

REVIEW ARTICLE

South to South Learning in Great Ape Conservation

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Despite evidence that killing of Bornean Orangutan (*Pongo pygmaeus*) in South-East Asia is a major threat to the species, few researchers and non-governmental conservationists have addressed it in management and research, and there is virtually no implementation of anti-killing strategies. In large parts of the Congo Basin, Central Africa, instead, illegal killing of great apes is acknowledged to be their largest threat, and many conservation strategies have been used to reduce killing pressure. However, since these strategies have not been subject to systematic and comprehensive review, it remains unclear which of them have been successful and why. Knowledge of the success, failure, and practices of common conservation strategies to manage great ape killing is critical to ensure adaptive conservation management in the Congo Basin. Understanding the Congo context also facilitates simultaneously highlighting great ape killing in Borneo and suggesting solutions to manage orangutan killing. Here, we compile and analyze the available literature on great ape conservation strategies for reducing killing rates in the Congo Basin. Through a systematic literature review of 198 publications, we find that the most widely employed conservation strategies in the Congo Basin are legislation and law enforcement, protected area management, community-based conservation, alternatives to bushmeat consumption and trade, ecotourism, education, and capacity building. Despite lack of rigorous post-intervention evaluation of conservation impact, we derive several recommendations for addressing the orangutan killing issue in Borneo. A critical lesson, widely applicable to developing countries for conservationists and not limited to Congo Basin realities, is the need for rigorous post-intervention evaluations compared to pre-intervention baselines and over appropriate time frames. *Am. J. Primatol.*

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INTRODUCTION

All non-human great apes are under threat of extinction from human actions including logging, habitat loss and fragmentation, and hunting [Jenkins, 2005; Miles et al., 2005]. Diseases, especially Ebola, pose another major threat for ape populations in some areas, including parts of the Republic of Congo and Gabon [Miles et al., 2005; Stiles et al., 2013; Tutin et al., 2005]. Appropriate and urgent conservation action is needed to save great ape populations, addressing the different pressures and taking into account local situations and customs [Bowen-Jones, 1998; Bowen-Jones & Pendry, 1999; Varty et al., 2005; Wilkie & Carpenter, 1999].

On the African continent, great ape killing has been acknowledged as a main threat to their survival for over 15 years, in addition to habitat loss and degradation and disease [Bailey & BCTF, 2001; Bowen-Jones, 1998]. While habitat loss was long considered the most important threat [Bowen-Jones, 1998], information about a growing bushmeat trade

and consumption stimulated investigation of the impact of hunting on great ape populations before the turn of the century. In 1998, a report issued by the Ape Alliance concluded that illegal hunting for bushmeat was a serious threat to African apes that needed to be addressed urgently [Bowen-Jones, 1998].

In Asia, people have hunted orangutans for tens of thousands of years, likely contributing to the local

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extinction of orangutan populations [Harrison, 1998; Hooijer, 1948; Piper & Rabett, 2009]. Killing of orangutans is considered by some as the key factor for determining the orangutan's current patchy distribution on Sumatra and Borneo, leaving large areas of suitable orangutan habitat devoid of orangutan populations [Rijksen & Meijaard, 1999]. In Kalimantan, Indonesian Borneo, various studies indicate that pressure on orangutans from killing has increased in the past decades due to improved forest access, commercialization of the wildlife trade, a growing, increasingly wealthy human population, increasing human-orangutan conflicts due to habitat loss, and loosening of traditional taboos prohibiting killing of orangutans [Bennett et al., 2000; CITES/UNEP, 2006; Corlett, 2007]. However, attention to the impact of killing on Bornean orangutans has been limited and while anecdotal information points to orangutan killings being common, quantitative data on the scale of orangutan killing and the impact on population numbers are lacking [Meijaard et al., 2011]. Only a few years ago, Meijaard et al. [2011] published the first study with estimates of orangutan hunting rates in Kalimantan. Further analysis of these data indicate that killing of orangutans in Kalimantan occurs at unsustainable levels, and that most populations will go extinct if no action against killing is taken [Davis et al., 2013; Meijaard et al., 2011]. Killings occur for a range of reasons and in different ecological conditions, with some killings being closely related to habitat loss and forest conversion, and others occurring in extensive forest areas where orangutans are primarily hunted for food [Abram et al., in press; Davis et al., 2013]. Ethnic and religious differences also influence different types of killing [Davis et al., 2013]. This suggests that reducing orangutan killing requires different strategies in different parts of the species' range.

