Photo: In their natural habitat, apes tend to avoid humans. Only habituated apes let people approach and observe them, whether for research or tourism. © Christophe Courteau / naturepl.com

CHAPTER 3

The Impact of Tourism and Research Activity on Ape Health

Introduction

Apes have fascinated humans since antiquity: several ancient myths and legends mention their existence (Russon, 2004). Over time, scientists, philosophers and others have made comparisons between humans and apes in efforts to define precisely what characterizes "humans" and what is unique about "humanity." Such investigations spurred research into ape behavior, communication, tool use, self-awareness, social structure, culture and social learning. As behavioral and ecological research was made available to the public, people's fascination with the apes grew, stimulating the desire to see them in captivity and in the wild. In 1925, Parc Albert (renamed Virunga National Park in 1969), the first national park in Africa, was

created to protect mountain gorillas (*Gorilla beringei beringei*) (Virunga National Park, n.d.-a). With the growth of the leisure industry, ex-situ and in-situ tourism operators have increasingly sought to capitalize on the fascination with apes.

Behavioral research is based on direct observation, which brings people close to apes in captivity and in their natural habitat. In response to observation in the wild, apes typically become habituated to the presence of field researchers. In turn, habituation opens the possibility of revenue creation from paying visitors and, potentially, the development of ape tourism projects.

As a primary global economic sector, tourism contributes substantially to most countries' incomes. In 2019, before the onset of the COVID-19 pandemic, the travel and tourism industry accounted for approximately 10% of the global gross domestic product (GDP), fluctuating between 2% and 15% for the African and Asian ape range states. The sector—a significant component of which is nature-based tourism—contributed about 10% of the global workforce (WTTC, 2020).

While ecotourism is a sustainable subset of nature-based tourism, the overall sector is a double-edged sword that can bring both significant economic and conservation benefits but also threats to great ape populations and their habitat (Wood, 2002). For example, the industry has played a critical role in the movement of pathogens and disease transmission, particularly since the 1970s, with the boom in national and international air travel.[1] Today, many pathogens can travel the world in less time than the incubation period of the diseases they cause (UNEP and ILRI, 2020).

Apes—humans' closest living relatives—are intelligent, sentient beings with complex social lives. As such, they attract local and international scientists, students, tourists, filmmakers and other visitors in the wild and in captivity (Carr, 2016; Nielsen and Spenceley, 2011; Rose, 2011). Governments, tour operators, local communities and conservation organizations increasingly view wildlife and ape tourism as a potential source of funding to support national and regional economies, sustain local development and employment, contribute to biodiversity conservation and raise awareness about wildlife and nature.[2] The ape tourism industry has grown considerably since the 1950s and is expected to expand even more in the future (Macfie and Williamson, 2010; Russon and Susilo, 2014; Russon and Wallis, 2014a).

Tourism also poses a significant risk to the apes, however. Behavioral disturbance, disease transmission, overhabituation and a higher risk of aggression, conflict and stress are among the documented impacts of tourism (Ampumuza and Driessen, 2021; Macfie and Williamson, 2010). In addition, unregulated and poorly planned ape tourism activities can lead to human–ape conflicts in adjacent communities, particularly if apes lose their fear of humans and enter cultivated fields, where they may consume or damage crops and engage in aggressive interactions with people (Ampumuza and Driessen, 2021). Such conflicts can negatively impact ape behavior and culture, as well as their chances of survival in areas where communities retaliate (Kühl *et al.*, 2019; Macfie and Williamson, 2010).

As detailed in Chapter 1, owing to their close genetic relationship to humans, apes are at risk of disease transmission from people (see Chapter 1). Pathogens of human origin can easily be transmitted to apes who are in close and repeated contact with people, both in the wild and in captive settings within and outside ape range countries (Dunay *et al.*, 2018; Hosey, Melfi and Ward, 2020). Studies have documented pathogen transfers from scientific researchers to free-ranging apes, for example (Köndgen *et al.*,

2008; Köster *et al.*, 2022; Nuno *et al.*, 2022). In captivity, the sheer number of visitors and daily close contact between apes and zookeepers, sanctuary managers or other professionals pose a threat to apes kept in these confined environments (Liptovszky *et al.*, 2019).

In their natural habitat, apes tend to avoid humans. Only habituated apes let people approach and observe them, whether for research or tourism (Knight, 2009; McLennan and Hockings, 2016). Habituation of wild apes for tourism and research in their natural habitat is mostly a planned process, unlike habituation of captive (and semi-captive) apes. The aim of a habituation process is to decrease the flight distance of apes when they encounter humans. The removal of apes' fear and need to flee effectively reduces any significant anthropogenic effect on their natural behavior, although some degree of human influence on their behavior is inevitable (Tutin and Fernandez, 1991; Williamson and Feistner, 2011). Moreover, habituation directly heightens the risks of disease spillover to apes, as they tolerate closer proximity to people (Köster *et al.*, 2022; Russon and Wallis, 2014a). One way of minimizing these risks is to ensure that habituation and

Photo: Apes—humans' closest living relatives—are intelligent, sentient beings with complex social lives. As such, they attract local and international scientists, students, tourists, filmmakers and other visitors in the wild and in captivity. © Paul Hilton/ Earth Tree Images

other activities related to tourism and field research have a minimum negative impact on ape health and behavior, as well as on ecosystems (Friend *et al.*, 2006; Muehlenbein and Ancrenaz, 2009; Williamson, 2001).

In some ape range states, sanctuaries have been established to care for apes who have been rescued from the illegal pet and wild meat trades or displaced by forest conversion (Farmer, 2002). Many sanctuaries, zoos and other wildlife collections aim to serve as vehicles for education and awareness (Ferrie *et al.*, 2014). As a result, hundreds of thousands of local and foreign visitors per year travel to these ex-situ facilities in ape range countries. In so doing, they create a considerable risk of disease transmission to captive and semi-captive apes (Muehlenbein and Wallis, 2014).

> "A growing body of evidence shows that habituated apes are at risk of disease spillover from humans."

This chapter assesses the risks of disease transmission by humans who come in close contact with wild habituated and captive apes. It examines these risks from a health perspective, recognizing habituation as a risk factor and visitors, carers and scientists as potential hazards to apes. The chapter identifies the costs and benefits of habituating apes and keeping them in captivity for research and tourism. Lastly, it identifies current knowledge gaps and ways to address the sanitary risks linked to ape research and tourism activities.

Key findings include:

- In Africa and Asia, stakeholders increasingly perceive wild apes as opportunities for socioeconomic development, spurring growth in the number of habituated groups across their ranges.
- A growing body of evidence shows that habituated apes—including those in captive facilities—are at risk of disease spillover from humans. The inverse is also true, with apes posing a threat to humans.
- A dearth of information on the risks of disease transmission between humans and apes—especially from Asia—hampers the design of effective management strategies that could minimize the risks linked to habituation for research and tourism, including in entertainment facilities.
- Although best management practices are available for research and tourism, poor enforcement, a lack of awareness, insufficient resources and inadequate capacity are hindering implementation.
- Disease surveillance, epidemiology and health studies at the human–ape interface are critical priorities for the prevention of disease transmission between humans and apes and vice-versa.
- Reducing the risks of disease transmission between people and apes is a conservation priority. The ape–human interface could become more secure for these threatened species through collaboration among stakeholders, including academics, businesses, conservationists, government authorities, local communities, scientists, tour operators, tourism facilities and tourists.

Habituation: A Prerequisite for Ape Research and Tourism

Habituating Wild Apes

Studying or visiting unhabituated wild apes is difficult. Apes tend to be suspicious of humans and generally flee; they may also display unnatural behaviors or become aggressive (Gruen, Fultz and Pruetz, 2013). For scientists who document ape behaviors and tourists who want to see and photograph the animals, however, being in close visual range is essential (Williamson and Feistner, 2011). Consequently, the first step towards developing and sustaining long-term scientific research and tourism is the

habituation of wild apes (Schaller, 1963; Tutin and Fernandez, 1991).

Habituation is the process by which animals gradually experience a loss of fear and become desensitized to the presence of human observers (Thorpe, 1963; Whittaker and Knight, 1998; Williamson and Feistner, 2011). It is a relatively new concept, triggered during the second half of the 20th century, following modern commercial tourism and scientific research on great apes (Gruen, Fultz and Pruetz, 2013; Russon and Wallis, 2014a). While humans can approach and observe habituated apes more easily than unhabituated ones, higher levels and frequencies of close contact with people result in increased stress, reduced resting and feeding times, and considerable disease transmission risks (Homsy, 1999; Knight, 2009; Köster *et al.*, 2022; Woodford, Butynski and Karesh, 2002).

In the past, scientists conditioned apes with food to approach them easily, but the artificial presence of food modified the animals' behavior and ranging patterns, while also creating a risk of food contamination (Goodall, 1986). Therefore, current best management practices for habituation strongly discourage the provisioning of food to apes and other primates (Macfie and Williamson, 2010; Power, 1986; Wrangham, 1974). Not all tour operators take the guidance on board, however. Hand feeding has become a popular means by which to increase the likelihood of close sightings of free-ranging apes, particularly in areas where they have been released following captivity (Orams, 2002). During feeding activity, humans and apes are in close contact, and the risk of disease transmission increases, compounded by a heightened risk of aggression towards humans and conspecifics, as well as conflict (Lappan *et al.*, 2020).

