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# Gorilla *Gorilla* spp conservation – from zoos to the field and back: examples from the Mbeli Bai Study

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Zoos and aquariums undoubtably have an important role to play in supporting species conservation through a diverse range of activities, including public awareness and financial support of field-conservation projects. Charismatic megafauna, such as gorillas *Gorilla* spp, play a crucial role as flagship species in their range countries, acting as ambassadors for conservation. Here, we present examples from the Mbeli Bai Study (MBS) in northern Congo, a long-term Western lowland gorilla *Gorilla gorilla gorilla* field-conservation project. We show how collaborations between zoos and field-conservation projects can support each other in numerous ways. Over the last two decades the MBS has received substantial support from zoos. A large portion of the operational budget has been provided by zoos and this has ensured a degree of financial independence over the long term. Intensive exchange of conservation-education techniques in terms of material and staff expertise has been helpful for MBS's education project 'Club Ebobo'. This has not only provided training for field educators but has also given zoo personnel and visitors better insight into the realities of conservation in range countries. Such exchanges can further help to promote awareness, raising the role of zoos in supporting field-conservation projects. Finally, the knowledge gained through scientific research has proven to be beneficial for animals both in the field (e.g. improved conservation measures) and in captivity (e.g. better-adapted group structure, feeding strategies and environment). Here, we discuss our experience and describe some of the benefits and challenges of conservation collaborations between zoos and field-conservation projects.

*Key-words:* animal husbandry; collaborations; conservation; education; field research; financial support; gorilla; zoo.

## INTRODUCTION

With over 1300 institutions worldwide, zoos and aquariums are uniquely positioned to foster conservation support on a global scale (Penning *et al.*, 2009; Gusset & Dick, 2011). Zoos support conservation through a diverse range of activities from captive breeding and reintroduction of threatened species and educating the public, to financing field-conservation projects (Miller *et al.*, 2004; Patrick *et al.*, 2007; Fa *et al.*, 2011). Prominent zoo associations, such as the Association of Zoos and Aquariums (AZA), the World Association of Zoos and Aquariums (WAZA) and the European Association of Zoos and Aquaria (EAZA), have pledged their commitment to international wildlife conservation, and their member zoos and aquariums are increasingly conscious of their leading roles and mission for *in situ* wildlife conservation (Barongi *et al.*, 2015; AZA, 2016a; EAZA, 2016a).

Charismatic megafauna, such as Tigers *Panthera tigris*, Giant pandas *Ailuropoda melanoleuca* and great apes, play fundamental flagship roles for conservation as these species are among the most preferred wildlife for both zoo visitors and wildlife-viewing tourists (Feldhamer *et al.*, 2002; Skibins & Powell, 2013; Skibins *et al.*,

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2013). As the largest living primate and one of our closest relatives, the gorilla *Gorilla* spp is a particularly appealing charismatic species that captures the imagination and grabs the attention of a wider public. Gorillas are among the most popular animals in zoos and are often used as examples in zoo-education programmes (Stoinski *et al.*, 2001). Gorillas and Forest elephants *Loxodonta cyclotis* (Blake & Hedges, 2004) play a fundamental role as ambassadors for wildlife conservation in Central Africa.

At the time of writing, two gorilla species are recognized: the Eastern gorilla *Gorilla beringei* and the Western gorilla *Gorilla gorilla*, each of which contains two subspecies (cf. Groves, 2017). Gorillas are interesting study subjects as they occur in a diverse range of habitats and such ecological differences are assumed to have led to the different social organization and life histories observed between the different (sub)species (Doran & McNeilage, 2001; Robbins *et al.*, 2004; Breuer *et al.*, 2009). Almost all gorillas in captivity are Western lowland gorillas *Gorilla gorilla gorilla*. Despite their relatively large population size, Western lowland gorillas are considered Critically Endangered owing to their projected population decline (IUCN, 2014). Free-ranging Western lowland gorillas are exposed to a diversity of direct threats, most notably habitat loss, poaching and disease exposure, particularly Ebola haemorrhagic fever (IUCN, 2014).

