



WWF

REPORT

HoB

2012

The Environmental Status of the Heart of Borneo

SHORT REPORT



Overview

The Heart of Borneo Declaration, signed on 12 February 2007, committed the governments of Brunei Darussalam, Indonesia and Malaysia to the conservation of a network of protected areas, productive forests and other sustainable land uses within the 22 million hectare Heart of Borneo (HoB) landscape.

This report analyses the area's environmental health via 13 key targets and more than 50 indicators, which include endangered animal species, such as orang-utans, rhinos and elephants, and a range of ecosystems, such as heath, lowland and montane forest and river systems. Each key target has been rated for its current quality within the HoB.

The report, the first of its kind, was produced in consultation with a wide range of scientists and conservation specialists who have been working on Borneo ecology for many years.

HoB's overall rating

Overall, most forest types in the HoB are currently rated as good or very good. This is particularly important for lowland forest, which is under severe threat across the rest of the island of Borneo. Lowland forest accounts for only 10% of the HoB protected forest area, but this is significant, given how little remains in other parts of the island.

Lowland forest is prime habitat for pygmy elephant, orang-utan and rhino – some of the most endangered species in the world. The HoB may be the world's last stronghold for the preservation of these animals and this type of forest.

Despite this favourable rating, the HoB remains under serious threat from industrial conversion of natural forest to palm oil and other agricultural crops as well as illegal logging and/or unsustainable rates of legal timber extraction. Forest fire, mining and over-hunting of wildlife are also major threats which future versions of this report will serve to monitor over time.

Baseline data never before assembled

This report represents WWF's first attempt to scientifically gather baseline data to assess the environmental health of the HoB – a process which has had its fair share of problems both technically and scientifically. As a science-based organisation, WWF encourages flora and fauna specialists with an interest in the HoB to discuss and review the report's conclusions. WWF hopes this report will be the first in a series of HoB monitoring reports. It welcomes constructive comment to improve subsequent reports.

Foundations for a Green Economy

Tangible examples of green economic growth and sustainable development are actively pursued by the three HoB governments and the recognition of the HoB as a 'green economy in action' is gaining acceptance.

The three HoB governments now have a credible and easy tool to monitor progress in terms of improvements or degradation in key natural health measures. The natural capital of the HoB needs to form the foundation for green economic development in the future. It is a management tool that can be used to improve policy, financing and planning decision-making with the long-term goals of sustainable use and conservation of the Heart of Borneo.

WWF encourages the three governments of Borneo to use the report to raise awareness of the high conservation values of the HoB and the major threats to its continued survival as an area of global biodiversity significance. WWF also considers this an important tool for private sector companies that are operating or financing in the Heart of Borneo to measure and report their impacts and progress toward sustainability.

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The HoB Environmental Status Project

Introduction

Despite all the global attention, until now no comprehensive data has been presented about the current state of the natural systems in the Heart of Borneo (HoB). Until recently, no-one had asked questions about this globally important region such as:

- > How much tropical rainforest remains in the Heart of Borneo (HoB)? Is it viable for the long term?
- > What are the top three threats in the HoB? What is that estimation based on?
- > How much peat forest is currently in protected areas in the HoB? Is that enough?

This report attempts to provide the data to help answer these questions.

Measuring the vital signs

Beginning with a small group of experts on the natural history of Borneo, a set of 13 indicators was chosen to represent the dominant and critical ecosystems and species on the island.

Once a consensus was reached on the indicators, remote sensing and geographic information specialists set out to collect meaningful data for each one. If data for a particular indicator was considered insufficient or unrepresentative, it has been put on hold until better methods or data become available.

A unique set of criteria was developed so that each indicator could be rated Very Good, Good, Fair or Poor in a meaningful way. By combining the indicators, statements can be made about particular components of the HoB's natural systems or about the HoB as a whole.

We need to know more about several indicators; we hope practical methods and resources will emerge to capture that data. Overall, enough information has been collected to make some broad statements about the vital signs of the HoB. These metrics will improve in the next few years.

