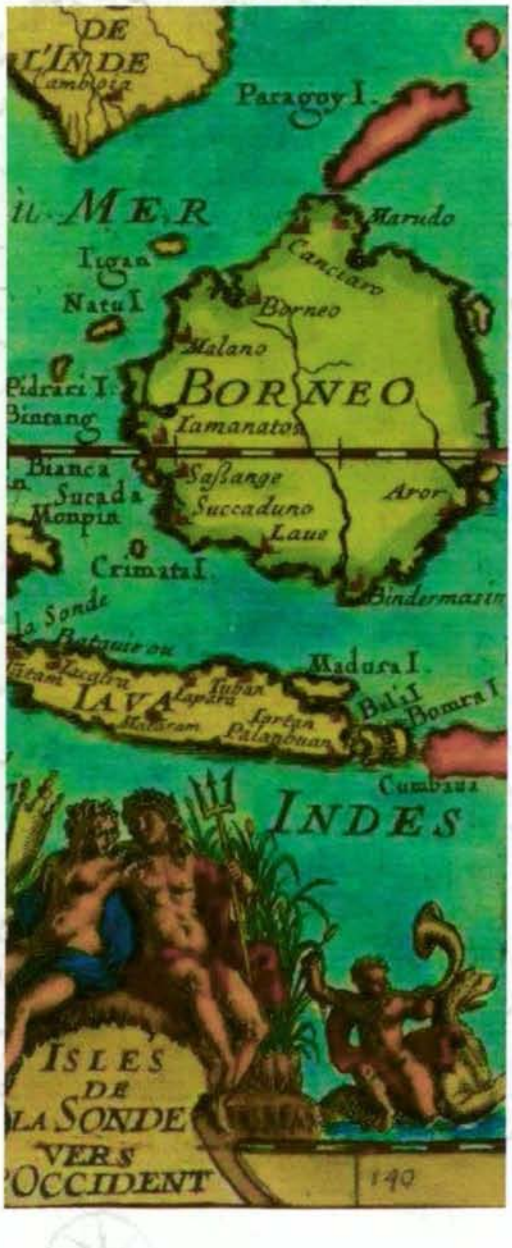
COUNTDOWN TO EXTINCTION, *DICERORHINUS SUMATRENSIS HARRISSONI* (GROVES, 1965)



by
Marc D Bowden BA
University of Tasmania

A thesis submitted in partial fulfilment of the requirements for the degree of Masters of Environmental Management (August 2006)

DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any tertiary institution, and to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Marc D Bowden BA

ABSTRACT

COUNTDOWN TO EXTINCTION, *Dicerorhinus sumatrensis harrissoni* (Groves 1965)

The Bornean subspecies of the Sumatran rhino is at imminent risk of extinction. During the last quarter century, concerted efforts have been made to counteract that risk. Despite early efforts that focussed on *ex situ* conservation, the situation did not improve and consequently the international Asian rhino conservation strategy changed its focus in the mid 1990s to *in situ* conservation. This strategy appears to have stabilised the situation for the present. This thesis examines the reasons for lack of progress in Bornean rhino population recovery. It argues that the current population stasis is unsatisfactory, and that a far more comprehensive analysis of the situation is required, one that accounts for, in broad terms, the human dimension to conservation in a regional context where human population density and growth, modification of moist tropical forest habitat, poverty, demand for animal parts used in folk medicines—and future challenges such as global climate change—conspire to perpetuate pressures conducive to the subspecies' extinction. The thesis concludes by identifying the need for a more detailed and comprehensive conservation planning process—open to peer review, and which identifies options for inclusion of human development issues—to be included in any future revision of the current 1997 Action Plan for Asian Rhinos, published by the IUCN's Asian Rhino Action Group.

ACKNOWLEDGEMENTS

My recently deceased father, David, actively fostered my delight in the natural world, and my desire to read and learn about it from a very early age. It took me many years to realise that reading books about ecology at age seven is far from standard bibliophilic fair for most children. As a child I spent many a family barbecue at Belair Recreation Park in the Adelaide Hills exploring woodland, creek beds, beneath rocks, under bark, and around reservoirs, fascinated by its abundant life—a sharp contrast with my suburban plains home. I dedicate this work to him. My mother has had unending faith and pride in my ability and desire to learn despite my vacillation in the years following high school. I thank her dearly.

In a supervisor the first quality I sought was inspiration, and I found that in Pete Hay along with pedagogic enthusiasm. His positive and constructive criticism has always been welcome. Without Pete's inspiration I am likely to have only ever completed a Graduate Diploma, rather than a Masters and, what is more, consider a PhD. Thanks, Pete! I also thank Dr Edwin Bosi from SOS Rhino Borneo in Sabah for his advice and assistance during the time I spent in Sabah volunteering as a field assistant in late 2005, and John Payne from WWF Malaysia has been great help and I thank him for his consistently prompt responses to my many email messages!

To my many friends who have tolerated my patchy commitment to them during the past year while I sat ensconced in the School of Geography and Environmental Studies' computer lab or my one-room apartment until late at night (while also managing full time work)...our next drink is courtesy of yours truly!

Extinction by human hands is inevitable in the absence of care and commitment. If you've ever marvelled at, been inspired, surprised or even shocked by life's abundance, complexity, beauty and sublimeness, you have, in my opinion, a responsibility to arrest by any legal means at your disposal the onslaught perpetrated against our fellow beings and ecological support systems in the names of progress, convenience, improved standards of living, and the 'national interest'—none of which need be contingent upon environmental collapse and a future where opportunities to experience the feelings I mention above are too scarce because too few of us did too little to avoid it.

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LIST OF ACRONYMS

AsRSG
Asian Rhino Specialist Group

BBSNP
Bukit Barisan Selatan National Park

CI
Conservation International

CITES
Convention on International Trade in Endangered Species of Wild Fauna and Flora

DVCA
Danum Valley Conservation Area

ENGO
Environmental Non-government Organisation

EU
European Union

FAO
Food and Agriculture Organisation of the United Nations

ICDP
Integrated Conservation and Development Projects

IDS
Institute for Development Studies

IRF
International Rhino Foundation

IUCN
The International Union for the Conservation of Nature and Natural Resources

KWR
Kulamba Wildlife Reserve

MAB
Programme on Man and the Biosphere

MBCA
Maliau Basin Conservation Area

MPOB
Malaysian Palm Oil Board

MRB
Malaysian Rubber Board

RCP
Rhino Century Programme

RPU
Rhino Protection Unit

SFD
Sabah Forestry Department

SSC
Species Survival Commission

TWR
Tabin Wildlife Reserve

UNESCO
United Nations Educational Scientific and Cultural Organisation

USMFR
Ulu Segama and Malua Forest Reserves

WCMC
World Conservation Monitoring Centre

WWF
World Wide Fund for Nature

YSFC
Yayasan Sabah Forest Concession

CHAPTER 1 INTRODUCTION

Pity the poor old rhino with the bodger on the bonce!
~ Flanders & Swann

Early in the third quarter of the twentieth century, the possibility that rhinos might become extinct in the wild became a major concern among human (*Homo sapiens sapiens*) populations mainly from so–called developed countries. The two African rhino genera—*Ceratotherium* and *Diceros* (White and Black rhinos, respectively)—received much of the international attention. This was unsurprising given that the latter's population "may have undergone the most precipitous decline of all living rhinos", its numbers falling from about a million at the turn of the twentieth century to about 3,500 today (Dinerstein 2003, p.17, International Rhino Foundation [IRF] n.d.). In Malaysia and Indonesia the global population of the smallest rhino species, *Dicerorhinus sumatrensis*, was also undergoing a dramatic contraction, but the threat of its extinction received little media attention compared with that of its much larger and possibly more charismatic African cousins.

Nevertheless a concerted effort to stave off the threat of the Sumatran rhino's extinction began in the early 1980s. By the early 1990s it had become apparent to some professionals within the conservation community that those efforts had been a miserable failure. *Dicerorhinus* was quite possibly extinct in Myanmar, and the prospects for the nominate species in Sumatra and peninsula Malaysia had not improved. *D. sumatrensis harrissoni*, from Borneo, appeared certain to become extinct. More than a decade on, little has changed in the way of population recovery. Indeed, it might be argued that at best the numbers have remained in stasis, but this is far from good news. As will be argued in this paper, without a deeper appreciation and broader consideration of the many and various matters that threaten the future viability of the Bornean subspecies of *Dicerorhinus*, there is little hope that its population can be sustained in the wild, let alone recovered there, in the near future.

1.1 OUTLINE

This thesis provides an overview of the conservation status and future of the subspecies of one of the most endangered large terrestrial mammalian herbivores on Earth—the Sumatran rhino. The subspecies of concern—*D. sumatrensis harrissoni*— has a few common names but is referred to herein by its scientific name, or the Bornean rhino, or *badak* (the Indo/Malay equivalent of 'rhino'). Chapter 2, 'Biology', provides a description of the subspecies' biology, and includes information relating to its physical appearance, life history attributes, range, abundance, distribution, dispersal and preferred habitat. Little is known about many of these aspects of its biology, and what is provided in the literature cited is often ambiguous or seemingly contradictory. Attempts to clarify these issues are provided where possible.

Chapter 3, 'Threats', examines why the Bornean rhino's existence is so tenuous, and describes the major proximate threats of poaching and habitat modification as a consequence of continued human population growth. The international conservation response to its declining population and risk of imminent extinction is explored in Chapter 4, 'Responses'. How and why the broad-based strategy of *ex situ* (captive) conservation was employed early and almost exclusively to thwart extinction is investigated and contrasted with the other broad-based strategy of *in situ* (wild) conservation, which grew in importance as the failure of the former strategy became more apparent.

Another two risks that if not accounted for in conservation strategies could exacerbate the subspecies' already delicate situation are discussed in Chapter 5, 'Risks'. Inadequately secured and under-resourced reserves—so-called 'paper parks'—are a major conservation concern, and particularly pertinent in the case of the Bornean rhino as much of its remaining habitat is located in either remote areas or regions undergoing rapid development. The looming threat of global-climate change is also discussed in relation to *D. sumatrensis harrissoni* conservation, and in so doing the need for detailed long-term conservation planning, which is further developed in Chapter 6, 'What's Missing', is introduced. Analysis of the Bornean rhino's prospect as a biodiversity surrogate is also provided in the same chapter, which, in addition, identifies and argues the need for far greater consideration of human development in the region. The potential for appropriately designed integrated conservation and development projects to augment Bornean rhino conservation goals, and help address the region's high incidence of poverty, is also discussed.

The thesis concludes with Chapter 7, the 'Conclusion', which draws together the major findings from each chapter, and presents an inventory of matters identified throughout the thesis that require further clarification, research and investigation.

1.2 METHODOLOGY

Prior to commencing the thesis I arranged a self-funded trip to Borneo and volunteered for three months as a field assistant with the environmental non-government organisation (ENGO), SOS Rhino Borneo in and around the Tabin Wildlife Reserve (TWR), on the Dent Peninsula in eastern Sabah. The content of this paper does not substantially draw from that experience, though some information has made its way into the text and is appropriately referenced as personal comments. Otherwise the information provided almost wholly relies upon written resources collected and collated into subject files (which largely reflect each chapter or section headings), read and analysed. All the material used was in the form of:

- articles, reports and data from ENGOs, government departments, various bodies of the United Nations (UN), private organisations, and research institutions
- peer reviewed literature and articles by academics and researchers from across numerous disciplines
- news service reports
- images, and
- personal communications.

These were sourced directly from:

- the stores of the major libraries on both the Launceston and Sandy Bay campuses of the University of Tasmania, and *via* the online e-journal registration service of the Morris Miller Library
- other university libraries *via* the document delivery service provided by the Morris Miller Library
- ENGOs, Malaysian and Sabahan government, and UN departments, private organisations and research institutions
- my private library and collection of photographs
- manipulation of data using Microsoft Excel (Figure 3.2), and
- friends employed by, but not commenting on behalf of, ENGOs (in the case of personal communications).

A literature review was also conducted and appears in the next section.

1.3 LITERATURE REVIEW

In 1995 a conservationist with the World Conservation Society (WCS), Alan Rabinowitz, published in *Conservation Biology* a critique of the response to *Dicerorhinus* conservation in general, and Bornean rhino conservation in particular. The author argued that *ex situ* conservation was essentially a failure and that *in situ* conservation would be the only possible strategy for averting the species' extinction. Critical of range state governments, their departments and international conservation ENGOs alike, his article provoked direct response through the journal, and contributed to a broader debate in conservation regarding the roles, virtues or otherwise of the two broad strategies.

Two years after Rabinowitz's critique, the Asian Rhino Specialist Group (AsRSG)—a specialty group member of the International Union for the Conservation of Nature's (IUCN) Species Survival Commission (SSC)—updated its *Asian Rhino Action Plan* (here after, the 'Action Plan'), duly noting the salience of *in situ* conservation, though it did not wholly eschew the role of *ex situ* conservation. In a comparison between that Action Plan and a similar document focussing on wild cats, McNeeley noted that even if all the recommendations made in both documents "were implemented to perfection, the species would not be as secure as we would like them to be" (McNeely 2000, p.358). McNeely's appeal for consideration and integration of broader issues that impact on Asian rhino conservation conjures the cross-discipline conservation approach of conservation biology espoused in various works by Noss and Cooperrider (1994), *inter alia*. Key elements from this relatively new field of science referred to herein include zoology, biology, economics, planning, and human demography.

Australian taxonomist Colin Groves provides much of the early material relating to Sumatran and Bornean rhino biology and ecology, which is not surprising since he determined the latter's status as a subspecies. Other major sources of material include the authors of the IUCN's Action Plan, Foose and van Strien (1997), and the ENGOs World Wide Fund for Nature (WWF) and the IRF.

The work of Jomo *et al.* (2004) details historical regional demographic and economic (primary resource) development, including information on habitat modification, while the Malaysian Palm Oil Board (MPOB) and Sabah Forestry Department (SFD) supply some historical and more recent data.

Reserve selection, especially in relation to forest habitat, has been developed by Noss and Coopperrider (1994) and Lindenmayer and Franklin (2002). Dinerstein (2003, in particular) is authoritative on the matter of integrating human development issues and endangered large mammal (especially rhino) conservation, while Terborgh (1999) has challenged the validity of such strategies. Borgerhof Mulder and Coppilillo (2005) offer an excellent overview of issues relating to conservation, economics and human culture, while articles edited by Lovejoy and Hannah (2005) comprise some of the most comprehensive and up-to-date synopses and prognoses of the impacts of climate change on biodiversity. A practical guide to thorough conservation planning processes is offered in the work of Craig Groves (2003).

Locating the cited material was initially achieved through noting published work referenced in the AsRSG's Action Plan (1997). This process, consistently applied in subsequent published material, had a cascading effect the consequence of which was that a large quantity of citations were rapidly collected. The online catalogues of *Web of Science, Current Contents, CAB Abstracts,* and *Inspec* also led to many of the journal articles cited, while a significant proportion of other material is sourced from my private library.

CHAPTER 2 BIOLOGY

The genera *Dicerorhinus, Rhinoceros, Ceratotherium* and *Diceros*—collectively and commonly known as rhinoceros or rhinos—comprise the family Rhinocerotidæ from the order Perissodactyla, in which horses (*Equus* sp.), and tapirs (*Tapirius* sp.) are also included. Though strictly a monotypic species, *Dicerorhinus sumatrensis* has two extant subspecies—*D. sumatrensis sumatrensis* and *Dicerorhinus sumatrensis harrissoni*. The former is the nominate species from Sumatra and peninsula Malaysia—the latter is endemic to Borneo in the Indo-Malay archipelago. *D. sumatrensis lasiotis*—a subspecies from Myanmar—is considered extinct by the IUCN (n.d.). *D. sumatrensis harrissoni* is also known as the 'Eastern Sumatran rhino', and with the nominate species is also referred to as the 'Hairy rhino' or 'Asian two-horned rhino'. A comprehensive biological description of the nominate species is provided by Groves and Kurt (1972). More relevant to endangered species conservation, however, is information regarding life history attributes. Those of the Bornean rhino are described below after a brief account of some of its more distinguishable physical characteristics. Details of its historical and contemporary distribution, habitat requirements, abundance and diet are also provided in this chapter. There is a paucity of detailed research and information specifically relating to the Bornean rhino. Where information provided herein is absent from the body of cited literature, it defaults to the nominate species.

2.1 PHYSICAL DESCRIPTION

An ungulate considered "extremely bulky for its size" (Metcalfe 1961, p.182), the Sumatran rhinos' height, length and weight ranges are 1-1.5 m, 2-3 m, and 600-950 kg respectively (IRF n.d.a): the Bornean rhino is smaller, however, than its western relative so its size tends toward the lower of these ranges (Groves 1982). Compared with the Greater one-horned rhino (*Rhinoceros unicornis*) which, at up to 2 m high, 2.8m long and 2.7 tonnes in weight, is the third largest terrestrial mammal on Earth, the Bornean rhino is considered "diminutive" (Groves 1982a, p.256). *Dicerorhinus* skin is "rough and granular and there are only three folds, the first being on the neck, the second behind the shoulder and continued across the back and the third just before the hindquarters" (Metcalfe 1961, p.182). Other than the shoulder fold, skin fold development is considered poor in contrast with the other Asian rhino species, *R. unicornis* and *R. sondaicus* (the Javan rhino) (Groves 1982). Its ungulæ, like all Perissodactyla, are oddly numbered—in this case, three *per* limb.

In the field this quadruped's colour is often determined by that of the mud from its last wallow, but otherwise it tends toward reddish-brown (Figure 2.1). Sumatran rhinos have been described as "anatomically overall the most distinctive of the five living species" (Wilson 2002, p.81). They are easily distinguished from the other species not just by their smaller size or skin folds, but also the density of body hair that, while variable, is distinct and most pronounced fringing the ears and tail (Figure 2.1). The Sumatran rhino is the closest living relative to the extinct pleistocene Woolly rhinoceros (*Coelodonta antiquitatis*), which ranged from Spain to Korea—"the widest range of all [rhinoceros] species recorded" (Dinerstein 2002, p.12). Unlike the other Asian rhino species—and as is described by one of its common names—*Dicerorhinus'* posses two horns; the anterior measuring between 25 and 79 cm in length, and posterior horn usually less than 10 cm (IRF n.d.a).

FIGURE 2.1 CAPTIVE BORNEAN RHINO (*D. sumatrensis harrissoni*)

2.2 LIFE HISTORY ATTRIBUTES

Little is known about the Bornean rhino's life history attributes other than what might be gleaned from those of the nominate species. Longevity is 25-40 years, though one lived to 47 years of age in captivity (Wilson 2002). Sexual maturity occurs at ten years in males, and six to seven years in females (IRF n.d.a). Other than during courtship or when a cow accompanies her calf for 16 to 17 months after its birth, Sumatran rhinos are solitary (WWF n.d.). The species is not aggressive except in defence of its calves or during courtship when males can be particularly aggressive toward females. Possibly citing Laurie (1978), Groves notes that while males can also be aggressive toward each other, among themselves "bigger males, at least, avoid coming into contact as much as possible" (1982 p.17).

It was only recently discovered that cows are induced ovulaters, requiring copulation to stimulate ovulation prior to repeated matings in order to successfully conceive (Khan *et al.* 2001). A Sumatran rhino in the Cincinnati Zoo is the only specimen to have given birth twice in captivity—first in 2001 and again in 2004 (Khan *et al.* 2001; 2004a)—and to have conceived and given birth in captivity in over one hundred years. The precise gestational periods recorded from these instances were 475 and 477 days respectively, with an inter-birth interval of 24 months—typical for the species. In June 2006 the Cincinnati Zoo confirmed that the cow, 'Emi', was pregnant once again: "a third successful pregnancy in just seven years" (Cincinnati Zoo 2006). In the wild, "[b]irths occur from October to May (the period of heaviest rainfall)" (United Nations Environment Programme/World Conservation Monitoring Centre [UNEP/WCMC] n.d.).

Frugivorous megafauna are considered by botanists as "mobile bags of seeds, capable of roaming large distances and defecating a large dollop of seeds in its own block of fertilizer" (Bush & Hooghiemstra 2005, p.134). Described as "an animal of methodical habits" the Sumatran rhino is known to defecate at established dung piles (Metcalfe 1961, p.187; Groves 1982), or 'latrines' (Dinerstein 2003). Latrines can be found "on regular routes and situated in shallow streams or on the edge of a swamp" (Metcalfe 1961, p.187). Dinerstein (2003), and Dinerstein and Wemmer (1988), establish a causal link between forest succession in Nepal and Greater one-horned rhinos, which eat seasonally abundant fruits of the shade intolerant tree, *Trewia nudiflora*. The trees' seed freely germinate from rhino latrines located at forest edges.[1] Surviving trees effectively advance forests beyond otherwise more inelastic boundaries. Wild mango (*Mangifera* sp.) is another shade intolerant tree (Bally 2005), and has been observed germinating from *D. sumatrensis* dung (Hubback 1931, cited in Corlett 1998). An association between the Sumatran rhino and

1 This phenomenon is referred to as 'active-internal' seed dispersal where "seeds are actively ingested as part of the fruit and later discarded through defecation" (Andresen 2000, p.14).

Mangifera sp. similar to that of the Greater one-horned rhino has been claimed. According to Cubitt *et al.* Sumatran rhino extinction has:

> *important ramifications for the forest ecosystem as a whole: certain trees produce seeds which must pass through rhinoceros gut before they can germinate. Such trees may include the many wild species of mango. The loss of the rhinoceros would, therefore, eventually cause the extinction of these wild mangos, and in turn the extinction of the species which depend on them* (1992 p.25).

This statement should, however, be considered with caution for three reasons. First, the claim is unreferenced. Second, it is far from definitive—the authors confusingly refer to "*certain* trees" that "*may* include" wild mango. Third, the Sumatran rhinos' partiality toward wild mango has similarly been noted among "almost the entire Malaysian mammal fauna at some time or other" including the Indo-Chinese tiger (*Panthera tigris corbetii*) (Corlett 1998, p.424)! Longitudinal research possibly involving selective exclosure experiments would be required to substantiate the authors' contention that *Dicerorhinus* is effectively a keystone species without which lowland rainforest ecology would radically alter, but such experimentation is likely to be unfeasible anytime in the near future given the subspecies' perilously low numbers. Certainly the Sumatran rhino's large range could play a significant role in wild mango seed dispersal, though this would be hindered where forests are adjacent to human activity, as *badak* avoid such areas (see Section 2.5).

2.3 DIET

Dicerorhinus are herbivorous browsers—"[s]pecies with ≥90% dicotyledons (i.e. tree and shrub foliage, including herbaceous dicotyledons, or fruit eaters) in their diet" (Fritz & Loison 2006, p.22). Their diet includes leaves, bark, twigs, and wild fruits, particularly figs (*Ficus* sp.) and, as noted above, wild mango (Evans 1904, and Hubback 1929, cited in Groves & Kurt 1972). Over 50 kg of food can be consumed daily (WWF n.d.). The dietary details of a zoo-captive Sumatran rhino is provided by Dierenfeld *et al.* (2000), and sanctuary-captive Sumatran rhinos by Candra *et al.* (2005). Table 2.1 lists dietary information for wild rhinos from three sources—the first and second of which pertain to the Bornean rhino, and the third to the nominate species. Although 31 plant species are identified in the second study, this amounts to approximately only "one third of the total species of food plants reported in numerous studies in Southeast Asia from 1905 to 1970" (Lee *et al.* 1993, p.252). A forthcoming Masters research thesis regarding the Bornean rhino's diet and nutrition should greatly enhance knowledge in this area (Thayaparan 2005, pers. comm.).

Badak—like other Asian rhinos—supplement their diet with mineral salts from exposed mineralised rock or clay, or sulphurous or muddy springs. In the Gunung Leuser National Park in Sumatra "as many as fourteen individuals were once counted within a square kilometre" of a salt lick (Wilson 2002, p.82). The salt licks in TWR are present as 'mud volcanoes'; geothermally active muddy upwellings about a hectare in area. There are at least two mud volcanoes in the TWR. Salt licks are recorded in the Danum Valley Conservation Area (DVCA), though it is unclear whether they are used by *badak*. Lee *et al.* (1992) suggest that salt-licks might not necessarily be an essential dietary element.

TABLE 2.1 SUMATRAN RHINO DIET

Source	Family	Genus	Species	Malay (and English) name
Anon. n.d.	APOCYNACEÆ	*Alstonia*	*angustiloba*	*pulai*
		A.	*macrophylla*	*pulai daun besar* (Devil tree)
		A.	*spathulata*	*pulai basung* (Marsh pulai)
		Dyera	*costulata*	*jelutong bukit*
		Tabernaemontana	*macrocarpa*	*burut-burut*
	ANACARDIACEÆ	*Dracontomelon*	*mangiferum*	*sengkaung* (New Guinea walnut)
		Koordersiodendron	*pinnatum*	*ranggu*
		Mangifera	*pajang*	*bambangan*
		Parishia	*insignis*	*layang-layang*
		Semecarpus	sp.	*rengas duri*
	DATISCACEÆ	*Octomeles*	*sumatrana*	*binuang*
	EUPHORBIACEÆ	*Baccaurea*	*angulata*	*belimbing hutan*
		B.	*bracteata*	*tampoi paya*
		B.	*lanceolata*	*limpaung*
		B.	*motleyana*	*rambai*
		Endospermum	*diadenum*	*sendok-sendok mata*
		E.	*peltatum*	*marapang*
		Glochidion	*rubrum*	*oba nasi*
		Macaranga	*beccariana*	*sedaman jari*
		M.	*gigantean*	*merkubang* (Giant mahang)
		M.	*hypoleuca*	*mahang puteh*
		M.	*tanarius*	*lingkabong* (Parasol leaf tree)
		Omalanthus	*populynes*	*ludai susu*
		Antiarus	*toxicaria*	*paliu* (Sack tree)
		Anthocephalus	*chinensis*	*laran*
	MORACEÆ	*Nauclea*	*gigantea*	*bangkal daun besar*
	RUBIACEÆ	*N.*	*subdita*	*bangkal kuning*
		Neonauclea	*bernadoi*	*bangkal merah*
	ANNONACEÆ	*Friesodielsia*	sp.	
		Popowia	sp.	
	APOCYNACEÆ	*Kopsia*	*Dasyrachis*	
	DIPTEROCARPACEÆ	*Shorea*	*sp.*	

Table 2.1...continued. Sumatran Rhino Diet

Lee *et al.* 1992	ANISOPHYLLEACEÆ	*Anisophyllea*	sp.	
	EBENACEÆ	*Diospyros*	sp.	
	EUPHORBIACEÆ	*Blumeodendron*	sp.	
		Koilodepas	sp.	*delek tembaga*
		K. cf.	*longifolium*	
		Macaranga	sp.	*meranti*
		M.	*beccariana*	*kayu arang*
		Mallotus	sp.	*gaham badak*
		M.	*wrayi*	*kayu gading*
	LAURACEÆ	*Litsea*	sp.	
	MELASTOMATACEÆ	*Kibbesia*	sp.	*macaranga, mahang*
		K. cf.	*korthalsiana*	
		Memecylon	sp.	
		Memecylon cf.	*peniculatum*	
	MELIACEÆ	*Aglaia*	*odoratisima*	*medang*
	MYRTACEÆ	*Eugenia*	sp.	
	RUBIACEÆ	*Croton*	*oblongifolius*	
		Ixora	*elitica*	*nipis kulit*
		Pavetta	sp.	*liuk*
		P.cf.	*axillaris*	*aglaia*
		Piper	sp.	*makaasim*
		P. cf.	*retrotractum*	Croton
		Psychotria	*woodii*	
		Uncaria	sp.	
		U. cf.	*borneensis*	
	ZINGIBERACEÆ	*Zingiber*	sp.	Ginger
Metcalfe 1961	ANNONACEÆ	*Mezzettia*	*leptopoda*	*mempisang*
	CLUSIACEÆ	*Garcinia*	*eugeniaefolia*	
		G.	*forbesii*	*bebata*
	EUPHORBIACEÆ	*Claoxylon*	*indicum*	Common claoxylon
		C.	*longifolium*	
		Endospermum	*malaccense*	*sendok-sendok*
		Macaranga	spp.	*mahang* (Macaranga)
		Mallotus	*paniculatus*	*melutos*
	FABACEÆ	*Millettia*	*sericea*	*taroi-taroi* (False monkey-flower)
	FLACOURTIACEÆ	*Flacourtia*	*indica*	*rukam* (Governor's plum)
	LEGUMINOSÆ	*Crotalaria*	spp.	*sial menahun*
	MELASTOMATACEÆ	*Pternandra*	spp.	*terap nasi*
	MORACEÆ	*Artocarpus*	*elasticus*	*ketedan temponek* (Monkey-jack)
		A.	*rigidus*	
		Ficus	*alba*	*ara*
		F.	*aurata*	*ara* (Yellow hairy fig)
		F.	*bengalensis*	*ara* (Banyan)
		F.	*fistulosa*	*ara* (Yellow-stem fig)
		F.	*glandulifera*	*ara*
	RHAMNACEÆ	*Zizyphus*	*calophylla*	*dawai-dawai*
	RUBIACEÆ	*Mussaenda*	*villosa*	
	RUTACEÆ	*Euodia*	*pilulifera*	
	SAPOTACEÆ	*Chrysophyllum*	sp.	*pepulut*
		Pouteria	*maingayi*	*nyatuh*
	SYMPLOCACEÆ	*Symplocso*	*fasciculata*	

2.4 Distribution & Dispersal

The historic distribution of *D. sumatrensis* "extended from Sumatra via the Malay peninsula through Burma to Bengal and Assam" (Groves 1982 p.12), and Laos, Bhutan, and Vietnam (IUCN n.d.a; IRF n.d.a; Wikramanayake *et al.* 2002). According to Meijaard (1996) *badak* were present throughout Borneo (see Figure 2.2) "until relatively recent times," and by the 1940s had all but "disappeared from most of the lowland areas of West, Central, South and East-Kalimantan" (p.15). Interestingly the subspecies' distribution suggested in Figure 2.2 is at variance with another diagram by van Strien (cited in Foose & van Strien 1997) showing *D. sumatrensis harrissoni* absent from Kalimantan's west, south, and far east, and north- and south-western Sarawak (Figure 2.3). On the basis that the latter map appears in two published manuscripts (it also appears in Wikramanayake *et al.* 2002) as opposed to a web-site in the case of the former, it is assumed here to be the more credible source. In 1961 Burgess described the subspecies range as "the upper Kinabatangan River, Darvel Bay, Dent Peninsula, near Ranau, and the Interior Residency of Sabah" (cited in Groves & Kurt 1972, p.4). Late last century only a few individuals were suspected to persist in Sarawak, Brunei Darussalam, and East Kalimantan (Meijaard 1996; Foose & van Strien 1997), but their persistence there is now highly unlikely, the animal being "possibly extinct in Sarawak and Kalimantan" (WWF n.d.).

