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Trio under threat: can we secure the future of rhinos, elephants and tigers in Malaysia?

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Abstract Three of Malaysia's endangered large mammal species are experiencing contrasting futures. Populations of the Sumatran rhino (*Dicerorhinus sumatrensis*) have dwindled to critically low numbers in Peninsular Malaysia (current estimates need to be revised) and the state of Sabah (less than 40 individuals estimated). In the latter region, a bold intervention involving the translocation of isolated rhinos is being developed to concentrate them into a protected area to improve reproduction success rates. For the Asian elephant (*Elephas maximus*), recently established baselines for Peninsular Malaysia (0.09 elephants/km^2 estimated from one site) and Sabah (between 0.56 and 2.15 elephants/km^2 estimated from four sites) seem to indicate globally significant populations based on dung count surveys. Similar surveys are required to monitor elephant population trends at these sites and to determine baselines elsewhere. The population status of the Malayan tiger (*Panthera tigris jacksoni*) in Peninsular Malaysia, however, remains uncertain as only a couple of scientifically defensible camera-trapping surveys (1.66 and 2.59 tigers/100 km^2 estimated from two sites) have been conducted to date. As conservation resources are limited, it may be prudent to focus tiger monitoring and protection efforts in priority areas identified by the National Tiger Action Plan for Malaysia. Apart from reviewing the conservation status of rhinos, elephants and tigers and threats facing them, we highlight existing and novel conservation initiatives, policies and frameworks that can help secure the long-term future of these iconic species in Malaysia.

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Abbreviations

AREAS	Asian Rhino and Elephant Action Strategy
CBD	Convention on Biological Diversity
DWNP	Department of Wildlife and National Parks
GFTN	Global Forest Trade Network
IUCN	International Union for Conservation of Nature
MYCAT	Malaysian Conservation Alliance for Tigers
NGO	Non-governmental organization
NRE	Ministry of Natural Resources and Environment
REDD	Reduced Emissions through Deforestation and Degradation
RET	Rhino, Elephant and Tiger
RSPO	Roundtable for Sustainable Palm Oil
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

Introduction

Southeast Asia has the highest rates deforestation among the tropics (Sodhi et al. 2004; Sodhi and Brook 2006) and the highest proportion of threatened mammal species (Sodhi et al. 2010). In fact, large-scale mammal extinctions in Southeast Asia are imminent; around 21–48% of regional mammal species are predicted to be extinct by 2100 (Brook et al. 2003). In Malaysia, various reports on the status of mammals have been contradictory. According to its 4th national report to the Convention on Biological Diversity (CBD) (NRE (Ministry of Natural Resources and Environment) 2009), Malaysia is on track to achieve targets such as improving status of threatened species, yet there has been no mention of any mammal population trends. In fact, the latest International Union for Conservation (IUCN) Red List (2009) suggests more mammals in Malaysia are closer to extinction following a reclassification of their 2007 status to a higher threat category. So how are endangered mammals such as rhinos, elephants and tigers (RETs) really coping in Malaysia? What are the current and emerging threats facing them? What are the most important local conservation initiatives, policies and frameworks relevant to RETs in Malaysia? In this review, we synthesize the latest information available on RETs from WWF-Malaysia's field surveys, as well as data from the government, partner non-governmental organizations (NGOs) and researchers to address these questions.

Conservation status of RETs

The Sumatran rhino is considered 'Critically Endangered', while the Asian elephant and Malayan tiger are classified as 'Endangered' by the IUCN Red List (IUCN (World Conservation Union) 2009). It is pertinent to note that the sambar deer (*Rusa unicolor*), one of the tiger's main prey species, was globally reclassified to a higher category of 'Vulnerable' in the latest 2008 Red List; this may have implications on the tiger's future threat status.

Malaysia has two subspecies of Sumatran rhino; one (*Dicerorhinus sumatrensis sumatrensis*) occurs in Peninsular Malaysia, while the other is endemic to the equatorial island of Borneo (*Dicerorhinus sumatrensis harrissoni*). Malaysia also has two subspecies of Asian elephants: one (*Elephas maximus indicus*) is found in Peninsular Malaysia and the other (*Elephas maximus borneensis*) in the Malaysian state of Sabah in northern Borneo. Only one tiger subspecies, the Malayan tiger (*Panthera tigris jacksoni*), can be found in Peninsular Malaysia.

Sumatran rhino

In 1995, around 79 rhinos were estimated to be found in Peninsular Malaysia (Foose and van Strien 1997). The latest population estimates from general inventories by the Department of Wildlife and National Parks (DWNP) range between 64 and 83 individuals (DWNP (Department of Wildlife and National Parks) 2005). In recent years, however, extremely low rhino track encounter rates (Table 1) have been recorded in two of Peninsular Malaysia's largest protected areas: Taman Negara National Park and Royal Belum State Park (Fig. 1). Endau Rompin National Park, which was gazetted in 1972 largely for rhino conservation (Flynn and Abdullah 1984; Fig. 1), has also failed to yield rhino signs for many years. Recent occupancy surveys for tiger prey (e.g., deer, wild boar, etc.) conducted by Wildlife Conservation Society (WCS) Malaysia Programme have not detected any rhino signs in the park so far. The statistics from all three protected areas are worrying as they have been traditionally considered the main rhino strongholds in Peninsular Malaysia. Granted that only WWF-Malaysia's surveys were specifically sampling rhino habitats, Peninsular Malaysia's rhino population estimates (which were omitted from Malaysia's 4th national report to the CBD; NRE 2009) may have to be revised and surveys in the few remaining inaccessible areas with large tracts of forests (e.g., Titiwangsa mountain range) must be intensified.

