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Key Biodiversity Area Special Series

Key Biodiversity Areas in the Indo-Burma Hotspot: Process, Progress and Future Directions

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Abstract: Key Biodiversity Areas (KBAs) provide geographic targets for the expansion of protected area coverage, and identify sites for urgent conservation action. Identification of KBAs in the Indo-Burma Hotspot was undertaken during 2003, for a region of analysis comprising Cambodia, Lao PDR, Myanmar (Burma), Thailand and Vietnam, plus parts of southern China. The starting point was information on 282 Important Bird Areas identified by BirdLife International and collaborators. These data were then overlaid with point locality data on globally threatened mammals, reptiles, amphibians, freshwater fish and plants, with additional KBAs identified as required. Through this process, a total of 438 KBAs were identified, covering 258,085km^2 or 11.5 percent of the region of analysis. Only 58 percent of the KBAs are wholly or partly included within protected areas, suggesting that there may be a need for further expansion of protected area networks, particularly in Myanmar and Vietnam. The criteria for KBA identification are triggered by 812 species, of which 23 are believed only to occur at a single KBA globally. The KBAs have proven to be a useful conservation priority setting tool in Indo-Burma, helping to guide investments by various donors and application of environmental safeguard policies by international financial institutions. There are fewer examples of KBAs being used to guide expansion of protected area systems in Indo-Burma. In large part, this is because the period of rapid expansion of protected areas in most hotspot countries predated the KBA identification process, and political support for further significant expansion is currently limited.

Keywords: Hotspot, Indo-Burma, Key Biodiversity Area, priority setting, protected area.

INTRODUCTION

The Indo-Burma Biodiversity Hotspot is centered on the Indochinese Peninsula, and comprises Cambodia, Lao PDR, Myanmar (Burma), Thailand and Vietnam, plus parts of southern China and northeastern India. The topography of the hotspot is complex, and is characterized by a series of north-south mountain ranges, which descend from the Himalayan chain and its south eastern extensions. These mountain ranges are drained

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by several major rivers, including the Ayeyarwaddy, Salween, Chao Phraya, Mekong and Red, whose floodplains and deltas are the main centers of human settlement.

The biota of Indo-Burma is a mixture of the floras and faunas of India, the Himalaya, southern China and the Sundaic Region, with a significant endemic component, particularly in the case of plants. Centers of endemism include montane isolates (such as Myanmar's Mount Victoria and Vietnam's Da Lat Plateau), limestone karst areas (such as those in northern Vietnam and China's Guangxi Zhuang Autonomous Region), and lowland evergreen forests (most notably the Annamese lowlands of Vietnam and Lao PDR, which are home to flagship species such as Saola *Pseudoryx nghetinhensis*).

A conservative estimate of total plant diversity in the hotspot reveals about 13,500 vascular plant species, of which about 7,000 (52 percent) are endemic (van Dijk et al. 2004). Of the 1,277 bird species found in Indo-Burma, 74 are endemic (van Dijk et al. 2004). Similarly, 71 of the 430 mammal species in the hotspot are endemic (van Dijk et al. 2004). Other vertebrate groups show much higher levels of endemism, with 189 of the 519 non-marine reptile species and 139 of the 323 amphibian species being endemic to the hotspot (van Dijk et al. 2004). Among these species, Indo-Burma supports probably the highest diversity of freshwater turtles in the world (van Dijk et al. 2004). The hotspot also has a remarkable freshwater fish fauna, with 1,262 documented species, accounting for about 10 percent of the world total, including 566 endemics (van Dijk et al. 2004). Available information on non-vascular plants, invertebrates and fungi is generally inadequate for conservation evaluation of species or sites.

With over 315 million people, Indo-Burma has the largest human population of the world's 34 hotspots (Mittermeier et al. 2004). This is reflected in the fact that remaining natural habitat is restricted to only five percent of its original extent (Mittermeier et al. 2004). The large and rapidly expanding human population, coupled with some of the fastest rates of economic growth in the world, is placing increasing pressures on remaining natural ecosystems. Expansion of agriculture (such as rice, rubber and oil palm), infrastructure development (especially roads and hydropower dams), timber extraction and a rapacious illegal trade in wildlife are the major current threats to the hotspot's biodiversity, with impacts of climate change and energy shortfalls set to exacerbate these dramatically in coming decades.