Habituation usually involves regular visual tracking of the target group until animals ignore the observers (Blom *et al.*, 2004; Doran-Sheehy *et al.*, 2007). During habituation, the animals' reactions fluctuate between aggression (especially for terrestrial African apes), avoidance (hiding or fleeing), curiosity and indifference to the observer's presence (Shutt, 2014). The duration of the habituation process depends on the species, the nature of prior encounters with humans, the frequency and type of contact, the social structure of the group and personalities of the individuals, and the habitat (Bertolani and Boesch, 2008; Morgan and Sanz, 2003; Werdenich *et al.*, 2003). In all cases, ape habituation is a long and challenging process. It can take more than 6 months for gibbons, 1–2 years for mountain gorillas, up to 4 years for orangutans, 2–5 years for bonobos (*Pan paniscus*) and more than 5 years for western lowland gorillas (*Gorilla gorilla gorilla*) or chimpanzees (*Pan troglodytes*).[3] In some instances, individuals may never become habituated and may remain wary of human presence (Oram, 2018).

> "Reducing the risks of disease transmission between people and apes is a conservation priority."

In the scientific literature, habituation and visitation are often presented as conservation tools that support the protection of animals and their habitat—or diversify and improve the livelihoods of local communities (Butynski and Kalina, 1998; Köster *et al.*, 2022; Robbins and Boesch, 2011; Spenceley *et al.*, 2010). In practice, however, the risks to the apes may outweigh the conservation benefits in the long run (Butynski and Kalina, 1998; Ferber, 2000; Shutt *et al.*, 2014). More information is needed to understand the risk balance at the individual and species levels (Russon and Wallis, 2014b). In the meantime, best management practices (BMPs) are key to guiding both habituation and visitation in ways that minimize costs and maximize benefits (Macfie and Williamson, 2010). Such BMPs ensure that new habituation attempts consider the latest scientific evidence on disease transmission and animal welfare (Gruen, Fultz and Pruetz, 2013; Laurance, 2013).

Photo: Carers tend to condition captive apes to facilitate animal compliance. Such conditioning also allows scientists and medical professionals to carry out research and routine veterinary health screenings without having to use physical restraint or tranquilization, ensuring both human and animal safety and welfare. Temperature check, Chimpanzee Sanctuary Northwest. © CSNW

Habituation of Captive and Semi-captive Apes

Captive apes may be held permanently at research facilities, zoos or sanctuaries, or temporarily at rescue and rehabilitation centers. Their level of fearlessness towards humans depends on the duration and degree of human intervention while they are in captivity, as well as their temperament and experience.[4] Habituation of captive and semi-captive apes is often an unintentional consequence of repeated exposure to human carers (Chelluri, Ross and Wagner, 2013).

Carers tend to condition captive apes to facilitate animal compliance, as well as individual or group behavior management more generally (Bloomsmith *et al.*, 1994; Leeds, Elsner and Lukas, 2016). Such conditioning also allows scientists and medical professionals to carry out research and routine veterinary health screenings without having to use physical restraint or tranquilization, ensuring both human and animal

safety and welfare.[5] Apes receive positive reinforcement, often in the form of a food reward (known as a "conditioned reinforcer"), at the end of each completed task to ensure their continued compliance.

In captive settings, wild-caught and semi-captive apes are typically exposed to stress factors such as environmental novelty, a new diet, an unfamiliar social group structure and the presence of humans. An individual's failure to cope with these changes may result in physiological strain (Morgan and Tromborg, 2007). This stress may lead to suppressed immune function, increasing susceptibility to various conditions and diseases, growth impairment and reproductive failure.[6] While some individuals may adapt before permanent physiological damage sets in, those who do not can continue to deteriorate and suffer premature death (Fischer and Romero, 2019; Špinka and Wemelsfelder, 2018).

Familiar and unfamiliar human presence can significantly impact the movement and spatial dispersion within an enclosure, aggressive behaviors and interaction among group members at captive facilities (Hosey and Druck, 1987; Lee, 2012). The presence of unfamiliar visitors and researchers has caused a decrease in grooming, foraging and tool-use behaviors in outdoor-housed captive chimpanzees (Wood, 1998). In contrast, indoor-housed animals demonstrate an increase in agonistic (combative) behaviors, such as aggression, biting, attacking and injuring group members (Lambeth, Bloomsmith and Alford, 1997; Maki, Alford and Bramblett, 1987). When some indoor-housed chimpanzees were given access to an outdoor area, there was a significant decline in aggressive behavior among group members and an increased interest in human visitors (Stevens *et al.*, 2008). Conversely, outdoor-housed captive apes such as orangutans were generally unaffected by the presence of unfamiliar zoo visitors (Choo, 2011). However, whenever visitor numbers have been high and and there is nowhere for the animals to hide, captive orangutans have been observed to use paper sacks to hide their heads (Birke, 2002).

The habituation process among captive apes may be reversible, as these animals can develop new normal or abnormal behaviors to cope with the presence of familiar and unfamiliar humans in their captive environment (Hosey and Druck, 1987). The response to the presence of humans may vary across arboreal and terrestrial captive ape species and may also be influenced by a host of other factors, including enclosure design and size, group size, available space per animal, the visual distance between apes and visitors, the ability of the captive apes to hide from humans, and visitors' activity level and associated noise (S. Sumita, personal observation, 2022).

Some conservationists argue that the cost of ape habituation for tourism and research may ultimately outweigh the benefits (Ferber, 2000; Litchfield, 2008; Shutt *et al.*, 2014). Others contend that without the economic incentive of ape tourism, it is unlikely that mountain gorillas and their habitat would have been protected, especially during prolonged periods of armed conflict in the region (Maekawa *et al.*, 2013). The following sections discuss the benefits and costs of habituating apes.

Actual and Potential Benefits of Habituating Apes for Research and Tourism

Owing to the global interest in apes and their corresponding economic value, many ape range countries use these animals as icons of national identity and pride, featuring them on passports, postage stamps, banknotes, statues and posters (Williamson, 2001). Some also use apes as major attractions for

Photo: Some conservationists argue that the cost of ape habituation for tourism and research may ultimately outweigh the benefits. Others contend that without the economic incentive of ape tourism, it is unlikely that mountain gorillas and their habitat would have been protected, especially during prolonged periods of armed conflict in the region. © Ronan Donovan

international and national tourists (Digun-Aweto, 2020; Shutt, 2014). In the Democratic Republic of Congo (DRC), Rwanda and Uganda, for instance, mountain gorilla tourism was established to prevent the extinction of the species. Tourism was a tool used for the conservation of apes, and its protective effects have been a source of pride in the three countries (Harcourt and Stewart, 2007; Mukanjari *et al.*, 2013; Robbins *et al.*, 2011b; Sabuhoro *et al.*, 2017). In Indonesia and Malaysia, increasing interest in conserving the only Asian great ape species—orangutans—has led to research activities, support for rehabilitation programs, and ape tourism projects (Rijksen, 1978; Rijksen and Meijaard, 1999). Recently, other Asian countries have started to encourage gibbon tourism to promote their conservation and support local livelihoods. These include Cambodia, India and the Lao People's Democratic Republic (Williams and Behie, 2020).

Apes represent a significant economic asset so long as best management practices are implemented and enforced (English and Ahebwa, 2018; Litchfield, 2008; Macfie and Williamson, 2010; Munanura *et al.*, 2016). Mountain gorilla tourism, for example, is among the most important sources of foreign exchange income for Rwanda and

Uganda, where it accounted for 15% and 7.7% of national GDP in 2018, respectively. After coffee and tea exports, the sector was the greatest foreign exchange earner in both countries that year.[7] In 2005, in the Bwindi, Mgahinga, Virunga and Volcanoes National Parks—which range across the DRC, Rwanda and Uganda—mountain gorilla tourism activities generated US$20.6 million per year in direct benefits and much more in indirect benefits. About 53% of that direct income accrued at the national level and 41% at the international level, but only 6% at the local level (Maekawa *et al.*, 2013). In 2010 alone, wildlife tourism, driven mainly by orangutan viewing, generated between US$13 and US$23 million for the local economy of Sarawak, Malaysian Borneo (Zander *et al.*, 2014).

Ape tourism activities provide local, national, regional and international employment opportunities. Increased income, more secure livelihoods and awareness among communities that live adjacent to the parks can contribute to poverty reduction and a better appreciation of the apes and other wildlife, as recently shown with gorillas in Uganda's Bwindi Impenetrable National Park and in Gabon's Loango National Park (Robbins, 2021). In the Kinabatangan floodplain in Sabah, Malaysian Borneo, tourism receipts surpassed an estimated MYR100 million (US$24 million) in 2019, although fewer than half of the local people are involved in the sector (Chan, Marzuki and Mohtar, 2021; Wong, 2020). Tourism has created a source of income for local residents, who work as tour guides, drivers and skippers or operate their own tourism businesses, such as homestays or bed and breakfasts. At the same time, work remains to be done to overcome barriers to local participation in ecotourism and to prevent the exploitation of local Indigenous communities (Chan, Marzuki and Mohtar, 2021; Latip *et al.*, 2015).

