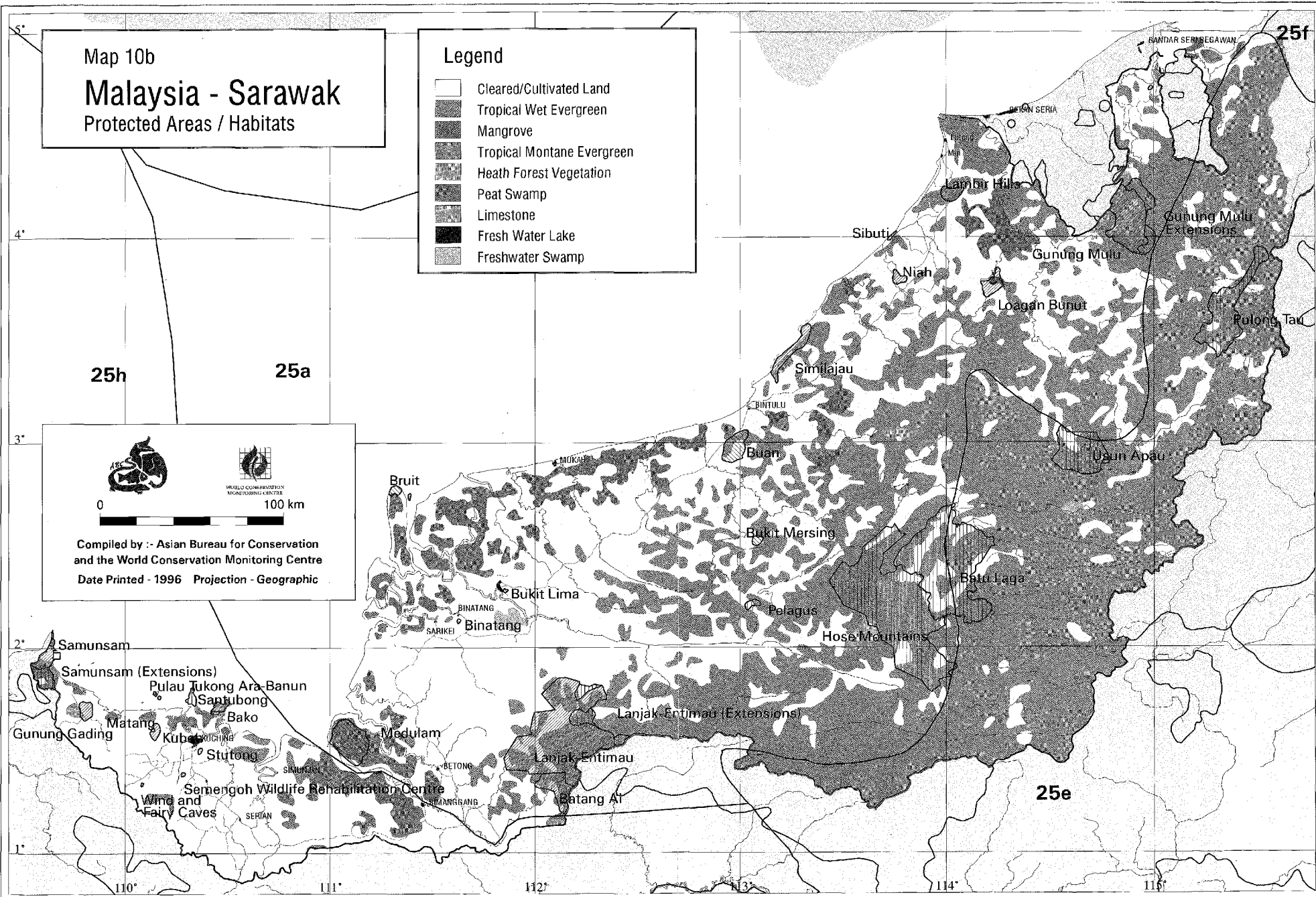
25h

25a



0 100 km

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Map 10c

Malaysia - Sabah

Protected Areas / Habitats

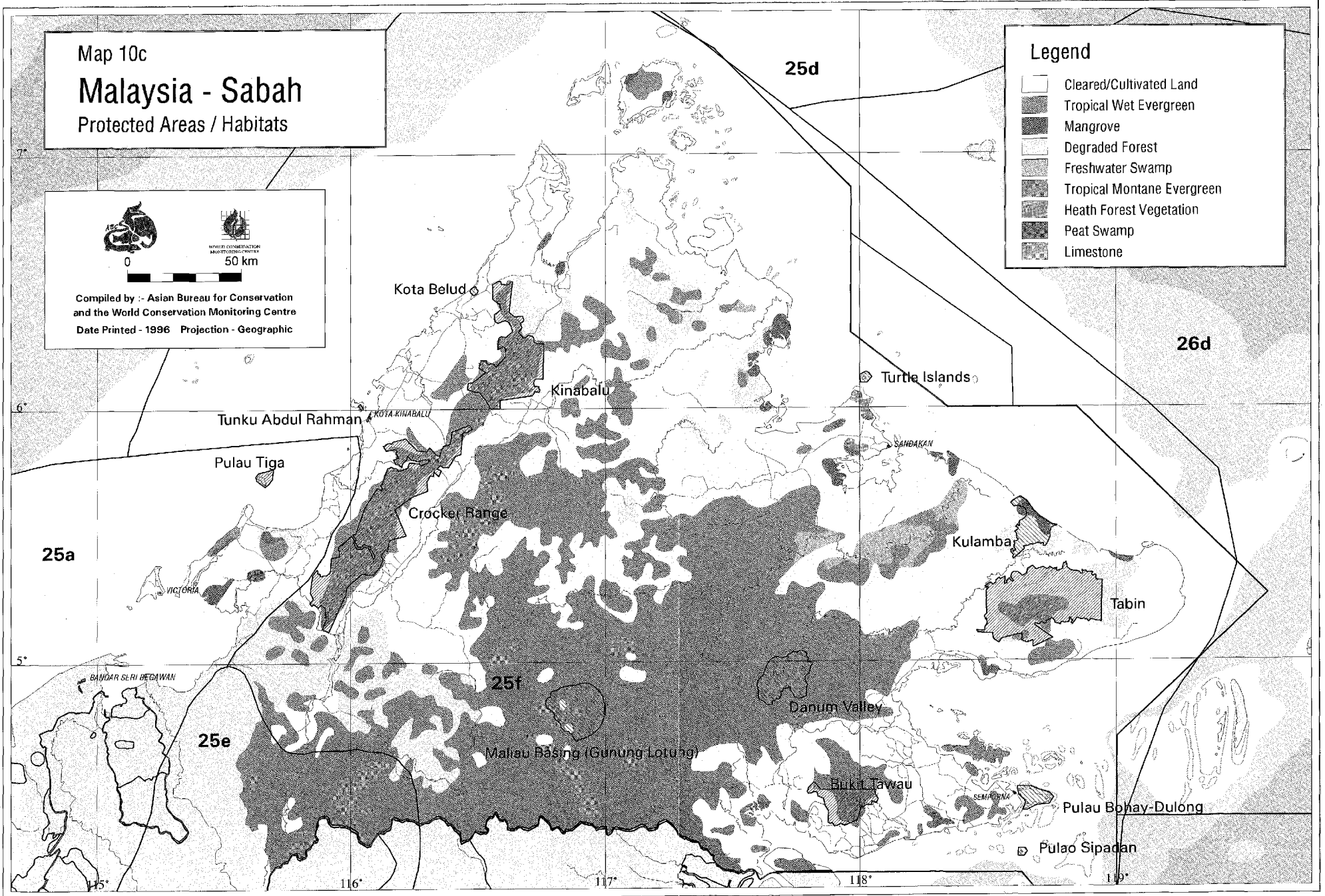


0 50 km

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Legend