During the past two decades in Malaysian Borneo, evidence of rhinos has been confirmed only from the state of Sabah, although the persistence of the species in northern Sarawak is sometimes quoted without evidence. Taking into account other isolated individuals in unprotected areas along the east coast, less than 40 individuals are estimated to survive in Sabah, with two of the largest rhino populations located in and around Danum Valley Conservation Area and Tabin Wildlife Reserve (Fig. 1; Table 1). It is likely that the isolated rhinos are doomed to extinction unless more resources are afforded to translocate them into either of these two protected areas.

Asian elephant

The government currently estimates between 1,223 and 1,460 elephants in Peninsular Malaysia based on general inventories at various forests since the turn of the century (DWNP 2006). According to Daim (2002), however, these elephant population estimates have been derived predominantly from 'footprint-count' methods, which are not particularly robust and are likely to yield conservative figures. It was also suggested that the increase in elephant populations in Peninsular Malaysia from 681 elephants in 1965 to the current estimates documented by DWNP could be due to double-counting or an artifact of shrinking forests yielding higher elephant densities (Daim 2002). For some time, Taman Negara was known to have the highest elephant population densities as the park encompasses large tracts of forest from the states of Pahang, Kelantan and Terengganu (Daim 2002). This was recently corroborated by Malaysia's first scientifically defensible elephant

Table 1 Estimated number of individuals or density (and associated error, track encounter rates, sampling effort, survey duration and source) of Sumatran rhinos, Asian elephants and Malayan tigers in key sites within Peninsular Malaysia and Sabah

	Estimated no. of individuals, population density (associated error or track encounter rates)	Sampling effort	Survey duration	Source
Species				
Sumatran rhino				
Peninsular Malaysia				
Taman Negara	NA (0.42 tracks/100 km)	716 km	1999–2001	Kawanishi and Sunquist (2004)
Royal Belum	NA (0.14 tracks/100 km)	710 km	2007-present	Ahmad Zafir et al. (in preparation)
Endau Rompin	NA (0.00 track/100 km)	2,500 km	2008-present	Melvin Gumal (personal communication)
Sabah				
Danum	≥13 (4.99 tracks/100 km)	621 km	2005-present	Raymond Alfred and John Payne (unpublished report)
Tabin	~15	NA	2005–2007	S. Thayaparan et al. (unpublished report)
Others	~8	NA	2005-present	Raymond Alfred et al. (in preparation)
Asian elephant				
Peninsular Malaysia				
Taman Negara	0.09/km^2	58 transects	2006–2007	WCS-Government of Malaysia 2008, unpublished report
Sabah				
Tabin	0.60 (±0.28)/km^2	55 transects	2005-present	Raymond Alfred et al. (in preparation)
Lower Kinabatangan	2.15 (±0.84)/km^2	16 transects	2005-present	Raymond Alfred et al. (in preparation)
CentralForest (Ulu Segama, Danum, Malua, Kuamut, Gunung Rara amd Kalabakan)	1.18 (±0.34)/km^2	104 transects	2005-present	Raymond Alfred et al. (in preparation)
North Kinabatagan (Deramakot, Tangkulup and Segaliud)	0.56 (±0.22)/km^2	34 transects	2005-present	Raymond Alfred et al. (in preparation)

Table 1 continued

	Estimated no. of individuals, population density (associated error or track encounter rates)	Sampling effort	Survey duration	Source
Malayan tiger				
Peninsular Malaysia				
Taman Negara	1.66 (± 0.21)/100 km^2	14,054 trap nights	1999–2001	Kawanishi and Sunquist (2004)
Gunong Basor	2.59 (± 0.71)/100 km^2	2,664 trap nights	2004–2005	Rayan and Shariff (2009)

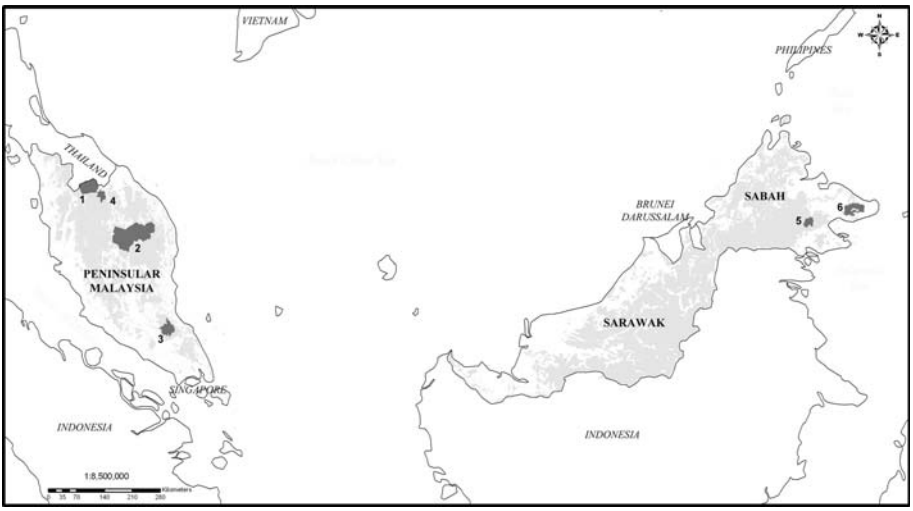

Fig. 1 Map indicating key sites (*dark grey*) within existing forests (*grey*) in Malaysia (i.e., Peninsular Malaysia, Sabah and Sarawak): (1) Royal Belum State Park (1175 km^2), Perak; (2) Taman Negara National Park (4343 km^2), Pahang, Kelantan and Terengganu; (3) Endau Rompin National Park (489 km^2), Johor and Pahang; (4) Gunong Basor Forest Reserve, Kelantan; (5) Danum Valley Conservation Area (438 km^2), Sabah; and (6) Tabin Wildlife Reserve (1,225 km^2), Sabah

monitoring study by DWNP and WCS, who together obtained a significant population density estimate from dung-count surveys at one study site within the park (Table 1). However, it is almost impossible to ascertain whether this large population size (around 631 elephants; Lee 2009) can be attributed to optimal environmental conditions and a natural carrying capacity; 527 elephants have already been translocated to Taman Negara and other protected areas between 1974 and 2005 (DWNP 2006). Nevertheless, it is encouraging that a baseline has been established for Taman Negara and further sampling should be carried out within the park to monitor population trends. In addition, more dung-count surveys should be replicated in other key areas in the peninsula with potentially significant elephant populations.

