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

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ABSTRACT

This article outlines the contemporary situation of the Bornean elephant *Elephas maximus borneensis* in Sabah (Malaysian Borneo), and focuses on existing challenges for 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 island of Borneo. 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 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 elephant across the entire landscape. Another issue is 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; the subspecies occurs 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). The Bornean elephant is thought to be native to the island (Fernando *et al.*, 2003; Sharma *et al.*, 2018) although an alternative hypothesis claims that the subspecies was introduced by people in more recent times (Fernando *et al.*, 2003). Two hypotheses have been proposed to explain the occurrence of elephants on Borneo. First, it is believed that they were introduced to Borneo when the East India Company presented a few elephants to 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). Second, Bornean elephants may have been indigenous to Borneo and 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*. However, Shim (2000) suggested that the elephants in Borneo might be the descendants of the extinct Javan elephant *Elephas maximus sondaicus*. 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 safeguarding 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 showed that only some female-led family units and some adult males were crop-raiders; but not all elephants (Sukumar, 2003; Joshi, 2010; Maltby & Bouchier, 2011). The increased rate of encounters between elephants and humans for most populations in Sabah may influence the behavioural repertoire of the elephants and may create negative attitudes in people (Kumar & Singh, 2010). Such encounters may aggravate human–elephant conflicts, which in turn may 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). At the time of writing, elephants increasingly rely on non-protected areas for their movements and food ranging activities (Fernando *et al.*, 2008; Kumar *et al.*, 2010; Gaveau *et al.*, 2014). Several Managed Elephant Ranges are completely isolated in extensive oil-palm production

landscapes, such as 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). Such occurrences create conflicts with the people living and working outside the protected forests.

The elephant range is further fragmented by roads and linear infrastructures, human settlements and other man-made elements, as illustrated by the Batu Puteh Bridge that crosses the Kinabatangan River and has split the Kinabatangan elephants into two completely isolated populations (Estes *et al.*, 2012). At the time of writing, two Managed Elephant Ranges are completely isolated from remaining elephant populations: Tabin Wildlife Reserve and Lower Kinabatangan. The fragmentation process of the elephant range is worsened by the recent development of the 'Pan Borneo Highway', a federal-government funded project, which involves the development of new road networks and the upgrading of existing ones. The proposed alignment of the highway will dissect the entire elephant range, will impede the movement of several herds and will further isolate elephant populations. This network will also potentially result in road accidents and could promote elevated hunting pressure (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 for their traditional migration routes and as 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 is resulting in increased human–elephant conflicts.

Management issues and lack of resources

At the time of writing, the priority for the Malaysian government is to stimulate economic growth by developing high-impact socioeconomic projects. The State government is also pursuing a goal of gazetted 30% of its land mass as Fully Protected Forests, but resources allocated towards environment and biodiversity protection remain insufficient (Hezri & Hasan, 2006). With a small operational budget, 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, this issue will remain a hurdle towards achieving functional 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 elephant movements. For example, electrical fences are erected by landowners without considering neighbouring estates and elephant movements. Elephants can learn that the shock administered is not dangerous and of very short duration, and then break through the fences easily (Hayward & Kerley, 2009; Desai & Riddle, 2015; Fernando, 2015). Once the elephants enter plantation areas, they are lost in a maze of fences, and this situation makes their return to the nearby forests extremely difficult, worsening the damage they cause. 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 try to identify ways for land users and elephants to coexist in non-protected forests. However, there is still a lot of debate going on 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 elephant presence 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 (but see for Peninsular Malaysia: Stuwë *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 (SAP 2019-2030, unpublished). 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). The long-term effects of translocation on individual elephants and the herds they leave behind are not fully understood and more research is needed to establish the impacts of such actions.

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 initiatives is being developed in Sabah (see below). In Peninsular Malaysia, similar initiatives also exist, such as the Management and Ecology of Malaysian Elephants (MEME), which is conducting scientific research to inform management decisions and support livelihoods of communities 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 that was carried out among people who live in elephant ranges (38 people were interviewed in three villages in the district 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 not to go to work (pers. obs), resulting in reduced daily wages.

Elephant killings and elephant deaths

Over the past decade, reported elephant killings have increased in Sabah, with more than 30 individuals reported dead for the year 2018 alone. This situation is worrying and is jeopardizing the viability of the elephant meta-population in the State. Several reasons explain elephant deaths.