Threats to the HoB

Looking forward 10 years, the top threats are:

- > industrial conversion of natural forests
- > illegal logging
- > legal commercial but unsustainable rates of timber extraction
- > forest fire
- > mining
- > over-hunting and collecting.

Because of the relatively short future window (10 years) climate change was not classified as one of the top threats. But an increase in climatic variability may exacerbate some of the other threats. Only two of the prioritised direct threats are currently amenable to data collection using remotely sensed data: industrial conversion and forest fires. There are no annual analyses of industrial conversion. Forest fire data were compiled for a 14-year period – locations were marked but no real information of annual forest fire loss was quantified in terms of carbon losses.



Photo: Stephan Wulffraat



Conservation management

The primary conservation management indicator is the extent to which different natural ecosystems are covered by legally protected areas. Ten per cent of each natural ecosystem is a globally agreed minimum. For the Heart of Borneo, 20% (of the remaining ecosystem) is a more reasonable goal. Conservation science indicates that larger percentages are more likely to support biodiversity and buffer against changing climate.

Another important component for conservation management is the extent to which protected areas are effectively performing their role. A comprehensive survey of the management of the HoB's protected areas has yet to be carried out – but would be a very high priority.

The definition of what constitutes a protected area is contentious. In Sabah, for example, Dermakot and Ulu Segama Forest Reserves are not considered protected areas, although they are managed for sustainable wood production, and forest restoration programs are in place for damaged areas within these Reserves. Together, they harbour the largest orang-utan population in Malaysia (J. Payne, pers. comm.).

KEY ECOSYSTEM OR SPECIES
Lowland rainforest
Upland rainforest
Montane forest
Peat swamp forest
Limestone forest
Heath forest
River ecosystems
Bornean elephants and banteng
Sumatran rhinoceros
Bornean clouded leopards
Orang-utans
Bearded pigs
Endemic pitcher plants

Protected area coverage in the HoB's main ecosystems		
ECOSYSTEM	AREA PROTECTED	% PROTECTED
Lowland rainforest	3,355 km ²	9.6%
Upland rainforest	13,177 km ²	18%
Montane forest	9,959 km ²	29%
Heath forest	<300 km ²	<1%
Limestone forest	<200 km ²	<1%
Peat swamp forest	<1%	0%

Implications

The ecological systems are broadly doing well, with some exceptions. The pressure on the remaining HoB forests and associated species has never been greater. Though precise data is not often available, as forest areas continue to shrink and experience fragmentation, the pace of conversion and degradation can increase, and increasing climate variability combined with fire can be devastating.

The largest ranking threat to the integrity of the HoB is industrial conversion of natural forests. Conversion is mainly occurring to establish oil palm plantations and smaller areas for pulp wood plantations. The ecosystem mostly affected is the lowland rainforest. Most locations are at the edges of the HoB, as defined by WWF though some inland areas in West Kalimantan are also allocated.

Forest fires are also considered a major threat. These devastating events have occurred mainly at the edges of the HoB and the main ecosystems affected are heath forests, lowland rainforests and peat swamp forests.

Mining is a threat that has been somewhat underestimated so far, probably because of lack of data. The major type of mining in the HoB is for coal, which is always done by digging in open pit mining. Mining concession data is not officially available and to complicate analysis even more, there are many small concession holders, less inclined to environmental protection, that get sub-concessions from the larger companies. Mining often occurs at interior foot slopes of mountains of the HoB, particularly in Central Kalimantan.



Future developments

The good news is that the governments of the HoB have pledged to protect and restore its natural gifts for the benefit of local, national, and even global constituencies.

Their bold commitments, supported by non-governmental organisations, provide great promise that a balanced configuration of land use will eventually protect and maintain natural systems in the HoB and the ecosystem services that they provide.

