


Int. Zoo Yb. (2019) **53**: 1–13

DOI:10.1111/izy.12226

Shift of paradigm needed towards improving human–elephant coexistence in monoculture landscapes in Sabah

N. OTHMAN^{1,2} , B. GOOSSENS^{3,4,5,6}, C. P. I. CHEAH⁷, S. NATHAN^{6,8},
R. BUMPUS⁹ & M. ANCRENAZ¹⁰

¹*Project Seratu Aatai, Unit S10-S12, 1st Floor, The Peak Vista, Block B, Lorong Puncak 1, Tanjung Lipat, 88400 Kota Kinabalu, Sabah,* ²*Movement and Spatial Ecology Lab, Department of Wildlife, Fish, and Environmental Studies, Faculty of Forest Sciences, Swedish University of Agricultural Sciences, SE-901 83 Umea, Sweden,* ³*Danau Girang Field Centre, c/o Sabah Wildlife Department, Wisma Muis, 88100 Kota Kinabalu, Sabah,* ⁴*Cardiff School of Biosciences, Cardiff University, Sir Martin Evans Building, Museum Avenue, Cardiff, CF10 3AX, United Kingdom,* ⁵*Sustainable Places Research Institute, Cardiff University, 33 Park Place, Cardiff CF10 3BA, United Kingdom,* ⁶*Sabah Wildlife Department, Wisma Muis, 88100 Kota Kinabalu, Sabah,* ⁷*WWF-Malaysia (Sabah Office), 6th Floor, Centre Point Complex, 88000 Kota Kinabalu, Sabah,* ⁸*Wildlife Rescue Unit (WRU), Sabah Wildlife Department, Wisma Muis, 88100 Kota Kinabalu, Sabah,* ⁹*Houston Zoo, 1513 Cambridge Street, Houston, Texas 77030, USA, and* ¹⁰*HUTAN-Kinabatangan Orangutan Conservation Project, Unit S10-S12, 1st Floor, The Peak Vista, Block B, Lorong Puncak 1, Tanjung Lipat, 88400 Kota Kinabalu, Sabah*

E-mail: nurzhafarina@gmail.com

This article outlines the contemporary situation of the Bornean elephant *Elephas maximus borneensis* in Sabah (Malaysian Borneo), and focuses on the existing challenges that need to be addressed to enable people and elephants to coexist, particularly in man-made landscapes dominated by oil-palm plantations. Bornean elephants are confined mostly to Sabah, to the north-east 5% of the Borneo Island. Sabah started to expand its commercial plantation sector in the early 1980s and is the largest producer of palm oil in Malaysia, contributing *c.* 10% of global output for this commodity. The rapid pace of plantation expansion has resulted in the loss of the majority of lowland areas that are also needed by large mammal species to sustain breeding populations. Elephants are extreme lowland/floodplain specialists, and they still attempt to use their former and preferred habitat, which is now mostly dominated by oil-palm plantations. At the time of writing, the land-use planning system favoured by the government insufficiently incorporates the ecological and management needs for elephants across the entire landscape. This article also highlights the need for better collaboration and coordination between stakeholders to address the increasing rate of human–elephant conflicts in Sabah.

Key-words: Bornean elephant; capacity building; coexistence; human–elephant conflict; local communities; oil-palm plantation; Sabah; stakeholders.

INTRODUCTION

The Bornean elephant *Elephas maximus borneensis* has the smallest distribution range of the four Asian elephant subspecies; occurring in the north-east 5% of Borneo Island, mostly in the east of Sabah in Malaysia and across to the north of Kalimantan in Indonesia (Othman *et al.*, 2013). This subspecies is the least aggressive of all Asian elephant taxa (Shim, 2000; Othman *et al.*, 2013; Payne & Davies, 2013). Two hypotheses have been proposed to explain the occurrence of elephants on Borneo. Either the Bornean elephant is native to the Island (Fernando *et al.*, 2003; Sharma *et al.*, 2018) or alternatively there

are claims that the subspecies was introduced by people in more recent times (Fernando *et al.*, 2003). For the first claim, the Bornean elephants may be indigenous to Borneo having migrated to the Island when the Sunda Shelf was exposed during the Pleistocene (Fernando *et al.*, 2003), in a similar way to the Bornean orangutan *Pongo pygmaeus*. Shim (2000) has suggested that the elephants in Borneo might be the descendants of the extinct Javan elephant *Elephas maximus sondaicus*. For the second claim, it is possible that Bornean elephants were introduced to Borneo when the East India Company presented a few elephants to the Sultan of Sulu as a gift in 1750 (Sharma *et al.*, 2018). These individuals might have been brought from India, Sumatra or Peninsular Malaysia (Fernando *et al.*, 2003).

Previous uncertainty over the evolutionary origin of the Bornean elephant has been greatly clarified by a series of population genetic analyses using recent techniques, such as the full-likelihood Bayesian approach (Sharma *et al.*, 2018). Comparing various model estimations based on relevant demographic and historical parameters, such as the effective population sizes of founding populations and putative introduction times, and using both microsatellite and mitochondrial data, Sharma *et al.* (2018) concluded that the results supported the natural colonization of Bornean elephants via the Sunda Shelf at the end of the Pleistocene bottleneck, 11 400–18 300 years ago. This conclusion strongly reinforces the conservation value of this subspecies and supports taking actions that will safeguard Bornean elephants for the future.

