EXPEDITION REPORT

Expedition dates: 3 May – 12 June | 26 July – 4 September 2015

Report published: May 2016

Forest flagship: Researching & conserving critically endangered Sumatran tigers in Rimbang Baling Wildlife Reserve, Sumatra, Indonesia

in partnership with

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Authors:
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Abstract

For 78 days, from May to September 2015, Biosphere Expeditions and WWF Indonesia ran an inaugural expedition with volunteers in Rimbang Baling Wildlife Reserve (RB), Riau Province, Sumatra, Indonesia. The aim of the expedition was to (1) make an assessment of the status of the Sumatran tiger (*Panthera tigris sumatrae*), its prey and of other threatened mammal species, (2) engage and educate the local community through interviews and school visits and (3) train members of Batu Dinding Community Group (BDCG) in ecotourism service provision, with the expedition serving as a showcase on how ecotourism can provide alternative incomes based on intact nature and tiger presence.

Target species were recorded by camera traps, sightings, calls and signs in the north-eastern and lowland section of RB, with interviews conducted at villages throughout. Data output consisted of recording rates (frequency) and distribution of target species in a grid of 2 x 2 km cells. Thirty-four cells and 15 villages were surveyed on foot or by boat; five cells were sampled with 13 camera trap stations equipped with double cameras (26 cameras in total), resulting in a total of 256 trap nights. Nineteen mammal species of interest were recorded, including six artiodactyl tiger prey species, Sunda pangolin *Manis javanica*, Malayan tapir *Tapirus indicus*, as well as clouded leopard *Neofelis diardi*, leopard cat *Prionailurus bengalensis*, agile gibbon *Hylobates agilis* and the siamang *Symphalangus syndactylus*. Fifty-one bird species were recorded opportunistically. The tiger was mentioned during interviews, but not sampled in the field. However, the presence of threatened and vulnerable species as found by the expedition points towards good tiger habitat quality. Despite not recording tiger in the lowland habitats and therefore close to human habitation, the authors agree with, and the data presented here corroborate, Sunarto et al. (2012), and we believe that RB is an important habitat for tigers because of its steep, rugged and forest-covered topography that inhibits human occupation away from the major rivers, where there are human settlements, disturbance and conversion of forest to either rubber tree plantations on the slopes and/or oil palm plantations on the few flat areas that fringe the larger rivers in RB. Future expeditions should seek to confirm this hypothesis of tiger presence deeper in the reserve by increasing sampling effort away from the high human impact lowland areas.

Threats to continued tiger presence in RB include an increasing human population with developing infrastructure, concomitant with further forest encroachment and conversion, logging and other illegal activities such as poaching, which were all documented by the expedition, but are barely studied and quantified, let alone contained by the authorities tasked with nature protection due to a severe shortage in resources. Hunting pressure on the tiger and its prey was found to be relatively low, but there was worrying evidence of the use of snares, which indicates selective tiger poaching. This should be investigated further.

The expedition engaged and interviewed local people in 15 villages, 260 pupils in five local schools and two local placements on the expedition. Eleven members of BDCG were employed and trained in ecotourism provision activities. These capacity-building activities should be extended during future expeditions, with Biosphere Expeditions serving as a showcase example on how ecotourism based on intact nature can support livelihoods, and WWF seeking to capitalise on the experiences gained. In particular, the local community should be trained and involved in camera trapping and other tiger research activities during and outside the expedition dates, thereby providing more alternative income and greatly increasing sampling effort. While Biosphere Expeditions and its activities combining wildlife conservation and ecotourism activities can only be a small part of this process, for one because expeditions happen only for part of the year, it can nevertheless be an important showcase and driver for successful community-based conservation in RB. WWF's continued involvement, as the local, on-the-ground NGO present year-round, is crucial in all this, as is its work with the authorities to keep RB on the agenda in what today is the very beleaguered world of nature conservation in general, and of the tiger in particular, on the island of Sumatra.

Abstrak

Untuk 78 hari, dari Mei hingga September 2015 Biosphere Expeditions dan WWF Indonesia menyelenggarakan sebuah ekspedisi bersama dan dibantu oleh para sukarelawan di Suaka Margasatwa Rimbang Baling (RB), Propinsi Riau, Pulau Sumatera, Indonesia. Adapun tujuan dari ekspedisi ini adalah untuk (1) membuat sebuah penilaian dari status harimau Sumatera (*Panthera tigris sumatrae*), satwa mangsanya, dan spesies mamalia terancam lainnya, (2) mengikutsertakan dan mengedukasi masyarakat lokal melalui wawancara dan kunjungan – kunjungan sekolah, dan (3) melatih anggota dari Komunitas Batudinding dalam pelayanan ekowisata dengan memberikan bantuan jasa kepada kegiatan ekspedisi sebagai tempat dimana praktek penyelenggaraan ekowisata berdasarkan pada alam yang utuh dan keberadaan harimau dapat memberikan alternatif pendapatan bagi mereka.

Spesies target berhasil tercatat dari pemasangan kamera jebak (*camera trap*), meupun terlihat langsung, perjumpaan suara, dan tanda keberadaan lainnya di bagian utara – timur dan sisi dataran rendah RB, selain itu juga dengan wawancara pada beberapa desa. Luaran data terdiri dari tingkat pencatatan (frekuensi) dan distribusi dari spesies target dalam grid sel 2 x 2 km. Tigapuluh empat grid sel dan lima belas desa telah tersurvai dengan berjalan kaki atau berperahu, lima grid sel telah tersample dengan tiga belas stasiun kamera jebak yang dilengkapi dengan kamera berpasangan (jumlah keseluruhan adalah 26 kamera), menghasilkan 256 hari kamera aktif secara keseluruhan. Sembilan belas spesies mamalia tertangkap, termasuk enam Artiodactyla mangsa harimau, trenggiling *Manis javanica*, tapir *Tapirus indicus*, maupun macan dahan *Neofelis diardi*, kucing hutan *Prionailurus bengalensis*, ungko *Hylobates agilis*, dan siamang *Symphalangus syndactylus*. Lima puluh dua spesies burung tertangkap secara oportunis. Harimau selalu diinformasikan selama wawancara, tetapi tidak tersampel di lapangan. Namun, kehadiran dari spesies terancam dan rentan yang dijumpai pada titik – titik pengamatan yang berkorelasi terhadap baiknya kualitas habitat harimau. Meskipun tidak merekam harimau di habitat – habitat dataran rendah dan yang berdekatan dengan kawasan manusia, para penulis setuju, dan data yang ditunjukkan disini cukup menguatkan, Sunarto et al. (2012) dan dipercayai bahwa RB adalah sebuah habitat penting untuk harimau karena tingkat kecuraman, tidak ratanya medan, dan topografi yang didominasi tutupan hutan yang mempersulit okupansi oleh manusia yang jauh dari jalur sungai utama, dimana disana banyak pemukiman manusia, gangguan, dan konversi hutan untuk perkebunan karet pada kawasan curam dan/atau perkebunan kelapa sawit pada beberapa kawasan yang lebih landai pada tepi sungai besar di RB. Ekspedisi – ekspedisi kedepan harus mengkonfirmasi ini dengan hipotesa bahwa harimau hadir pada kawasan suaka margasatwa yang lebih dalam dan jauh dari padatnya aktifitas manusia, dan dapat dicapai dengan meningkatkan usaha sampling pada kawasan yang lebih dalam tersebut.

Ancaman – ancaman terhadap keberadaan harimau in RB termasuk peningkatan populasi manusia dengan pengembangan infrastruktur, hal – hal yang terkait dengan perambahan dan konversi hutan, pembalakan, dan aktifitas – aktifitas ilegal lainnya seperti perburuan, yang telah didokumentasikan oleh ekspedisi ini, tetapi jarang dipelajari dan dikuantifikasikan, dibiarkan begitu saja oleh pihak otoritas dengan tugas perlindungan alam karena keterbatasan sumberdaya yang tersedia. Tekanan perburuan pada harimau dan satwa mangsanya yang ditemukan umumnya relatif rendah, tetapi terdapat perburuan dengan menggunakan jerat yang diindikasikan sebagai perburuan selektif untuk harimau. Perlu melakukan kegiatan investigasi lebih lanjut terkait perburuan harimau tersebut.

Ekspedisi ini mengikutsertakan dan mewawancarai masyarakat lokal di 15 desa, 260 siswa sekolah di lima sekolah lokal, dan dua orang lokal yang ditempatkan untuk membantu ekspedisi ini. Sebelas anggota dari Komunitas Batudinding dilibatkan dan dilatih dalam aktifitas – aktifitas kaitannya dengan ekowisata. Aktifitas – aktifitas peningkatan kapasitas ini harus ditambahkan pada ekspedisi – ekspedisi kedepannya dengan Biosphere Expedtions, untuk peningkatan pengalaman mereka. Utamanya, masyarakat lokal juga harus diajarkan dan dilibatkan dalam pemasangan kamera jebak dan aktifitas – aktifitas penelitian harimau lainnya selama dan diluar waktu ekspedisi, dengan demikian dapat memberikan pendapatan alternatif yang lebih mengkombinasikan aspek konservasi satwaliar dan aktifitas – aktifitas ekowisata, kegiatan ekspedisi ini hanya bagian kecil sekali setahun, dengan demikian dapat mendorong kesuksesan konservasi berdasarkan komunitas di RB. WWF juga akan berperan dalam pelibatan sebagai NGO tempatan, sehingga sangat penting untuk ini, bekerja dengan otoritas – otoritas lokal untuk menjaga RB untuk upaya konservasi alam umumnya, dan utamanya untuk konservasi harimau di Pulau Sumatera.

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1. Expedition review

M. Hammer (editor)
Biosphere Expeditions

1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (biological or otherwise) required to join. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This project report deals with an expedition to the Rimbang Baling Wildlife Reserve that ran from 3 May to 12 June and 26 July to 4 September 2015 with the aim of conducting a much-needed survey of critically endangered Sumatran tigers in one of the last remaining forest refuges left on one of Indonesia's largest islands. Tiger prey animals such as various species of deer, pig, bird and primate were recorded and general forest biodiversity studied. Working together with WWF Indonesia and the local community, the expedition also worked on mitigating the critical threat of poaching through education, capacity-building and incentive creation for local people. Data collected by this expedition will be crucial in identifying pockets of tiger habitat and viable strategies for tiger conservation and recovery, which are all vital if the species is to survive.

As its name implies, the Sumatran tiger (*Panthera tigris sumatrae*) is endemic to Sumatra, one of the largest islands in the Indonesian archipelago. It is the smallest of all of the tiger subspecies and is distinguished by heavy black stripes on its orange coat. Listed in IUCN's Critically Endangered category, there are probably fewer than 400 individuals left in the wild. As a top predator, the tiger needs large joined-up forest blocks to thrive, and used to roam across the whole island. It now occurs in isolated populations, its habitats having been drastically reduced by clearing for agriculture, plantations and settlements. This habitat destruction also forces the tiger into settled areas in search of food, where it is more likely to come into contact – and conflict – with people. Next to habitat destruction, poaching is another very potent threat. Studies have estimated that up to 78% of Sumatran tiger deaths, consisting of about 40 animals per year, are as a result of poaching, either as retaliatory killings or to feed the demand for tiger parts. Despite increased efforts in tiger conservation – including law enforcement and anti-poaching capacity – a substantial market remains in Sumatra and the rest of Asia for tiger parts and products.

Today many wild Sumatran tigers are found in the Tesso Nilo Protected Landscape, which has been identified as a 'Global Priority Tiger Conservation Landscape' because it harbours a globally important tiger population and includes other important facets of Asian biodiversity, including many other endangered species, such as Sumatran elephants and four other cat species (e.g. clouded leopard & golden cat). Rimbang Baling Wildlife Reserve, the expedition study site, forms one of the core tiger refuges inside this area that plays a vital role in maintaining connectivity among other key tiger landscapes.

Although the outlook for tigers may often sound bleak, there are success stories too. In well-managed areas with effective tiger patrols and where local communities benefit from tiger presence, there are clear signs of recovery. It is therefore of critical importance that tiger populations are monitored regularly to effectively safeguard the populations that still exist and that local communities play a key role in and benefit from tiger conservation. WWF Indonesia has been at the forefront of these efforts since the end of the last millennium and has asked Biosphere Expeditions for assistance with tiger monitoring and to act as a showcase for how responsible, low-impact tiger tourism activities can generate local jobs and build capacity.

1.2. Research area

Indonesia is an archipelago comprising approximately 17,000 islands, only 8,000 of which are inhabited. It encompasses 34 provinces with over 238 million people, making it the world's fourth most populous country. Sumatra is one of the biggest islands of the archipelago. Indonesia's size, tropical climate and archipelagic geography support the world's second highest level of biodiversity (after Brazil) and Indonesia is second only to Australia in terms of total endemic species.

Figure 1.2a. Indonesia, Sumatra, the expedition study site and assembly point. An overview of Biosphere Expeditions' research sites, assembly points, base camp and office locations is at Google Maps.

