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Ape Reintroduction and Health Measures: What can be done in the field?

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A number of ape-range countries are facing the question of what to do with young apes that are rescued directly from the wild or seized by national authorities following their illegal capture by people. Reintroduction of these orphans into their natural habitat is increasingly perceived as a valuable conservation tool. However, the complexity of ape release programs still makes them controversial (especially for African apes) and ape reintroduction should be undertaken only when it makes a positive contribution to the survival of the species in the wild, not because a stock of orphans is available.

One major concern of any reintroduction project is the development of a proper preventive sanitary program to: (1) minimize disease transmission between apes and human caretakers during the period of captivity and after their release into the wild; (2) minimize disease transmission in the captive colony when new individuals are introduced; (3) prevent the introduction of diseases and the possible transmission of pathogen agents to wild conspecifics and other wildlife species when apes are (re)introduced or translocated in the wild; (4) minimize the risks for introduced apes from contracting disease from animals living in the reintroduction area.

In this paper, we will present and summarize the different sets of sanitary guidelines currently available for captive management of apes in sanctuaries and for their ultimate reintroduction into the wild.

These sanitary guidelines will be then confronted with the constraints faced by most of the ape sanctuaries in order to (1) assess the strengths and weaknesses of the guidelines currently available; (2) try to adapt the need for sound sanitary preventive measures with the reality of most of the ape sanctuaries.

Spreading of Ebola infection in wildlife on the Lossi Sanctuary: New cases of Ape Mortality in 2004

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All human outbreaks of Ebola virus infection that have occurred during the last three years in the forest zone straddling the border between Gabon (north-east) and Republic of Congo (west) resulted from the manipulation of infected wild-animal carcasses (mainly gorillas, chimpanzees and duikers). These outbreaks caused a dramatic and rapid decline in wild great-ape populations in Gabon and Republic of Congo during 2001, 2002 and 2003. A census of wild animals in the 320-km^2 Lossi sanctuary before and after the Kelle outbreak in 2003 indicated a rapid great-apes decline in the western half of the Lossi sanctuary (144 km2) between October 2002 and March 2003. Subsequently, observational data were obtained from a study of gorilla groups non affected by the viral spot, inhabiting the sanctuary's eastern boundary on the bank of the Lebamou river. This study provides a basis to evaluate the slowing down effect of large swamps for the spread of Ebola. Four different gorilla groups (25, 15, 11, and 10 individuals) were regularly monitored between June 2003 and February 2004. We observed new cases of high gorilla mortality on these study groups between November and December 2003. Results, based on gorilla monitoring, indicate that about 75% of individuals of the focal group (25 individuals) died in a two-weeks period. Recent surveys indicate that the Ebola outbreak in 2004 caused a decline in great ape populations in the sanctuary's eastern (about 100km2), an area non affected by the Kelle outbreak in 2003. These outbreaks affected the whole great-ape populations of the sanctuary in a year period. Our findings are important for understanding the extent and spread rate of Ebola infection. Preliminary survey results indicate that gorilla populations in the sanctuary declined by about 80%. The bulk of conservation investment should be focused on law

enforcement, community health programs and long-term relationships between local people and conservation projects.

Health protective measures to limit the risk of disease transmission: Interface between field and the laboratory

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Impact and control of rabies in wild carnivores: lessons for disease management in primate populations

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The emergence of rabies as one of the major disease threats to endangered wild carnivore populations in Africa and Asia can be attributed to two major factors. First, rapid increases in domestic dog populations are likely to have altered the dynamics of infection, resulting in larger outbreaks, the expansion of reservoir populations and increasing contact with wildlife. Second, the decline in the infrastructure for delivery of veterinary services in many countries in Africa has led to a breakdown in disease control measures and a resurgence of rabies throughout the continent. For both factors, parallels can be drawn with increasing disease risks for great apes arising from the expansion of human populations.

Several options are available for managing the risk of rabies for threatened wildlife populations, which include no intervention, reducing contact between populations, intervention in the reservoir population and control measures targeted at the wild population at risk. Each strategy has a distinct set of advantages and disadvantages, which need to be evaluated in the context of each specific setting and the magnitude of the disease risk.

Public health issues are a key element in the management of many wildlife diseases, including rabies and many (if not most) primate diseases. Benefits for public health can provide important motivation and funding for implementing and sustaining disease control measures. Conversely, the finding that infection of wildlife hosts is a risk factor for emerging human diseases poses a new set of challenges that need to be addressed collaboratively by wildlife managers, veterinarians and medical professionals.