The Bornean rhino's mainstay is the Malaysian state of Sabah in the north of Borneo. Two populations with "good prospects of long-term survival" (WWF n.d.) are TWR in the east, and the Ulu Segama and Malua Forest Reserves (USMFR)/DVCA region in the 9,782 km^2 Yayasan Sabah Forest Concession (YSFC) which includes the Maliau Basin Conservation Area (MBCA) west of the DVCA (Foose & van Strien 1997; WWF n.d.). These major demes are referred to herein as the eastern and western populations respectively. Although Bornean rhinos have been noted in the Mount Muruk Miau region, and the Segaliud-Lokan, Deramakot, and Tangkulap Forest Reserves, their presence there is now questionable due to recent forestry activity (WWF n.d.). In the YSFC's southwest, any *badak* present in MBCA might be divorced from the remaining western population depending on the extent of forestry operations in the Gunung Rara Forest Reserve (GRFR). The coastal Kulamba Wildlife Reserve (KWR) in the east of Sabah is disconnected from the TWR to its south by a linear area of oil-palm plantation. Both reserves are considered one for estimating population carrying capacities of the latter because at least one Sabahan ENGO, the Borneo Conservation Trust, envisages a future where the oil-palm production area dividing the two reserves is rehabilitated in order to reconnect them (Andau *et al*. 2005).

FIGURE 2.2 INFERRED HISTORIC AND CURRENT RANGE OF THE SUMATRAN RHINO

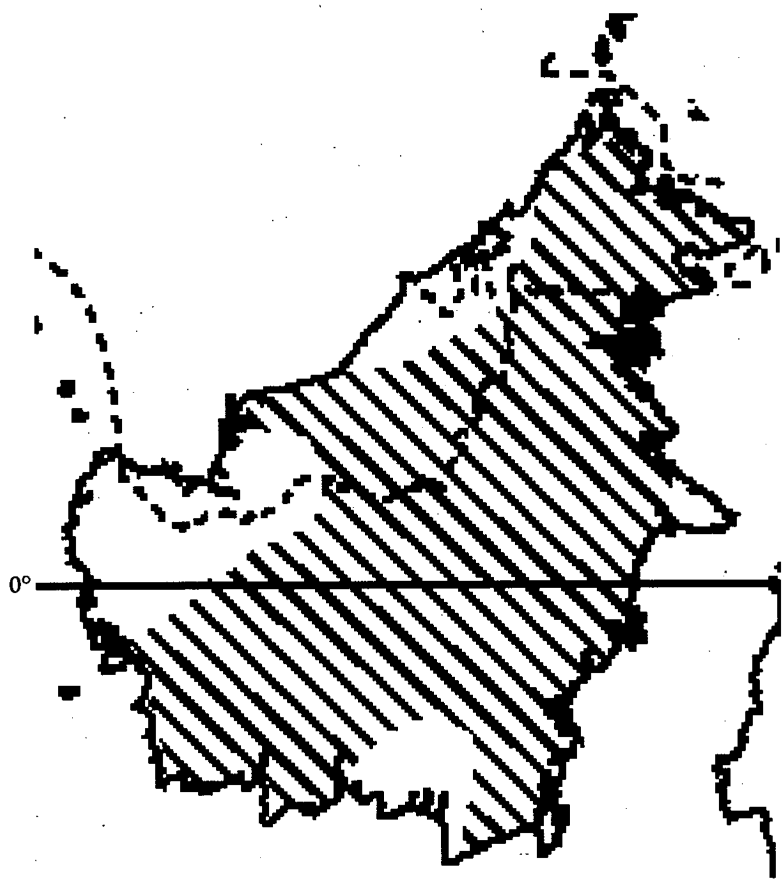

FIGURE 2.3 *Dicerorhinus sumatrensis harrissoni*, ORIGINAL RANGE (SHADED)
Source: van Strien 1997

Sumatran rhinos are "known as wanderers" which "unlike their one-horned relatives, did not build up high populations in any one place" (Groves 1982 pp.17, 21). A highly vagile species, however, they require large areas of habitat, although some territorial overlap has been noted to occur (Kurt 1971, cited in Groves 1982). According to Wilson (2002) calves tend to stay close to their mothers for the first 2-3 years of their lives by which time they "are nearly of adult stature" (Groves 1982, p.15). In 2005 two young Sumatran rhinos wandered into village areas in southern Sumatra (Figure 2.4). The first was found one kilometre from Way Kambas National Park, and the second as far as 30 km from the Bukit Barisan Selatan National Park (BBSNP) (IRF 2006). The AsRSG believes the BBSNP exhibits signs of rhino population pressure (Asian Rhino Project [ARP] 2005)—a possible explanation for the second rhino's peripatetic tendencies.

IRF

FIGURE 2.4 SUMATRAN RHINO, SUOH VILLAGE, SUMATRA 2005

2.5 ABUNDANCE & HABITAT

The Sumatran rhino population was estimated to be 10,000 at the turn of the twentieth century, but by 1980 had plummeted to about 1,000 (Pellegrini 2002, cited in SOS Rhino n.d.). In 2005 the IRF estimated there were approximately 300 wild Sumatran rhinoceros, 50 of which comprised the subspecies' population in Sabah (IRF n.d.b). In 2005 the TWR's population comprised "6 *Known*, 10 *Probable* and 35 *Possible* rhinos" (van Strien 2005, p.16), whilst 13 *badak* are estimated to presently 'reside' in the DVCA (van Strien & Maskey 2006). There is a chance that a few individuals might be scattered throughout some remaining habitat but this is unlikely.

Davies and Payne note that *badak* are "renowned for...staying inside forest cover" (1982, p.80). This closed-habitat dweller—a "species that spend[s] most of the year in dense habitats" (Fritz & Loison 2006, p.21)—prefers high- and lowland tropical dipterocarp forests, the vast majority of which in Sabah are either fragmented, acutely modified, in the process of modification, or are slated for modification *vis-à-vis* forestry activity and agricultural development (see Chapter 4). Vegetation maps of the reserves comprising the two major population areas are provided in Figures 2.5, 2.6, 2.7, and 2.8 (a map of the USMFR is unavailable). Other than the swampy peat forest in the KWR (Figure 2.6) and Kerangas (heath) forest in the MBCA (Figure 2.8). these maps confirm that high- and lowland dipterocarp forests comprise the vast majority of these reserves' ecosystems. *Dicerorhinus* are, however, also denizens of "low-lying swampy areas" (Foose & van Strien 1997, p.12). Metcalfe notes the Sumatran rhino present in "the Bernam Swamp area of Selangor and another similar area in Johore" (1961 p.187). The KWR's swampy peat forest contains eight tree species in common with the same forest type in Sumatra: "namely *Shorea uliginosa, Gonystylus bancanus, Dyera lowii, Mangifera havilandii, Mezzettia leptopoda, Garcinia rostrata, Palaquium warsufolium, and P. alternifolium*" (Mogea & Mansur 2000, p.191). A quick comparison between this list and the species from Table 2.1 reveals five genera in common (i.e. *Shorea* sp., *Dyera* sp., *Mangifera* sp., *Mezzettia* sp., and *Garcinia* sp.).

Other habitats in which *Dicerorhinus* sightings have been recorded include "hilly, even mountainous areas" (Groves 1982, p.17), so the Kerangas forest of the MBCA—although relatively extensive compared with the reserve's dipterocarp and mixed dipterocarp forests—might be suitable habitat in terms of cover, though whether it comprises primary habitat in which *badak* can reasonably be assumed to be resident, or secondary habitat through which they move between areas of primary habitat is unknown.

Dinerstein notes that Sumatran rhino's "seek out forest gaps caused by falling trees, the most common type of disturbance in natural rain forest habitats" (2002 p.15). Indeed their "highest densities"—if the present population can justify such a generous accolade—occur "in early successional habitats maintained by local disturbance regimes" (Dinerstein 2002, p.15). Citing Strickland (1967), Groves and Kurt speculate that the Sumatran rhino "is probably basically a species of the forest margin; it seems to be attracted to man-made secondary growth, where it may feed on cultivated plants" (1972 p.2). Certainly, Sumatran rhinos have been recorded in complex damar (*Shorea javanica*) agroforests (Michon & de Foresta 1995), durian (*Durio zibethinus*) and other agroforests (Sibuea & Herdimansyah 1992, cited in Michon & de Foresta 1995), and rubber (*Hevea* sp.) plantations (McNeely & Scherr 2002). It seems unsurprising then that, according to Foose and van Strien, the Sumatran rhino was once "so abundant that it was described as a garden pest in the journals of some of the 19th century residents" (1992 p.6). The rhino's apparent predilection toward human-modified habitats seems incompatible, however, with Kinnaird *et al.* (2002) researched the effects of tropical deforestation on large mammals in south-east Asia. They note that Sumatran rhinos in Indonesia's BBSNP tend to avoid "human activities that reduce cover and increase disturbance (including hunting) at the forest edge and in the peripheral forests" (2002 p.254), and recommend that a two-kilometre wide buffer zone with little or no human activity be initiated to protect known populations. The species' avoidance of human activity has more recently been confirmed by van Strien and Maskey who note that "repeated confronting of large groups of people entering the [Way Kambas] park for fishing" drove a young individual female "from the safety of the park into unknown territory" (2006 p.16). How could it possible that Sumatran rhinos—animals that are "[s]hy and elusive in the extreme" (Wilson 2002, p.79)—have previously been so 'abundant' as to be described a garden pest?

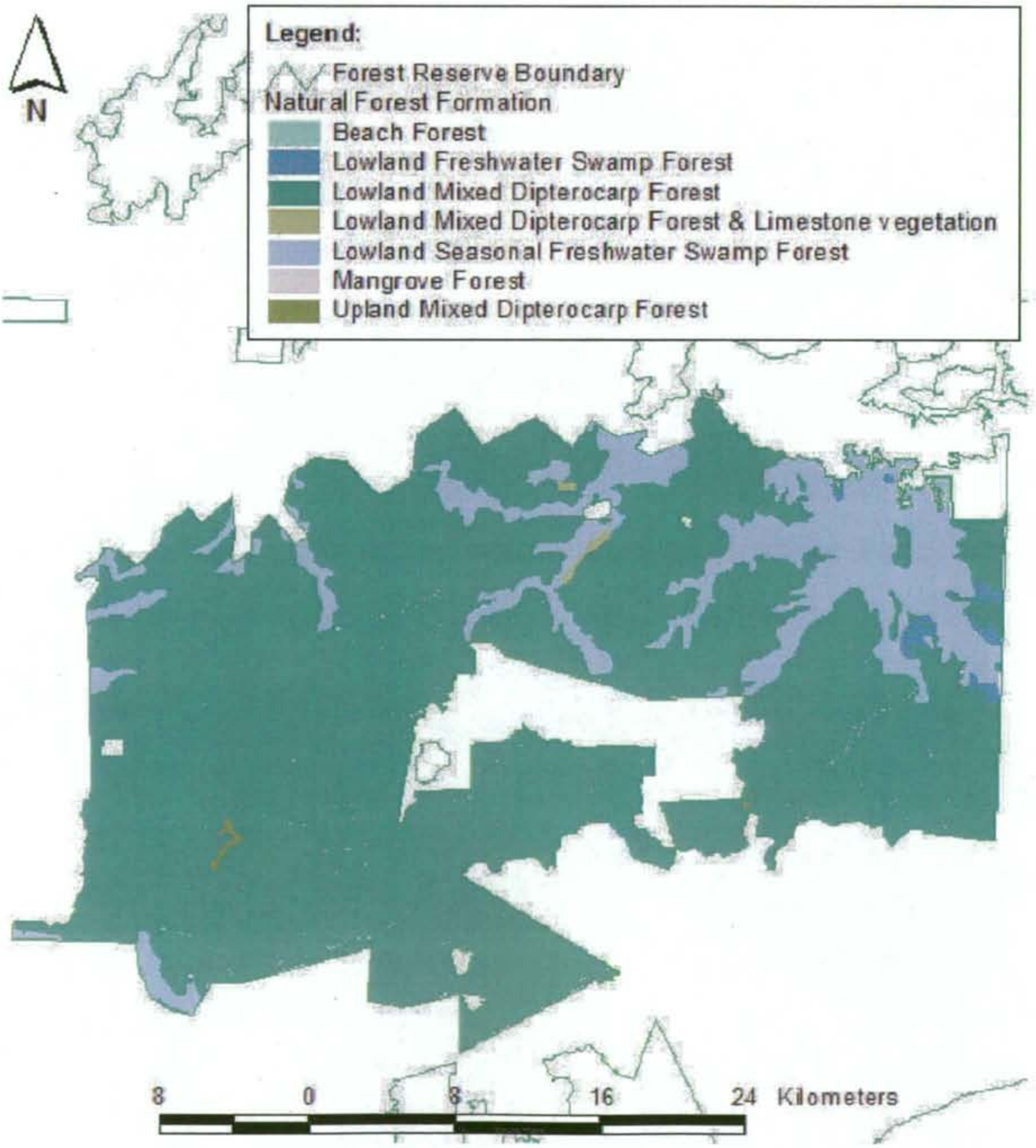

FIGURE 2.5 TABIN WILDLIFE RESERVE VEGETATION

Source: Sabah Forestry n.d.

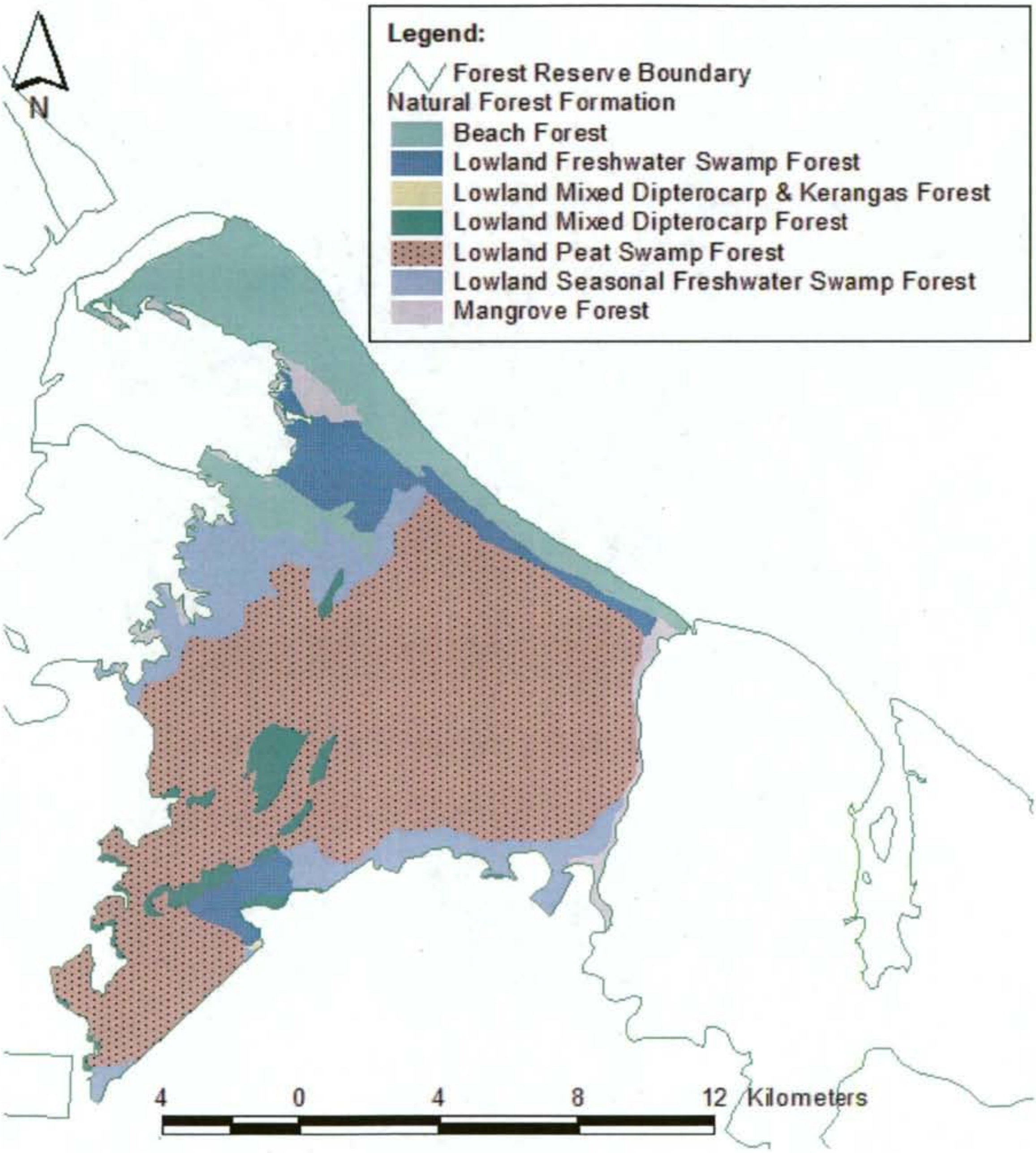

FIGURE 2.6 KULAMBA WILDLIFE RESERVE VEGETATION

Source: Sabah Forestry n.d.

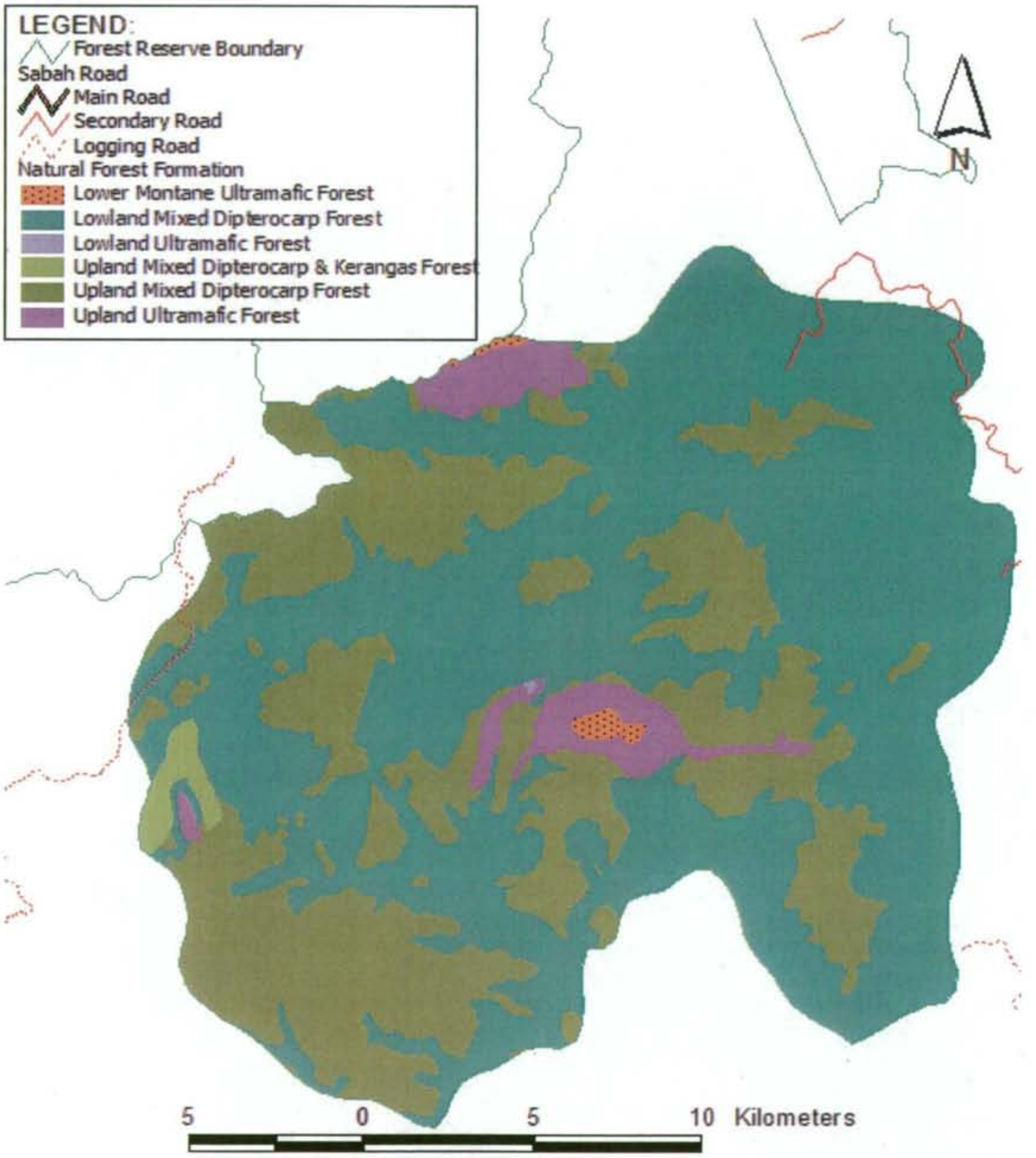

FIGURE 2.7 DANUM VALLEY CONSERVATION AREA VEGETATION

Source: Sabah Forestry n.d.

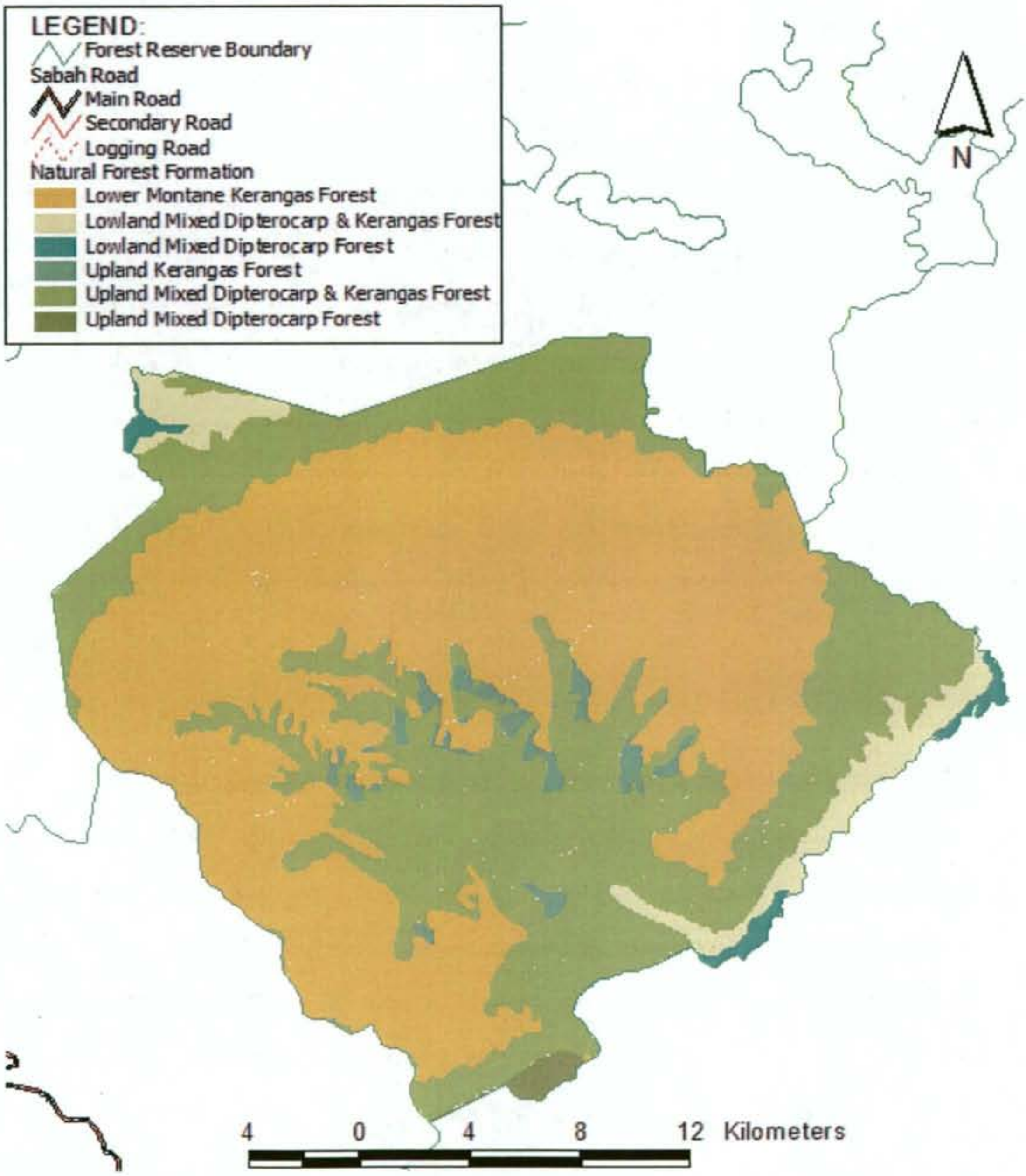

FIGURE 2.8 MALIAU BASIN CONSERVATION AREA VEGETATION

Source: Sabah Forestry n.d.

Dinerstein, too, refers to the same 'garden pest' characterisation of the Sumatran rhino, but not in terms of abundance: "[e]arly naturalists described the Sumatran and Javan rhinoceros as pests in the gardens and tea estates of the early colonials in Indonesia. Gardens were part of a highly simplified, disturbed landscape that these large ungulates found attractive" (2002 p.15). Here 'pest' is used in the context of a dietary preference for commercial-scale agricultural crops and tropical gardens. In this regard the animal appears to be more a nuisance than a pest. The species' apparent gastronomic fondness for garden and plantation vegetation might be explained by a particular novel delicacy, or by simply being lured by a readily available cornucopia of food condensed in one area. Another reason for these colonial garden and plantation forays might be explained by the clearing of forest habitat for settlement and agriculture. In such a scenario refugee rhinos from formerly forested habitat sought sanctuary in adjacent forests, possibly triggering food scarcity there as a consequence of temporarily increased population densities. Though not a loss of habitat in a normative sense this is, nevertheless, recognised as a type of habitat loss (Ranta *et al.* 2006). Food-scarce habitat is likely to have forced some rhinos—whether primary refugees from cleared habitat or secondary refugees from food-scarce habitat—to encroach into adjacent gardens and/or plantations because they were deprived of sufficient nutritional input. Then again, Foose and van Strien might have mistakenly attributed 'abundance' rather than 'nuisance' to the pejorative 'pest'. Yet another alternative—if indeed the original colonial documents did mention abundance—is that eyewitnesses might have double-counted individuals, mistaking multiple visits by one or a few for a greater number of individuals.