With the right policies and planning, ape tourism can theoretically benefit local and national economies through multiplier effects. It is considered successful when local communities around an ape tourism site derive tangible benefits, have an active say in how they are involved and impacted, and enjoy respect for their social and economic systems and values, rather than being overwhelmed by tourism (Dawson, 2008; Litchfield, 2008). In practice, however, these objectives have not generally been met at the community level, which tends to benefit the least.[8] Inequalities in ape tourism benefit-sharing are significant concerns for ape conservation and could be among the reasons why hunting and poaching persist in many sites used for tourism (Munanura *et al.*, 2020; Tolbert *et al.*, 2019). Other reasons may relate to social, cultural and economic factors, which financial benefits from tourism alone cannot address (Munanura *et al.*, 2016; Plumptre *et al.*, 2004).

Concepts such as "pro-poor tourism" and "sustainable tourism" were developed in part to help address the unfair distribution of benefits and to ensure that poverty alleviation and reduction were key objectives addressed through tourism activities (Chok, Macbeth and Warren, 2007; Goodwin, 2007, 2014, 2016; Roe and Urquhart, 2001). In range states, the focus of ape tourism is on the reduction of poverty among communities living in the vicinity of ape habitats (Maekawa *et al.*, 2013). Most of these countries have developed legal frameworks to ensure the revenue from tourism in national parks is shared with adjacent local communities (Ahebwa, van der Duim and Sandbrook, 2012; Archabald and Naughton-Treves, 2001; Zander *et al.*, 2014). In Uganda, for example, 20% of park entrance fees and US$10 per US$700 gorilla permit are provided to people who live in the vicinity of the park. In Rwanda, in 2017, the government increased its revenue sharing allocation for

community development projects from 5% to 10% of each gorilla permit (Maekawa *et al.*, 2013; Mukanjari *et al.*, 2013; Plumptre and Williamson, 2001).

In the past 25 years, the price of gorilla tracking permits has increased substantially. In Uganda, tracking fees rose from US$175 in 1997 to US$700 in 2022. In Rwanda, permit costs increased from US$250 in 1999 to US$1,500 in 2017 (see Case Study 6.2). No comparable or even significant increase in revenue has been accorded to the communities of the gorilla parks.[9] Despite some examples of success at the local level, ape tourism has yet to maximize benefits for economically deprived rural communities across range countries (Baker, Milner-Gulland and Leader-Williams, 2012; Maekawa *et al.*, 2013).

Tourism revenue arguably benefits governments, elites, foreign investors and other professionals disproportionately, while local communities face opportunity costs in land they cannot cultivate or exploit and the challenges of "crop-raiding" wildlife or conflicts with animals venturing out of the forests (Odhiambo, 2021; Scherl *et al.*, 2004; Tumusiime and Vedeld, 2012). Tourism has yet to fulfill its potential to contribute to poverty alleviation in a meaningful way.

Nevertheless, answering some of the basic needs of communities that share habitats with apes forms an integral part of the conservation agenda to protect habituated apes (Munanura *et al.*, 2016; Tolbert *et al.*, 2019). Tourism activities can provide direct or indirect support for schools and health facilities, for example. In line with the One Health approach—which recognizes that ape health and the wellbeing of human communities sharing the same habitat are interconnected—they can also allow for family planning, vaccinations and other prophylactic campaigns (see Chapter 2). Benefits can include improved health and hygiene among communities and a lower risk of disease transmission between the local people and habituated apes (Cranfield and Minnis, 2007; Kalema-Zikusoka and Byonanebye, 2019).

Ape research and tourism may also lead to a better understanding and acceptance of the biodiversity conservation agenda, which can result in fewer poaching or snaring incidents (Ancrenaz, Dabek and O'Neil, 2007; Robbins, 2021). In addition, the daily presence of researchers and rangers researching and monitoring the apes offers increased protection from hunting and snaring (Köster *et al.*, 2022; see Box 3.1). By following habituated groups, researchers also facilitate rapid veterinary interventions when necessary (Robbins *et al.*, 2011b). Indeed, studies show that habituated mountain gorillas exhibit a higher population growth rate (4.1%) than wild groups (0.7%) (Gray *et al.*, 2010; Robbins *et al.*, 2011b). Taken together, research and tourism activities, positive engagement from communities around the mountain gorilla habitat and other cross-boundary collaborative efforts probably contributed to the downlisting of *Gorilla beringei beringei* from critically endangered to endangered. While they are still threatened with extinction, mountain gorillas are the only great ape species whose conservation status has improved (Hickey *et al.*, 2019b; Robbins *et al.*, 2011b).

In addition to fostering a better understanding and acceptance of conservation goals, tourism revenue can help to safeguard protected areas. In Uganda, mountain gorilla tourism generates more revenue than other protected areas and contributes more than half of the funds used to run other national parks managed by the Uganda Wildlife Authority (Ahebwa, van der Duim and Sandbrook, 2012; English and Ahebwa, 2018; Walaga and Mashoo, 2009). Without these funds, most of the country's protected areas would be in peril and perhaps destroyed by land-use conversion or illegal resource extraction (English and Ahebwa,

2018). Indeed, Litchfield (2008) notes that without mountain gorilla tourism in Uganda, it is unlikely that the tiny Mgahinga Gorilla National Park (about 40 km² or 4,000 hectares) would exist today.

Limitations and Costs of Habituating Apes for Research and Tourism

Ape tourism is associated with some benefits, as discussed above, yet it also poses real risks to apes (Buckley, Morrison and Castley, 2016; Krüger, 2005). Ape visitation, even with fully habituated apes, often results in individual and group behavioral changes (time budget and daily ranges), higher vigilance levels and various stress-related signs.[10]

Compared to wild orangutans who are not subjected to tourist visitation, those who are visited are characterized by range restriction, reduced arboreal behavior, increased infant mortality and inter-female aggression, both in the wild and in semi-captive conditions (Kuze *et al.*, 2012; van Noordwijk *et al.*, 2018). At the group level, ape tourism may harm intergroup dynamics by discouraging female or male immigration or preventing unhabituated animals from coming close to habituated groups and individuals (Goldsmith, 2000; Morton *et al.*, 2013). In rehabilitation sites such as Indonesia's Bukit Lawang in Sumatra and Tanjung Puting in Kalimantan, as well as in Sepilok in Sabah (Malaysian Borneo), former rehabilitants not only stopped their usual foraging activities during tourist visitation and food provisioning, but also increased their vigilance and self-directed behaviors (Dellatore, Waitt and Foitovà, 2014).

Stress triggered during habituation may negatively impact apes' welfare and reproductive success (Moberg, 1985). Chronic and repeated exposure to stress can eventually suppress immune function, increasing

BOX 3.1

Impact of the COVID-19 Pandemic on Ape Research and Tourism Activities

On 30 January 2020, the World Health Organization declared the outbreak of COVID-19 a public health emergency of international concern (WHO, 2020b). As a result, all countries were expected to curb the spread of the disease among human populations. Some immediately instituted measures such as the closure of national borders, nationwide lockdowns and travel restrictions. By April 2020, protective measures against COVID 19 were instituted in all African and Asian ape range states. Other protective measures included a ban on tourism and research activities in national parks and other sites (Orangutan Foundation, 2020; Richardson, 2021; UWA, 2020a).

Research and tourism activities were probably among the first and most severely affected of all conservation-related activities (Henseler, Maisonnave and Maskaeva, 2022; Huynh *et al.*, 2021; Reuter *et al.*, 2022). By mid-March 2020, the fear of COVID-19 transmission by travelers resulted in travel bans and entry refusals in ape range countries, which drastically reduced and eventually halted the influx of tourists and researchers into ape sites. In most range countries where ape visitation sites are located, much of the funding for running these sites comes from tourism activities, international donor agencies and foundations (Maekawa *et al.*, 2013; Tumusiime and Vedeld, 2012). National governments provide a relatively small amount of funding, most of which is earmarked for staff salaries at ape facilities and sites.

The COVID-19 pandemic resulted in a drastic reduction or halt of revenue from ape tourism. Consequently, ape monitoring patrols were reduced in number, intensity and quality at most sites, or stopped altogether. In the Virunga Massif and the Bwindi Impenetrable National Park, the cuts severely affected mountain gorilla patrols, while the monitoring of park boundaries came to a halt (N. Guma, personal communication, 2020). In Bwindi alone, the number of snares and illegal park entries substantially increased in 2020, due to the measures instituted to curb COVID-19 (IUCN, 2020a; UWA, 2020b). Furthermore, in June 2020, a male silverback gorilla was killed by poachers who took advantage of the reduced presence of rangers, trackers and tourists (BBC, 2020).

The decline in the number of tourists significantly affected most countries' economies, including the local economy of communities engaged directly or indirectly in ape tourism, as well as local residents who were involved in income-generating activities in captive ape facilities (Henseler, Maisonnave and Maskaeva, 2022; Huynh *et al.*, 2021). This situation also resulted in reduced revenue to support parks and locally active conservation organizations, which were forced to cut down or pause most field activities, such as community conservation programs. In addition, travel restrictions placed on researchers caused a drop in conservation research fee revenues at ape facilities in range countries.