The HoB Environmental Report will be used by the WWF network to monitor progress of the HoB Initiative in terms of improvements in key biological measures for the HoB.

With appropriate funding, future editions of this report will

include biological indicators in increasing number and diversity, leading to a broader and increasingly accurate representation of the flora and fauna of the HoB.

A number of current HoB projects, such as the expedition to discover and document wildlife in the Sungai Ingei Protection Forest in Brunei's portion of the Heart of Borneo, will provide added information to further improve the use and accuracy of this document.

This report also serves as a bell-wether on progress towards the delivery of WWF's conservation goals for the HoB. It is hoped that the three HoB governments will also find the report useful as they plan the conservation and sustainable development of the 22 million hectares of the interconnected, biodiversity-rich forest within the HoB.

KEY ECOSYSTEM OR SPECIES	INDICATOR	RAW DATA	RESULT	2008 RATING
Lowland rainforest	% of historical extent	58,897 km ²	63%	Good
Upland rainforest	% of historical extent	89,879 km ²	82%	Very Good
Montane forest	% of historical extent	38,511 km ²	89%	Very Good
Peat swamp forest	% of historical extent	6,572 km ²	72%	Good
Limestone forest	% of historical extent	386 km ²	79%	Good
Heath forest	% of historical extent	4,285 km ²	48%	Fair
River ecosystems	% natural cover in Kapuas watershed	39,230 km ²	47% overall	Fair
	% natural cover in Barito watershed	38,020 km ²	63% overall	Good
	% natural cover in Mahakam watershed	41,130 km ²	54% overall	Fair
	% natural cover in Kayan watershed	28,280 km ²	95% overall	Very Good
Bornean elephants	Total population	~1,000 individuals	~1,000 individuals	Fair
	% of historic distribution	22,000 km ²	~60%	Good
Sumatran rhinoceros	Total population	<50 individuals	<50 individuals	Poor [#]
Bornean clouded leopards	Suitable habitats for viable populations	165,170 km ²	76%	Good
Orang-utans	Average densities in peat swamp and lowland forests	0.61 and 0.48 individuals/km ²		Fair
Endemic pitcher plants	% of viable historic locations	21	80%	Good

Current rating for rhino – the rating of FAIR in the body text is aspirational.



Key HoB indicators

The results for the natural system indicators for which there was sufficient data are summarised in the table on page 5. When combined, these individual indicator ratings result in an overall rating of Good for the HoB. That is encouraging, though the picture is mixed and each indicator tells a story that is worth reading. It should be noted that the discussion of ecosystem viability is restricted to the HoB only – not the entire island of Borneo.

Lowland rainforest

The project produced an updated map of the extent of lowland rainforest ecosystems. The HoB boundaries were drawn to incorporate adjacent, contiguous lowland rainforest, so the 63% of remaining historic lowland rainforest (classified as Good) is a bit misleading. Island-wide, lowland rainforest is quickly becoming rare, due to logging and forest fires. Elephants and orang-utans live in lowland rainforest almost entirely below 150 m asl.

Upland rainforest

The picture looks brighter for upland rainforest ecosystems, the major HoB ecosystem. Most (82%) are still standing and in many cases in primary condition, giving a Very Good rating.

Montane forest

Nearly all Borneo's montane forest ecosystems are within the HoB, and the 89% of remaining historic montane forests are generally still in primary condition, resulting in a Very Good rating. These areas have a very high rate of local endemism (unique to a defined geographic location) for animal and plant species.

Peat swamp forest

Peat swamp ecosystems occur mainly in the wide coastal lowlands. Many of those areas have either been converted or are highly disturbed. Interior peat swamp areas within the HoB are generally in better condition, and 72% of historic peat swamp is still present, resulting in a viable rating of Good. However, we have to keep in mind that most of these forests have been logged.