Standardized Health Monitoring System for the Mountain Gorilla

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Introduction: MGVP aids with the health care of the mountain gorillas (Gorilla beringei beringei) of Uganda, Rwanda and Democratic Republic of Congo. The 18-year-old program began at the request of Dian Fossey to reduce human-induced loss of individuals necessary to the genetic sustainability of these small populations, and has evolved to now approach health on an ecosystem level. Poor standardization of early data collection hampered the ability to produce objective information for conservation management.

Methods: IMPACT (Internet-supported Management Program to Assist Conservation Technologies) is designed to collect, store and analyze diverse data, and to facilitate rapid data sharing among multiple users. It is comprised of several modules including clinical sign observations, interventions, laboratory tests, necropsies, sample collection, biological resource storage, and human exposures, linked through the use of unique identifiers. Daily gorilla baseline health monitoring, based on observed clinical signs, utilizes handheld computers with a program developed by MGVP. Data is downloaded into IMPACT and when linked with past events allows for the prognosis of present clinical signs, helping with the decision to provide clinical care.

Results: This system allows for fast and easy entry of observed gorillas, clinical signs, and abnormalities. The clinical signs module also indicates a disease outbreak and triggers a contingency plan. The severity, incidence and prevalence of clinical signs gathered by the system allow veterinarians to place the outbreak into a low, medium or high-risk category that then dictates a local, regional or international response to minimize the negative impact outbreak to the gorilla population.

Conclusions: Standardized health monitoring provides baseline data to help quickly recognize unusual health events, and respond in a timely and appropriate manner.

Forest Fragmentation Alters Primate Parasite Dynamics: Implications for Primate Health and Conservation

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In the face of ever-increasing rates of habitat loss throughout the tropics, the conservation of many primate species will depend on their ability to survive in forest fragments, and on our capacity to manage landscapes to mitigate the effects of fragmentation. Knowledge of the complex relationship between primate declines and fragmentation-induced ecological change will be critical in this effort. We provide empirical support for the role of parasitic disease in primate declines in forest fragments. From August 1999 to July 2003, we surveyed red colobus (*Procolobus badius*) and black-and-white colobus (*Colobus guereza*) populations in undisturbed areas of Kibale National Park and in 22 forest fragments (1.2 to 8.7 ha) that lie within the agricultural landscape from the western boundary of Kibale to the foothills of the Ruwenzori Mountains in Uganda. Prevalence and richness of gastrointestinal parasite infections were determined for each colobus population by non-invasive fecal flotation and sedimentation (n = 1,440). Relative infection risk was quantified for the area surveyed within the national park and in two fragments, comparing densities of infective-stage parasites from canopy and ground vegetation plots (n = 42). We used regression techniques to determine what fragment characteristics best explained variation in parasite dynamics. Prevalence and richness of infections were greater for colobus in forest fragments compared to undisturbed forest. Infective-stage primate parasites were found at higher densities in both canopy and ground vegetation plots from fragmented compared to undisturbed forest, demonstrating a greater infection risk for primates in fragments. Regression results suggest that the form and intensity of human use within fragments and the surrounding landscape matrix play the strongest role in explaining

altered parasite dynamics including the risk of infection with anthropozoonotic pathogens.

Scabies, Mountain Gorillas and Public Health in Uganda

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Critically endangered mountain gorillas (*Gorilla beringei beringei*) are found in two populations, Bwindi Impenetrable National Park in Uganda and the Virunga Volcanoes in Rwanda, Democratic Republic of Congo and Uganda. The first reported mountain gorilla scabies skin disease outbreak occurred in 1996 in a tourist group of habituated Bwindi gorillas resulting in morbidity and mortality. Clinical signs resolved after Ivermectin anti-parasitic treatment. The mountain gorilla scabies outbreak was eventually associated with the relatively high incidence of scabies in the local community. This tourist gorilla group could have come into contact with contaminated human clothing during a tourist visit or when eating banana plants in local community gardens.