Between June and July 2020, most ape sites reopened for local and international research and tourism activities—with strict standard operating procedures (SOPs) in place (UNCST, 2020). These SOPs required tourists and researchers to be tested for COVID-19 before they entered the ape range states, quarantine for 14 days before visiting apes, wear face masks and use hand sanitizer, and maintain a physical distance of at least 10–15 meters from the apes (UWA, 2020a). Despite the reopening of ape research and tourism sites and a decline in COVID-19 cases, researcher and tourist numbers have remained low at most ape sites.[11]

Photo: In rehabilitation sites such as Indonesia's Tanjung Puting in Kalimantan and Malaysian Borneo's Sepilok in Sabah, former rehabilitants not only stopped their usual foraging activities during tourist visitation and food provisioning, but also increased their vigilance and self-directed behaviors. Tanjung Puting National Park, Borneo, Indonesia. © Suzi Eszterhas / naturepl.com

susceptibility to diseases (Sapolsky *et al.*, 1990; Shutt *et al.*, 2014; Wasser, Sewall and Soules, 1993; Woodford, Butynski and Karesh, 2002). Studies undertaken during ape habituation processes have documented clinical signs of infectious diseases in chimpanzees, as well as higher parasitic loads in mountain gorillas, although the latter could be related to them living in close proximity to humans, near the park boundary (Fujita, 2011; Morton *et al.*, 2013). In contrast, analysis of fecal and hair cortisol concentrations shows that wild chimpanzees habituated to ecotourism are not chronically stressed, unlike orangutans and western lowland gorillas (Carlitz *et al.*, 2016; Muehlenbein *et al.*, 2012; Shutt *et al.*, 2014).

Tourists in ape habitats create additional pressure on the environment, including trampling, habitat damage, noise and waste pollution (Plumptre and Williamson, 2001). The construction of facilities and infrastructure necessary for tourism also has a negative impact on wildlife habitats as it directly alters the landscape and forest connectivity. In addition, deforestation and habitat fragmentation can lead to an increase in illegal activities such as poaching, while also contributing to environmental degradation (Arcus Foundation, 2018).

As noted above, habituation reduces apes' natural fear of humans. In some cases, however, apes may become overhabituated —or completely unafraid of humans. These

apes may seek out physical interaction with humans, which can increase the risk of conflict, aggression and disease spillover (Ampumuza and Driessen, 2021; Williamson and Feistner, 2011). Habituated individuals occasionally leave the safety of protected areas, approach tourist facilities and enter local residential areas, gardens and orchards, where they may engage in crop-foraging or find themselves in conflict with local communities.[12] People may commit retribution killings in response to crop damage or human–animal conflict, particularly if they perceive apes as life-threatening or want to express their anger to park authorities (Davis *et al.*, 2013; McLennan and Hockings, 2016).

In Bwindi, Uganda, where several habituated mountain gorillas have regularly entered local people's gardens and damaged crops, human–ape conflict is not uncommon (Seiler and Robbins, 2016). Indeed, conflicts between humans and gorillas are a concern for most protected area managers in gorilla range countries (Hockings and Humle, 2009). At sites where habituated apes cross over into human-dominated landscapes, establishing buffer zones between community lands and ape habitats is a potential solution, as is the cultivation of crops that are non-palatable to gorillas (such as tea) or the creation of barriers. In Asia, conflicts with habituated apes are far less frequent, mainly because apes there are primarily or fully arboreal and live in smaller groups (see the Apes Overview).

Increased proximity between habituated apes and humans heightens the risk of direct disease transmission via contact with aerosols and droplets as well as indirect transmission via fecal deposits, contaminated fomites or substrates.[13] Before reaching ape visitation sites, international tourists and researchers often pass through several countries and continents. From an epidemiological perspective, they present a very effective means of transporting and disseminating pathogens to apes (Litchfield, 2008). In the past few decades, apes have been victims of several disease outbreaks of human origin, such as anthrax, measles, parasites, respiratory viruses, scabies and yaws (see Chapter 1).[14] Meanwhile, people involved in ape research and tourism are also susceptible to possible zoonoses of viral, bacterial or parasitic origin as they come near apes.[15] Box 3.2 and Chapter 1 focus on disease risks from tourists, or researchers.

As range states realize that habituated apes are a potential source of foreign exchange earnings, managers of protected areas are increasingly under pressure to habituate more ape groups for tourism (Munanura *et al.*, 2020; Nielsen and Spenceley, 2011). For example, in Uganda's Bwindi Impenetrable National Park, only three groups of gorillas were habituated in 1994 for research or tourism activities (Kabano, Arinaitwe and Robbins, 2014). Today, 17 groups are regularly used for research and tourism (Hickey *et al.*, 2019b). Indeed, about 43% of Uganda's mountain gorilla population has been habituated to tourism and research (Hickey *et al.*, 2019b). In the Virunga Massif, which spans Rwanda and the DRC, nearly three-quarters (73%) of the total gorilla population is habituated (Gray *et al.*, 2013). Furthermore, several groups of mountain gorillas specifically habituated for research are also concurrently used for tourism. This additional pressure increases all the human-induced negative impacts on the target groups and individuals.

As noted above, ape habituation is a long and challenging process. It is very costly and exceeds the budget of most national parks, typically requiring support from the international donor community. In the Central African Republic, for example, habituating one group of western lowland gorillas at Dzanga-Sangha took more than two years and cost at least US$250,000 (Blom, 2001b). This figure excludes the budget for the

health monitoring programs that are conducted prior to, during and after the habituation processes (Blom, 2001a). In view of the resources necessary for habituating apes, carrying out the process would be nearly impossible without international agencies' support.

Risks to Habituated Wild and Captive Apes

Diseases of Human Origin

Apes have been regular victims of zoonotic disease outbreaks since people have shared their range. However, data from health monitoring have only been collected since humans started visiting apes in the wild for tourism or research.

The longest-running research program on wild chimpanzees, the Gombe Stream Research Centre, is located in Gombe National Park, which was established in 1968 (Collins and Goodall, 2008; Figure 3.1). Before the early 2000s, many Gombe chimpanzees died of flu-like diseases that were probably of human origin (Lonsdorf *et al.*, 2006; Wallis and Lee, 1999; Williams *et al.*, 2008). In Mahale, Tanzania, human respiratory viruses were identified in habituated groups of chimpanzees, who exhibited morbidity rates between 34% and 98% and mortality rates between 3% and 7% (Hanamura *et al.*, 2008; Kaur *et al.*, 2008). In Ivory Coast, five distinct outbreaks of respiratory diseases occurred in groups of wild chimpanzees habituated for research; their morbidity rate reached 90% and their mortality rate fluctuated between 3% and 19% (Köndgen *et al.*, 2008). More recently, several outbreaks of respiratory diseases have affected chimpanzee and bonobo communities across their range (Grützmacher *et al.*, 2018b; Negrey *et al.*, 2019; see Box 3.2 and Chapter 1).

In the past 20 years, habituated mountain gorilla groups experienced 18 documented outbreaks of respiratory disease, possibly of human origin; nearly every group that was habituated for research or tourism suffered from at least one outbreak (Spelman *et al.*, 2013). Health monitoring of mountain gorillas between 2018 and 2019 showed that habituated individuals had a higher infection rate than their unhabituated counterparts, particularly with reference to intestinal parasites of livestock or human origin (Hickey *et al.*, 2019b). Similar results were found among gibbons but not orangutans (Ancrenaz, 2015; Hilser, 2011). No large-scale epidemics of human origin have yet been documented in Asian apes, although disease transmission between humans and orangutans or gibbons has been reported in the region (Kilbourn *et al.*, 1997, 2003; Mul *et al.*, 2007; Rijksen, 1978; Smith *et al.*, 1969).

Risks of Exposure in the Wild

In the wild, differences in diet, social structure and ranging behavior influence the risks of exposure and disease spread between wildlife populations and groups (Herrera and Nunn, 2019; see Chapter 1). For example, parasite richness depends on host body size, social group size, diet and individual ranging patterns (Freeland, 1976; Nunn *et al.*, 2003; Vitone, Altizer and Nunn, 2004).

The spread of a disease within an infected population depends on the nature of the pathogen, its infectiousness and the host's recovery time (Masi *et al.*, 2012; Rushmore *et al.*, 2013). It is also influenced by the social organization of the host species and the frequency of contact between individuals (Altizer *et al.*, 2003; see the Apes Overview).

Immunocompetence is an essential element of an individual's survival. As immunity and stress levels are correlated, increasing stress levels due to habitat fragmentation, climate change and regular close exposure to humans make animals more susceptible to pathogens (Acevedo-

BOX 3.2

Disease Spillover at the Oldest Chimpanzee Research Program in Africa: Gombe

Since the inception of standardized data collection on the Gombe chimpanzees, the primary cause of death has been infectious disease, often of suspected human origin (Williams *et al*., 2008). In the 1970s and 1980s, during the initial decades of research at Gombe National Park, close interaction between researchers and chimpanzees was not unusual. Such interactions were encouraged through supplemental food provisioning of the wild chimpanzee population (Goodall, 1986). By the mid-1970s, tourists began to visit the park—without any specific regulation protocol regarding group size or safety distance (Collins and Goodall, 2008).

