Chapter 16

Protected Areas, Human Livelihoods and Healthy Animals: Ideas for Improvements in Conservation and Development Interventions[1]

Gladys Kalema-Zikusoka, Conservation Through Public Health, Kampala, Uganda

Introduction

Disease is becoming increasingly recognized as a threat to wildlife conservation, especially for endangered species (Werikhe *et al*. 1998). Often the threat is increased by diseases that can be transmitted between closely related species such as people and primates or cattle and buffalo. Transmission of such diseases at the interface of protected areas with human settlements can be exacerbated by mixing of people, wildlife, and domestic animals when wild animals leave the park boundaries, when domestic animals graze illegally within the park (Bengis *et al*. 2002), and when, for example, tourists, researchers, and field staff enter protected areas to view primates (Macfie 1992, Woodford *et al*. 2002). Zoonotic disease transmission is particularly important in local communities around protected areas, which, in developing countries, tend to be surrounded by some of the poorest of the population (Balmford and Whitten 2003). Problem animals threaten these people's lives and property (Karanth and Madhusudan 2002), possibly reducing the value of land around protected areas. In the case of Uganda, with a gross domestic product (GDP) per capita–purchasing power parity of US $1200 (CIA 2003), those community and rural settings have very limited basic health care because most people have no transportation and live at least 20 miles away from the nearest health centre (Ministry of Planning and Economic Development 1997, Homsey 1999). This marginalized target group also has very little access to information on zoonotic disease prevention because very little content has been developed for local education (Grant 2002). Even when people manage to get to the health centres, many centres are not adequately equipped to diagnose and treat diseases. This has resulted in a persistence of preventable diseases such as tuberculosis (TB) and scabies that can be transmitted between people, wildlife, and domestic animals.

Although there are relatively few documented cases of disease transmission between people and wild primates, there is a growing number of cases of suspected disease transmission (Table 1). A disease for which transmission from primates to people has been proved is Ebola, from a chimpanzee (*Pan troglodytes*) in Cote d'Ivoire (Formenty *et al*. 1999) and, more recently, in outbreaks (Leroy *et al*. 2004) involving western lowland gorillas (*Gorilla gorilla gorilla*) and chimpanzees.

Diseases that have reportedly been transmitted from domestic cattle to cape buffalo (*Syncerus caffer*) in Africa include BTB (Woodford 1982, de Vos *et al*. 2001) and rinderpest (Kock 1999). Foot and mouth disease can be transmitted between cape buffalo and cattle (Dawe *et al*. 1994, Chilonda *et al*. 1999, Sutmoller *et al*. 2000). There are also examples of disease transmission between species that are unrelated; for example, mongooses (*Mungos mungo*) in

Table 1. Cases of suspected disease transmission from people to primates

Disease	Species	Location	Reference
Polio	Chimpanzees, *Pan troglodytes*	Gombe National Park, Tanzania Beni, Democratic Republic of Congo	Goodall 1971 Kortlandt 1996
Scabies	Mountain gorillas, *Gorilla gorilla beringei* Chimpanzees	Bwindi Impenetrable National Park, Uganda Gombe National Park	Graczyk *et al*. 2001, Kalema-Zikusoka *et al*. 2002 Pusey 1998
Measles	Mountain gorillas	Parc de Volcans, Rwanda	Hastings *et al*. 1991
Intestinal parasites	Baboons, *Papio cynocephalus anubis* Mountain gorillas	Gombe National Park Parc de Volcans	Murray *et al*. 2000 Sleeman *et al*. 2000
Yaws	Baboons	Gombe National Park	Wallis and Rick 1999

[1]See abstract on p.xxvii.

Botswana and suricates (*Suricata suricatta*) in South Africa have contracted human TB (*Mycobacterium tuberculosis*) from a rubbish heap outside a tourist lodge frequently visited by someone with a chronic cough (Table 1) (Alexander *et al*. 2002).