- Cleared/Cultivated Land
- Tropical Wet Evergreen
- Mangrove
- Degraded Forest
- Freshwater Swamp
- Tropical Montane Evergreen
- Heath Forest Vegetation
- Peat Swamp
- Limestone

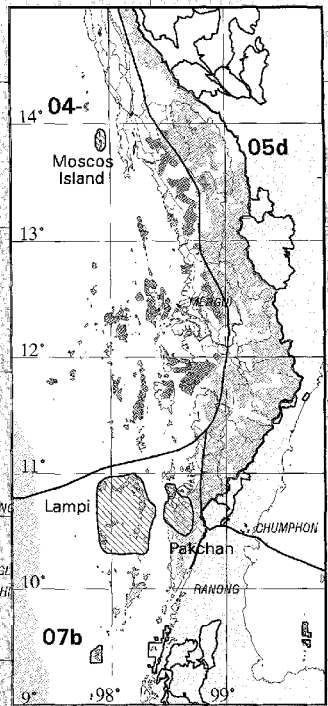
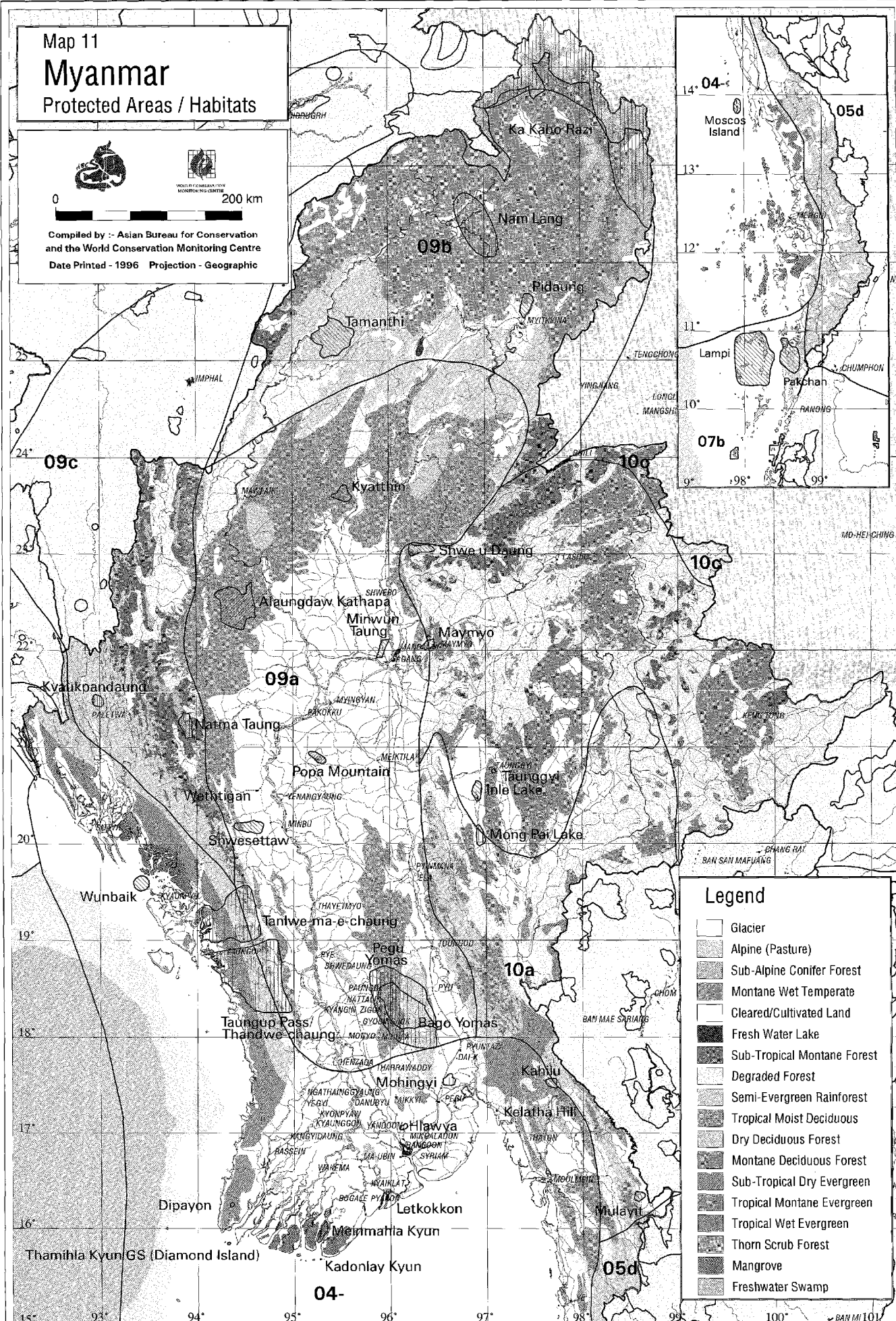