The latest published estimate of elephant numbers in Sabah (Ambu et al. 2002) was based on a combination of dung counts and anecdotal sightings. Extracting tabulated information from this study (where the listing is based on administrative district rather than contiguous forest blocks), between 680 and 874 elephants were estimated within the central main forest block in Sabah. However, scientifically defensible dung-count surveys by WWF-Malaysia's within four main sites recently yielded significant population density estimates (Table 1), which translate to around 2,030 elephants (Raymond Alfred et al. in preparation). Nevertheless, additional dung-count transects are required in these and other key sites in Sabah to obtain more reliable population estimates of elephants.

Malayan tiger

In the 1950s, Locke (1954) estimated that Peninsular Malaysia had approximately 3,000 wild tigers and in 1987, this figure was revised to 600–650 individuals (Mohd Khan 1987).

The latest government report cites a population of around 500 tigers (DWNP (Department of Wildlife and National Parks) 2008). This estimate was first provided by Topani (1990) based on surveys and human-tiger conflict reports and was similar to estimates from Kawanishi et al. (2003), who derived this figure based on assumptions that: (1) tropical forests had at least 1 tiger/100 km^2; and (2) confirmed and expected tiger habitats in Malaysia encompass a total of 49,300 km^2. In an attempt to quantify the population densities of tigers in Malaysia, camera-trapping surveys in nine forest sites were conducted between 1997 and 1999 by Lynam et al. (2007), but only crude density estimates were derived due to insufficient data. So far, tiger population density estimates based on robust capture-recapture frameworks are known only from two sites: Taman Negara and Gunung Basor Forest Reserve (Table 1). It is therefore critical that DWNP and NGOs strive to determine and monitor the conservation status of tigers and their prey in the three priority areas identified in the National Tiger Action Plan for Malaysia (see conservation initiatives), as well as embark on a landscape-level occupancy survey (similar to the Sumatra-island-wide-survey) to evaluate the overall status of tigers in Peninsular Malaysia.

Current and emerging threats

Mammals are particularly vulnerable to anthropogenic threats; a meta-analysis by Sodhi et al. (2009) revealed this group is generally more sensitive (in terms of richness, abundance and demographics) to human-induced forest disturbances than taxa such as plants, birds and certain invertebrate groups. Agricultural expansion, for example, is probably one of the most significant threats to RETs in Malaysia. This is not a new phenomenon as large tracts of lowland dipterocarp forests, formerly the main habitats for RETs, have been rapidly converted to agricultural plantations through government and private land development schemes since the country gained independence in 1957 (Aiken and Leigh 1985). Oil palm, in particular, has become one of the most lucrative crops, with profits exceeding those of sustainably managed timber forests. With the growing global demand for edible oils (Corley 2009), lowland natural forests will continue to come under pressure for conversion. Between 1990 and 2005, 55–59% of oil palm expansion in Malaysia originated from the clearance of natural forests (Koh and Wilcove 2008). Agricultural expansion not only affects RETs via habitat loss, but also: (1) increases accessibility to poachers (AREAS (Asian Rhino and Elephant Action Strategy) 2007); (2) disrupts movement patterns around forest edges (Kinnaird et al. 2003); and (3) causes a surge in elephant crop raids and tiger attacks that ultimately result in retaliatory killings of conflict elephants and tigers (Nyhus and Tilson 2004). In five states within Peninsular Malaysia that encompass most of the confirmed elephant habitats, there has been a 8–22% increase in human-elephant conflict incidences every year (Table 2), assuming all conflict cases were reported. Although this trend cannot be attributed solely to agricultural expansion, elephant populations have probably suffered from the conversion of lowland forests into plantations. The impact of agricultural expansion on rhinos in Malaysia can perhaps be illustrated by an incident on the 3rd of August 2008, when an adult male Sumatran rhino wandered into an oil palm plantation in Sabah (NST 2008). It is likely that the rhino would have been poached if not for interventions from the Sabah Wildlife Department and WWF-Malaysia, which along with SOS-Rhino Borneo had been monitoring this individual for the past two years. The rhino was jointly-translocated to Tabin, where the Borneo Rhino Sanctuary is currently being established (see conservation initiatives).