To prevent further outbreaks, Uganda Wildlife Authority in partnership with International Gorilla Conservation Programme and the Bwindi District Health Authorities held participatory rural appraisal health education workshops on the risks of human and gorilla disease transmission in 2000. The workshops were held with affected communities from five parishes bordering the national park. Communities that benefited from tourism were receptive to the workshop ideas and wanted to improve their health while also protecting an income from mountain gorilla tourism. Ecotourism provides employment for surrounding communities and revenue that is shared for community development. Further

scabies outbreaks in another habituated group of mountain gorillas in 2000 and 2001 is one of the reasons for delaying the start of tourism to this group. The mountain gorilla scabies outbreaks highlight the great need to integrate wildlife conservation with public health to also promote sustainable ecotourism.

Population Health Concerns for Lowland Gorillas and other Great Apes

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Presently, only scant information is available on the health status of free-ranging populations of lowland gorillas in areas without current human contact or in areas where research or tourism projects are being conducted or developed. This current lack of information makes it impossible to evaluate changes in wildlife health, and the effects of conservation, research, or development programs on wildlife health.

Eco-tourism is one method used to generate funds for the conservation of wilderness areas. The interest in eco-tourism and application in remote areas that are home to some of the most endangered species has increased substantially in the past 10 years. In areas of the Central African Republic, Republic of the Congo, and Gabon, programs geared towards the development of gorilla eco-tourism as well as long-term ecological and behavioral research are currently underway by several organizations, including WWF, ECOFAC, EDG, WCS, and CIRMF. One reason for the increased concern about disease is due to recent reports of thousands of square kilometers of good gorilla habitat now almost devoid of gorillas and chimpanzees following the Ebola virus outbreaks in north-eastern Gabon in the mid 1990's. Additional outbreaks in more recent years have reduced chimpanzee and gorilla populations in neighboring areas.

Health concerns for populations of free-ranging wildlife that are used in eco-tourism projects or any multiple-use programs include: 1) the transmission of infectious and parasitic agents from humans and domestic animals, 2) stress-induced illnesses due to the presence of humans, and 3) human impact on habitats that may alter food availability and animal behavior. The first concern is particularly relevant for great apes since many human diseases are shared with the great apes.

The Field Veterinary Program of the Wildlife Conservation Society is developing an integrated approach to protecting the health of lowland gorillas by partnering with

ongoing projects and providing health care advice, services, and training where requested. The overall objective of this program is to ensure the long-term health of lowland gorilla populations as eco-tourism and other human activities expand in the region, as well as to ensure the health of humans (tourist and project staff) that have direct or indirect contact with gorillas. This can be achieved by collecting baseline data from gorillas, tourists, project staff (researchers, trackers, and guides), implementing preventive health measures, and conducting long-term health monitoring of gorillas with the following four goals in mind:

(1) Preparedness for potential disease epidemics in the gorilla population.

(2) Establish baseline health information on which future changes due to human activities or other variables can be evaluated. Currently, no one knows levels of occurrence of diseases in lowland gorillas, hence, abnormal prevalence or incidence can not be determined.

(3) Increase knowledge of the concerns for human health in relation to their contact with gorillas.

(4) Demonstration of professional approach to dealing with health concerns by project implementers.

Results and benefits of a multi-method health monitoring in Kanyawara chimpanzees

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The health-status of wild chimpanzees (*Pan troglodytes schweinfurthii*) from the Kanyawara community in Kibale National Park in Uganda was investigated using non-invasive methods. Urine samples assigned to identified chimpanzees were collected over a 5-year period providing a large data set of 2000 analysis and demonstrating the feasibility of this method for diagnostic purposes without disturbing the study subjects. Activity budgets and veterinary health inspection of individuals were then combined over a 5-month survey with coprological studies on two-hundred and fifty two stool samples and urine examinations in an attempt to provide an accurate assessment of body condition of wild chimpanzees. Few abnormal high values were detected in urine samples indicating medical problems. Urinalysis results were consistent with the general good health status of Kanyawara chimpanzees as evaluated by coprological analysis. Almost all fecal samples showed the presence of parasites whether collected in the dry or in the rainy season. However, for almost all of the infected individuals, parasite numbers in feces were low. Using different methods for parasite detection was useful in describing protozoa and eggs as well as larvae of helminths present in stools especially in the case of mild infections. A few study cases presented data in which the different methods were convergent in the diagnosis of poor health status: during the study period, ten cases of obviously ill chimpanzees were observed, improving quickly after small injuries or flu-like symptoms. Our results underlined the benefits of multi-method investigation for monitoring body condition and diseases with minimal disturbance of chimpanzees under study.