Rimbang Baling Wildlife Reserve, the expedition's study site, was established in 1984 and currently measures 1,360 km^2 comprising highland and mountain tropical rainforest ecosystems. There are various slopes between 25% and 100% and the highest elevation is 1,070 m. The reserve is a biodiversity hotspot and a known Sumatran tiger breeding area. As such it has been classified by WWF and others as an all-important global priority tiger conservation area.

1.3. Dates

The project ran over a period of several months, divided into six one-week slots, each composed of a team of international research assistants, scientists and an expedition leader. Slot dates were:

3 – 15 May | 17 – 29 May | 31 May – 12 June || 26 July – 7 August | 9 – 21 August | 23 August – 4 September 2015

Team members could join for multiple slots (within the periods specified). Dates are chosen to be in the dry season for ease of working.

1.4. Local conditions & support

The study was a collaboration between the organisations Biosphere Expeditions, WWF Indonesia and Batu Dinding Community Group.

Expedition base

The expedition was based at WWF Indonesia's Subayang Field Station, a large wooden house on the banks of the Subayang River, in a remote part of the forest about 30 minutes by boat from the end of the road and nearest village. The field station has a single large 20 x 20 m common room, a kitchen, toilets and showers. Electricity at 110/220 V was provided by a generator. Expedition participants slept either in the large common room, dome tents or hammocks, all dotted around the site. All meals were prepared by the expedition cook.

Weather

The weather during the expedition was generally warm and humid as the expedition period fell between the rainy season and dry season. Temperatures ranged from a low of 22ºC to a high of 35ºC with high humidity. River water levels were relatively high to start with, but low towards the end of the expedition, causing some problems with the ability to move around the study site in boats.

Field communications

There was no mobile or radio coverage at base or around the study site. The expedition leader had a satellite phone, as did WWF staff, and all survey groups carried an Emergency Position Indicating Radiobeacon (EPIRB) into the field on their surveys. The expedition leader posted a diary with multimedia content on Wordpress and excerpts of this were mirrored on Biosphere Expeditions' social media sites such as Facebook and Google+.

Transport & vehicles

Team members made their own way to the Pekanbaru assembly point in time. From there onwards and back to the assembly point all transport, vehicles and boats were provided for the expedition team, for expedition support and emergency evacuations.

Medical support and incidents

The expedition leader was a trained first aider and the expedition carried a comprehensive medical kit. Further medical support was provided by a small hospital in Gema village (about 4 km from the expedition base) and several district hospitals in Pekanbaru town (about 100 km from the expedition base). Safety and emergency procedures were in place, but did not have to be invoked, as there were no serious medical or other emergency incidents during the expedition. Minor incidences included a bruised shin, which required an X-ray, some infected skin areas, treated with antibiotics, and an animal bite on a toe while bathing in the river as well as a head injury, both of which required stitches. All minor incidences were dealt with by Gema hospital and team members were required to carry adequate travel insurance covering emergency medical evacuation and repatriation.

1.5. Local scientist

Febri A. Widodo is WWF's tiger research programme coordinator. His BSc, majoring in nature forest conservation, is from Gadjah Mada University in his native Indonesia. As WWF Indonesia's tiger research coordinator, he organises tiger research mainly by capture-mark-recapture methods in various landscapes throughout Sumatra. He is a member of the HarimauKita Sumatran tiger conservation group and has experience in jungle survival, search and rescue and ecotourism.

1.6. Expedition leaders

May/June: Ronald Seipold graduated from the University of Berlin with a Master's Degree in Business Administration and then spent several years working in different branches of industries leading organisational and IT related projects. He then decided to go for a total change of career and lifestyle and focus on his passion for travelling, wildlife and the outdoors. After a 100-day intensive training course with COLT (Canadian Outdoor Leadership Training) he qualified as an outdoor leader, radio operator, sea kayak and canoeing guide, backcountry first aider, etc. Ronald then began leading and instructing groups in the outdoors primarily in Scandinavia and Canada as well as working for outdoor camps and lodges. Ronald joined Biosphere Expeditions in 2007. His favourite activities are mountaineering, canoeing and climbing.

July – September: Anthony Lyons initially trained as carpenter in his early 20s and started in business as a self-employed carpenter. This allowed him the freedom to pursue his main passion of outdoor pursuits and gain some mountaineering qualifications. He then went on to spend four years teaching bushcraft and wilderness survival on UK-based expeditions and spent two seasons running a mountaineering programme in Snowdonia. Anthony has also worked for the British Antarctic Survey at their polar Halley Research Station.

1.7. Expedition team

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of all ages, nationalities and backgrounds. They were (in alphabetical order and with country of residence):

3 – 15 May 2015

Manuela Bratusa (Germany), Andreas Hub (Germany), Franz Lerchenmueller (Germany), Tessa Merrie (UK), Matthias Paul (Germany), Michael Paull (Australia), Sugiono Sugi* (Indonesia), Steve White (China). Also present: Matthias Hammer (Germany), Biosphere Expeditions.

17 – 29 May 2015

Will Armstrong (UK), Beston Barnett (USA), Diane Barnett (USA), Andrea Guerrero (USA), Olga Heijtmajer (the Netherlands), Ryan Park (USA), John Rothman (USA), Ingeborg Stephan (Germany), Sugiono Sugi* (Indonesia).

31 May – 12 June 2015

Gelluny Ferry* (Indonesia), Beate Hinterreither (Austria), Jatt Khaira (UK), Teresa Marcisz (New Zealand), Ryan Park (USA), Peter Pilbeam (UK), Ngoc anh Tran (France).

26 July – 7 August 2015

Arnau Bernad-Esteve (Germany), Sabine Corzelius (Germany), Helga Kuehl (Germany), Sian Lovegrove (China), Caitlin Moore (UK), Martyn Roberts (UK), Sugiono Sugi* (Indonesia), Nicola West (Australia).

9 – 21 August 2015

Helen Bacon (UK), Donna Brown (USA), Mike Burt (UK), Natalya Fenston (UK), Sharon Goell (USA), Nicola Jones (UK), Laura Rutherford (UK), Claire Waring (UK).

23 August – 4 September 2015

Susanne Ahlqvist (Norway), Andrew Coogan (UK), James Dobson (UK), David Farr (UK), Natalya Fenston (UK), Derek Ho (USA), Bob Hussey (UK), Maggie Neal (UK), Verena Thuerey (the Netherlands), Stefan Thuerey (the Netherlands), Georgina Treherne (the Netherlands), Alexander Watson (UK).

*Placement kindly supported by the Friends of Biosphere Expeditions. The Biosphere Expeditions placement programme seeks to indentify, train and encourage the next generation of local conservationists.

1.8. Expedition budget

Each team member paid towards expedition costs a contribution of £1,940 per person per two-week slot. The contribution covered accommodation and meals, supervision and induction, special research equipment and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs etc., or visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	£
Expedition contributions	103,479
Expenditure	
Expedition reconnaissance & setup includes travel, expenses and staff time spent in 2014 and 2015	14,384
Expedition base includes all board & lodging, and extra food & meals	10,167
Transport includes team transfers, boat rides, fuel	4,639
Equipment and hardware includes research materials & gear etc. purchased in Indonesia & elsewhere	5,880
Staff includes local and Biosphere Expeditions staff salaries and travel expenses	15,880
Administration includes miscellaneous fees, permits & sundries	1,545
Team recruitment Sumatra as estimated % of annual PR costs for Biosphere Expeditions	4,186
Income – Expenditure	**46,789**
Total percentage spent directly on project	**55%***

*This is less than the 66% guaranteed by Biosphere Expeditions. However, in 2015 the expeditions to the Maldives and South Africa ran at a loss with totals spent at 105% and 143% respectively (see expedition budgets in the expedition reports on www.biosphere-expeditions.org/reports). This shortfall was covered by the surplus income from Sumatra, bringing the percentage project expenditure across all 2015 expeditions back in line.

1.9. Acknowledgements

We are grateful to the volunteers, who not only dedicated their spare time to helping, but also, through their expedition contributions, funded the research. Thank you also to the staff of BKSDA (Natural Resource Agency) of Riau in Pekanbaru (Hamka Ginting, Purwanto, Nila, Jhonny Lagawurin, Lukito Awang), local people in and around Rimbang Baling, WWF Indonesia (Wishnu Sukmantoro, Elmadia Achmad, Sunarto, Heri Irawan, Rianto, Riza Sukriana, Zulfahmi, Eka Septayuda, Efendi Panjaitan, Kusdianto, Rahmad Adi, Tugio, Rafselia Novalina, Syamsidar, Suparman, Fendi), Batu Dinding Community Group (Mahwel, Yusri Andesta, Masrizal, Amrin, Sapri, Anto, Elsi Susanti), science volunteer Beno Fahriza and Nuri, who helped train local people in cooking for the expedition groups, and to all those other people who provided assistance and information. Biosphere Expeditions would also like to thank members of the Friends of Biosphere Expeditions and donors for their sponsorship. Finally, thank you to Batu Dinding Community Group and Tanjung Belit villagers for being such excellent hosts and making us feel at home at WWF's Subayang Field Station.

1.10. Further information & enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Enquires should be addressed to Biosphere Expeditions at the address given on the website.

2. Tracking the surviving tigers: A report of the Sumatran tiger habitat monitoring in the Rimbang Baling Landscape, Riau, Sumatra

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Marcelo Mazzolli (editor)
Projeto Puma

Matthias Hammer (editor)
Biosphere Expeditions

2.1. Introduction

According to Goodrich et al. (2015), the world's tiger (*Panthera tigris*) population has declined to as few as 3,200 individuals. Extant populations of tigers are grouped into five remaining subspecies: *P. t. sumatrae*, *P. t. tigris*, *P. t. altaica*, *P. t. corbetti* and *P. t. amoyensis*; and three subspecies have become extinct within the 20th century: *P. t. virgata*, *P. t. sondaica* and *P. t. balica* (Goodrich et al. 2015). The Sumatran tiger (*Panthera tigris sumatrae*) is the only living subspecies inhabiting an island, with an estimated number of 250 adult tigers living in 8 of the 18 tiger habitats across Sumatra (Indonesian Ministry of Forestry 2007).

The Sumatran tiger faces many threats, such as large-scale degradation, fragmentation and loss of habitat, prey depletion, as well as direct poaching in retaliation for livestock depredation and poaching for the Asian traditional medicine market (Indonesian Ministry of Forestry 2007, Ng and Nemora 2007, Uryu et al. 2010, Wibisino and Pusparini 2010, Margono et al. 2012). Riau, the province in which the expedition took place, has been one of the major suppliers of tiger bones and skins to the international black market, along with its neighbour West Sumatra (Sheppard and Magnus 2004, Indonesian Ministry of Forestry 2007).

Sumatra as a whole harbours important tiger habitats with 12 Tiger Conservation Landscapes (TCL) covering approximately 88,000 km² (Sanderson et al. 2006). However, Sumatra's forest cover is being lost rapidly because of a variety of factors, including logging (legal and illegal), development of estate crops (primarily oil palm and pulpwood plantations), conversion to agriculture (by opportunistic settlers and those arriving through Indonesia's official transmigration programme) and forest fires (Wibisino and Pusparini 2010).

Rimbang Baling Landscape (which inclues Rimbang Baling Wildlife Reserve) is also part of the TCL. It harbours the tiger (Linkie et al. 2008) and four other felids, namely Sunda clouded leopard *Neofelis diardi*, golden cat *Catopuma temminckii*, marbled cat *Pardofelis marmorata* and leopard cat *Prionailurus bengalensis*.

Sunarto et al. (2013) have shown that tiger density in Sumatra is much lower than in India, and amongst Sumatran landscapes, RB ranks as having one of the lowest densities (0.86 individuals/100 km², SE 0.5 in Sunarto et al. 2013 and 0.74 individuals/100 km², SE 0.39 from unpublished, updated WWF Indonesia data). Despite its low tiger density and a TCL with 'questionable persistence of tiger over the long term' (see Fig. 2.1a below), another study by Sunarto et al. (2012) has argued that RB has relatively large areas with high probability of tiger occupancy, particularly to the northwest of the reserve.

WWF Indonesia began its tiger research programme in Central Sumatra in 2004 focusing on Tesso Nilo – Bukit Tigapuluh Landscape. Soon after, the programme expanded to three provinces in Central Sumatra, namely Riau, West Sumatra and Jambi. RB, which is located in the province of Riau, Central Sumatra, is of high interest to WWF, so in 2012, WWF joined forces with local partners and the community to build a multi-purpose field station at Subayang to host researchers and conservation teams, as well as conduct local community empowerment projects such ecotourism programmes.

Besides tiger research and patrols, WWF has been active in promoting community awareness of tiger protection and conflict mitigation, while also running programmes to generate income from the sustainable use of natural resources and intact nature with tiger presence. One aspect of this is the collaboration with Biosphere Expeditions and its teams of voluntourists helping with research and using the services of the local community, thereby creating alternative incomes and supporting livelihoods based on intact nature and tiger presence.