As of 2004, the total area under protection was 236,000km², representing roughly 10 percent of the original extent of terrestrial ecosystems in the hotspot, although out of this only 132,000km² (a little under six percent) was in IUCN protected area categories I to IV (Mittermeier et al. 2004). Moreover, not all ecosystem types are adequately represented within the protected area systems of the hotspot, with lowland evergreen forests, lowland rivers and intertidal habitats being notably under-represented (van Dijk et al. 2004). Key Biodiversity Areas (KBAs) provide geographic targets for the expansion of protected area coverage, and identify sites for urgent conservation quickly, simply, and cheaply (Langhammer et al. 2007). The synthesis paper and Langhammer et al. (2007) <http://data.iucn.org/dbtw-wpd/edocs/PAG-015.pdf> provide an overview of the KBA criteria and terminology. This paper describes how KBAs have been identified in the Indo-Burma Hotspot, and briefly discusses opportunities for further improvement of the analysis and application to conservation planning and priority setting.

METHODS

The identification of KBAs in the Indo-Burma Hotspot was undertaken during 2003 as part of the process to develop an investment strategy ('Ecosystem Profile') for the Critical Ecosystem Partnership Fund (CEPF). The region of analysis (Image 1) included only part of the original Indo-Burma Hotspot, which, as defined by Mittermeier et al. (1999), included areas that were later split off to form the Himalaya Hotspot (Mittermeier et al. 2004). Specifically, the region of analysis excluded parts of the original Indo-Burma Hotspot within northeastern India and eastern Bangladesh, as well as the small part of peninsular Malaysia that falls within the hotspot. The Andaman Islands, which are politically part of India, were also excluded from the analysis.

The KBA identification process was led by BirdLife International *in Indochina,* with technical support from the Center for Applied Biodiversity Science at

Image 1. Region of analysis within the Indo-Burma Hotspot, comprising Cambodia, Lao PDR, Myanmar, Thailand, Vietnam and parts of southern China.

Conservation International. The starting point was the network of Important Bird Areas (IBAs) in the region, defined by BirdLife International and its partners. For Cambodia, Lao PDR, Thailand and Vietnam, published or draft IBA directories were available (Tordoff 2002; Ounekham & Inthapatha 2003; Seng et al. 2003; Pimathai et al. 2004). For southern China, draft IBA accounts prepared for the IBA directory of China were used, some of which were not, ultimately, included in the directory (Chan et al. 2009); the rapid biodiversity assessments of Kadoorie Farm and Botanic Garden (2001–2004) were also a major information source. For Myanmar, a preliminary list of IBAs was prepared as part of the KBA analysis (Chan et al. 2004).

KBA designation is triggered by the presence of species meeting certain criteria. For birds, the vulnerability criterion (regular occurrence of a globally threatened species) was applied, as well as three of the irreplaceability criteria: (a) restricted-range species; (c) globally significant congregations; and (e) bioregionally restricted assemblages. For the most part, the application of these criteria was consistent with the guidelines set out in Langhammer et al. (2007). The main departure from these guidelines was that a small number of KBAs were defined on the basis of either the regular occurrence of congregations of at least 20,000 waterbirds or migratory bottlenecks for at least 20,000 raptors and/or cranes (a criterion used in identifying IBAs), whereas the only threshold for globally significant congregations given in the guidelines was the regular occurrence of one percent of the global population of a species. One implication of this was that five KBAs defined solely on this criterion had no KBA trigger species, because although they regularly support at least 20,000 waterbirds, raptors and/or cranes, they do not necessarily support one

percent of the global population of any particular species.

Based on the IBA data, a starting list of 282 KBAs was prepared. The IBA data were then overlaid with point locality data for other taxonomic groups, specifically mammals, reptiles, amphibians, freshwater fish and plants, with additional KBAs identified as required. Due to lack of data on global range and population sizes for most species in these other groups, the only KBA criterion applied was the vulnerability criterion. The principal data source on the global conservation status of species was the 2002 IUCN Red List of Threatened Species, which represented the best available data at the time. In Myanmar, where the KBA identification process continued into 2004, updates contained within the 2004 IUCN Red List of Threatened Species were taken into account. For amphibians, preliminary results of the Global Amphibian Assessment (IUCN-SSC & CI-CABS 2003) were used in lieu of the IUCN Red List, which was only updated with the final results of this comprehensive amphibian assessment in 2004. An implication of this is that several amphibians used as KBA trigger species based upon the assessments in IUCN-SSC & CI-CABS (2003) were later assessed by IUCN (2004) as not globally threatened.