In conclusion, non-invasive health status monitoring of individuals is a beneficial way to measure the impact of different threats such as poaching, or environmental degradation as well as the effect of eco-tourism and human proximity on chimpanzees in their natural habitat.

Taï chimpanzees death: The search for the death causes in the wild

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Abstract

Mark Leighton

Gombe chimpanzee health-monitoring: past, present and future.

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Managers in parks containing chimpanzees perceive that disease outbreaks have been and continue to be significant causes of mortality for chimpanzees. Major epidemics at Gombe National Park include suspected polio in 1966, respiratory diseases in 1968, 1987, 1996, 1999 and 2000 and Sarcoptic mange in 1997. Previous unpublished analysis estimates that epidemics have caused 28% of total mortality at Gombe. These outbreaks have led park managers and researchers working in Gombe to conclude that diseases originating from and/or spread by humans pose a substantial risk to the long-term survival of Gombe's chimpanzee population. The study of the chimpanzees at Gombe National Park has spanned over 40 years and all of the behavioral data records are housed at the University of Minnesota. We surveyed these records for health-related data and found non-standardized data, consisting of long-hand notes and journal entries, for the entire period (1960 - 2003). Standardized health data, in the form of checksheets, were found for the period from 1970 – 1987 and 2000 - 2002. At present, individual health data sheets are collected on focal individuals who appear to be ill. A new collection protocol in development will include collecting health data sheets on healthy individuals to provide baseline data for comparison. We present data on the utility of the various data types for outbreak surveillance and management in the context of cooperative and comparative data collection schemes across great ape study sites.

Skin disease in lowland gorillas (G.g.gorilla) at Odzala National Park (Congo)

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The gorilla population visiting Lokoué clearing at Odzala National Park in Congo is studied since 2001. A total of 377 individuals have been identified including 31 solitary males and 45 groups. Skin diseases were precisely described as they left highly visible and irregular marks that were used for identifying individuals. We describe the distribution of skin diseases depending on age, sex and status of individuals and discuss their potential implication on behaviour, reproduction and dynamics. About 16% of individuals showed signs of skin disease and about 5% showed large wounds on their face including nose, eyelids and lips. Some wounds induced obvious difficulties for eating. Skin lesions were more frequent in solitary silverback males than in group living silverback males, suggesting that they could affect the reproductive success of males. Adult males appeared to suffer from these handicaps with a higher frequency than adult females and immature individuals. Comparisons with neighbouring gorilla populations indicate that similar skin diseases are also present in the gorilla population visiting Maya clearing (40 km N from Lokoué) while they have not been described at Mbeli clearing, 200 km NE farther.

Links between human and mountain gorilla health: an example from the mountain gorilla veterinary project in Rwanda

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Introduction: Potential disease transmission from humans has been identified as a key threat affecting population viability of the mountain gorillas (*Gorilla beringei beringei*). In 2000, the Mountain Gorilla Veterinary Project's (MGVP) human health working group identified strategies that could be incorporated into future programming to reduce the risk of disease transmission between humans and gorillas, while improving both the health of humans living in close proximity to the gorillas and relations with local community members. One strategy, an employee health program (EHP), targets park conservation employees as the human group with the most frequent close contact with mountain gorillas

Methods: In 2001 MGVP initiated an EHP for personnel in the Parc National des Volcans, Rwanda, which involves clinical history and physical examination, laboratory tests, follow-up care for health problems, vaccinations and health education. Socio-demographic data provide a basis for developing disease risk profiles. Standardized data collection allows for comparative analyses of health indicators over time to strengthen understanding of the relationship between human and gorilla health.

Results: A high prevalence of potentially transmissible pathogens was found. For example, 48.8% of personnel were positive for at least one gastrointestinal parasite, and 37.3% had *Campylobacter,* 4.6% *Salmonella,* and 0.7% *Shigella.* The type of latrine used and education level were the variables most strongly associated with pathogen prevalence.

Conclusion: Results of the EHP indicate that conservation personnel carry pathogens that can be transmitted to the mountain gorillas. Focusing on human health as a wildlife

disease prevention strategy is a novel approach, and is particularly relevant at interfaces between human and non-human primate populations.