In this article, we demonstrate the link between zoos and field-conservation projects on Western lowland gorillas, particularly in relation to financial support and conservation education, with examples from the Mbeli Bai Study (MBS) in the Republic of Congo. Mbeli Bai is a 13 ha large swampy forest clearing in the southwest of Nouabalé-Ndoki National Park (NNNP). NNNP is part of the Sangha Trinational World Heritage, a stronghold for Western lowland gorillas, Central chimpanzees *Pan troglodytes troglodytes* and Forest elephants; for further details of the study area, see Parnell (2002a), Stokes *et al.* (2003) and Breuer *et al.* (2009). Gorillas visit Mbeli Bai to feed on mineral- and protein-rich aquatic herbs (Metsio Sienne *et al.*, 2014; Breuer, 2015). More than 480 animals have been observed at Mbeli Bai since 1995, resulting in a total of 3229 gorilla years (as at June 2017) of observational data in our records and providing an insight into the natural history of this elusive species. The research carried out at Mbeli Bai does not involve daily following of habituated gorillas into the dense forest; all observations of the non-habituated animals are carried out from an observation platform overlooking the clearing (see also Fishlock & Breuer, 2015).

Here, we highlight some of the ways in which zoos can support field-conservation projects, and how these field projects can inform and assist the work carried out in zoos. We do not aim to provide an exhaustive list of such productive exchanges but instead present a powerful example that can serve as a framework for future collaborations complementing existing recommendations for successful partnerships (e.g. Conway *et al.*, 2001; AZA, 2016b). First, information is provided on the role of zoos as funders (both in general and of the MBS in particular). Next, the collaboration between zoos and MBS on conservation education is summarized, and their roles in scientific research and its importance for gorilla conservation (both in the wild and in captivity) are discussed. Finally, the implications of the experience of MBS and its relevance for collaborations between zoos and *in situ* conservation projects including potential challenges are reviewed.

## COLLABORATION BETWEEN ZOOS AND FIELD-CONSERVATION PROJECTS

The collaboration between different zoos and the MBS demonstrates an intensive association between both partners with positive feedback loops (Fig. 1).

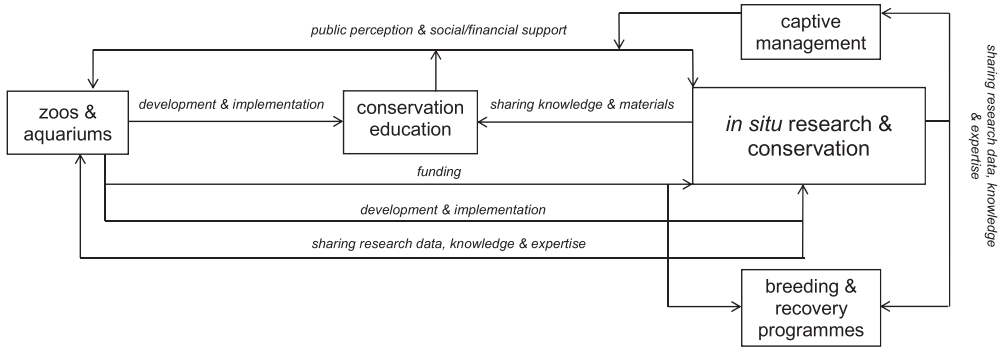


**Fig. 1. A systematic representation of the positive feedback loop between the zoo and aquarium community, and *in situ* research and conservation projects: arrows indicate the direction of feedback (*italic text*).**

## Funding

With a current annual expenditure of US $350 million on wildlife conservation (Gusset & Dick, 2011) and an estimated potential of US$1 billion of funds generated for conservation (Barongi *et al.*, 2015), zoos and aquariums are important players in conservation finance. Without funds from such institutions, many field-conservation projects with demonstrable global impacts in terms of conservation significance, scale and outcome would not be viable (Gusset & Dick, 2010). Many zoos have their own conservation funds actively supporting gorilla conservation. Zoos develop their own particular fundraising initiatives, such as the successful 'Quarters for Conservation' programme [generates funds from a gate-fee increase (e.g. 25 cents), which is restricted for conservation work], animal-adoption schemes, tip jars, cell-phone collection and community-collection events (AZA, 2016a). Zoos frequently combine their funding; for example, through conferences (e.g. Zoos and Aquariums Committing for Conservation: https://www.zaccconference.com) or through special campaigns, such as the Year of the Gorilla declared by the Convention of Migratory Species (Dick, 2009) or the EAZA Ape Campaign (Melicharek, 2010).