The 1990s witnessed repeated fatal epidemics of flu-like disease in chimpanzees. While the pathogens responsible for these outbreaks remained unknown, it was recognized that exposure to humans increased the risk of illness for chimpanzees (Wallis and Lee, 1999). By 2000, researchers stopped regular provisioning of chimpanzees and worked with park staff to codify and implement best management practices for disease monitoring and prevention, targeting scientists and tourists (Collins, 2003; Pusey, Wilson and Collins, 2008). Following the recommendations of Homsy (1999), these protocols stipulated a minimum distance from chimpanzees of 7.5 m for researchers and 10 m for tourists, who are more likely to carry unfamiliar disease strains. Tourist visits were restricted to no more than six individuals for no more than one hour. Visiting researchers were asked to supply proof of vaccinations and to complete a seven-day quarantine prior to following wild habituated chimpanzees (Collins, 2003). For more on the chimpanzees of Gombe, see *State of the Apes: Industrial Agriculture and Ape Conservation* (Arcus Foundation, 2015, pp. 207–15).

Additional measures were introduced in view of chimpanzees' frequent movement through areas of the park where staff members lived. Researchers moved families of personnel out of the park, built wire mesh cages around the front of staff houses to prevent chimpanzees from accessing cooking and cleaning implements, and introduced a shift system to reduce the numbers of staff members present at any given time. Latrines and garbage pits were also modified to prevent access. In 2012, latrine facilities were upgraded with secure structures, plumbing and flush toilets. In addition, since 2017, observers (researchers and tourists) have been required to wear face masks in the presence of chimpanzees (Lonsdorf *et al*., 2022).

Most recently, in 2020, outbreak response protocols were implemented, which include a threshold for additional fecal and fruit wadge sampling from infected chimpanzees and their social contacts. While flu-like outbreaks have occurred once or twice a year in the two decades since the best management practices were implemented, only four have resulted in mortality in the chimpanzee community (T.R. Gillespie, personal communication, 2021).

FIGURE 3.1

Gombe National Park and Vicinity

Sources: Protected area—UNEP-WCMC (2021h); country boundaries—GADM (n.d.); other base map detail—OpenStreetMap (n.d., © OpenStreetMap contributors, published under Creative Commons Attribution License CC BY; for more information see http://creativecommons.org)

Whitehouse and Duffus, 2009; Lochmiller, 1996). In two separate studies, orangutans and western lowland gorillas used for tourism had higher glucocorticoid metabolite concentrations than unhabituated conspecifics, indicating a certain level of chronic stress (Muehlenbein *et al.*, 2012; Shutt *et al.*, 2014). No visible symptoms were associated with these findings, however. Little is known about these mechanisms, and more research is needed to explore their long-term impact on ape survival.

Anthropogenic habitat fragmentation exacerbates the risks of disease spillover from humans to both Asian and African apes by causing ecological stress, temporary or permanent increases in population densities, confinement of pathogens that can disseminate more rapidly and efficiently, and exposure to pathogens from people or domesticated animals (Daszak, Cunningham and Hyatt, 2001; Gillespie and Chapman, 2008; Nunn and Altizer, 2006). Compared to large populations living in vast protected areas, fragmented populations are more vulnerable to stochastic events, including disease outbreaks (Acevedo-Whitehouse and Duffus, 2009). However, the paucity of data on ape adaptation and survival in highly fragmented landscapes precludes accurate assessments of the real risks (Ancrenaz, 2015).

Risks of Exposure in Captivity

The risk of disease transmission between people and captive apes depends on the facility design and the nature and management of the captive environment. Apes at rescue and rehabilitation centers may have limited or no contact with visitors. Nevertheless, they are subjected to close contact with their regular carers and staff working at these ex-situ facilities. Occasionally, short-term visitors, such as interns, researchers or documentary film crews, may be present.

Photo: The risk of disease transmission between people and captive apes depends on the facility design and the nature and management of the captive environment. Apes at rescue and rehabilitation centers may have limited or no contact with visitors. Nevertheless, they are subjected to close contact with their regular carers and staff working at these ex-situ facilities.
© Lwiro Primates Rehabilitation Center

Before arriving at rehabilitation centers and approaching apes who are expected to be released into the wild, visitors are required to follow strict standard operating procedures (SOPs), including stringent health screenings, which are drawn from best management practices (see Box 3.3).

Captive apes are frequently housed with conspecifics in enclosures designed to facilitate the expression of natural behaviors. Carers monitor their health and welfare closely, with a certain degree of intervention, to ensure that the animals are provided with appropriate nutrition and optimum veterinary care (see Chapter 8). Captive apes may experience nutritional, metabolic or degenerative conditions that are rarely reported in wild ape populations.[16] Such conditions can be exacerbated by a pronounced sedentary life and an increase in lifespan.

> “Apes held as pets by private owners are generally at greater risk of contracting and transmitting infectious diseases.”

The risk of zoonosis is high in captive facilities such as zoos, where a constant stream of carers and visitors come close to the apes. The risk is especially high when tourists are encouraged to have close encounters with habituated apes during photography sessions or similar experiences. If people who come close to apes fail to abide by SOPs, they effectively place both themselves and the apes at risk of contracting a transmissible disease. A recent review has identified a minimum of seven occurrences of respiratory anthroponosis among captive apes in zoos and rehabilitation centers (Dunay *et al.*, 2018).

Poorly designed and non-species-specific enclosures, in tandem with a lack of biosecurity measures, pose a health risk to captive apes by enabling the transmission of diseases from visitors. However, funding gaps and inadequate knowledge of appropriate enclosure design, infrastructure materials, landscaping and enrichment requirements can make it challenging to provide a suitable captive environment for apes. In addition, visitors often throw food and other items into outdoor exhibits in efforts to attract attention or provoke a reaction from apes. These items may be contaminated with pathogens of human origin that can potentially cause disease in naive captive apes. Too often, signage discouraging feeding of captive wild animals at zoological facilities is ignored by zoo visitors (S. Sumita, personal observation, 2021).

Apes held as pets by private owners are generally at greater risk of contracting and transmitting infectious diseases, as they live in closer proximity to humans. Illegally kept apes often suffer from various degrees of malnutrition and malabsorption. They are also susceptible to various zoonotic diseases, trauma and mental health issues due to their experience and abnormal living conditions (see Case Study 4.3).[17]

Serological surveys of rehabilitant orangutans show that captive apes visited by tourists have been exposed to human diseases, including typhoid, hepatitis (A, B, C), tuberculosis, scabies, measles, conjunctivitis and meningitis, as well as various parasites. Mortality among rehabilitant apes has been linked to respiratory ailments, tuberculosis, hepatitis B and scabies (Rijksen, 1978; Warren, 2001; Yeager, 1997). In Sabah, rehabilitant orangutans who were exposed to humans produced antibodies in response to common human respiratory viruses, unlike their wild conspecifics with no human exposure (Kilbourn *et al.*, 1997, 2003). Gilardi *et al.* (2014) report a case of vesicular stomatitis caused by human herpes simplex virus type 1 in a confiscated juvenile Grauer's gorilla (*Gorilla beringei graueri*) who had been hand-reared by humans in the DRC.

Some rehabilitation centers continue to promote tourism for educational and financial reasons, thereby heightening the risk of spreading human diseases to rehabilitant apes and wild ape populations following the translocation and release of rehabilitated individuals (Rijksen, 1978; Russon and Susilo,

2014). Due to the frequent movement of related government agency personnel involved in implementing and enforcing established policies, practices and processes related to translocation and release of rehabilitants, best management practices (BMPs) are not always observed. Appropriate handover documentation can minimize risks associated with staff turnover and ensure continuity and adherence to SOPs and BMPs.

Managing Disease-Related Risks in Apes

It is not possible to prevent new pathogens from emerging or to eliminate the occurrence of zoonoses. Reducing the risks of pathogen spillover from humans to wildlife and vice versa requires the implementation of adequate legislation and the vigorous enforcement of practices regulating human–wildlife interactions and contacts, especially for people who come in regular or close contact with apes, such as tourists, researchers and local community members.

Disease-Related Risks Associated with Visitors

People who visit apes can be divided into two main categories: short-term visitors (mainly tourists) and long-term visitors (mainly researchers). To date, most documented cases of zoonotic disease in wild habituated apes have been linked to local communities, park staff and researchers—rather than tourists (Muehlenbein and Ancrenaz, 2009; Wallis and Lee, 1999). This finding is not surprising, as tourists spend less time on site than it takes most diseases to incubate and infected animals to display clinical signs, making it very challenging to identify the source of infection. The risk of disease transmission depends on several factors, such as the distance between people and apes, the duration of contact and visitor numbers. Tourism exposes certain groups of habituated apes to more people in a single year than average people let into their homes throughout a lifetime (Homsy, 1999).