The following case study describes a few health interventions that were carried out in the aftermath of a scabies disease outbreak in mountain gorillas in Bwindi Impenetrable National Park (BINP) in southwestern Uganda in 1996. This outbreak is thought to have been associated with scabies in the local community. This paper provides a situation analysis of the BINP environment, with an emphasis on the status of human and primate interaction leading up to the disease outbreak. Included are descriptions of the first reported scabies outbreak in mountain gorillas that resulted in the death of an infant gorilla, and a subsequent conservation and development intervention that was carried out in specific community and rural settings to improve the situation through health education campaigns. Potential opportunities for improvement in conservation and development interventions are described, as well as how to address cross-sectoral linkages between health, wildlife conservation, education, ecotourism, and information technology.

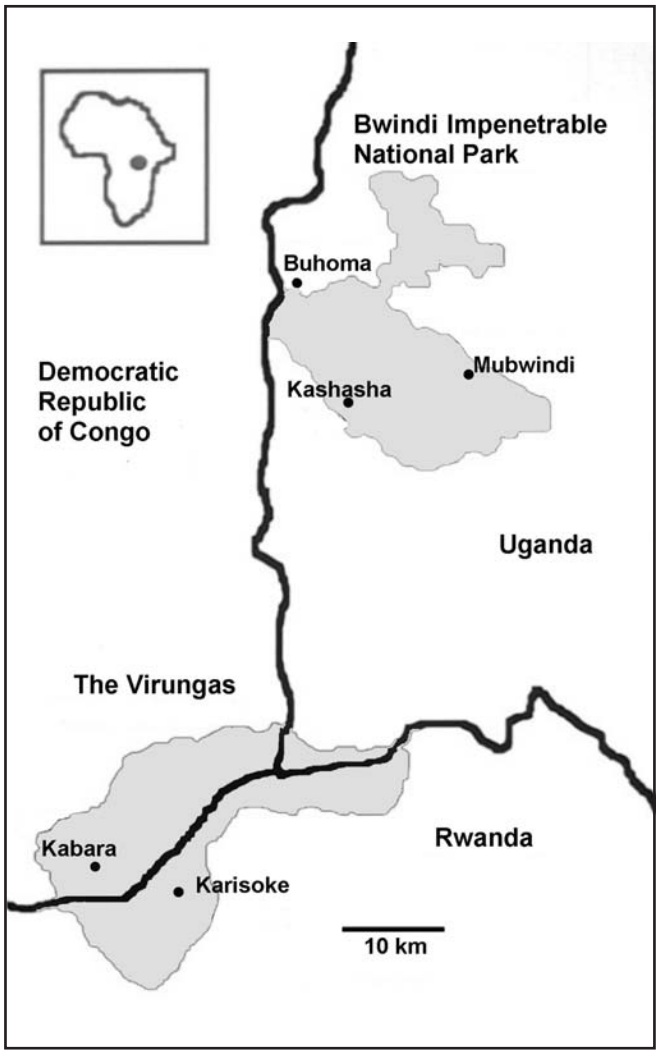
Human and primate interaction in Bwindi Impenetrable National Park, Uganda

Mountain gorillas and people are very closely related and are therefore potentially at risk of transmitting pathogens to each other (Ott-Joslin 1993, Wallis and Rick 1999). Approximately 300 of the estimated 655 mountain gorillas (*Gorilla gorilla beringei*) live in BINP, southwestern Uganda (Fig. 1). The remaining individuals of this highly endangered species are found in Rwanda, Democratic Republic of Congo (DRC), and Mgahinga National Park in Uganda (McNeilage *et al*. 2001). A small forest remnant in Sarambwe, DRC, is contiguous with BINP. The area surrounding Bwindi and the Virungas has one of the densest human populations in Africa, with an estimated 200–300 people per square kilometre (UWA 2001). BINP is approximately 331km^2 and was gazetted in 1991 (Butynski and Kalina 1993). The establishment of this park restricted people's access to the forest to controlled activities such as tourism and research, while allowing multiple-use access for products such as medicinal plants, basket-weaving materials, and honey (UWA 2001).