However, despite intensive efforts by WWF Indonesia and many othes, the conservation outlook for Sumatran tigers is still not good. A poor legal framework has allowed widespread conversion of forests to many other land uses, especially into oil palm and rubber plantations, as well as *Acacia* spp. and *Eucalyptus* spp. plantations for the pulp and paper industries, and mining for several valuable minerals such as coal and gold. Broad initiatives for conservation of habitats include increasing international consumer and supply chain awareness, environmental certification of oil palm plantations (High Conservation Value Areas – HCVA) and payment for carbon stock in standing forests (Reduced Emissions from Deforestation and Forest Degradation – REDD). On the ground, to improve management of plantations and concessions, WWF develops Better Management Practices (BMP) to accommodate ecological aspects in production lands. Global awareness is another important tool in this process and one of the goals of Biosphere Expeditions: empowering people from all backgrounds to join efforts to promote wildlife research and conservation. Another goal is to cover part of the reserve with conservation expeditions as an additional protection measure. WWF has allocated monitoring and protection resources to tigers in RB, but the very difficult terrain and large reserve size make comprehensive cover impossible with the resources at hand, especially along the Subayang River. During the expedition, teams actively covered the study area for several months, collecting data and promoting environmental awareness in traditional communities that inhabit the reserve. Research on the Sumatran tiger and its habitat during expeditions is a crucial activity that provides vital information for landscape management. Biosphere Expeditions during the expedition complemented WWF's survey by sampling uncovered areas using grid cells of 2 x 2 km, mostly along rivers and near traditional communities, where surveys had never been carried out before.

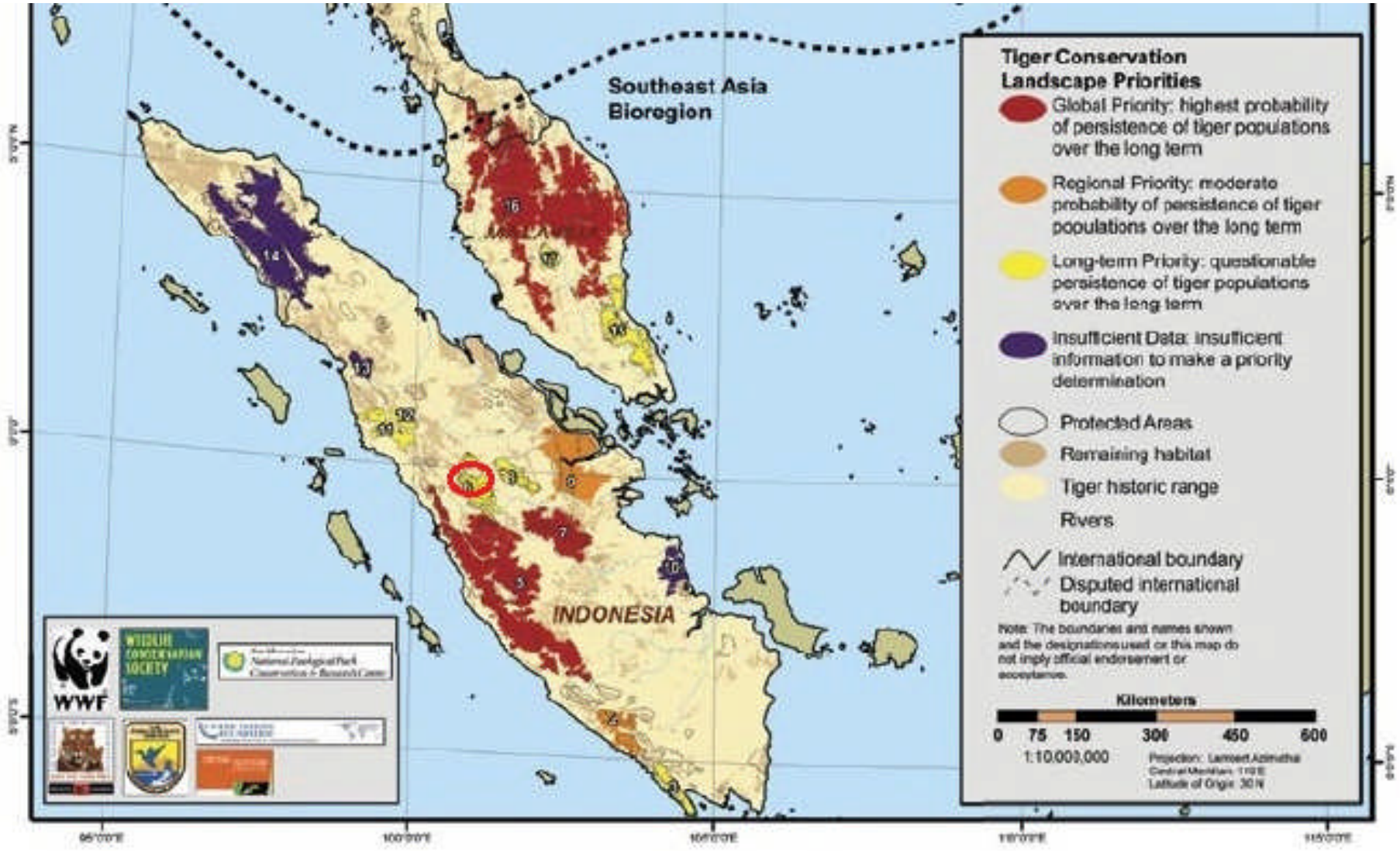

Figure 2.1a. Map of Tiger Conservation Landscapes (TCL) in Sumatra.
Rimbang Baling is highlighted by a red circle (© 2006 WWF, WCS, SMITHSONIAN, STF) (Sanderson et al. 2006).

2.2. Study area

The study area was the Bukit Rimbang Bukit Baling Landscape (Bukit Rimbang Bukit Baling Wildlife Reserve and surrounding areas, hereafter Rimbang Baling or RB) (Fig. 2.2a). RB's terrain is broken with steep, but not high, hills ranging around 200 m. RB's main forest block measures 1,680 km^2, and has high humidity (>80%) and precipitation ranging from 2,000 to 3,000 mm annually (Sunarto et al. 2015).

RB was established in 1984 and is managed by BKSDA Riau (Natural Resource Conservation Agency of Riau), an environmental agency linked to the Ministry of Forestry and Environment of Indonesia (Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia). RB is a protected area of IUCN category IV, which means it is 'a habitat or species management area similar to a natural monument or feature and focused on specific areas of conservation such as an identifiable species or habitat that requires continuous protection, rather than that of a natural feature' (according to IUCN).

In Indonesia there are two major divisions of reserves: 'Sanctuary Reserves' to protect biodiversity and allow little human access, and 'Nature Conservation Areas' for 'sustainable utilisation of living resources and their ecosystem' (Ministry of Forestry 1990), in some of which private areas and plantations are allowed, but not hunting of protected animals or timber harvest (Cooke 2006). These protected areas should be sufficiently controlled to ensure the maintenance, conservation and restoration of particular species and habitats – possibly through traditional means – and public education of such areas is widely encouraged as part of the management objectives.

RB was originally a Sanctuary Reserve, but an additional regulation has allowed resource use. This may explain why RB is dotted both inside and along its boundaries by at least a dozen villages (see Fig 2.2.a) that were established a few decades ago and subsist on natural resource use and on semi-wild livestock.

The current purpose of RB, according to the Indonesian government, is a wildlife reserve that has the function to serve as a conservation area that is protecting wildlife and biodiversity, the hydrological cycle and sustainable conservation activities such as, for example, research. However, it only has four Ministry of Forestry and Environment rangers active in the field, some of whom accompanied and supported the expedition at irregular intervals. These rangers are also tasked to patrol other regions and are not based at RB, but in the regional capital Pekanbaru, which means they only visit RB for a few days at a time. For this reason WWF, in collaboration with BKSDA Riau (RB Wildlife Reserve Authority) and with local communities, has created and allocated patrol teams to monitor tiger threats in RB and surrounding areas. This WWF Tiger Protection Unit (TPU) in 2015 alone collected 101 tiger snares and conducted a tiger community awareness programme for local people (WWF Indonesia, unpublished report).

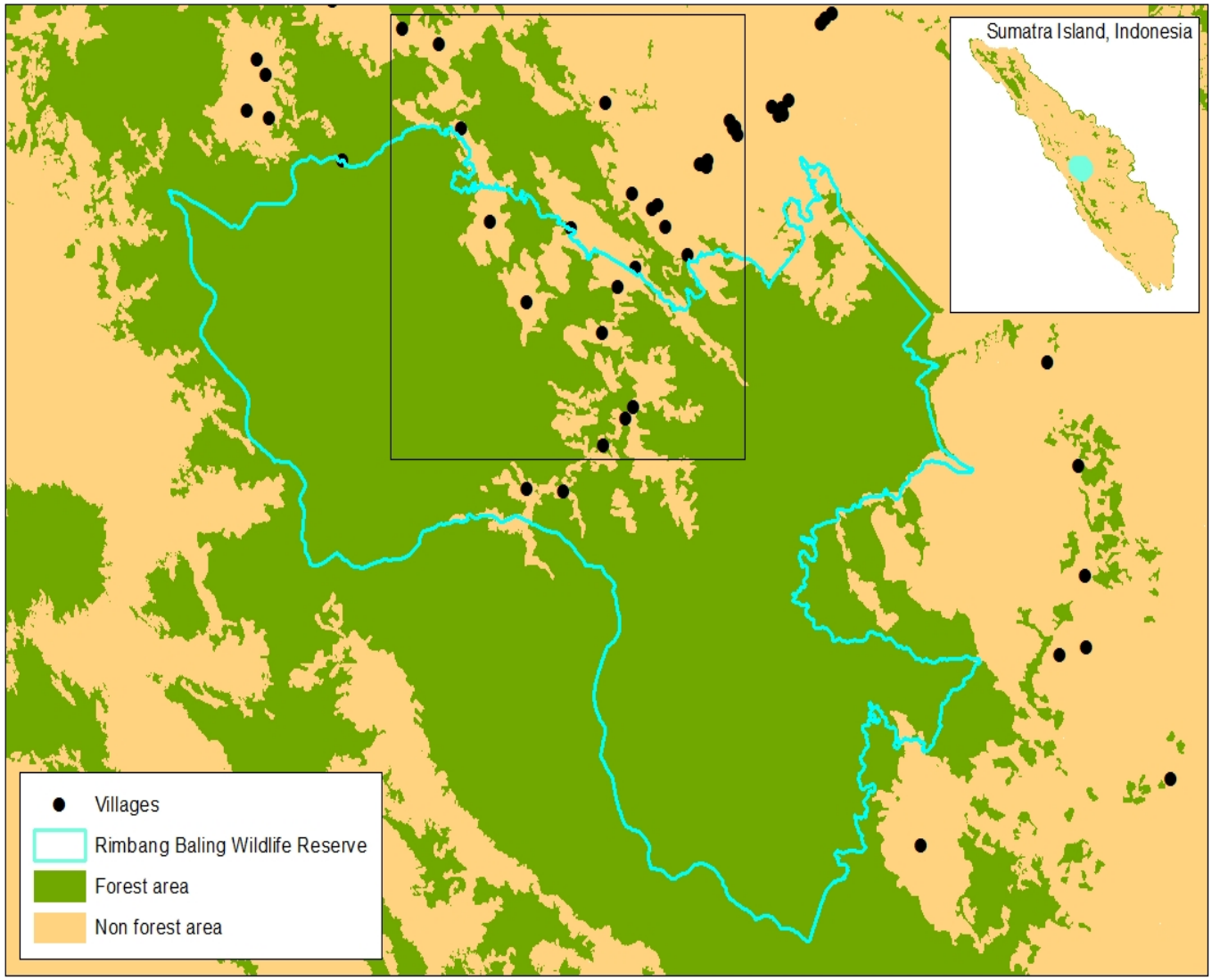

Figure 2.2a. Bukit Rimbang Bukit Baling Wildlife Reserve and surrounding area. The rectangle outlined in black represents the general area surveyed by the expedition.

2.3. Materials & methods

The tiger was the focal species of this study, but prey species and species that may contribute additional information on habitat quality or human disturbance were also recorded. For instance, redundant records of species that are rare from being excessively poached or which require an undisturbed habitat elsewhere may indicate a peaceful coexistence with human communities and a good habitat in the survey area, a condition that may extend to the tiger.

Surveys and site selection

Surveys were conducted on foot or by boat, covering the north-eastern section of Rimbang Baling along the Subayang and Biobio rivers (Fig. 2.4a). During its inaugural year, the expedition's goal was to concentrate on areas that are relatively easy to reach via the main rivers, and therefore close to human habitation (where relationships were also built with local communities and schools). A few overnight surveys pushed deeper into the forest, but by and large the very steep and difficult to reach terrain of the remaining area was avoided.

Mammals were recorded for presence-absence analysis using camera traps, sightings, calls and signs. WWF's tiger capture-recapture survey for density estimation (following Karanth et al. 2004 and Ancrenaz et al. 2012) and monitoring of prey availability were also conducted. Nomenclature of species was based on the IUCN Red List (IUCN 2016).

Training of participants

Before field work began, volunteers were introduced to the conservation and habitat management conditions and issues of the Sumatran tiger, particularly in the Rimbang Baling Landscape, and the efforts of WWF Indonesia for tiger conservation.