The analysis of other taxonomic groups was initially conducted through review of published and unpublished literature. The preliminary results were then peer reviewed and improved at a series of expert roundtables, held in Phnom Penh, Cambodia; Vientiane, Lao PDR; Yangon, Myanmar; Bangkok, Thailand; and Hanoi, Vietnam. No expert roundtable was held in southern China due to the outbreak of the SARS virus; instead, stakeholders were consulted individually. The expert roundtables were attended by more than 150 representatives of national and international conservation organizations, academic institutions, donor agencies, and government institutions in the region, and the results were published as the Ecosystem Profile for the Indochina Region of the Indo-Burma Hotspot (Tordoff et al. 2007) and as a separate, stand-alone document for Myanmar (Tordoff et al. 2005).

The starting point for KBA boundary delineation was the IBA boundaries. In most cases, when the IBAs were overlaid with point locality data for other taxonomic groups, these could be adopted as KBA boundaries without any adjustment. In a few cases, the IBA clearly did not contain sufficient area of suitable habitat to support species from other taxonomic groups (mainly large, wide-ranging mammals, such as Tiger *Panthera tigris* and Asian Elephant *Elephas maximus*). In these cases, the KBA boundary was enlarged, where feasible, by incorporating contiguous areas of suitable habitat outside of the IBA.

For KBAs defined for non-bird globally threatened species, two approaches were adopted. Where locality data overlapped with existing protected areas, KBA boundaries were based upon these areas. In cases where existing protected areas were considered to form biologically sensible units, containing sufficient suitable habitat to support the KBA trigger species, each protected area was delineated as a separate KBA. If two or more contiguous protected areas were not considered individually large enough to form biologically sensible units, they were delineated as a single KBA. Eighty nine KBAs were delineated based on existing protected areas. The remaining 67 KBAs were identified outside both IBAs and existing protected areas. To delineate their boundaries, point locality data were overlaid onto land cover data and hydrological data, and biologically sensible units were delineated based on a consideration of the ecological requirements of the KBA trigger species. In most cases, it was relatively straightforward to reconcile the ecological requirements of different species because the KBAs identified outside both IBAs and existing protected areas were defined for relatively few species each (see Langhammer et al. 2007, Box 14).

RESULTS

A total of 438 KBAs were identified in the Indo-Burma Hotspot through the process outlined above (Table 1, Image 2). Of these, 244 sites (equivalent to 55 percent of the total) were defined for globally threatened mammals, 284 (65 percent) were defined for globally threatened, restricted-range, congregatory or biome-restricted birds, 110 (25 percent) were defined for globally threatened reptiles, 42 (10 percent) were defined for globally threatened amphibians, 16 (4 percent) were defined for globally threatened freshwater fish, and 177 (40 percent) were defined for globally threatened plants (Table 3).