Despite the wide publication of the above findings, many conservation scientists, NGOs, local communities, and government officials publicly doubt the magnitude and severity of the orangutan killing problem [Davies, 2011; JakartaPost, 2011; Pahlevi, 2014]. Indonesia's national action plan for orangutans only refers briefly to killings as a threat, and lists two killing-related management interventions among a total of 45 [Soehartono et al., 2007]. A development that appears to go against the trivialization of orangutan killing has been a recent *Fatwa*, or Islamic Edict, against killing of endangered wildlife, including orangutans [Mangunjaya & McKay, 2012].

One of the reasons for the lack of recognition of killing as a major threat to orangutans may be because it is a culturally sensitive issue, especially since half of the killings occur for food [Davis et al., 2013]. Another reason is that relative to other wildlife, orangutans are killed at low rates of, on

average, one animal every two year per village. This may give the impression that orangutan killings are rare, even though cumulatively they occur at rates that are unsustainable [Meijaard et al., 2011]. Given that orangutan killing has so long been ignored, it is not surprising that none of the present governmental and non-governmental conservation programs have developed programs to address the issue. Orangutan conservation focuses strongly on managing habitat loss, primarily through protected areas, and on orangutan rehabilitation and reintroduction [Wilson et al., 2014]. Although managing habitat loss is critical, by neglecting to address orangutan killing, conservation activities might be in vain [CITES/UNEP, 2006; Davis et al., 2013; Meijaard et al., 2011; Simorangkir, 2011]. Therefore, there is an urgent need for developing and implementing dedicated conservation strategies directly addressing orangutan killing.

Because of the limited research on orangutan killing and lack of experience in developing effective anti-killing strategies on Borneo, we reviewed the African literature on great ape conservation, with a specific focus on learning which strategies had been most effective in reducing the incidence of great ape killing. We aim to use lessons learned from the African experience in the design and implementation of new conservation programs for reducing orangutan killings. Here we present a summary of our general findings. A more detailed overview of our literature analysis as well as all literature sources used is provided by Schoneveld-de Lange [2014].

METHODS

This research adheres to the American Society of Primatologists principles for the ethical treatment of primates.

To formulate effective and realistic strategies for controlling orangutan killing on Borneo, we analyzed the scientific literature on conservation strategies in the Congo Basin, an area in Africa consisting of six nations (Cameroon, Central African Republic (CAR), Republic of Congo, Democratic Republic of the Congo (DRC), Equatorial Guinea, and Gabon) where illegal killing of great apes is considered a serious threat [Bailey & BCTF, 2001; Bowen-Jones, 1998; Bowen-Jones and Pendry, 1999; Buttlar, 2011; Wilkie and Carpenter, 1999]. All six nations contain one or more great ape species (Eastern Gorilla, Western Gorilla, Chimpanzee, and Bonobo) [Bowen-Jones et al., 2002].

Our systematic review brings together the different publications on (the effectiveness of) great ape conservation strategies in the Congo Basin. Although many publications exist, we are unaware of any substantial reviews of this body of work to establish the effectiveness of different initiatives and determine common reasons for success or failure. In

our review, we followed the Guidelines for Systematic Review in Conservation and Environmental Management, developed by the Center for Evidence-Based Conservation [2009]. The CEBC acts as the coordinating center for the Collaboration for Environmental Evidence (CEE), and the CEBC Guidelines are the first standard for systematic reviews in the field of conservation and environmental management [CEBC, 2013; CEE, 2013].