Training sessions were carried for each expedition group. Participants were shown how to use maps and a compass, recognise animals by their calls (primates) and signs, collect scats, deploy camera traps and transfer information to datasheets with accurate coordinates taken from GPSs. For track identification, Van Strien's (1983) guide with tracks in natural size was used. Sun bear *Helarctos malayanus* can confidently be identified by its claw marks (Steinmetz and Garshelis 2008 & 2010), particularly when other bears do not overlap in range, as it is the case in Sumatra. Regarding the different species of deer, hooves of the mouse deer *Tragulus* spp. (two species) are half the size of those of barking deer *Muntiacus muntjac*, which in turn are a little over half the size of those of sambar *Rusa unicolor* (see Van Strien 1983). This makes it relatively easy to distinguish species by their tracks. Also, according to one of the authors (F.A.W.), some animals can be detected by their burrows (Malayan porcupine *Hystrix brachyura*) and by wallows and diggings (such as the wild pig *Sus scrofa* and water buffalo *Bubalus bubalis*).

Camera trapping

Camera traps were deployed randomly on a grid of 2 x 2 km along the Subayang and Biobio rivers (Fig. 2.4a). Biosphere Expeditions provided 19 Bushnell camera traps model Trophy Cam HD and WWF provided 10 Bushnell camera traps model NatureView HD and five Reconyx model PC800.

GIS and mapping

WWF Indonesia's standard survey map in GIS with geographic projection and datum WGS 84 was used. Grid cells of 2 x 2 km as per WWF Indonesia's tiger programme standard were used, with RB being covered by 416 2 x 2 km cells. The program TrackMaker (Geo Studio Tech, MG) was used to upload grid cells with their respective codes to GPS units (five Garmin eTrex 20 and one Garmin 78s) to help with navigation and data collection, and also to download GPS features collected in the field. ArcGIS (ESRI) was used to produce the final mapping results.

Data analysis

Sign, calls and sighting survey data plus camera trapping data were used to describe species' distribution (presence-absence in a grid of 2 x 2 km cells) following Biosphere Expeditions standard methodology as developed by Mazzolli and Hammer (2013). Data and images from camera trapping were stored in a database software described in Sanderson and Harris (2013).

Relative Abundance Index (RAI) was calculated based on data from camera traps only, as the number of independent records for each species multiplied by 100 and divided by the total number of camera trap nights (O'Brien et al. 2003, Jenks et al. 2011). Camera trapping effort was calculated as the number of nights of sampling multiplied by the number of camera stations minus any days when both cameras at a station malfunctioned (Sunarto et al. 2013). Survey effort per cell was not computed, but a higher effort was placed near the expedition base.

Both distributions and RAI indicate species abundance, but they should be used with care when probabilities of detection are not modelled, as is the care here, because detection probabilities vary between species and locations (MacKenzie et al. 2002, Buckland et al. 2004, Jathanna et al. 2015). Furthermore, as variations around the mean are usually not calculated (e.g. Standard Errors and Coefficient of Variation), comparison of abundances across locations or through time are likely more trustworthy when values (frequency) differ by several times their order of magnitude.

Semi-structured interviews were carried out in villages within the survey area to understand how villagers perceive and react to the presence of tigers and other wildlife, to know the extent of human–tiger interaction, to gather information on recent tiger sightings or signs to improve the expedition's ability to record them, and to use this information as baseline data for tiger conservation programmes bordering inhabited areas.

Finally, activities at five schools were carried out, including elementary, junior high and senior high schools. Activities included environmental education with an emphasis on wildlife, habitat conservation in Rimbang Baling Landscape and also promoting conservation programmes in Rimbang Baling Landscape.

2.4. Results

Thirty-four cells and 15 villages were surveyed on foot and by boat and five cells were sampled with 13 camera trap stations (26 cameras in total), resulting in a total of 256 trap nights and 18 km^2 for Effective Trapping Area (ETA) (Fig 2.4a). The only camera trap station accessible by car was station X128, but the majority were nonetheless impacted by human disturbances with one stolen camera trap (Appendix I).

The mammals survey resulted in the identification of 19 different mammal species, plus four unidentified species, identified only at genus level, of which two were carnivores (civet and otter), one was a primate (leaf monkey) and one was an artiodactyl (mouse deer). Included in the list are two livestock animals (water buffalo and cattle derived from wild cattle or banteng *Bos javanicus*) and a domestic dog (Table 2.4a). The tiger was mentioned during interviews, but not sampled in the field. Fifty-one birds were recorded opportunistically (Appendix II).

Species occurrence

Several species relevant to determine habitat quality for tigers, including prey species and those listed in a high category of threat by the IUCN, were recorded in cells occupied by villages, both within and outside RB borders, indicating some level of coexistence of the fauna with local communities (Table 2.4a & Appendix III).

Two parameters were used to measure the relative abundance of species, presence in cells and RAI, the latter based solely on camera trap rates. Species considered common include those detected in many cells, mainly by other means such as by tracks or by sight, even when scoring low RAI. High RAI scores are considered an *a priori* indication of abundance, but the high rates may be attributable to recurrent photographs of the same individuals of a given species by a few camera trap stations.

Wild pig *Sus scrofa* (n=32) and water buffalo (n=19) were the species recorded in the largest number of cells, by their tracks, followed by long-tailed macaque *Macaca fascicularis* (n=17), recorded mostly by sight (Table 2.4a).

In terms of relative abundance (RAI), both wild pig and water buffalo also had the highest scores (Table 2.4a), meaning that besides being recorded in more cells, they were also recorded more frequently with camera traps. The high detection rate of the long-tailed macaque, on the other hand, was much less attributable to records by camera traps than by other means, thus being present in a high number of cells and scoring a low RAI.

Other species present in more than eight cells and scoring low RAI were the agile gibbon *Hylobates agilis* (n=10), the siamang *Symphalangus syndactylus* (n=9), the Malayan sun bear (n=12) and the barking deer (n=10).

The pig-tailed macaque *Macaca nemestrina* had good scores in terms of number of cells (n=8) and RAI (7.81), whereas the Malayan porcupine *Hystrix brachyura* had relatively low scores in terms of cells (n=4), but a considerably good RAI (8.20).

The great argus pheasant *Argusianus argus*, considered tiger prey (O'Brien et al. 2003), was repeatedly recorded by camera traps.

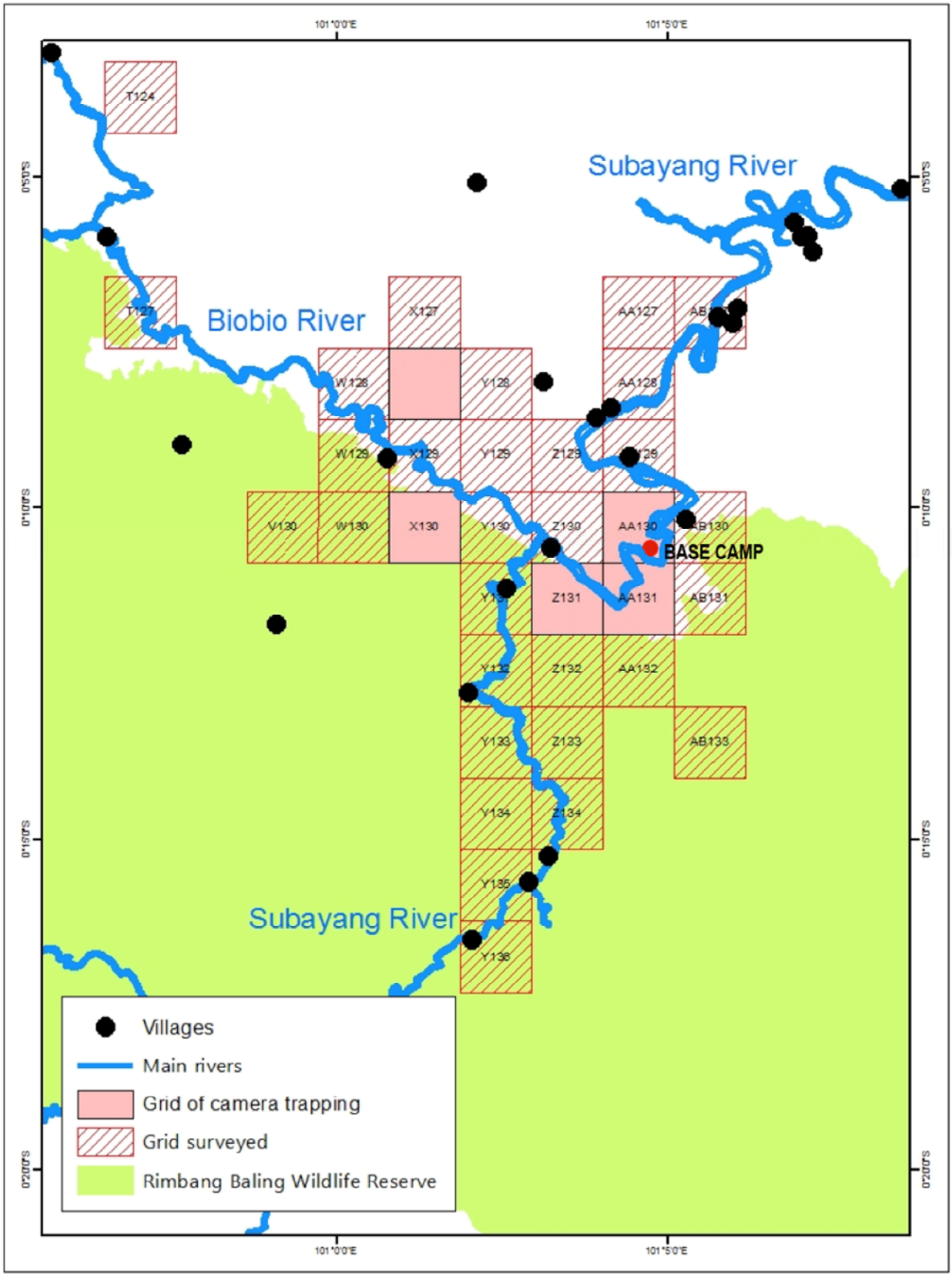

Figure 2.4a. Grid cells surveyed, rivers and villages.

Table 2.4a. Mammals recorded in Rimbang Baling and results of sampling.

Taxon	Global status [1]	Regional status [2]	Camera traps	Sighting	Track	Scat	Other [3]	Cells [4]	RAI [5]
Artiodactyla									
Cattle			0	1	0	0	0	1	0
Mouse deer *Tragulus* sp.	LC	P	8	0	6	0	0	4	3.13
Barking deer *Muntiacus muntjac*	LC	P	1	1	12	0	0	10	0.39
Bearded pig *Sus barbatus*	VU	NP	2	0	0	0	0	1	0.78
Sambar deer *Rusa unicolor*			0	0	4	1	0	4	0
Water buffalo *Bubalus bubalis*			0	13	18	2	2	19	0
Wild pig *Sus scrofa*	LC	NP	38	12	29	2	12	32	14.84
Carnivora									
Binturong *Arctictis binturong*	VU	P	1	0	1	0	2	3	0.39
Civet sp. (ten species)	-	-	0	0	0	2	1	3	0
Clouded leopard *Neofelis diardi*	VU	P	2	0	2	0	0	2	0.78
Domestic dog			0	0	1	0	0		0
Leopard cat *Prionailurus bengalensis*	LC	P	2	0	3	1	0	4	0.78
Malayan sun bear *Helarctos malayanus*	VU	P	5	0	6	0	12	12	1.95
Otter (three species)	VU to EN	P	0	0	8	0	0	6	0
Yellow-throated marten *Martes flavigula*	LC	NP	3	0	0	0	0	1	1.17
Perissodactyla									
Malayan tapir *Tapirus indicus*	EN	P	0	0	0	0	1	1	0
Pholidota									
Sunda pangolin *Manis javanica*	CR	P	1	0	0	0	0	1	0.39
Primata									
Agile gibbon *Hylobates agilis*	EN	P	0	3	0	0	11	10	0
Leaf monkey *Presbytis* sp.			0	1	0	0	0	1	0
Long-tailed macaque *Macaca fascicularis*	LC	NP	3	16	12	2	5	20	1.17
Pig-tailed macaque *Macaca nemestrina*	VU	NP	20	2	5	0	1	8	7.81
Siamang *Symphalangus syndactylus*	EN	NP	0	1	0	0	9	9	0
Rodentia									
Malayan porcupine *Hystrix brachyura*	LC	P	21	1	0	0	3	4	8.20
Total				**51**	**107**	**8**	**58**		

1 IUCN Red List, 2 Indonesian Law (PP No. 7/1999) P = protected, NP = not protected, 3 Tracks, scats, burrows (porcupine), diggings (buffalo and wild pig), claw marks (bear), calls (primates), 4 number of cells recorded in, 5 number of camera trap records x 100 / total number of camera trap nights

Camera traps record the time a picture is taken, from which the high and low peaks of activities of species can be derived. Clouded leopard, as the second most important predator , is mostly active during the night. Wild pigs, one of the main tiger prey species, is mostly diurnal, but also displays crepuscular and nocturnal peaks of activity (Fig. 2.4b).