- Shooting: this happens mainly as a way to mitigate conflicts or for the ivory trade (three males were shot and their tusks removed in 2018). Many animals show signs of injuries by firearms and every year several elephants die following shooting. Most of these shootings result from 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 (wild boars and deer) (Plate 1).
- Accidental deaths: in 2016, five elephants were found dead in a mud pool and two individuals that were rescued there had to be euthanized later. The mud pool was an abandoned quarry pit previously used by a timber company. It is important that such sites are filled in after use or cordoned off so wildlife cannot fall into them.

- **Poisoning:** this is a growing threat to elephant survival. Poisoning can be intentional in conflict situation, or unintentional. Indeed, elephants spend an increasing amount of time in oil palm plantations. There they are exposed to a wide spectrum of chemicals used by growers for their operations. Some of these chemicals could be potentially toxic 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 and colleagues, unpubl. data). We can hypothesize that these plantations were once part of elephant's traditional routes and roaming grounds (Alfred *et al.*, 2012). At the same time, oil-palm plantations provide easily accessible food to the animals, such as palms, banana (*Musaceae* spp) and grasses. Elephants can easily push down palm trees and feed on the heart of the plant. They also feed on the palm chips cut down by estate managers at the end of a palm rotation cycle, before new replanting. However, most damage happens when elephants enter areas planted with palms that are between 6 months and 3 years of age; the elephants can destroy hundreds of plants overnight and be responsible for significant financial losses (Ancrenaz *et al.*, 2007). Over the past 5 years in Lower Kinabatangan, a herd has been extensively using the oil-palm landscape close to the village of Sukau. A plausible explanation is that the elephants ventured into these oil-palm plantations to find alternative routes during their migration up and down the Kinabatangan River. Sukau has been identified as one of two major bottlenecks that could hinder the flow of elephant movements in their home range (Estes *et al.*, 2012). Moreover, 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.*, in press). There is a lack of coordination between plantation owners about where to set up fences and protection barriers, which results in the elephants being pushed further away into non-natural landscape instead of going back to the nearest forest.

CURRENT INITIATIVES TO TACKLE THE CHALLENGES

Policy and law enforcement

In 2018, Sabah recorded the highest number of elephant death cases with 30 elephants killed in a year, mostly as a result of gunshot wounds and suspected poisoning. To address the increasing rates of elephant deaths related to human–elephant conflict (gunshot wounds, suspected poisoning), the government of Sabah is committed to implement a strict liability policy in which 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 new law comes into place, 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, one of the risks being for landowners to hide any elephant deaths occurring 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 an elephant die.

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 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 their favourite habitats and the areas they avoid, locations of the most-important feeding areas and confirmation of the bottlenecks for movements. 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 the 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 also being made to build and strengthen local capacity and to enable villagers to accept the presence of wild elephants. Several community-based initiatives, such as KOCP (Kinabatangan Orang-utan Conservation Programme), have established local 'Elephant Conservation Units' (Ancrenaz *et al.*, 2007). The aim of these initiatives is to reduce the number of human–wildlife conflicts and increase tolerance and acceptance of the elephants. This KOCP team has developed a series of tools to mitigate conflicts, from active intervention (use of noise cannons or light to drive away the animals from people's crops) to defensive activities (electrical fences and integrated corridors) and provided micro-loans for fence building to landowners with small plots (Ancrenaz *et al.*, 2007). The unit also carried out scientific studies on elephant feeding strategies, home-range patterns and bottleneck locations to find ways to reduce the conflicts in the region.

Over a 5 year period in the area around the village of Sukau, the unit succeeded in mitigating human–elephant conflicts and fostering the support of communities towards elephant conservation (Ancrenaz *et al.*, 2007). The team is replicating this approach with other communities that are newly affected by human-elephant conflicts, such as those in Telupid and Ulu Muanad.

Under the Wildlife Conservation Enactment 1997, the state government can appoint members of the public as Honorary Wildlife Wardens (HWW). 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, with the overall aims to empower local communities, to build a sense of pride and to increase awareness among Malaysian people, especially Sabahans, to protect Bornean elephants from extinction. 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 created by elephants in mature oil-palm plantations and what options are best to mitigate potential conflicts. It is also necessary to engage more with plantation workers to explain what to do (and what not to do) when facing elephants in a plantation in order to reduce the risks to human safety. Most importantly, estate managers need to see elephants not as a liability but as an opportunity for their business in terms of ecotourism. Being able to manage elephants within an agriculture landscape will bring a different perception and a better image to this industry. Elephants can also be source of natural fertilizers, and some on-going research indicates that they might be able to detect and push down palms at their early infestation stages by *Ganoderma*, one of the major pests for this industry. If this was confirmed, elephants could thus be an early warning system of infestation. A way to develop this approach is to embrace a ‘Jurisdictional Approach’ where entire landscapes are considered as management units, and not only individual estates. Sabah has embarked on such an approach when the State government decided to have its entire palm-oil production RSPO-

certified by 2025. Through this approach, the government will work closely with the palm-oil industry and civil-society organizations in leading efforts 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 that lives in that habitat.