Map 11
Myanmar
 Protected Areas / Habitats



0 200 km

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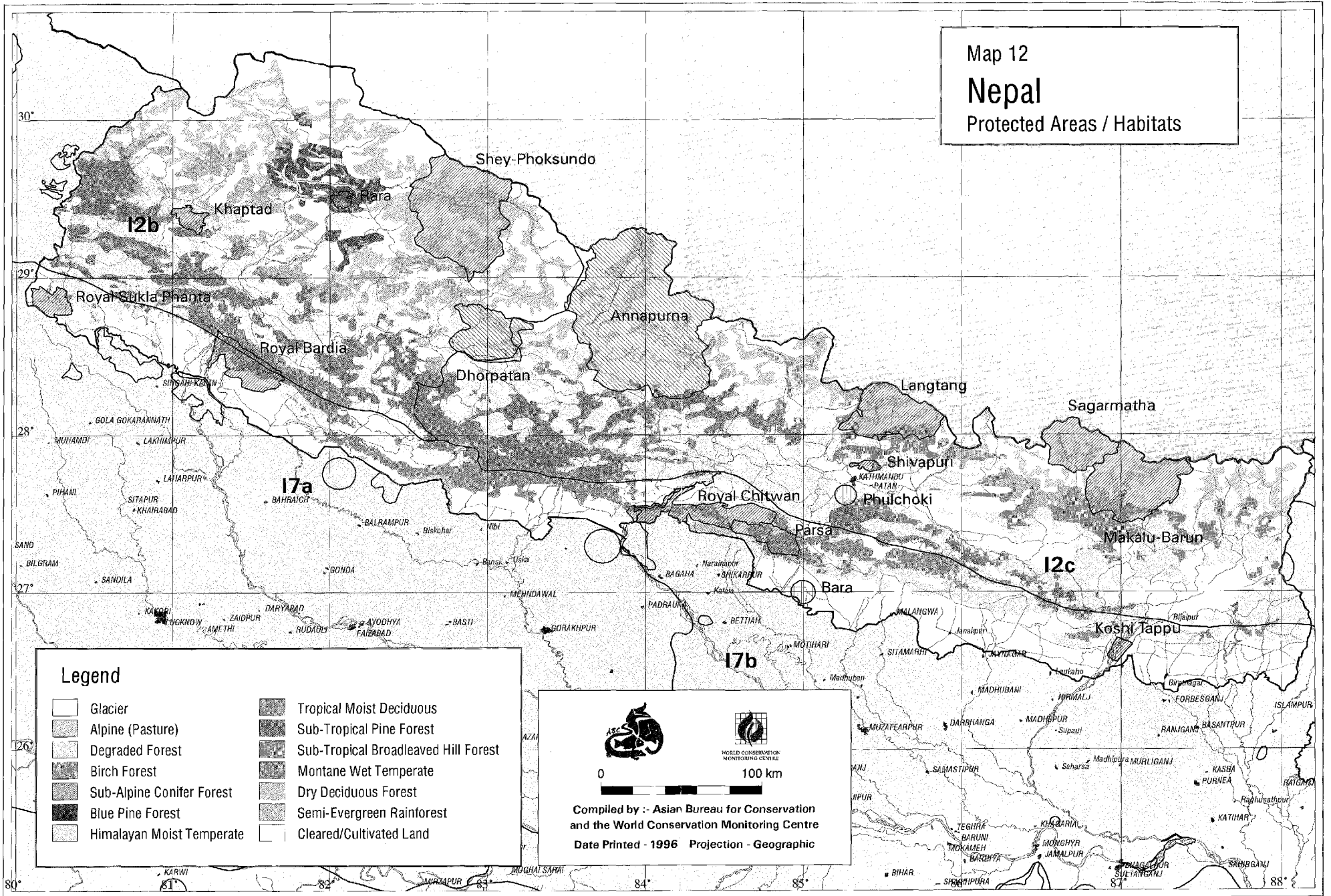
Legend