Short-term visitation typically involves proximity to apes for less than a few hours; however, visitors can potentially spend several hours or days in the visited animals' range. Short-term visitors include national and international tourists, interns, camera crews and reporters, VIPs, veterinarians and medical staff, and general workers (in the case of captive or semi-captive facilities). Overall, tourists have a poor understanding of the risks they pose to the places and animals they are visiting, and they rarely adhere to a preventive health strategy before visiting (Hamer and Connor, 2004; Van Herck *et al.*, 2004). Many travelers are unaware of their vaccination status and are not protected against vaccine-preventable diseases that may spread to apes (Van Herck *et al.*, 2004). A key step in mitigating these threats to ape health is enhancing communication about transmission risks (see Chapter 2).

A study conducted in Sabah shows that the vaccination status of nearly half of the visitors at the Sepilok Orangutan Rehabilitation Center was unknown or not up to date before the introduction of COVID-19 regulations. In addition, more than two-thirds of visitors with medical occupations who were aware of the risks of influenza were not vaccinated when they visited the orangutan rehabilitation center (Muehlenbein *et al.*, 2008). About 15% of the tourists reported symptoms of respiratory or gastrointestinal diseases during their visit, meaning that their presence represented a real risk of disease transmission to the apes (Muehlenbein *et al.*, 2010). More recently, similar findings were reported with respect to mountain gorillas (Hanes *et al.*, 2018). Future research

“Due to the frequent movement of related government agency personnel, best management practices (BMPs) are not always observed.”

could usefully assess whether tourists and short-term visitors have become more aware of the risks since the COVID-19 pandemic (Anthes, 2022; BES Press Office, 2022; Gilardi and Uwingeli, 2022).

International tourists are of particular concern because they are often victims of respiratory infections or gastrointestinal ailments (due to unfamiliar diets and tropical intestinal pathogens) that can potentially be passed on to apes (Rack *et al.*, 2005). While traveling, they spend hours in enclosed spaces such as airplanes and are exposed to thousands of other people when transiting. Many are under physiological stress resulting from their journey, such as from a lack of sleep or jetlag, or in response to an unfamiliar environment (Gilardi *et al.*, 2015). Tourists often visit apes shortly after arrival or explore several ape sites in succession (Muehlenbein and Wallis, 2014).

The scientific literature has not yet documented contamination of apes by short-term tourists. Nevertheless, several factors could combine to devastating effect for entire groups of apes, including the sheer number of people visiting apes each year, the proximity they seek with the animals, their overall lack of consideration for health issues, the transmissibility of some diseases even before the first symptoms are detected and the presence of many people in a restricted environment (Russon and Wallis, 2014a).

On the whole, tourists fail to adhere to rules at many wild and captive ape ecotourism sites (Russon and Wallis, 2014a). As they typically spend a considerable amount of money in order to see apes in their natural habitats or in captive settings, they may be reluctant to declare illness for fear of being barred from visiting them. Moreover, park and sanctuary staff, who depend on tourists' financial contributions, may feel uncomfortable about challenging visitors who seem unwell or are not adhering to standard operating procedures.

Long-term visitors include researchers, documentary film crews, rangers and park personnel, local community members, carers and volunteers for captive and semi-captive

Photo: Apes held as pets by private owners are generally at greater risk of contracting and transmitting infectious diseases, as they live in closer proximity to humans. Illegally kept apes often suffer from various degrees of malnutrition and malabsorption. Juvenile gorilla at a hotel in Gabon. He was later sent to a sanctuary. © Alison White

apes. These visitors are more likely to engage in close and repeated contact, including physical contact with apes. The risk of disease transmission is thus high, and the consequences can be devastating. The number of long-term visitors at any single location is generally low, however, which may facilitate enforcement of SOPs to reduce the likelihood of disease spillover. Strict enforcement can help ensure adherence to precautionary practices. Targeted strategies to minimize the risk of disease transmission can usefully be developed, adapted and implemented among local communities that share the same habitat as apes, given that ape health is intimately linked with human health (see Chapter 2).

Many short- and long-term visitors—including primatologists, conservationists, volunteers, carers and workers in the entertainment industry—share photographs and videos showing close interaction with captive or wild apes. Photos of apes in close contact with humans can promote the view that these animals are suitable pets or that they are not endangered (Leighty *et al.*, 2015; Ross *et al.*, 2008; Ross, Vreeman and Lonsdorf, 2011). By giving the false impression that touching apes is acceptable, such images play down sanitary risks associated with these situations and undermine conservation objectives (Ross, Vreeman and Lonsdorf, 2011).

A recent analysis of holiday photographs taken with wild animals shows that many pictures portraying close encounters with great apes are extremely popular on various social media sites, including Instagram, Facebook and personal blog sites (Otsuka and Yamakoshi, 2020; Waters *et al.*, 2021). The popularity of shared human–animal close contact in photographs and videos on social media platforms encourages tourists to engage in risky behaviors (Van Hamme *et al.*, 2021). As noted above, many tourists spend a significant amount of money and time traveling in the hopes of getting as close as possible to apes; they want to be able to get their fill of "memories" from their once-in-a-lifetime encounters, irrespective of the potential sanitary risks such situations create (Cox *et al.*, 2009).

In response to the growing popularity of human–animal images, an increasing number of conservationists are calling for an end to the posting of images of physical and close contact between people and wildlife (Sherman, Brent and Farmer, 2016). Relevant guidance, recently published by the International Union for Conservation of Nature (IUCN) Primate Specialist Group Section for Human Primate Interaction, is entitled *Best Practice Guidelines for Responsible Images* (Waters *et al.*, 2021).

Best Management Practices for Disease Prevention in Apes

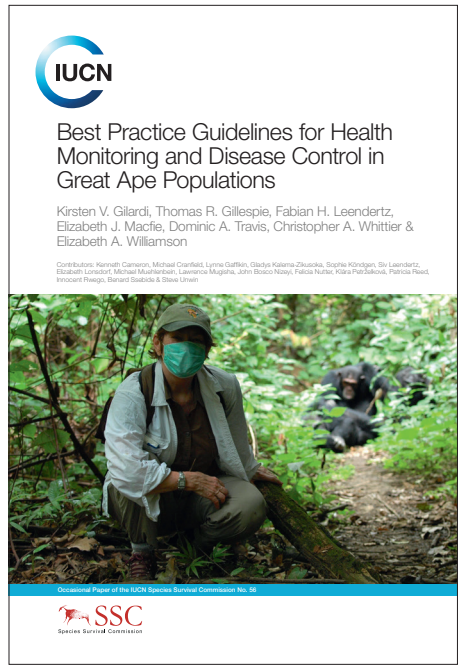
The IUCN Red List classifies all ape species and subspecies as vulnerable, endangered or critically endangered. All three categorizations signal the need to minimize the risks created by human proximity to habituated and captive apes and to adopt precautionary measures regarding the use of apes in research and tourism activities (Macfie and Williamson, 2010). As it is impossible to eliminate the emergence of zoonoses and anthroponoses, the focus is on minimizing the risks of disease transmission to apes. Indeed, it is far easier, more affordable and more efficient to prevent the introduction of a pathogenic agent to a population than to control, treat or eradicate a disease outbreak (Macfie and Williamson, 2010; Santos, Guiraldi and Lucheis, 2020). Therefore, protected area authorities, ape researchers and tourism projects emphasize the implementation of vital disease prevention programs and the adoption of BMPs for disease prevention.

The first regulations to target mountain gorilla tourism were developed in the Virungas in the 1970s (Williamson, 2001). They subsequently underwent scientific review and were later revised based on field experience and impact studies (Homsy, 1999). These regulations limited each habituated gorilla group to a single one-hour visit per day by no more than eight tourists at a time, with a minimum of 7 meters between gorillas and humans (Weber, Kalema-Zikusoka and Stevens, 2020).

In view of the increasing number of ape tourism sites, the IUCN Species Survival Commission Primate Specialist Group developed the *Best Practice Guidelines for Great Ape Tourism* (Macfie and Williamson, 2010). The guidelines aimed to manage various risks, including diseases, to ensure that tourism contributed positively to ape conservation. Five years later, the IUCN produced the *Best Practice Guidelines for Health Monitoring and Disease Control in Great Ape Populations* (Gilardi *et al.*, 2015). Separate guidelines have been developed for managing the risk of disease transmission to gibbons in rehabilitation centers and to great apes (Beck *et al.*, 2007; Campbell, Cheyne and Rawson, 2015; PASA, 2009).

Practical tools found in BMPs include "dos and don'ts" that park managers and authorities can easily implement. They were translated into simple, straightforward SOPs to offer practical guidance about how to implement the BMPs. They were produced in local languages and adapted to the local ape species, habitat conditions and socio-economic contexts, as well as the type of human interventions at each site (Gilardi *et al.*, 2015; Macfie and Williamson, 2010). BMPs aim to cover the various scenarios in which apes come into close contact with humans (see Box 3.3). Habituated mountain gorillas, for example, are exposed to more than 2,000 hours of visitation by tourists every year and thus face far more risks than groups that are followed by a limited number of scientists (Homsy, 1999; Litchfield, 2008).