Bwindi gorillas have close contact with tourists and researchers (Macfie 1992) and when crop raiding (Madden 1998) or foraging on community land. Some of the foraging areas outside the park are crossed by village pathways or are in areas where villagers obtain firewood. Additionally, fragmented patches of secondary forest owned by local people surround parts of Bwindi, and gorillas utilize these land patches. In addition to poor health services and information, the local communities lack hygienic amenities including clean water and pit latrines (Ministry of Planning and Economic Development 1997, Homsey 1999). These factors have resulted in a large percentage of people suffering from preventable diseases that can spread to gorillas. These include scabies, diarrhoeal diseases, measles, and TB (WHO 2002). TB is exacerbated by a greater than 35% coinfection with human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) (Kibuga 2001) of which Uganda, Rwanda, and DRC are among the highest-prevalence nations in the world (Castro 1995) and are among the 22 countries contributing to 80% of the global TB burden (WHO 2002). Fortunately, Uganda's HIV rate has dropped from an estimated 35% to 6% (CIA 2003), and this has been attributed to education (Kiwanuka-Tondo, personal communication 2003).

Uganda Wildlife Authority (UWA), a national conservation authority, has developed an ecotourism program in BINP. Sustainable ecotourism depends on maintaining gorilla health, improving the welfare of local communities through tourism, and promoting the national economy. Often the welfare of local communities in BINP has been improved through tourism revenue (via sharing of funds), development

Fig. 1. Mountain gorilla range



Courtesy of Dr. Michelle Goldsmith.

of income-generating activities (selling crafts, food, and lodging), and employment in restaurants and lodging facilities (Kamugisha *et al*. 1997, Ratter 1997). The national economy is enhanced by the funds generated by mountain gorilla tourism, funds which amount to up to 50% of the overall income of the Uganda National Park System in some years (McNeilage *et al*. 2001).

Continuous monitoring of gorilla health is carried out by UWA and supporting agencies. However, successful management of gorilla health is undermined by an unhealthy buffer zone surrounding the gorilla habitat. For example, of the 19 parishes surrounding BINP, three are in Kisoro district, which has an estimated population of 1,867,000 and a population density of 301 people per km^2. To support this population, Kisoro district has 11 health centres, of which only two have laboratory services (Rooney and Sleeman 1998). If human health in the areas surrounding BINP is not improved, then gorilla health is put at an ever-increasing risk.

According to the district medical personnel surrounding BINP, the most commonly treated diseases in people are malaria, respiratory tract infections, diarrhoeal diseases, scabies, ringworm, intestinal parasites, tropical ulcers, and eye infections, including river blindness (R. Sajjabi and B. Nkomejo, personal communication 2001). Through self-reported medical histories, it was determined that respiratory disease was the most common clinical manifestation seen in the local community of Kibale National Park. Respiratory disease was also reported more frequently than diarrhoea in tourists visiting the park (Adams *et al*. 2001).

Mountain gorilla scabies outbreak

The first reported scabies outbreak in mountain gorillas occurred in 1996 in a tourist-habituated group of four gorillas adjacent to the Buhoma tourist site in BINP. The gorillas were scratching excessively and developed white scaly skin. The group was treated with ivermectin, and all recovered after one treatment except for an infant that died (Kalema-Zikusoka *et al*. 2002). The source of the scabies was never determined, although people were suspected for two reasons: scabies is common in the local communities, and the gorillas' severe reaction to the disease indicated a lack of prior exposure to this mite from a closely related host. The gorillas could have been exposed to scabies through contaminated clothing or other fomites of infected people during tourist visits or when the gorillas were outside the park boundary raiding banana crops.

Four years later, a scabies outbreak occurred in another group of gorillas being habituated for tourism in Nteko parish, also in BINP, resulting in morbidity of some of the group. They, too, recovered with ivermectin treatment (Graczyk *et al*. 2001). While the ivermectin treatment was successful, it was felt that interventions addressing the public health situation around BINP were needed to prevent further outbreaks.

Health education intervention

In early to mid 2000, UWA conducted health education workshops with local communities to improve the situation. Over 1000 people in 5 of 19 parishes surrounding BINP participated in the community outreach, which included eight villages. During these participatory rural appraisal workshops, the team presented lectures in the local language to introduce diseases common in the BINP area that can be transmitted between gorillas and people. Prevention strategies were also discussed.