In this search, we targeted both scientific as well as non-scientific reports, as well as online available books through Google Scholar. To capture a wide range of publications, we used predefined search terms in twelve databases and search engines: Academic Search Elite, Business Source Premier, Cambridge Journals, EBSCO E-journals, EBSCO Host, Google Scholar, JSTOR, PlosOne, Science Direct, Taylor and Francis, Web of Science, and Wiley Online Library. We applied the search terms (Suppl. Table S1) using different combinations and Boolean operators (Suppl. Table S2), where necessary adjusting to requirements of the different online databases. We also explored gray literature sources by conducting the searches on Google.com.

We limited assessments to the first 1,000 results returned for each search. We screened search results for relevance in a two-stage process to systematically remove studies that were not relevant for the research at hand. If in doubt, we retained publications for the next screening stage. The inclusion criteria for publications were: (i) a focus on hunting in the Congo Basin; (ii) either a focus on great apes or on areas which contain great apes; and (iii) discussion of one or more conservation strategies that address the hunting issue. In the first stage, we screened abstracts of the publications according to these three inclusion criteria. In the second stage, we screened full texts of all publications according to the inclusion criteria.

Following the search protocol of screening 1,000 results per search, the searches of databases and search engines identified 41,146 potentially relevant titles for further screening (including duplicates) (Table I). After the first screening stage (abstract-level screening) and removal of duplicates, we assessed 462 as relevant, out of which 303 publications remained after the full-text screening, and 158 also discussed the effectiveness of conservation strategies. The remaining 145 publications discussed the conservation strategy only, not its effectiveness (Table II and online Appendix for all studies used in the final analysis).

Based on these results, we decided that the search yielded insufficient publications to determine the effectiveness of the following conservation strategies: Private Sector Partnerships, Research, Payment for Ecosystem Services, Species Action Plans, and Sports Hunting (Table II). Therefore, the final analysis only included the remaining six strategies: (i) Protected areas (96 publications); (ii) Community-based conservation (40); (iii) Legislation and law enforcement (32); (iv) Ecotourism (32); (v) Alternatives to bushmeat consumption and trade (31); and (vi) Education and capacity building (30). In total we used 198 unique publications from the database and 34 additional publications, with some publications discussing more than one strategy (see the Online Supporting Information for a complete list of publications used for below conclusions).

RESULTS

Legislation and Law Enforcement

African great apes are protected under national law in all range countries, as well as under international laws and agreements [Anonymous, 2006; Bailey, 2000; Furniss, 2005]. Our review

TABLE I. Number of Results for Each Search String Per Database/Search Engine (Number of Titles Screened). For Search Strings see Supplementary Table S2

Search string	1	2	3	4	5
Academic search elite	385 (385)	934 (934)	2,205 (1,000)	3,177 (1,000)	112,240 (1,000)
Business source premier	69 (69)	196 (196)	593 (593)	869 (869)	2,528 (1,000)
Cambridge journals	169 (169)	176 (176)	3,357 (1,000)	3,545 (1,000)	1,130 (1,000)
EBSCO E-journals	3 (3)	41 (41)	41 (41)	151 (151)	236 (236)
EBSCO host	485 (485)	1,180 (1,000)	3,634 (1,000)	5,406 (1,000)	8,184 (1,000)
Google scholar	3,020 (1,000)	10,400 (1,000)	40,800 (1,000)	45,500 (1,000)	56,800 (1,000)
JSTOR	247 (247)	472 (472)	1,023 (1,000)	1,346 (1,000)	2,571 (1,000)
PIOS ONE	2 (2)	5 (5)	264 (264)	269 (269)	21 (21)
Science direct	51 (51)	95 (95)	2,256 (1,000)	2,352 (1,000)	272 (272)
Taylor and Francis	0 (0)	411 (411)	2,476 (1,000)	2,832 (1,000)	6,309 (1,000)
Web of science	3 (3)	69 (69)	73 (73)	231 (231)	313 (313)
Wiley online library	2,342 (1,000)	4,081 (1,000)	7,695 (1,000)	8,652 (1,000)	26,090 (1,000)
Google.com	1,570,000 (1,000)	1,690,000 (1,000)	6,380,000 (1,000)	12,100,000 (1,000)	16,600,000 (1,000)