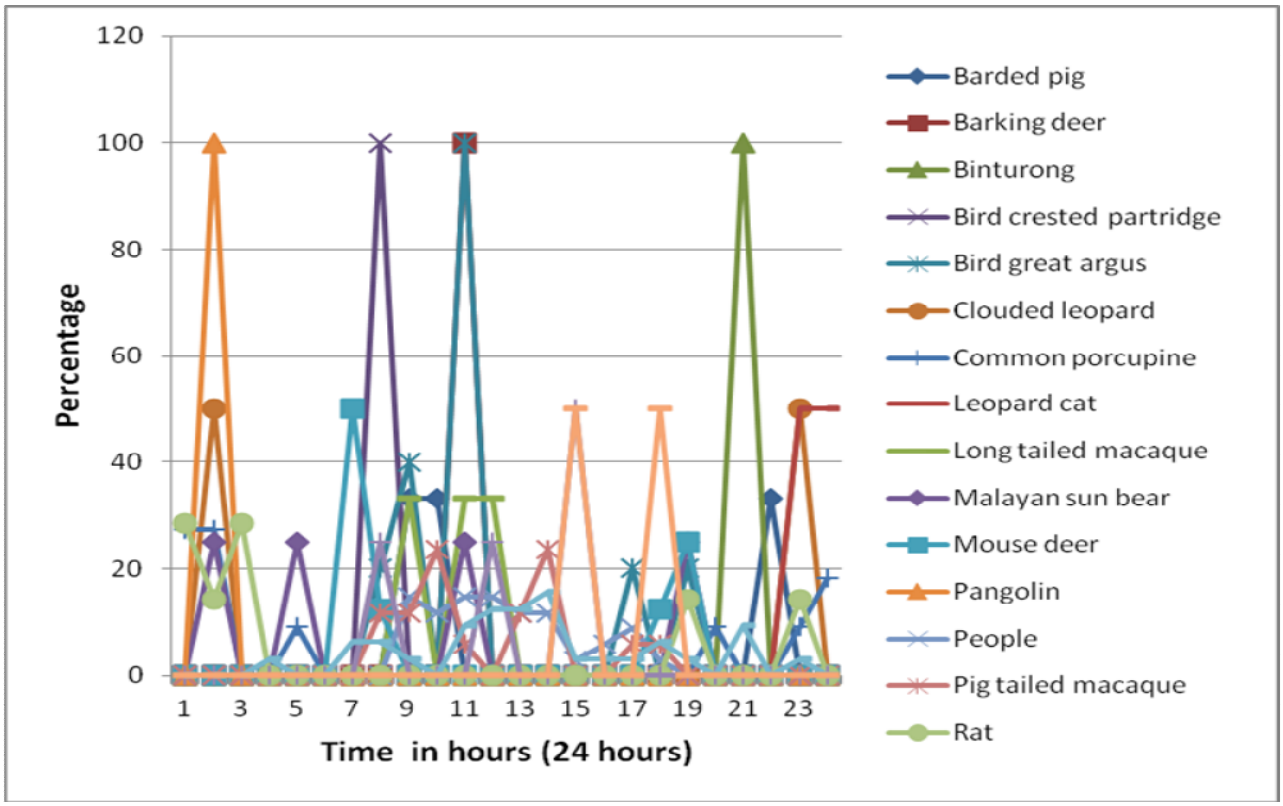

Figure 2.4b. Species activity patterns based on camera trapping results.

Community perception

Fifteen villages were surveyed, of which five were located inside the reserve, three just outside its boundaries and seven from two to nine kilometres outside RB boundaries. Fifty-seven villagers were interviewed. Perceptions of local people varied greatly, but in general the data showed there to be (a) some level of coexistence with animals, with (b) no recently reported conflict of any nature, (c) respect for the tiger and (d) support of tourism as a means of alternative income, culture and conservation programmes. Most of the interviewees were male, as it was almost exclusively men who were encountered opportunistically during surveys, working on their plantations (mostly rubber). The main livelihood of the local people was rubber farming and the low rubber price was a consistent cause of great concern and reported as a genuine threat to livelihoods.

Most interviewees mentioned their belief that tigers are their ancestors. Tigers were mentioned as having roared occasionally around plantations and having been seen along village roads and swimming across rivers. This is corroborated by WWF camera trap pictures that show tigers in plantations and in close time proximity to humans (WWF Indonesia unpublished data). However, tigers strongly prefer forest and use plantations of acacia and oil palm only occasionally (Sunarto et al. 2012). Although tigers are believed to occur nearby village areas, no significant conflicts with humans were recorded. Tiger sightings were reported just before the expedition started.

The last significant human–tiger conflict issues, according to villagers, occurred around 30 years ago. Finally, villagers often reported that they would like better infrastructure (more and better roads, electricity, mobile signal).

Illegal logging and poaching

Illegal logging was found frequently along the Subayang and Biobio rivers and their tributaries. Evidence recorded included the sound of chainsaws, logging camps, evidence of logging and logging infrastructure such as chutes for timber extraction. Government rangers expressed their frustration with the high level of logging and the lack of resources to identify and prosecute poaching and illegal logging activities. Logging occurs as an opportunitistic means of income as sources of income are few and far between locally. One of the main sources of income is rubber farming, but the low price of rubber on the market depressed income available from this source, pushing more people towards logging.

Some local people indicated that there are opportunistic and professional tiger poachers active around RB. Tiger poaching is conducted mostly through using wire snares, because the snares are easy to install, light in size and very quick to deploy. Poachers then sell tiger parts to national and international markets. As well as direct tiger poaching, RB also faces tiger prey poaching, which can also influence tiger survival rates. Local people poach tiger prey mainly opportunistically, for example to protect plantations from wild pig invasion. However, neither poaching activity seems to be prevalent at a very high level.

Rangers

Government rangers accompanied and supported the expedition's survey teams at various times throughout the expedition, and also voiced their opinions at various points during the daily debrief session in the evenings. They expressed their commitment towards nature conservation, but were clearly frustrated by the enormity of the task of patrolling several very large protected areas with only four rangers and much paperwork in the Pekanbaru office. When questioned by expedition participants about this situation, one ranger said 'it may not be very much, but it is the best we can do given the circumstances'. While accompanying survey teams, they recorded logging and logging camps found, talked to and challenged locals with timber and rubber produce, and supported teams with local information and knowledge.

School visits and engagement

Two hundred and sixty pupils in five schools were engaged during the expedition (see Table 2.4b). Activities included environmental education with an emphasis on wildlife, habitat conservation in Rimbang Baling Landscape and also promoting conservation programmes in Rimbang Baling Landscape. The outcome was an improved understanding of and support for conservation programmes in RB. Feedback from children included their plans and dreams to become conservationists or supporting conservation during their daily activities. School staff frequently stated that they were aware that they should conduct further environmental education within their school curriculum, and thanked the expedition for doing this and invited it to come back.

Table 2.4b. Schools visited during the expedition (also see photos in Appendix V).

Name of school	Type of school	Location	Pupils engaged
SD 002 Tanjung Belit	Elementary	Tanjung Belit village	74
SD 004 Batusanggan	Elementary	Batusanggan village	55
SD 003 Tanjung Belit Selatan	Elementary	Pulau Pencong village	69
SMP 4 Kampar Kiri Hulu	Junior high	Koto Lamo village	46
SMA 1 Kampar Kiri Hulu	Senior high	Gema village	16
		Total	260

Capacity-building and generation of alternative incomes

One of the joint aims of WWF and Biosphere Expeditions is to generate alternative incomes for local people based on responsible ecotourism, intact nature and tiger presence. To this end, the expedition served as an opportunity to train members of the local Pokja Batu Dinding (= Batu Dinding Community Group, BDCG). Before Biosphere Expeditions' arrival in RB, all tourism was domestic, small-scale groups and homestays. The expedition participants from Europe, North America and Australasia (see chapter 1.7) were the first ever large foreign group to visit RB. BDCG provided services such as boats and boat drivers, cooking and cleaning staff and nature guides. A total of 11 members of BDCG were employed and trained during the expedition, generating significant local income and providing training on how to accommodate and handle larger groups of visitors from industrialised nations. WWF's ecotourism officer Elmadia Achmad was the crucial link between BDCG, WWF and Biosphere Expeditions. Feedback from WWF's ecotourism programme was that 'the expedition was the first large step and chance to develop ecotourism in RB' and from BDCG that the 'expedition was our first big responsibility and encouraged us to handle such large groups of ecotourists in the future' (both quotations from Elmadia Achmad, personal communication).

In addition, two Indonesians (see chapter 1.7.) with an interest or a career in conservation were hosted and trained on the expedition as part of the Biosphere Expeditions placement programme, which seeks to indentify, train and encourage the next generation of local conservationists.

2.5. Discussion & conclusions

Tiger presence/absence

WWF has been monitoring tiger density in RB through camera trapping since 2006. Data obtained before 2013 have revealed seven tigers in RB, with only two of them residing in the reserve (Sunarto et al. 2013), and a low tiger density compared to most other Sumatran landscapes. Although longer in duration than the expedition, the WWF study, like the expedition, did not record any tigers in lowland areas of RB.

The average tiger capture rate during the WWF study (no variation around the mean was given), carried out to the southeast of the current study site, was 0.4 tigers for every 100 camera trap nights (Sunarto et al. 2013), or one tiger captured for every 250 trap nights. The survey effort of 265 trap nights during the current expedition thus had a theoretical chance of recording a tiger, provided camera traps were placed in suitable tiger habitat. The deployment of camera traps along the borders of the reserve was done on purpose during the inaugural year of the expedition in order to ascertain whether this was suitable habitat. Sampling was conducted along rivers, with villages being found all along, with the hypothesis being that such areas are a valid representation of the entire sampling area. However, compared to the WWF study, camera traps recorded nine times more people (ratio of 100:9.4 trap nights:people) with the low ground obviously facilitating access and thereby in all likelihood having a negative influence on tiger presence rates. This corroborates findings by Sunarto et al. (2012) who showed that human disturbance negatively affected occupancy and habitat use by Sumatran tigers. Indeed, their presence at all spatial scales was shown to be strongly and positively correlated with core areas of forest blocks and altitude, and negatively with human settlement and disturbance. That does not mean, though, that tigers are completely absent from low ground, only that they may not be as frequently captured by camera traps as on high ground. Tigers are likely to be present, as during this survey villagers reported seeing or hearing tigers occasionally roaming near villages and swimming across rivers. Much of the initial stage of the expedition was spent on scouting the ground and building relationships with local people. Only later were camera traps employed more intensely. This is the reason for the relatively low number of trap nights (256). Given that, firstly, 250 trap nights on average yield one tiger capture in good tiger habitat and, secondly, that good habitat is found away from human disturbance, it is not surprising that no camera traps recorded tigers during the expedition.

Our survey detected low hunting pressure directed at both tiger prey and vulnerable species. However, the fact that WWF has seized over a hundred tiger snares in the reserve in 2015 indicates that the tiger is threatened by selective poaching. It is not known whether poachers are from outside local communities or whether they have any type of support from them.

Prey species

The feeding habits of Sumatran tigers have thus far not been investigated by standard procedures such as analysis of faecal samples, records of carcasses or direct observation. Linkie and Ridout (2011) used an alternative approach to determine prey preferences in the Kerinci Seblat National Park in west-central Sumatra. Using camera traps that record the time pictures were taken, they quantified the temporal overlap between the Sumatran tiger and five of its presumed prey species. They found that tiger activity patterns were correlated with those of the barking deer and sambar *Rusa unicolor*, with sambar occurring at low abundances in their study site and being detected nearly ten times less frequently than the other species and as frequently as the wild pig.

The sambar is absent or nearly absent from RB, and wild pigs, in contrast to the conditions found by Linkie and Ridout (2011) in their study area, are the most abundant and widespread prey species in RB. Wild pigs have also been found to be the most abundant prey species in Barisan Selatan National Park in the extreme southwest of Sumatra, where

the species was found to share with sambar a correlation with tiger abundance (O'Brien et al. 2003). The widespread presence of wild pigs in the people-disturbed lowland area of RB may mean several things. First, that a good amount of prey is available to the tiger, which would increase the likelihood of its presence in the surveyed area. Its apparent low presence could thus possibly be derived from disturbance, in support of Sunarto et al.'s (2012) conclusions. Second, the presence of wild pigs near relatively high human density may mean that hunting of wild pigs is not excessive in RB, denoting a good level of coexistence of people and the most common prey species of the tiger in the area. The study made by O'Brien et al. (2003) supports this theory. They found that prey species and tigers have a greater abundance distant from human disturbances. Abundance (RAI) of tigers, two species of mouse deer, wild pigs and sambar deer were shown to be four times higher in areas with low human population density, while densities of red muntjac and pigtail macaques were twice as high. As prey species were frequently recorded during sampling by the expedition in lowland habitats, this could be considered supporting evidence that tigers in fact occasionally roam on low ground, as reported by villagers.

One of the authors (F.A.W), who is familiar with the habits of villagers, adds that local people have a tradition of hunting with dogs, targeting deer and other prey species. Wild pigs, however, are not hunted for food (the vast majority of local people are Muslims), but as a pest animal that causes losses to plantations. Our results, on the other hand, support the notion that such hunting is not very intensive in the surveyed area, given that camera traps detected dogs just once, and wild pigs were found to be quite widespread.