There was initial concern among wildlife managers that the local community would believe the park authorities valued gorillas more than people. However, those communities that had directly benefited from the creation of BINP were actually very receptive to these ideas, and gave more recommendations than those communities that had benefited less. Most people received at least one educational brochure to take home at the end of the workshop. Two or more posters were given to the local parish council leaders to display in public areas.

Having a multidisciplinary team of community conservation, wildlife health, human health, and education personnel appears to have been helpful. Additionally, the target communities seem to realize that healthy gorillas can generate income to build villages, which have already become trading centres as a result of ecotourism. Additionally, communities that received conservation education appear to have a greater understanding of the need to protect mountain gorillas both for conservation and a sustainable income (Kalema-Zikusoka *et al*. 2001). By contrast, one community in DRC that had received very little conservation education and virtually no tourism and research benefits did not trust the team enough to admit that they had seen gorillas.

One village in Nteko parish was adjacent to the range of a gorilla group undergoing habituation and that subsequently contracted scabies. The community recognised the benefits of the health education workshop because they desperately wanted tourism so that their village could eventually look like Buhoma, an established tourist site. They were aware that one of the reasons that UWA was not establishing tourism in spite of the adjacent gorilla group being fully habituated was that this gorilla group spent over 50% of the time outside the park in public land and people's gardens. They had been told that the park authorities were concerned about these gorillas getting infected by exposure to contaminated clothing, uncovered rubbish heaps, and shallow pit latrines. Communities realised these problems had to be addressed.

Recommendations from the communities were divided into three categories: medical, nonmedical, and hygiene. Medical recommendations, with the Ministry of Health having primary responsibility, included bringing health services, such as mobile clinics, closer to the protected area and employing a nurse for Bwindi. Issues such as having access to safe water were also discussed. Nonmedical recommendations included strengthening the human/gorilla conflict (HUGO) team, made up of local community members trained by UWA, to chase gorillas back to the park; and holding more health

education programmes. UWA was deemed to be primarily responsible for these measures. Hygiene recommendations included covering rubbish heaps and digging proper pit latrines of at least 10 feet (three metres) deep. The local community would have primary responsibility for these activities.

Despite receiving economic benefits from tourism, some villages complained about problem animals. A farmer was interviewed when a tourist gorilla group had just damaged his banana crop. He acknowledged that the mountain gorillas have brought wealth and economic development to his village and his children have benefited from park employment, but pointed out that farmers like himself whose crops are destroyed are not being compensated for individual loss of income, which could be used to pay for children's school fees and to build family assets. In this case, problem animals undermined the success of the health education workshops.

As long as problem animals exist, the potential for disease transmission at the human, wildlife, and domestic animal interface will always be present. Problem animals also undermine conservation efforts such as revenue sharing and conservation education. Compensation for problem animal damage is often controversial because, for example, it is often difficult for the victims and the organization responsible for providing compensation to agree on how much payment is sufficient and fair (Nyhus *et al*. 2003). However, individual compensation appears to have reduced the resentment of farmers to wildlife (wolves) taking their livestock around Yellowstone National Park in the USA (Nyhus *et al*. 2003), and may have been able to appease this farmer (at least in the short term) whose crops were destroyed by mountain gorillas.

Health education appears to be a conservation tool that can bring together the public health, wildlife conservation, and ecotourism sectors. Local communities that received mountain gorilla ecotourism benefits recognized that they could prevent mountain gorillas from getting human diseases by doing things like digging better pit latrines and covering rubbish heaps. However, some recommendations were beyond their control, such as access to better health services or safe water. The lack of access to clean water not only contributes to a range of gastrointestinal illnesses but also undermines efforts to control scabies, as the mites survive on dirty clothes that can be handled by curious wild animals, such as mountain gorillas (Fossey 1983).

Ideas for improvements in conservation and development interventions

An integrated approach to controlling disease transmission between wildlife, people, and domestic animals needs to be developed by stakeholders. This could start with dialogue among the affected communities and professionals from the wildlife, human health, veterinary, education, and information and communication technology sectors, and sharing of information using print, radio broadcasts, video, CD-ROM, handheld computers, databases, or the internet to play a supportive role in improving education and enhancing access to health services and information (Grant 2002).