Only 58 percent of the KBAs identified to date in

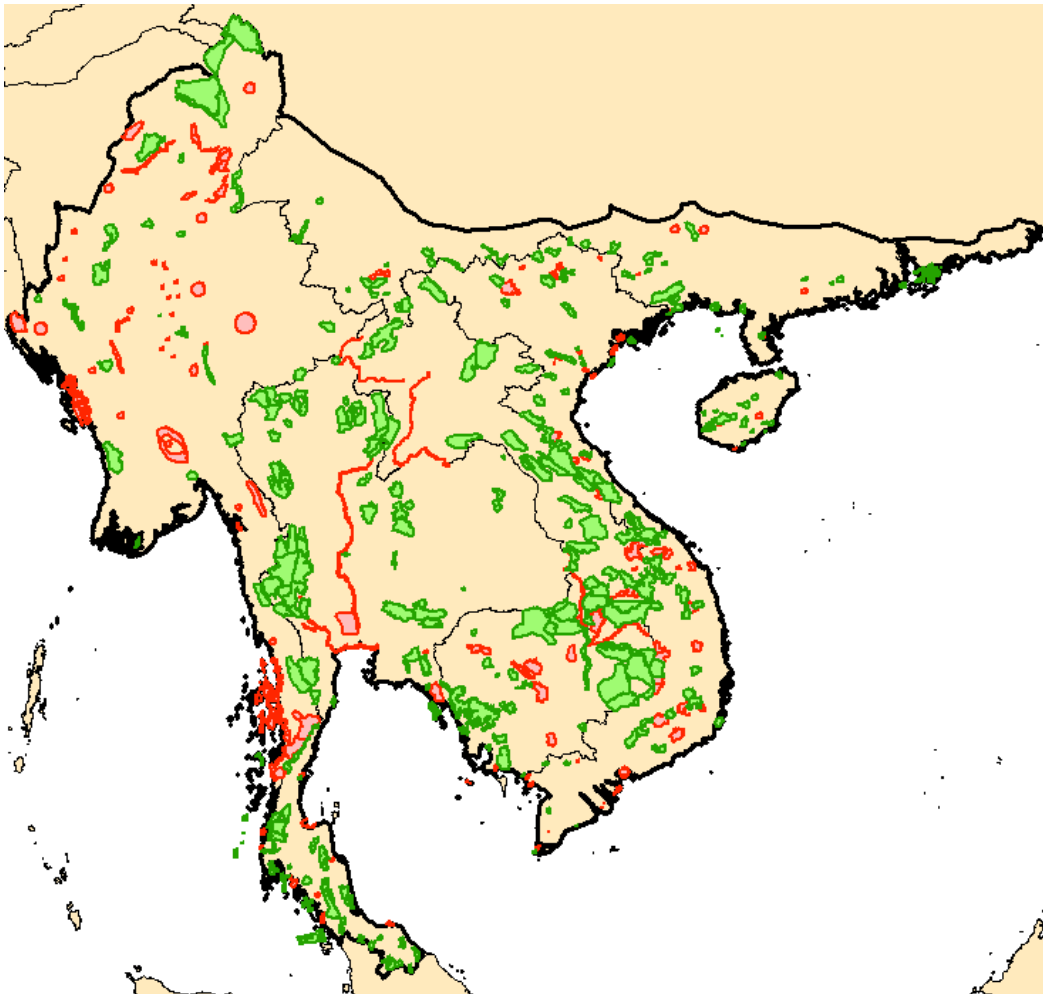

Image 2. Key Biodiversity Areas in the Indo-Burma Hotspot. The outline of the hotspot is shown in black, with protected KBAs in green and unprotected KBAs in red.

Table 1. Area, number and coverage of KBAs in each country included within the analysis for the Indo-Burma Hotspot

Jurisdiction	Area (km²)*	Area of KBAs (km²)	% country in KBAs	# KBAs	# KBAs protected	% KBAs protected
Cambodia	176,520	42,046	23.8	40	22	55.0
Lao PDR	230,800	47,698	20.7	38	22	57.9
Myanmar	653,520	43,017	6.6	76	24	31.6
S. China	355,485	15,392	4.3	69	54	78.3
Thailand	510,890	76,741	15.0	113	95	84.1
Vietnam	310,070	33,191	10.7	102	36	35.3
Total	**2,237,285**	**258,085**	**11.5**	**438**	**253**	**57.8**

Note: * = country land areas based on The World Bank (2011)

the Indo-Burma Hotspot are wholly or partly included within protected areas (Table 1). The figures for each country may not be strictly comparable, due to the varying concentration of survey effort in protected areas; in southern China, for example, little information was available from unprotected forest sites, and the figures may thus overestimate protected area inclusion overall. In any case, the low total indicates that there may be a need for further expansion of protected area systems, particularly in Myanmar and Vietnam, where

Table 2. Number of species in each higher taxonomic group triggering each of the KBA criteria/subcriteria

Higher taxon	Vulnerability			Irreplaceability			Total*
	CR	EN	VU	Restricted-range	Congregations/ aggregations	Biome-restricted	
Birds	6	16	47	44	73	350	488
Mammals	6	18	31	Not defined	Not defined	Not defined	55
Reptiles	7	14	9	Not defined	Not defined	Not defined	30
Amphibians	1	8	34	Not defined	Not defined	Not defined	43
Fishes	2	8	3	Not defined	Not defined	Not defined	13
Plants	43	46	94	Not defined	Not defined	Not defined	183
Total	**65**	**110**	**218**	**44**	**73**	**350**	**812**

Note: * = species falling into more than one category are counted only once.

Table 3. Number of KBAs triggered by each of the criteria/subcriteria for each higher taxonomic group

Higher taxon	Vulnerability			Irreplaceability			Total
	CR	EN	VU	Restricted-range	Congregations/ aggregations	Biome-restricted	
Birds	41	86	220	95	100	139	284
Mammals	21	224	204	Not defined	Not defined	Not defined	244
Reptiles	34	78	59	Not defined	Not defined	Not defined	110
Amphibians	1	16	52	Not defined	Not defined	Not defined	42
Fishes	5	12	3	Not defined	Not defined	Not defined	16
Plants	97	121	150	Not defined	Not defined	Not defined	177

over 60 percent of the KBAs lack formal protection. It also suggests that there may be opportunities in all countries for alternative approaches to site-based conservation, such as community-based conservation and partnership with private landholders.