Resolution of the matter is impossible in the absence of the primary source. What is clear is that the Sumatran rhinos, characterised as 'pests', sought food where they could. Gardens were presented *à la carte*, as it were, and duly invaded. Finding early successional-type vegetation serendipitously as a consequence of human desires to create an earthly replication of paradise in the form of a garden—or create wealth through particular commercial monocrops—does not necessarily indicate that the species was so abundant as to be a pest. Before the Bornean rhino population decline noted in the 1930s (NIVN 1929, cited in Meijaard *et al.* 2005), there would have been a time when they were abundant compared with today's bleak situation, but just how abundant remains indeterminable. "[A] species of the forest margin" (Strickland 1967, cited in Groves & Kurt 1972, p.2)—and by this it is meant forest edges adjacent to human modified habitat—is unlikely to be an apposite description of *Dicerorhinus*' preferred habitat, but more a dietary source utilised in times of nutritional scarcity. Though Sumatran and Bornean rhinos have been found in human-modified habitats, the evidence provided by Davies & Payne (1982), Kinnaird *et al.* (2002), ARP (2005), and van Strien & Maskey (2006) discussed above, strongly suggests that their presence in such areas is a sign of a population pressure and/or food scarcity.

Kinnaird *et al.* (2002) cite individual *Dicerorhinus* range estimates of 50-60 km² apparently from Hutabarat *et al.* (2001). In the source, however, there is no explicit or implicit reference to the estimate of 50-60 km². There is a reference to "about 50-60" Javan rhinos in Ujong Kulon National Park in west Java, but no other data is provided from which a range of 50-60 km² for Sumatran rhinos could be inferred. Notwithstanding this anomaly, the range estimates provided by a number of authors vary by 1,500 *per cent* (Table 2.2), probably because estimates are "based largely on educated guesses and a few intensive surveys" (Dinerstein 2002, p.21). Continuing population decline might also have affected some estimates, for if a population in a defined area at one time instance is—unbeknownst to the researcher—lower than a previous calculation for the same area, the range may be calculated as higher. Estimates might therefore be more temporal 'snapshots' than reliably conclusive. Furthermore, habitat variability might compound range estimations. For example, although the TWR is Sabah's largest wildlife reserve, estimates of its *badak* population could be confounded by the quality of its habitat as it was largely logged up until the early 1980s and is now predominantly secondary dipterocarp forest. As its forest ages the Bornean rhino population could decrease in proportion to the decline in available successional vegetation—its favoured diet source. Alternatively, it might increase if a thicker forest affords greater protection from poaching, or the population might stagnate as a consequence of these factors negating each other. The effects are unknown, and reliable range estimates are likely to remain elusive due to the lack of research of conditions prior to the severe habitat fragmentation that rapidly occurred during the past thirty or so years. This difficulty is implied—albeit in passing—by Wilson: "In normal circumstances, which hardly exist anymore, each adult patrols a home range of ten to thirty square kilometres" (2002 p.82).

TABLE 2.2 SUMATRAN RHINO INDIVIDUAL RANGES

Source	Habitat area (km²)
Kurt 1971, cited in Groves 1982	♀ 2-9.5, ♂ > 2-9.5
Foose & van Strien 1997	10‡
Groves 1982	20
Wilson 2002	10-20
Davies & Payne 1982	30€
Hutabarat *et al.* 2001	50-60

‡ From Table 2.5, pp. 14-15; € Based on an assumed minimum viable population of 200 adults.

With a dangerously low population, caution would dictate that in the absence of a definitive individual range estimate, higher estimates be used for conservation purposes. The practical consequences of doing so are, however, likely to be socially prohibitive in a rapidly modernising state with a rapidly increasing population generating competing land uses for settlement, agriculture and forestry for example (see Chapter 3). Regardless of which range figure is used, however, it is clear that Bornean rhinos require large individual home ranges in the order of at least 10 km^2.

Sabah's four reserves known or suspected to contain Bornean rhino populations collectively cover some 470,000 ha. Using the lower individual range estimate of 1,000 ha—which, coming from the AsRSG is perhaps the most authoritative—and a rough calculation; these reserves potentially provide for a maximum population of 470 animals. This is an overestimate, however, as the effective population—one that comprises breeding adults—will be lower than the total population. And as *Dicerorhinus* tend to avoid edges within two kilometres of human activity, the effective habitat area is therefore significantly less than the actual area. Two-kilometre wide buffers *external* to each of the reserves would be required just to increase the total population to something resembling the estimated potential population of 470. A target population of 1,000 (see Section 4.2) would require at least a doubling in area of the current reserve system to account for edge effects, fragmentation and sexual heterogeneity of small demes. If, however, individual *badak* require 3,000 ha (or even 2,000) ranges, the expansion implied by the lesser estimate pales in comparison.

Furthermore, the reserves comprising the 470,000 ha are not contiguous. There is a chance that some demes may be skewed toward sexually homogeneity. The disconnectedness and matrix quality between and within the eastern and western demes prevents dispersal and outbreeding between them, and hence any population increase beyond the estimated potential of 470. In the absence of suitable habitat restoration of human-modified habitat such that the two populations are reconnected, their geographical isolation is assured.

2.6 Summary

The relatively small but sturdy pachyderm that is the Bornean rhino—which probably roamed throughout the island after which it takes its common name up to the mid nineteenth century—is restricted to two isolated demes in the Malaysian state of Sabah.

With the exception of small areas of peat swamp and Kerangas forests in the KWR and MBCA, the habitats of these populations comprise primary and secondary dipterocarp forests. The subspecies' very low population density and dangerously low actual population necessitates a need for extensive well-connected dipterocarp rainforest reserves for it to recover and persist. Prior to examining issues relating to population stabilisation, recovery, and persistence, an examination of how the present situation arose is needed to understand how to negate the impacts of, or eliminate, drivers of Bornean rhino population decline, and avoid repetition of past mistakes. The major stressors that precipitated a declining Bornean rhino population are discussed in detail in the next chapter.

CHAPTER 3 THREATS

In 2005 the Millennium Ecosystem Assessment (MEA) issued a blunt warning regarding human impacts on biodiversity:

> *Human actions are fundamentally, and to a significant extent irreversibly, changing the diversity of life on Earth, and most of these changes represent a loss of biodiversity. Changes in important components of biological diversity were more rapid in the past 50 years than at any time in human history. Projections and scenarios indicate that these rates will continue, or accelerate, in the future* (p.2).

The greatest threat to global biodiversity is anthropogenic conversion of natural habitat, particularly for the purposes of agricultural and forestry production (Wilson 1999; Lindenmayer & Franklin 2002; Donald 2004; IUCN n.d.a; Sodhi *et al.* 2004). Human population growth and increasing demand for resources as a consequence of sheer numbers and increased affluence are the prime drivers of habitat conversion (Noss & Cooperrider 1994; Vitousek *et al.* 1997; Terborgh 1999; Wilson 1999; MacKinnon 2000). Resource demand for basic necessities such as food, shelter, clothing and fuel is compounded by industrial and commercial processes associated with their manufacture, transportation, trade and purchase. These compounding factors equally apply to goods and services such as education, recreation, travel, and entertainment. An almost pathological mass addiction to the accumulation and/or upgrading of material goods among the world's wealthy minority can also be added to the list of factors responsible for resource depletion. Indeed, "the global demand for resources now exceeds the biological capacity of the Earth to renew these resources by some 20%" (Secretariat of the Convention on Biological Diversity 2006, p.3).

Twenty-three per cent of Earth's mammalian species—most of which are found in tropical regions—are threatened with extinction (IUCN 2006). Forest ecosystems contain "the highest species diversity and endemism of any ecosystem type" (Sengupta & Maginnis 2005, p.21), and tropical lowland rainforests—those beneath 500 m altitude—are the "most species-rich of all terrestrial habitats" and in many regions throughout the world have "been reduced to less than 10% of their original areas" (MacKinnon 2000, pp.336-7). Between 60 and 90 per cent "of all species are found in moist tropical forests" although these ecosystems cover only two per cent of the planet's surface (UNEP Global Biodiversity Outlook, cited in Sengupta & Maginnis 2005, p.21).

Eminent Harvard biologist E.O. Wilson is a passionate defender of the natural environment in general and biodiversity in particular: "[t]he mindless horsemen of the environmental apocalypse have been overkill, habitat destruction, [and the] introduction of...exotic animals" (1999 p.253). WWF and IUCN identify the first and second of Wislon's troika as the major threats to the Sumatran rhino's existence—and thus, by default, the Bornean rhino's (IUCN n.d.a; WWF n.d.). Because human activities are the primary cause of over-hunting and habitat devastation, this chapter focuses on population, poaching, and habitat loss, conversion and fragmentation in Sabah.

3.1 HUMAN POPULATION

In 1921 Sabah's total population was 263,252—increasing to 334,141 30 years later, and almost doubling from then to 653,604 in 1970 (Jomo *et al.* 2004). During the past 25 years the population has dramatically increased. In 1980 it just exceeded one million—in 1991 it was 1.8 million (Jomo *et al.* 2004)—and in 2005 it had almost trebled from its level in 1980 to 2.9 million (Institute for Development Studies, IDS n.d.). Between 1991 and 1995 the average annual rate of growth was 6.2 per cent (Sadiq 2005), and it was 3.92 per cent for the decade to 2000 (IDS n.d.). Based on a population estimate of 2.6 million for 2000, continued growth of the latter magnitude translates to a population doubling period of 17.5 years—precipitating a potential total of about 5.5 million in 2017 (IDS n.d.), just over a decade from now.

Much of Sabah's recent population growth has occurred because of immigration rather than increased fertility. In 1991 "nearly a quarter of Sabah's inhabitants...were counted as non-Malaysians, of whom more than 98 *per cent* were from Indonesia or the Philippines" (Jomo *et al.* 2004, p.7). A recent report by the United Nations Development Program (UNDP) estimates that at the turn of the twentieth century 23.5 *per cent* of Sabah's population comprised non-citizens (UNDP 2005). If Sabah's international borders were less porous to illegal immigrants, future population growth and its inevitable impacts on land use (e.g. settlement and primary production) could be significantly ameliorated. Unfortunately, however, Malaysia's present internal political machinations—which include unsubtle manipulation of population censuses and blurring of the definition of citizen (Sadiq 2005)—are likely to prevent such a scenario from arising.

TABLE 3.1 HUMAN POPULATION DENSITIES AND GROWTH BY ADMINISTRATIVE DISTRICT, SABAH, 2000

Administrative District	Area (sq.km.)	Density (*per* sq.km.)	Growth (%) 1991-2000
Tawau Division	**14,762**	**44.4**	**2.4**
Tawau	5,994	54	2.45
Lahad Datu	6,537	25	3.11
Semporna	1,117	103	1.86
Kunak	1,114	47	2.20
Sandakan Division	**28,895**	**19.7**	**5.6**
Sandakan	2,182	169	4.98
Kinabatangan	7,456	13	7.36
Beluran	9,215	9	3.63
Tongod	10,042	2	6.41
Pantai Barat Division	**7,357**	**113.7**	**3.9**
Kota Kinabalu	317	1,173	5.89
Ranau	2,844	26	3.99
Kota Belud	1,308	58	2.41
Tuaran	1,194	71	2.65
Penampang	514	266	4.56
Papar	1,180	78	4.43
Kudat Division	**4,520**	**37.4**	**3.1**
Kudat	1,247	59	2.51
Kota Marudu	1,721	36	3.55
Pitas	1,552	22	3.23
Pendalaman Division	**18,463**	**20.1**	**2.8**
Beaufort	1,671	39	2.71
Kuala Penyu	901	19	1.65
Sipitang	2,710	11	2.04
Tenom	2,288	21	2.16
Nabawan	5,918	4	2.00
Keningau	3,717	42	5.57
Tambunan	1,258	23	3.82
Sabah*	**73,997**	**47.1**	**3.56**

Source: IDS n.d.

Eastern Sabah comprises the two Divisions of Tawau and Sandakan. The population density of the former is higher than for any division other than Pantai Barat—a smaller area with the state's capital, Kota Kinabalu (Table 3.1). Sandakan Division's population growth rate in the decade to 2000 was the highest in Sabah. Eastern Sabah's recent population growth is impressive given that other than "scattered coastal and riverine settlements, eastern Sabah was almost uninhabited until about 1960" (Marsh & Greer 1992, p.332). The area is also geographically synchronous with the establishment of expansive oil-palm (*Elaeis guineensis*) plantations (Figure 3.1). In the quarter century to 2000 the area of oil-palm established in Sabah increased at an annual average rate of 17 *per cent* (Table 3.3), and the state presently has the largest area of oil-palm of any state in Malaysia (see Section 3.3.1). The crop is labour-intensive and harvested by hand (Donald 2004). Malaysia is economically stronger than its neighbours, the Philippines and Indonesia. Comparatively higher wages in Malaysia and demand for unskilled labour for oil-palm production have driven the recent immigration boom in eastern Sabah. The region's high human population density has implications for Bornean rhino conservation because it is geographically contemporaneous with the subspecies' last known habitat strongholds (see Chapter 2). Wherever humans have settled in large numbers, they have drawn on their surrounding natural resources to provide for shelter, food, water, clothing and fuel. Future population growth in Sabah will undoubtedly impact on the region's remaining unmodified habitats and those recovering from previous modification, including that which comprises habitat for the Bornean rhino.

3.2 POACHING

According to Rabinowitz "[i]t is no small miracle that rhinos still walk the face of the earth. No other group of animals has been so highly prized for so long yet managed to survive human onslaught" (1995 p.482). Use of rhinoceros body parts—particularly the horn—in traditional Chinese medicine is widely known among most westerners, but its demand is often incorrectly assumed to be driven by use as a male aphrodisiac. Actually, dried rhino penis and the animal's blood are used for such, whereas powdered horn is used as a cure-all for health complaints as minor as headaches and as serious as life-threatening fevers (Ellis 2005). South and North Koreans also consume rhino body parts, while in Nepal and India rhino urine is consumed as a treatment for asthma and tuberculosis, and is also applied "topically to treat inner-ear infections" (Dinerstein 2003, p.29). Use of "rhino horn is recorded from China as early as 2600 B.C.", and in late fourth-century China it was recommended for treating "snakebites, hallucinations, typhoid fever, headaches, boils, carbuncles, vomiting, food poisoning, and 'devil possession'" (Ellis 2005, p.77). By the "Tang Dynasty (600-900 A.D.), large quantities of horn were being imported to China" as rhinos had by then already become scarce (Rabinowitz 1995, pp.482-3). Rhino parts were also used in the occident: Nicholas Culpeper (1616-54) listed them in a catalogue of animal derivatives he advised be kept in English apothecaries (Ellis 2005).

International trade in all rhino body parts was made illegal under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1977—though the Sumatran rhino received attention two years earlier (CITES n.d.). Illegal trade persists, however, despite water buffalo horn having replaced "rhinoceros horn in the official pharmacopœia of the People's Republic of China" (Dinerstein 2003, p.32). As recently as 2004, raids in Australia seized rhino horn-based goods (Reuters 2004, cited in Planet Ark n.d.). Poaching is likely to remain a problem for some time, especially if a poacher "can earn ten years' income with a single rhino kill" (Wilson 2002, p.86). Poaching is acknowledged by Foose and van Strien (1998) and the Sabah Wildlife Department as a major cause of the subspecies' decline (Maskilone 2002). The coastal port-town of Tawau—located near the Indonesian border in Sabah's southeast—has been identified as a hub for illegal trade in rhino parts (Martin 1988). Whether this activity remains there is uncertain, but in 2001 a reproductively aged female rhino—invaluable in terms of population recovery—from the Maliau Basin area west of Tawau was shot and decapitated (Ong 2001).

According to Bruner (2001, cited in Sodhi *et al.* 2004), effective reserve protection is most strongly correlated with density of guards. Strict protection of reserves where rhino are present is considered essential to Southeast Asian rhino conservation (Dinerstein 2003). In Sabah the threat of poaching remains sufficiently high that in early 2006 SOS Rhino Borneo formed two extra rhino protection units (RPUs), each comprising five members. The organisation now has five RPUs operating in the TWR, and plans to introduce another four by the end of 2006 (Edward Bosi, pers. comm. 2005). SOS Rhino Borneo does not, however, extend its operations into the KWR, and there are no similar anti-poaching schemes operating in either the USMFR/DVCA or MBCA. Yet even if RPUs were established in the MBCA, secure populations of *badak* could not be guaranteed as it is too small an area, and isolated from the other reserves. As noted earlier, habitat loss, fragmentation and conversion are driven by growing human demand for resources. The drivers of these processes in Sabah are the subjects of the following section.

3.3 Habitat Loss, Conversion & Fragmentation

Sabah's forested landscape has been severely fragmented during the past half-century due to rapid agricultural and forestry development. The area of land devoted to Sabah's agricultural and forestry production accounts for more than 4.4 million hectares or about 60 *per cent* of total land area (Table 3.2). The agricultural commodities identified in Table 3.2 include only major crops and exclude terrestrial aquaculture, pepper, tapioca, and coffee production, *inter alia.* One estimate of Sabah's agricultural area attributes 30 *per cent* of land to cultivation (IDS n.d.). *Ipso facto* 70 *per cent* is likely to be a more realistic estimate of area dedicated to forestry and agricultural production.

TABLE 3.2 SABAH'S MAJOR AGRICULTURAL AND FOREST-RESOURCE COMMODITIES

Commodity	Total area (ha)	% Total land area
Production forest	3,027,626*	41.0
Oil-palm	1,209,368#	16.5
Rubber	84,700†	1.1
Rice	41,217±	.5
Cocoa	21,600ə	.3
Coconut	20,836±	.3
Fruits	15,799±	.2
Vegetables	2,140±	.03
TOTAL	**4,423,286**	**59.9**

Sources: *Sabah Forestry Department 2004; #Malaysian Palm Oil Board n.d.; †Malaysian Rubber Board n.d.; əMalaysian Cocoa Board n.d.; ±Institute for Development Studies n.d.

Forest-based commodities and oil-palm dominate Sabah's non-metals primary production sector. The administrative divisions of Tawau and Sandakan were the top two from among Sabah's administrative divisions in terms of increasing cultivated land area during the decade to 2004—94,000 and 216,000 ha respectively (IDS n.d.). Forestry and oil-palm are of particular relevance to Bornean rhino conservation for four reasons. First, the subspecies is "highly sensitive to logging" (Davies & Payne 1982, p.220). Second, forestry and agriculture monopolise vast tracts of land. Third, land dedicated forest-based commodities comprise the matrix between the MBCA and DVCAs—an area populated by Bornean rhinos (see Chapter 2). Fourth, oil-palm plantations (Figure 3.1) almost wholly encloses the TWR, divorcing it from the KWR to the north. For these reasons, oil-palm and forestry-based production are examined in more detail below.

FIGURE 3.1 MATURE OIL-PALM (*Elaeis guineensis*) PLANTATION

3.3.1 OIL-PALM

Large mammal populations in Asia's lowland forests "are particularly vulnerable [to extinction] because these habitats are under the greatest pressures from conversion to agriculture and oil palm plantations" (Dinerstein 2003, p.3, citing Wikramanayake *et al.* 2002). From 1960 to 2005 Malaysia's oil-palm estate expanded from 54,638 ha to over 4,000,000 ha (Teoh 2000; MPOB n.d.). Though oil-palm cultivation grew by an astounding 478 *per cent* in the decade to 1970, subsequent lower decadal growth rates are nonetheless impressive. A rate of 165 *per cent* occurred over 1990/99 for example (Teoh 2000). In Sabah, oil-palm expansion more than doubled in the decade to 2005 (see Table 3.3), at an average annual increase of 69,100 ha. In 2005 Sabah's oil-palm estate of 1,209,368 ha was the largest of any Malaysian state, and accounted for about a third of the nation's total.

TABLE 3.3 MALAYSIAN OIL-PALM CULTIVATED AREA 1975-2005

Year	Peninsular Malaysia	Sabah	Annual incr. (Sabah)	Sarawak	Total (ha)
1975	568,561	59,139		14,091	641,791
1976	629,558	69,708	10,569	15,334	714,600
1977	691,706	73,303	3,595	16,805	781,814
1978	755,525	78,212	4,909	19,242	852,979
1979	830,536	86,683	8,471	21,644	938,863
1980	906,590	93,967	7,284	22,749	1,023,306
1981	983,148	100,611	6,644	24,104	1,107,863
1982	1,048,015	110,717	10,106	24,065	1,182,797
1983	1,099,694	128,248	17,531	25,098	1,253,040
1984	1,143,522	160,507	32,259	26,237	1,330,266
1985	1,292,399	161,500	993	28,500	1,482,399
1986	1,410,923	162,645	1,145	25,743	1,599,311
1987	1,460,502	182,612	19,967	29,761	1,672,875
1988	1,556,540	213,124	30,512	36,259	1,805,923
1989	1,644,309	252,954	39,830	49,296	1,946,559
1990	1,698,498	276,171	23,217	54,795	2,029,464
1991	1,744,615	289,054	12,883	60,359	2,094,028
1992	1,775,633	344,885	55,831	77,142	2,197,660
1993	1,831,776	387,122	42,237	87,027	2,305,925
1994	1,857,626	452,485	65,363	101,888	2,411,999
1995	1,903,171	518,133	65,648	118,783	2,540,087
1996	1,926,378	626,008	107,875	139,900	2,692,286
1997	1,959,377	758,587	132,579	175,125	2,893,089
1998	1,987,190	842,496	83,909	248,430	3,078,116
1999	2,051,595	941,322	98,826	320,476	3,313,393
2000	2,045,500	1,000,777	59,455	330,387	3,376,664
2001	2,096,856	1,027,328	26,551	374,828	3,499,012
2002	2,187,010	1,068,973	41,645	414,260	3,670,243
2003	2,202,166	1,135,100	66,127	464,774	3,802,040
2004	2,201,606	1,165,412	30,312	508,309	3,875,327
2005	2,298,608	1,209,368	43,956	543,398	4,051,374

Source: MPOB: n.d.

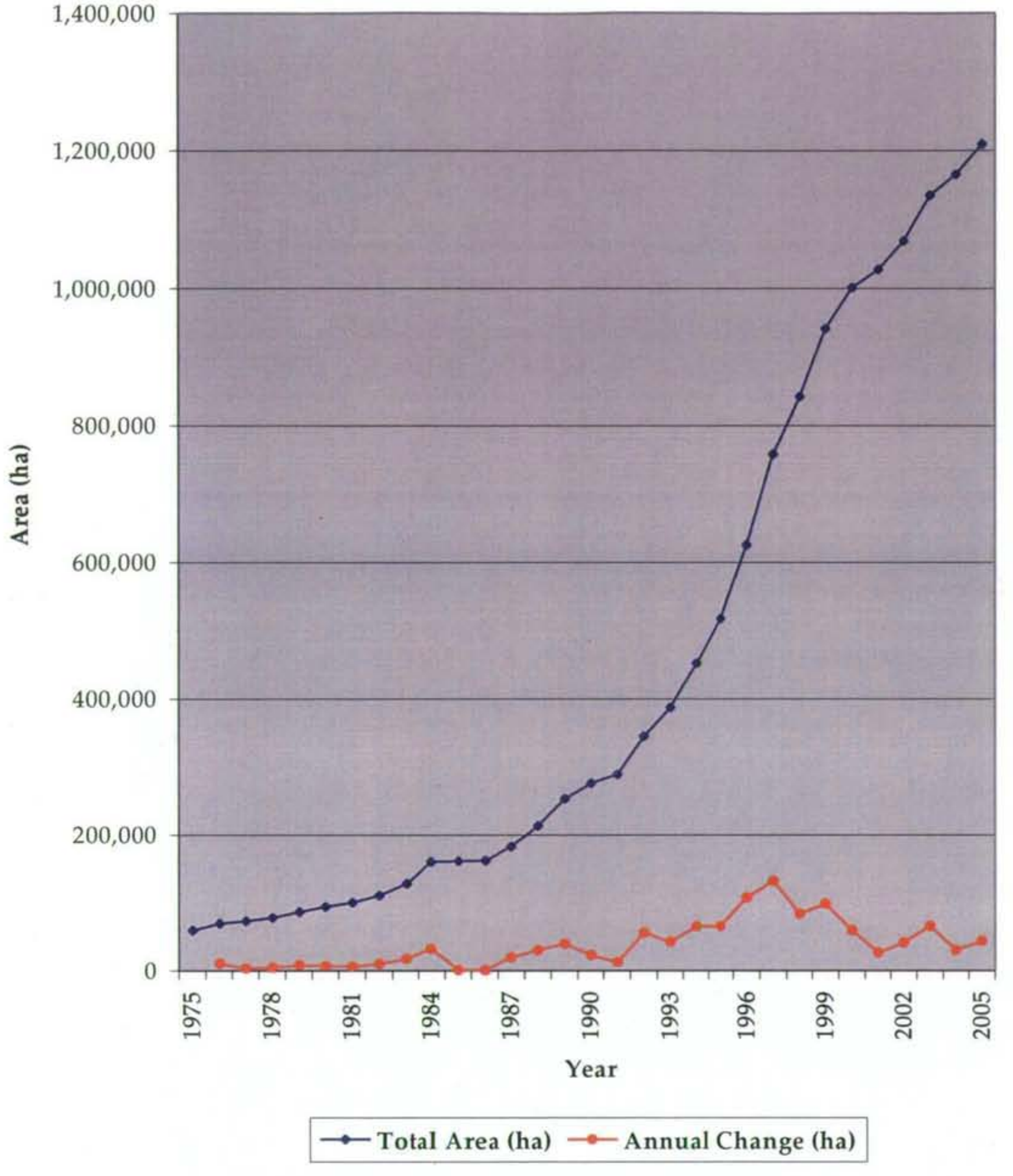

FIGURE 3.2 ANNUAL GROWTH IN OIL-PALM CULTIVATED AREA SABAH 1975-2005.

Source: MPOB n.d.

Figure 3.2 represents growth in Sabah's oil-palm cultivation between 1975-2005, and annual change in area. The former's trending line approximates the beginning of a parabola or bell-curve for which the zenith appears to be approaching in the near future—as supported by the declining trend in annual increase since 1997. The curve's shape resembles that of a growth curve approaching a constraint. One possible constraint could be land availability. Oil-palm cultivation in Sabah is not limited by area, however, as it covers only 16.5 *per cent* of total land area. The constraint is more likely to be competition with alternative land uses (e.g. other agriculture, forestry, and human settlement). Another constraint might be declining prices for oil-palm. In Malaysia in 2005, "prices and export earnings dipped, despite an increase in exports of all oil palm products during the year" (Basri Wahid 2006, cited in MPOB n.d.). Despite this deviation, oil-palm prices have increased by about 50 *per cent* over the five years to 2005 to US$395 *per* tonne and was predicted to reach US$430 by the end of 2006—driven by demand for oil-palm based bio-diesel (Krishnan & Mohanty 2006). Indeed, this figure was surpassed in July 2006 as a consequence of Indonesia and Malaysia announcing that 40 *per cent* of their crude oil-palm output would be reserved for biodiesel production (Thukral 2006). Given the European Union's (EU) directive to increase the bio-diesel content of its motor fuels to 5.75 *per cent* by 2010[2], there is considerable incentive for production capacity to increase. This particular threat has recently been summarised:

> *with a seemingly insatiable demand for automotive fuel, farmers will want to clear more and more of the remaining tropical forests to produce sugarcane, oil palms, and other high-yielding fuel crops. Already, billions of dollars of private capital are moving into this effort. In effect, the rising price of* [petroleum] *oil is generating a massive new threat to the earth's biological diversity* (Brown 2006, p. 8).

In the absence of improved productivity from the present estate, a future Sabahan government could be tempted to permit further forest clearing for oil-palm production.