Limestone forest

Limestone ecosystems are scattered throughout Borneo, but the only large areas are at the Sangkuliran peninsula in East Kalimantan and northern South Kalimantan. These are partly degraded while the smaller limestone areas in the interior are all in relatively healthy condition. Degradation of limestone ecosystems is usually irreversible. The extent of limestone forest is above the proposed viable threshold of 60% of historic extent and is rated as Good.

Heath forest

Originally, there were large stretches of heath forest, particularly in Indonesian Borneo. Few wide areas are left, and these are mainly in central and east Kalimantan. Even these are not in pristine condition, as several areas have been burned in the past 25 years. Due to the poor soils that heath forest develops on, their restoration is extremely difficult. Existing heath forest is 48% of historic levels compared with the proposed viable extent of about 60%, giving a Fair rating.



River ecosystems

There is little information about the in-stream biodiversity status of Borneo's rivers. The most practical indicator considers the percentage of forest cover in the watershed of each of the main rivers. Southern and western Borneo are generally converted, while conditions in the north are somewhat better. The overall HoB rating for this indicator is Fair. A more comprehensive picture of freshwater biodiversity must be seen as a priority.

Bornean elephants and bantengs

Due to their similar ecological roles and use of habitat, elephants and banteng were grouped into one conservation target – forest-edge herbivores – but little information is available about bantengs. Elephants, which are mostly in Sabah, have suffered as a result of habitat conversion. Population size, distribution and connectivity will be the major indicators to measure. The total population remains relatively stable, as elephant herds move from destroyed habitats into protected habitats. The proposed desired rating for population size is only Fair (seen as the best long-term scenario, requiring constant management).

Sumatran rhinoceros

The only locations where there is still an opportunity for Borneo rhinoceros to survive are in a few protected areas in Sabah, partly outside the HoB. The occasional records from other areas most likely refer only to single individuals and no viable populations. WWF in Sabah keeps records of all rhino sightings and is compiling updated documentation. The proposed desired future rating for rhinoceros is only Fair (the best long-term scenario, requiring constant management).

Bornean clouded leopards

The clouded leopard is one of the top predators and the largest cat species of the island. It is likely to play a major role in regulating healthy populations of monkeys, ungulates and smaller mammals. A viable population of at least 50 individuals needs an estimated 400 km² of uninterrupted forest blocks. The rating for viable populations is a good indicator of connectivity of large connecting blocks of forests. There is currently minimal data on the clouded leopard in Borneo, but based on available habitat, it is possible the conservative rating for the population is Fair to Good.

Orang-utans

Most orang-utan populations of Borneo live outside the HoB boundaries. However the HoB also harbours a number of large populations, mainly in its lowland and peat swamp forests in West and Central Kalimantan and in Sabah. The populations in the HoB are relatively stable, because most are in protected areas. However, many populations in the other parts of Borneo are under severe pressure. The densities in lowland as well as in peat swamp forests of the HoB are rated Fair. The long-term scenario is to improve the rating for peat swamp forests to Good through the many conservation efforts in the Danau Sentarum and corridor to Betung Kerihun area. Good chances of orang-utan conservation success can also be achieved in remote hilly lowland areas where orang-utans can now be reintroduced.

Endemic pitcher plants

Endangered plant species are represented by the rare endemic pitcher plants (Nepenthaceae), for which distribution records exist for most species. These pitcher plants serve as a good indicator species as they grow mainly in fragile habitats. Several species are restricted to mountain summits in Sabah, which are all State parks. A number of species occur only in locations without any legal protection status. The relatively high level of attention to these rare species provides some form of protection. The estimated rating is Good.

Recommendations for project follow-up

Biological Indicators

Some of the biological indicators could not be finished due to lack of field data and time constraints. In several cases, it was still possible to develop workable information by extrapolation of existing data and knowledge.