[White box]	Glacier
[Diagonal lines /]	Alpine (Pasture)
[Diagonal lines \]	Sub-Alpine Conifer Forest
[Cross-hatch]	Montane Wet Temperate
[White box]	Cleared/Cultivated Land
[Blue box]	Fresh Water Lake
[Dark grey box]	Sub-Tropical Montane Forest
[Light grey box]	Degraded Forest
[Vertical lines]	Semi-Evergreen Rainforest
[Horizontal lines]	Tropical Moist Deciduous
[Dotted pattern]	Dry Deciduous Forest
[Diagonal lines /]	Montane Deciduous Forest
[Diagonal lines \]	Sub-Tropical Dry Evergreen
[Cross-hatch]	Tropical Montane Evergreen
[Vertical lines]	Tropical Wet Evergreen
[Dotted pattern]	Thorn Scrub Forest
[Dark grey box]	Mangrove
[Light grey box]	Freshwater Swamp

Map 12

Nepal

Protected Areas / Habitats



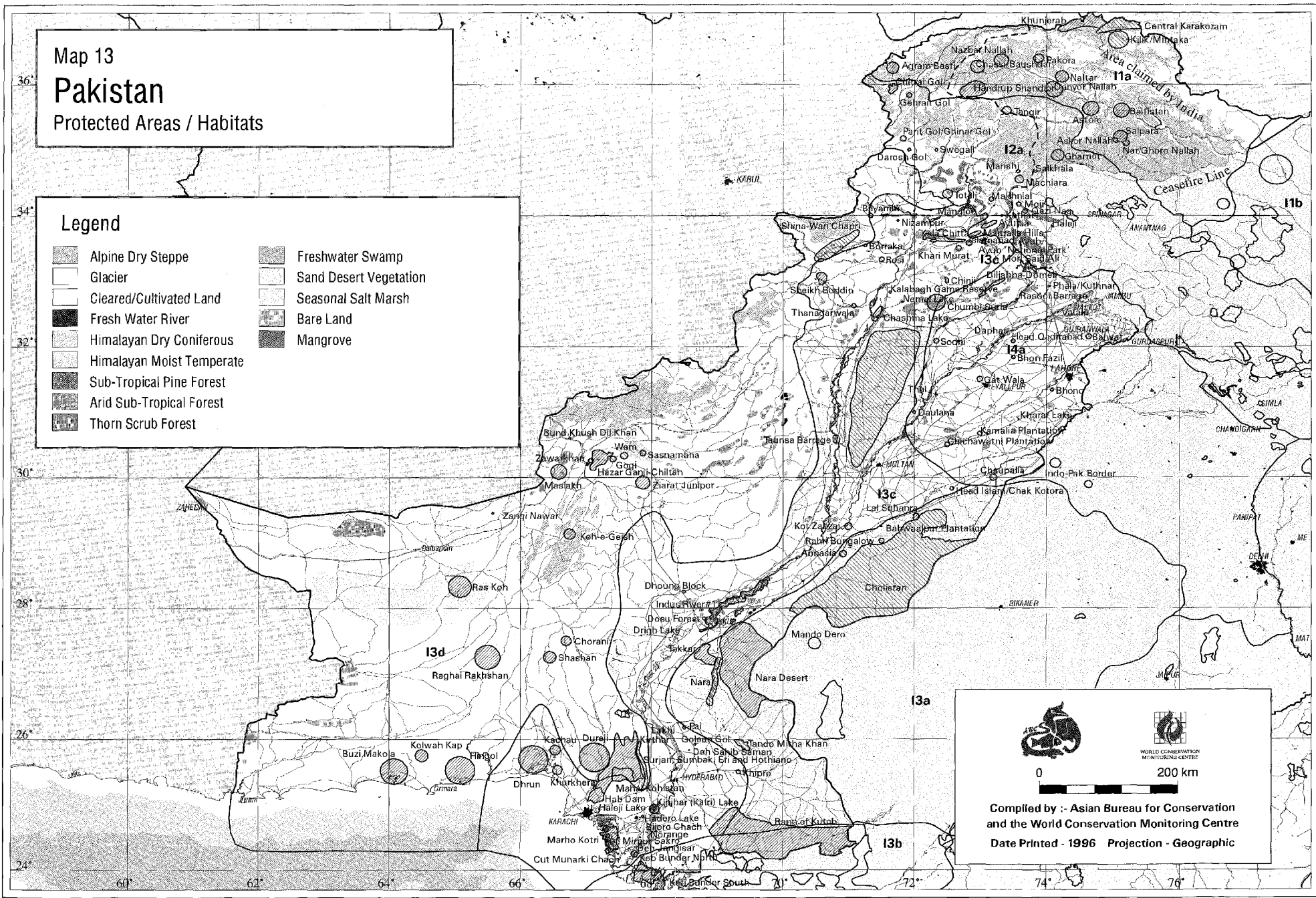
Map 13

Pakistan

Protected Areas / Habitats

Legend

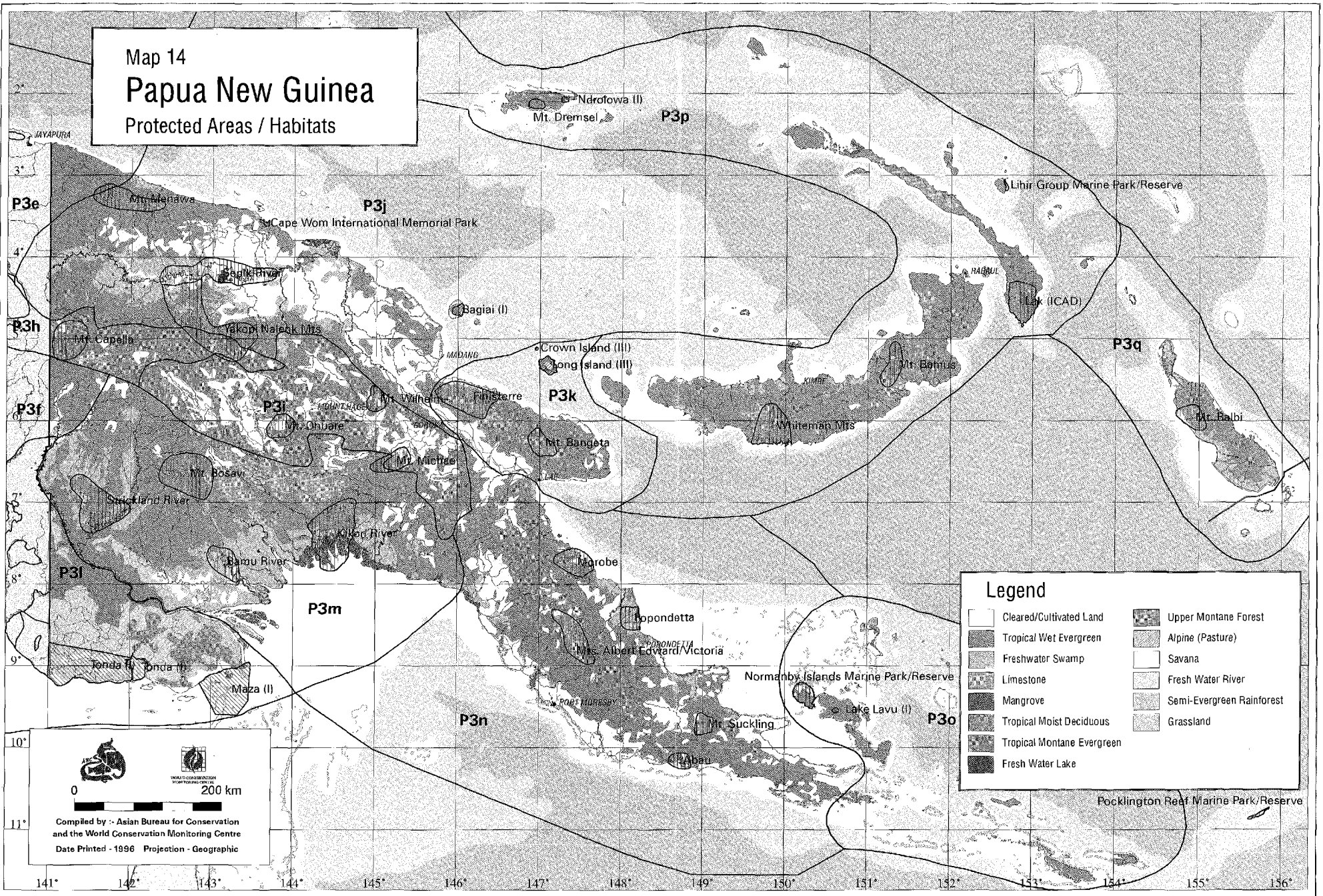
- | | | | |
|--|---------------------------|--|------------------------|
| | Alpine Dry Steppe | | Freshwater Swamp |
| | Glacier | | Sand Desert Vegetation |
| | Cleared/Cultivated Land | | Seasonal Salt Marsh |
| | Fresh Water River | | Bare Land |
| | Himalayan Dry Coniferous | | Mangrove |
| | Himalayan Moist Temperate | | |
| | Sub-Tropical Pine Forest | | |
| | Arid Sub-Tropical Forest | | |
| | Thorn Scrub Forest | | |



0 200 km

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Map 14
Papua New Guinea
 Protected Areas / Habitats



- Legend**
- | | | | |
|--|----------------------------|--|---------------------------|
| | Cleared/Cultivated Land | | Upper Montane Forest |
| | Tropical Wet Evergreen | | Alpine (Pasture) |
| | Freshwater Swamp | | Savana |
| | Limestone | | Fresh Water River |
| | Mangrove | | Semi-Evergreen Rainforest |
| | Tropical Moist Deciduous | | Grassland |
| | Tropical Montane Evergreen | | |
| | Fresh Water Lake | | |