One estimate of future *global* demand for oil-palm translates to establishing another 4-6,000,000 ha during the next quarter century (Hai 2004, cited in WWF Indonesia n.d.). Another estimate equates to a need for "a planting rate of 280,000 ha/annum" over 20 years to 2023 (Chapman *et al.* 2003, p.134). Though annual cultivation increases in Sabah have slowed since 1997, increasing global demand is almost certainly to influence future land-use. In an effort to counter international concerns about rainforest clearing, the Malaysian Palm Oil Board (MPOB) asserts that rainforests are not cleared to establish oil-palm plantations. Its claim does not, however, withstand critical scrutiny. In its online report, *Sustainable Production of Malaysian Palm Oil: THE FACTS* (Appendix A), the MPOB states that "over the last two decades, there is [*sic.*] rapid replacement of the major other perennial tree crops to oil palm rather than destruction of jungle per se" (MPOB n.d.). The statement is, however, entirely inconsistent with analysis provided by Jomo *et al.* (2004) which shows that during

2 The EU is reviewing this target and considering a revised target of eight *per cent* by 2015 (Reuters 2006, cited in Planet Ark n.d.a).

the decade to 2000, oil-palm production monopolised another 9.3 *per cent* of total land area, while during the same period cultivation (by hectare) of all other major crops (rubber, cocoa, coconut *and* rice) decreased by only 2.6 *per cent* of total land area. Furthermore, although the MPOB's discussion is related to "the last two decades" there is inconsistency with the title of its table headed, "...the last two decades 1990-2000." The same publication declares that the "Malaysian Government does not allow clearing of jungle for oil palm in Peninsula [*sic.*]"—presumably meaning 'Peninsula Malaysia' (MPOB n.d.). This does not repudiate, however, a situation in which "jungle" (i.e. rainforest) cleared for some initial purpose (e.g. timber harvesting) is then developed for another purpose (e.g. oil-palm production). What is more, it disregards rainforest conversion in Sabah or Sarawak.

Arguments about whether oil-palm expansion in Sabah continues at the expense of natural forest seem *almost* indulgent since the subspecies is in such a perilous situation—its low metapopulation segregated into two geographically isolated populations, and most of the land surrounding these have already been converted to either agricultural production (in the case of the eastern population), or forestry production (the western population). Figures 3.3 and 3.4 show the extent of Sabah's oil-palm production and forest reserves respectively. Comparing the two illustrates the extent to which the reserved habitats are isolated from each other and occur within matrices that are hostile, if not impermeable, to *badak*; oil-palm and production forestry—the subject of the next section.

3.3.2 FORESTRY

Pertinent to this section is acknowledgment of inconsistent figures relating to forest types in an online Sabah Forestry Department (SFD) publication (SFD n.d.). Figures used here are the lower of those cited for Classes 4, 6 and 7 forest reserves (underlined in Appendix B).

Until the mid-twentieth century Sabah—a land of 7,371,261 ha—was almost wholly forested (WWF 2005). According to the Food and Agriculture Organisation of the United Nations, forest covered 6,285,000 ha or 85.26 *per cent* of the state twenty-five years ago (FAO 1981). Within five years 25 *per cent* of *total* land—all forested—had been cleared (FAO 1987, cited in Marsh & Greer 1992). In 2004 Sabah's total forest area—4,392,072 ha—covered 59.6 *per cent* of the state (SFD 2004). That the SFD's definition of 'forest' might include plantations is supported by Jomo *et al.* who cite a lesser area of 56.7 *per cent* of total land being covered by forest at an earlier date in 1991 (2004 p.97).

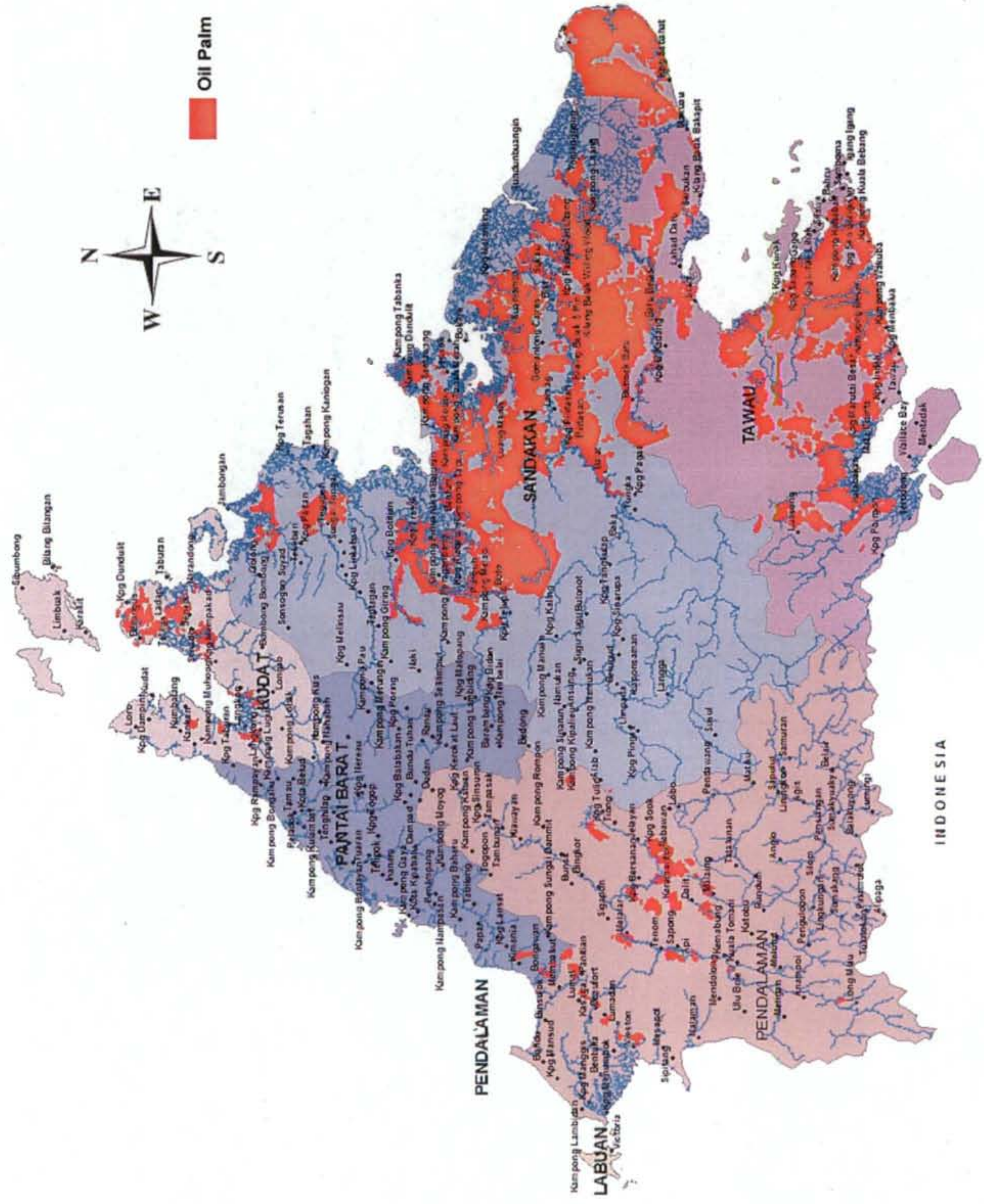

FIGURE 3.3 OIL-PALM DISTRIBUTION, SABAH.

Source: MPOB n.d..

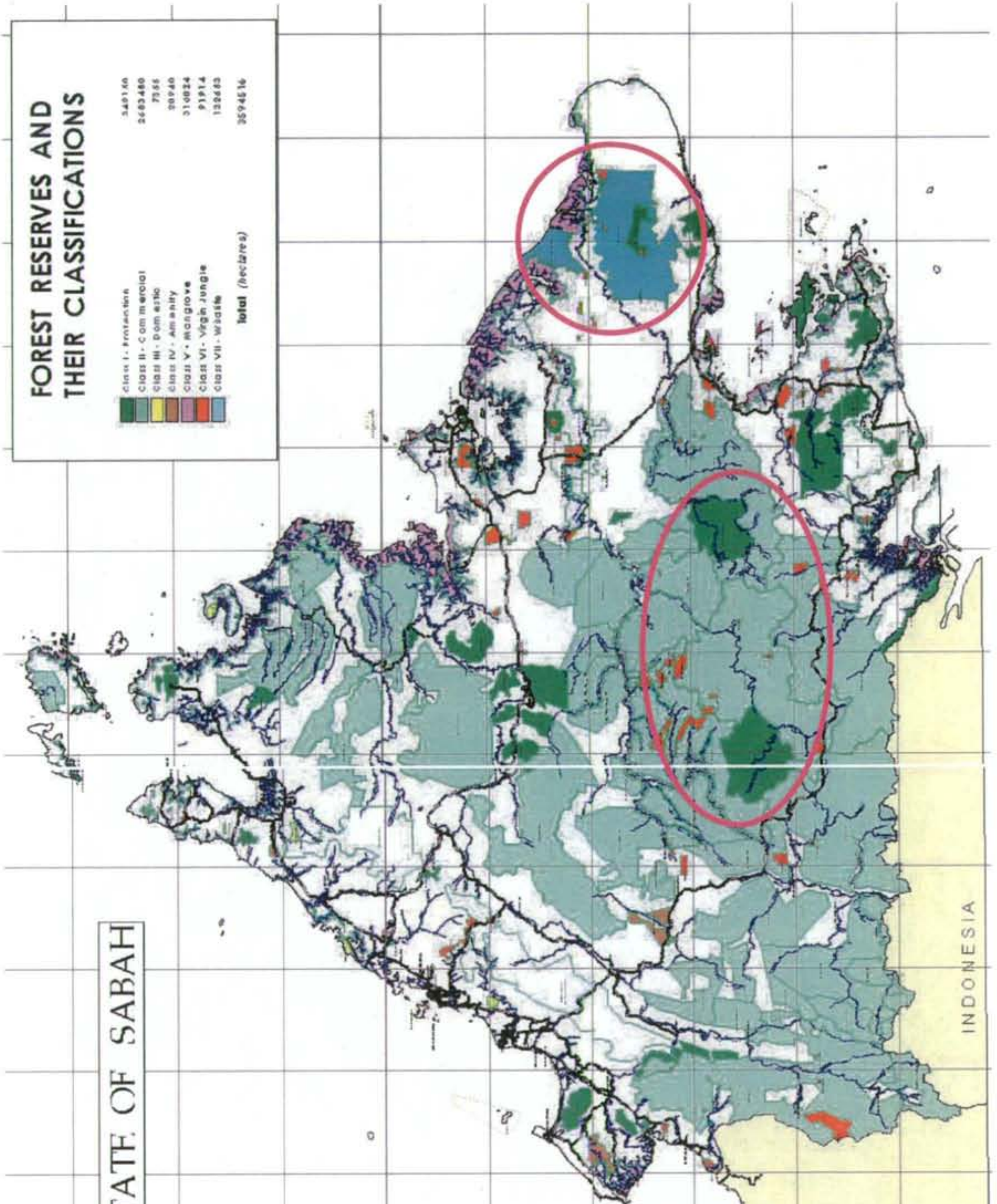

FIGURE 3.4 SABAH'S FOREST RESERVES (TWR & KWR ARE LIGHT BLUE, AND THE MBCA AND DVCA IN DARK GREEN – BOTH CIRCLED).

Source: Sabah Forestry Department 2004

Notwithstanding uncertainty over the SFD's definition of forest, a significant loss of almost 2,000,000 ha of forest occurred over the last 25 years—most of it occurring in the five years to 1986. Biodiversity impacts of this activity would be greater than the figures suggest because deforestation did not occur in a single large block. As forests are cleared remaining habitat becomes fragmented and isolated, edge effects are amplified, and disturbance intensified. The SFD is not inhibited in acknowledging that 2,953,061 ha of forest it manages—67 *per cent* of all forests—is "immature disturbed regenerating forests" (SFD n.d.). Sabah has dedicated 3,027,626 hectares or 84.3 *per cent* of its total forest reserve system to timber harvesting, be it commercial or customary (SFD n.d.). In 1992 almost 800,000 ha of forest—18.2 *per cent* of total forests—external to the forest reserve system comprised "the state or national park system" (3.4 *per cent* of total forest), with the remainder (12 *per cent* of total forest) "destined for conversion to agricultural use" (Marsh & Greer 1992). No doubt these figures have altered since 1992, but they are provided here for illustrative purposes.

Sabah's timber industry has the dubious distinction of being the greatest source of forest disturbance in that state (Marsh & Greer 1992), as evinced by the loss of much of Sabah's lowland dipterocarp forest—where "most of the best timber species occur" (SFD n.d.a). In 1971 Sabah's primary forests (all types) covered 61 *per cent* of its land, but this figure had more than halved just nine years later to 27 *per cent* (Davies & Payne 1982). By 1990 81.5 *per cent* of all lowland forests (mainly dipterocarp) were recovering from forestry activity, and over the five years to 2004 the remaining area of undisturbed mixed (low- and highland) dipterocarp forest decreased some 13,500 ha from 286,838 ha to 273,177 ha (SFD 2004). This might not seem much over five-years, but it occurred from a small and fragmented base that comprised just 3.7 *per cent* of Sabah's total land area (6.2 *per cent* of remaining forests). The remainder of Sabah's dipterocarp forests are included among the 2,953,061 ha of "[o]ther forests" the SFD considers "immature, disturbed regenerating forests" (SFD n.d.a).

Extinction-prone species "include large wide-ranging taxa (often predators), rare species, or species that are sparsely distributed" (Lindenmayer & Franklin 2002, p.35). If it were not already threatened with extinction, the Bornean rhino would, other than being a predator, be a prime candidate for such. It risks immediate extirpation in the wild should adequate dipterocarp forest habitat be inadequately protected and secured.

3.4 Summary

In the last 25 years eastern Sabah has experienced a rapid increase in human population concomitant with rapacious land clearing—particularly for oil-palm production—and severe reduction in area and structural integrity of lowland dipterocarp forests—primarily from industrial forestry. It is worth acknowledging that although the human activity associated with logging operations (road construction, felling and trucking, for example) would drive Bornean rhinos from those areas affected, and that recently clearfelled forests destroy their habitat, forests recovering from logging and which have formed closed canopies can present habitat opportunity. The TWR, for example, almost wholly comprises secondary regrowth dipterocarp forest. Nevertheless, land transformations of the scale that have occurred during the last quarter century have—in addition to poaching activity—severely impacted on the Bornean rhino's tenuous existence. Forest fragmentation and degradation will, in all likelihood, continue in Sabah for the foreseeable future. For example, 24,000 ha of land have been targeted for future rubber plantations (Malaysian Rubber Board, MRB n.d.a), and 547,693 ha of forest have been identified for timber plantation development (SFD n.d.b). And though the annual increase in area of newly established oil-palm plantation declined over recent years, if only half the increase over the five years to 2005 were repeated to 2010, another 120,000 ha would be created. Biodiesel demand already influences oil-palm development (MPOB n.d.). With growth in oil-palm production presently competing with other land uses, there is a risk that future development could be at the expense of forest—especially if 'cold-tolerant' oil-palm hybrids are cultivated in higher altitudes where current hybrids have hitherto been excluded (Chapman *et al.* 2003). According to Reid and Miller: "[t]ropical deforestation is expected to be responsible for the loss of an estimated 5-15 per cent of the world's species between 1990 and 2020, a rate unparalleled in modern history" (1989, cited in Sengupta & Maginnis 2005, pp.48-49). Should that prediction eventuate, the wild Bornean rhino population would almost certainly be included amongst that fraction were it not for successful conservation intervention. The international conservation community's response to the Bornean rhino's precipitous decline in numbers is examined in Chapter 4.

CHAPTER 4 RESPONSES

The population of wild *Dicerorhinus* is estimated to have halved during the last decade of the twentieth century (Pellegrini 2002, cited in SOS Rhino 2002), and a fifty *per cent* decline is also estimated to have occurred in Indonesia during the decade ending 2005 (*Antara News* 2006). Its rapidly dwindling population elicited responses from within the international conservation community in the early 1980s. In October 1984 a meeting of the IUCN's AsRSG met in Singapore "to evaluate proposed ex situ programs as part of the overall strategy" for the species' conservation (Foose *et al.* 1995, p.977). This meeting endorsed "a strategy for the captive breeding of the Sumatran rhinoceros in Malaysia, Indonesia, and European and north America zoos" (Species Survival Commission, SSC 1989, p.1). In response to objections by its citizens no individual rhinos were, however, exported from Malaysia. As is explained in this chapter, consequences of *ex situ* conservation strategies were disastrous with almost all the animals brought into captivity dying well in advance of their 'utility' as breeding stock. Criticism of the *ex situ* approach appeared in the mid 1990s. The AsRSG released a new edition of its Action Plan in 1997 "[p]repared by 48 of the world's leading experts on Asian rhinos" (McNeely 2000, p.357). The new plan did not eschew *ex situ* strategies, but the focus had clearly shifted to *in situ* conservation. Captive Sumatran rhinos continued dying, however, and as recently as 2003 five died in a sanctuary on the Malaysian peninsula. The more recently supported *in situ*—and now all-but-disgraced intensive *ex situ*—conservation strategies are discussed in detail here.

4.1 CAPTIVE BREEDING

Among the variously authored chapters in a 1987 book, *Viable Populations for Conservation,* one was dedicated to the Sumatran rhino. The authors employed 'decision analysis' to prioritise management options from among six alternatives[3] and concluded that captive breeding was the best (but not only) option available. Meanwhile, the IUCN's SSC created the AsRSG which first convened in 1979 (Rabinowitz 1995). In 1989—the year of the second reprint of *Viable Populations for Conservation,* also known among conservation biologists,

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3 Six options were considered;

(1) increasing control of poaching in existing reserves; (2) doubling the size of one national park; (3) creating a new national park; (4) fencing a large area of prime habitat, managing the enclosed population with supplemental feeding and veterinary care, and translocating isolated rhinos into the enclosure; (5) translocating rhinos among wild subpopulations to restock depleted habitats and to maintain gene flow among subpopulations; and (6) capturing wild rhinos to form captive breeding populations in at least four separate institutions in four countries. The captive populations would serve both as a reservoir of genetic material and as a source of animals to bolster populations in currently or previously occupied habitat (Maguire et al. 1989, pp. 148-149).

island biogeographers and the like as the 'Blue Book'—the AsRSG published *Asian Rhinos: An Action Plan for their Conservation*. Though the Action Plan recognized "the importance of *in situ* protection and management of wild populations...[it also] clearly emphasized *ex situ* management" (Rabinowitz 1995, p.484).

Between 1984 and 2001, 40 wild Sumatran rhinos were captured for *ex situ* breeding (Khan *et al.* 2001). Of these, 23 survived in 1993 (Rabinowitz 1995), 20 remained in 1996 (Foose & van Strien 1997), 17 in 1998 (Foose & van Strien 1998), 13 in 2002 (Pellegrini 2002, cited in SOS Rhino n.d.), and eight survived to 2003 (Khan *et al.* 2004). After the death of 'Rapunzel' in the Bronx Zoo in January 2006 (Newman 2005, cited in IRF 2005), seven captured rhinos at most remain in captivity, and of these, two Bornean rhinos in the Sepilok wildlife sanctuary, Sabah, are past their reproductive years. No Bornean rhino has been brought into captivity since the female of these two, 'Gelugob', was introduced into Sepilok in 1995. In 2005, two wild female Sumatran rhinos were added to Way Kambas sanctuary (Figures 2.2 and 4.1).


IRF

FIGURE 4.1 SUMATRAN RHINO (*D. sumatrensis sumatrensis*)
WAY KAMBAS 2005

If not for the birth of two Sumatran rhino calves in the Cincinnati Zoo since 2001 (see Section 2.2), the *ex situ* conservation strategy during the closing decades of the twentieth century could quite easily be regarded an unmitigated disaster. Though the captive breeding attempt was made in ignorance of the species' reproductive idiosyncrasies (see Section 2.2), this does not explain the programme's failure, which occurred more as a consequence of the captive population's high mortality rate. Other than deaths in captivity, according to unsubstantiated reports some rhinos died before they could be released from the pit-traps used to capture them, and the five that died in the sanctuary at *Sungai Dusun* in Peninsula Malaysia were apparently maintained in poor conditions. Interestingly, a paper published 18 years after *Viable Populations for Conservation*, employed 'information-gap theory'—which "assesses the robustness of decisions in the face of severe uncertainty"—to reassess "the decision problem explored by Maguire *et al.*" (Regan *et al.* 2005, p.1472). Though this reassessment was based on three of the management options considered by Maguire *et al.* and other assumptions—including the mutual exclusiveness of the causes of *Dicerorhinus* population decline—the conclusion was that a new reserve had "the greatest robustness to uncertainty" (Regan *et al.* 2005, p. 1476). It would be an interesting but ultimately futile exercise to speculate by what degree the current situation regarding *Dicerorhinus* might be had information-gap theory been invented and employed prior to 1987.

Captive breeding has been an absolute failure for Bornean rhino conservation. The "reproductive senescence" (van Strien 2005, p.17) of the only captive female in Sepilok means that, barring the rapid development and broad adoption of artificial insemination and/or *in vitro* fertilisation procedures, there is no possibility of the subspecies' population increasing or recovering as a consequence of *ex situ* conservation strategies anytime soon. The very small and diffuse extant population presents seemingly insuperable difficulties for *ex situ* conservation in the present and foreseeable future. Acquiring more wild 'propagules' would decrease the wild population further and risk hastening their decline *in situ* from genetic and natural stochastic events. Exposing wild populations to accelerated extinction by inadvertently exaggerating the male/female ratio such that the chance of potential breeding-pairs meeting and conceiving, is also a possible risk.

In a 1995 critique of *ex situ* Sumatran rhino conservation in Borneo the author, Alan Rabinowwitz, argued that financially and temporally-intensive *ex situ* conservation efforts failed to address fundamental causes of extinction—i.e. poaching and habitat loss (see Chapter 3). He also claimed that along with "international funding and conservation organizations" (Rabinowitz 1995, p.487), the Malaysian and Indonesian governments—

neither of which had until then enacted legislation relating to CITES, or increased enforcement of existing legislation relevant to Sumatran rhino protection—avoided difficult choices. There was an implication that the Malaysian government aggravated the species' decline because its response in securing the TWR—formerly a forest reserve that had been almost completely logged up to the mid 1980s—equated to 'picking low fruit' lest its actions interfere with planned forestry and agricultural development. The strategy also neglected to implement "antipoaching patrols, education campaigns, and surveys to assess the adequacy of reserve size" (Rabinowitz 1995, p.486).

In response to Rabinowitz's article, members of the AsRSG noted "several serious errors of commission and omission" (Foose *et al.* 1995, p.977). Their response, however, discloses an admission that a small pool of funds had limited what was able to be accomplished: "[m]uch of the previous money expended on the ex situ program was not available for in situ" (Foose *et al.* 1995, p.978). This acknowledgement vindicates Rabinowitz's point that conservation efforts were unreasonably skewed in favour of *ex situ* strategies. Among other responses, a representative from the Sabah Wildlife Department—while defending his employer's actions—also admitted that the quality of surveys conducted until then had been inadequate and that what was required was "an intensive, full-time study led by one specialist over a period of several years" (Andau 1995, p.980). Another vindication; this time of Rabinowitz's claim that adequate surveys were wanting.

It is impossible to know whether the AsRSG's next and most recent—but now almost decade-old—edition of its Action Plan was influenced by the discourse between conservation groups, range-state governments and conservation professionals ensuing from Rabinowitz's fomenting remarks. The Action Plan, does, however, recognise the failure of the temporally- and resource-intensive *ex situ* conservation strategy: "[t]he 1989 version of the Asian Rhino Action Plan had placed great emphasis and expectation on ex situ programs for Asian rhinoceros...However, traditional captive methods and programs have proven unsuccessful for the Sumatran rhinoceros despite investment of considerable time and effort" (Foose & van Strien 1997, p.3). Thus the Action Plan could hardly be anything but unequivocal in noting the principal role of *in situ*-based conservation strategies: "The major requirement for Asian rhino conservation is increased protection *in situ*..." (Foose & van Strien 1997, p.4)—the subject of the following section.

4.2 RESERVES

Large reserves afford habitat protection from natural disturbance regimes, and "contain a greater area of interior habitat buffered from negative edge effects...associated with the boundaries of reserves" (Lindenmayer & Franklin 2002, p.83)—a crucial requirement for Bornean rhino populations, as explained in Section 2.6. Large reserves are also essential for maintaining wide-ranging taxa and those for which highly-modified habitats are inhospitable. *D. sumatrensis harrissoni* fits both categories (see Sections 2.4 and 2.5), though it might be argued that *Dicerorhinus* are not completely averse to highly-modified habitat since two were recently wandered through villages close to national parks in Sumatra, and others have been observed

Errata

p.53, par.1, sentence 3 should read « *D. sumatrensis harrissoni* fits both categories (see Sections 2.4 and 2.5), though it might be argued that *Dicerorhinus* are not completely averse to highly-modified habitat since two recently wandered through villages close to national parks in Sumatra, and others have been observed in complex agroforests (see Section 2.5) »

p.53, par.1, sentence 6 should read « The presence of Bornean rhinos in the TWR confirms that the subspecies is not averse to certain types of modified habitat, as the reserve almost wholly comprises secondary regrowth forest »

Distribution of Bornean rhino populations does not conform to orthodox models of metapopulations where a group of local populations "interact via individuals moving between" them (Hanski & Gilpin 1991, cited in Lindenmayer & Franklin 2002, p.31). A matrix of agricultural and settled land between the western and eastern populations is impermeable to forest-interior species thus negating migration and outbreeding. It is a matter of reason that if viable wild populations of *badak* are to persist into the future they will require secure large reserves with permeable matrices, if not dedicated corridors, configured for the subspecies' needs. The present arrangement of reserves is inadequate with regard to connectivity.

Maintaining large animal populations is desirable because they "have greater levels of genetic variation" (Lindenmayer & Franklin 2002, p.7), and are therefore more immune to "extinction as a result of genetic stochasticity" (Lacy 1987 and Saccheri *et al.* 1998, cited in Lindenmayer & Franklin 2002, p.83). Developing a population of "at least 700-1000 [Bornean] rhinos" (Foose & van Strien 1997, p.24) is identified as a long-term goal in the Action Plan, but the necessity for secure, inter-connected, large reserves is only mentioned briefly, and there is no discussion of how or where "stabilization, extension, and improvement of rhino habitat" (Foose & van Strien 1997, p.4) might occur. Until very recently securing additional Bornean rhino habitat had not occurred (see below). The MBCA, TWR and KWR boundaries remain unchanged since the Action Plan was published. The first of these reserves remains an island in a sea of commercial forestry activity, and the TWR and KWR are disconnected by a linear area of oil-palm plantation some five to ten kilometres wide either side of the lower reaches of the Segama River. The Action Plan states that the TWR "will be extended to incorporate an area of adjacent forest in the north, connecting Tabin to Kulamba Wildlife reserve" (Foose & van Strien 1997, p.26), but unless this is the very narrow connection joining TWR with a Mangrove Reserve immediately east of the KWR (see Figure 3.4), the extension did not eventuate. And if this narrow connection *is* the extension sought, it is a mere kilometre or two wide at most, and connects with mangrove forest which is unsuitable Bornean rhino habitat.

Almost a decade after the Action Plan was published, a phase-out of logging by 2007 in the USMFR—which almost wholly encircles the DVCA—was announced in April 2006 by Sabah's state government. Although widely reported as a means of protecting habitat for the Bornean orang-utan (*Pongo pygmaeus*), the area is also one of only two places on Earth where that species and the Bornean elephant (*Elephas maximus borneensis*) and Bornean rhino coexist—the other being the TWR. WWF US described the move as "one of the most important actions ever taken to secure the future of Borneo's endangered wild mammals" (*The Star* 2006). The contiguous area which includes the DVCA and some lesser areas of Virgin Jungle Forest Reserves covers 284,200 ha. Such an area has the potential to maintain a significant population of Bornean rhinos—being considered one of two areas that "have good prospects of long-term survival with adequate protection and management" (WWF n.d). The habitat quality of the 'new' area is, however, unclear, and there are no wildlife reserves connecting it with the MBCA or TWR. Nevertheless, it is a substantial development with significant short-term opportunity costs in forgone income from logging amounting to US$270 million dollars (*The Star* 2006).