The Asian elephant *Elephas maximus* is categorized as Endangered on the Red List of the International Union for Conservation of Nature (IUCN, 2018). Since 2013, the Bornean elephant has been protected under Schedule I 'Totally Protected Species' in Sabah, which is the highest level of protection under the Sabah Wildlife Conservation Enactment 1997. Consequently, any person

caught killing or hunting an elephant will receive a mandatory jail sentence of between 6 months and 5 years (Sabah Wildlife Department, 2012). In the early 2000s, the Bornean elephant population in Sabah was estimated to be *c.* 2040, split into five managed ranges (Alfred *et al.*, 2011).

REASONS FOR INCREASING HUMAN–ELEPHANT CONFLICTS IN SABAH

Several factors that work either in isolation or in combination have resulted in increased human–elephant conflicts over the past few years throughout the state of Sabah.

Elephant behaviour

Individual animals differ in behaviours, such as movement and dispersal, exploration and tendency for risk taking, and these behaviours can vary in response to environmental conditions (Freeman *et al.*, 2004; Sih *et al.*, 2011). Several studies have shown that some female-led family units and some adult males are crop-raiders; however, this behaviour is not observed in all elephants (Sukumar, 2003; Joshi, 2010; Maltby & Bouchier, 2011). As the number of encounters between elephants and humans increases in Sabah there may be a corresponding influence on the behavioural repertoire of the elephants resulting in the people developing even more negative attitudes (Kumar & Singh, 2010). Such cyclical processes may aggravate existing human–elephant conflicts, which in turn could lead to undesirable consequences on both sides.

Habitat loss, conversion and fragmentation

Prime elephant habitat used to cover the extreme lowland and flat terrain of the eastern area of Sabah (Payne & Davies, 2013). Over the past 40 years, this natural habitat

has been reduced by at least 60% following forest conversion to other types of land use (primarily agriculture) (Gaveau *et al.*, 2014). Elephants increasingly rely on non-protected areas for their movements and dispersal, and food ranging activities (Fernando *et al.*, 2008; Kumar *et al.*, 2010; Gaveau *et al.*, 2014). Several Managed Elephant Ranges are completely isolated from other elephant populations in extensive oil-palm production landscapes; for example, Tabin Wildlife Reserve and Lower Kinabatangan. Therefore, elephants will venture outside the forest and encroach on agricultural lands to forage (Ancrenaz *et al.*, 2007; Othman *et al.*, 2013), creating the potential for conflicts with the people living and working outside the protected forests.

The elephant range in Sabah is fragmented by roads and linear infrastructures, human settlements and other man-made elements; for example, the Batu Puteh Bridge, which crosses the Kinabatangan River, has split the Kinabatangan elephants into two completely isolated populations (Estes *et al.*, 2012). Furthermore, the recent ongoing upgrade of the ‘Pan Borneo Highway’, a federal-government-funded project that involves the development of new road networks while upgrading existing ones, will worsen the fragmentation of the elephant range. The proposed alignment of the highway will transect the entire range, impeding the movement of several herds and further isolating elephant populations. This expanded road network will also potentially result in more road accidents involving elephants and could facilitate increased hunting pressure as poachers will gain better access routes into areas inhabited by wildlife (Othman *et al.*, 2013; Redpath *et al.*, 2013; Clements *et al.*, 2014; Ancrenaz *et al.*, 2015; Goossens *et al.*, 2016).

Lack of consideration for elephant needs in land-use planning

Incorporating conservation strategies into forest development and land-use planning is a significant challenge when trying to

conserve large, roaming megafauna, such as elephants, especially around existing wildlife habitats (Johnsingh & Williams, 1999). One of the major issues in Sabah results from land conversion to various uses without considering key areas that are used by elephants as traditional migration routes and feeding grounds. For example, a total area of 25 000 ha of forest that was identified as highly suitable for elephants in Gunung Rara and Kalabakan Forest Reserves was recently earmarked for conversion to oil-palm plantation under the Malaysia-UNDP project (Othman *et al.*, 2013). The objective of this project was to institutionalize a multiple-use forest landscape-planning and management model, bringing the management of critical protected areas and connecting landscapes under a common management umbrella (Othman *et al.*, 2013). A major shortfall of this project was the original development of a new land-use plan without considering the requirement to sustain wild-animal species in the region. Although the Sabah Forestry Department and its conservation partners were able to identify and set aside key corridor areas for elephants during the implementation stage of this project, the conversion of prime elephant habitat to oil-palm plantations has already resulted in increased human–elephant conflicts (pers. obs).

Management issues and lack of resources

The priority for the Malaysian government is to stimulate economic growth by developing high-impact socio-economic projects. The state government is also attempting to gazette 30% of its land mass as Fully Protected Forests. However, resources allocated towards protection of the environment and biodiversity remain insufficient (Hezri & Hasan, 2006). With small operational budgets, and limited human and technical resources, conservation agencies are not effectively able to manage, protect and preserve the environment and wildlife in Sabah, especially given the recent extension

of the protected areas' network. Unless concerted efforts are made to reinforce local capacities and address funding gaps, these issues will continue to be obstacles to achieving effective elephant conservation in the region.

Lack of collaboration and coordination

The lack of coordination and communication between government agencies, non-governmental organizations (NGOs), smallholders and large industrial estates contribute to create a very complex and highly fractured landscape that becomes unsuitable for elephants. For example, electrical fences are erected by landowners without considering neighbouring estates and traditional elephant routes. Elephants also learn that the shock administered is not dangerous, and is of very short duration, and they can easily break through the fences (Hayward & Kerley, 2009; Desai & Riddle, 2015; Fernando, 2015). Once the elephants enter plantation areas, they roam within a maze of fences, which inhibits their return to nearby forests and worsens the damage they cause to property. The state government recently called for scientists working in Sabah to come up with general guidelines about elephant management in agricultural landscapes. The consensus was to identify ways for land users and elephants to coexist in non-protected forests. However, there is still a lot of ongoing debate between NGOs, scientists, government agencies and industry stakeholders about potential management options to prevent human–elephant conflicts; for example, compensation, translocation and integrated electrical fencing, among others.