0 200 km

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Map 15

The Philippines

Protected Areas / Habitats

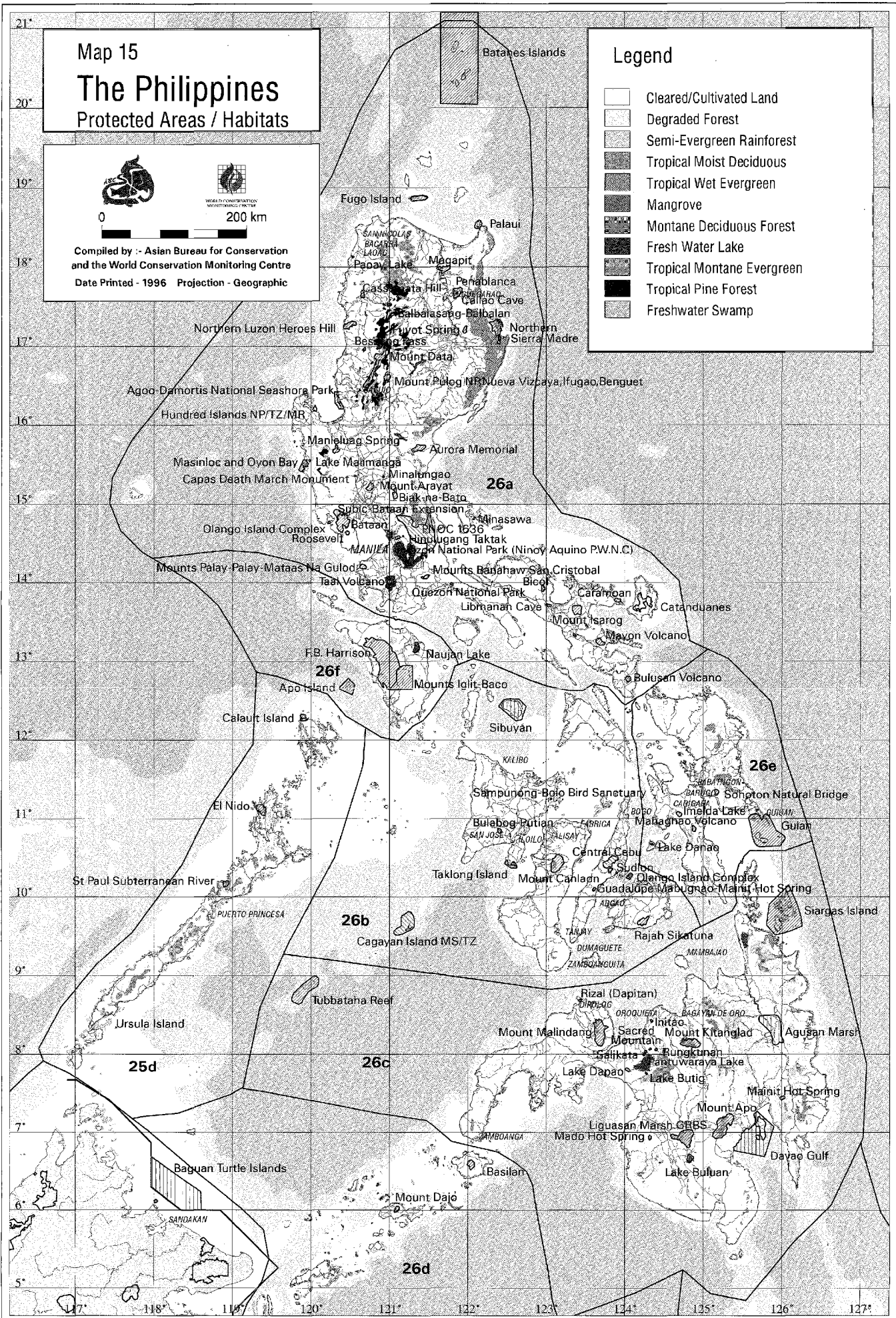


0 200 km

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Legend

- Cleared/Cultivated Land
- Degraded Forest
- Semi-Evergreen Rainforest
- Tropical Moist Deciduous
- Tropical Wet Evergreen
- Mangrove
- Montane Deciduous Forest
- Fresh Water Lake
- Tropical Montane Evergreen
- Tropical Pine Forest
- Freshwater Swamp

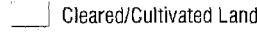
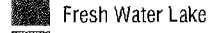
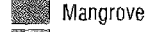
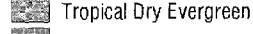
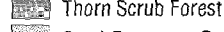
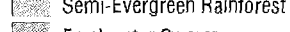
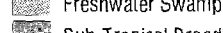
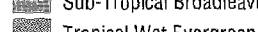
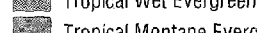
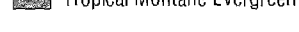