4.2 RESERVES

Large reserves afford habitat protection from natural disturbance regimes, and "contain a greater area of interior habitat buffered from negative edge effects...associated with the boundaries of reserves" (Lindenmayer & Franklin 2002, p.83)—a crucial requirement for Bornean rhino populations, as explained in Section 2.6. Large reserves are also essential for maintaining wide-ranging taxa and those for which highly-modified habitats are inhospitable. *D. sumatrensis harrissoni* fits both categories (see Sections 2.4 and 2.5), though it might be argued that *Dicerorhinus* are not completely averse to highly-modified habitat since two were recently wandered through villages close to national parks in Sumatra, and others have been observed in complex agroforests (see Section 2.5). The argument is, however, indefensible since, in the first instance, two examples do not constitute a general rule. And in the second instance, complex agroforests are structurally similar to natural forests, and ought not be regarded as 'highly-modified.' The presence of Bornean rhinos in the TWR does, however, confirm that the subspecies is not averse to certain types of highly-modified habitat as the reserve almost wholly comprises secondary regrowth forest. As noted in Section 3.4, however, forests recovering from clearfelling which have yet to form closed canopies are unsuitable habitat. Furthermore, the value attributed to rhino body parts exposes Bornean rhinos to the risk of poaching; thus recovering forest habitat—where *badak* would be more visible—is *averse* to *badak*.

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Another of the Action Plan's goals in relation to the Sumatran rhino is "[to] preserve, manage and where appropriate expand all populations that have the potential to increase to 100 animals or more" (Foose & van Strien 1997, p.24). Implicit here is once again the requirement for large reserves of suitable habitat to accommodate the population targets. The potential carrying capacity estimated for the eastern population, which includes the TWR, KWR and "Lower Segama" (the borders, area and exact location of which are uncertain but is presumably between the two Wildlife Reserves), is 120 (Figure 4.2). This estimate appears to be based on an erroneous assumption of the area being 120,000 ha—as opposed to at least 132,000 ha for the combined area of the TWR and KWR (exclusive of the area that comprises the 'Lower Segama')—and an assumed range of 10 km² *per* individual.

Table 2.5 ... continued. Population estimates of the wild Sumatran rhinoceros

	Estimated Number of Rhino		Habitat Availability (sq km)			
Location	AsRSG Meeting 12/1993	AsRSG Meeting 12/1995 Known/Probable/Possible	Presently (% Surveyed)	Potentially	Protection Status	Potential Carrying Capacity
Malaysia						
Sabah						
Tabin Wildlife Reserve (+ Kulama W.R. & Lower Segama)	20+	13/2/5	1,200 (100%)	1,200	Wildlife Reserve	120
Kretam	18-28	1/0/0	1,000	0		
Yayasan Sabah Forest Concession	10-20					80
A) Danum Valley		6/2/3			Protected Forest Reserve	
B) Maliau Basin		1/2/1				
C) Kuamat River		2/2/2				
D) Ulu Segama & Malua FR		2/4/2	438 (80%)	2,000 ?	Protection Forest	
Damarakot-Tangkulap		1/0/2				
Lower Kinabatangan		3/2/3				
Lamag		1/0/2				
Other		0/6/0				
Sub-total	48-68+	30/20/20=70				200
Sarawak						
Limbang	10+	0/?/?	600	600	Prmry/secndry forest	60
Sub-total	10+	0/?/?				60
Total Malaysia	143-204	71/54/24+=149+				678-728
Total	356-495	110/118/72+=300+				1538-3048

FIGURE 4.2 ABRIDGED TABLE FROM 'ASIAN RHINO ACTION PLAN'

Source: Foose & van Strien 1997, p.15.

The Action Plan also estimates a potential population of 200 for the entire YSFC which *appears* to include the, MBCA, USMFR/DVCA, and the Kuamat River Forest Reserve (a.k.a Quarmot River, the precise location and classification of which is not provided): a combined area of at least 343,000 ha. Why the estimate is not proportional to that of the TWR (in which case it would be 343) is unclear. The table in which these estimates are presented is somewhat difficult to decipher due to its layout, spelling and lack of any explanatory (graphic or otherwise) information regarding the locale of each of the habitat areas referred to. What is clear, however, is that the combined area of the TWR, KWR, MBCA and the new region surrounding and including the DVCA exceeds 478,000 ha. If the Bornean rhino populations of these areas are able to secured they could possibly expand about ten times the 2005 estimate to 480 or thereabouts (based on the 10 km^2 individual range estimate used by the AsRSG). According to the Action Plan's goal of expanding "all populations that have the potential to increase to 100 animals or more", this would exclude the MBCA due to it being far less than 100,000 ha in area. Perhaps in recognition of this possible oversight, and the ambitious original population goal of 700-1000, a 2004 workshop involving 42 participants from various organisations, discussed and refined strategies for conserving "the Sumatran rhino in Sabah and Borneo" (Khan *et al.* 2004, p.14). Three major goals for *in situ* conservation were identified:

- *Short term: preserve the current population (< 50 rhinos, mainly in Tabin Wildlife Reserve and Danum Valley), and create conditions for increase in numbers.*
- *Mid term: establish contiguous habitat covering about 3000 km^2 capable of sustaining over 300 rhinos (Tabin Wildlife Reserve with 1200 km^2 has an estimated carrying capacity of 120 rhinos).*
- *Long term: restore viable rhino populations in all historical and suitable habitats throughout Borneo* (Khan *et al.* 2004, p.14).

Prior to addressing each goal in turn, it is worth noting that they were made in the context of the *Sumatran* rhino in Borneo. It might be a matter of semantics but in the absence of further clarification it is unknown whether *Sumatran* is deliberately used or an oversight on behalf of the authors. If the latter, one could safely assume that the goals specifically relate to *D. sumatrensis harrissoni*, otherwise one might assume that the authors no longer observe the taxonomic difference between the Bornean and nominate subspecies. Advocates of a similar position in relation to species recovery include Rabinowitz who tentatively notes that "[t]his perhaps should not matter when a species is near extinction" (1995a p.981); and Dinerstein who states that endangered species "[r]estoration may require the mixing of populations that might be considered subspecies" (2003 p.101). These authors base their views on a paper by

Amato, Wharton, Zainuddin and Powell (1995). In discussing the *ex situ* and *in situ* conservation debate, Dinerstein characterises supporters of *ex situ* conservation as being concerned with maintaining genetic potential, whereas proponents of the *in situ* strategy are field conservationists who focus "on the ecological role that species play in the landscape" (Dinerstein 2003, p.233). An alternative to the '*ex situ*/genetic purity' *vs.* '*in situ*/ecological role' dichotomy might be a hybrid '*in situ*/genetic purity' position where genetic purity is maintained with *in situ* conservation. This might characterise the AsRSG's position:

> *Breeding between individuals from different geographical regions (e.g. Peninsular Malaysia and Sabah) should be avoided unless further studies show that there are no appreciable genetic differences between these areas or until a demographic imperative argues for subordination of genetic considerations in favor of maximizing breeding* (Foose & van Strien 1997, p.27).

Although the authors cite the work of Amato *et al.* published two years prior to the Action Plan, the AsRSG chose to wait for corroborating evidence regarding Sumatran rhino taxonomy, while expounding the virtues of *in situ* conservation. *In situ* rhino conservation is not without precedence in situations where a 'demographic imperative' looms large. The successful recovery of the Greater one-horned rhino in the Chitwan Valley from a population numbering some 60 to 80 animals in the mid 1960s to more than 500 in 2000 (Dinerstein 2003), clearly demonstrates that rhino populations can recover from very low numbers "when provided with sufficient habitat and strict protection" (Dinerstein 2003, p.84).[4] The recovery in Chitwan is not an isolated example. In Assam, India, the population of Greater one-horned rhinos in 1966 "was a mere 366; it jumped up to 658 in 1972, 939 in 1978, 946 in 1984, 1129 in 1991 and 1164 in 1993" and 1855 in 2006—increasing by 300 since 1999 (van Strien & Maskey 2006 p.22). All things being equal, the same might be achievable for the Bornean rhino, though in reality, other things are not equal—reproductive biology being a major difference. The following discussion in relation to the three goals from the 2004 workshop mentioned above assumes they were made in context of the Bornean subspecies.

Since the three goals were devised, the first has been partially achieved. As noted in Section 3.2 the number of RPUs operating in the TWR increased from three to five in 2005 and there

4 Due to Nepalese army personnel being removed from Chitwan to assist in quelling the recent Maoist insurgency, rhino poaching increased, and the population dropped to 372 in 2005 (WWF n.d.b.). This tragedy underscores the need for constant on-ground vigilance and greater emphasis on demystifying the apparent health benefits of rhino body-parts.

are plans to increase that number to nine by the close of 2006. Unfortunately, there are no RPUs to secure the western population. This requires urgent attention if the short-term goal is to be completely realised, and especially if the rumours regarding continued illegal logging in and around the DVCA have any foundation (E. Bosi 2005, pers. comm.).

With about 230,000 ha of Bornean rhino habitat reserved and a contiguous area of 240,400 ha slated for protection from commercial logging, the median goal of increasing the overall population to 300 could be achieved and surpassed, though it is likely that the population would be split between the east, and the MBCA and USMFR/DVCA area in the west (which is disconnected by the GRFR where industrial logging occurs). There is also the matter of whether the goal of 300 represents a total or effective population. Although wanting of greater clarification, the goal is, nevertheless, worthy of pursuit. The reservation of 300,000 ha of contiguous habitat suited to Bornean rhino conservation requires greater effort despite recent developments in providing more 'habitat' through the USMFR (see Section 5.1).

Restoring viable populations of *badak* to "all historical and suitable habitat throughout Borneo" could be construed as audacious, but a geographically-broad metapopulation secured in suitable well-connected habitat will lessen the risk of extirpation from disease, genetic depression, natural stochastic events such as fire, poaching, and continued anthropogenic habitat fragmentation and modification in the surrounding matrix. Noticeable by its absence is the target population of 700-1,000 referred to in the 1997 Action Plan. Whether this is a deliberate omission or incidental oversight is unknown. Nonetheless, that such a bold long-term goal has been expressed by the international Asian rhino conservation community ought to be commended, and vigorously pursued.

Interestingly, the 2004 workshop also "recommended continuing and improving the breeding programme at Sepilok" (Khan *et al.* 2004, p.14). How that could possibly be achieved without recruiting more wild rhinos, and possibly hastening extirpation of remaining wild animals, remains unexplained.

TABLE 4.1 ESTIMATED SUMATRAN RHINO POPULATIONS 1998 AND 2005

Species or Subspecies	Wild 1998	Wild 2005	Global Captive 2005
Bornean Sumatran Rhino	50-70	~ 50¢	2
Malay/Sumatra Sumatran Rhino	170-250	~ 250¢	8‡
Total Sumatran Rhino	220-320	~ 300¢	10‡

Sources: Foose & van Strien 1998; ¢IRF n.d.b. ‡Includes two captured in 2005, and accounts for one loss at Bronx Zoo 2006.

Gauging from the most recent population estimates provided by the IRF (Table 4.1), and those from the 1997 Action Plan, the Bornean rhino population has altered from a range of 48-68 to approximately 50. Given that the initial population range estimate does not significantly vary from the latter approximation, it appears that the population has quite possibly remained static. Nevertheless, these *are* only estimates, and there is a risk that the actual number of either or both could be lower. Even if the actual numbers for either estimate were 50 *per cent* higher, it would almost bear no mention that without significant progress toward the three goals most recently identified by the AsRSG, there would remain the risk that these goals could soon be rendered obsolete in the saddest possible way.

4.3 SUMMARY

Ex situ conservation of *Dicerorhinus* might have initially been perceived as a means of complementing *in situ* conservation with the prospect of reintroducing captive-bred specimens into suitable habitat at some opportune time in the future. It seems, however, that over time the emphasis on *ex situ* efforts increased such that the strategy became the default option, so much so that extinction in the wild risked becoming a *fait accompli*. MacKinnon offers a blunt warning in this regard:

> *Captive breeding schemes should be seen as a supplement rather than an alternative to in situ species protection...They should not be allowed to divert attention and funding away from in situ conservation efforts nor to become an excuse for giving up on conservation of a species in the wild* (2000 p.343).

Rabinowitz's concerns regarding arresting the fundamental causes of extinction have subsequently been echoed by Entwistle and Dunstone (2000 p.378): "Without *in situ* conservation, and work focusing on the causes of species decline, reintroduction may never be an option." And again by MacKinnon (2000 p.344): "[r]eintroductions and translocations are only practicable if the original threats or causes of extinction have been removed and adequate habitat remains and is well protected." That potential captive-bred propagules should be behaviourally independent of direct human support can also be included as a requirement for successful reintroduction. There are no documented examples from the body of literature cited of captive-bred *Dicerorhinus* ever having been successfully reintroduced into the wild.

It might be argued that because *ex situ* conservation efforts were deployed in ignorance of the species' reproductive biology the strategy was premature and ill-conceived. A counter-argument might be that without *ex situ* efforts the species' reproductive idiosyncrasies might never have been revealed. That knowledge was, however, gained at the expense of 13 *per cent* of the present estimated total population of Sumatran rhinos. Captive breeding—as an integral component of a broad conservation programme—in the opening years of the twenty-first century offers only a glimmer of hope for future *Dicerorhinus* recovery for two reasons. First, there are only ten individuals managed in *ex situ* locales (at least one female of which is beyond breeding years), and second, any further capture of wild animals presents a high risk of relegating remaining wild populations to the ranks of the "'living dead' phenomenon" where a population is so small that it is reproductively unviable (Janzen 1986, cited in MacKinnon 2000, p.336). The latter reason is acutely obvious in terms of the Bornean subspecies' conservation where there is no possible chance of intensive *ex situ* strategies being of any immediate benefit.

In situ conservation gained greater import at the expense of *ex situ* efforts with publication of the IUCN's 1997 Action Plan. The new emphasis did not, however, completely eschew *ex situ* conservation:

> *Considering the intense, even intensifying threat, to this species caused by continued poaching as well as the difficulties of protecting this species because of its large ranges and dense forest habitat, managed breeding is still considered an essential part of the strategy. However, emphasis is now being placed on the development of managed breeding centers in natural habitat or sanctuaries* (Foose & van Strien 1997, p.24).

This statement indicates that the AsRSG appears to be 'hedging its bets' or spreading risk by maintaining some semblance of *ex situ* conservation—in the form of extensive sanctuary-type enclosures—within a broader *in situ* strategic framework. That:

- too few animals present in isolated reserves might have negative implications for potential mates finding each other
- apparently insignificant genetic differences between the two extant subspecies exist, and
- unravelling of *Dicerorhinus* reproductive biology has recently occurred

might be a compelling combination of reasons for resorting to extensive *ex situ* sanctuary-type strategies. For the present, however, *in situ* protection has been afforded the greatest priority by the international rhino conservation community—one, which, as mentioned above, has recently been responded to positively by the Sabahan government. If, however, current *in situ* strategies do not live up to their promise—if populations are unable to be secured from poaching, for example—it might be that sanctuaries and mixing subspecies gain greater import in the future.

The problems associated with managing small populations aside, the practicalities of conserving Bornean rhinos *in situ* remain difficult. Malaysia is recognised as one of the Asian 'tiger economies' of the late twentieth century, but most of the economic growth and development has occurred in Peninsular Malaysia. In eastern Sabah poverty remains high and government expenditure on managing reserves in one of the world's richest areas of terrestrial biodiversity and endemism compete with social spending in an increasingly populated region. Encroachment on protected areas from swelling human populations with their attendant requirements for land, shelter and largely agrarian means of income, is a common risk to conservation strategies in rural areas worldwide. The following chapter examines this and another risk to the stabilisation and recovery of very small populations of endangered wide-raging megafauna like the Bornean rhino—global climate change.

CHAPTER 5 RISKS

Providing habitat for *in situ* conservation, though fundamental to its conservation, is unlikely to stabilise the Bornean rhino population let alone stimulate its growth and recovery. There are many barriers to achieving these goals. At the species level there are threats inherent to the species' biology (induced ovulation, age of sexual maturity and lengthy gestational periods for example). Population-level impediments include genetic homogeneity, risk of disease, and unfavourably skewed sex ratios. There are also a number of external impacts including poaching by its only known predator, *Homo sapiens sapiens* (Groves & Kurt 1972). Rapidly growing numbers of humans are also the source of the Bornean rhino's habitat modification and fragmentation—the combined effects of which render the landscape in which the subspecies recently roamed devoid of its presence. Some humans have attempted to avert the subspecies' extinction only to realise later that their efforts were in vain, as its numbers slipped precipitously toward oblivion. It seems that during the course of the attempted salvation of the Bornean rhino and its Sumatran cousin, human understanding and appreciation of what is required to avoid extinction has improved in inverse proportion to the wherewithal needed to realise that goal.

To compound the complexity of Bornean rhino rescue and rehabilitation are two risks that have the potential to profoundly complicate conservation efforts. Leaving isolated reserves containing a few remnant individuals of a critically endangered species—still poached for use in traditional medicine—without providing vigilant protection is a conservation option lacking any credibility, and it has been argued that it should never have been seriously entertained. If protecting reserves requires urgent attention, there is also the phenomenon of global climate change to contend with. That global climate change is inevitable is no longer doubted. What remains debatable is its degree of severity, and rate of progress. The risk of future climate change is particularly pertinent to Bornean rhino conservation because "restricted-range endemic species may be especially vulnerable" (Thomas *et al.* 2004, cited in Malcolm *et al.* 2006, p.539). The matters of severity and rate of progress are beyond the scope of this paper. What is discussed here, however, are the risks to current and future Bornean rhino conservation efforts posed by unprotected habitat and global climate change.

5.1 PAPER PARKS

Until recently, reserves in Sabah known to be prime Bornean rhino habitat and in which forest harvesting activity is precluded comprised the TWR and KWR in the east, and the MBCA and DVCA in the west—areas of 132,653 ha and 105,762 ha as *per* respective longitudes, or 238,415 ha *in toto* (Table 5.1). This area effectively doubled with the addition in March 2006 of 240,400 ha of forest reserve comprising the USMFR and some minor Virgin Forest Reserves, contiguous with the DVCA (see Section 4.2).

TABLE 5.1 BORNEAN RHINO HABITAT AREAS

Reserve	Area (ha)
Tabin Wildlife Reserve	111,971
Kulamba Wildlife Reserve	20,682
Maliau Basin Conservation Area	62,964¢
Danum Valley Conservation Area	42,800
Ulu Segama and Malua Forest Reserves	240,400*
Total	**469,817**

Source: Sabah Forestry n.d., ¢Ambu *et al.* n.d.
***Slated for sustainable forest management (see Chapter 6).**

Though Sabah's government has been highly praised for this significant habitat augmentation, there remain some outstanding questions regarding it and other 'rhino' reserves. For example, though logging in the USMFR is scheduled to be phased out by the close of 2007, this goal contradicts the proposed new management regime—as reported in *Bernama* (2006)—that aims to emulate management practices in the Deramakot Forest Reserve where Forestry Stewardship Council certified logging still occurs. And according to Rabinowitz, the DVCA "remains protected only at the discretion of the Sabah Foundation" (1995 p.486). If, however, the inconsistency over logging the USMFR was resolved in favour of no logging, and it and the DVCA were declared a Wildlife Reserve, there would unfortunately remain the problem of providing adequate resources for:

- ongoing reserve border security and monitoring
- investigating poaching incidents, and
- enforcing anti-poaching laws.

Declaring a biodiversity conservation area is often easier than managing it. This is known as the problem of so-called 'paper parks'—reserves that exist in a jurisdiction's statutes but which are, at site, inadequately protected, managed and resourced.

The problem has recently been illustrated *à propos* of Greater one-horned rhino protection in Nepal. Writing in 1999 Terborgh reckoned that, "[w]ithout constant vigilance and vigorous enforcement, requiring the presence of the Nepalese army, Chitwan's rhinos and other wildlife would be doomed" (p.89). The Nepalese army's presence in and around Chitwan was identified later by Dinerstein (2003) as one of several requirements that led to the Greater one-horned rhinos' rapid population recovery there. That success was so positive in terms of an increasing population that some rhinos were translocated elsewhere within Nepal, including the Bardia National Park. Recent events have unfortunately supported Terborgh's contention. WWF Nepal reported in early 2006 that in the wake of the Nepalese Maoist insurgency, a 40-strong team survey of the Babai floodplain in the Royal Bardia National Park—west of Chitwan where 72 rhinos had been translocated since 1986—yielded evidence of only three individuals (WWF 2006). Though the decline in Nepal was identified as causally related to the recent conflict there, it is more specifically a consequence of army personnel being withdrawn from the Park, as was the case in the Royal Chitwan National Park (see Section 4.2), and the cessation of patrolling due to staff safety concerns—in Parsa Wildlife Reserve a landmine killed five staff, and 10 staff were killed in a blast in Suklaphanta Wildlife Reserve. Furthermore, Royal Bardia National Park and Parsa Wildlife Reserve "are suspected as a transit route for insurgents" (van Strien & Maskey 2006, p.21), and provided a high risk of an unsafe working environment for park employees.

Paper parks do not only exist in situations as extreme as armed conflict. Terborgh notes that "[m]any countries currently lack robust institutions, so ways must be found to strengthen them. But institution building is a long-term process, whereas the need to protect nature is immediate" (1999 p.189). It may be, however, that immediacy can lead to ineffective responses and outcomes. Gazetting the formerly logged TWR has been described as being among "the easiest, most palatable, and most visible steps toward Sumatran rhino conservation" (Rabinowitz 1995, p.486). Although the TWR was formally recognised in Malaysia's statutes, institutionalisation of means by which its habitat could be afforded sufficient protection from extractive activity and poaching were at the time difficult to achieve, and are even now not wholly adequate. The Rhino Protection Units (RPU) presently operating in the TWR demonstrates that safeguarding the reserve has only been addressed—albeit partially—through the activities of an ENGO reliant on private funding.

Notwithstanding the lack of institutional support and a tenuous reliance on private sponsorship, were it possible to quickly institute effective protection of Sabah's rhino's in the TWR/KWR, USMFR and MBCA, managing two populations in what are essentially polarised hemispheres—themselves both fragmented—would still present difficulties. In the east the TWR and KWR should be reunited. There is a case for restoring the modified land separating the two reserves in favour of habitat specifically 'primed' for *D. sumatrensis harrissoni*. Even if the Bornean rhino was extinct in the KWR (as might be the case), the reserve's reconnection with the TWR should not, however, be abandoned. Ecological rehabilitation of a gap sufficient to allow for dispersal of *badak* and their subsequent re-colonisation of the KWR would also permit the dispersal of many of the region's other closed-habitat/forest-interior dwellers. This effort might, however, be considered more a medium-term goal with priority being to secure the TWR's current population.

It is unlikely that reconsideration of the status of the USMFR in favour of a Wildlife Reserve will occur so soon after announcement of the scheduled cessation of logging there, but it is nevertheless a goal that ought to be pursued. In the interim, however, a detailed and comprehensive assessment of the suitability of a portion of the Gunung Rara Forest Reserve—which comprises the gap between the MBCA and the USMFR—appropriated for a suitably sited, configured and secured corridor specifically designed to facilitate dispersal and mixing of Bornean rhinos between both localities could be undertaken. Given the urgency, and the Bornean rhino's aversion to forest edges, extractive activity should be withdrawn from the USMFR and any corridor with the MBCA, as well as within a two kilometre buffer surrounding the entire configuration. Such an undertaking could be considered more a long-term goal if, for example, translocating Bornean rhinos from the MBCA eastward were possible: "[s]umatran rhinoceros populations that are widely scattered and difficult to protect should be translocated to form a few larger populations in several well-patrolled areas in Malaysia" (Dinerstein 2003, p.240). But translocation is logistically difficult. There is the physical act of locating individuals from a very small but widely dispersed population in dense and physically challenging habitat to consider, and the high risk of mortality among captured individuals, as has previously occurred (see Section 4.1). Rather than disregard a few individuals and consign them to almost certain extinction in the MBCA, it would be more prudent to create circumstances favourable to their protection, dispersal and mixing, despite possible inconvenience to humans if extractive activities were entirely excluded. As explained by Dinerstein: "[t]he history of endangered species and habitat conservation in Chitwan demonstrates that short-term gains are achievable through strict protection, even if local residents do not share in the benefits" (2003 p.225). This is not an argument for the forced resettlement of any extant local communities, or resettlement without compensation: "[f]or resettlement to be a valuable tool for landscape management and poverty alleviation, it must be creatively and equitably structured. First and foremost, resettled villagers should receive more amenities in their new location than they had in their old location" (Dinerstein 2003, p.242).

The role of community development and education becomes critical at this juncture, because Bornean rhino populations "can be considered secure only when local residents view them as being worth more alive than dead" (Dinerstein 2003, p.237). This was largely achieved in Nepal through wildlife tourism development. But such an option is perhaps unrealistic in the case of the Bornean rhino, as its average population density of .01 animals *per* square kilometre—compared with 6.4 animals *per* km^2 for the Greater one-honed rhino in Chitwan (Dinnerstein 2003)—provides little opportunity for viewing. Notwithstanding this, it ought to be remembered that the latter species' population density was of a similar magnitude to the former's some 40 years ago. Time is, however, a resource in short supply with regard to Bornean rhino conservation because unlike its sub-continental cousin its reproductive physiology is particularly idiosyncratic (see Section 2.2). There is, therefore, little margin for error in designing appropriate local development projects.

Chitwan's success illustrates the important role of local people and communities in endangered species recovery: "[l]andscape management for area-sensitive megafauna requires partnerships with locals...Without giving local residents tangible incentives, it will be hard to make the case for making room for megafauna in an increasingly crowded Asia" (Dinerstein 2003, p.225). Section 3.1 briefly examined an "increasingly crowded" Sabah with a rapidly expanding population. If in just over a decade from now the human population there approached or reached 5.5 million, demand for land for agriculture, settlement, roads and other infrastructure, and for materials like fuelwood and other natural resources, is likely to impact greatly on Sabah's remaining forested landscapes in general, and extant and potential Bornean rhino habitat in particular. According to MacDonald and Nierenberg there is growing acceptance among "[b]iologists and conservation practitioners...that changes in human population dynamics—including growth, migration, and density—and in patterns of resource consumption are among the root causes of biodiversity loss" (2003 p.41). There is a noticeable absence, however, of recognition of these problems in relation to the Bornean rhino in the IUCN's Action Plan or material published by the AsRSG or its representatives in IUCN-sponsored journals such as *Pachyderm* or *Species*. Indeed, judging from the material in these sources, there is no acknowledgment of the high rates of human population growth and increasing poverty in eastern Sabah during recent decades (see Section 3.1), nor is there any analysis of how these phenomena could impact on Bornean rhino conservation. It might be argued that addressing problems associated with demography are the exclusive province of governments. If, however, the relevant jurisdictions are unwilling or unable to address them, can ENGOs involved in endangered species conservation be realistically expected to take them on? The problems in relation to population, poverty, human development and their implications for the effectiveness of Bornean rhino conservation are examined in greater detail in Chapter 6.

The recent troubles affecting Chitwan's rhino population demonstrate the difficulty in anticipating and planning for all contingencies. Despite the recent drawbacks, the project nevertheless serves as a template for endangered species recovery in general, and rhino-population recovery in particular. Nepal's civil unrest vividly illustrates how species extinction—though a naturally occurring phenomenon—is presently and overwhelmingly exacerbated by human activity. The following section explores how global climate change brought about by the enhanced (anthropogenic) greenhouse effect is another stressor that ought to be accounted for in Bornean rhino conservation.

5.2 The Greenhouse Effect & Global Climate Change

During the twentieth century, global energy consumption increased more than tenfold from 911 million tons of oil-equivalent to 9,647 million tons (Flavin & Dunn 1999, p.23). With a global population estimated to exceed 9 billion by mid century (UN 2005), there is every reason to expect that a similar if not greater growth rate in energy consumption will be repeated this century. Three quarters of the world's total energy use is derived from fossilised hydrocarbons (Dunn 2001 p.88). Their combustion releases immense volumes of carbon dioxide (CO_2) and other gases into the atmosphere where their increasing concentrations have the potential to rapidly alter the Earth's climate. Figures 5.1 and 5.2 show incontrovertible evidence of increasing concentrations of atmospheric CO_2 over the last fifty years or so. The trend is a consequence of CO_2 emissions from all sources exceeding the assimilative capacity of Earth's terrestrial and oceanic CO_2 sinks (terrestrial and marine plants, soils and the oceans). Simmons explains the significance of increasing concentrations of atmospheric CO_2, which lies "in the property of carbon dioxide to enhance the transmission of incoming solar radiation and at the same time retard its radiation back to space: the so-called 'greenhouse' effect" (1989 p.333).