Furthermore, WWF has recorded in RB, always in low numbers, the Sumatran serow *Capricornis sumatraensis*, a species not recorded during the expedition. The serow belongs to the family Capridae. It is rare in most places and in Riau is found only in RB. Its range encompasses Malaysia, Thailand and Sumatra, but always in small populations and concentrated in a few areas. In Sumatra its range is limited almost entirely to the volcanic mountain chain of the Barisan Mountains, which run along the western spine of Sumatra, from Aceh in the north to Lampung in the south (Duckworth et al. 2008). The serrow is hunted for its meat and for traditional medicine, at local and international level (Shepherd and Krishnasamy 2014).

Other target species

The presence of threatened and vulnerable species as found by the expedition may be an indication of good habitat quality and relatively low human pressure. The agile gibbon and the siamang, both classified as Endangered (EN) by the IUCN, were commonly found during the surveys in RB. Their threat status is primarily due to loss of habitat, but also due to illegal hunting and trade (Nijman 2009). Their presence in RB may thus be interpreted as the availability of suitable high-quality habitat and low pressure for trade. Although both species also occur in Peninsular Malaysia, over 90% of their populations are found in Sumatra (Nijman 2009).

Otters (unidentified species) were repeatedly recorded in RB. Three species occur in Sumatra; two of them are considered Vulnerable (VU) and one, *Lutra sumatrana*, is considered Endangered (EN) by the IUCN. It is the rarest and least known among the five species of otters occurring in Asia, being endemic to Southeast Asia. It is threatened by illegal wildlife trade and loss of habitat (Aadrean et al. 2015).

Two other highly threatened species, the Sunda pangolin *Manis javanica* and the Malayan tapir *Tapirus indicus*, were recorded only once, the first by camera trap and the latter by its droppings (dung). The Sunda pangolin is considered Critically Endangered (CR) by the IUCN due to high levels of hunting and poaching for its meat and scales, which is primarily driven by exports to China, though local consumption and utilisation also take place across the species' range (Challender et al. 2014). The species has a wide range, but historical hunting and trade have depleted most of its populations. Despite national and international protection, 12,000 pangolins were seized recently in Indonesia, in an industrial, international-scale trade, indicated by the size of shipments and transportation in containers and seizures in seaports and at airports (Nijman 2015). The reason they have not been recorded more often during the expedition is not known, but it may be due to hunting, as the animal is relatively easy to catch.

The Malayan tapir is listed as Endangered (EN) by the IUCN. Regularly recorded elsewhere in Sumatra (O'Brien et al. 2003, Novarino 2005, Linkie and Ridout 2011), it appears to occur at low numbers in RB, not necessarily as a result of poaching, but possibly as a result of the difficult terrain, as it prefers lowland forests (Lynam et al. 2008).

Other species considered Vulnerable (VU) by the IUCN that were repeatedly recorded were the pig-tailed macaque, the Malayan sun bear and the clouded leopard, supporting the hypothesis of the relatively good habitat conditions in RB. Other species of the same IUCN status that were recorded only occasionally were the binturong and the bearded pig.

Community and capacity

Although most local people appear to have a positive attitude towards the tiger and not perceive it as a threat that needs to be combated, the mere presence of humans in the area is detrimental to the tiger. In addition, the authorities are clearly struggling to both quantify and contain illegal activities such as logging, poaching and forest conversion. One way around this seeming impasse and one-way street towards nature destruction is to convert local people into conservationists and guardians of nature and the tiger. However, this will only happen through education and if intact nature and tiger presence can generate alternative incomes. As Feintrenie et al. (2010) have observed for Indonesia, local people ‘do not hesitate to change their livelihood system if it can increase their income’, but also that ‘their cultural or sentimental attachment to the forest is not sufficient to prevent forest conversion’. Shanee (2012) has shown in detail how this can work, even for single-species conservation challenges, and there are many other success stories of community-based conservation initiatives (e.g. Abensperg-Traun et al. 2011, Standley and Emslie 2013, Horwich 2015). While Biosphere Expeditions and its activities combining wildlife conservation and ecotourism activities can only be a small part of this process, for one because expeditions happen only for part of the year, it can nevertheless be an important showcase and driver for successful community-based conservation in RB. WWF’s continued involvement, as the local, on-the-ground NGO present year-round, is crucial in all this, as is its work with the authorities to keep RB on the agenda in what today is the very beleaguered world of nature conservation on the island of Sumatra.

Conclusions

Despite the relatively short survey times and the widespread presence of people in the area studied, a number of species including tiger prey and those considered highly threatened were repeatedly recorded, pointing towards relatively good and intact habitat conditions in the areas of RB that were surveyed by the expedition.

The authors agree with, and the data presented here corroborate, Sunarto et al. (2012), and we believe that RB is indeed an important habitat for tigers because of its steep, rugged and forest-covered topography that inhibits human occupation away from the major rivers, where there are human settlements, disturbance and conversion of forest to either rubber tree plantations on the slopes and/or oil palm plantations on the few flat areas that fringe the larger rivers in RB.

However, there are significant threats to continued tiger presence in RB. These include an increasing human population with developing infrastructure, concomitant with further forest encroachment and conversion, logging and other illegal activities such as poaching, which are barely studied and quantified, let alone contained by the authorities tasked with nature protection due to a severe shortage in resources.

These threats can be countered by a combination of continued (1) research and conservation activities, with Biosphere Expeditions continuing to assist WWF Indonesia, (2) education and capacity-building with the expedition playing its role in training BDCG, local placements, visiting further schools, as well as interviewing and educating more adults, and (3) advocacy by WWF to keep RB on the government's conservation agenda with Biosphere Expeditions assisting by continuing to build good relations with government rangers and relevant authorities.

Recommendations for conservation and future expeditions

1. As the main target species, the tiger, is quite rare, using single camera traps rather than double cameras per station will double their sampling power.

2. Bunching several cameras in a single 2 x 2 km cell creates autocorrelated data and hampers sampling of different habitats. Instead, only up to two cameras for each 2 x 2 km cell should be used and the sampling effort should be spread out more.

3. The number of trap nights should be increased through working with the local community in trap placement and maintenance so that traps are not just placed for the duration of an expedition, but beyond, with the expedition serving as a focal point for data-gathering activities.

4. Training members of BDCG and other communities in camera trap placement and maintenance should be given high priority as this will greatly increase number of trap nights and also create another means of nature-based income for the local communities. WWF and Biosphere Expeditions should develop a training and payment system and attempt jointly to raise funding for this. The expedition can then serve as a focal point for training and data-gathering activities.

5. Surveys should be extended away from the main rivers and deeper into the forest, thus getting away from human disturbance and covering cells deeper in the forest. This can be done by organising multi-day excursions into the forest with the support of the local community. This will also increase educational and capacity-building opportunities and generate more income for local communities. For this purpose, the ability and willingness of expedition participants to take part in such extended surveys should be assessed as soon as participants arrive on site and a plan should be formulated in discussion with participants and BDCG during the first few days of the expedition. Participants willing and able to take part in extended surveys should then do so, together with a capable member of senior staff (either the expedition leader or the scientist). Remaining participants should then concentrate on surveys as well as community activities that can be done within the space of a single day, and do so under the supervision of the remaining member of senior staff (either the expedition leader or the scientist). Finally, as far as possible, a re-structured study design should compare lowland cells with villages with highland cells without villages.

6. Continue and extend school visits, and cooperation with rangers and local authorities and the BDCG, with the expedition serving as a showcase and focal point for such activities. The WWF scientist should develop a plan for community visits, relationship development and interviews, to be worked through by the expedition.

7. Capacity-building activities should be continued and extended. More connections with villages should be made to increase survey range and alternative income generation. The WWF scientist should develop a plan for this, to be worked through by the expedition.

8. The local placement programme should be continued, with WWF assisting in recruiting suitable candidates.

9. Authorities and WWF should find means to investigate the groups that are placing snares in the reserve. The expedition can assist with this as necessary.

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Appendix I: Summary of expedition camera trapping effort in Rimbang Baling 2015.

Station Code	Cell ID	Latitude*	Longitude*	Date installed**	Date removed**	Trap Nights
AA130_1	AA130	11251865	-21439	25/5/2015	8/6/2015	15
AA130_2	AA130	11252091	-19590	25/5/2015	8/6/2015	15
AA130_3	AA130	11252329	-19504	25/5/2015	8/6/2015	15
AB131	AB131	11250721	-18736	13/5/2015	6/6/2015	25
AA130	AA130	11250721	-18736	4/8/2015	2/9/2015	30
AA131_1	AA131	11250690	-20272	30/7/2015	31/8/2015	33
AA131_2	AA131	11252823	-21224	19/8/2015	2/9/2015	15
X128	X128			19/8/2015	Stolen	0
X130	X130	11246361	-18706	18/8/2015	29/8/2015	12
X131	X130	11246361	-18706	1/8/2015	18/8/2015	18
Z131_1	Z131	11250010	-21439	30/7/2015	1/9/2015	34
Z131_2	Z131	11249898	-20917	30/7/2015	1/9/2015	34
Z131_3	Z131	11249175	-85053	14/8/2015	1/9/2015	19
					Total trap nights	265

*UTM Datum WGS 84 **day/month/year

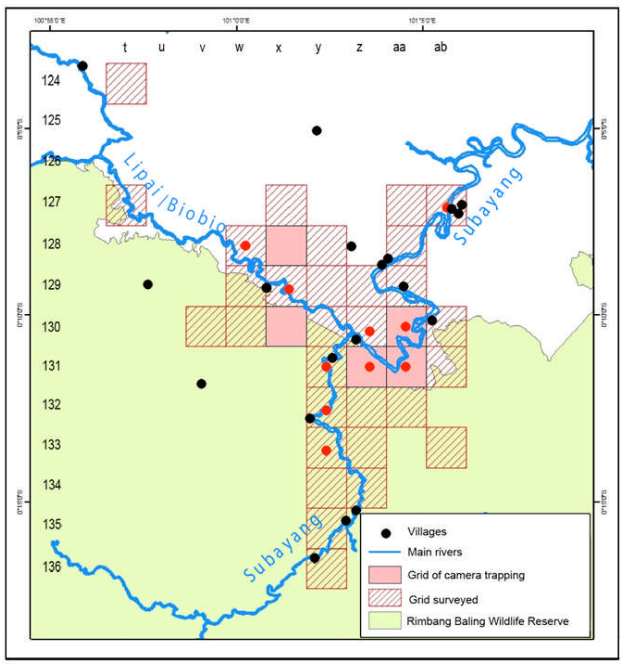
Appendix II: List of birds recorded during the expedition in Rimbang Baling 2015.

	Species	Scientific name
1	Asian palm swift	*Cypsiurus balasiensis*
2	Black bittern	*Ixobrychus flavicollis*
3	Black nest swiftlet	*Aerodramus maximus*
4	Black-capped kingfisher	*Halcyon pileata*
5	Blue-breasted quail	*Coturnix chinensis*
6	Blue-crowmed hanging parrot	*Loriculus galgulus*
7	Blue-eared kingfisher	*Alcedo meninting*
8	Blue-throated bee-eater	*Merops viridis*
9	Blue-wattled bulbul	*Pycnonotus nieuwenhuisii*
10	Blue-winged leafbird	*Chloropsis cochinchinensis*
11	Bronzed drongo	*Dicrurus aeneus*
12	Chestnut-naped forktail	*Enicurus ruficapillus*
13	Chestnut-breasted malkoha	*Phaenicophaeus curvirostris*
14	Chestnut-headed bee-eater	*Merops leschenaulti*
15	Collared kingfisher	*Todiramphus chloris*
16	Common pipit	*Anthus pratensis*
17	Crested serpent eagle	*Spilornis cheela*
18	Crimson-breasted flowerpecker	*Prionochilus percussus*
19	Dowitcher	*Limnodromus* sp.
20	Mossy nest swiftlet	*Aerodramus salangana*
21	Eurasian tree sparrow	*Passer montanus*
22	Great argus	*Argusianus argus*
23	Greater coucal	*Centropus sinensis*
24	Greater green leafbird	*Chloropsis sonnerati*
25	Greater racket-tailed drongo	*Dicrurus paradiseus*