The top table on the next page shows what indicators need to be completed so that the status information for the HoB is as representative as possible:

Several suggestions for additional biological indicators were raised during meetings and discussions with colleagues, including:

1. Sun bear – another top level carnivore, easier to observe and study than clouded leopard, good field data already available. It is also a large carnivore but with a completely different feeding ecology. Sun bears can survive in large secondary forests and slightly disturbed areas. Hunting pressure is higher than on clouded leopard because there is a market for gall bladders and bears are easier to encounter. However data collection requires significant efforts.
2. The Proboscis monkey (and possibly the False Gavia) might be a good indicator for conditions of peat swamp, mangrove and wide riparian forests, but these ecosystems have very restricted ranges inside the HoB boundaries.
3. Endangered fish species such as Arawana get a lot of attention but this is more about over-harvesting.
4. Other endangered plant species: So far we have concentrated on endemic Nepenthaceae, but other families, including Fagaceae, Dipterocarpaceae, and other plant groups such as certain Orchid taxa should be evaluated. A selection should be made on which species are vulnerable to what threat.
5. Hornbills: Certain species of hornbill, notably the helmeted hornbill, are good indicators of forest conditions. Information on these hornbills can be obtained through interviews of local communities, but only on a local scale.
6. The straw-headed bulbul is severely affected by (illegal) trade and has become locally extinct in several areas.

7. Gibbons might be good indicators for forest conditions as they are mainly found in tall primary and old secondary forests. However information on gibbons can only be obtained at a local scale.
8. Pangolins: It would be very useful to include a species that can be used as an indicator for specific hunting, for example pangolins, which have been hunted to near extinction for the medicine trade (E. Meijaard, pers. comm.).

Threat indicators

Threat indicators are very important, but our data on these issues is still limited. Further efforts (through counterparts) are needed to obtain data from Malaysia (including Sabah but particularly Sarawak) and Brunei. During the threat analysis, mining turned out to be a more pressing issue than originally assumed, and mining concessions data should become available at least from Indonesia. Some forest conversion indicators can be obtained by further analysis of remote sensing data. Very localised threats such as over-hunting and illegal logging can only be evaluated with comprehensive data sets from the field.

Conservation management indicators

Several conservation management initiatives for the HoB have only started recently. The indicators will be important to measure impacts of conservation work and will be investigated as soon as further developments are made.

'Cross cutting' issues

Protocols for the frequency of collection for each indicator need to be worked out. For some data this would be annually, while for other data every 2-5 years might suffice.

It is our aim to hire local monitoring officers, at least one for each Kalimantan province, but particularly for Malaysia, where data collection has been challenging.

In addition to the questions about specific indicators noted above, the monitoring working group will be continuing to add additional documentation on where the data was collected. Methods will be developed to integrate biological and socio-economic indicators.

Status of difficult biological indicators in the HoB

TARGET	INDICATOR	COMMENTS
Heath forest ecosystems	% historical remaining	Small areas of heath forests have never been mapped. Occurrence of heath forest is strongly related to specific geo-morphological and soil characteristics which have been mapped to a more detailed level. This can to a certain extent be used to map smaller areas of heath forest.
Limestone forest ecosystems	% historical remaining	Small areas not currently mapped using 250 m resolution remote sensing imagery. This information is particularly important for unique ecosystems that are often not large in extent. These areas can be mapped by analyzing the REPPROT Land System maps. Information on collection of edible bird nests from caves will also be helpful because these caves are usually found in limestone areas.
River ecosystems	Fish species diversity	Fish survey reports exist for several major rivers of Borneo but more time is needed to compile these and to prepare a data format that can be used as an indicator.
Bornean orang-utan	1. Densities in peat swamp 2. Densities in lowland rainforest	More data will become available with ongoing orang-utan research throughout Borneo, such as the OSCP interview based orang-utan survey.
Sumatran rhinoceros	1. Population size	Species on verge of extinction: in Sabah only; wild rhinos are no longer adequate to sustain the species.
Banteng	1. Presence in known sites	We have the most important banteng locations for Borneo. However, extrapolation of habitat information (as for the clouded leopard) will not work well with this species. Relatively open areas of abandoned cultivation might be an indicator.
Bearded pigs	1. Presence of large numbers at representative sites 2. Group size at representative sites 3. Fat condition at representative sites	Information from research projects could give us better insights to predict large numbers of pigs in Borneo, and in certain areas even predict mass movements. Large numbers might only be recognised in mast fruiting years. Over-hunting and fat condition are very localised issues.
Endangered plant species	% of viable historic locations	This will also be done for other endangered plant species on the IUCN Red List; unfortunately distribution data is often very limited.