In response to the COVID-19 pandemic, guidelines were produced to minimize risks



of human transmission of the disease to captive and wild apes (Gillespie and Leendertz, 2020). Following the precautionary principle, many conservationists advocated halting ape-related fieldwork in the wild (Reid, 2020). However, the sudden cancellation of these activities had detrimental effects on habituated apes, as field workers had afforded them some degree of protection against poaching; local communities also suffered, largely due to loss of employment and income (Lappan *et al.*, 2020; see Box 3.1). This experience has highlighted the need to adapt and modify field protocols and develop more robust occupational health policies to make fieldwork safer for both people and apes (Lappan *et al.*, 2020; Trivedy, 2020).

Despite BMPs and localized site-specific SOPs, one of the significant weaknesses at most sites is poor enforcement, which can lead to an overall lack of adherence by tourists, researchers and park staff (Daud, 2019; Hanes *et al.*, 2018; Sandbrook and Semple, 2006; Weber, Kalema-Zikusoka and Stevens, 2020). On several occasions in Bwindi, for example, tourists and researchers did not maintain the 7-meter minimum distance from gorillas, while others stayed with gorillas for more than an hour (Hanes *et al.*, 2018; Sandbrook and Semple, 2006; Weber, Kalema-Zikusoka and Stevens, 2020).

If tourists and researchers are well informed and understand the risks they pose to the animals they encounter, they are more likely to follow best practice guidelines (Russon and Wallis, 2014a). Clear punitive and incentive measures are prerequisites for the enforcement of proper sanitary guidelines (Sandbrook and Semple, 2006). The dissemination of such guidelines requires the development of targeted awareness raising materials for various audiences, especially on travel websites (Horvath, Murray and DuPont, 2003; Muehlenbein and Ancrenaz, 2009). Park personnel, tour operators, surrounding local communities and anyone who

BOX 3.3

Health Best Management Practices for Ape Visitation: A Summary

The health best management practices summarized below are designed to minimize the risk of disease transmission from people—including personnel, researchers, filmmakers, tourists and veterinarians—to great apes and gibbons in captive facilities and in their habitats.

- People who are feeling unwell or exhibiting signs of illness may not visit the apes.
- Before visiting the apes, people who have been ill must undergo a quarantine period of at least seven days after the cessation of clinical signs of illness.
- People who may have acquired infectious agents prior to or during international travels must undergo a seven-day quarantine prior to visiting the apes.
- People who visit the apes must be at least 15 years old.
- People who are likely to come within 10 m of apes must wear a surgical mask.
- People must maintain a minimum distance of 7 m from the apes.
- No individual ape or ape group may be visited by more than one tourist group per day.
- The number of tourists in such groups may not exceed the maximum deemed appropriate for the relevant ape species.
- A visit to an ape group may not last more than one hour.
- People must sanitize their hands before and after entering ape habitat and captive ape facilities.
- Before and after visiting apes, people must clean (and then, if possible, disinfect) their clothing and footwear, including between visits to different ape groups.
- People who need to sneeze or cough while visiting apes must keep their mask on, turn away from the animals and cover their mouth and nose with the crook of the elbow or clothing, rather than with the hand.
- People who need to urinate while in ape habitat must move away from and out of sight of the apes and dig a hole at least 30 cm deep.
- Defecation is not permitted in ape habitat. People who need to defecate while in ape habitat must bag and then dispose of any solid waste, such as feces and toilet tissue, outside of the forest.
- Cigarette smoking is prohibited and cigarette butts may not be disposed of in ape habitat.
- Artificial items, such as plastic bags and containers, may not be discarded in ape habitat.
- People who are likely to come into frequent or close proximity to apes must be immunized according to local government recommendations. At a minimum, long-term visitors—including site staff, researchers and veterinarians—must be immunized against measles and other highly infectious diseases that can affect apes.
- Site staff and longer-term visitors must be tested for tuberculosis annually and show negative results before commencing ape visits (Gilardi *et al.*, 2015; Johnson *et al.*, 2009; Jones and Brosseau, 2015; Macfie and Williamson, 2010; Monto, 2002; Muehlenbein *et al.*, 2012; Shutt *et al.*, 2014; Xie *et al.*, 2007).

could come near habituated apes (including poachers) also need to be aware of the risks of disease transmission between people and apes (Filippone *et al.*, 2015). Park authorities, tour operators and site managers can ensure that all tourists and other people who visit apes have read and understood these recommendations—and that they adhere to them.

Another concern is the disposal of non-biodegradable personal protective equipment (PPE), such as face masks, gloves and hand sanitizer dispensers. Most PPE items contain plastic or microplastic ingredients, which negatively impact the environment, especially if they are not disposed of properly. Plastics can act as fomites for pathogen transmission and are potentially dangerous pollutants of ape habitats such as Bwindi (Bitariho, Akampurira and Mugerwa, 2020). While current BMPs recommend the use of PPE items, they do not specify how to dispose of them after use.

Over the past 15 years, a growing number of zoological facilities issued plastic bans to prohibit the provision, sale, distribution and introduction of plastics on their premises. One of the first was Nepal's Central Zoo in Kathmandu, which educates members of the public on the environmental concerns related to plastic. In 2009, the zoo banned plastic bags and began to offer its visitors environmentally friendly alternatives. Its messaging included information on the health implications of accidental ingestion of plastic material by the zoo animals (Himalayan News Service, 2009). Since then, many other captive facilities worldwide have launched on-site campaigns about plastic waste and the danger it poses to both terrestrial and aquatic animals and it has become a global focus with a number of ape range states banning single use plastics (Cerdán and Kirk-Cohen, 2020; Greenpeace Africa, 2020; Inclean Magazine, 2019; Rivas *et al.*, 2022).

The Role of Legislation and Regulatory Frameworks

Most sanitary guidelines and BMPs for habituated ape populations were developed voluntarily by conservationists or practitioners. On the whole, BMPs are not legally binding, although a few research sites implement these guidelines strictly and captive facilities are required to adhere to legislation about animal welfare or fulfill health requirements (see Chapter 8). Overall, the implementation and effectiveness of non-binding BMPs are poor, and the legal framework for addressing the risk of disease transmission to habituated apes is still fragile. The lessons from the COVID-19 pandemic could help to bridge these gaps. Adequate legislation is required to support the enforcement and implementation of BMPs so that they can be applied across all ape sites, rather than at exceptional facilities. Incentives and punitive measures would help managers of protected areas to ensure that people who come into contact with apes comply with the guidelines.

Researchers must adhere to national and international laws concerning veterinary medicine, biological sample collection and interactions with both wild and captive apes. Depending on the range country, researchers must submit a "wildlife animal use protocol" under the Institutional Animal Care and Use Committee and undergo health screenings before arriving at the field research site. On-site animal welfare and ethics committees further scrutinize the research topic, especially in the case of captive apes, before permission is granted to proceed with the proposed research.

The Role of Evidence-Based Assessments

In view of the growing demand for ape visitation, various stakeholders perceive the

habituation of additional ape groups as a way to promote conservation while diluting sanitary and other risks, as this approach could provide more options for research and tourism activities (Ancrenaz, 2018). Disease-related and other risks associated with habituation are barely understood, however. Before any additional ape habituation processes for research or tourism could begin, extensive site- and species-specific risk assessments and feasibility studies would need to be carried out. Such evaluations are most useful when they consider the environmental, welfare and socioeconomic characteristics of a situation, as well as the vulnerability and long-term protection of the apes selected for habituation (Russon and Wallis, 2014a).

Moreover, the governance of tourist sites that offer visits to wild, habituated ape populations would benefit from the joint input of professionals, including conservationists, ecologists, ape managers, travel medicine specialists and social scientists (Muehlenbein and Ancrenaz, 2009; Munanura, Backman and Sabuhoro, 2013; Russon and Wallis, 2014a). The first step could be to conduct an in-depth assessment of ape visitation sites, including through a cost–benefit analysis of current ape tourism projects and analysis of their contributions to ape conservation. The assessment could give rise to recommendations for improving governance and decision-making processes that guide ape habituation and ape-related tourism.

Photo: Habitat destruction leads to disease emergence, but the underlying mechanisms, the prediction and the prevention of possible outbreaks are still poorly understood. Knowing and cataloging pathogens that affect ape species may benefit human medicine while supporting conservation efforts. Habitat conversion along the edge of Volcanoes National Park.

Understanding Disease Ecology in Natural Habitats

Addressing health threats requires an understanding of what can potentially infect or kill apes, how and under which circumstances. There is an urgent need to collect reliable baseline data to quantify the impact of habituation on the health of ape populations that are used for tourism and research (Leendertz *et al.*, 2006b; see Chapter 2). Although a fair amount of research is being carried out to identify pathogens that occur in the wild, very little is known about their actual impact and the health risks they pose. The lack of information about what could be considered "normal" in a population severely impedes the identification of sanitary issues that require attention. Baseline data on unhabituated apes in Asia and other fast-changing environments is particularly scarce (Calvignac-Spencer *et al.*, 2012).

> "Recent technological improvements provide tools for studying apes in their natural habitat without habituation or the need for human observers to be in close proximity to them."