Disease outbreaks in lions of Tanzania: Frequencies, impact and recovery

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Over the past 40 yrs, lions in the Serengeti National Park and Ngorongoro Crater, Tanzania, have been subject to at least a dozen disease outbreaks. Five of these outbreaks were devastating to the host populations, inflicting 25-80% mortality (median 35%). The Crater lion population has been held about 50% below its carrying capacity for most of the past decade, despite high per capita food intake rates. These lions suffered from three severe disease outbreaks between 1994 and 2001, and the Crater population may be unusually vulnerable to infectious disease due to its close proximity to a growing human population and to its history of close inbreeding. In contrast, the Serengeti lion population has only suffered from one major disease outbreak (in 1994), but the subpopulation in the Serengeti woodlands took five years to recover because of the constraints on population growth imposed by group territoriality. Our lion populations offer insights into the potential impact of infectious disease on group territorial species like chimpanzees and on any isolated population of great apes.

Non-invasive testing for pathogens in great apes

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Ebola Outbreaks in wildlife on the Gabon- Congo Border (2001-2003): Results and Reflections on the Prevention of Human and Great Apes Outbreaks.

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All human outbreaks of Ebola virus (EBOV) infection that have occurred during the last three years in the forest zone straddling the border between Gabon (north-east) and Republic of Congo (west) resulted from the manipulation of infected wild-animal carcasses (mainly gorillas, chimpanzees and duikers). After the first outbreak (Mekambo, December 2001), we decided to create an animal mortality monitoring network, in collaboration with the Waters and Forestry Ministry and wildlife organisations (ECOFAC-WCS-WWF) with the aim of predicting and even preventing Ebola outbreaks in humans.

Since December 2001, 96 wild-animal carcasses have been recovered over an area of nearly 15 000 km^2, including 65 great apes and hundreds of animals could have died unnoticed in these vast uninhabited forests. Twenty-three gorilla, chimpanzee and duiker carcasses were sampled and subsequently analysed in the BSL4 laboratory at C.I.R.M.F ; 14 of these tested positive for Ebola virus by RT-PCR and/or antigen assay and/or immunohistochemical staining. These outbreaks caused a dramatic and rapid decline in wild great-ape populations in Gabon and Republic of Congo during 2001, 2002 and 2003. A census of wild animals in the 320-km^2 Lossi sanctuary before and after the Kelle

outbreak in 2003 indicated that the gorilla and duiker abundance indices fell by about 50% and chimpanzee abundance indices by about 88% between October 2002 and March 2003. Recovered carcasses were infected by a variety of Ebola strains, suggesting that the Ebola outbreaks in great apes resulted from multiple virus introductions from the natural host.

The fight against these outbreaks in great apes is a big challenge and should be focused on the discovery of the Ebola reservoir, a better understanding of the conditions favouring outbreak emergence and indeed a vaccination program.

Preventative Measures and Health Monitoring to Reduce the Risc of Diseases Transmission in the Goualougo Triangle, Republic of Congo

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Since the Goualougo Triangle Chimpanzee Project was initiated in 1999, several preventative measures have been taken to lessen the impact of our research presence on vegetation and wildlife while monitoring the behavior and distribution of apes in the study area. We have successfully implemented a protocol for researcher etiquette while conducting surveys and observing apes, a human health program to monitor employees working in the study area, and remote censusing technology to further remove the possibility of disease transmission. Specific survey methods used during this study included direct observations of a semi-habituated chimpanzee community, line-transect nest surveys, and remote video monitoring. We describe the low-impact camping, tracking, and observation techniques used when monitoring ape populations residing in the 300 km^2 study area. A vaccination and health monitoring program was also established for Goualougo Triangle Chimpanzee Project researchers, trackers, and guides through collaboration with the local village clinic. Individual and family health histories for field staff are compared before and after a health program was implemented. These health profiles are then juxtaposed to the local village population health. Specifically, the frequency of potential anthropozoonotic disease epidemics in the local village are presented and compared. We also introduce remote video monitoring as a new technique

for documenting ape health, community structure by individual identification, ranging patterns, and behavioral observations of tool use at termite nests. Six remote video monitoring units that consist of infrared motion sensors and a computer triggered digital video camera were placed throughout the range of a semi-habituated chimpanzee community for six months. The results of this study demonstrate the feasibility of implementing low-impact monitoring techniques to conduct surveys of ape density and direct observations in remote areas.