Lack of general awareness

It is difficult to harness people's support for conserving elephants while they continue to consider the species as a pest and a source of conflicts. Raising tolerance about the presence of elephants with the general public is important. For example, some people

assume that removing (either translocating or killing) the oldest or biggest females (i.e. the matriarchs) will make the other elephants in the group leave the area, and they put pressure on the government to translocate these individuals. However, this action will actually leave the other elephants confused and likely to act more aggressively (McComb *et al.*, 2001; Shannon *et al.*, 2013). Limited research has been carried out and published on the post-release movements of translocated elephants in Malaysia (Peninsular Malaysia: Stüwe *et al.*, 1998). While the radio-collared male appeared to link up with other elephants and ranged within a relatively fixed area of c. 350 km², the female roamed over a much wider area, changed location twice and appeared to remain on her own (Stüwe *et al.*, 1998). Our experience in Sabah indicates that the long-term effects of translocation on individual elephants and the herds they leave behind are not fully understood, and that more research is needed to establish the impacts of such actions (Sabah Action Plan 2019–2030, unpubl. data).

One of the greatest priorities is to develop integrated awareness campaigns for local communities to explain how people can peacefully share the same habitat as elephants. This kind of initiative is being developed in Sabah (see below). In Peninsular Malaysia, similar initiatives also exist, such as the Management and Ecology of Malaysian Elephants, which is conducting scientific research to inform management decisions and support livelihoods of communities in order to conserve elephants and their habitats for the long term (Ning *et al.*, 2016).

Unlike the Indian elephant *Elephas maximus indicus*, the Bornean elephant seems to have a less significant role in the history, culture, religion, mythology, folklore and even politics in Sabah. In a small survey carried out among people who live in elephant ranges (38 people interviewed in three villages in the districts of Lahad Datu, Tawau and Tongod), many respondents were unsure about the potential benefits of

living with elephants, with the exception of attracting tourism (N. Othman, unpubl. data). General workers in the plantations complained that they were afraid of being attacked and they often used the presence of elephants as a reason for not going to work (pers. obs), resulting in reduced daily wages.

Killings and accidental deaths of elephants

Over the past decade, the number of elephant deaths has increased in Sabah. This situation is jeopardizing the viability of the elephant metapopulation in the state. Several factors are involved in these deaths.

Shooting Guns are used to resolve conflict situations or by poachers (e.g. three male elephants were shot and their tusks removed in 2018). Many animals show signs of injuries caused by firearms and every year several elephants die following shooting incidents. Most of these shootings

arise from human–elephant conflict situations.

Snaring Elephants are a common by-catch of snares and pitfall traps that are set up by plantation workers and villagers to catch small ungulates (e.g. wild boars and deer) (Plate 1).

Accidental deaths In 2016, five elephants were found dead in a mud pool and two individuals rescued from there had to be euthanized later. The mud pool was an abandoned quarry pit previously used by a timber company. It is essential that such sites are filled in after use or cordoned off so wildlife cannot fall into them.

Poisoning Poisoning can be intentional in conflict situations or unintentional. Either way it is a growing threat to elephant survival. Elephants spend an increasing amount of time in oil-palm plantations where they are exposed to a wide spectrum of chemicals used by growers. Some of these chemicals could be potentially toxic



Plate 1. The pitfall trap that was newly discovered in an oil-palm plantation in Lahad Datu, Sabah. *Courtesy of WWF-Malaysia.*

in the medium to long term and result in progressive poisoning of the animals.

CHALLENGES TO CONSERVING BORNEAN ELEPHANTS IN MONOCULTURE LANDSCAPES

Recent studies have shown that elephants are increasingly using oil-palm plantations for roaming (N. Othman *et al.*, unpubl. data). We can hypothesize that these plantations were once part of the traditional routes and roaming grounds of elephants (Alfred *et al.*, 2012). At the same time, oil-palm plantations provide a source of easily accessible food, such as palms, banana (*Musaceae* spp) and grasses. Elephants can effortlessly push over palm trees and feed on the heart of the plants. They also feed on the palm chips cut down by estate managers at the end of a palm rotation cycle, before replanting. However, the elephants cause most damage when they enter areas planted with young palms (6 months to 3 years of age), potentially destroying hundreds of plants overnight and causing significant financial losses (Ancrenaz *et al.*, 2007).

The village of Sukau has been identified as one of two major bottlenecks that hinder the flow of elephants in their home range (Estes *et al.*, 2012). Over the past 5 years, a herd has been extensively roaming in the oil-palm landscape close to Sukau. A plausible explanation is that the elephants ventured into these plantations to find alternative routes during their migration up and down the Kinabatangan River. The existing network of electric fences within this landscape has made it increasingly difficult for the elephants moving between forested areas (Fig. 1) (Skara *et al.*,). The lack of coordination between plantation owners about where to erect fences and protection barriers results in the elephants being pushed further away from their migration routes into non-natural landscapes, instead of returning to the nearest forest.

CURRENT INITIATIVES TO TACKLE THE CHALLENGES

Policy and law enforcement

In Sabah, the highest number of deaths reported in a single year was 30 elephants in 2018, mostly as a result of gunshot wounds and suspected poisoning. To address these increasing rates of deaths related to human–elephant conflict (gunshot wounds, suspected poisoning), the government of Sabah is committed to the implementation of a strict liability policy, whereby landowners will be considered responsible for the death of any elephant on their land (Tracy Patrick, ‘Landowners made liable for elephant deaths in Sabah’, *Free Malaysia Today*, 30 August 2018: <https://www.freemalaysiatoday.com/category/nation/2018/08/30/landowners-made-liable-for-elephant-deaths-in-sabah/>). This provision would reverse the burden of proof, which would no longer rest with prosecutors. If this policy is enacted into law, it is expected that landowners will be more responsible and vigilant towards any illegal or suspicious activities occurring on their land, such as poaching, snaring and the erection of hunting platforms. However, it is far too early to know whether this approach will result in positive outcomes and one of the most-obvious risks will be that landowners will attempt to hide any deaths that occur on their estates.