Status of difficult threat indicators in the HoB

THREAT	INDICATOR	COMMENTS
Industrial conversion of natural forests	Areas (km ²) planned for clearing Areas (km ²) planned for logging	This information should officially be included in the provincial land use planning but is in reality not easily available.
Illegal logging	Areas (km ²) affected by illegal logging	Only few official records are made available. Police records should be monitored.
Legal commercial but unsustainable rates of timber extraction	% of crown cover in production forests	This data can only come from concession holders, who are naturally not willing to provide this.
Mining	Existing extent and projected extent	The Ministry of Mining has not yet published an official mining concessions map. Mining data should be complemented with information from districts.
Conversion of forest through small-scale agriculture	Areas and locations of annual conversion	Forest cover time series with higher resolutions are needed, combined with spatial information on settlements and agriculture.
Direct impacts of road Construction	Areas of forest conversion along new roads	Satellite images with higher resolution (than the current 250 m) are needed.
Expansion of hydropower dams	% of major rivers obstructed	Satellite images with higher resolution (than the current 250 m) are needed.
Recent extreme droughts	Areas affected by extreme droughts; length of periods in between droughts	No protocol developed yet to measure this.
Unsustainable firewood extraction	Areas of forest destruction caused by over-harvest	Forest cover time series with higher resolutions are needed, combined with spatial information on settlements.
Over-hunting and collecting	Areas with animal populations strongly declining Areas (km ²) effected by over-hunting	This information can only be collected through long-term biological research, something which has been done in only a few places in Borneo, and these were mainly protected areas. Perceptions of population trends from local communities will be useful.

Status of difficult conservation management indicators in the HoB

CONSERVATION MANAGEMENT	INDICATOR	COMMENTS
Proposed protected areas	km ² of proposed protected areas by habitat	HoB initiatives for proposing corridors with sustainable land use and protected status are still in an early stage and cannot yet be measured.
Protected area effectiveness	RAPPAM (Ervin 2003) score	Indications of effectiveness through scoring designated by officers working in protected areas is currently being compiled
Regeneration in protected areas	Regeneration Post HoB	Areas with significant re-growth of natural vegetation. This requires more detailed images and ground-truthing.