The MBS has been receiving substantial financial support from zoos since its inception in 1995. Between 2002 and 2017, MBS received more than US$730 000 with zoos providing an average 69% (range 25–100%) of the funds raised annually, fully covering the operational budget. Support was provided by a total of 21 North American and European zoos with some of them pledging long-term commitment in the range of US$5000–US$25 000 annually. In particular, some zoos have commited to support selected activities (e.g. research-assistant salary, education project, research activity) over several years and, therefore, have helped to cover specific aspects of MBS business. In addition, financial support was given to principal investigators to attend conferences and present the results of the MBS research to a wider audience.

## Conservation education and public awareness

The role of zoos and aquariums in conservation education has evolved over the years from mere awareness and knowledge building to engagement that leads to conservation action and sustainable behaviours (Patrick *et al.*, 2007; Barongi *et al.*, 2015; see also Fisken, 2016). Zoos and aquariums can offer a rare opportunity for urban citizens to connect to nature, and increasingly people in the affluent West are looking for leisure experiences that contribute to personal fulfilment and learning (Ballantyne *et al.*, 2007; Falk & Storksdieck, 2010).

Collaboration on conservation education between zoos and field studies can be beneficial for both parties. For example, often zoo staff possess particularly developed conservation-education skills and materials that can be shared with *in situ* projects. An excellent example is the 'Club Ebobo' environmental-education project that was established in 1998 by MBS researchers. Club Ebobo (Ebobo is the local name for gorilla) was established as an extra-curricular school conservation-education project in the villages surrounding NNNP (Breuer & Mavinga, 2010). Club Ebobo has since received significant support from the international zoo community, not only in terms of financial resources but also through advice and materials developed by zoo-based education experts. Similarly, zoo staff visited the project in Congo and conducted joint education missions that provided substantial insights into the realities of conservation education in the range countries of great apes (Breuer *et al.*, 2017). As a consequence, this collaboration helped to improve the educational information offered to the wider zoo audience; for example, message boards at exhibits were improved to help visitors understand the realities of on-the-ground conservation.

Field-conservation projects can substantially help to broadcast the conservation efforts of zoos, through television programmes, combined campaigns, magazines, newsletters, social media or web pages. These all help to create emotional connections between the zoo audience and the stories about the gorillas living in the field. Lastly, great ape field projects can make exciting discoveries and media material. For example, the detection of splash display (Parnell & Buchanan-Smith, 2001), the first observation of tool use in wild gorillas (Breuer *et al.*, 2005) or photographs of rarely observed face-to-face copulation in wild gorillas (Breuer & Ndoundou Hockemba, 2007) have received substantial media awareness and helped to emphasize the link between zoos and the MBS. These findings have received wide media coverage and the field researchers used press releases and interviews to mention the importance of zoos in supporting the MBS.

## Capacity building and transferable skills

Several zoos have formalized their capacity-building approaches for conservation leaders in developing countries; for example, through specialized training courses (including language courses), exchange visits, and exchange of techniques and materials. The collaboration between zoos and the MBS has helped to improve the conservation capacity of national Congolese staff. Training was provided for the main educator at MBS, who visited several zoos and gained valuable experience in education techniques and social sciences. Furthermore, research assistants of the MBS have benefited from higher academic training initiatives in collaboration with zoo partners and their respective field-staff training programmes. Field projects in turn can help to support capacity building among zoo staff through knowledge sharing, provision of lectures, data and imagery, or by hosting staff or members of zoological institutes, all of which can help to improve understanding of the realities of field conservation.

## Scientific research for field conservation and to inform captive management

Another important aspect of collaboration between zoos and field-conservation projects is scientific research. Science-based breeding, reintroduction and population-recovery programmes led by zoos have had immediate conservation impacts by saving threatened species from the brink of extinction (Jachowski & Lockhart, 2009; Earnhardt *et al.*, 2014). For example, in the case of gorillas, veterinary techniques (Cranfield & Minnis, 2007) originally developed in captivity have had substantial influence on the population increase of Mountain gorillas *Gorilla beringei beringei* (Robbins *et al.*, 2011). Furthermore, zoos are in the position to carry out research that would be difficult

or impossible to conduct in the wild, such as manipulation of group composition (Hoff *et al.*, 1996; McCann & Rothman, 1999), observations of behaviour towards novelty (Lukas *et al.*, 2003), and hormone (Atsalis *et al.*, 2004) and nutritional studies (Remis & Dierenfeld, 2004).