Community consultation, engagement and collaboration are essential components to ensure that stakeholders will not be antagonistic to the presence of elephants on their land for fear of being held accountable should any die on their landholdings.

Joint operations to remove snares

Sabah Forestry Department, Sabah Wildlife Department and WWF-Malaysia have identified one hotspot area where four elephants were found with snare-related injuries. Joint operations have been conducted in the area

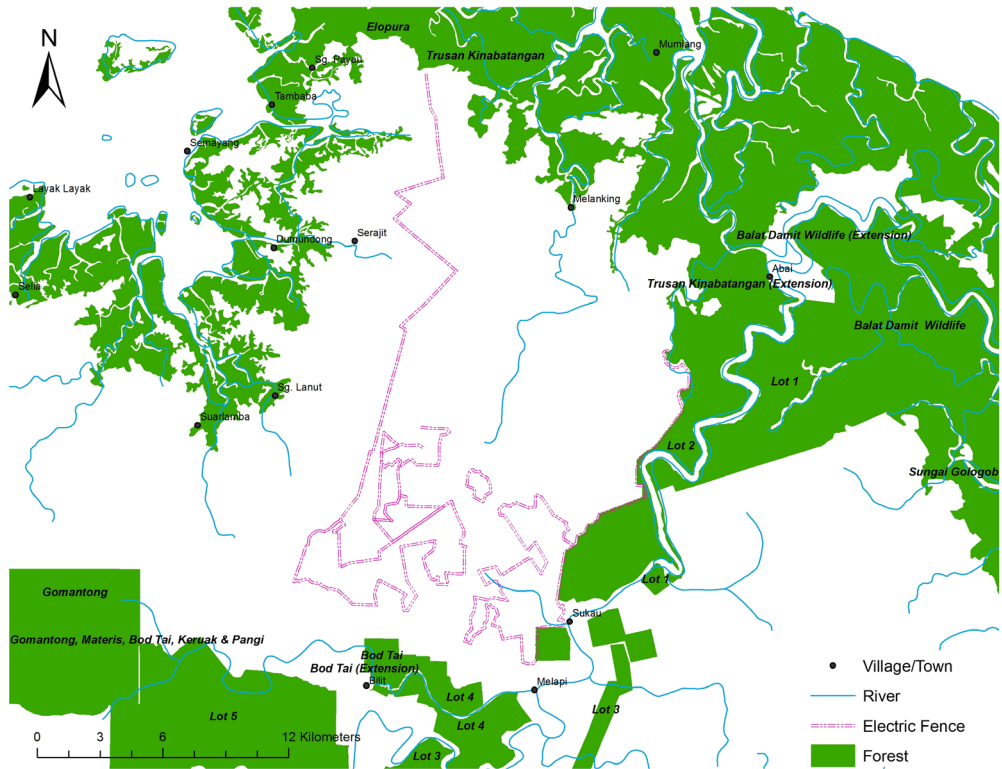


Fig. 1. Electric fences and trenches that have been erected by estate managers and smallholders that create the so-called ‘bottlenecks’ that prevent Bornean elephant *Elephas maximus borneensis* movements in the Kinabatangan area of Sabah.

to make a thorough sweep of the forest reserve bordering the plantation and remove snares. Such operations are very labour intensive and time consuming.

Scientific research on movement and behaviour

The design of a holistic management and conservation strategy for elephants in Sabah requires a better understanding of elephant movements, including identification of preferred habitats, areas they avoid and the most-important feeding locations, as well as confirmation of the sites and causes of movement bottlenecks. Over the past 8 years, Sabah Wildlife Department, Danau Girang Field Centre and WWF-Malaysia

have tracked more than 50 elephants, and collected information on their movements while observing important changes in the landscape and habitat availability (Evans *et al.*, 2018). The data gathered from tracking and close monitoring of collared elephants improve our understanding of the habitat requirements of elephants in the region, making it possible to identify the landscape where habitat connectivity can be optimized and human–elephant conflicts can be minimized.

Capacity building, education and awareness programme

Efforts are being made to build and strengthen local capacity, and to encourage

villagers to accept the presence of wild elephants. Several community-based initiatives, such as Kinabatangan Orangutan Conservation Programme (KOCP), have established local 'Elephant Conservation Units' (Ancrenaz *et al.*, 2007). The aim is to reduce the number of human-wildlife conflicts, and increase tolerance and acceptance of the elephants. The KOCP team has developed a series of tools to mitigate conflicts, from active intervention (use of noise/sound cannons or light to drive the animals away from crops) to defensive activities (electrical fences and integrated corridors), and provided micro-loans to landowners with small plots for fence building (Ancrenaz *et al.*, 2007). The Elephant Conservation Unit carried out scientific studies on elephant feeding strategies, home-range patterns and bottleneck locations to identify ways of reducing conflicts in the region. Over a 5 year period in the area around the village of Sukau, the Elephant Conservation Unit succeeded in mitigating human-elephant conflicts and fostering the support of communities towards elephant conservation (Ancrenaz *et al.*, 2007). The KOCP team is now replicating this approach in other communities that are newly affected by human-elephant conflicts, such as in Telupid and Ulu Muamad.