Three-quarters of KBAs were triggered by 20 or fewer species, with half being triggered by seven or less. Eighty three KBAs were triggered only by a single species (Table 4). At the other end of the spectrum, nine KBAs were triggered by over 100 species, with the highest number occurring at Thailand's Hala Bala (153 species) and Vietnam's Fan Si Pan (140 species), owing to the very high numbers of biome-restricted bird species at these sites. In the Indo-Burma Hotspot, where KBA identification built upon the network of IBAs previously identified by BirdLife International and partners, the bioregionally restricted assemblages criterion was applied on the basis of the occurrence of bird species restricted to a major regional ecological community or 'biome'. Specifically, this criterion was triggered if a site supported over 25% of the species restricted to a specific biome within a particular country, or supported individual species found at two or less other sites in that country.

A total of 812 species triggered KBA criteria for at least one site, comprising 488 globally threatened, restricted-range, congregatory and biome-restricted bird species (60 percent), and 324 globally threatened species from other taxonomic groups (40 percent; Table 2). A few trigger species have been recorded at many KBAs, with the most widespread being the threatened mammal, Southern Serow *Capricornis sumatraensis*, recorded at 96 KBAs. However, three-quarters of trigger species have been recorded at 10 or fewer KBAs, with 142 species only recorded at a single KBA in the hotspot (Table 4). The majority of these species were congregatory birds or globally threatened plants at the edge of their global ranges. However, 23 trigger species are believed to only occur at a single KBA globally (Table 5). These 23 species trigger 19 KBAs, five of which are recognized as Alliance for Zero Extinction (AZE) sites (AZE 2010). The discrepancy between the two figures can be explained by the fact that AZE sites, at least in the 2010 update, have not been defined for single populations of Vulnerable species (but only Critically Endangered and Endangered species), and have only been defined for certain taxonomic groups (specifically not vascular

Table 4. Frequency distributions of the number of trigger species per KBA, and the number of KBAs per trigger species

n	# KBAs holding *n* trigger species	# trigger species occurring in *n* KBAs
0*	5	0
1	83	142
2	40	88
3	29	81
4	28	66
5	19	58
6	12	43
7	23	38
8	15	24
9	12	30
10	9	28
11–20	49	97
21–30	29	57
31–40	17	19
41–50	12	20
51–60	16	7
61–70	14	6
71–80	7	2
81–90	3	5
91–100	7	1
>100	9	0

Note: * - as previously mentioned, five KBAs are triggered by the regular occurrence of congregations of more than 20,000 waterbirds, raptors or cranes but are not known to regularly support more than 1% of the global population of any individual species.

plants or fish, which trigger most of the KBAs listed in Table 5).

DISCUSSION

To date, the KBAs of the Indo-Burma Hotspot have proven to be a useful conservation priority setting tool, helping to guide investments by various donors, including the Asian Development Bank and CEPF. They have also played an important role in guiding the application of environmental safeguard policies by international financial institutions, such as the World Bank, which typically include commitments not to finance activities that degrade or damage critical natural habitat. Because the KBA criteria correspond closely to the safeguard policies of these institutions, there are multiple examples of KBAs being used to identify and avoid potential negative environmental impacts of development projects, particularly in areas outside formal protected areas.

There are fewer examples of KBAs being used to guide expansion of protected area systems in Indo-Burma, although there are a few notable exceptions, such as the recent declaration of Boeung Prek Lapouv and Kampong Trach KBAs in southern Cambodia as Sarus Crane Reserves. This is largely because the period of rapid expansion of the protected area networks in most countries in the hotspot predated the KBA identification process, and political support for further significant expansion is currently limited. The one exception may be Myanmar, where 68% of KBAs remain unprotected (Table 1), and there remain major gaps in the coverage of the national protected area system.