Innovative research techniques can be developed at zoos, and subsequently tested and implemented in the field. For example, staff of MBS and zoo collaborators have helped to trial laser pointer and range-finder photogrammetry in the zoos to measure morphological traits remotely without the need to immobilize the great ape (Galbany *et al.*, 2016), which is now being applied at two gorilla research sites in the field (Breuer *et al.*, 2007; Galbany *et al.*, 2017). A project has also been initiated to estimate the age of adult female gorillas in zoos with the hope that age estimates of wild female gorillas can be improved. Another study is carrying out combined assessments of gorilla personalities both in zoos and in the field (see also Kuhar *et al.*, 2006; Eckardt *et al.*, 2015). It is hoped that this study can contribute to our understanding about the well-being of captive gorillas through personality–health links and the consequences of personality to life-history traits and fitness in wild gorillas (see also Gartner & Weiss, 2018). A further example of innovative research is the development of automated facial recognition in camera-trap studies (Crunchant *et al.*, 2017). Individual pictures of the MBS gorilla population have successfully been used to test the application of this method on free-ranging gorillas, eventually enabling gorilla research in a remote forest setting without needing humans to identify individuals, saving on time and costs, while answering a myriad of socioecological questions (Brust *et al.*, 2017).

In turn, field research can provide important information to improve captive management (Eisenberg & Kleiman, 1977). In the past, information from the long-term Mountain gorilla field site at Karisoke, Rwanda, was used to inform animal husbandry of gorillas; for example, by stimulating mating compatibility and sociosexual development, and by reducing male sexual aggression and sperm depletion, and managing male grouping patterns (Harcourt, 1987, 1988; Watts, 1990). However, while these initial studies have confirmed similarities between the life-history patterns of wild Mountain gorilla and captive Western lowland gorilla (Sievert *et al.*, 1991; Watts, 1991), long-term data from MBS indicate a much slower life-history pace in wild Western lowland gorillas (Nowell & Fletcher, 2007; Breuer *et al.*, 2009; Stoinski, Perdue *et al.*, 2013) and a substantial difference between Eastern and Western gorillas in grouping (Parnell, 2002a; Robbins *et al.*, 2004), and transfer and reproductive patterns (Stokes *et al.*, 2003; Breuer *et al.*, 2010; Breuer, Robbins *et al.*, 2012; Breuer, 2011). Long-term research at MBS provided new and clearer understanding of social behaviour (Parnell, 2002b; Stokes, 2004; Breuer *et al.*, 2016), communication (Genty *et al.*, 2009), and feeding and learning patterns (Parnell, 2001; Nowell & Fletcher, 2006, 2008) of relatively understudied Western lowland gorillas; see also other Western lowland gorilla studies at forest clearings (Gatti *et al.*, 2004; Levréro *et al.*, 2006; Caillaud *et al.*, 2008). With these new data and through exchanges between zoo keepers and field researchers, the husbandry and welfare of gorillas can be improved; for example, for 'surplus' male gorillas in all-male bachelor groups (Price & Stoinski, 2007; Less *et al.*, 2010; Stoinski, Lukas & Kuhar, 2013; Leeds *et al.*, 2015), enclosure enrichment or the management of group size.

## Field data for conservation assessment

Our research has important implications for Western lowland gorilla conservation. Slower life history and higher mortality (Breuer *et al.*, 2010; Breuer, Robbins *et al.*, 2012) lead to a longer generation time in Western lowland gorillas compared with Mountain gorillas. Risk assessment using data from MBS and other sites helped to

categorize the Western lowland gorillas as Critically Endangered (Maisels *et al.*, 2016). According to the International Union of Conservation of Nature and Natural Resources (IUCN) criteria, a predicted decline of more than 80% of Western lowland gorillas over three generations makes the species eligible for Critically Endangered status. More detailed population modelling using life-history tables from MBS is currently under way. The long-term data collection from the undisturbed gorilla population at MBS provides crucial comparative data for recent assessments of a population impacted by Ebola haemorrhagic fever (Caillaud *et al.*, 2006; Genton *et al.*, 2012, 2015, 2017), which will make it possible to evaluate fully the recovery potential of Western lowland gorillas. The visual health observations at MBS and other sites have helped to develop a health protocol for NNNP (Breuer, Cameron *et al.*, 2012), which has been included in the best-practice guidelines for great apes (Gilardi *et al.*, 2015). Similarly, observations from MBS have provided insights into potential disease-transmission patterns with particular relevance for Ebola management (Walsh *et al.*, 2007). Lastly, the permanent presence of researchers at Mbeli Bai as seen at other sites (Campbell *et al.*, 2011; Piel *et al.*, 2015) has substantially helped to contribute to habitat and *in situ* species protection with virtually no poaching events at the site in more than 20 years.