Multidisciplinary teams from the wildlife management, medical, and veterinary sectors could be established to carry out joint education, health training, and research programmes while helping to maximize the use of limited resources. Close collaboration among governments, nongovernmental organizations, the private sector, universities, and schools is needed to develop effective and efficient programmes, focusing specifically on interrelated human and animal diseases such as TB, BTB, scabies, brucellosis, rabies, and Ebola. Local involvement in designing these programmes is crucial for long-term success.

Examples of such interventions include joint education programmes, such as the health education workshops carried out in BINP in 2000. These grassroots education programmes would benefit from input from all key stakeholders to ensure that the materials used would be relevant to the local situation and printed in local languages. Participatory rural appraisal techniques can help to promote local community ownership of the recommendations put forward by the affected communities at a grassroots level. UWA has started to hold planning workshops with health policymakers and local leaders to further strengthen links between wildlife conservation and public health (Rainer 2002).

Developing "multiple use" health care and diagnostic services and facilities can potentially be more effective in preventing diseases that spread between people, domestic animals, and wildlife because information can be shared more easily. Sharing facilities and services could also save costs. Many places with wildlife have poorly developed infrastructure and few resources for transporting needed goods to the population. Tour operators and wildlife managers with access to good vehicles could help by transporting free medication, such as TB medication (WHO 2002), from the capital city, Kampala, to the people who need it. A similar programme has been successfully carried out via the Healthy Community Initiatives of the Kayapo Health Project in Brazil, where researchers bring malaria medication to people residing next to the forest (Margoluis *et al*. 2001). Joint domestic and wild animal laboratories at the interface of protected areas and human settlements could help to facilitate information sharing and better control of disease outbreaks.

Joint training programmes could involve medical and veterinary technicians carrying out laboratory work together and could help wildlife personnel, veterinarians, medical doctors, and other health workers to carry out integrated education campaigns on interrelated wildlife conservation and public health issues. In addition to promoting collaboration, local community involvement could be encouraged through "training of trainers" to educate others.

Research on interrelated wildlife conservation and public health issues should be encouraged to increase our understanding of these links, and results should be shared with policymakers. Such research could help to identify the most common diseases that pose a threat to public health, wildlife conservation, and ecotourism.

Other research studies could help to evaluate local community attitudes and behaviour that facilitate disease transmission at the interface. Because public health depends on people's behaviour, evaluation of programmes integrating wildlife conservation and public health should focus on how people's behaviour is changing (or not) over time. Behaviour such as failing to boil milk and eating uninspected meat occurs commonly in rural areas of Uganda (Opuda-Asibo 1995), predisposing people to infectious diseases, such as zoonotic BTB from cattle (Cosivi *et al*. 1998). Recent field surveys have shown that almost 50% of the people living around Queen Elizabeth National Park in Uganda drink unboiled milk, potentially exposing them to BTB from cattle that mix with buffalo. Studies to determine how poor wildlife conservation and public health practices are affecting socio-economic development would be useful. Furthermore, research could explore models for sustainability for integrated conservation and public health programmes.

Finally, there is growing evidence of the need for an integrated approach to wildlife conservation and public health to maximize the limited resources available to control disease transmission between wildlife, people, and domestic animals at the interface. Funds from wildlife conservation could be allocated to public health, where it directly affects conservation, such as the case of scabies in the Bwindi mountain gorillas. Similarly, donor funds earmarked for health improvement could be allocated to wildlife conservation where it directly affects public health, such as the case of people being exposed to bovine TB from drinking unboiled milk, and people contracting Ebola from eating gorillas or chimpanzees (Leroy *et al*. 2004).

Beyond reducing the risks of disease transmission across the wildlife/domestic animal/human interface, a favourable outcome of improving the health status of local communities living around protected areas is the potential to cultivate a more positive attitude towards wildlife conservation and public health.