Over the past decade, several African sites have reported a significant increase in respiratory disease outbreaks in wild, habituated chimpanzees (Desmond and Desmond, 2014; Fujita, 2011; Negrey *et al.*, 2019; Scully *et al.*, 2018). Scientists are still trying to determine whether this observation reflects ecological changes—such as climate change or increased contact with human beings or domestic animals—or improvements in the ability to detect outbreaks. For now, the real threats to the survival of these populations remain unknown.

The COVID-19 pandemic illustrates how little is known about the dynamics between hosts, reservoirs and pathogens on the one hand, and the impacts of deforestation, habitat fragmentation and climate change on the other (Lappan *et al.*, 2020). Habitat destruction leads to disease emergence, but the underlying mechanisms, the prediction and the prevention of possible outbreaks are still poorly understood. Knowing and cataloging pathogens that affect ape species may benefit human medicine while supporting conservation efforts. For example, in Southeast Asia, ticks are increasingly found on newly captured wild orangutans (Sabah Wildlife Department, personal communication, 2019). However, scientists still do not know whether this increase is a result of the apes' close contact with cattle or people, habitat fragmentation, or an adaptation of the parasites to new environmental conditions resulting from climate change. Such examples illustrate the knowledge gaps in disease ecology, highlighting the need for epidemiological and holistic studies that investigate the underlying variation of infectious disease pathogenicity under different environmental conditions (see Chapter 1).

Early warning systems based on monitoring protocols prioritize risks to habituated apes and support immediate intervention to prevent catastrophic outbreaks (Leendertz *et al.*, 2006b; see Chapters 4 and 6). Direct and visual monitoring can easily be implemented at all sites without expensive equipment (Knott *et al.*, 2021; Shutt, 2014). Although the lack of rapid diagnostic tests is still a challenge in the field, recent technological advances in molecular diagnostics, in tandem with improved sequencing techniques and mobile diagnostic laboratories, can improve the current understanding of disease ecology and complement the arsenal already used to monitor animal health, pathogen burden and physiological status (Calvignac-Spencer *et al.*, 2012; Knott *et al.*, 2021; Quick *et al.*, 2016). Combined with human disease monitoring, such early warning mechanisms can contribute to effective One Health approaches (see Chapter 2).

Recent technological improvements provide tools for studying apes in their natural habitat without habituation and without the need for human observers to be in close proximity to them. Genetic sampling is a practical and effective non-invasive approach

for studying apes in their natural habitat (Arandjelovic *et al.*, 2010, 2011; McCarthy *et al.*, 2015). Over the past few years, scientists have used terrestrial environmental DNA sampling for ecosystem and biodiversity surveys. Animals are shedding DNA in the environment: hair and skin, feces and urine, saliva and blood. By testing contaminated water or soil, scientists can identify the shedding individual's species (Deiner *et al.*, 2017; Leempoel, Hebert and Hadly, 2020). In practice, however, such non-invasive techniques are challenging, and genetic material is often difficult to analyze due to DNA fragmentation and degradation, as well as allelic dropout.

Camera-trapping is increasingly used to study the impacts of conservation threats and management, socio-demographics, behavior and feeding ecology, disease screening, mapping of habitat use and ranging patterns of wild habituated and unhabituated apes (Boyer-Ontl and Pruetz, 2014; Head *et al.*, 2013; Klailova *et al.*, 2013; Steinmetz *et al.*, 2014). One major limitation of using camera-trapping, smartphones or conventional cameras to collect images is the time-consuming nature of processing hundreds or thousands (or even more) pictures. However, the emerging field of animal biometrics and ape facial recognition can overcome some obstacles (Crunchant *et al.*, 2017; Loos and Ernst, 2013; Loos and Kalyanasundaram, 2015). Devices such as drones and other unmanned tools can potentially serve to minimize the proximity of tourists and researchers to the apes they are observing. Passive acoustic monitoring has been used to monitor long calls of wild orangutans, as well as vocalizations of chimpanzees (especially "pan-hoots" and "drumming") and gibbons; this method allows for the monitoring of spatio-temporal patterns of habitat use by unhabituated groups of apes (Clink, Crofoot and Marshall, 2019; Kalan *et al.*, 2016; Kaplan and Rogers, 2000; Spillmann *et al.*, 2015).

Despite these tools, effective health monitoring of apes (both habituated and unhabituated) is still rare. The number of sites where health monitoring and disease prevention are implemented is small compared to the number of habituated ape populations in Africa and Asia (Calvignac-Spencer *et al.*, 2012; Knott *et al.*, 2021; Morton *et al.*, 2013). As long as governments and other stakeholders perceive wildlife health as a low priority, funding for sanitary monitoring is likely to remain insufficient.

Conclusion

Although ape research and tourism have often been viewed as potential tools for conserving wild populations and supporting captive care, they are associated with significant risks to ape health. Evidence at most ape sites shows that research and tourism are managed with little adherence to sanitary best management practices (Russon and Wallis, 2014a). Given that research and tourism activities pose enormous health risks to habituated apes and their environments, a clear assessment of the actual benefits and costs of habituation is necessary, particularly to guide the use of tourism as an ape conservation tool.[18]

> "Most of the time, a relatively small portion of the funds from research and tourism are channeled directly into ape conservation programs or to the communities living near ape habitats."

A key health concern is the distance between people and habituated apes (see photograph on pp. 76–77). While some argue that proximity to the apes is necessary to satisfy tourists' expectations, better management of such expectations, greater public awareness of health risks and more responsible behavior by tour operators and guides would go a long way to protecting the apes. Similarly, researchers, captive care staff and park employees could prioritize methods that do not require close contact with apes (Knight, 2009; Russon and Wallis, 2014a; Tapper, 2006). In addition, social

Photo: In theory, research and tourism can secure much-needed revenue for the protection of wild ape populations, yet how the money is actually invested depends on a range country's priorities. Most of the time, a relatively small portion of these funds is channeled directly into ape conservation programs or to the communities living near ape habitats. Ngamba Island Chimpanzee Sanctuary, Uganda. © Friends of Chimps

media could be utilized to make it "shameful" for people to be close to apes. In this context, conservationists and carers have an essential role to play.

Enforcing simple BMPs such as those calling on visitors to wash their hands, wear a mask or maintain a minimum distance from apes can significantly reduce the risk of disease transmission to the animals (Macfie and Williamson, 2010). Before the COVID-19 outbreak, tourists, scientists and park personnel were reluctant to wear masks, thereby posing a severe risk to habituated apes (Van Hamme *et al.*, 2021). Future research could examine public perceptions of mask wearing since the start of the coronavirus pandemic, as well as its impact on the health of habituated apes and the financial value of the ape tourism experience (Anthes, 2022; BES Press Office, 2022).

Guidelines and BMPs have been used to minimize the risk of disease transmission to many habituated wild ape populations. However, laws and regulations in ape range countries generally do not require the implementation of BMPs. As is already the case in accredited rescue centers, sanctuaries and zoos, robust legal frameworks that assist practitioners in both captive and wild settings to enforce BMPs would ensure best practice for all apes, especially with the addition of punitive measures for BMP offenders. Simultaneously, government departments and conservation practitioners, including park managers, could secure more resources and incentives to support the enforcement of BMPs.

In theory, research and tourism can secure much-needed revenue for the protection of wild ape populations, yet how the money is actually invested depends on a range country's priorities. Most of the time, a relatively small portion of these funds is channeled directly into ape conservation programs or to the communities living near ape habitats. Moreover, a significant

Photo: In captive settings, an individual ape's failure to cope may result in severe stress leading to suppressed immune function, increasing susceptibility to various conditions and diseases, growth impairment and reproductive failure. While some individuals may adapt before permanent physiological damage sets in, those who do not can continue to deteriorate and suffer premature death. © Jo-Anne McArthur/ Born Free Foundation/ We Animals Media

proportion of great ape and gibbon conservation funding still comes from international donors (Macfie and Williamson, 2010). A greater proportion of the proceeds from ape research and tourism is required for the long-term protection of habituated ape populations, as well as for related law enforcement, research, veterinary and local community health care, education campaigns and interventions through One Health programs (see Chapter 2).

By integrating long-term observational health data with non-invasive diagnostics, future studies could fill knowledge gaps regarding the epizoology and biology of pathogens in apes. They could also allow for impact assessments of the habituation process and people's presence near apes, especially those whose populations are dwindling and whose habitats are declining because of development projects and hunting (Calvignac-Spencer *et al.*, 2012; Devaux *et al.*, 2019).

Finally, addressing the risks of spillover diseases caused by ape-related research and tourism requires a multipronged approach

—one that combines the development and implementation of stringent biosafety protocols, the adoption of appropriate practices during ape encounters, the development of adequate outreach and social media campaigns, the collection of long-term data on the sanitary status of apes living at the interface with people, and the prioritization of sanitary risk as a significant conservation threat to the survival of great apes and gibbons (Lappan *et al.*, 2020).

Acknowledgments

Principal authors: Sumita Sugnaseelan,[19] Marc Ancrenaz[20] and Robert Bitariho[21]

Contributors: Tom Gillespie[22] and Elizabeth Lonsdorf[23]

Box 3.1: Sumita Sugnaseelan and Robert Bitariho

Box 3.2: Tom Gillespie and Elizabeth Lonsdorf

Box 3.3: Marc Ancrenaz and Robert Bitariho

Endnotes

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