## DISCUSSION

In this brief review, examples have been provided from our own long-term gorilla study in northern Congo on the various ways zoos and field-conservation projects are collaborating. This report complements other publications on the role of long-term studies for conservation management (Steklis & Steklis, 2008; Wrangham & Ross, 2008; Chapman *et al.*, 2017). This is not a holistic summary of all the benefits of long-term research; however, it does emphasize the particular link between zoos and field-conservation projects with practical examples from the experiences at MBS in relation to the conservation of a mega-charismatic species. Readers are referred to other engagement guidelines to establish their partnerships (e.g. Conway *et al.*, 2001; Barongi *et al.*, 2015; AZA, 2016b); however, here we discuss a few selected challenges and lessons learned from experiences at MBS.

### Funding

Funding is a crucial element of all field-conservation projects, and it is not unusual for conservation funding to be time limited (e.g. 2 or 3 years) and/or restricted (i.e. can only be spent on specific aspects of a project), which makes long-term planning difficult. However, zoos should make financial contributions annually as part of a long-term commitment to conservation, which would ensure the continuity of funding for conservation projects/studies (Conway *et al.*, 2001). This is particularly important for species with a slow reproductive rate, such as great apes, that need substantial time to accumulate the relevant life-history (and other) data (e.g. the MBS). In our case, the site visit of zoo donors and regular visits of the field-conservation staff have tremendously helped to highlight the importance of a long-term partnership. In addition, funds from zoos are often not restricted to a single activity, which provides financial flexibility. Furthermore, having a multitude of smaller grants compared with one large grant also makes a project less dependent and more resilient, and thus more likely to continue for the long term. The fact that many zoo grants are relatively small and cannot generally cover the entire operational budget of a field-conservation project could potentially result in a high demand for proposal and reporting requirements. However, reporting to zoos is usually less labour-intensive compared with other funding reports as there is often a flexible format and annual reports are frequently sufficient. In the case of the MBS, it took some time to develop the relevant

relationships with zoos. Occasionally potentially new zoo funders were reluctant to provide additional support given the long list of existing zoo funders of our field-conservation project.

While funding from zoos provided crucial financial support for the MBS over the long term, this might be different for species that receive far less attention. Indeed, the zoo community has been criticized for biasing their funding and conservation efforts towards less-threatened charismatic taxa while largely ignoring others (Pritchard *et al.*, 2012; Conde *et al.*, 2013). However, zoos need to balance *ex situ* conservation priorities with a complex range of arguably competing objectives, such as commercial entertainment and sustainable revenue (Carr & Cohen, 2011; Fa *et al.*, 2014). Potentially, zoos with more charismatic species in their collection attract more visitors and thus more revenue, which could in principle be used to support less-popular taxa and habitats. A further balancing of conservation efforts in line with clear conservation priorities and targets (Gusset *et al.*, 2014), pooling of resources and coordinated funding as well as transparency and accountability for measurable outcomes will help to gain public trust and improve conservation effectiveness.

## Conservation education and public awareness

Collaboration on environmental education and public awareness is beneficial for both zoos and field-conservation projects. Well-executed conservation education can improve visitor experience and feeds back to how zoos are perceived in society; for example, through natural enclosures that mimic wilderness conditions, interactive displays of natural behaviour or eliciting an emotional connection with animals (e.g. by providing access to appealing species), particularly charismatic megafauna such as gorillas (Stoinski *et al.*, 2001; Ogden & Heimlich, 2009). Well-managed conservation efforts by zoos may bring about social acceptance in visitors, improve visitor experience, and inspire support for the existence of zoos and aquariums and the work they do. Modern-day environmentally conscious visitors are no longer satisfied with an outmoded 'display-only' attitude (Barongi *et al.*, 2015). Inspiring people to support the international plight of wildlife conservation is generally not a result of one single zoo visit or one lesson from a conservation project; it is a cumulative process by which the learners' capacity for further action and learning is built step by step through exposure to a multitude of different channels (EAZA, 2016b). In addition, social science and educational psychology demonstrate that the effectiveness and lasting impact of conservation education in zoos is dependent on a complex array of factors, such as the degree to which education is tailored to diverse visitor identity-related motivations and goals, the opportunity offered to reflect and build an emotional connection, the use of novel stimulation approaches and technologies, and the availability of post-visit action resources (Falk *et al.*, 2007; Ogden & Heimlich, 2009).