Acknowledgements

The author thanks WCS and the organizers of the World Parks Congress for the opportunity to participate in the *AHEAD* forum. The author thanks the following organizations: Uganda Wildlife Authority, International Gorilla Conservation Programme, African Wildlife Foundation Charlotte Fellowship Conservation Award, North Carolina State University, North Carolina Zoological Park, the National Tuberculosis Control Unit, and Conservation Through Public Health for facilitating the projects mentioned in the paper. The author thanks the following individuals who participated in this work: Dr. Richard Kock, Dr. Liz Macfie, Benon Mugyerwa, Steven Asuma, Robert Sajjabi, Dr. Roy Bengis, Dr. Mike Woodford, Dr. Anita Michel, Dr. Suzanne Kennedy-Stoskopf, Dr. Jay Levine, and Dr. Francis Adatu. The author also thanks Lawrence Zikusoka for editorial assistance and comments on the manuscript.

References

Adams HR, Sleeman JM, Rwego I, New JC. Self-reported medical histories of humans as a measure of health risk to the chimpanzees (*Pan troglodytes schweinfurthii*) of Kibale National Park, Uganda. *Oryx.* 2001;35:308–312.

Alexander KA, Pleydell E, Williams MC, Lane EP, Nyange JFC, Michel AL. *Mycobacterium tuberculosis*: an emerging disease of free-ranging wildlife. *Emerg Infect Dis.* 2002;8:598–601.

Balmford A, Whitten T. Who should pay for tropical conservation, and how could the costs be met? *Oryx*. 2003;37:238–250.

Bengis RG, Kock RA, Fischer J. Infectious animal diseases: the wildlife/livestock interface. *Rev Sci Tech*. 2002;21:53–65.

Butynski TM, Kalina J. Three new mountain national parks for Uganda. *Oryx*. 1993;27:214–224.

Castro KG. Tuberculosis as an opportunistic disease in persons infected with human immunodeficiency virus. *Clin Infect Dis.* 1995;21(Suppl 1):S66–S71.

Central Intelligence Agency (CIA). Uganda. In: *The World Fact Book*. Washington, DC, USA: CIA Publications; 2003.

Chilonda P, Woodford JD, Ahmadu B, Samui KL, Syakalima M, Mlangwa JE. Foot and mouth disease in Zambia: a review of the aetiology and epidemiology and recommendations for possible control. *Rev Sci Tech.* 1999;18:585–592.

Cosivi O, Grange JM, Daborn CJ, Raviglione MC, Fujikura T, Cousins D, Robinson RA, Huchzermeyer HF, de Kantor I, Meslin X. Zoonotic tuberculosis due to *Mycobacterium bovis* in developing countries. *Emerg Infect Dis.* 1998;4:59–70.

Dawe PS, Flanagan FO, Madekurozwa RL, Sorensen KJ, Anderson EC, Foggin CM, Ferris NP, Knowles NJ. Natural transmission of foot-and-mouth disease virus from African buffalo (*Syncerus caffer*) to cattle in a wildlife area. Zimbabwe. *Vet Rec.* 1994;134:230–232.

de Vos V, Bengis RG, Kriek NPJ, Michel A, Keet DF, Raath JP, Huchzermeyer HF. The epidemiology of tuberculosis in free-ranging African buffalo (*Syncerus caffer*) in the Kruger National Park, South Africa. *Onderstepoort J Vet Res.* 2001;68:119–130.

Formenty P, Hatz C, Guenno BL, Stoll A, Rogenmoser P, Widmer A. Human infection due to Ebola virus, subtype

Cote d'Ivoire: clinical and biologic presentation. *J Infect Dis.* 1999;179(Suppl 1):S48–S53.

Fossey D. *Gorillas in the Mist*. Boston, USA: Houghton Mifflin; 1983. 326pp.

Goodall J. *In the Shadow of Man*. Boston, USA: Houghton Mifflin; 1971. 297pp.

Graczyk TK, Mudakikwa AB, Cranfield MR, Eilenberger U. Hyperkeratotic mange caused by *Sarcoptes scabiei* (Acariformes: Sarcoptidae) in juvenile human-habituated mountain gorillas (*Gorilla gorilla beringei*). *Parasitol Res.* 2001;87(12):1024–1028.