Table 2 Reports of human-elephant conflicts from five states encompassing most of the elephant habitats in Peninsular Malaysia between 2000 and 2007 and the mean percent increase in conflict incidents each year

	Perak	Johor	Pahang	Terengganu	Kelantan
Year					
2000	108	178	203	94	70
2001	92	178	141	51	60
2003	136	182	138	132	143
2004	171	308	155	121	144
2005	167	186	168	189	191
2006	252	178	275	89	104
2007	NA	289	272	162	NA
Mean % increase/year	21.46	14.99	8.44	31.68	22.37

Source: Compiled from annual reports by the Department of Wildlife and National Parks (Peninsular Malaysia)

While clear-felling of natural forests for conversion to plantations can extirpate entire populations of RETs, altered forest environments created by selective logging can still sustain elephants and tigers (Aiken and Leigh 1985; Miquelle et al. 1999). In fact, surveys from a selectively logged forest in Peninsular Malaysia yielded a higher tiger population density estimate (Mark Rayan and Shariff 2009) than a protected primary forest (Kawanishi and Sunquist 2004). A likely explanation for this is that large canopy gaps in logged forests allow more sunlight into the understory, consequently increasing browse availability for tiger prey (Davies et al. 2001). For elephants, satellite tracking surveys in Sabah have also revealed a preference for logged forests or secondary forests with grassy areas (Alfred et al. 2007). However, the effects of selective logging on rhinos are not yet well understood and the long-term response of tigers and elephants needs to be further studied. As timber resources in remaining logged forests of Malaysia continue to decline, monoculture timber plantations may eventually take over. For example, an emerging threat in Malaysia is the clearance of areas within selectively logged forests for Latex-Timber Clone rubber plantations, which are essentially rubber trees that provide high latex and timber yields (Tan 2009). Since rubber trees are still classified as 'forests' according to the definition by the United Nations Food and Agriculture Organization (FAO (United Nations Food and Agricultural Organization) 2006), State governments are allowed to allocate parcels of land within selectively logged forests for the planting of rubberwood 'forests'. Unless this loophole is addressed, this recent trend may yet sound the death knell for isolated RET populations within selectively logged forests.

Infrastructure development such as the construction of roads is known to have several deleterious effects on mammals in the tropics (Laurance et al. 2009). Linkie et al. (2006) demonstrated that tiger occurrences negatively correlated with distance to public roads in Sumatra. In Malaysia, it has been suggested that major roads increase the probability of direct mortality due to vehicular traffic, as well as provide greater accessibility to poachers targeting threatened mammals including RETs (Mohd. Azlan 2006; Mohd. Azlan and Lading 2006). According to DWNP and WWF-Malaysia's anti-poaching patrols in the Belum-Temengor Forest complex (which is part of a Level 1 Tiger Conservation Landscape; Dinerstein et al. 2006), around 38 access points for poachers can be found along the 100-km East–West highway bisecting this landscape. Hydroelectric dams also result in the loss of RET habitats; their construction has already resulted in extensive submergence of land under natural forests (and unwarranted logging of surrounding catchment areas; Sharma 2008) in Peninsular Malaysia.

Illegal hunting and trade (Nowell and Xu 2007; Nijman 2010) is another major threat to RETs in Malaysia. This has been facilitated, to an extent, by increased accessibility due to agricultural expansion, opening of new forest compartments for logging and infrastructure development. Although illegal hunting is undoubtedly a significant cause of the rhino's decline in modern times (Rabinowitz 1995), their natural population densities may already have been low when humans began targeting them for their valuable horn ($45,000/kg; TRAFFIC unpublished report); Piper and Cranbrook (2008) suggested that the relatively low productivity and paucity of understory plants in closed canopy rainforests have not been optimal for browsers such as rhinos. For tigers, Chapron et al. (2008) demonstrated that poaching is by far the most serious short-term threat (vis-à-vis habitat loss and fragmentation) as it reduces populations beyond a recovery threshold. Illegal hunting of tigers for the wildlife trade has directly depressed population densities in Malaysia (Lynam et al. 2007). In the first five months of 2009 alone, at least nine tigers may have been poached from Malaysia (e.g., Noor Adzman and Povera 2009; NST 2009). Hunting also appears to have resulted in population declines of tiger prey. For instance, sambar deer (*Rusa unicolor*), which was formerly assumed to be one of the commonest animals, accounted for a mere 4% of 10,145 photocaptures taken from 23 studies conducted between 1997 and 2008 in Malaysia (Kae Kawanishi unpublished report). Although we do not know the extent to which elephants in Malaysia are poached for their ivory, this is rapidly becoming a serious issue in other Southeast Asian countries as well (Shepherd and Nijman 2008).

Indirect factors such as governance structure and inadequate laws have also hampered the ability to conserve RETs in Malaysia. For example, under the Constitution of Malaysia, land and forests come under the jurisdiction of State governments, so the Federal government has limited and indirect influence over conversion of RET habitats to other land use. In fact, State governments (particularly under opposition rule) may be less amenable to gazette important logged forests as protected areas for the conservation of RETs without compensation from the federal government for loss in potential logging revenue (Buang 2008). The Protection of Wildlife Act 1972, which has not been amended since 1988, also contains loopholes that have been exploited by poachers. For example, when a product's label blatantly claims to be derived from a protected species, the burden of proof lies with the prosecution to demonstrate that the product does contain protected species parts or derivatives. Furthermore, the relatively small penalties imposed under the Wildlife Act do not have a deterrent effect because high financial rewards and the low risk of detection continue to create incentives to commit wildlife crimes involving RETs. In fact, only six tiger-related cases have resulted in fines between 2001 and 2005 and maximum penalties are rarely imposed; a man found with a butchered tiger was only fined RM7,000, despite the Wildlife Act providing a maximum custodial sentence of five years, or fine of up to RM15,000 (DWNP 2008).

Conservation initiatives, policies and frameworks

We describe below the best currently available strategies to secure the future of RETs in Malaysia. Several RET-relevant conservation initiatives (i.e., species conservation alliances, anti-poaching units, species action plans, and breeding programmes) that have recently emerged require sustained political commitment to ensure success, while existing RET-relevant policies and frameworks (i.e., government policies, sustainable guidelines for agriculture and logging, and sustainable finance mechanisms) may

need further refinement to produce more targeted impacts on-the-ground for RET conservation.