TABLE II. Literature Search Results; Number of (#) Publications on Different Conservation Strategies

Conservation strategy	#Publications on strategy	#Publications on effectiveness of strategy
Total #publications	303	158
Protected areas	130	79
Alternatives to bushmeat consumption and trade	67	9
Legislation and law enforcement	60	25
Community-based conservation	60	27
Education and capacity building	50	15
Ecotourism	43	14
Private sector partnerships	6	2
Research	4	1
Payment for ecosystem services	3	3
Species action plans	3	1
Sports hunting	2	1

indicates that voluntary compliance does not occur in the absence of law enforcement. Yet, in the countries under study, wildlife law enforcement and prosecution are often weak; underlying factors include weak governments [Redmond et al., 2006], pervasive corruption at various levels of government and at every stage of the law enforcement process, lack of political will and resources, lack of governance structure for effective implementation, and an absence of sufficiently deterrent punitive measures in response to arrests. One initiative that stands out in the review is the Last Great Ape Organization (LAGA), which achieved significant improvements in law enforcement for wildlife crimes in Cameroon using an NGO-Government model. LAGA's success in Cameroon has been replicated under the EAGLE network in Congo, Gabon and CAR, as well as in some countries outside the Congo Basin (Senegal, Togo and Guinea, with Chad and Nigeria being in the process). LAGA's model of an NGO-government partnership has proven effective in fighting corrupt practices and bringing about arrests and prosecutions, starting with a baseline of zero prosecutions under the wildlife law in these countries for at least ten years [Ononino, 2011]. The conservation impact of increased law enforcement levels has, however, not yet been established formally.

Protected Areas

Our review identified three common problems in protected areas in the Congo Basin: (i) inadequate

management of protected areas; (ii) inadequate law enforcement within protected areas; and (iii) lack of meaningful community engagement. The first two problems primarily stem from lack of funding, as well as insufficient, underpaid, unequipped, and unqualified staff, facilitating corruption. Indeed, in several protected areas, park staff appears to be involved in illegal activities, often as a result of low pay or long periods without salary payments.

Conventionally, protected area management dictated the complete exclusion of human communities from protected areas. This dichotomy proved ineffective, however, and it is now accepted that support and involvement of local communities are critical for protected area success. Even with current efforts, lack of meaningful engagement of local communities is still a common problem, including failure to resolve community disputes, inadequate compensation, and disregard for the specific situation and needs within local communities. Some indigenous communities conserve natural resources voluntarily based on customary rules and agreements. These Community Conserved Areas (CCAs) can make an important contribution to conservation, but often go unnoticed and unrecognized [Borrini-Feyerabend et al., 2004; Porter-Bolland et al., 2012]. CCAs in their purest form did not come up in this literature search, but several community-conservation programs in the analysis originated from CCAs.

Although ranger-based monitoring systems have been put in place in some protected areas in the Congo Basin, this information did not come up in this literature search. Systematic evaluations of wildlife population trends or hunting rates are necessary to empirically validate the conservation impact of protected areas. Several surveys in the Virunga landscape (DRC, Rwanda, and Uganda) find an increasing trend in gorilla population numbers for different time periods over the past three decades and an almost complete absence of gorilla hunting. This success is attributed to the fact that local communities hold a taboo on consumption of gorilla meat, gain economic benefit from the gorillas in the ecotourism program, and the continuous long-term conservation efforts in the landscape (see also the recommendation section of this article).

Community-Based Conservation

Given the underlying determinants of biodiversity loss (human population growth and poverty) [Newmark & Hough, 2000; Sunderland et al., 2013], a solution that has gained popularity in the Congo Basin since the 1980s involves the integration of natural resource management with economic development to improve the quality of life of rural people [Kaeslin & Williamson, 2010]. It is difficult to establish the overall success of this approach. Our

review indicates that evaluations of community-based conservation projects in Africa often take place before the activities can realistically have an impact; evaluations are often tied to short-term funding cycles, whereas more time is likely needed to see results. In addition, monitoring of wildlife populations is usually foregone, which means that it is impossible to prove whether or not project activities had any conservation impact.