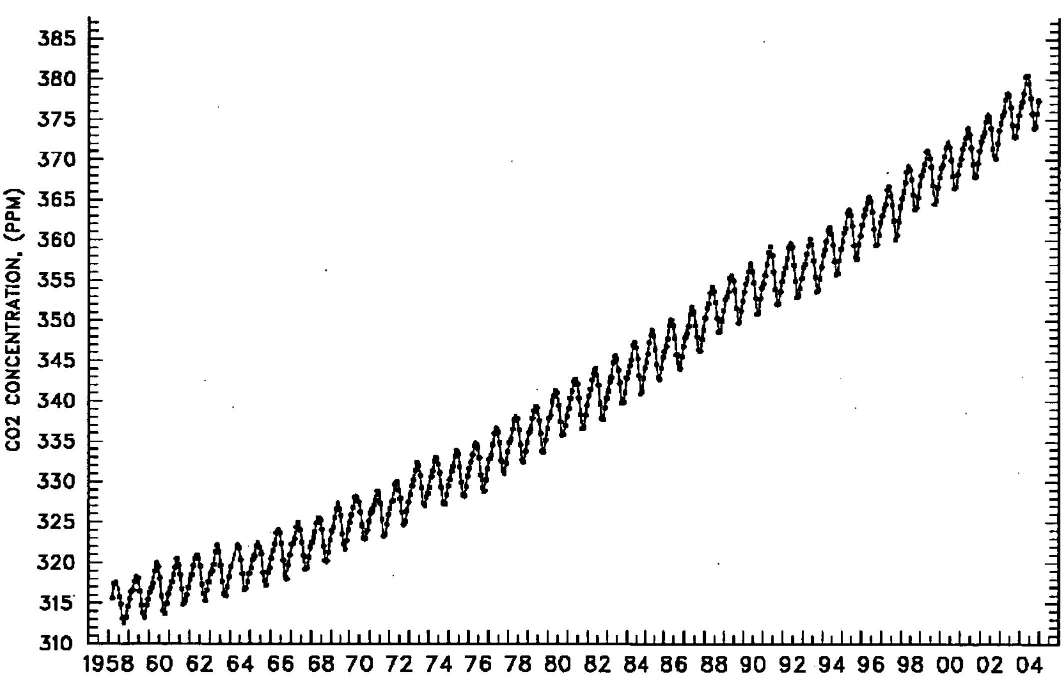

FIGURE 5.1 MONTHLY AVERAGE ATMOSPHERIC CO_2 CONCENTRATION, MAUNA LOA, HAWAII, 1958-2004

Source: Keeling & Whorf 2005

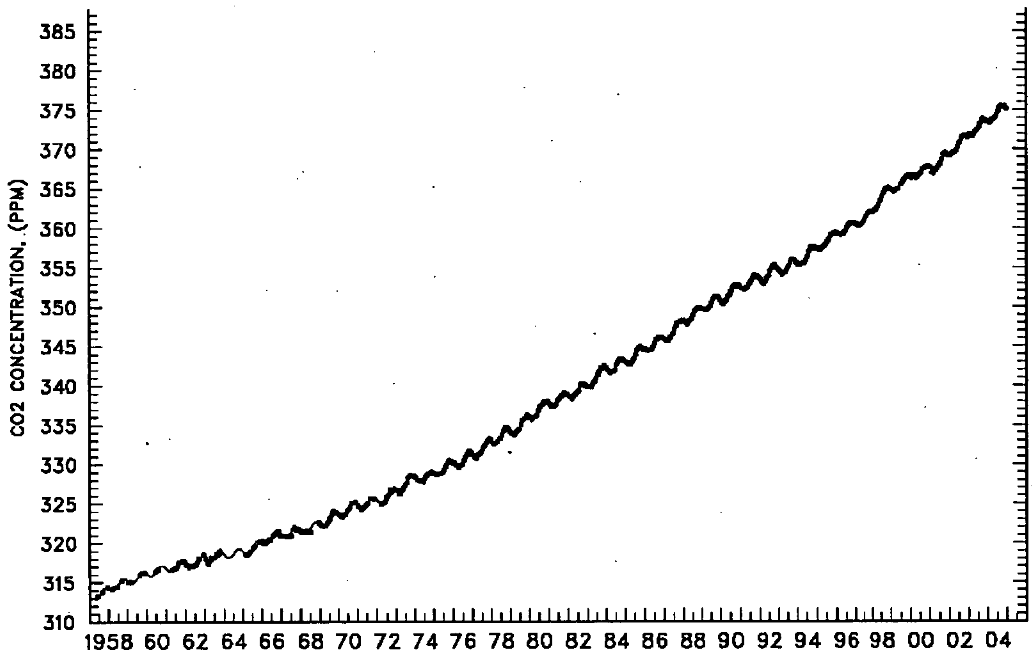

FIGURE 5.2 MONTHLY AVERAGE ATMOSPHERIC CO_2 CONCENTRATION SOUTH POLE, ANTARCTICA, 1957-2004
Source: Keeling & Whorf 2005

The greenhouse effect is a natural phenomenon. Too little atmospheric CO_2 and other gases with similar properties, would cause solar radiation absorbed at the Earth's surface to re-radiate into space and render the planet inhospitably cold; too much would inhibit emissions of infrared radiation from the Earth's surface, effectively trapping heat within its atmosphere rendering it inhospitably hot. The enhanced or anthropogenic greenhouse effect is caused by greenhouse gas emissions from human activity exceeding the Earth's absorptive capacities and adding to the natural atmospheric greenhouse gas budget. The result is an atmospheric warming trend, projections of which have no natural paleoclimatic analogue over at least the past 800,000 years (Wolff 2006, cited in *Reuters* 2006). Though most climate change projections predict temperature changes to be more evident at high latitudes, the greatest impacts on biodiversity might occur in moist tropical systems, because they "hold such huge diversity, and because the vast majority of those species are thought to have narrowly restricted niches" (Bush & Hooghiemstra 2005, p.125).

The Intergovernmental Panel on Climate Change (IPCC) reports that anthropogenic greenhouse gas emissions will "continue to alter the atmosphere in ways that are expected to affect the climate" (IPCC 2001). The IPCC has modelled seven future scenarios and found that in all, mean atmospheric CO_2 concentrations, average global temperatures, and global sea levels are projected to rise during the twenty-first century (IPCC 2001). The IPCC warns that some consequences of climate change are expected to be adverse, and will impact on, *inter alia*, biodiversity, which has limited adaptive abilities (IPCC 2001a). When climates "deteriorate, the environment becomes unlike that experienced by any other population...[and] there is little or no potential for gene flow to introduce useful genetic variation; populations are more likely to become extinct than to adapt fully to the new conditions" (Thomas 2005, p.77). Hannah *et al.* explain that:

> [w]*ith species being increasingly isolated in fragments, a rapidly changing climate will force migration; but unlike past migrations, in the future species will find factories, farms freeways, and urban settlement in their path. The synergy between climate change and habitat fragmentation is the most threatening aspect of climate change for biodiversity, and is a central challenge facing conservation* (2005 p.4).

If climate change alters the range of environmental parameters (e.g. temperature, humidity, rainfall frequency and duration among others) that any given species can tolerate, there are, according to Peterson *et al.* (2005), only three possible futures for said species:

1. Dispersal to similar habitats with favourable environmental fitness.
2. Intergenerational adaptation (or *in situ* evolution).
3. Extinction.

The last of these is an evolutionary *cul-de-sac*, and the worst possible outcome for Bornean rhinos. The second is a strategy that *r*-selected species—opportunist species exhibiting rapid reproductive development, high birth rates, short inter-gestational periods, broad environmental tolerances and other strategies suited to swift colonisation, particularly in disturbed and rapidly changing environments—are more readily able to benefit from. Being a *k*-selected subspecies with a low birth rate, long gestation and inter-gestational periods, lengthy reproductive development, and being more a habitat specialist than a generalist, there is very little opportunity for the Bornean rhino—even were it not critically endangered—to evolve *in situ* anytime in the near future in response to rapid and adverse climate change as predicted by most global circulation models (GCMs).

The salience of providing contiguous habitat to permit Bornean rhino dispersal and outbreeding (see Section 4.2) is underscored by its other role in supporting the subspecies' persistence into the future should climate change impacts be adverse. Groves warns that "designing a successful conservation adaptation strategy for a species' hypothetical long-term movement is impossible, because it requires a great deal more knowledge than we currently have or are ever likely to have" (2003 p.349). But because the Bornean rhino's historical and extant range occurs across significant altitudinal gradients—a 1961 Royal Society manuscript notes tracks at 3,020 m on Mt Kinabalu's east (*Daily Express* 2005, cited in SOS Rhino Borneo 2005)—long-term planning for precaution against future negative climate change-based impacts at low-altitude might very well be feasible. Indeed, Foose and van Strien (1997) calculate that ample potential habitat is available for the Bornean rhino, although these calculations are almost a decade old and, in light of the broadscale habitat modification over that period, require review in terms of connectivity between extant reserve, and suitability now and into a future blighted with climate-change.

Because most GCM data is at a global level, it is comparatively coarse compared with regional level data. Planning at a regional-scale for climate change and contiguous habitat for future Borneo rhino dispersal from less to more fit habitat will require identification, analysis and modelling of a range of environmental parameters and potential scenarios such as altitude, coastal inundation (especially in the lower Segama river region), extreme weather events (e.g. extended dry periods), forest community compositional and structural change, host-pathogen relationships, ecological restoration, and flowering/fruiting periodicity of food-plants. The latter is especially pertinent in relation to herbivores like the Bornean rhino, because in the tropics "[a] dry period of inadequate length or intensity may fail to trigger or synchronize flowering" (Root & Hughes 2005, p.62), and could effect food availability.

There is also the risk that without addressing human population growth and poverty now, farmers experiencing climate change in the future who also live in the vicinity of reserves "are less likely to have the resources or information needed to adapt effectively to changing conditions, and are more likely to rely on natural resources as a fallback source of income" (Hannah *et al.* 2005, p.11). Indeed, managing biodiversity conservation at landscape levels "will require integration of the human or development agenda with the conservation agenda to a degree rarely seen before [and] will be needed at all scales from the local to the regional, national, and international" (Lovejoy 2005, p.326). Why human development should be positioned as a core focus of Bornean rhino conservation, rather than languish at its periphery, is examined further in Chapter 6.

Though most GCMs suggest climate change impacts will be less evident in equatorial regions than higher latitudes, there is no room for complacency in conservation planning for at these latitudes, especially as "changes in the timing and intensity of precipitation may be more critical than temperature changes" (Root & Hughes 2005, p.67). Furthermore, although tropical species seem to be more "adapted to withstand climate change and to survive in novel communities" than temperate species, such resilience can only occur "[s]o long as a migratory path exists" (Bush & Hooghiemstra 2005, p.135). Where they do not exist, or are ineffective, ecological restoration of perforated habitat in order to facilitate dispersal becomes crucial. Indeed, "[r]estoration of connections in landscapes between protected areas...is central to conservation under climate change" (Lovejoy 2005, p.327).

While "[c]urrent projections of the response of the terrestrial biosphere to global climate change indicate potentially large expansions of tropical forests" (Townsend Peterson *et al.* 2005, p.218), future climate change does not bode well for conservation targets that happen to be critically endangered insular endemics with a range comprising fragmented habitat. There is, for example, presently no opportunity for dispersal of the eastern deme westward to higher elevations. Since present ranges for most species "are more dissected, with dispersal more difficult and extinction more likely"—no less so for the Bornean rhino—"preservation of the remaining corridors for dispersal is therefore a clear priority" (Hewitt & Nichols 2005, p.188). So the need for secure, connected habitat is underscored not only by the subspecies currently existing in such small numbers within a fragmented landscape with little opportunity for outbreeding, but also by the future need for potential range shift preferences from lower to higher altitudes and/or refuge from climate-change induced habitat modification as a consequence of coastal inundation or saline water intrusion. In addition, there is also a need to anticipate increased anthropogenic habitat modification as coastal communities migrate inland and "pressure to open up new natural areas" increases as agricultural crop ranges alter (da Fonseca *et al.* 2005, p.348).

5.3 SUMMARY

Projected rates of global human population growth give great cause for concern for the persistence of threatened species everywhere. "Both affluence and poverty cause humans to damage terrestrial and aquatic biodiversity, as well as ecosystem functioning, and modify the earth's climate" (Dee Boersma 2001, p. ix). Affluence drives increased demand for material wealth. Though goods can be used very efficiently, efficient use is overwhelmed by *per capita* demand for more goods and greater levels of material wealth. Environmental degradation caused by people living in absolute poverty is a consequence of their having too few if any alternatives for survival, let alone improving their livelihoods, other than utilising resources from natural—and often legally protected but otherwise unsecured—habitats. People living in poverty do not use anywhere near as many materials as do people living in affluence, but total numbers overwhelm this enforced *per capita* frugality.

Where reserves are adequately protected they "provide the least disturbed natural habitat, and therefore the best hope for natural response (e.g., range shifts) to changing climates" (Hannah & Salm 2005 p.363). Future climate change projections should be integrated into a broad strategic conservation planning process for the Bornean rhino "[b]ecause anticipation of changes improves the capacity to manage" and fosters proactive rather than reactive effort (Root & Hughes 2005, p66). The spectre of global climate change is so great that conservation planning for its impacts requires consideration of time horizons extending 25-45 years from now (Hannah & Hansen 2005), which fits neatly with rhino conservation planning timelines (see Chapter 7).

Though there are many natural risks associated with small populations, such as inbreeding depression, disease, and natural disasters, these can be reduced by providing large areas of suitable and secure habitat. The risks explored in this chapter have one thing in common in that they are anthropogenic. The current accelerated global species extinction spasm is fundamentally a human problem—caused by human actions; recognised by human intellect; for which humanity is the poorer; and which requires human responses if it is to be arrested. It might be trifling to claim that since the accelerated rate of contemporary species extinction is anthropogenic, so too should be its solutions. But if human actions and behaviours are significant drivers of species rarity and extinction (see Chapter 3), why can they not also be brought into the service of endangered species conservation, especially if this can be achieved in parallel with the goal of alleviating poverty? These dual goals are examined in the following chapter.

CHAPTER 6 WHAT'S MISSING?

According to various authors' estimates, the *Dicerorhinus* population freefall of the late twentieth century appears to have eased in the opening years of the twenty-first century (Table 6.1). In securing the Bornean rhino population and hastening its recovery, if captive breeding is for the foreseeable future a *non sequitur* (see Section 4.1), and reserves have yet to yield positive results, what other conservation strategies should be considered?

TABLE 6.1 RECENT *Dicerorhinus* POPULATION ESTIMATES

Year	Total Population Estimate
1964	150†
1976	120†
1989	962§
1993	557§
1995	540§
2000	234¥
2005	<300¥

Sources: Various from UNEP-WCMC n.d.; ¥ IRF n.d.b.
† Figures probably reflect deficient survey techniques
§ Higher figures of each range estimate.

Echoing Rabinowitz's 1995 critique of *Dicerorhinus* conservation, McNeely declares in his appraisal of the AsRSG's 1997 Action Plan that it:

> *is essential to treat the underlying causes of threats to mammals rather than simply treat the symptoms, though of course the symptoms also need their fair share of attention. I think that attention we are giving to symptoms needs to be significantly augmented by serious attention to fundamental causes* (2000 p.358).

He also identifies a failure to address development in *Dicerorhinus* range states as the weakest component of the Action Plan:

> *no activities are being proposed to address the development-related problems that are threatening rhino habitats, nor are any looking at the government policies that may be contradictory to the interests of rhino conservation, for example, agricultural subsidies in rhino habitats* (McNeely 2000, p.358).

Though the Action Plan identifies the need for improved protection of reserves, and "appropriate forms of sustainable development in the buffer-zones around these parks, to enable people to derive economic benefits from the protected areas" (Foose & van Strien 1997, p. 25), this only appears in the context of Indonesia.

In recognising "development-related problems" McNeely implicitly acknowledges the "underlying causes of threats to mammals" as anthropogenic (2000 p.358). The influence of government policies in Bornean rhino population decline is worthy of analysis beyond the scope of this paper (see Jomo *et al.* 2004 for a recent analysis of deforestation due to agricultural and forestry policy in Sabah and elsewhere in Malaysia). Presented here is an overview of how human development and conservation are intrinsically linked. An exploration of the popular integrated conservation and development projects (ICDP) concept is also presented, and followed by examination of how biodiversity conservation might provide "an entry point" (McNeely 2000, p.358) for improving Bornean rhino conservation.

6.1 HUMAN DEVELOPMENT

To help defray "the costs of living with wildlife, particularly for poor, rural communities in the developing world," local economic development was embraced by the international conservation community in the 1980 joint IUCN/UNEP/WWF publication, *World Conservation Strategy: Living Resource Conservation for Sustainable Development* (Walpole & Thouless 2005, p.122). Predating its publication by ten years, UNESCO's Man and the Biosphere Programme (MAB) was launched in the hope that it would "encourage interdisciplinary research to form the foundations for sustainable resource use worldwide" (Borgerhoff Mulder & Coppilillo 2005, p.37). Fundamental to the MAB concept is consideration and inclusion of human activity, settlement and modified landscapes as integral to conservation in increasingly human-dominated landscapes. That these matters were absorbed into new models of conservation where previously the focus was natural habitat protection, constituted a paradigm shift in conservation.

A review of international conservation development provided by Borgerhoff Mulder and Coppilillo concludes that "there is still no consensus over how to manage protected areas" (2005 p.52)—a sentiment similarly shared by Berkes: "[i]t has become increasingly important to incorporate the dynamic interactions between societies and natural systems, rather than viewing people merely as "managers" or "stressors." There is little agreement, however, on how this can be accomplished, conceptually or methodologically" (2004 p.623).

Notwithstanding the lack of accord among conservationists, a conceptual trend has emerged—one characterised as "a marked shift away from protectionism toward utilization" (Borgerhoff Mulder & Coppilillo 2005, p.51). That protectionism 'ceded ground' to a more utilitarian philosophy reflected the global rise of neoliberal economics late last century—the new conservation has been summarised thus: "[i]f a species or habitat is to be conserved it should be exposed to, not protected from, the market" (Borgerhoff Mulder & Coppilillo 2005, p.45). The fundamental flaw with such an argument is that the so-called 'market' only reflects preferences with a monetary value (as opposed to other less tangible values such as intrinsic, religious, ethical, or otherwise). This is exemplified by the plight of Rhinocerotidæ, where all representative species have suffered from market exposure driven by demand for body parts used in traditional medicinal preparations and ornamental/ceremonial crafts. All species are now listed in the IUCN's Red-List of Threatened Species™ as either critically endangered (3 species), endangered or 'near threatened'.

Human utility of natural resources is in some circumstances fundamentally incompatible with conservation. Indeed, it might be that in some regions 50-100% of their area would require reservation and exclusion of extractive and consumptive activities (Lindenmayer & Franklin 2002, citing Noss & Cooperrider 1994). Furthermore: "[t]he establishment of large ecological reserves is essential for ecological processes and taxa negatively impacted by even low levels of human disturbance. Putz *et al.* (2000) recognized this need for tropical forest ecosystems and stressed that some areas should never be logged" (2002 p.76).

Utilising wildlife and habitats need not, however, necessarily be predicated on consumptive or extractive activities. Zube and Busch (1990, cited in Walpole & Thouless 2005) contend that ecotourism, for example, is the principal means of non-consumptive wildlife use. Another example is protected forested water catchments that maintain or improve downstream water quality (IUCN/WWF 2003).

In its 1987 publication Our Common Future (also known as the 'Brundtland Report'), the World Commission on Environment and Development advocated and help popularise the concept of sustainable development. One of the report's arguments, inter alia, was "that conservation is not the opposite of development insofar as human welfare depends on nature" (Borgerhoff Mulder & Coppilillo 2005, p.39). From the findings of the Brundtland Report and others such as Caring for the Earth by IUCN/UNEP/WWF, concepts of community-based conservation (CBC) began to distil from the associated discourse. Defined as "the sustainable management of natural resources through the devolution of control over these resources to the community" (Barrow & Murphree 2001, cited in Borgerhoff Mulder & Coppilillo 2005, p.46), the CBC concept recognises the inherent dynamism between nature and humanity: "the old narrative of 'fortress conservation' was largely displaced by the counter-narrative of development through community conservation and sustainable use" (Murphree 2002, cited in Berkes 2003, p.622). Its popularity was partly in response to biologists realising "that small populations with limited genetic diversity were exposed to extinction risk, necessitating the conservation of remaining viable populations in landscapes in which human communities lived" (Borgerhoff Mulder & Coppilillo 2005, p.46)—apposite in the case of the Bornean rhino. Its successful in situ conservation could only presently be considered in a regional context for two reasons. First, managing their metapopulation across eastern Sabah would be far preferable to isolated sub-populations, which would be the case if considered at a lesser scale. This would help maintain outbreeding between the small western and eastern populations as well as their dispersal. Second, a broad regional approach will also have benefits in terms of managing impacts from human activity and, as is discussed below, improving human development in Sabah's rural communities.

Natural resource extraction and export drive Sabah's economic development. Offshore crude petroleum oil, oil-palm and forestry products, for example, accounted for 46, 38, and 15 per cent of the state's 2001 major commodity exports respectively (Jomo *et al.* 2004, p.132). Tourism is becoming another important economic driver (IDS n.d.), and is included in the 28 per cent of Gross Domestic Product that in 1998 was derived from the service sector (Jomo *et al.* 2004). Despite rapid economic development during the last quarter century or so, and the incidence of poverty more than halving over the 25 years from 1976, prosperity in Sabah has recently receded. The proportion of people living in poverty, for example, increased to 23 per cent in 2005 (Table 6.2)—the highest among Malaysia's thirteen states (Daily Express 2005, 2005a). This decline suggests that recent continued high population growth rates are at odds with Sabah's ability to provide services such as health, education, sanitation, and potable water. There is a well-established correlation between rapidly growing populations and increased poverty. Whether this is the case in Sabah as a consequence of unregulated immigration is worthy of further investigation to determine a causal relationship.

TABLE 6.2 INCIDENCE OF POVERTY IN SABAH 1976-2005

Year	Incidence (%)
1976	51.2
1984	33.1
1987	35.3
1989	34.3
1997	22.1
1999	20.1
2005	23.0¢

Sources: Various from Jomo *et al.* 2004; ¢Daily Express 2005.

Assuming the planet is spared from catastrophic human-induced climate change or any other human-driven or natural disasters, can the goals of alleviating Sabah's high incidence of poverty, its growing population, and Bornean rhino conservation be successfully served through human development projects?

6.2 INTEGRATED CONSERVATION & DEVELOPMENT PROJECTS

ICDPs seek to achieve poverty reduction, human development and positive conservation outcomes (Fisher *et. al* 2005) including endangered species recovery (WWF 2006b). The concept is not, however, without its detractors. Terborgh claims, for example, to have "no objection to ICDPs per se" (1999 p.169), and that though they might aim "to reduce external threats to parks by promoting sustainable development in surrounding areas" (Terborgh 1999, p.164), they "represent little more than wishful thinking" (p.165) and "are an inappropriate response to the external forces that threaten parks," and so by default the species therein (p.168). He argues that "project managers who successfully innovate and invigorate the local economy risk aggravating the very problem they are trying to solve. By stimulating the local economy, an ICDP attracts newcomers to a park's perimeter, thereby increasing the external pressure on the park's resources" (1999 p.165).

Terborgh's argument is essentially one against human population increase and ecological impacts ensuing from elevated human activity in the vicinity of or inside protected areas: "[i]f there are to be ICDPs, they should be located at a distance from parks so that people might be drawn away from park perimeters rather than attracted to them" (1999 p.169). MacKinnon supports this line of reasoning: "[e]ncouraging development around the boundaries of protected areas...may not be the most appropriate conservation strategy, especially when these protected areas are in remote forest areas or on poor soils where agricultural opportunities are limited." He cites Kramer and van Schaik (1997) in advocating the following: "[a] better alternative for reducing pressure on valuable biodiversity areas and forests may be to promote development elsewhere" (2000 p.347). This caution is also strongly endorsed in relation to Asian rhino conservation. Dinerstein for example, using 'eco-development' as synonym for ICDPs, advises that they ought to be sited:

> *where nature is on our side. The development part of eco-development inevitably leads to a reduction or degradation of some fraction of biodiversity (temporarily or permanently). The best way to ensure the minimum loss of biodiversity is to locate eco-development projects in the most resilient habitats* (2003 p.223).

Although it is inevitable that greater numbers of humans require greater volumes of natural resources, with regard to human population growth there is, paradoxically, a strong positive, albeit complex, relationship between improved standards of living and education—especially among women—and decreased fertility and population decline (Axinn & Barber 2001). Indeed, "[w]here women are free to determine when and whether they will have children, fertility rates fall. Research also shows that the more education a woman receives, the fewer children she has and the healthier and better educated those children are" (MacDonald & Nierenberg 2003, p.48).

So, although stimulating local economies might beget immigration, and population and resource use increase in the short-term, if education and livelihoods are simultaneously stimulated with specific emphasis on gender equity, especially at a broad regional level, it is likely to lead to declining rates of population growth in the long-term, and significant negative ecological impacts might otherwise have resulted could be avoided. The term 'demographic transition' broadly describes the phenomenon whereby in a given population child mortality and total fertility rates (the number of births *per* woman) decline as sanitation, nutrition, education and general living standards improve. Whereas this had previously been observed as a process taking a century or so in Europe from the late nineteenth to the mid twentieth century, it has been more recently observed in many East Asian countries over a period of 25-30 years (Bright 2003). Rescuing the Bornean rhino from extinction will occur over a time frame at least three times as long (van Strien & Maskey 2006). And so, beyond the need for greater habitat security and connectivity (see Section 4.2), successful long-term conservation might *ideally* involve projects which integrate poverty alleviation, sustainable development, and improved education and gender equity undertaken at a distance from protected areas so as to deflect any unexpected ecological impacts from proximate areas of rhino habitat.

The increase in numbers of illegal Filipino and Indonesian immigrants in eastern Sabah over the last two decades—attracted by greater employment opportunities (especially in the agricultural sector), and increased income-earning capacity (see Section 3.1)—appositely illustrates the basis for Terborgh's concerns noted above. The problem might, however, be addressed by making national borders less porous to migrants through greater enforcement of border security and regulation of immigration, and improved development inside the Philippine and Indonesian borders with Sabah. The response required if the current situation is at all to be significantly remedied is, however, multilateral, complex, and clearly one requiring the involvement of government.

Though ENGOs are keenly aware of the difficulties in 'engineering' environmentally sustainable development in less developed countries in tandem with conservation, it is beyond their remit and capacity to institute national policy and regulatory requirements. Similarly, Walpole and Thouless declare that when it comes to development "inputs such as schools and roads should be the responsibility of the state, not the wildlife or tourism sectors" (2005 p.137). And just as "[p]arks cannot be held responsible for alleviating every structural problem—from corruption to poverty, or from market failure to injustice" (Borgerhoff Mulder & Coppilillo 2005, p.50), neither can ENGOs with an interest in how protected areas and biodiversity are managed. The capacity for cross-sectoral cooperation in achieving poverty alleviation, greater gender equity, human population management, conservation, and sustainable development, should not, however, be underestimated. Just as conservation groups with programmes that used to focus "on small areas of land or water in or around national parks or reserves" are now operating at broader scales, they are now also including "in their planning and programming the socio-economic realities that affect biodiversity, including population dynamics, relationships between women and men" (MacDonald & Nierenberg 2003, p.48)

A conservation project by the name of TACARE, for example, established in Tanzania by the Jane Goodall Institute:

delivers conservation education in local schools and villages and has supported the creation of village forest reserves (for fuel and cooking wood), and tree nurseries, as well as the planting of nearly 750,000 new trees. With regional government health authorities, TACARE supports community-based health promoters and contraceptive distributors who are trained to deliver reproductive health care, preventative health services, and HIV/AIDS awareness. Central to TACARE's activities is developing the capacities of women for improved household and resource management. Training is provided to women in the cultivation of fruit and palm oil trees, savings and loans programs support women who launch environmentally friendly small business, a girls' scholarship program is in operation, and legal support is offered to make women's rights better known and to protect them (MacDonald & Nierenberg 2003, pp.55-6).