With all conservation priority setting exercises, priorities change over time, as new information becomes available and the status of biodiversity changes on the ground. The KBA analysis for Indo-Burma, conducted eight years ago, is not immune from these changes. Certainly, there is a need to update the analysis to take into account taxonomic changes, new distributional information, and changes to species' Red List status. In addition, a small number of sites (mainly wetlands) have been seriously degraded in the intervening period and are believed to have lost the values that led them to qualify as KBAs in the first place. For the most part, however, simply refreshing the analysis would not be expected to lead to many changes to the KBA list itself. KBA trigger species may be added or removed from some sites but few sites would be added or removed from the list.

The key priorities for future work are to incorporate the results of two major Red List assessments currently underway in the Indo-Burma Hotspot. The first of these is a plant Red List assessment, led by Missouri Botanical Garden, with support from CEPF. This initiative will assess the global threat status of non-tree vascular plants for the first time in the hotspot, as well as update and expand the assessments of many tree species. The second assessment, led by the IUCN Species Programme, with support from CEPF and the MacArthur Foundation, focuses on four groups of aquatic species: fish, odonates, molluscs and plants. This initiative will, for the first time, enable comprehensive identification of KBAs in freshwater ecosystems, which has hitherto been restricted by the small number of trigger species. These two

Table 5. Trigger species occurring at only one KBA globally, and the KBAs they trigger

KBA (* if global AZE site)	Species	Taxonomic group	IUCN category
Myanmar			
Natmataung (Mt Victoria)*	*Sitta victoriae*	Bird	EN
Southern China			
Babianjiang	*Pterospermum kingtungense*	Vascular plant	CR
Bawangling*	*Nomascus hainanus* (1)	Mammal	CR
Daweishan	*Manglietia sinica*	Vascular plant	CR
Fangcheng Shangyue	*Camellia tunghinensis*	Vascular plant	VU
Ganshiling	*Hopea exalata*	Vascular plant	VU
Paiyangshan*	*Paramesotriton guanxiensis* (2)	Amphibian	EN
Sanya	*Paranephelium hainanensis*	Vascular plant	EN
Shiwandashan	*Reevesia rotundifolia*	Vascular plant	CR
Xishuangbanna	*Leptolalax ventripunctatus* (3)	Amphibian	DD
	Nyssa yunnanensis	Vascular plant	CR
	Pterospermum menglunense	Vascular plant	CR
	Vatica xishuangbannaensis	Vascular plant	CR
Thailand			
Khao Sam Roi Yot	*Wrightia lanceolata*	Vascular plant	VU
Lum Nam Pai	*Schistura oedipus*	Fish	VU
Sai Yok	*Nemacheilus troglocataractus*	Fish	VU
Tham Ba Dan	*Schistura jarutanini*	Fish	VU
Vietnam			
Chu Yang Sin	*Alleizettella rubra*	Vascular plant	VU
Cuc Phuong	*Pistacia cucphuongensis*	Vascular plant	VU
Fan Si Pan*	*Actinodaphne ellipticbacca*	Vascular plant	VU
	Vibrissaphora echinata	Amphibian	EN
Kon Ka Kinh	*Leptobrachium xanthospilum* (4)	Amphibian	DD
Trung Khanh*	*Nomascus nasutus* (1)	Mammal	CR

Notes: (1) At the time of the KBA analysis, *Nomascus hainanus* and *N. nasutus* were lumped with *N. concolor* and assessed as EN; (2) At the time of the KBA analysis, *Paramesotriton guanxiensis* was provisionally assessed as VU; (3) At the time of the KBA analysis, *Leptolalax ventripunctatus* was provisionally assessed as CR; (4) At the time of the KBA analysis, *Leptobrachium xanthospilum* was assessed as VU.

assessments will enable a significant expansion of the KBA analysis in the Indo-Burma Hotspot, particularly with regard to freshwater ecosystems and limestone karst isolates.

In the long term, a more robust KBA analysis will require a better understanding of the population size, ecological requirements and minimum area requirements of KBA trigger species. For the most part, KBAs have been triggered based on the recorded presence of a species and the availability of supposed suitable habitat. This is not, by itself, sufficient evidence that the site in question, alone or as part of a network with other sites, can sustain a population of the species indefinitely. As part of developing a more complete understanding of the suitability of KBAs to sustain populations of trigger species over the long-term, there is also a need to better understand the potential impacts of climate change on the ecological parameters that determine the distribution of KBA trigger species. Such an analysis may argue for maintaining or reinforcing ecological connectivity among KBAs, to allow for changing species' distributions in response to climate change. It may also reinforce the need for improved in situ conservation management, so as to ensure healthier, more resilient populations of species and assemblages.

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