Our review identifies some common problems across community-based conservation projects in the Congo Basin, including lack of meaningful engagement of all major stakeholder groups, disregard for the historical, social, and economic context of local communities, and unfulfilled community expectations. The literature shows that an overemphasis on development activities (at the expense of conservation activities) can have negative effects on wildlife populations. Important but often lacking is a strong conservation logic to clearly link the benefits to the conservation activities, and establish firmly that benefits are compensatory and dependent on adherence to conservation agreements, rather than gifts without obligations from the side of the community. The Gorilla Guardians scheme in Cameroon shows that collaboration between traditional authorities and local hunters—who are employed to monitor gorilla nests—can be effective in reducing hunting pressure. In addition to a clear conservation logic, employment of local community members as Gorilla Guardians proves effective in strengthening wider community support for gorilla conservation [Nicholas et al., 2010].

Alternatives to Bushmeat Consumption and Trade

Offering sustainable livelihood or protein substitutes to bushmeat exploitation to reduce pressure on wildlife can take the form of diversification of income sources, or captive breeding of wildlife or domesticated species. Since these projects have a conservation as well as an economic dimension, impact evaluations should include measures to identify the success on both dimensions. However, none of the case studies found in the literature evaluate the conservation impact of such alternatives to bushmeat projects. Since there is a risk for substitutes to become additional income sources, rather than replacing destructive activities, measuring the conservation impact is critical, yet admittedly difficult.

Impact evaluations on the economic dimension are more common, and several projects in the Congo Basin have succeeded to improve individuals' livelihoods. Successful projects provide start-up capital and training, provision of equipment, and long-term support [Gray and Rutagarama, 2011; Yanggen, 2010]. Several projects failed, often due to

economic, technical, and social obstacles. The main challenges to project success are prohibitive start-up costs (especially in comparison with “free” wildlife), failure to make provisions for short-term income, lack of cultural acceptance of substitutes, technical obstacles to farming, low demand for farmed wildlife, high price of domestic meat, and absence of a clear conservation logic. Some projects exclusively target community sub-groups (e.g., chiefs, widows) without clear links to conservation. Without evaluation of the conservation impact, it is questionable whether these initiatives are successful on the conservation dimension. Most projects target a low number of participants, raising questions about the investment versus impact ratio.

Ecotourism

The logic behind ecotourism goes that the money flowing in from turning great apes into a tourist attraction will persuade poor communities and governments to protect the apes. The opportunities for ecotourism in the Congo Basin relate to the presence of unique wildlife including (habituated) populations of gorillas, bonobos, chimpanzees, and elephants [Djoh & van der Wal, 2001]. At the same time, the challenges facing ecotourism development in the Congo Basin are numerous. As shown through our review, wildlife tourism in West and Central Africa does not have mass appeal due to remoteness of viewing sites, poor visibility of wildlife, harsh climate, poor human and structural capacity in the tourism sector, lack of infrastructure, and safety issues. Political instability, corruption, and logistical challenges in some countries prohibit the successful establishment of a tourism industry. Due to these challenges, the income generated will in many cases not be enough to satisfy entrepreneurs and host communities. Anecdotal evidence shows that there are some exceptions. One example is the Odzala-Lossi area, in the Republic of Congo, where high-end tourism to track western lowland gorillas in a community conservation area appears to be successful for generating revenues for the local communities. Another similar example from the same country is the Nouabale-Ndoki national park. Although these projects did not show up in this literature research, they are worth further investigation.

The publications indicate low revenue potential or even losses for several ecotourism undertakings in the Congo Basin. Ecotourism has been cited as one of the activities leading to conservation success of gorillas in the Virunga Volcanoes [Jolly, 2005] where annual direct revenue from gorilla tourism of US\$ 3 million and an additional US\$ 20 million in additional income from hotels and restaurants is shared between Rwanda, Uganda, and DRC [Mwijuke, 2014].