Grant G (ed). *Guidelines for Sectoral ICT Policy and Planning: Regional Initiative for Informatics Strategies, Sectoral ICT Strategies Planning Templates*. Ottawa, Canada: The Commonwealth Network of IT for Development (COMNET-*IT*) and The Commonwealth Secretariat; 2002. 67pp.

Hastings BE, Kenny D, Lowenstine LJ, Foster JW. Mountain gorillas and measles; ontogeny of a wildlife vaccination program. In: Junge RE (ed). *Proc. American Association of Zoo Veterinarians (AAZV) Annual Meeting*. Blackwell, Philadelphia, USA: AAZV; 1991. pp198–205.

Homsey J. *Ape Tourism and Human Diseases: How Close Should We Get? A Critical Review of the Rules and Regulations Governing Park Management and Tourism for the Wild Mountain Gorilla, Gorilla gorilla beringei.* Report, Feb 1999. Consultancy for the International Gorilla Conservation Programme (IGCP) Regional Meeting. Rwanda, Uganda: IGCP; 1999.

Kalema-Zikusoka G, Mugerwa B, Asuma S. Health education workshops for local communities of Bwindi Impenetrable National Park, Uganda. *Proc. American Association of Zoo Veterinarians (AAZV), American Association of Wildlife Veterinarians (AAWV), Association of Reptilian and Amphibian Veterinarians (ARAV), and National Association of Zoo and Wildlife Veterinarians (NAZWV) Joint Conference* 18–23 Sept 2001. Orlando, USA: AAZV/AAWV/ARAV/WAZWV; 2001. pp.194–198.

Kalema-Zikusoka G, Kock RA, Macfie EJ. Scabies in free-ranging mountain gorillas (*Gorilla gorilla beringei*) in Bwindi Impenetrable National Park, Uganda. *Vet Rec.* 2002;150:12–15.

Kamugisha JR, Oguta ZA, Stahl M. *Parks and People – Conservation and Livelihoods at the Crossroads: Four Case Histories*. *Technical Report 17*. Nairobi, Kenya: Regional Soil Conservation Unit/Swedish International Development Agency (SIDA); 1997.

Karanth KU, Madhusudan MD. Mitigating human-wildlife conflicts in southern Asia. In: Terborgh J, van Schaik CP, Davenport L, Rao M (eds). *Making Parks Work. Strategies for Preserving Tropical Nature*. Washington, DC, USA: Island Press; 2002. pp.250–264.

Kibuga D. Multi-sectoral approach to DOTS – the only hope. *Scand J Infect Dis.* 2001;33:725–727.

Kock R. Rinderpest in wild ruminants. *Proc. Organization of African Unity (OAU)/Interafrican Bureau for Animal Resources (IBAR)/African Wildlife Veterinary Project (AWVP) Training Workshop*. Nairobi, Kenya: AWVP; 1999. pp.17–20.

Kortlandt A. An epidemic of limb paresis (polio) among the chimpanzee population at Beni (Zaire) in 1964, possibly transmitted by humans. *Pan Africa News*. 1996;3:2.

Leroy EM, Rouquet P, Formenty P, Souquière S, Kilbourne A, Froment J-M, Bermejo M, Smit S, Karesh W, Swanepoel R, Zaki SR, Rollin PE. Multiple Ebola virus transmission events and rapid decline of central African wildlife. *Science* 2004;303:387–390.

Macfie EJ. Gorilla tourism programme for Uganda: veterinary recommendations. In: *Bwindi Impenetrable National Park – a Tourism Development Plan*. Kampala, Uganda: International Gorilla Conservation Programme; 1992.

Madden F. *The Problem Gorilla–A Report of the East and Central African Workshop on Problem Mountain Gorillas Using the Situation in Bwindi Impenetrable National Park as a Basis for Solution Development.* International Gorilla Conservation Programme (IGCP) and Cooperative for Assistance and Relief Everywhere (CARE)–Development Through Conservation (DTC); 1998.