Conservation initiatives

Species and habitat conservation alliances

Until this decade, there have been few collaborative alliances between the Malaysian government and local NGOs for the conservation of RETs. In Peninsular Malaysia, the Malaysian Conservation Alliance for Tigers (MYCAT) was formed by the government in 2003 to provide a novel platform for integrated tiger conservation in Malaysia (Table 3). Members of MYCAT participate in regular working group meetings to monitor the implementation of the Tiger Action Plan, share conservation experiences, and discuss strategies to address issues impacting tiger habitats and populations. Other global alliances supporting tiger conservation in Malaysia include the Tigers Forever project and Tiger Network Initiative (Table 3), with the latter implementing transformational strategies (e.g., recovery of tiger and prey populations, high-level political engagement, and elimination of the tiger trade) across tiger landscapes in order to double the wild tiger population by 2020. Less formal alliances can be found in Sabah, where WWF-Malaysia partners closely with the Sabah Wildlife Department to: (1) determine the elephant population status; (2) identify key elephant habitats; and (3) mitigate human-elephant conflict. WWF-Malaysia also works closely with Sabah Forestry Department and Sabah Foundation to improve enforcement efforts for better protection of rhinos in Danum. In Tabin, the Borneo Rhino Alliance (Table 3) continues the role of the NGO formerly known as SOS-Rhino Borneo. With rhino survival as its key focus, the Borneo Rhino Alliance is a not-for-profit company focusing on rhino monitoring surveys, anti-poaching patrols, and assisting the State government in the development and management of the Borneo Rhino Sanctuary (see below). Finally, one of the most prominent habitat-conservation alliances in Malaysian Borneo has been the Heart of Borneo programme (Table 3), which involves a tripartite commitment to conserve 220,000 km^2 of rainforest through a network of protected areas and sustainably-managed forests. This programme attempts to provide a tri-lateral institutional framework across the three participant countries to: (1) address trans-boundary issues such as illegal logging and wildlife trade; (2) provide necessary capacity building for conservation personnel; (3) promote sector reform within the timber and oil palm industry by utilizing pressure points within regional and international markets and relevant financial institutions; and (4) promote sustainable financing through suitable private–public partnerships and payment for eco-system services. Key rhino and elephant habitats in Sabah that lie within the Heart of Borneo are likely to benefit from this programme through the abovementioned strategies.

Government species action plans

Several species action plans have been developed over the years in Malaysia (e.g., DWNP (Department of Wildlife and National Parks) 1990), but very few are actually implemented and monitored to ensure accountability. The National Tiger Action Plan for Malaysia promises to be different with its ambitious plan to double the number of wild tigers to 1,000 by 2020 (DWNP (Department of Wildlife and National Parks) 2008). This action plan outlines four main outcomes: (1) ensuring priority tiger areas are connected with corridors; (2) providing long-term protection of tiger and tiger prey; (3) promoting sound

Table 3 Summary of Sumatran rhino, Asian elephant and Malayan tiger relevant conservation initiatives, policies and frameworks and associated leading and supporting entities, target species and references in Malaysia

	Leading and supporting entities*	Target species	References
Conservation initiatives			
Species and habitat conservation alliances and (known acronyms)			
Malaysian Conservation Alliance for Tigers (MYCAT)	Malaysian Nature Society TRAFFIC Southeast Asia Wildlife Conservation Society, Malaysia Programme World Wide Fund for Nature-Malaysia Department of Wildlife National Parks*	Tiger	Siti Hawa and Kawanishi (2003); www.malayantiger.net
Tigers Forever	Panthera Wildlife Trust Wildlife Conservation Society	Tiger	www.tigersforever.org www.wcsmalaysia.org/Projects/Tigers_Johor.htm
Tiger Network Initiative	World Wide Fund for Nature TRAFFIC	Tiger	www.panda.org/what_we_do/endangered_species/tigers/
Borneo Rhino Alliance (BORA)	HUTAN Land Empowerment Animals People Universiti Malaysia Sabah	Rhino	www.leapsprial.org/content/project09.php
Heart of Borneo (HOB)	Government of Brunei Government of Malaysia Government of Indonesia World Wide Fund for Nature-Malaysia*	Elephant and rhino	www.panda.org/what_we_do/where_we_work/borneo_forests/

Table 3 continued

	Leading and supporting entities*	Target species	References
Species action plans			
National Tiger Action Plan for Malaysia (TAP)	Relevant government agencies and MYCAT partners*	Tiger	www.wildlife.gov.my/printed_material/misc/TAP.pdf
Sabah Rhino and Elephant action plans	Sabah Wildlife Department NGOs*	Elephant and rhino	Sabah Wildlife Department (in preparation)
Anti-poaching patrols			
Taman Negara and other protected areas in Peninsular Malaysia	Wildlife Crime Unit, Department of Wildlife and National Parks Royal Malaysian Army	Elephant and tiger	DWNP (Department of Wildlife and National Parks) (2008)
Belum-Temengor	Department of Wildlife and National Parks Perak State Parks Corporation Royal Malaysian Police Wildlife Protection Unit, World Wide Fund for Nature-Malaysia*	Rhino, elephant and tiger	www.wwf.org.my/media_and_information/newsroom_main/?9460/Tiger-rescue-points-to-urgent-need-for-more-patrols
Endau Rompin	Department of Wildlife and National Parks Forestry Department Peninsular Malaysia Johor National Parks Corporation Kulim Bhd Royal Malaysian Police Wildlife Conservation Society, Malaysia Program*	Elephant and tiger	johorparks.com.my www.wcsmalaysia.org/Projects/Tigers_Johor.htm