Although standardized best practice guidelines are available to limit the negative effects of habituation of great apes [Macfie & Williamson, 2010], there are still considerable risks and costs associated with habituation of great apes. Critics argue that the impact of tourism will come too late to save the decimated ape populations, while developing a tourism industry will divert the attention from the more pressing issue of stopping great ape poaching in the immediate term [Anonymous, 2009].

Education and Capacity Building

Our review suggests that conservation education plays a critical role to help end the hunting crisis in the Congo Basin, by increasing knowledge on the value of wildlife in the short-term and shaping attitudes and behavior in the long-term. The presence of great apes in protected areas attracts a lot of researchers [Marshall et al., in review], and the knowledge generated in areas with great apes provide an excellent basis for education programs. For such education programs, it is important that groups at all levels are targeted, including school children, government, the general public, and journalists. Despite this generally optimistic view on the role of education and awareness, a major issue across education and capacity building projects in the Congo Basin is lack of evaluations. Hard evidence for positive impact of education is thus lacking. Most projects do not include an evaluation component at all, or focus on the program's content or reach rather than conservation impact. An exception, data from an awareness campaign run by Jane Goodall International shows that use of roadside billboards in key regions can lead to a reduction in ape confiscations [Cox et al., 2014]. Measuring conservation impact of education and awareness programs, while extremely difficult, is critical to gain feedback on program impact [Wallis & Lonsdorf, 2010].

DISCUSSION

Lessons Learned for Borneo

Our review indicates that the effectiveness of conservation strategies for controlling great ape hunting in the Congo Basin remains poorly understood. Yet, several lessons can be formulated for orangutan conservation in Borneo.

Protected areas are the most popular strategy for orangutan conservation in Borneo [Sabah Wildlife Department, 2012; Simorangkir, 2011]; however, in all protected areas with Bornean orangutan populations, illegal hunting of the species takes place [Nellemann et al., 2007; Rijksen and Meijaard, 1999; Singleton et al., 2004]. It is therefore critical that protected area management is improved to offer protection from hunting for the orangutan

populations within protected area boundaries. Globally, the only great ape populations which have shown an increase over the past 30 years are the populations of mountain gorillas in the Bwindi Impenetrable Forest and the Virunga Volcanoes. In the Virunga Volcanoes, a combination of factors is responsible for this success, including long-term, continuous presence of NGO activities; a protected area complex which is clearly demarcated and relatively easy to patrol; community benefits with a clear link to gorilla conservation (employment in conservation activities and ecotourism); a local taboo on consumption of gorilla meat; and protection for some habituated gorilla groups through daily monitoring activity. It should be noted that the situation in the Virungas is unique [Plumptre & Williamson, 2001; Robbins et al., 2011; Weber & Vedder, 2001; Williamson & Fawcett, 2008], and consequently the conservation model used for conservation of the mountain gorillas cannot be directly replicated elsewhere. Yet, we argue that orangutan conservationists can draw lessons from the contributing factors to the success of mountain gorilla conservation in the Virungas, which can be adjusted to the local context. The orangutan conservation program in the Lower Kinabatangan Wildlife Reserve, Sabah, Malaysia mirrors the success factors in the Virungas, and the program has indeed managed to more or less stabilize orangutan populations, despite high levels of habitat fragmentation and degradation [Bruford et al., 2010]. We note, however, that illegal killing in the Kinabatangan area is not presently a problem.

Since the protected area approach is costly and labor intensive [Wilson et al., 2010, 2014], we suggest initially selecting protected areas with significant orangutan populations, and at least some of the above "Virunga success factors," for implementation of improved conservation programs. This could include the Tanjung Puting NP, Gunung Palung NP, Kutai NP, Danau Sentarum NP, and Wehea protected forest, although especially areas with cooperative park management should be selected. Following IUCN guidelines [Nellemann et al., 2007], we recommend that guards are increased to the level of one guard per 19 km², along with proper selection, training, and provision of equipment and salaries. Protected areas should be clearly demarcated, where possible using natural boundaries. Also, strengthening local community taboos on killing and/or eating orangutans can offer protection for ape populations. The above-mentioned religious edict (*Fatwa*) on the killing of endangered wildlife could provide an effective grassroots tool for informing people and influencing behavior. After implementing additional conservation strategies as suggested, orangutan populations in protected areas in Borneo should be systematically monitored to evaluate trends and impact of activities.