Ape Health Monitoring in Nouabalé-Ndoki National Park: Assessment of Field Methodologies and Recommendations for Field Monitoring Programmes

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The Nouabalé-Ndoki National Park (NNNP) represents 4,000 km² of pristine lowland rainforest, harbouring undisturbed populations of large mammals including western gorillas (*Gorilla gorilla gorilla*) and chimpanzees (*Pan troglodytes troglodytes*). The Park is located in the sparsely populated northern sector of the Republic of Congo and connects to two large protected areas in neighbouring Central African Republic and Cameroon. NNNP is an important site for ape health monitoring due to1) its intact state and hence utility as a baseline for great ape health status in the region, 2) the need for this baseline data in the face of rising human-wildlife disease risks to great ape populations as a result of i) population growth and increased access to remote forest areas facilitated by the spread of mechanised logging in the region ii) the imminent development of ecotourism in the Park, and 3) the need for an early warning system for Ebola, which is spreading rapidly through the Congo/Gabon border region.

In 2001, NNNP was enlisted as a site for the Wildlife Conservation Society's Field Veterinary Gorilla Health Program, largely through collaboration with researchers at the long-term gorilla research station at Mbeli Bai. Since then, a number of independent ape and human health monitoring components have been added, initiated in particular through researchers at the Goualougo Triangle Chimpanzee Study.

In this presentation we discuss the relative costs and benefits of tried and tested field methodologies for ape health monitoring in the NNNP, focussing on data collection

(dung, urine, visual observations and carcasses), sampling design (systematic and opportunistic) and recording method (cyber tracker and data check sheets). We also discuss limitations arising from on-site storage and analysis capacity, and provide recommendations for future monitoring programmes. Finally, in order to complement an effective ape health monitoring programme we address the importance of implementing parallel preventative health measures for the human population, and education and awareness schemes that deal with human and wildlife health issues

The Risk of Diseases Transmission in Ape Ecotourism

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Ecotourism has both positive and negative implications for ape conservation. Despite the potential for revenue generated for local communities and a heightened awareness about primate protection, there are potentially harmful aspects of ecotourism. Of primary concern is the risk of disease transmission. Because humans and nonhuman primates share many of the same diseases, the risk of spreading dangerous pathogens increases when we share the same environment. Moreover, an ape that is naïve to an exotic pathogen may react more adversely than when faced with an indigenous pathogen; something as simple as a "common cold" spread from a non-local human can have devastating consequences for a wild ape population. Thus, visitors to ape habitats can create a great risk to primates in the wild. Tourists pose an especially high danger. Tourists are often exposed to a wide-array of pathogens while in transit – during international flights or while taking public transportation in host countries. This risk is exacerbated when park personnel fail to impose strict rules for tourism (e.g., monitoring the number and health status of visitors in a group and imposing limits for visitor proximity to the animals). This presentation will review surveys conducted at ape tourist sites, indicating a lack of awareness for health concerns and a lack of enforcement of any existing health rules. These studies suggest a need for improved education both for tourists and tour operators. As primatologists concerned about ape conservation, we must develop better health standards and instructional materials for our own field personnel and share this information with the tourism industry. We must also work to educate potential ape ecotourists prior to travel, to assure a safe visit. Finally, we can cooperate in evaluating the tourism industry and offer recommendations for where and when ecotourism should be limited or halted for specific ape habitats.

Does Ebola really spread in waves? Yes.

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In the last decade Ebola hemorrhagic fever has killed tens of thousands of gorillas and chimpanzees in the Republics of Gabon and Congo. Much of the literature on Ebola assumes that these deaths are due to entirely independent outbreaks of Ebola from some reservoir species in which the virus is of low virulence and has long been enzootic. Here we present compelling evidence that ape deaths are actually part of a small number (possibly one) of spreading waves of Ebola infection. Analyses of human and ape mortality data reveal a clear pattern and consistent rate of epizootic wave movement. It is not yet clear which animals are most heavily involved in the continuing transmission chain. However, several independent lines of evidence suggest substantial transmission between apes and\or other terrestrial mammals. A positive correlation between snare density and ape density in the Minkebe region of northern Gabon suggests that the rate of Ebola transmission to apes is dependent on the density of hunted species. A recurrent blocking effect of rivers and large swamps suggests that most transmission events are between terrestrial animals. Analyses of gorilla group size distributions suggest high levels of Ebola transmission within gorilla groups. Contrary to previous reports, genetic data do not falsify an epizootic hypothesis. But they do cast doubt on whether a highly

mobile, airborne reservoir species is more than occasionally involved in Ebola transmission. These results suggest that both prediction of the location of future outbreaks and Ebola control may be much more feasible than previously appreciated.