At the time of writing, a few oil-palm estate managers have agreed to share their plantations with elephants; these plantations work with NGOs to improve conditions of monoculture landscapes to guarantee the welfare of both people and elephants. For example, by removing electrical fences and by providing safer passage to elephant, we have witnessed a decrease of conflicts in these estates accompanied with elephant behavioural changes. The animals become less wary of people, less aggressive and they destroy fewer human belongings (such as motorbikes or water tanks). They also mostly feed on palm chips produced at the end of a rotation cycle when old palms are replaced with new ones (once every 25 years). Observations tend to indicate that in these estates, damage to adult and mature palms are less important than in estates with electrical fences (unpubl. obs); new strategies are being tested in relation to using fences to provide protection for only the youngest palms that are the most at risk (i.e. < 8 years of age). Such a landscape would allow safe passage to the elephants within mature palm areas. Some of these estates are also planting elephant food such as grasses to try to reduce human–elephant conflicts.

Ultimately, there is an urgent need to recreate 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 objective is to reduce human–wildlife conflicts in the area, to prevent river-bank 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 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 in 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 river bank at the end of the afternoon where they engage in social and feeding activities, and where they can have an easy water access to reduce 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 and alter the behaviour of these animals. Sometimes, boats come a few meters away from the elephants or people go on shore to take close-up pictures with the animals. There is an urgent need for the tourism industry, the government and scientists to develop suitable guidelines that will secure safety for people and minimize disturbance to the animals. 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).

ROLE OF THE ZOO COMMUNITY TO SUPPORT ELEPHANT CONSERVATION IN SABAH

Coexistence will only be achieved by increasing people's capacity to deal with elephants, research and invention of new mitigation tools, management, policies, and action. Below several ways in which zoos could help to increase the chances of coexistence in the monoculture landscapes are discussed.

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 number of elephants translocated by the Wildlife Rescue Unit (WRU) of Sabah Wildlife Department (SWD), number of elephants killed or poisoned (Othman *et al.*, 2013), increased in frequencies of elephant controls using (mainly sounds of canon and guarding) were carried out by SWD or number of villages raided by the pachyderms. Since 2013 the number of orphans that have been rescued from within oil-palm plantations has increased drastically. To date, 16 infant elephants have been found without their mothers or herds and rescued from various oil-palm plantations and villages throughout eastern Sabah; all these infants were < 1 year of age when they were rescued (P.N. pers. comm.). The increase in the number of orphaned elephants can likely be attributed to elephant controls (sounds of canon and guarding) conducted in plantations/villages by inexperienced personnel which may have displaced mothers from their young. At the time of writing, only five of the 16 infants have survived and they are kept mainly in Sepilok Orang-utan Rehabilitation Centre, Sabah. Realizing the limited resources and facilities of local wildlife authority to keep more orphans, certain oil-palm companies took the responsibility to look after these orphans that were found in their land. However, they are lacking in experience and

skills to train the elephants and require guidance to develop standard operational procedures to ensure best practices. Zoos through their conservation partners who are working with these oil-palm plantations on the ground could facilitate the training of elephant keepers on how to handle elephants in captivity and to train the keepers how to identify disease, such as elephant endotheliotropic herpesviruses (EEHV).

Financial support

Elephant-conservation projects 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 initiated 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 Bornean elephant conservation. The same institution 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 contribute to support *in situ* conservation. A recent example in Sabah involved zoos 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 have also a very important role to play to inform their visitors about the situations faced by elephants in Borneo and what the public could do to be involved (see for example Ancrenaz *et al.*, 2018).

Zoos also 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) they 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 also 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 zoos, which could provide technical and practical support on how to run public-engagement facilities. The experience of some of the largest international zoos could 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 also 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; the 'Wildlife Warriors' supported by Houston Zoo or the 'Disney Conservation Heroes' award by the Disney Conservation Fund (Burbank, CA, USA), to quote 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 will 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.

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CAPTIONS

Plate 1. The pitfall trap that was newly discovered in an oil palm plantation in Lahad Datu.

Courtesy of WWF-Malaysia.

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.