Under the Wildlife Conservation Enactment 1997, the state government can appoint members of the public as Honorary Wildlife Wardens. Wardens become the eyes and ears of the state authorities by organizing patrols to control human encroachments, monitor wildlife and mitigate conflicts. Wardens also hold events in schools and within the community to raise conservation awareness. This alliance between a state agency and community members lays the foundation for securing the long-term management of threatened species in the region (Ancrenaz *et al.*, 2007).

The UmbrElephant Campaign is a new initiative led by Project Seratu Aatai to raise awareness about elephant-conservation

needs. The overall aim of this Campaign is to protect Bornean elephants from extinction by empowering local communities, building a sense of pride and increasing awareness among Malaysian people (especially Sabahans). Through this Campaign, the public (including government agencies, private bodies and individuals) has the opportunity to express its concerns, interest and passion for helping Bornean elephant conservation through activities that they will be involved in organizing.

WAY FORWARD

Collaboration with the oil-palm industry for better land-use planning

Agricultural landscapes dominated by oil-palm plantations are increasingly being used by elephants. Therefore, it is an urgent priority to engage with this industry to improve the management of Bornean elephants within the monoculture areas in Sabah. However, a better understanding is required of the real (vs perceived) extent of conflicts in mature oil-palm plantations and what options are best to mitigate potential conflicts. Engaging with plantation workers – explaining what to do (and what not to do) when they encounter elephants – is essential to reduce risks to human safety. Most important, estate managers need to see elephants as an opportunity for their business (e.g. ecotourism) rather than a liability. Successfully managing elephants within an agricultural landscape will result in an improved perception of the oil-palm industry.

Elephants can be source of natural fertilizers. Ongoing research also indicates that elephants might be able to detect and push down palms that are at the early stages of infestation by White rot fungus *Ganoderma boninense*, which is a major pest for oil-palm plantations. If this is confirmed by further research, elephants could be used an early warning system. A possible way forward is to embrace a 'Jurisdictional Approach' where entire landscapes (rather than individual estates) are considered as

management units. Sabah embarked on this approach when the state government pledged to have its entire palm-oil production Roundtable of Sustainable Palm Oil certified by 2025. The government will work closely with the palm-oil industry and civil-society organizations to remove the drivers of deforestation and environmental damage. In addition, methods will be developed to achieve conservation and sustainable development across the entire jurisdiction. Scientists and NGOs will play a crucial role in ensuring that all stakeholders take a holistic view of the environment in and around plantations, and the wildlife inhabiting the region.

At the time of writing, a few oil-palm estate managers have agreed to share their plantations with elephants, working with NGOs to improve conditions in the monoculture landscapes to guarantee the welfare of both people and wildlife. For example, removing electrical fences – thereby providing safer passage to elephants – has resulted in a decrease in conflict situations in these estates in tandem with behavioural changes observed in the elephants (unpubl. obs). The animals have become less wary of people, less aggressive and they destroy fewer human belongings (e.g. motorbikes or water tanks) (unpubl. obs). The elephants mostly feed on the palm chips produced at the end of a rotation cycle when old palms are replaced with new plantings (once every 25 years). Observations indicate that, in the participating estates, damage to adult and mature palms is less significant than in estates that are still using electrical fences (unpubl. obs). A new strategy of using fences to protect only the youngest, most-vulnerable palms (i.e. < 8 years of age) is also being tested, allowing safe passage to elephants within mature-palm areas. Some of these estates are also planting elephant food, such as grasses, in an attempt to reduce human–elephant conflicts.

Ultimately, there is an urgent need to create safe passageways or corridors for elephants to roam across contiguous landscapes. Recently, the Sabah Wildlife

Department and Genting Plantations Berhad entered an official Memorandum of Agreement to establish the Keruak Wildlife Corridor in Lower Kinabatangan. The Keruak Wildlife Corridor project aims to establish a c. 182 ha riverine forest corridor to reconnect two fragmented protected areas near the village of Sukau in the Lower Kinabatangan, the most fragmented Managed Elephant Range in Sabah. The overall objectives are to reduce human–wildlife conflicts in the area, prevent riverbank erosion, protect local freshwater fisheries and maintain the scenic beauty of this world-renowned ecotourism destination. Local landowners from the Sukau community and Hutan-KOCP have already secured 72.8 ha of riverine forest with the financial support of the British charity the World Land Trust (Halesworth, Suffolk, UK) and the Rainforest Trust (Warrenton, VA, USA). The Sabah government allocated an additional 52.6 ha to the corridor. By signing a long-term conservation agreement with the Sabah Wildlife Department, Genting Plantations Berhad contributed 44.5 ha of land planted with palms to the Keruak Wildlife Corridor. Native-tree seedlings will be planted between the mature palms, ensuring a gradual return of the area to natural forest. This groundbreaking conservation agreement will hopefully serve as a model for future innovative and mutually beneficial partnerships fostering a more peaceful human–wildlife coexistence in Sabah.

Raise the profile of the elephant as a tourism asset

Bornean elephants, especially herds living in Lower Kinabatangan, are not particularly aggressive or elusive, thus making them ideal for sustainable wildlife tourism (pers. obs). Elephants are frequently seen along the riverbank at the end of the afternoon where they engage in social and feeding activities, and where they have easy access to water to lower their body temperature. This situation provides a good opportunity for tourists to observe the elephants from

boats. However, the lack of proper guidelines and best-tourism practices may disturb the elephants and alter their behaviour. Sometimes, boats come within a few metres of the elephants or people go ashore to take photographs with the animals. The tourism industry, the government and scientists urgently need to develop suitable guidelines that will ensure safety for people and minimize disturbance to wildlife. Promotion of elephant tourism, using sustainable-viewing guidelines, has the potential to bring revenue and employment to local communities. Money generated from this activity could be channelled into compensation schemes and human–elephant conflict mitigation activities (Desai & Riddle, 2015).