Table 3 continued

	Leading and supporting entities*	Target species	References
Danum and Tabin	Royal Malaysian Police	Rhino and elephant	www.wwf.org.my
	Sabah Foundation		
	Sabah Forestry Department		
	Sabah Wildlife Department		
	Rhino Protection Units, World Wide Fund for Nature-Malaysia and Borneo Rhino Alliance*		
Breeding programmes			
Borneo Rhino Sanctuary	Sabah State Government	Rhino	www.leapsprial.org/content/project09.php
	Borneo Rhino Alliance*		
Policies and frameworks			
Government policies			
Revision of Protection of Wildlife Act 1972	Department of Wildlife and National Parks	Rhino, elephant and tiger	Damis (2009)
	Ministry of Natural Resources and Environment		www.nre.gov.my
	MYCAT*		
Two-year moratorium on hunting of sambar and barking deer	Department of Wildlife and National Parks	Tiger	Damis (2009)
	MYCAT*		www.wildlife.gov.my
National Physical Plan	Federal Department of Town and Country Planning	Rhino, elephant and tiger	www.townplan.gov.my/english/service_dev_npp.php
	Ministry of Housing and Local Government		
Central Forest Spine Master Plan for Ecological Linkages	Federal Department of Town and Country Planning	Rhino, elephant and tiger	Federal Department of Town and Country Planning (in press)

Table 3 continued

	Leading and supporting entities*	Target species	References
Sustainability guidelines			
Refinement of Roundtable for Sustainable Palm Oil (RSPO) guidelines	World Wide Fund for Nature-International Members: Oil palm growers, palm oil processors and/or traders, consumer goods manufacturers, retailers, banks and investors, environmental NGOs, and social developmental NGOs	NA	www.rspo.org
Improvement of 2002 Malaysian Criteria and Indicators for Forest Management	Wildlife Assessment and Monitoring for Sustainable Forest Management Working Group: Department of Wildlife and National Parks, Forestry Department Peninsular Malaysia, Malaysian Timber and Certification Council and World Wide Fund for Nature-Malaysia	Tiger	www.wwf.org,my
Expanding Global Forest Trade Network (GFTN) to provide greater incentives for sustainable logging	World Wide Fund for Nature-International Members: More than 360 companies, communities, NGOs, and entrepreneurs in more than 30 countries	NA	gftn.panda.org
Sustainable finance mechanisms			
Reduced Emissions from Deforestation and Degradation (REDD)	United Nations Framework Convention on Climate Change	Unknown	unfccc.int/methods_science/redd/items/4531.php
Malua Wildlife Habitat Conservation Bank	Sabah government New Forests	Elephant	www.maluabank.com

landuse surrounding priority areas; and (4) improving knowledge on tiger ecology. These objectives will be realistically achieved through 80 activities, which are chiefly implemented by DWNP with support from other government agencies and monitored by MYCAT. Based on confirmed and expected tiger habitats (Kawanishi et al. 2003), three priority areas were identified for tiger conservation and these also overlap with the global priority Tiger Conservation Landscapes (Dinerstein et al. 2006): Belum-Temengor Forest Complex (3,546 km^2), Taman Negara (4,343 km^2), and Endau-Rompin Forest Complex (2,389 km^2). Thus, the implementation of Tiger Action Plan activities across the tiger landscapes and priority areas may be the best strategy to ensure the survival of tigers and other threatened large mammals in Malaysia. State and National action plans for the Bornean elephant (Ambu et al. 2002) and rhino in Peninsular Malaysia (DWNP-DWS-DFS 1993) are out of date. New action plans are being developed for elephants and rhinos in Sabah (Table 3), with the action plan for latter having three main components—institutional and sustainable financing arrangements, better protection of wild rhinos, and the development of Borneo Rhino Sanctuary.

Anti-poaching patrols

While RET population trends should be monitored regularly, conservation resources should not be diverted from efforts to curb illegal hunting and encroachment. Linkie et al. (2010) showed that focused long-term patrols can be effective in deterring illegal activities in and around Sumatran protected areas. In Peninsular Malaysia, enforcement efforts by DWNP thus far have been commendable (Table 3); around 75 foreign poachers have been arrested in PAs between 2001 and 2005 (DWNP (Department of Wildlife and National Parks) 2008). However, in protected areas where enforcement capacities are lacking, joint patrols by government enforcement agencies and NGOs can also help reduce illegal hunting activities (Table 3). Royal Belum, for example, has a capacity of 0.68 guards/100 km^2; this level of enforcement is inadequate as Bruner et al. (2001) showed that 15 of the most effective Totally Protected Areas in the tropics had a median number of more than 3 guards/100 km^2. Recognizing the need to bolster enforcement capacities, WWF-Malaysia set up the Wildlife Protection Unit with the aim of reducing illegal hunting activities in and around Royal Belum. This unit was modeled after the laudable Rhino Protection Units funded by the Indonesian Rhino Conservation Program, which has helped curb the hunting of RETs in protected areas within Indonesia (Isnan et al. 2006). It is commendable that joint government-NGO patrols in and around Royal Belum have resulted in the removal of 102 snares, apprehension of 10 poachers and traders, and a rescued tiger since January 2009 (Table 3). Prior to this, ranger patrols have been ad-hoc and no poaching hotspots had been identified for regular monitoring. For two of Sabah's protected areas with viable rhino populations, WWF-Malaysia and the Borneo Rhino Alliance have also set up Rhino Protection Units in Danum and Tabin to conduct regular patrols and rhino monitoring (Table 3). However, existing NGO-backed anti-poaching units cannot sufficiently protect RETs due to limited patrolling coverage and may be unsustainable given budgetary and manpower constraints. With appropriate sustainable finance mechanisms in place, governments should increase current enforcement capacities and form alliances with private plantation owners and forest concessions to improve law enforcement in RET habitats. Ultimately, it remains to be seen how wildlife crime data and intelligence gathered from such anti-poaching units and alliances in both Peninsular Malaysia and Malaysian Borneo will feed into the Association of Southeast Asian Nation's Wildlife Enforcement Network (www.asean-wen.org), which is a regional inter-

governmental law-enforcement network designed to combat illegal wildlife trade and to facilitate the sharing of best practices among partner enforcement agencies. Due to its sheer scale and recent emergence, it will probably take some time before this regional enforcement network yields effective and concerted strategies to tackle wildlife crime in the region.