The Heart of Borneo Indicators

Biological Indicators

TARGET	KEA	INDICATOR	JUSTIFICATION FOR INDICATOR	LONG-TERM VIABILITY GOAL
Bornean clouded leopard	Distribution & densities	km ² of suitable habitats	Top predator, viable suitable habitats also for prey species	Good (>400 km ² forest blocks)
Orang-utan	Presence in peat swamp forests	Densities	Critically endangered species, threatened habitats	Good (1.0-1.5 per km ²)
	Presence in lowland rainforests	Densities		Fair (0.5-1.0 per km ²)
Endangered plant species	Distribution of endemic Nepenthaceae	Historical locations that are still viable	Representing fragile ecotones	Good (70 % historical locations)
Forest edge herbivores	Bornean elephant	Total population size	Endangered sub-species; directly affected by land use pressure	Fair (60% of original population, stable)
		Total population distribution		Fair (60% of original distribution, stable)
		Population connectivity		Good (>60 % of main populations connected)
		Extent suitable habitats		Good (all remaining habitats without conflict. land use retained)
	Banteng	Presence & numbers in known sites	Limited knowledge of bantengs in Borneo	
Bearded pigs	Population size	Presence/densities @ rep. sites	Monitoring this major food source is important as fewer other species are hunted as long as there are enough pigs.	Good (large numbers frequently passing through)
			Group size and condition	Good (25-50 individuals)
Rhinoceros	Population size	Number	Critically endangered, needs permanent monitoring	Fair (50-200 individuals)
Heath forest ecosystems	Extent	% of historical	Endangered ecosystem	Good (>60% of original extent)
Peat swamp ecosystems	Extent	% of historical	Ecosystem under pressure	Good (>50 % of historical extent)
	Condition	km ² undegraded - % canopy cover		Fair (<60% canopy cover)
Limestone ecosystems	Extent	% of historical	Endangered ecosystem; one of the main ecosystems of Borneo	Good (>60 % of historical extent)
Lowland rainforest ecosystems	Extent	% of historical	Most of this ecosystem has been converted or degraded	Good (35-50 % of orig. extent)
	Extent and condition	km ² undegraded		Good (20-30 % undegraded)
	Size-landscape context	Connectivity between fragments	Many fragments remaining but often not connected	Good (>50% of fragments connected)
	Species composition	Tree diversity Dipt. & Fag.	Good general indicators for tree species richness	Fair (5-15 endemic Dipt./Fag. spp. per 100 ha)
Upland rainforest ecosystems	Extent	% of historical	Ecosystem under pressure, much degraded	Good (60-80 % of historical extent)
	Extent	km ² undegraded		Good (40-60 % undegraded)
	Species composition	Tree diversity Dipt. & Fag.	Good general indicators for tree species richness	Good (15-30 endemic Dipt./Fag. spp. per 100 ha)
Montane forest ecosystems	Extent	% of historical	Fragile ecosystem	Very good (>80% of historical range)
River ecosystems	Water quality	% intact watersheds	Ecosystem under pressure	Fair (50-70% intact montane, 40-60% upland, 20-40% lowland)
	Connectivity	riparian cover 100 m buffer		Very good (>70 % riparian cover)
	Species composition	Fish species diversity		Good (>30 species per 10 km river stretch)

The Heart of Borneo Indicators

Threat indicators

TARGET	KEA	INDICATOR	NOV 2007 THREAT RATING
Industrial conversion of natural forests	Extent Extent & condition	Annual conversion Annual plans for conversion Forests within plantations	Very high threat
Forest fire	Incidence Incidence Incidence Incidence Incidence Incidence	Annual number and extent of fires Fires in logging concessions Fires by year Fires in heath forest ecosystems Fires in peat swamp forest ecosystems Fires in lowland rainforest ecosystems Fires in limestone ecosystems	Very high threat
Mining	Extent Extent	Existing extent Projected extent	High threat
Illegal logging	Incidence	loss of forest or crown cover in protected areas	High threat
Commercial unsustainable rates of wood (legal) extraction		% of crown cover in production forests	High threat
Over hunting and collecting	Extent	Areas with animal populations strongly declining	High threat
Poor legal commercial harvesting practices		Data from Commercial Concessions	High threat
Conversion of forest through small-scale agriculture	Extent	Areas and locations of annual conversion	Medium threat
Direct impacts of road construction	Extent	Areas of forest conversion along new roads	Medium threat
Expansion of hydropower dams	Extent	% of major rivers obstructed	Low threat
Recent extreme droughts	Extent Time	Areas effected by extreme droughts Length of period in between droughts	Medium threat
Unsustainable firewood extraction	Extent	Areas of forest destruction caused by over-harvest	Low threat

Conservation management indicators

TARGET	INDICATOR
Protected area representation	% of peat swamp forest in protected areas
	% of lowland rainforest in protected areas
	% of upland rainforest in protected areas
	% of montane forest in protected areas
	% of heath forest in protected areas
	% of orang-utans in protected areas
Protected area intactness	% of intact natural habitats in protected areas
% of remaining forest in concessions	% of production forest that remains forest
Enforcement of existing legislation	Peat Conversion
Proposed protected areas	km ² of proposed protected areas by habitat
Protected area effectiveness	RAPPAM score
Regeneration in protected areas	Regeneration Post HoB
Regeneration in protected areas	Regeneration Post HoB