ZOO-COMMUNITY SUPPORT OF ELEPHANT CONSERVATION IN SABAH

Peaceful coexistence will only be achieved by: (1) increasing people's capacity to deal with elephants, (2) research to improve knowledge and understanding of the ecology and behaviour of this subspecies, (3) the creation of new mitigation tools, management and policies, and (4) direct action (e.g. removing fences, providing safe wildlife corridors, planting elephant food). There are several ways in which zoos could help to increase human–elephant coexistence in monoculture landscapes.

Training and capacity building

For the past 10 years, the conflicts between people and elephants in Sabah have been increasing, based on indicators such as (1) the number of elephants translocated by the Wildlife Rescue Unit of Sabah Wildlife Department, (2) the number of elephants killed or poisoned (Othman *et al.*, 2013), (3) the increased frequencies of elephant controls (mainly sounds of cannon and guarding) carried out by Sabah Wildlife Department or (4) the number of villages raided by elephants. Since 2013 the number of orphaned elephants rescued from

oil-palm plantations has increased. To date, 16 infant elephants have been found without their mothers or herds, and rescued from oil-palm plantations and villages across eastern Sabah; all infants were < 1 year of age at rescue (P. N. Pakeeyaraj, pers. comm.). The increase in the number of orphaned elephants can likely be attributed to elephant controls (i.e. sounds of cannon and guarding) conducted in plantations/villages which may have resulted in separating mothers from their young. At the time of writing, only five of the 16 infants have survived and they are mainly kept at the Sepilok Orangutan Rehabilitation Centre, Sabah.

Realizing the limited resources and facilities of the local wildlife authority to keep more orphaned elephants, some oil-palm companies took on the responsibility of caring for the orphans that were found on their land. However, the experience and skills necessary to care for and train these elephants as they grow are not available. Caretakers require training and guidance, and standard operational procedures must be developed to ensure delivery of high-quality husbandry and management practices. Zoos have much experience in the care of elephants in captivity, and could support their conservation partners who are working with oil-palm plantations to facilitate the training of elephant keepers. This would include promoting the most appropriate husbandry practices and knowledge about how to identify diseases, such as elephant endotheliotropic herpesviruses, to ensure the good health of the animals.

Financial support

Conservation projects for elephants in Sabah are supported by various partners, including several zoos from North America and Europe. Securing long-term financial support is always a challenge but zoos are in a good position to offer mutually beneficial partnerships (Ancrenaz *et al.*, 2018). One of the current challenges is to secure long-term support for the formal academic

training of local conservationists. This is essential to ensure that conservation initiatives established in the region are sustained in the long term. For example, Houston Zoo (TX, USA) is supporting the academic training of local Malaysians at Master's degree and PhD levels. With funding assistance from Houston Zoo, one author (N. Othman) has been able to focus her studies on movements of Bornean elephants and has completed a PhD at Cardiff University, UK. This author then started 'Project Seratu Aatai', which is dedicated to the conservation of Bornean elephants. Houston Zoo is also supporting another Malaysian student for her Master's degree at a local university for a study into the feeding ecology of elephants in monoculture landscapes.

Awareness raising and technical advice

Field conservationists are often trained scientists and need additional skills, such as the ability to educate, and information-technology and creative-design capabilities. However, members of the zoo community possess some of these skills and could productively contribute to support *in situ* conservation. A recent example in Sabah involved institutions such as Woodland Park Zoo (Seattle, WA, USA), Oregon Zoo (Portland, OR, USA), Chester Zoo (UK) and Houston Zoo, which created posters, produced a guidebook describing elephant behaviours, and generated videos and additional education materials based on the input and experience of people working in the field. At their own institutions, zoos inform their visitors about the challenges faced by elephants in Borneo and what the public could do to be involved (e.g. see Ancrenaz *et al.*, 2018).

Zoos possess an extensive range of expertise and knowledge about *ex situ* management. By providing technical advice on animal welfare and veterinary care to local zoos and rescue centres (including orphanages) zoos can support local efforts and institutions that often lack the resources to

provide adequate housing facilities and expertise to engage positively with the public. Local zoos could become a platform to raise awareness about elephants among the civil society in Sabah. The management of local zoos would benefit from the established knowledge of more-experienced international zoos, which could provide technical and practical support on how to run public-engagement facilities. The experience of some of the largest international zoos would be extremely valuable for the conservation of elephants in Sabah, not least by fostering skills and expertise at local zoos. Once gained, this knowledge will make it possible for local zoos to work collaboratively with their communities, and to inform them about the importance and value of the wildlife and habitat in their region.

Exchange programme

Zoos often support exchange programmes between *in situ* conservation projects and their own institutions. This gives people working in the field an opportunity to gain more experience and to increase their motivation to continue their conservation work in their own country (cf. Offord-Woolley *et al.*, 2016). Recently, several initiatives were created to recognize local individuals as key conservationists by offering them an award; for example, the 'Wildlife Warriors' supported by Houston Zoo or the 'Disney Conservation Heroes' award by the Disney Conservation Fund (Burbank, CA, USA), to cite just two. Wildlife Warriors are awarded an educational experience (e.g. training course or exchange to another related conservation project) of their choice and a US\$500 donation to their conservation programme, while Disney Conservation Heroes share a US\$1500 award from the Disney Conservation Fund with their nominating organization. Such awards can make a huge difference to the conservation work of the people who received them, providing a sense of pride and achievement.