It seems to have taken two decades or thereabouts but the crucial synthesis of conservation and human development stipulated in the Brundtland Report, appears to have found expression in at least some international institutions.

Terborgh's critique of ICDPs also raises the matter of voluntary compliance (1999 p.169). The ephemeral nature of private land tenure illustrates how conservation benefits accruing from the temporally and resource-intensive process of teaching and implementing conservation management practices in communities of private landowners can easily be lost. The risk is that, in the absence of legally binding zoning, covenants, or other permanent protective mechanisms, conservation security afforded by a landholder can be purposefully or incidentally forfeited once land ownership changes.

But this objection serves more as instructive in refining and improving the concept rather than it needing to be dispensed with entirely. Though Dinerstein's example of a successful endangered large mammal species recovery—the Greater one-horned rhino—occurred in parallel with local community development, he admits that legislation and enforcement are a necessary part of the success of the particular project. He describes how: "[t]he new legislation mandating community forest management and recycling of park revenues to local communities guaranteed the long-term sustainability of these revenues" (2003 p.194). Furthermore: "the Nepalese army stationed in the reserve actively discourages illegal activities…economic incentives and the enabling legislation were strong enough to address the magnitude of the threats to wildlife and their habitats" (p.223).

Discussing the spectre of global mass species extinction, Wilson concludes that "the strong hand of protective law and international protocols" are preferable "to tax incentives and marketable pollution permits" (1999 p.342). The need for appropriate legislation in support of conservation and human development was pivotal to the Chitwan project: "[l]obbying for this legislation was an essential component of the general conservation program" (2003 p.194). In order to be successful then, it appears that the NGOs proposing an ICDP will have to engage governments in varying degrees and at various levels so that the multifarious regulatory apparatuses and other mechanisms at their disposal (planning and land reform, economic incentives, compliance and monitoring, security, and legislation, for example) can, if necessary, be deployed. Dinerstein has an optimistic but tempered view of ICDPs:

> *Despite their complexity and other problems, eco-development projects still have a critical role in defining the future of biodiversity in developing nations... Eco-development projects may be an important tool for conserving landscape features such as corridors, buffer zones, and multiple-use areas that enhance the persistence of endangered species living in fragmented habitats or small reserves. But these projects require a careful design and certain preconditions* (2003 p.194).

These "preconditions" appear in an abridged version in Appendix C. Dinerstein also attributes success at Chitwan to cultural respect for the rule of law, absence of powerful firearms, community leadership, economic incentives and enabling legislation (2003 p.223). He also describes how income from harvesting timber plantations and community-based wildlife tourism provided capital to invest in community services like new schools—the roles of which in education can also be harnessed in favour of conservation. Borgerhoff Mulder and Coppilillo refer to the critical function education can play in successfully conserving endangered species: "conservation actions require a change in people's behaviour and compliance with new legislation, the success of any conservation program depends upon active public support, participation, and understanding" (2005 p.244).

Raising public awareness is, according to Dinerstein, "an essential part of promoting local guardianship" (2003 p.238), by which is presumably meant a sense of pride in and 'ownership' of the conservation target and the conservation process. He recognises the pivotal role of community leaders in this regard: "[i]dentify bold leadership to rally the political will to carry out essential measures" (2003 p.239). The same prerequisite is similarly identified by Borgerhoff Mulder & Coppilillo:

> [t]*here is enormous mileage to be achieved by training selective* [sic.] *members of the community with a view toward their becoming environmental leaders in their own right....Educated local leaders can play a key role in designing or revitalizing common pool property regimes....Critically important, too is the education of higher-level officials, who are often responsible for regional policies that render local conservation projects practicable* (2005 p.244).

There is also a need for public education beyond the limits of communities surrounding reserved areas. In the case of the Greater one-horned rhino, "television and radio shows and nature documentaries filmed in Chitwan" encouraged wider national support for the project (Dinerstein 2003, p.238). Although removal of references to rhino body parts in the Chinese pharmacopœia occurred in the 1990s (Dinerstein 2003, p.33), greater public awareness raising of the consequences of using rhino products, and of their alternatives, is still required in order to arrest the demand. Saturation-style public education in the rhino-product 'sink' countries—China and the two Koreas—of rhino alternatives would be of huge benefit.

That "careful design" is identified as a component of successful ICDPs (above) indicates another prerequisite for successful conservation: effective planning. Two significant developments in conservation over the last few decades have been the elevation of biodiversity to an internationally validated conservation target (*via* the Convention on Biological Diversity—CBD), and the advent of conservation planning as a distinct discipline. Both are discussed briefly in relation to Bornean rhino conservation in the next section.

6.3 BIODIVERSITY CONSERVATION & PLANNING

McNeely declares biodiversity conservation to be "a significant improvement on either ecosystem-based or species-based approaches alone" (2000 p.360), and links declaration of the CBD with extension of conservation concerns beyond mere "issues of mammalian biology or proximate threats", and the audience beyond "those who are already supportive of our [presumably biologists' and conservationists'] efforts" (2000 p.358). He further contends that "[b]iodiversity breaks down barriers between disciplines, enabling those concerned with conserving mammals to identify new and useful partners" (p.360). His latter statement is perhaps best exemplified by the advent of conservation biology, the basis for a more catholic approach to conservation, and "a mission-oriented discipline comprising both pure and applied science" (Soulé & Wilcox 1980, cited in Quammen 2002, p.528), "dedicated to halting the decline in biological diversity" (Borgerhoff Mulder & Coppilillo 2005, p.67). Conservation biology predates the CBD by at least 10 years, however, and from its initial breadth of sub-disciplines (Table 6.3), has expanded to include, *inter alia*, anthropology, sociology, philosophy, political science, economics, law, and education.

TABLE 6.3 THE MULTIDISCIPLINARY SCIENCE OF CONSERVATION BIOLOGY AS ENVISAGED IN 1985

Disciplines
Genetics
Social Sciences
Ecophilosophy
Environmental Monitoring
Veterinary Medicine
Hazard Evaluation
Historical Biogeography
Island Biogeography
Physiology
Population Biology
Population Genetics
Ecology
Sociobiology
Natural Resource Fields
Forestry
Fishery Biology
Wildlife Biology
Public Policy
Management

Source: Soulé 1985, cited in Borgerhoff Mulder & Coppilillo 2005, p.68.

The difficulties with orthodox science-based approaches to biodiversity conservation are that they are resource intensive and information poor. This would not be too much of a problem if it were not for the pace of contemporary global human population growth and materially resource-based economic development, which overwhelm progress in strictly science-based research. In attempting to conserve biodiversity, systematic science-based assessments of the "many thousands of species and potentially hundreds of natural communities" in any region "are simply impractical"—conservation biologists and planners must therefore "focus on a smaller set of features that they believe will have a high likelihood of conserving the full array of biological diversity in a region" (Groves 2003, p.82).

Many biodiversity surrogates exist; particular species, for example, or species guilds, assemblages, ecological processes, and abiotic or environmental units. The relative merits of each are discussed by Groves (2003) who also notes that identification of conservation targets should be the first of seven steps for effective conservation planning (Table 6.4). Although a detailed conservation plan specifically for the Bornean rhino would be extremely valuable (as it appears that one does not exist), its formulation and presentation here—whether in the context of a seven-step process or otherwise—is well beyond the scope of this paper. The possibility of the Bornean rhino being a suitable biodiversity conservation surrogate is, however, worth exploring.

TABLE 6.4 SEVEN STEPS TO EFFECTIVE CONSERVATION PLANNING

Number	Action
#1	Identify conservation targets
#2	Collect information and identify information gaps
#3	Assess existing conservation areas for their biodiversity values
#4	Set conservation goals
#5	Evaluate the viability and integrity of conservation targets
#6	Select and design a network of conservation areas
#7	Assess threats and setting priorities within the planning unit

Source: Groves 2003

6.3.1 THREE BIRDS & ONE STONE?

Leader-Williams and Dublin reviewed three definitions of 'umbrella species' by Heywood (1995), Meffe and Carroll (1997) and Simberloff (1998), and found that they "achieve good internal agreement and consistency" (2000 p.57). They summarise the three authors' definitions thus: "'umbrella' species have such demanding habitat and/or area requirements that, by maintaining minimum areas needed for viable populations, sufficient areas should also be maintained to ensure the viability of smaller and more abundant species" (p.58).

Their review also compares definitions of 'keystone', 'indicator' and 'flagship' species, and found that the use of each term fulfilled a particular role in conservation contexts. For example, 'umbrella' species is an ecological term indicating that protection of one species confers the protection of many others. A 'flagship' species is noted as a strategic term in that it helps raise "public awareness, action and funding" (2000 p.59). A 'keystone' species is another ecologically-based term that denotes a species' pivotal role in maintaining an ecosystem's structural integrity. 'Indicator' species—in reflecting community composition or environmental change—can be either an ecological or ecological/strategic term.

All rhino species have long been considered charismatic conservation targets—that is, flagship species—by ENGOs like the WWF and the WCS. Their wide ranges and low population densities have rhinos recognised as an umbrella species: "[w]hen star species like rhinoceros and eagles are protected, they serve as umbrellas for all the life around them" (Wilson 1999, p.259). The Greater one-horned rhino appears to be a keystone species, and the Bornean rhino is also quite possibly a candidate (see Section 2.2). According to the first two authors' definitions of indicator species cited by Leader-Williams and Dublin, *badak* can also be considered as such as they represent a particular ecosystem (dipterocarp forests), and are also "sensitive to habitat fragmentation" (Meffe & Carrol 1997, cited in Leader-Williams & Dublin 2000, p.57). The Bornean rhino is also an insular endemic species from one of the most biodiverse and mammalian species rich areas on Earth. According to Loucks, "Borneo Lowland Rain Forests [*sic.*] are the richest rain forests in the world and rival the diversity of New Guinea and the Amazon" (cited in Wikramanayake *et al.* 2002, p.475). Its plant species diversity is greater than the neighbouring islands of Sumatra and Java—the other two major islands in the Sundaland hotspot, a region in which 60 *per cent* of plant species are endemic (CI n.d.).[5] The island's lowland dipterocarp forests are especially species-rich, and Sabah is home to at least 180 of Borneo's 265 Dipterocarpaceæ species (Marsh & Greer 1992). New species are routinely catalogued and described. For example, 422 plant species were catalogued in the 25 years to 2005 (Schilthuizen 2006), and in the decade to 2004, 260 insect species, "30 freshwater fish, 7 frogs, 6 lizards, 5 crabs, 2 snakes and a toad" were also described as new to science (Pio 2005, p.5). A carnivorous mammal species was discovered in 2005, and in 2006 a snake that alters its colouration like a chameleon was discovered on an outlying island (WWF 2006c; 2006d).

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5 Conservation International, after Norman Myers (1988), defines a biodiversity hotspot as an area that contains a minimum of "1,500 species of vascular plants (> 0.5 percent of the world's total) as endemics" and has "lost at least 70 percent of its original habitat" (CI n.d.). CI has identified 34 hotspots.

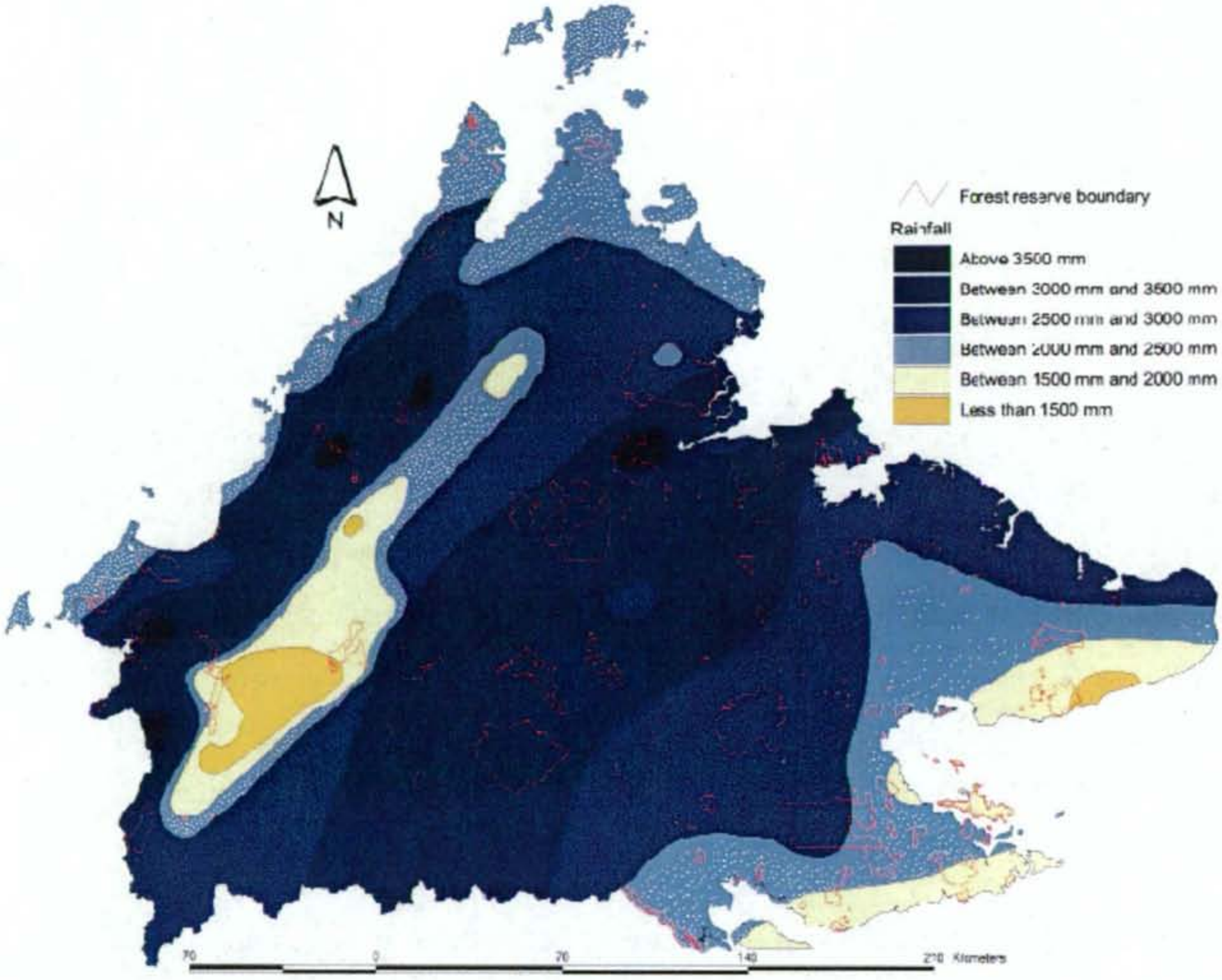

FIGURE 6.1 SABAH RAINFALL ISOHYET MAP

Source: Conservation Areas Information and Management System n.d.

Badak have been found from sea level to 3,000 m (*Daily Express* 2005, cited in SOS Rhino 2005), and in areas receiving rainfall from 1,500-3,500 mm *per annum* (Figure 6.1). Consideration and inclusion of environmental variables like these in conservation planning "help [to] ensure that ecological and genetic variation in biotic-based targets will be conserved" (Grove 2003, p.111). In citing Smith *et al.* (2001), Hunter *et al.* (1988), Halpin (1998), and Noss (2001), Groves adds that: "representing biotic targets in conservation areas across a range of environmental conditions is one of the leading recommendations for how to best conserve biodiversity in the face of global climate change" (2003 p.111) (see Section 5.2).

The subspecies is worthy of conservation in its own right:

> [s]*pecies with low population density, low reproductive potential, narrow geographic distributions, and relatively larger body mass within a taxonomic group tend to have a higher likelihood for extinction* (Groves 2003, p.92)

and:

> [the] *future loss of large mammal biodiversity could be far more rapid than expected* (Cardillo *et al.* 2005, p.1239).

But the Bornean rhino also epitomises the very essence of a species-based biodiversity conservation surrogate. Its *in situ* conservation and expansion into former ranges should also protect much of Sabah's biodiversity—endemic, threatened (Table 6.5), known or otherwise. And if the subspecies were included in a guild of threatened large wide-ranging mammals, for example, and core habitat, buffer zones, and corridors were identified and secured for all, it is highly likely that a major fraction of Sabah and Borneo's biodiversity would be guaranteed. Furthermore, since "persistence of many mammal (meta)populations is probably contingent upon large scale landscape structure, a scale at which most of the pivotally important decisions affecting biodiversity are taken" (Bright *et al.* 1994, May 1994, cited in Bright & Morris 2000 p.148), Bornean rhino conservation should also neatly dovetail with regional planning in eastern Sabah.

À propos of the modified adage alluded to at the head of this sub-section, successful *in situ* Bornean rhino conservation (i.e. the 'stone') not only ensures the subspecies' persistence into the future (one of the 'birds'), but also that of the myriad terrestrial, lacustrine and riverine faunal and floral species present in its coastal, lowland and montane range (another 'bird'). And if its protection in the wild is linked with improved regional human development in relation to poverty alleviation, sustainable development, and possibly increasing gender equity, its conservation could provide benefits beyond biodiversity conservation—in this case, socio-economic, the third bird. Furthermore, its habitat includes, for example, the important watersheds of the Kinabatangan and Segama Rivers—Sabah's two largest river basins, both important in terms of local transport, inland fisheries and freshwater aquaculture, and the growing ecotourism industry. The former river system is also the main water supply for the coastal city of Sandakan (Cheng Hai *et al.* 2001).

TABLE 6.5 SOME THREATENED MAMMALS FROM SABAH

Family	Genus	Species	Common name
BOVIDÆ	*Bos*	*javanicus lowi*	Banteng
CERCOPITHECIDÆ	*Macaca*	*fascicularis*	Crab-eating macaque
	M.	*nemestrina*	Pigtail macaque
	Nasalis	*larvatus*	Proboscis monkey
	Presbytis	*chrysomelas*	Banded langur
	P.	*frontata*	White-fronted langur
	P.	*hosei*	Grey leaf monkey
CYNOCEPHALIDÆ	*Cynocephalus*	*volans*	Flying lemur
ELEPHANTIDÆ	*Elephas*	*maximus borneensis*	Bornean pygmy elephant
FELIDÆ	*Catopuma*	*badia*	Bay cat
	Neofelis	*nebulosa*	Clouded leopard
	Pardofelis	*marmorata*	Marbled cat
	Prionailurus	*viverrinus*	Fishing cat
HOMINIDÆ	*Pongo*	*pygmaeus*	Orang utan
HYLOBATIDÆ	*Hylobates*	*albibarbis*	Agile gibbon
	H.	*muelleri*	Bornean gibbon
HYSTRICIDÆ	*Hystrix*	*brachyura*	Malayan porcupine
MANIDÆ	*Maxomys*	*alticola*	Mountain spiny rat
MUSTELIDÆ	*Lutrogale*	*perspicillata*	Smooth-coated otter
RHINOLOPHIDÆ	*Hipposideros*	*breviceps*	Short-headed roundleaf bat
	H.	*ridleyi*	Ridley's roundleaf bat
SCIURIDÆ	*Lariscus*	*hosei*	Four-striped ground squirrel
	Rousettus	*spinalatus*	Bare-backed rousette
	Sundasciurus	*jentinki*	Jentink's squirrel
URSIDÆ	*Helarctos*	*malayanus euryspilus*	Sun bear
VESPERTILIONIDÆ	*Hesperoptenus*	*doriae*	False serotine bat
VIVERRIDÆ	*Cynogale*	*bennettii*	Otter civet

Source: CI 2006, IUCN 2006, Payne & Francis 2005

6.4 SUMMARY

In the race to save the Bornean rhino the primary causes of the subspecies' extinction spiral—human activity, habitat appropriation and modification—appear to have somehow received secondary, if not cursory consideration. At best, strategies to bring the subspecies back from the brink have been wanting of a more holistic approach to endangered species conversation and recovery, one that considers human development an equally important and necessary goal.

Humans have for too long considered themselves *apart from* the natural world though we are unquestionably *a part of* the natural world. Indeed, we are utterly dependent on the natural world for our very existence. Our numbers and demand for natural resources and ecological services are now so great that we have become, whether we like it or not, managers of the natural world. If not managed well, we suffer as a consequence, as do many of Earth's other inhabitants. In Sabah, population growth and resource use have impacted greatly on the natural environment, and many species have, as a consequence, a tenuous future. The recovery and expansion of one of these species, the Bornean rhino, has the potential to significantly ameliorate biodiversity decline and other environmental deterioration while also improving living standards for human populations that share its insular home.

A modest example of human development now linked with the Bornean rhino is offered by the ENGO SOS Rhino Borneo, which, as demonstrated in Section 3.2, provides community outreach to a few *kampungs* (villages) adjacent to TWR. It employs about fifty local staff, and also receives 'volunteer' workers mostly from developed nations who pay for their time while providing field assistance or teaching local communities English. Expansion of its operations—or emulation thereof—is desperately required to provide greater security for the western population of Bornean rhinos. This would increase employment and inject income into some of the more remote and developmentally depressed areas in Sabah. There is, nevertheless, much more that could be done with regard to addressing major threats to the Bornean rhino in Sabah and the problems of poverty and population growth. The success of the Chitwan Project, as described in some detail by Dinerstein (2003) serves as a model of community development and endangered species conservation that is ripe for adaptation in other contexts, especially in relation to large mammals in general, and the Bornean rhino in particular. Despite significant physiological differences between the Greater one-horned and Bornean rhinos, there remains potential for adjusting, revising and planning a long-term broad-scale project aimed at Bornean rhino population recovery and conservation, poverty alleviation and community development in Sabah.

Borgerhoff Mulder and Coppolillo contend that ICDPs are more likely to succeed in areas with:

> *high tourist revenues, strong national political support, high potential for sustainable extraction, low natural growth in population, low immigration rates, strong and intact communities, stable consumption norms, and a fundamental compatibility between project goals and local cultural and economic traditions; [and where]...the resource to be exploited is of too high value* (2005 p. 259).

If they are correct, there might be very little chance of successfully conserving the Bornean rhino. The complexity involved in designing and managing a successful ICDP cannot be underestimated. Despite recent difficulties relating to the Greater one-horned rhino project in Chitwan, the project demonstrates that, although daunting, ICDPS can be successful. Dinerstein quotes a conservationist and critic of ICDPs, Barry Coates: "[t]he answer is an eco-development project. What's the question?" (2003 p.192). Remembering Dinerstein's use of 'eco-development' as a synonym for ICDPs, the implication is that ICDPs have little if no capacity to assist in any meaningful way with biodiversity conservation. The exhortation is rather simplistic, however. Though examples of ICDPs that have failed in their aim to conserve biodiversity exist, ICDPs should not be perceived as *the* answer or a panacea but as one component of a comprehensive, cross-disciplinary approach to biodiversity conservation in general, and, as in the case of the Bornean rhino, critically endangered species conservation in particular.

CHAPTER 7 CONCLUSION

Extinction—that slightly tired word that defines the *cessation of being*, or expressed less moderately, *obliteration from the face of the planet*—is for the present an irreversible evolutionary endpoint for any species. The exceptionally rare, relatively long-lived, wide-ranging, reproductively-awkward, closed-habitat browser that is *D. sumatrensis harrissoni* stands at the precipice of its extirpation, with gaze firmly fixed toward oblivion—a casualty of two proximate threats originating from the activity of only one other species, *Homo sapiens sapiens*. These threats, examined in Chapter 3, are:

- excessive harvesting/overexploitation of wild resources (poaching), and
- habitat conversion/modification (habitat destruction by another name),

and are—in so far as the Bornean rhino risks extinction—amplified by the dynamics of the subspecies' exceptionally small and fragmented populations (Chapters 2 and 4), and its particular biology and ecology (Chapter 2). Early attempts by humans who intervened on behalf of *D. sumatrensis harrissoni* to avert its extinguishment focussed on *ex situ* conservation (Chapter 4), and were expended in ignorance of an understanding of the subspecies' reproductive peculiarities.

It is clear, however, that even with a far greater appreciation of those peculiarities, until sufficient numbers of wild *badak* exist, the subspecies cannot be rescued from extinction by resorting to *ex situ*-based conservation strategies—this argument was also presented in Chapter 4. Only when each of the subspecies' major population groups are adequately protected and recover to a number far greater than is presently the case can further population recovery be augmented by *ex situ* strategies. *In situ* conservation is, for now and the foreseeable future, the only option from these two broad strategies if the long-term goal of restoring "viable rhino populations in all historical and suitable habitats throughout Borneo" is to be achieved (Khan *et al.* 2004, p.14).

WWF confirmed in June 2006 that the first photographic image of a wild Bornean rhino had been recorded (WWF 2006e). Within two weeks of their announcement SOS Rhino Borneo reported that not only had it confirmed evidence of a calf's tracks alongside those of an adult—presumably its mother—but it had also found evidence of another five individual rhinos in the TWR (SOS Rhino 2006). These discoveries contrast with WWF's earlier and somewhat more sombre news suggesting that the Bornean rhino's population had suffered an almost irreversible crash, citing evidence that only 13 had been found in a recent survey of the DVCA (WWF 2006a). That news was, however, a misrepresentation: "[i]n most press coverage it was suggested that the 13 rhinos in Danum were the only ones to survive in all of Borneo, ignoring the other known populations in particular that in Tabin Wildlife Reserve, which may have more rhinos than Danum" (van Strien & Maskey 2006, p.19). That the figure of 13 equalled the minimum population estimate for the same area in 1992 (Rabinowitz 1995), could be a tantalising indication of population stabilisation. Another sign that the subspecies' population might have passed its nadir is a recent prediction from a ranger with 13 years experience in studying the Sumatran rhino in Sumatra that TWR's rhino population is likely to increase to about 30 over the next decade given sufficient protection (*Daily Express* 2006 and Goh 2006, cited in SOS Rhino 2006a; 2006b).

Chapter 4 also explained how populations of wide-ranging, extremely rare, closed-habitat, species that are intolerant of further 'harvesting' cannot persist in reserves that:

- are too small to accommodate viable breeding populations
- prevent dispersal, recruitment and outbreeding between other reserves
- are too disturbed to provide suitable habitat, and
- are not adequately secured against poaching and habitat modification.

With enough protection from its "only known predator" (Groves & Kurt 1972 p.2), and provision of expansive forest habitat, it might be assumed that recovery of the subspecies' population to one that it is ecologically viable could be ensured. The content of Chapter 5 dispels that assumption, however, arguing that even if the limitations from the list provided above were overcome, the subspecies' conservation could not be assured in a future marred by global climate change and a fifty 50 *per cent* increase in numbers of human beings, if reserves:

- prevented altitudinal dispersal, and
- did not enjoy the support of communities surrounding them.

Eminent environmentalist and founder of the Worldwatch and Earth Policy Institutes, Lester Brown, states that: "[a]s a species, humans have an enormous influence on the habitability of the planet for the millions of other species with which we share it. This influence brings with it an unprecedented responsibility" (2006 p.157). A recently published document—titled *Setting Priorities for the Conservation and Recovery of Wild Tigers: 2005-2015. A Users Guide* (referred here after as the 'Tiger User's Guide')—focusses on forestalling the precipitously declining population of another wide-ranging wild Asian mammal, the tiger (*Panthera tigris*). This report might very well embody the degree of "unprecedented responsibility" required to be undertaken—at a planning stage at least—in order to avert the extinction of a large mammal. In it the authors note, *inter alia,* that successful *in situ* tiger conservation is "predicated on the reality that tiger conservation also results in conservation of ecological services that support and enhance local economies and livelihoods" (Dinerstein *et al.* 2006, p.ii). This statement encapsulates the major theme presented in Chapter 6—that is, the interdependence of biodiversity conservation and human development such that the former is sustained and the latter is, *at minimum,* of a standard that alleviates the incidence of poverty in communities settled in areas adjacent to critical habitat for conservation-dependent species.