Alternatively, social science developed in zoos can enhance the effectiveness and behavioural outcomes of the education efforts of conservation projects (Brewer, 2002). However, it is crucial to take the cultural context of the range country into account when communicating conservation messages because too often ideas developed in the context of the Western world do not reflect the social norms in range countries and cultural differences can be huge (Esson & Moss, 2016). Therefore, it is important that both teams work together to develop the communication tools and messages, and adapt them to the cultural context of the range country. For example, Brewer (2002) demonstrates how multi-directional learning through an outreach partnership led to improved knowledge and attitudes towards sea turtle conservation among Costa Rican students. At MBS, we found it extremely useful to host zoo staff and broadcast a combined education programme in the local

communities, which not only improved knowledge and attitudes but also provided information about the role of zoos for conservation.

## Capacity building and transferable skills

Zoos can play an important role in the training of field-conservation staff, and can provide useful materials and equipment for field-conservation projects. However, logistical constraints and language barriers can present challenges. In the case of MBS, zoos often could not provide materials in French, so existing material had to be translated or could not be used. In the past, we tried to establish a pen-pal programme, which failed because of language issues, and the limited reading and writing skills of children in northern Congo. Similarly, several zoo staff wanted to visit the study site but because of language difficulties and the time needed to be able to learn the data-collection techniques and observational skills, it was not possible for them to make a truly valuable contribution to the field-conservation project. Other projects that do not need to have a long introductory phase might be better placed to host zoo staff and eco-volunteers. The training of range-country research assistants, including visits to zoos, has proven to be extremely successful. However, despite its obvious importance, this type of programme can be challenging to access because of the difficulties involved for non-native speakers (with limited education opportunities) in passing internationally accredited English tests. We suggest that pre-programme language courses (also in collaboration with zoos) might help to overcome this obstacle. Again, the long-term commitment of zoo partners and their investment into capacity building has provided the means to achieve higher academic training. The commitment zoos make to conservation is often linked to individuals, who are strong ambassadors for supporting the capacity-building and training aspects of local researchers in range countries, which is crucial for long-term studies (Trevelyan & Nutman, 2008). It has to be seen how capacity building and skill exchange can be expanded, either through conservation academies or through other programmes by which nationals are trained and motivated to carry out the conservation work in their countries. There is a plethora of skills and expertise available in the international zoo community that need to be shared; for example, through online platforms, symposia or workshops, or through a scientific journal devoted to zoo-relevant research, such as special editions in the *International Zoo Yearbook*.

## Scientific research for field conservation and to inform captive management

Scientific research to improve the well-being of both captive and wild-ranging great ape populations is substantially strengthened by collaboration between zoos and field-conservation projects. Field studies can provide significant context for the basic needs of wild animals in their natural habitat, yielding starting points for meaningful enrichment of the environment in zoos, adequate nutrition and suitable social grouping (Maple & Finlay, 1989). This in turn can improve the well-being of the animals, stimulate natural species-specific behaviour, improve reproductive success, and stimulate 'normal' parenting behaviour and other social interactions (Pruetz & McGrew, 2001). Creating enclosures that replicate the natural habitat more closely is generally more aesthetically pleasing and appealing to visitors, strengthening the conservation-education messages (Durrell & Mallinson, 1998; Barongi *et al.*, 2015). For example, detailed data on the activity patterns and feeding ecology of Western lowland gorillas (Masi *et al.*, 2009, 2015) have helped to improve substantially the nutrition and health of captive gorillas after adjustments were made to the diets offered (Less *et al.*, 2013, 2014; see also Cabana *et al.*, 2017). However, it took a long time before zoos were aware of these findings despite their availability in the scientific literature.

As more data are gathered from the field and their significance understood better, animal husbandry, health and welfare can potentially be improved. Therefore, it is crucial to find means for accessible communication of useful scientific knowledge for zoo staff to improve animal husbandry. However, it is not possible to compare natural habitats and zoo enclosures equally, because in zoos there is restricted space and limited inter-specific interactions of separated apes.

Field-conservation projects can potentially benefit from more research conducted at zoo facilities, which can in turn be applied in the field. Not all zoos are able to develop their own research and conservation units (e.g. Bronx Zoo and the Wildlife Conservation Society) but these institutions can develop partnerships with research institutions. Such an approach can help zoos to establish a stronger link between the conservation of wild populations and the welfare of captive populations (see also Barongi *et al.*, 2015).

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