CONCLUSION

Human–elephant conflict is a complex problem and there are no easy solutions. A combination of tools and resources that are adapted to local situations has to be used to reduce the occurrence of such conflicts. In some cases, human–elephant conflict results from habitat compression and fragmentation, and the broader issues of habitat loss and land-use planning need to be tackled. In other cases, human–elephant conflict is a result of natural population growth and options such as translocations or use of immunocontraceptives should be investigated (Fayrer-Hosken & Bertschinger, 2000). However, since we entered the Anthropocene era, most human–elephant conflict is the result of encroachment by people into traditional elephant ranges and migration routes. If elephants are to survive in Sabah in the long term, it is crucial for people and members of the civil society to learn new ways of sharing the environment with such megafauna.

The time has come for the society, plantations and local communities to share the responsibility of safeguarding the precious Bornean elephants in Sabah, because achieving success cannot be the responsibility of the Sabah government or NGOs alone. The only way forward is for plantations, people and elephants to coexist in harmony.

ACKNOWLEDGEMENTS

The authors are grateful for the opportunity to contribute to this themed volume on Conservation of Elephants. We would like to thank Datuk Dr. John Payne for his thoughtful input on wildlife management practice in Sabah.

REFERENCES

ALFRED, R., AMBU, L., NATHAN, S. K. S. & GOOSSENS, B. (2011): Current status of Asian elephants in Borneo. *Gajah* **35**: 29–35.

ALFRED, R., AHMAD, A. H., PAYNE, J., WILLIAMS, C., AMBU, L. N., MUI HOW, P. & GOOSSENS, B. (2012): Home range and ranging behaviour of Bornean elephant (*Elephas maximus borneensis*) females. *PLoS ONE* **7**(2): e31400.

ANCRENAZ, M., DABEK, L. & O'NEIL, S. (2007): The costs of exclusion: recognizing a role for local communities in biodiversity conservation. *PLoS Biology* **5** (11): 2443–2448.

ANCRENAZ, M., ORAM, F., AMBU, L., LACKMAN, I., AHMAD, E., ELAHAN, H., KLER, H., ABRAM, N. K. & MEIJAARD, E. (2015): Of *Pongo*, palms and perceptions: a multidisciplinary assessment of Bornean orangutans *Pongo pygmaeus* in an oil palm context. *Oryx* **49**: 465–472.

ANCRENAZ, M., BARTON, C., RIGER, P. & WICH, S. (2018): Building relationships: how zoos and other partners can contribute to the conservation of wild orangutans *Pongo* spp. *International Zoo Yearbook* **52**: 164–172.

CLEMENTS, G. R., LYNAM, A. J., GAVEAU, D., YAP, W. L., LHOTA, S., GOOSEM, M., LAURANCE, S. & LAURANCE, W. F. (2014): Where and how are roads endangering mammals in Southeast Asia's forests? *PLoS ONE* **9** (12): e115376.

DESAI, A. A. & RIDDLE, H. S. (2015): *Human–elephant conflict in Asia*. Washington, DC: US Fish and Wildlife Service, and St Louis, MO: Asian Elephant Support.

ESTES, J. G., OTHMAN, N., ISMAIL, S., ANCENAZ, M., GOOSSENS, B., AMBU, L. N., ESTES, A. B. & PALMIOTTO, P. A. (2012): Quantity and configuration of available elephant habitat and related conservation concerns in the Lower Kinabatangan Floodplain of Sabah, Malaysia. *PLoS ONE* **7**(10): e44601.

EVANS, L. J., ASNER, G. P. & GOOSSENS, B. (2018): Protected area management priorities crucial for the future of Bornean elephants. *Biological Conservation* **221**: 365–373.

FAYRER-HOSKEN, R. A. & BERTSCHINGER, H. (2000): Population control: African elephants and contraception. *Nature* **407**: 149–150.

FERNANDO, P. (2015): Managing elephants in Sri Lanka: where we are and where we need to be. *Ceylon Journal of Science (Biological Sciences)* **44**: 1–11.

FERNANDO, P., VIDYA, T. N. C., PAYNE, J., STUEWE, M., DAVISON, G., ALFRED, R. J., ANDAU, P., BOSI, E., KILBOURN, A. & MELNICK, D. J. (2003): DNA analysis indicates that Asian elephants are native to Borneo and are therefore a high priority for conservation. *PLoS Biology* **1**(1): Art. e6.

FERNANDO, P., WIKRAMANAYAKE, E. D., JANAKA, H. K., JAYASINGHE, L. K. A., GUNAWARDENA, M., KOTAGAMA, S. W., WEERAKOON, D. & PASTORINI, J. (2008): Ranging behavior of the Asian elephant in Sri Lanka. *Mammalian Biology* **73**: 2–13.

FREEMAN, E. W., WEISS, E. & BROWN, J. L. (2004): Examination of the interrelationships of behavior, dominance status, and ovarian activity in captive Asian and African elephants. *Zoo Biology* **23**: 431–448.

GAVEAU, D. L. A., SLOAN, S., MOLIDENA, E., YAEN, H., SHEIL, D., ABRAM, N. K., ANCENAZ, M., NASI, R., QUINONES, M., WIELAARD, N. & MEIJAARD, E. (2014): Four decades of forest persistence, clearance and logging on Borneo. *PLoS ONE* **9**(7): e101654.