Authors of the Tiger User's Guide—built on the *1997 Tiger Conservation Unit Analysis*—note that: "[a] serious gap in the first analysis was lack of engagement with the sectors of development that drive land-use change in the tiger range. We cannot repeat that mistake" (Dinerstein *et al.* 2006, p.14). As presented in Chapter 6, it appears that a similar mistake befell the Bornean rhino conservation effort. Integrating conservation with development—both human and economic (the latter being a construct of the former, and both being subservient to irreplaceable ecosystem processes)—is fundamental to the success of a comprehensive programme aimed at conserving threatened species whose populations are adjacent to human activity and settlements. For too long the notion that *Homo sapiens sapiens* is in some way extrinsic to the natural world has dominated the manner in which the species interacts with it. There is plenty of evidence to suggest that this remains overwhelmingly the case in the early twenty-first century (see Brown 2006, and Kennedy *et al.* 2006).

Despite some successes in forestalling some species' extinction (see Quammen 2002), the planet is experiencing "the sixth major extinction event in the history of the Earth, and the greatest since the dinosaurs disappeared, 65 million years ago" (Secretariat of the Convention on Biological Diversity 2006, p.10). The risk that the sturdy but diminutive Bornean rhino will enter into the list of species extinguished during the modern epoch is great, but such a result need not be inevitable. As noted in Chapter 6, it is unknown if a comprehensive conservation plan specifically targeting *D. sumatrensis* and its Bornean subspecies exists. A document of this type would be a necessary first step in garnering and reinvigorating efforts to prevent the species' extinction in Borneo and elsewhere in the Malay Archipelago. That such a document is needed is justified by:

- the most recent Action Plan being released just shy of a decade ago
- all Asian rhino species and subspecies being in a worse situation *à propos* of their current numbers and long-term future than at the time of the last Action Plan's publishing
- the rapid development in Geographical Information Systems (GIS) technologies over the last decade, and
- the discipline of conservation planning also rapidly maturing.

There exists an urgent and ideal opportunity for a rigorously executed conservation planning process to address the particular needs of the Sumatran rhino and its last remaining subspecies, D. *sumatrensis harrissoni,* in the context of a developing region experiencing high population growth and unacceptable rates of poverty. The Tiger User's Guide (including its technical report) could serve as a template for progressing this objective. A rudimentary comparison between it and the 1997 Action Plan, reveals that whereas the former:

- is focused solely on one species and its subspecies
- is jointly published by four ENGOs (WWF, WCS, the Smithsonian National Zoological Park Conservation and Research Centre, and the US National Fish and Wildlife Foundation's 'Save the Tiger Fund')
- is co-authored by thirteen conservation professionals
- synthesises input from about 200 expert individuals and institutions from across a variety of disciplines from around the globe
- contains some 80 references, and
- runs just shy of 250 pages in total,

the latter:

- is concerned with three species and their subspecies
- is published by one organisation (the IUCN)

- has two authors
- contains 42 references, and
- runs to a total of 114 pages.

The Sumatran rhino and its Bornean subspecies are conservation-dependent. A document with a strength and breadth similar to that of the Tiger User's Guide prepared for the Sumatran rhino might ideally be the domain of the AsRSG, but need not necessarily be so as the former was published independently of the IUCN's Cat Specialty Group (the tiger equivalent of the AsRSG). The conservation planning process could, however, be undertaken as part of a revision of the most recent Action Plan. Regardless of who and/or what organisations are involved, or how it is undertaken, the process should also benefit from peer review, as does the Tiger User's Guide. It is unknown if a process of peer review was integral to either of the Action Plans mentioned in this report.

Aside from the need for an holistic conservation planning process and documentation thereof, a number of other matters requiring further development and research in relation to Bornean rhino conservation can be distilled from the preceding chapters. Before cataloguing them, however, it is worth outlining first why a rigorously researched comprehensive planning process and its documentation is required. It might, for example, be argued that given the urgency of the situation, and limited funds available for conservation, the benefits of such a process might be marginal in comparison with its costs in terms of time, money, and human resources—which, if the Tiger User's Guide is any indication, would be considerable as it took 18 months to complete. The response to this line of reasoning is simple. Many of the policy, regulatory and institutional changes that might potentially be needed to perpetuate the Bornean subspecies of *Dicerorhinus*—expanding conservation areas, excluding extractive activities from habitat, potential human resettlement, legislative changes and introduction of new legislation, and infrastructure development, for example—can only be delivered by governments with the will to do so, *ipso facto* there must be credible evidence to persuade and convince decision-makers to enable responses as befit the goal. It would be naïve of course, to believe that even if politicians did base their decisions on good information that their decisions would in turn be good—political fickleness is difficult to account for. But a decade-old document devoid of any GIS analysis and lacking in sophisticated conservation planning, is very dated indeed. It is also unlikely that many of the decision-makers present at the time of the release of the 1997 Action Plan remain in their positions, so many of the present mix of decision-makers might effectively be ignorant of not only plight of the Bornean rhino, but the issues that affect its persistence and the options that might be available in responding to prevent the subspecies' extinction.

To return to the matter of issues requiring further investigation, they are identified here according to the order in which they appear in the text. The basis for the claim that the Bornean rhino is a keystone species was identified in Chapter 2 as being somewhat doubtful. Investigation of what role the Bornean rhino might have in forest structure and succession is worthy of future research, though there would be inherent difficulties such as finding forest that has recently become devoid of only that subspecies. A GIS vegetation map of the USMFR—should one not already exist—would complement others that cover present reserves. More detailed digital vegetation maps than those provided herein—in addition to detailed altitude, land use and tenure (including native title), human population density, and topographical maps for south and eastern Sabah—would be invaluable in planning for reserves and buffer zones at a landscape/regional level. On the matter of the USMFR, clarification of whether logging is to be wholly excluded from within its perimeter is also required as there is some uncertainty regarding this implicit in reporting of the matter (Chapter 6). Clarification of the Bornean rhinos' habitat range is also needed as the estimates cited in Table 2.2 vary by a factor of 30.

Discussion in Chapter 3 of the impact of poaching on the Bornean rhino's population identifies a need to investigate the degree to which that activity continues in Sabah. The gap in habitat between the KWR and TWR, noted in Section 4.1 and elsewhere, is impermeable to *badak*. If disconnected populations of Bornean rhino are to be reconnected or expand in the future, ecosystem rehabilitation of highly modified habitat will be required in many areas. There is, therefore, opportunity to research vegetation succession in modified habitats—especially broad-scale oil-palm plantings—to determine the degree to which active habitat restoration would need to be employed. Pending no or only marginal improvement in future oil-palm yields *per* hectare, there will, however, be significant obstacles to ecological restoration of oil-palm estates. While global demand for petroleum oil increases as reserves are depleted, biodiesel produced from agricultural crops becomes more economically viable. As is shown in Table 7.1, oil-palm dominates other crops according to yield *per* hectare.

TABLE 7.1 BIODIESEL YIELD PER HECTARE OF SELECTED CROPS

Crop	Fuel Yield (litre)
Oil-Palm	5950
Coconut	2689
Olives	1212
Canola	1190
Peanut	1059
Sunflower	952
Linseed	478
Soybean	446

Source: Various cited in Brown 2006, p.34

As substitutability between petroleum and plant-based oils increases, there is a "risk that economic pressures to clear land for expanding…palm oil plantations in countries such as Indonesia and Malaysia will pose a major new threat to plant and animal diversity" (Brown 2006, p.36). As the price for crude-oil has risen sharply over the past 12 months, and there is little sign of it significantly abating, there is a sense of urgency in researching ecological restoration options, and, furthermore, purchasing strategic areas of cultivated oil-palm which will serve—in part or whole—as corridors between existing habitat and reserves.

There is an argument that as Bornean rhino numbers decline, the concern over breeding remaining individuals with the nominate species becomes less relevant. Greater elucidation of the matter of the subspecies' population viability would be vital in order to maximise opportunities for species recovery in the event that overall numbers decline in future. The problems of so-called 'paper parks' examined in Chapter 5 give cause for more research over whether and to what degree there is any biodiversity impact from human activity on the structural integrity and ecological processes in Bornean rhino reserves and habitat. The subject of future climate-change impacts on biodiversity conservation, also discussed in Chapter 5, identifies a need for regional-scale modelling of future climate change scenarios, as GCM resolutions are probably too coarse for planning purposes.

Greater integration of human development with Bornean rhino conservation was highlighted in Chapter 6. Since human activity in adjacent habitat reduces effective habitat area there is a need to examine what types, to what degree and at what scales alternative human and economic development could be integrated with conservation efforts to improve the livelihoods of local communities. That development projects ought to be conducted in consultation with local communities is emphasised by Dinerstein *et al.*: "land use that brings economic and livelihood benefits to people while being compatible with conservation goals...can only be achieved with the support and involvement of the local communities" (2006 p.14). The Bornean rhino should prove an exemplary biodiversity conservation surrogate (Chapter 6), but the degree to which its current and potential habitat overlaps with other critically endangered species could and should be rigorously tested.

While particular population goals have been identified, and the debate over which broad-based conservation strategy is better has been laid to rest, there appears to remain some uncertainty regarding how to actively progress conservation efforts. The Bornean rhino has been 'slated' for interbreeding with its Sumatran cousin should its numbers (probably currently at the lower end of a range between 20-50) slip too low. Evidence that the subspecies continues to breed *in situ* has recently been discovered, and though promising, there is still a very real risk that should *in situ* conservation, along with some small measure of on-ground protection as is currently afforded, continue as the *de facto* approach, there can be little hope for this creature's long-term future as a distinct subspecies.

Though not mentioned in the text, utilising conservation performance payments in place of ICDPs where these are inappropriate—for example, difficulties in sustaining projects due to market fluctuations (Ferraro 2001)—could augment Bornean rhino conservation. This and other alternative mechanisms should be considered, and where appropriate, included in a revised conservation plan.[6] Incentive-based strategies are not without their risks, however, especially if they:

> *distort perceptions, create dependencies, and give the misleading impression that local people are supportive of externally driven initiatives. When little effort is made to build upon local skills, interests, and capacity, then local people have no stake in maintaining practices once the flow of incentives stops* (Pretty & Smith 2004, p.636).

There can be no underestimation of the enormity of completing a comprehensive 'up-to-the-minute' plan for averting the Bornean rhino's extirpation in the wild. Though planning for

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[6] Wikramanyake *et al.* (2002) and Borgerhoff Mulder and Coppilillo (2005), provide summaries of many alternatives, which were unable to be included here for lack of space.

global climate change requires consideration of time horizons in the order of half a century, recovering populations of the Sumatran rhino, including its Bornean rhino subspecies, requires consideration of time horizons double that: "achieving the goals of viable and secure population of both the Sumatran and Javan rhinos will take a long time, probably as much as a century"—indeed a project dubbed 'Rhino Century Programme' (RCP) will be launched in late 2006 (van Strien & Maskey 2006, p.18). Whether the RCP will include the Bornean rhino is somewhat uncertain as the news of the RCP and its launch was reported among news of Sumatran rhino conservation in Indonesia, and immediately preceded news of last year's DVCA rhino survey.

Throughout the Tiger User's Guide there is consistent reference to 'tiger landscapes', reflecting, no doubt, the significance of landscape level biodiversity and threatened species conservation planning. If indeed "[c]ore landscapes for large mammal populations can serve as an umbrella for the conservation of many of the most biologically rich area of Asia west of Wallace's Line" (Dinerstein 2003, p.247), perhaps there is also a need now, before it is too late, to embrace the concept and legitimacy of rhino landscapes in Borneo.

The IUCN issued a statement in July 2006 regarding the tentative declaration of extinction of a subspecies of the Black rhino—the West African black rhino (*Diceros bicornis longipes*)—and news that the population of another rhino subspecies restricted to the Garamba National Park in the Democratic Republic of Congo—the Northern white rhino (*Ceratotherium simum cottoni*)—is now possibly as low as four and in imminent risk of extinction. Should the world sit idly as contraction in the genetic line of Rhinocerotidæ—a family which contains the world's third largest terrestrial mammal—continues? If in its determinations the AsRSG—through the RCP—estimates the Bornean rhino situation as not being too late—that is, its numbers are not so few as to require translocation and interbreeding with its Sumatran cousin—then the AsRSG must consider more comprehensively than has hitherto been apparent the subspecies' present circumstances and long-term future. That *Dicerorhinus sumatrensis harrissoni* still breeds in at least the far east of northern Borneo elicits some hope for its future. But if this most recent news fails to galvanise a redoubling of the efforts of the conservation community and relevant governments to counteract the threats to the Bornean rhino's survival, its future is, fearfully, almost certainly guaranteed to follow the recent fate of its distant West African cousin.

APPENDIX A

Sustainable Production of Malaysian Palm Oil: THE FACTS

The Malaysian palm oil industry regularly reviews the issues with various stakeholders as new concerns and new questions are likely to emerge especially those with social responsibilities. One such new concern is the anti-palm oil campaign launched by Friends of the Earth (FoE) on orangutans with their misleading allegations in the 'Oil for Ape scandal' report; and Borneo Orangutan Survival (BOS) Foundation & Nature Alert, the latter with their leaflets that are distributed in some supermarkets in London. Such a review in order to be timely and visible, is usually done on a point-by-point basis with a brief statements of established facts are given to refute claims posed in their report or leaflets. These factual information by MPOB is posted in its website www.mpob.gov.my so that it can challenge the environmental NGOs to show that their claims are largely unsubstantiated. Further the factual information is provided by MPOB is to maintain the good image of the Malaysian palm oil industry and the country.

Claim No 1

The claim that it is "*A true story of corruption, overexploiting and mercilessly destruction of rainforests and the genocide of one of its most charismatic and magnificent animals ever to have graced this earth i.e. the orangutans*" needs to be challenged.

Fact No 1

The truth of the matter is that the Malaysian palm oil industry is a strategic and well planned agricultural industry that responds to global challenges by practising sustainable production. Here the triple objectives are fulfilled. They are firstly, of protecting the society i.e. the people with food quality and safety, improving farmers' skills and raising rural social and economic conditions; secondly, of protecting the environment i.e. the planet with optimize use of natural resources and minimize input requirements onto soil, water, air, energy and maintenance of a large number of varieties and species according to local conditions and preserving and improving wildlife habitats; and thirdly improving the economy i.e. profit where the challenge is to provide food for a growing population at an affordable prices where there is good input/output efficiency, application of modern technologies, optimizing utilization of products, minimizing losses and enhancing positive economic benefits.

Over the last two decades, there is rapid replacement of the major other perennial tree crops to oil palm rather than destruction of jungle per se. This is shown in Table 1.

Table 1. Major perennial tree crops in Malaysia over the last two decades 1990-2000 (in 10^6 ha)

Decades	Oil palm	Rubber	Cocoa	Coconut	Total
1990	1.980	1.823	0.416	0.315	4.534
2000	3.377	1.430	0.078	0.108	4.993
Difference	+1.397	-0.393	-0.338	-0.207	+0.459

As Malaysia practices free enterprise, the bulk of the area converted to oil palm over the last two decades came from conversion of rubber, cocoa and coconut and the balance from logged-over forests. The areas planted with oil palm are well within the 6.02million ha designated for agriculture under the Third Malaysian Agricultural Plan 1998-2010. As of 2004, palm oil area had reached 3.875million ha. To date there are 59% of Malaysia's total 32.86million ha retained under forests and together with the perennial tree crops, the total land cover under tree crop is over 86%. Thus, there is no merciless destruction of forests and wildlife habitat by Malaysian palm oil industry as claimed.

Claim No 2

The claim by Borneo Orangutan Survival Foundation's Founder Chairman in Indonesia that "*The rate of loss of orangutans has never been greater in the last three years and oil palm plantations are mostly to blame... We are facing a silent massacre, taking place far from where people can see what is going on*" is unfounded.

Fact No 2

This spurious claim is disputed here. The Malaysian palm oil industry is more transparent than is claimed. Firstly, in 1990 the Government of Malaysia had decreed that no primary forests are to be converted to plantations except for logged-over forests and that also with permission from the respective State governments. Secondly, the rate of increase in oil palm area had in fact slowed down over the last three years rather than increased.

Table 2. Oil Palm Planted Area (in 10^6 ha)

Area	2001	2002	2003	2004
Mature	3.005	3.188	3.303	3.451
Immature	0.494	0.482	0.499	0.424
Total	3.499	3.670	3.802	3.875

The new area planted in 2002, 2003 and 2004 are only 0.171, 0.132 and 0.073 million ha respectively. Thus there is no increase of forests being mercilessly destroyed and that the magnificent orangutans are not silently massacred in Malaysia as claimed by the BOS & Nature Alert leaflet.

Claim No 3

The claim that "...*The shelves in your local supermarket are full of products containing palm oil, which is contributing to the annihilation of rainforest wildlife. Without knowing it millions of people are fuelling growth in demand for a crop that is leaving a trail of destruction in its wake*" is again untrue.

Fact No 3

The Malaysian Government and the oil palm industry besides practising sustainable development have taken efforts to protect the rights of the indigenous people, wildlife and natural environment. For example clearing of land in excess of 500ha for agriculture requires permission from the Department of Environment so as to comply with the Environment Impact Assessment (EIA) study. Other environmental laws include the Land Conservation Act 1960, Environmental Quality Act 1974, Pesticide Act 1974, National Park Act 1984, and Environmental Quality Act 1986. Malaysia is also a signatory to Convention on Biological Diversity (CBD), International Tropical Timber Agreement, Charter of Indigenous-Tribal Peoples of the Forests, and Cartegena Protocol of safe handling of genetic organisms 2000.

Our forests are logged sustainably and it is done under the control of a different Government Ministry. Likewise our planting and replanting practices under another Government Ministry does not permit open burning. Any misplaced orangutans from affected areas such as logging under a different Government Ministry are put into the Sepilok Orangutan Sanctuary for the displaced orangutans, especially the young, to learn the necessary skills and given the medical treatment before returning them to the wild. The Sepilok Orangutan

Sanctuary is well known to the world and many visitors including many British Nationals have visited the place and have even made moves to raise funds for the center to support the orangutan rehabilitation programmes there. There are an estimated 80 over orangutans in the Sanctuary covering about 43 square km at the Kabili Sepilok forest reserve. Often other wildlife such as sun bears, Sumatran rhinos, gibbons and pygmy elephants get treated at the center.

To further strengthen the fact that Malaysia cares for the orangutans, since 2000 about 27,000 ha of the flood plain of Kinabatanganan, which has rich and abundant biodiversity of flora and fauna, have been gazetted as Kinabatangan Wildlife Sanctuary under the Land Ordinance. The Lower Kinabatangan floodplain is Sabah's most impressive natural ecosystem and is a natural habitat not only of orangutans, but also that on pygmy elephants, Proboscis monkeys, gibbons, rhinos and hornbill birds.

Besides the protection of wildlife in Kinabatangan, there are similar projects when the plantation companies, NGOs and the Governments are collaborating in the protection and conservation of wildlife. Examples are the Asian Rhino Elephant project, and the Fish and aquatic life conservation in oxbow lakes, both projects being in Sabah, and the conservation of the slow loris (Lorisidae primate) in Peninsula Malaysia.

Therefore it is not just the laws and enactments but the good enforcement of them that makes Malaysia stands out in conservation and protection of indigenous people, wildlife and their habitats. Malaysia is one of the 12 Mega biodiversities of the world and Malaysia intends to maintain and enhance this. So how can it is claimed that the Malaysian oil palm industry "leaves behind a trail of destruction in its wake"

Claim No 4

The general claim of "*How much more forest will disappear, since there is a lucrative business? The expansion of plantation causes a significant loss of biodiversity as well as poses a health hazard to people due to haze from land being set on fire. Therefore a control mechanism for better management practices in this sector should be strictly imposed*"... is made by some one who does not know the Malaysian palm oil industry.

Fact No 4

As seen in Table 2 there is slowing down of new planting of oil palm in Malaysia as the Malaysian Government does not allow clearing of jungle for oil palm in Peninsula. In areas of logged-over forests being cleared, the plantation companies practices zero burning whereby no fire is used to clear the debris from planting from these logged-over forests as sizes of logs with more that six inches are harvested; and for replants all trunks are chipped. There is also strict enforcement of the ASEAN Zero Burning agreement in Malaysia. So the problem of haze does not arise at all.

Claim No 5

The claim that "*Despite an abundance of degraded land available for plantations, many palm-oil companies are deliberately targeting forest areas for conversion... Legitimate palm oil companies prefer to cut down the forests, as they provide source of income from logging before a single palm tree is planted. ....It is the total clearance of forests ultimately for planting of oil palm, that has reaped by far the most havoc*" again is made by someone who does not know the Malaysian palm oil industry.

Fact No 5

Malaysia does not have the luxury of an abundance of degraded land available for plantation development. Most of the plantation companies have to replant from existing perennial tree crops as shown in Table 1 and there is no logging of forest to provide income for the plantation companies. The plantation companies are highly sustainable as the same land, replanted with oil palms, have been in cultivation over the last three replanting cycles on the same land. So the claim that it is the total clearance of forests ultimately for planting of oil palm that has reaped by far the most havoc is not true in Malaysia.

Claim No 6

The claim that "*The palm oil industry has caused extreme loss of habitat of wildlife such as orangutans, gibbons, tigers and elephants... This habitat destruction has resulted in such wild life becoming easy prey for hunters. In 2003, ProFauna reported, that there are about 1000 orangutans caught annually for the pet trade*" points towards an Indonesian situation.

Fact No 6

In Sarawak and Sabah, there are no tigers; and this points towards the Indonesian situation with regards to the rest of the Borneo situation. This is because as shown in the factual information earlier Malaysian palm oil industry and Malaysia do not destroy the natural habitats of the wildlife as we intend to maintain our "Mega Biodiversity' image.

Conclusion

Based on the factual information, especially in 4, 5 and 6, there is now more data to counter many of the allegations made in the FoE report and BOS & Nature Alert leaflets We can only come to the conclusion that perhaps the ENGOs should not lump the Malaysian palm oil industry with that of Indonesia. This is because Malaysian palm oil industry is practicing an advanced form of sustainable agriculture. Malaysia will continue to speak up against the practices that are not sustainable, and that is why Malaysia is in the forefront in bringing the roundtable discussions on sustainable palm oil (RSPO) to a successful conclusion.

APPENDIX B

Forest Reserves

To facilitate better forest management and control, the forest reserves in Sabah are divided into 7 different classes:

Class I - Protection Forest. Forest conserved for the protection of watershed and maintenance of the stability of essential climatic and other environmental factors. These areas cannot be logged. There are 342,150 hectares of Protection Forest in 43 locations throughout Sabah.

Class II - Commercial Forest. Forest allocated for logging to supply timber and other produce, contributing to the State's economy. Logging is carried out according to Sustainable Forest Management (SFM) principles. Collectively there are 2,683,480 hectares of Commercial Forest Reserves in 28 locations throughout Sabah.

Class III - Domestic Forest. The produce from this forest is for consumption of local communities only and commercial use is discouraged. Collectively there are 7,355 hectares of Domestic Forest Reserves in 10 locations throughout Sabah.

Class IV - Amenity Forest. Forest for providing amenity and recreation to local inhabitants. Recreational facilities may be provided in attractive sites, often on roadsides, within these reserves. Exotic tree species are often planted to enhance the amenity value of these areas. Collectively, there are 20,767 hectares of Amenity Forest Reserves in 11 locations throughout Sabah.

Class V - Mangrove Forest. Forest for supplying mangrove timber and other produce to meet the general trade demands. The Rhizophora sp. is the most commonly harvested, and the products range from firewood to fishing stakes. Collectively, there are 316,024 hectares of Mangrove Forest Reserves in 17 locations throughout Sabah.

Class VI - Virgin Jungle Forest. Forest conserved intact strictly for forestry research purposes. Logging is strictly prohibited in this forest reserve. The Sepilok Virgin Jungle Reserve in Sandakan covers 4000 hectares and is one of the largest tracts of undisturbed lowland dipterocarp forests in Sabah. Collectively, there are 90,386 hectares of Virgin Forest Reserves in 50 locations throughout Sabah.

Class VII - Wildlife Reserve. Forest conserved primarily for the protection and research of wildlife. The Sumatran Rhinoceros is one of the endangered wild animals homed in the Wildlife Reserves. Collectively, there are 132,652 hectares of Wildlife Reserves in two locations, both in the Dent Peninsula on the East Coast of Sabah. They are Tabin Wildlife Reserve and Kulamba Wildlife Reserve.

Types of Forest Reserves		Areas In Hectares
Class I	Protection Forest	342,150
Class II	Commercial Forest	2,683,480
Class III	Domestic Forest	7,355
Class IV	Amenity Forest	20,940
Class V	Mangrove Forest	316,024
Class VI	Virgin Jungle Forest	91,914
Class VII	Wildlife Reserves	132,653
Total		3,594,516

APPENDIX C

The following transcription from Dinerstein (2003, pp.223-225), is in relation to the rhino recovery and local development projects in Chitwan, Nepal.

"The project has been a success for other reasons. First, the virtual absence of powerful firearms reduces poaching pressure. Second, the law-abiding nature of Nepalese citizens works in favour of conservation. In any case, the Nepalese army stationed in the reserve actively discourages illegal activities. Third, the passionate commitment of a local villager, Shankar Choudhury, shows that the efforts of a single individual on one small plot of land can start a process that conserves a larger landscape. Choudhury spearheaded the on-farm forestry project on his own property in 1988 and organized the village committees to experiment with plantations and regeneration areas. Fourth, the economic incentives and the enabling legislation were strong enough to address the magnitude of the threats to wildlife and their habitats.

The experience in Chitwan and observation of other similar projects help identify some useful guidelines for locating and designing eco-development projects to meet wildlife conservation goals. Serious consideration of these recommendations could multiply the effectiveness of eco-development projects.

- In more fragile habitats, species typically occur at low densities and require large areas to maintain viable populations. In such cases, the design of eco-development projects should include very large areas with an extensive core reserve. The large size of the core areas allows for mistakes or poor stewardship in the early stages of project implementation. Large areas also permit recolonization by previously exploited species populations where extraction (logging or other types of extractive measures) in the eco-development target area has not been well managed.

- Eco-development programs should never be considered as geographically isolated projects but as an integral part of a comprehensive landscape- or ecoregion-scale conservation strategy. Specifically, an eco-development area should be linked to adjacent sites with more restrictive management. Such an approach ensures that those elements of biodiversity that are eroded or lost in the project area are still conserved in the larger landscape. As an example, a project in southern Africa (Caprivi Strip, Namibia) did not want to include lions in a buffer zone because they compete with sport hunters for wild buffalo. However, the buffer zone supports so many buffalo that some wander into an adjacent park. Here they serve as prey for lions, and the lion population is well protected (Jo Tagg, Personal communication, 1998).

- Eco-development projects are more likely to have a conservation effect if the immediate goal is to take the pressure off a protected area and to maintain wildlife corridors by extending buffer zones rather than to attempt to conserve all elements of biodiversity within the project area. Eco-development projects are not substitutes for strictly protected areas; they will fail if evaluated using the same criteria.

- All eco-development projects will result in a net loss of biodiversity. Be clear about the trade-offs, state them explicitly at the beginning of the project, and determine thresholds beyond which further loss is unacceptable.

- Monitor conservation effects at several levels of biodiversity: species, critical habitats, landscapes, and the ecological processes that maintain biodiversity. Tailor monitoring efforts to the type of ecosystem—for example, projects located in mangroves, estuaries, sea-grass beds, or coral reefs. In some instances, ecological processes may be far more important to monitor than species abundance or composition.

- Allow for uncertainty in the design of the eco-development project, particularly in the area of landscape management. The role of dispersal corridors—their size, extent, and condition— in the context of conservation biology has a good theoretical understanding, but little empirical data exist to guide corridor design (Beier and Noss 1998). For large mammals, corridors are likely to be the most crucial landscape elements in human-dominated landscapes. Planners should err on the side of caution by setting aside and protecting corridors larger than the minimum estimate.

- State explicitly the linkages to biodiversity conservation of each project intervention for both biological and community-based activities. The single most cost-effective means to improve the conservation effect of eco-development projects is to use the best biological insights at the design phase and throughput implementation. Ensure that a biodiversity specialist familiar with the rudiments of experimental design is involved. Local participation in monitoring is vital, but a trained biologist is essential for designing and overseeing adaptive management, evaluation of trends, and other, more technical, aspects of monitoring.

- Reinforce anecdotal accounts of the success of the project with data (maps, tables, graphs, etc.) that demonstrate the trajectory of indicators being monitored.
- Communicate important aspects of the monitoring and evaluation program to decision makers and local stakeholders through maps, posters and powerful visuals."

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