Breeding programmes

Managed breeding programmes for rare large mammals are usually recommended in exceptional circumstances as potential problems with subsequent re-introduction, competition with in situ conservation needs for resources, animal diet and health issues, and concerns over long-term sustainability are pertinent (Tan 2003). As described in earlier sections, the status of the Sumatran rhino clearly warrants a carefully-managed breeding programme. With such low numbers, extinction may not only result from random deaths through sickness or poaching, but also from inadequate breeding rates and deleterious effects of inbreeding. In 2008, the government of Malaysia launched the Sabah Development Corridor programme, which includes a Rhino Rescue Program that endorses the concept of a closely-managed population in a designated area to ensure perpetuation of the subspecies. Eight sites were reviewed, to which scattered rhinos outside Tabin and Danum could be brought, in order to have a greater number of genetically unrelated rhinos at one managed site. The former was eventually chosen as the best location for the establishment of the Borneo Rhino Sanctuary (Table 3). Here, approximately 4,500 ha of forest will be fenced up to function as a breeding area for isolated rhinos translocated from all over Sabah (Cheang 2009).

Policies and frameworks

Government policies

It is encouraging that the government is currently improving the Protection of Wildlife Act 1972 (Table 3), and the revised act is likely to be tabled at an upcoming Parliament sitting (Damis 2009). At least 13 new provisions are being suggested: (1) a significant increase in penalties (e.g., minimum fines of RM100,000 to a maximum of RM500,000 coupled with mandatory prison sentences of not more than five years) for wildlife crimes involving protected species including RETs; (2) provisions for the prosecution of cases involving the trade of products that claim to contain the derivatives of protected species; and (3) inclusion of additional species such as the Asian elephant under the totally protected species list (Damis 2009). It is also commendable a two-year moratorium on the hunting of sambar and barking deer has been instituted in 2009 (Table 3), which would relieve hunting pressure on tiger prey to an extent and facilitate investigations into the sustainability. Another laudable government policy is the National Physical Plan (Table 3), which sets the policy and measures on spatial planning for Peninsular Malaysia and emphasises the conservation and sustainable use of resources within environmentally sensitive areas and core landscapes. Pursuant to this plan, a specific plan to prevent habitat fragmentation and ensure connectivity between RET habitats within a network of forest complexes through green linkages to form a contiguous forest spine for Peninsular Malaysia has been prepared and is currently being finalized. This plan, known as the Central Forest Spine Master Plan for Ecological Linkages (Table 3), provides specific recommendations and action plans which include maintenance of current gazetted forest reserves with no further

revocation, as well as a moratorium on development projects along primary ecological linkages. Ultimately, the retention of large tracts of forests and reconnection of fragmented habitats (as advocated in these plans) can help ensure survival of smaller RET subpopulations (e.g., Linkie et al. 2006).

Sustainability guidelines

In order to ameliorate the effects of agricultural expansion on wildlife in surrounding protected areas and selectively logged forests, existing certification guidelines for agriculture such as the Roundtable for Sustainable Palm Oil (RSPO; Table 3) need to incorporate more practical RET-sensitive indicators that emphasize the importance of population viability and maintenance of high conservation value areas encompassing RET habitats. These indicators should be assigned the status of 'major' compliance and needs greater enforcement and socialization with state government agencies and plantation companies to support their compliance. Currently, RSPO guidelines are also being developed for smallholders in Malaysia—this is crucial given the burgeoning number of smallholders who have little or no incentives to comply with RSPO. Compliance can be further strengthened by the internal RSPO monitoring of reports of auditors who assess compliance to the principles and criteria of client plantations. Such monitoring should ensure that the strictest norms are followed when certification is awarded to plantations and any deviations should be reported for corrective or punitive action. Furthermore, NGOs should assist plantations in the implementation of sustainability guidelines such as RSPO (Clements and Posa 2007). Ultimately, there should also be no further conversion of high value secondary and logged forests to agriculture (Koh and Wilcove 2008; Rayan and Shariff 2009). For local communities that own plantations in close proximity to forests, compensation efforts (Nyhus et al. 2003) and assistance programmes to improve income-earning opportunities should also be implemented to encourage the adoption of better farming practices or alternative livelihoods to minimize human-wildlife conflict.