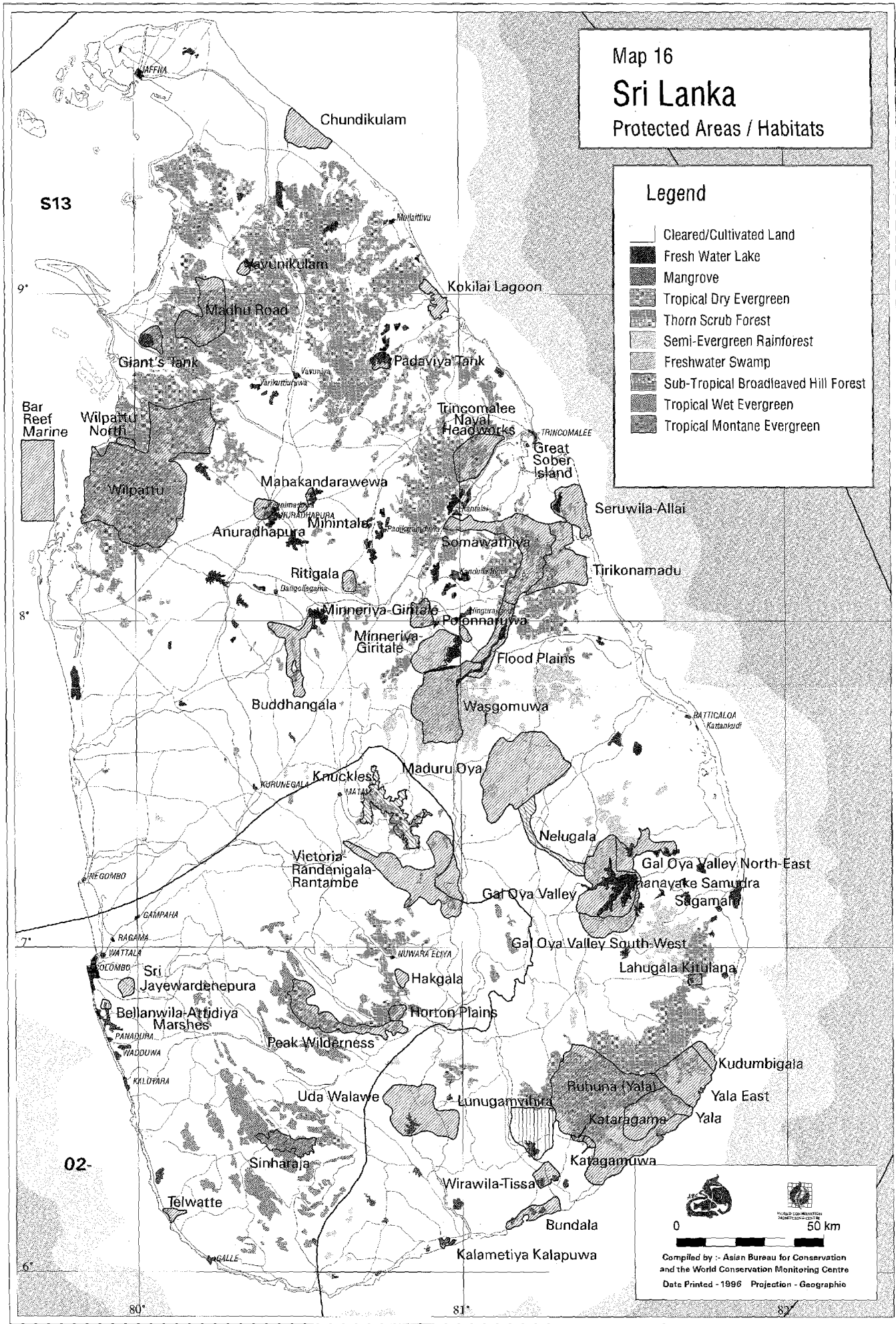
Map 16

Sri Lanka

Protected Areas / Habitats

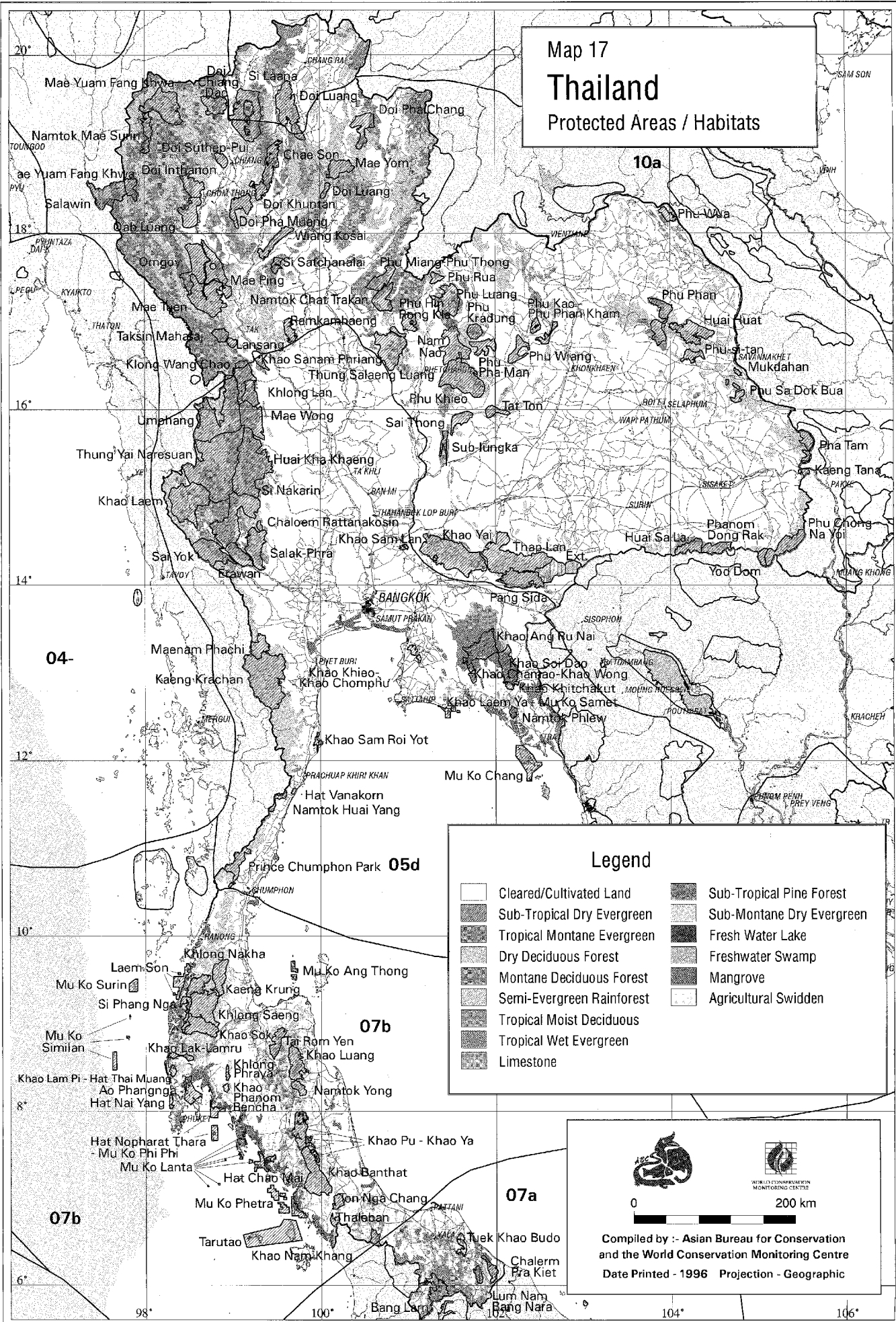
Legend

-  Cleared/Cultivated Land
-  Fresh Water Lake
-  Mangrove
-  Tropical Dry Evergreen
-  Thorn Scrub Forest
-  Semi-Evergreen Rainforest
-  Freshwater Swamp
-  Sub-Tropical Broadleaved Hill Forest
-  Tropical Wet Evergreen
-  Tropical Montane Evergreen

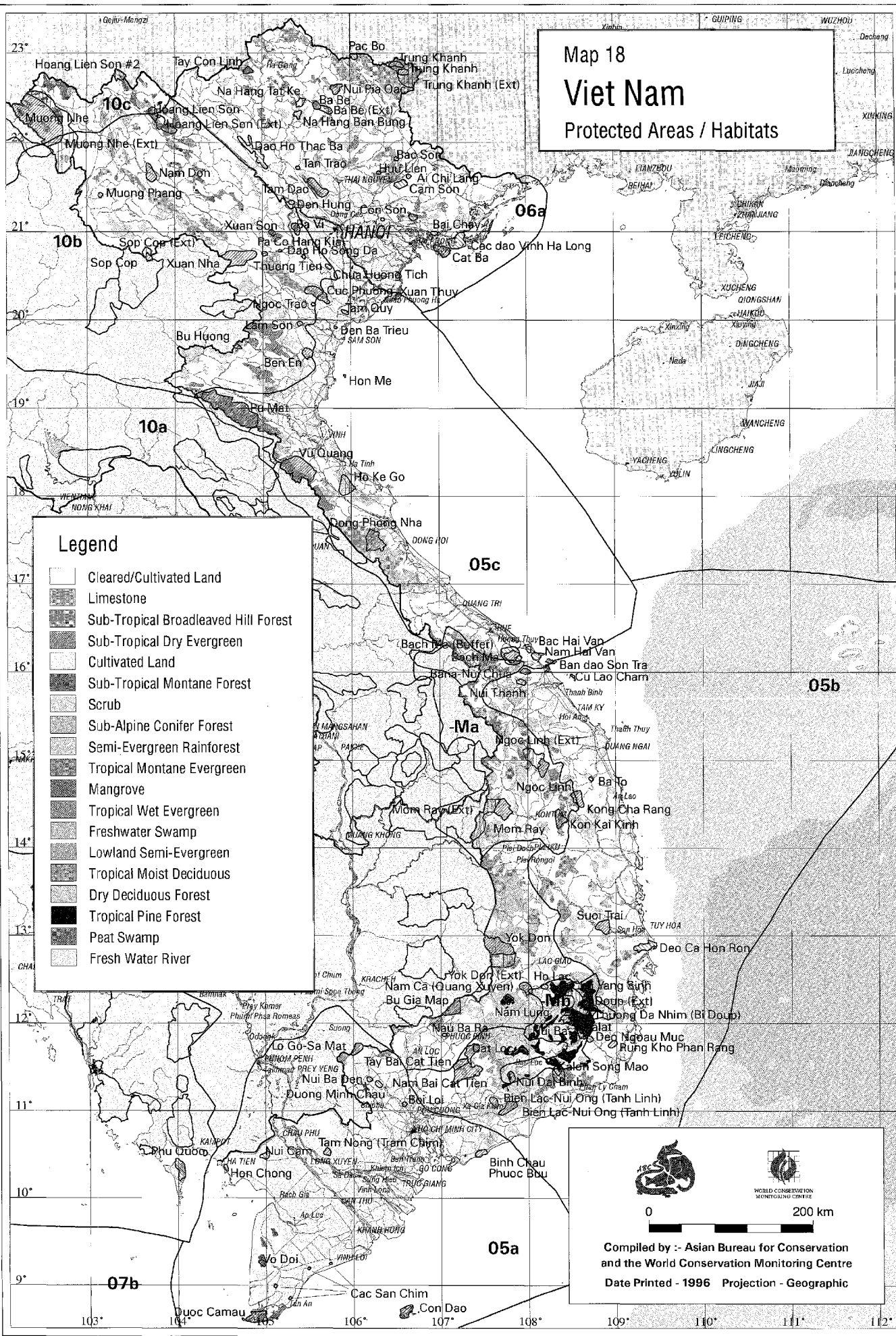


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Map 17
Thailand
 Protected Areas / Habitats






Map 18 Viet Nam Protected Areas / Habitats



Legend

- Cleared/Cultivated Land
- Limestone
- Sub-Tropical Broadleaved Hill Forest
- Sub-Tropical Dry Evergreen
- Cultivated Land
- Sub-Tropical Montane Forest
- Scrub
- Sub-Alpine Conifer Forest
- Semi-Evergreen Rainforest
- Tropical Montane Evergreen
- Mangrove
- Tropical Wet Evergreen
- Freshwater Swamp
- Lowland Semi-Evergreen
- Tropical Moist Deciduous
- Dry Deciduous Forest
- Tropical Pine Forest
- Peat Swamp
- Fresh Water River



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