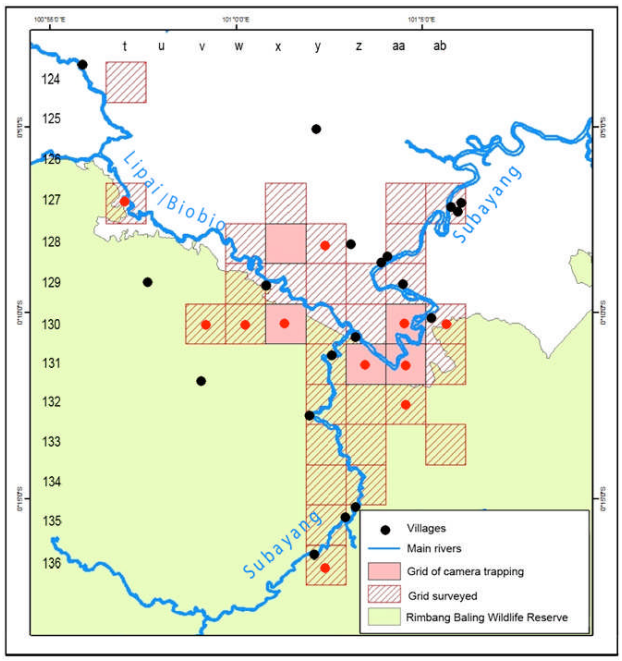
26	Horsfield's babbler	*Malacocincla sepiaria*
27	Javan myna	*Acridotheres javanicus*
28	Red jungle fowl	*Gallus gallus*
29	Lesser adjutant	*Leptoptilos javanicus*
30	Lesser coucal	*Centropus bengalensis*
31	Lesser green leafbird	*Chloropsis cyanopogon*
32	Magpie robin	*Copsychus saularis*
33	Orange-breasted trogon	*Harpactes oreskios*
34	Pacific swallow	*Hirundo tahitica*
35	Plain-throated sunbird	*Anthreptes malacensis*
36	Purple heron	*Ardea purpurea*
37	Red billed malkoha	*Phaenicophaeus javanicus*
38	Rhinoceros hornbill	*Buceros rhinoceros*
39	Scaly-breasted bulbul	*Pycnonotus squamatus*
40	Scarlet-breasted flowerpecker	*Prionochilus thoracicus*
41	Slender-billed crow	*Corvus enca*
42	Sooty-headed bulbul	*Pycnonotus aurigaster*
43	Spectacled spiderhunter	*Arachnothera flavigaster*
44	Stork-billed kingfisher	*Pelargopsis capensis*
45	Striated heron	*Butorides striata*
46	Yellow wagtail	*Motacilla flava*
47	Whiskered treeswift	*Hemiprocne comata*
48	White-chested babbler	*Trichastoma rostratum*
49	White-crowned hornbill	*Berenicornis comatus*
50	White-fronted scops-owl	*Otus sagittatus*
51	Woodpecker, unidentified	-

Appendix III: Distribution of mammals recorded in the grid space, indicated by red circles (accurate to cell location). For a bigger map of the study site, see Fig. 2.4a.