Margoluis R, Myers S, Allen J, Roca J, Melnyk M, Swanson J. *An Ounce of Prevention: Making the Link Between Health and Conservation*. Biodiversity Support Program; Washington, DC, USA: World Wildlife Fund; 2001. 58pp.

McNeilage A, Plumptre A, Brock-Doyle A, Vedder A. Bwindi Impenetrable National Park, Uganda: gorilla census. *Oryx.* 2001;35:39–47.

Ministry of Planning and Economic Development. Statistical Abstract. Kampala, Uganda: The Republic of Uganda; 1997.

Murray S, Stem C, Boudreau B, Goodall J. Intestinal parasites of baboons (*Papio cynocephalus anubis*) and chimpanzees (*Pan troglodytes*) in Gombe National Park. *J Zoo Wildl Med.* 2000;31:176–178.

Nyhus P, Fischer H, Madden F, Osofsky S. Taking the bite out of wildlife damage: the challenges of wildlife compensation schemes. *Conservation in Practice.* 2003;4:37–40.

Opuda-Asibo J. Uganda – regional and country status reports. In: Thoen CO, Steele JH (eds). *Mycobacterium bovis Infection in Animals and Humans*. Ames, USA: Iowa State University Press; 1995. pp.299–303.

Ott-Joslin JE. Zoonotic diseases of nonhuman primates. In: Fowler ME (ed). *Zoo and Wild Animal Medicine, Current Therapy 4.* Philadelphia, USA: WB Saunders; 1993. pp.358–373.

Pusey A. Scabies in chimpanzees of Gombe National Park, Tanzania. Newsletter. *Eur Assoc Zoo Wildl Vet*. 1998;1:10.

Rainer H (ed). *Strengthening Linkages Between Public Health and Conservation Workshop, Kisoro, Uganda*. Report Uganda Wildlife Authority and International Gorilla Conservation Programme. Kisoro, Uganda, 2002.

Ratter A. *Participatory Evaluation.* Evaluation report. Kampala, Uganda: Community Conservation for Uganda Wildlife Authority Project; 1997.

Rooney M, Sleeman J. *Identifying Potential Disease Threats to the Mountain Gorillas (Gorilla gorilla beringei) and Chimpanzees (Pan troglodytes schweinfurthii) of Uganda by Establishing the Diseases Endemic to the Human Populations Living in Close Proximity to the Great Ape Habitats*. Report. Fort Collins, USA: Colorado State University; 1998.

Sleeman JM, Meader LL, Mudakikwa AB, Foster JW, Patton S. Gastrointestinal parasites of mountain gorillas (*Gorilla gorilla beringei*) in the Parc National des Volcans, Rwanda. *J Zoo Wildl Med.* 2000;31:322–328.

Sutmoller P, Thomson GR, Hargreaves SK, Foggin CM, Anderson EC. The foot-and-mouth disease risk posed by African buffalo within wildlife conservancies to the cattle industry of Zimbabwe. *Prev Vet Med.* 2000;44:43–60.

Uganda Wildlife Authority (UWA). *Bwindi Impenetrable National Park/Mgahinga Gorilla National Park (Bwindi/Mgahinga Conservation Area) General Management Plan (Jul 2001–Jun 2011)*. Kampala, Uganda: UWA Planning Unit; Printers Den; 2001. 93pp.

Wallis J, Rick LD. Primate conservation: the prevention of disease transmission. *Int J Primatol.* 1999;20:803–825.

Werikhe S, Macfie L, Rosen N, Miller P (eds). *Can the Mountain Gorilla Survive? Proc*. *Population and Habitat Viability Assessment Workshop for Gorilla gorilla beringei.* Apple Valley, USA: Conservation Breeding Specialist Group (CBSG); 1998.

Woodford MH. Tuberculosis in wildlife in the Ruwenzori National Park, Uganda (Part I). *Trop Anim Health Prod*. 1982;14:81–88.

Woodford MH, Butynski TM, Karesh WB. Habituating the great apes: the disease risks. *Oryx*. 2002;36:153–160.

World Health Organization (WHO). *Global Tuberculosis Control: WHO Report, 2002.* Geneva, Switzerland: World Health Organization; 2002.