Certification guidelines for selective logging also require further improvement. Selectively logged forests encompass around 85% of confirmed tiger habitats in Peninsular Malaysia (DWNP (Department of Wildlife and National Parks) 2008) and they are known to sustain relatively high tiger prey densities (Heydon and Bulloh 1997). However, current forest management plans do not sufficiently protect tiger and tiger prey habitats. As such, WWF-Malaysia initiated the multi-partner Wildlife Assessment and Monitoring for Sustainable Forest Management working group in 2005 (Table 3), in part to push for the incorporation of tiger- and tiger prey-friendly forest management guidelines into the 2002 Malaysian Criteria and Indicators for Forest Management Certification standards. Furthermore, selective logging has been promoted by several forestry paradigms that have attempted to attain credible standards for forest management. Among the highest standards that are globally recognized are those receiving certification under the Forest Stewardship Council, which supports wildlife conservation and preservation of high conservation value forests (Newsom et al. 2008). However, as seen in the need for making RSPO guidelines more species compliant, Bennet (2000) pointed out that biodiversity conservation has been poorly represented and undefined among the principles of forest certification schemes and requested for the broadening of standards to include the effects of logging on biodiversity. Certified forest schemes require incentives for their maintenance and the Global Forest Trade Network (GFTN; Table 3) attempts to facilitate this by creating a global market for environmentally responsible forest products. Since 1991, international market-driven demands from GFTN participants have increased economic incentives for responsible

forest management (e.g., Tawie 2009). However, there needs to be greater reconciliation between GFTN objectives and conservation of RET habitats in Malaysia. At present, the GFTN tends to operate on a stand-alone basis to support responsible forestry, and not specifically to save endangered large mammals from extinction. The success of the GFTN is largely driven by the associated economic incentives within export markets in the European Union and the United States that have the necessary and supporting policy frameworks. Similar to the challenges faced by RSPO, the concept and benefits of forest certification schemes promoting sustainable forest management needs to be socialized with domestic and regional export-market driven small-holders who have few incentives to comply. Wildlife conservation, though increasingly appearing in the strategies of the GFTN, needs to be streamlined into sustainability guidelines for selective logging with greater support from studies involving the impact of logging on RETs. In summary, incentives and schemes to promote sustainable forestry are to be supported, but they will have low impact on the conservation of RETs as long as State governments continue to allow conversion of lowland forests to plantations.

Sustainable financing mechanisms

In the lead up to the Conference of Parties for the 13th Conference of Parties (COP) of the United Nations Framework Convention of Climate Change, governments convened in Bali in December 2007 to discuss issues such Reduced Emissions from Deforestation and Degradation (REDD; Table 3), a novel frame-work which attempts to provide sustainable financing for the maintenance of tropical rainforests. While intense debates still surround the incorporation of a REDD framework in a treaty succeeding the Kyoto protocol, there is little doubt that this materializes, it could provide much security to RET habitats if included in future climate change agreements (e.g., Venter et al. 2009). Even if REDD emerges in a dilute though politically endorsed form (e.g., forest based carbon schemes financed by voluntary carbon markets rather than compliance markets), this will still be a strong boost for the conservation of RET habitats, especially those currently not enjoying a protected status such as selectively logged forests. It is now clear that such habitats, if retained long-term under a sustainable management regime, are vital for conservation of RETs. Unfortunately, logged forests have been perceived as having little current economic value, which is the main reason why their conversion to plantations of fast-growing crops (e.g., oil palm and rubber) is seen by many as a superior alternative to retention of logged forests. A recent study by Butler et al. (2009) calculated that the conversion of 1 ha of forest for palm oil production (yielding net present values of $3,835–$9,630 over a 30-year period) will be more profitable than preserving it for carbon credits ($614–$994). As such, there is a need to develop novel ways to generate income from retaining logged forests, such as the concept of 'biobanks'. In 2008, the Malua Wildlife Habitat Conservation Bank (Table 3) was set up in 2008 to raise funds for the protection and restoration of degraded habitats in Malua Forest Reserve in Sabah. Malua consists of 34,000 ha of heavily logged forests that support breeding populations of elephants and other threatened species such as Orangutans (*Pongo pygmaeus*). The Malua BioBank involves an agreement between the government and private sector, to which the State government has licensed conservation rights over Malua for a period of 50 years. So far, a private investor has committed up to US$10 million for the rehabilitation of Malua over the next six years. The Malua BioBank will sell Biodiversity Conservation Certificates, with each certificate representing 100-square meters of forest restoration and protection. By purchasing certificates, buyers such as palm oil companies can help support conservation of Malua. However, purchase does

not constitute an offset, so palm oil companies cannot absolve themselves of causing forest loss elsewhere. Revenues generated from the sale of the certificates will be used to recover costs incurred, including payment of 'conservation rent' to the State government, repayment and profit to the private investor, and establishment of a trust fund to sustain management of Malua over the remaining 44-year period of the license. Under this scheme, staffing for protection of Malua and its wildlife has already been increased over pre-2008 levels. Nevertheless, it is too early to evaluate the effectiveness of novel sustainable funding mechanisms such as the Malua BioBank. Efforts should also be simultaneously devoted towards refinement of other existing schemes (e.g., REDD and payment for ecosystem services) to provide economic incentives to retain undisturbed, logged and degraded natural forests for RET conservation.

Conclusion

Based on our review of the current conservation status of RETs and manifold threats facing them, Malaysia may not be on track to achieve certain 2010 CBD targets relevant to RETs (e.g., status of threatened species improved; no species of wild flora or fauna endangered by international trade). This is unsurprising as baselines are only just being determined and monitoring programmes for RETs are not in place to measure population trends against these baselines. Among the three species, the future of the Sumatran rhino is the most precarious and a carefully managed breeding programme (i.e., the Borneo Rhino Sanctuary) may be the only solution to catalyze a population recovery. Although there are several recent encouraging population estimates for Asian elephants and Malayan tigers, long-term studies now need to be started in order to assess and monitor the conservation status of both species the across priority landscapes and areas. In addition, RET habitats in Southern Thailand contiguous to Malaysia need to be assessed and secured to minimize genetic bottlenecks in the peninsula. Nonetheless, the emergence and refinement of the abovementioned conservation initiatives, policies and frameworks in Malaysia provide hope that we *might* secure the future of RETs in Malaysia. Only a concomitant increase in political will and improvements in civil attitudes to wildlife conservation will ensure that we *can*.

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