The orangutan has been protected by national law, ordinances or government regulations since the early 1900s, as well as by international agreements [CITES, 2011; CITES/UNEP, 2006; GRASP, 2005]. Law enforcement efforts in Borneo are largely ineffective, hampered by lack of resources and corruption at every stage of the law enforcement process [CITES/UNEP, 2006]. In 2014, the local government of West Kalimantan Province objected against the imprisonment of two people who were accused of eating orangutan meat, because they suggested that eating such meat was a local tradition [Pahlevi, 2014]. To improve law enforcement and tackle corruption, we recommend following the NGO-government collaboration of the Last Great Ape Organization (LAGA), which has proved successful in bringing about arrests and prosecutions of major wildlife traffickers in several African nations. This would require the identification of at least one highly committed and competent NGO in Kalimantan that focuses on research on orangutan trade and killing, working with police and the judiciary to ensure effective prosecution, and communicating this effectively to a wide audience. The involvement of professional lawyers with experience in environmental law would boost the ability of government authorities to effectively prosecute wildlife crimes. Such enforcement is likely to be effective. News about the one, and one only ever court case in Kalimantan in which hunters were jailed for killing orangutans, resonated widely among Kalimantan communities [G. Limberg, pers. comm. to EM] indicating that effective law enforcement could provide a powerful tool for reducing orangutan killing and trade.

Problems identified with the few community-based conservation efforts in Borneo include absence of conservation logic and lack of monitoring of conservation impact [BOSF, 2012; FFI, 2013; ICES, 2013]. As community support for conservation projects is critical to prevent encroachment and other illegal activities, conservationists in Borneo should pay more attention to this aspect of orangutan conservation. Some important lessons from the Congo Basin include the establishment of a strong conservation logic, safeguarding the balance between conservation and development objectives (admittedly a highly subjective issue), ensuring meaningful engagement of communities taking into account local culture and customs, and evaluating the conservation and development impact. Compared to the Congo Basin, the importance of orangutan meat as food and income source for rural people in Borneo is limited [Corlett, 2007; McConkey, 2005; Meijaard et al., 2005]. It is therefore unlikely that offering alternatives to bushmeat is a sensible approach in controlling orangutan hunting in Borneo. Taking into account the limited success of alternative livelihoods in the Congo Basin, the

large amount of resources and training that go into these initiatives, and the local-only impact, it is recommended to focus efforts in Borneo on getting buy-in for, and understanding of, orangutan conservation programs first.

Both in the Congo Basin and in Borneo, ecotourism has some potential for improved ape management. Ecotourism programs based on orangutan viewing have been operational in Borneo since the early 1970s, the main destinations involving rehabilitant orangutans in Tanjung Puting NP and in rehabilitation centers [Anonymous, 2013; Drewry, 1997; Laszlo, 2003; Russon & Russell, 2005; Russon, 2009], and wild populations in protected areas such as Kinabatangan, Danum Valley, and Batang Ai [King & Nair, 2013]. The close contact between tourists and orangutans in rehabilitation centers proved problematic for orangutan health; however, the discontinuation of the projects was problematic due to economic dependence on tourists of both communities and orangutan rehabilitation projects [Russon & Russell, 2005]. Still, the trend is to increasingly minimize contact between people and rehabilitant orangutans and this aspect of ecotourism is likely to decrease. Wild orangutans are much harder to reliably find and ecotourism on the basis of orangutan encounters, similar to those for mountain gorillas, are unlikely to generate major income. We did not identify any publications quantifying economic and educational impacts of ecotourism for orangutans [see also, Russon & Russell, 2005] and what is needed first and foremost is an evaluation of the current situation with respect to orangutan tourism; not only in financial terms, but also more importantly in terms of human impacts on orangutans.