The Heart of Borneo Indicators

Final Selected Indicators and Indicator Ratings

Target	Key Ecological Attribute	Indicator	Indicator Ratings (Bold = Current, Italics = Desired)			
			Poor	Fair	Good	Very good
Lowland forest ecosystems	Extent	% of historical extent (historical baseline = 58,900 km ²)	<15%	15-35%	36-50%	>50%
	Condition	% of historical extent un-degraded	<10%	10-20%	21-30%	>30%
	Connectivity	Connectivity between fragments (% of fragments connected – currently about 40% of the lowland fragments are connected to each other and about 70% are connected through upland forests)	<20%	20-40%	41-60%	>60%
Upland forest ecosystems	Extent	% of historical extent (historical baseline = 89,900 km ²)	<40%	40-60%	61-80%	>80%
	Condition	% of historical extent un-degraded	<20%	20-40%	40-60%	>60%
Montane forest ecosystems	Extent	% of historical extent (historical baseline = 38,500 km ²)	<40%	40-60%	61-80%	>80%
Peat swamp ecosystems	Extent	% of historical extent (historical baseline = 38,500 km ²)	<25%	25-50%	51-75%	>75%
	Canopy cover	% of historical extent un-degraded (%)	<40%	40-60%	61-80%	>80%
Limestone ecosystems	Extent	% of historical extent (historical baseline = 400 km ²)	<40%	40-60%	61-80%	>80%
Heath forest ecosystems	Extent	% of historical extent (historical baseline = 4,900 km ²)	<40%	40-60%	61-80%	>80%
River ecosystems	Habitat condition	% 'intact' watersheds (intact to be determined)				
	Connectivity	% of length of river with intact 100 m riparian forest buffer on both sides	<30%	30-50%	51-70%	>70%
Bornean elephant	Population size	% of historical population size (about 2,000 individuals in 1980, before large-scale conversion began) (Ambu et al, 2003)	<60%	60-80%	81-99%	>100% or more
	Population distribution	% of historical distribution (about 27,000 km ² in 1920, before large-scale conversion began) ((Ambu et al, 2003)	<40%	40-60%	61-80%	>80%
	Connectivity	% of subpopulations that are interconnected. The subpopulations are mapped by WWF Sabah	none	<60%	>60%	all
	Amount of suitable habitat	% of historical habitat that is suitable	only concentrations	all remaining habitats	all remaining suitable	all original habitats restored
Rhinoceros	Population size	Total number of individuals (data from J. Payne)	<50	50-200	201-500	>500
Bornean clouded leopard	Amount of suitable habitat	km ² of suitable habitat for viable populations (>50 individuals)	<50,000	50-150,000	150-250,000	>250,000
Orangutans	Population density	Average density in all remaining (2007) peat swamp forests	<0.5	0.5-1.0	1.0-1.5	>1.5
		Average density in all remaining (2007) lowland forest	<0.5	0.5-1.0	1.0-1.5	>1.5
Endemic Nepenthaeae Pitcher Plants	Extant distribution	% of historical locations still viable	<50%	50-70%	71-90%	>90%
Banteng	Population distribution	% of historical locations occupied	<50%	50-80%	81-99%	100% or more
Bearded pig	Periodic large concentrations	Presence of large numbers (>50 individuals) at representative sites	no large numbers present	Present occasionally	Present frequently	Large numbers are resident

Sources:

Ambu, L.N., Andua, P.M., Nathan, S., Tuuga, A., Jensen, S.M., Cox, R., Alfred, R. & Payne, J. (2003) Asian elephant action plan Sabah (Malaysia), Wildlife Department, Sabah.

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Note: This table provides the full viability criteria for each indicator, whether or not data is yet available.