- GOOSSENS, B., SHARMA, R., OTHMAN, N., KUN-RODRIGUES, C., SAKONG, R., ACRENAZ, M., AMBU, L. N., JUE, N. K., O'NEILL, R. J., BRUFORD, M. W. & CHIKHI, L. (2016): Habitat fragmentation and genetic diversity in natural populations of the Bornean elephant: implications for conservation. *Biological Conservation* **196**: 80–92.
- HAYWARD, M. W. & KERLEY, G. I. H. (2009): Fencing for conservation: restriction of evolutionary potential or a riposte to threatening processes? *Biological Conservation* **142**: 1–13.
- HEZRI, A. A. & HASAN, M. N. (2006): Towards sustainable development? The evolution of environmental policy in Malaysia. *Natural Resources Forum* **30**: 37–50.
- IUCN (2018): *The IUCN Red List of Threatened Species*. Gland, Switzerland, and Cambridge, UK: International Union for Conservation of Nature. Available at <https://www.iucnredlist.org>
- JOHNSINGH, A. J. T. & WILLIAMS, A. C. (1999): Elephant corridors in India: lessons for other elephant range countries. *Oryx* **33**: 210–214.
- JOSHI, R. (2010): How social are Asian elephants *Elephas maximus*? *New York Science Journal* **3**: 27–31.
- KUMAR, M. A. & SINGH, M. (2010): Behavior of Asian elephant (*Elephas maximus*) in a land-use mosaic: implications for human–elephant coexistence in the Anamalai Hills, India. *Wildlife Biology in Practice* **6**: 69–80.
- KUMAR, M. A., MUDAPPA, D. & RAMAN, T. R. S. (2010): Asian elephant *Elephas maximus* habitat use and ranging in fragmented rainforest and plantations in the Anamalai Hills, India. *Tropical Conservation Science* **3**: 143–158.
- MALTBY, M. & BOURCHIER, G. (2011): Current status of Asian elephants in Cambodia. *Gajah* **35**: 36–42.
- MCCOMB, K., MOSS, C., DURANT, S. M., BAKER, L. & SAYIALEL, S. (2001): Matriarchs act as repositories of social knowledge in African elephants. *Science* **292** (5516): 491–494.
- NING, H., PHIN, W. E., CHACKRAPANI, P., SOLANA-MENA, A., LING, A. T. S., NAGULENDRAN, K., WADEY, J., WYN, L. T., ONG, L., OSMAN, N. A., KROMANN-CLAUSEN, A., YAMAMOTO-EBINA, S., PONNUSAMY, V., SAABAN, S., OTHMAN, N. B. & CAMPOS-ARCEIZ, A. (2016): MEME – moving towards a science-based conservation of Malaysian elephants. *Malayan Nature Journal* **68**: 191–197. Available at https://www.researchgate.net/profile/Jamie_Wadey/publication/316553576_MEME_-_moving_towards_a_science-based_conservation_of_Malaysian_elephants/links/59037595aca272116d2fab99/MEME-moving-towards-a-science-based-conservation-of-Malaysian-elephants.pdf
- OFFORD-WOOLLEY, S., BAMFORD, P. & DESFORGES, R. (2016): Developing an environmental-education programme using black rhinoceros *Diceros bicornis* in Zambia as a case study. *International Zoo Yearbook* **50**: 84–95.
- OTHMAN, N., FERNANDO, P., YOGANAND, K., ANCRENAZ, M., ALFRED, R. J., NATHAN, S. & GOOSSENS, B. (2013): Elephant conservation and mitigation of human–elephant conflict in government of Malaysia-UNDP multiple-use forest landscapes project area in Sabah. *Gajah* **39**: 19–23.
- PAYNE, J. & DAVIES, G. (2013): Conservation of rain forest mammals in Sabah: long term perspectives. *The Raffles Bulletin of Zoology* Suppl. No. 29: 187–201.
- REDPATH, S. M., YOUNG, J., EVELY, A., ADAMS, W. M., SUTHERLAND, W. J., WHITEHOUSE, A., AMAR, A., LAMBERT, R. A., LINNELL, J. D. C., WATT, A. & GUTIÉRREZ, R. J. (2013): Understanding and managing conservation conflicts. *Trends in Ecology and Evolution* **28**: 100–109.
- SABAH WILDLIFE DEPARTMENT (2012): *Elephant action plan 2012–2016*. Kota Kinabalu, Sabah: Sabah Wildlife Department.
- SHANNON, G., SLOTOW, R., DURANT, S. M., SAYIALEL, K. N., POOLE, J., MOSS, C. & MCCOMB, K. (2013): Effects of social disruption in elephants persist decades after culling. *Frontiers in Zoology* **10**: Art. 62.
- SHARMA, R., GOOSSENS, B., HELLER, R., RASTEIRO, R., OTHMAN, N., BRUFORD, M. W. & CHIKHI, L. (2018): Genetic analyses favour an ancient and natural origin of elephants on Borneo. *Scientific Reports* **8**: Art. 880.
- SHIM, P. S. (2000): Elephants of Sabah – *Elephas maximus sondaicus*. *Sabah Society Journal* **17**: 65–71.
- SIH, A., FERRARI, M. C. & HARRIS, D. J. (2011): Evolution and behavioural responses to human-induced rapid environmental change. *Evolutionary Applications* **4**: 367–387.
- SKARA, B., ABRAM, N. K., OTHMAN, N., ANCRENAZ, M. & GOOSSENS, B. (In press): Beyond natural habitats: an analysis of spatial and temporal trends of Bornean elephant (*Elephas maximus borneensis*) hotspots in oil palm. *Scientific Reports*.
- STÜWE, M., ABDUL, J. B., NOR, B. M. & WEMMER, C. M. (1998): Tracking the movements of translocated elephants in Malaysia using satellite telemetry. *Oryx* **32**: 68–74.
- SUKUMAR, R. (2003): *The living elephants: evolutionary ecology, behaviour, and conservation*. Oxford: Oxford University Press.

Manuscript submitted 17 September 2018;
revised 25 April 2019; accepted 9 May 2019