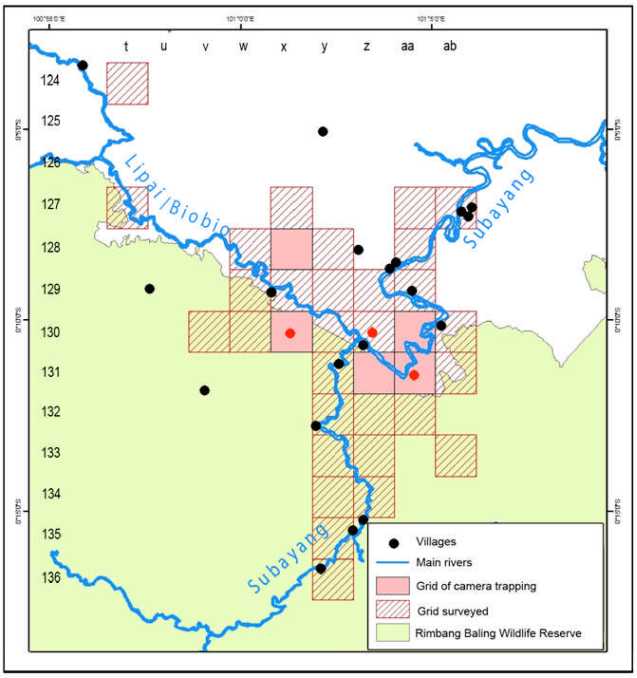
Agile gibon



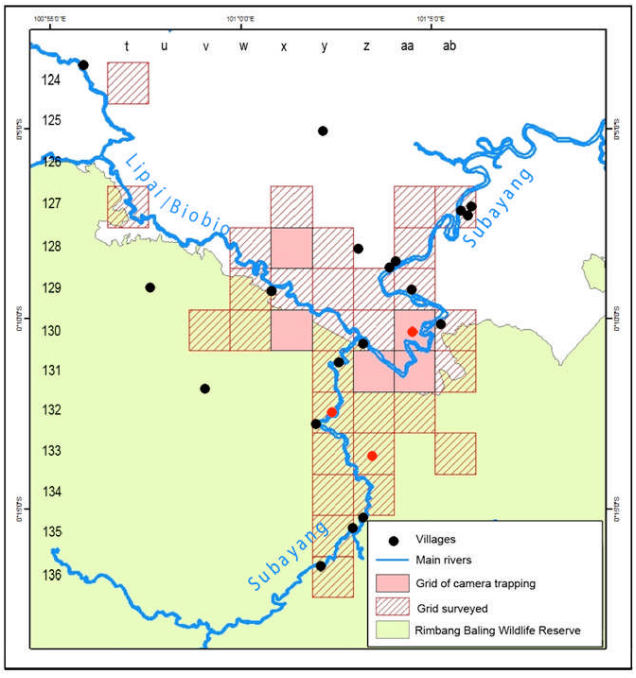
Barking deer



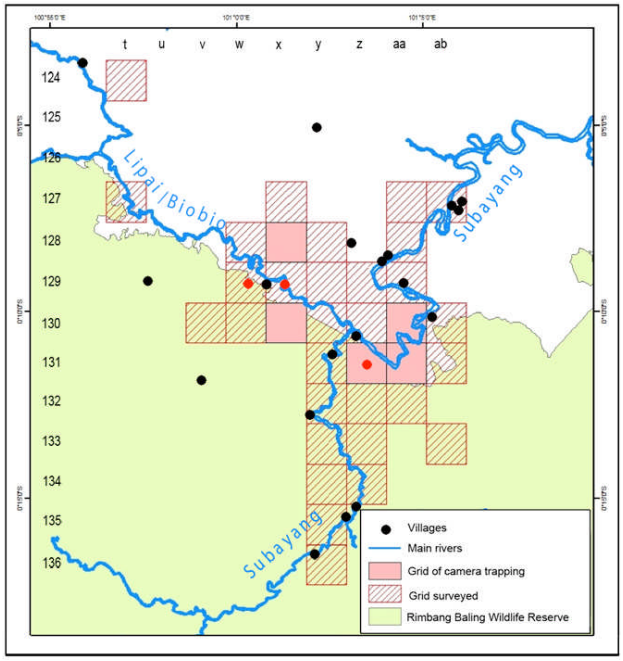
Binturong



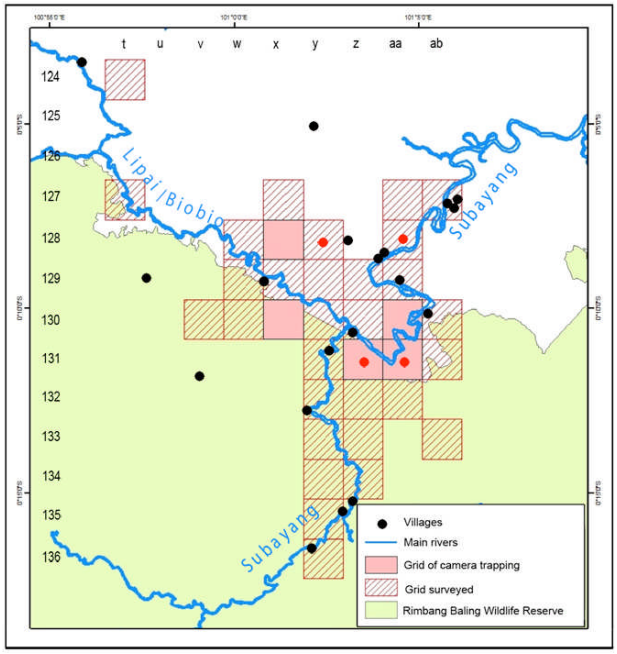
Civet



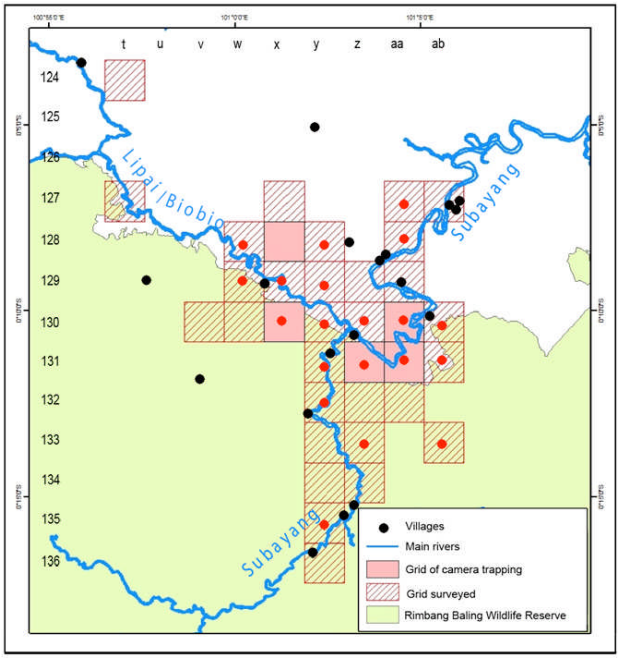
Clouded leopard



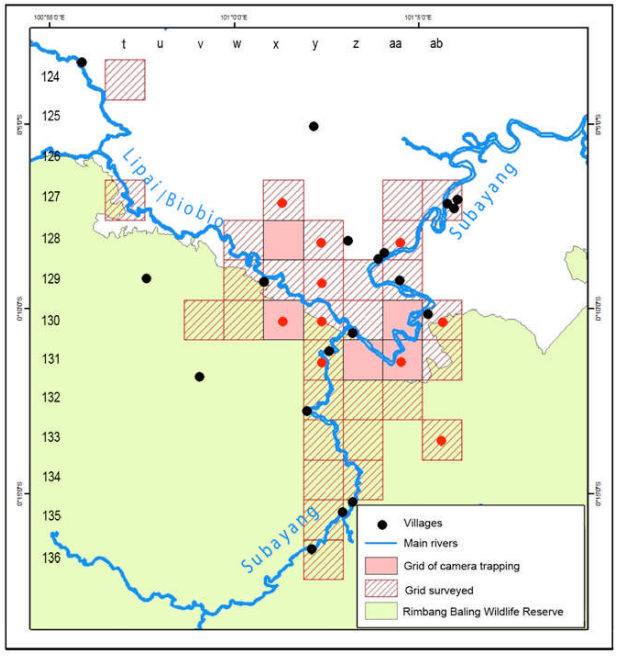
Leopard cat



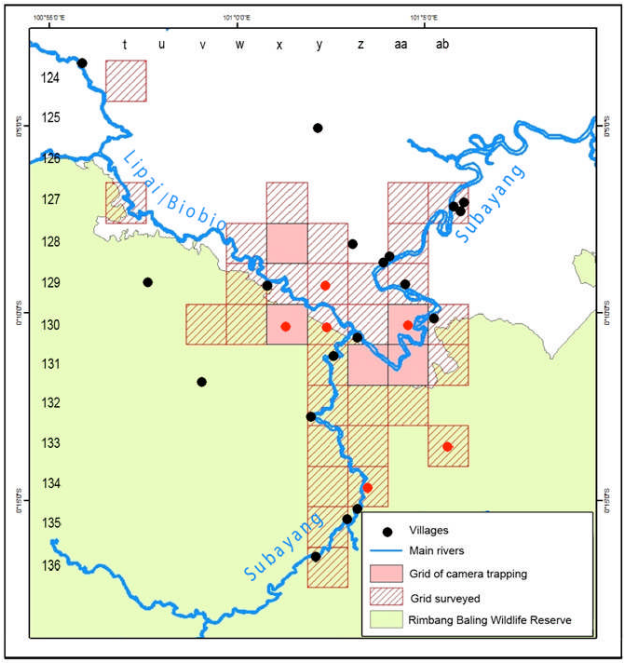
Long-tailed macaque



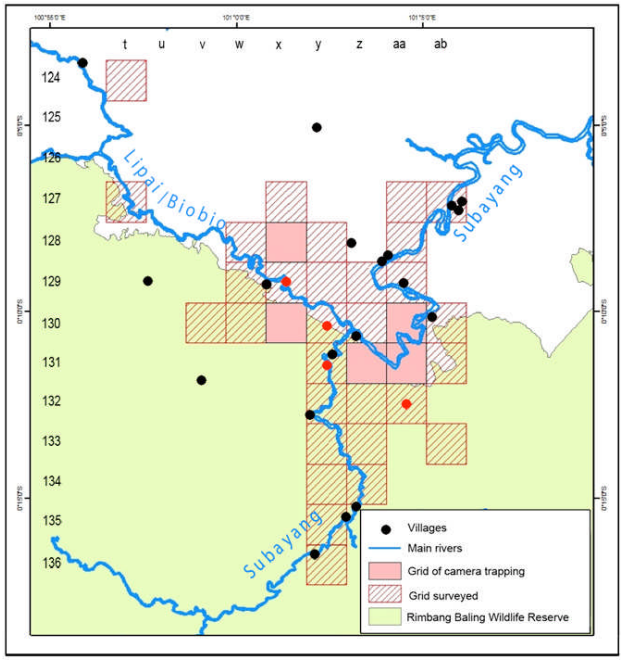
Mouse deer



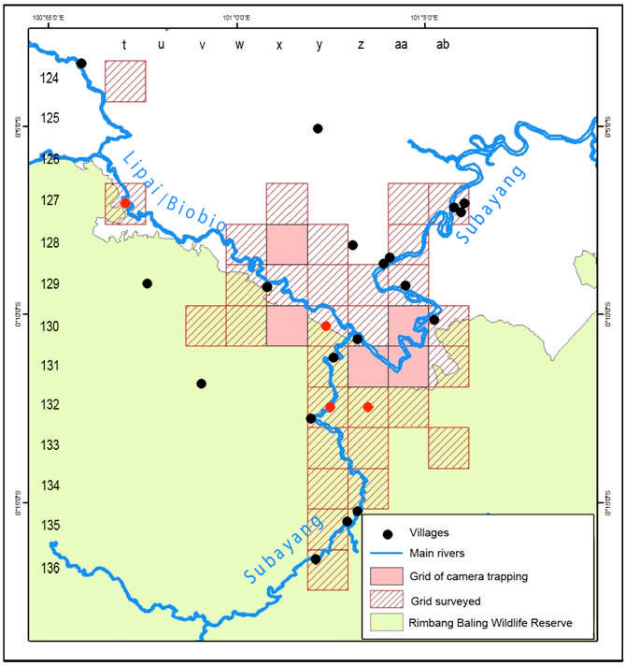
Otter



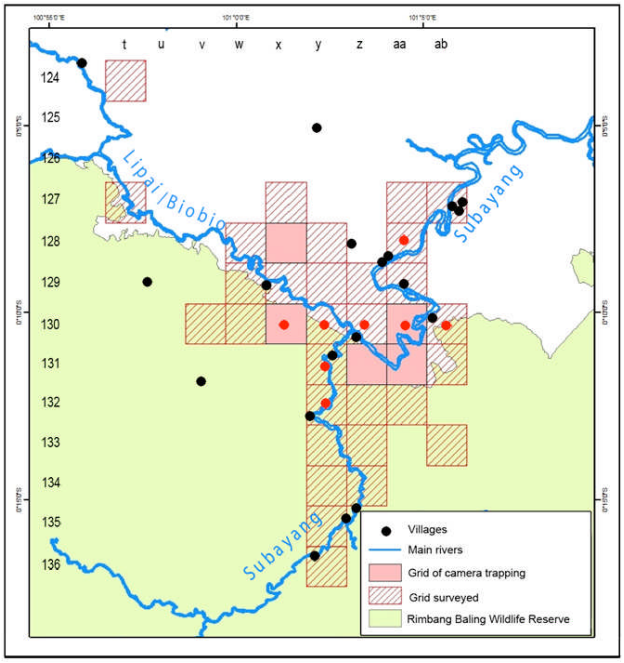
Porcupine



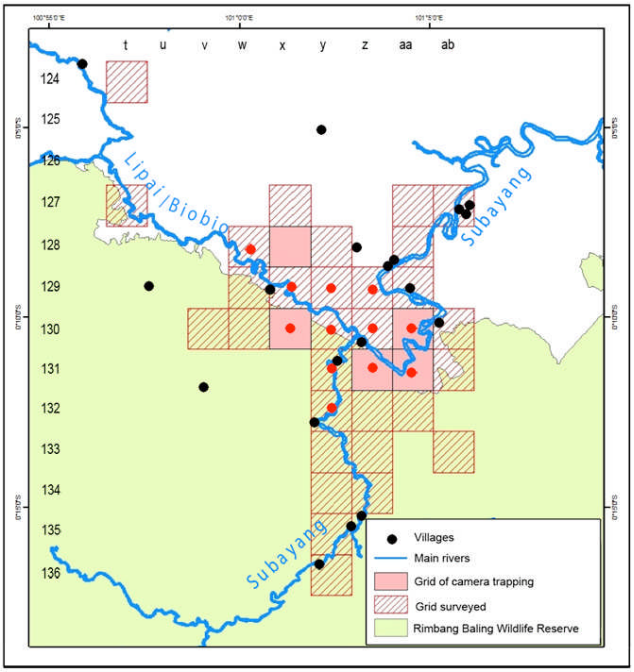
Sambar



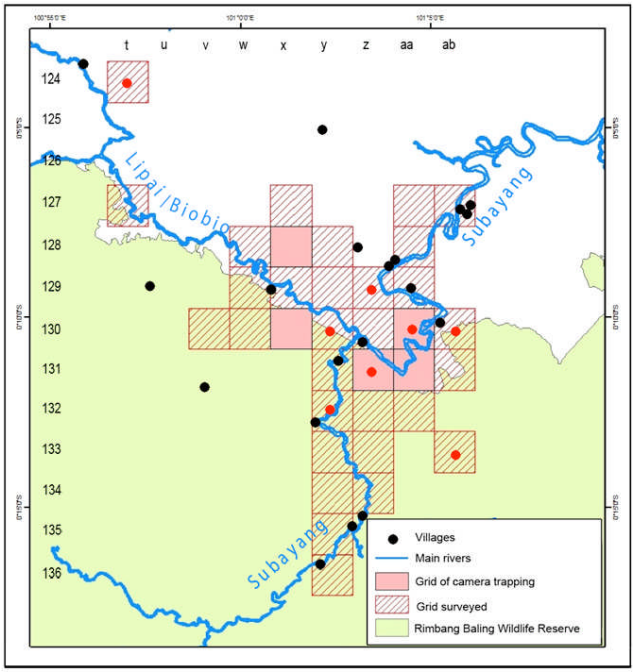
Siamang



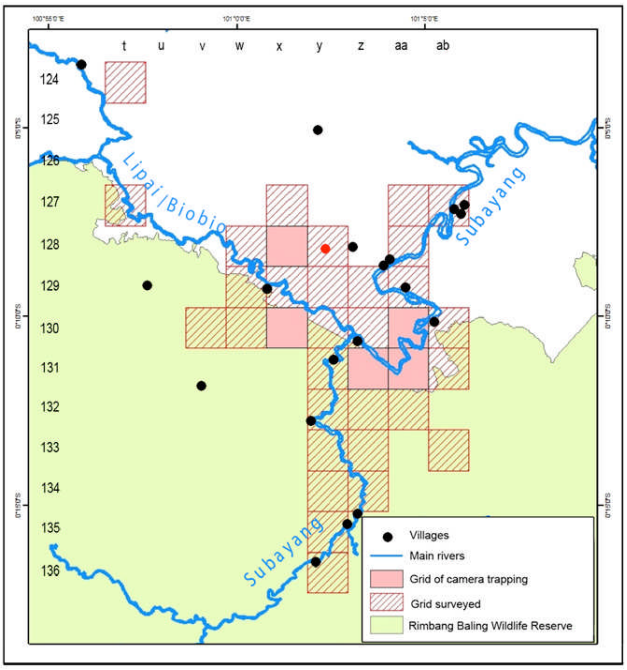
Sun bear



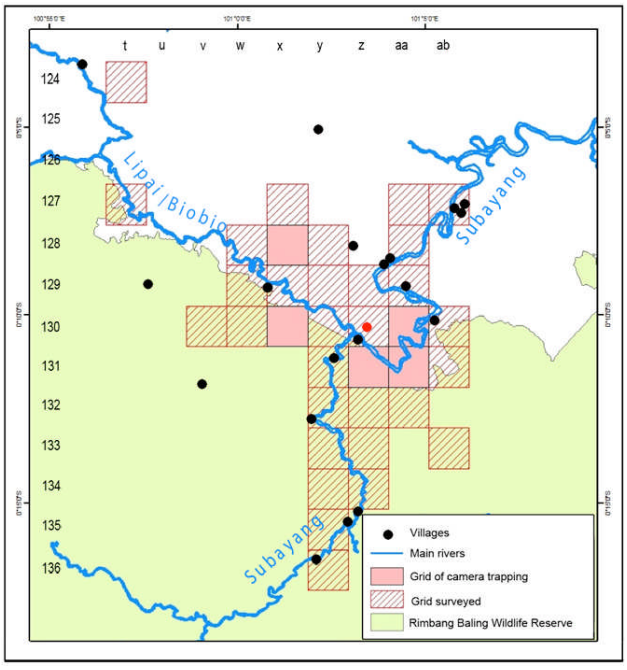
Pig-tailed macaque



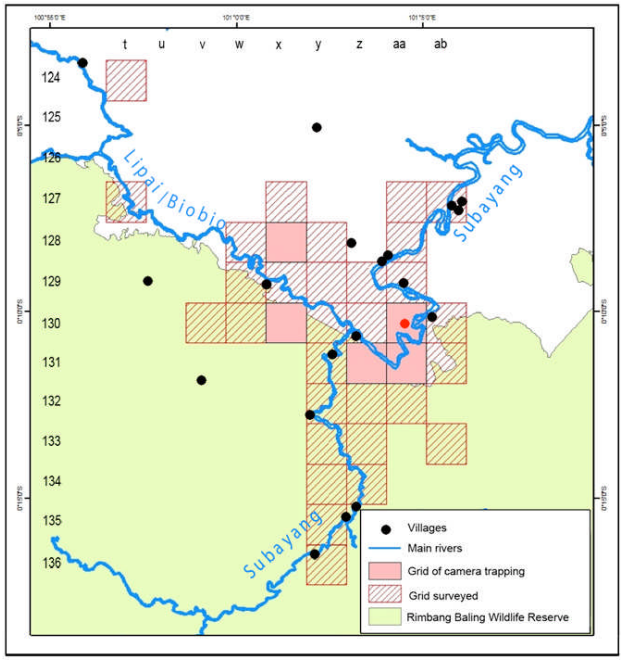
Leaf monkey



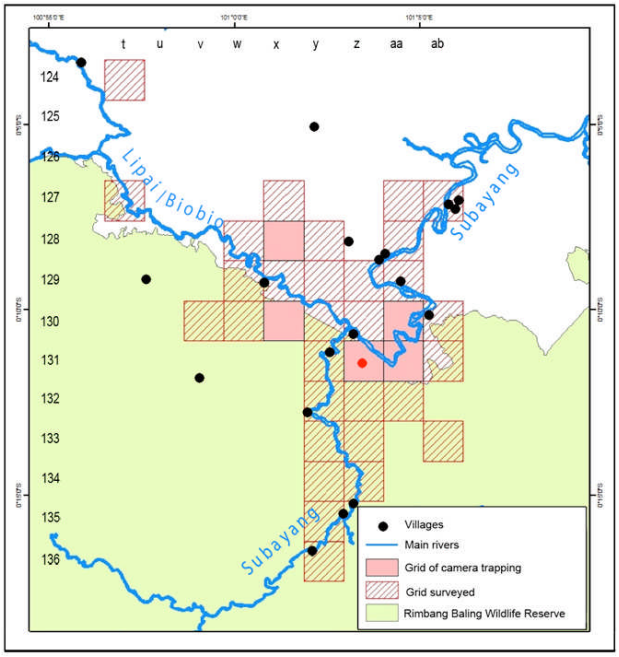
Malayan tapir



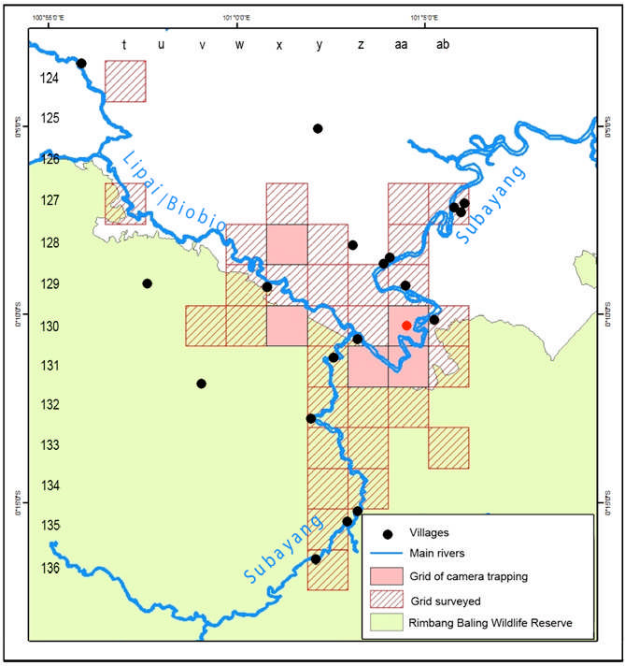
Pangolin



Bearded pig



Yellow-throated marten



Appendix IV: Species recorded by camera traps: clouded leopard (top), Malayan sun bear (centre) and pig-tailed macaque (bottom).

Appendix V: School visit pictures: SMP 4 Kampar Kiri Hulu (top), SD 002 Tanjung Belit (middle), SMA 1 Kampar Kiri Hulu (bottom).

Appendix VI: Expedition diary and reports

A multimedia expedition diary is available at https://biosphereexpeditions.wordpress.com/category/expedition-blogs/sumatra-2015/.

All expedition reports, including this and previous expedition reports, are available at www.biosphere-expeditions.org/reports.