Finally, similar to the Congo Basin, education and awareness programs can play an important role in increasing the effectiveness of orangutan conservation in Borneo. Especially in Borneo's interior, there is still limited knowledge about the orangutan's protected status [Meijaard et al., 2011]. People are aware of the impacts of deforestation on their livelihoods and well-being [Meijaard et al., 2013; Pellier et al., 2014]. Still, local people and politicians often claim that conservation activists favor the life of "a monkey" over theirs [Meijaard & Sheil, 2008]. Getting people to understand the extent to which they benefit from forests and forest services might be a more effective focus of awareness programs than ones concentrating on orangutans only. Having said that, as mentioned above about improving law enforcement in orangutan conservation, there are likely to be powerful impacts of effective prosecution of illegalities regarding orangutans, with major impact on public awareness regarding the conservation of the species.

The Role of Evidence-Based Conservation

Despite the fact that conservation projects have been operational for decades, wildlife populations keep dwindling. This does not automatically mean that conservation activities failed; the pressures might just be so intense, that much worse scenarios have been prevented. Yet, with limited resources to be allocated to the different projects, prioritizing efforts between strategies is extremely important [Wilson et al., 2014]. Furthermore, with decimated ape populations, there is little time left for trial and error. For effective prioritization, it is necessary to know which (combination of) strategies are most effective in species and habitat conservation. Additionally, it is important to know where different conservation actions have failed, and in which cases they have been successful in preventing a much worse-case scenario. To establish effectiveness of different conservation strategies, proper evaluations need to be carried out linking conservation actions to desired outcomes. However, in the publications studied, hardly any evaluations were found that focus on the ultimate objective: conservation of great ape populations. Projects claiming “success” often do so on the basis of anecdotal evidence rather than rigorous analysis, taking counterfactuals, confounding factors and baselines into consideration [Ferraro, 2009; Miteva et al., 2012], and often do not refer to a reduction in hunting levels or increase in wildlife populations. Indeed, “success of conservation actions is usually based on ‘common sense’ instead of systematic review of key indicators” [Hartel, 2011]. It is acknowledged that “despite the growing amount of scientific information produced by the research community, conservation practice and policy remain largely experience-based with limited evaluation of what works and what does not” [2013]. One way to get more information is by collecting and analyzing internal records from NGOs. Since NGOs have a stake in overemphasizing successes and obscuring problems to secure future funding, the methodology and indicators for evaluation should be scrutinized carefully. This will be an important next step to identify effectiveness and success factors of different conservation strategies.

Providing conclusive evidence of effectiveness of conservation activities would allow funders to distribute money to the activities that matter most [Sutherland et al., 2004]. In practice, this evidence is not easy to obtain. Even if research questions are formulated in advance, it is extremely difficult to link specific actions to conservation impacts, as impacts are not seen until much later [Game et al., 2013]. Furthermore, it is difficult to differentiate between the impacts of different project components over a long timescale. Grants usually operate under 3–5 year timeframes, by which time the impacts cannot realistically be

measured; also, few grant agencies fund the monitoring of outcomes after implementation. Another problem is the fact that in an arena with competitive funding, studies with negative results are far less likely to be published. Difficult also is the communication of information regarding conservation strategies’ effectiveness; often, scientific papers in peer-reviewed journals reach a level of abstraction where practical conclusions are difficult to draw [Dyson & Wentworth, 2011].

Incorporation of rigorous evaluation protocols will entail a radical shift in the routines in which conservation work is carried out [Sutherland et al., 2004]. However, conservationists might not perceive the need to make the shift from experience-based, anecdotal information to a more standardized, abstract, scientific protocol [e.g., Hartel, 2011] and might be unwilling to change their practices to accommodate evaluations [Sutherland et al., 2004]. What is clear is that without measuring conservation success, it remains questionable whether resources are directed to the strategies that have most—if any—positive conservation impact. Especially with the growing popularity of integrating conservation and development, wildlife populations might be worse off if overemphasis on easy-to-measure development indicators increases pressure on wildlife. It is therefore important that scientists and conservationists find a consensus under which they can incorporate evaluation protocols that are acceptable for all while providing adequate information for management decisions.

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