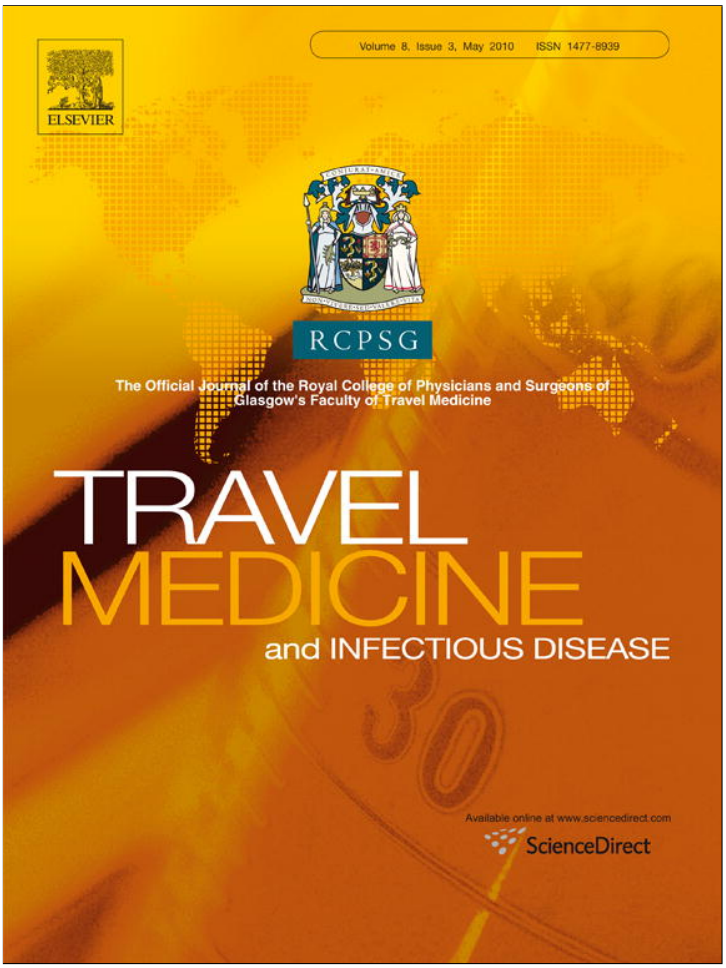

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Unhealthy travelers present challenges to sustainable primate ecotourism

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Summary *Background:* Ecotourism can function as a powerful tool for species conservation. However, a significant proportion of travelers at wildlife sanctuaries may be ill and potentially infectious, creating unnecessary risk of pathogen transmission to wildlife.
Methods: A questionnaire was distributed to adult visitors at the Sepilok Orangutan Rehabilitation Centre, Sabah, Malaysia. The questionnaire recorded age, occupation, region of origin, history of recent travel, recent contact with livestock, domestic and wild animals, and diagnoses/symptoms of various infections.
Results: 15% of the 633 tourists self-reported at least one of the following current symptoms: cough, sore throat, congestion, fever, diarrhea and vomiting. Participants who reported recent animal contact were significantly more likely to report current respiratory symptoms compared to other participants. Likewise, participants with a medical-related occupation were more likely to report current respiratory symptoms while at Sepilok compared to other participants.
Conclusions: Despite being ill and potentially infectious, these tourists were visiting a wildlife sanctuary to view endangered species. Many of these visitors had animal contact immediately prior to arriving, and many had at least some basic knowledge about infection transmission. While participants in nature-based tourism are generally concerned about environmental protection, present analyses suggest that a significant proportion of ecotourists are uninformed of the risks they may pose to non-human animal health.

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Introduction

Ecotourism accounts for a significant proportion of all international tourism and contributes significantly to the national income of various countries.[1] Ecotourism can function as a powerful tool for species conservation by increasing public awareness, empowering community members to understand their natural heritage and take action against habitat degradation, as well as raising much-needed funds for habitat conservation.[2–4] Furthermore, wildlife sanctuaries play important roles in protecting biodiversity from logging and poaching.[5] However, intensive, unmonitored use of these habitats for tourism can produce deleterious effects on animal well-being including lowered reproductive success in the very species we wish to conserve.[6] For example, range restriction of Tibetan macaques (*Macaca thibetana*) in China for tourism purposes resulted in increased levels of food-associated aggression in adult animals with subsequent major increases in infant mortality.[7]

Habituation of animals to human presence can increase the likelihood that animals will actively seek out contact with humans, as during crop raiding and invasion of garbage pits. These animals are more vulnerable to poaching because of their loss of fear of humans. Habituation may also lead to alterations in animal stress responses. Among wild adult magellanic penguins (*Spheniscus magellanicus*), unhabituated animals exhibited elevated plasma corticosterone levels in response to tourist visitation compared to habituated animals, although this response diminished quickly during the habitation process.[8] More importantly, habituation may permanently alter adrenocortical tissue function as evidenced by blunted corticosterone responses following capture and restraint as well as blunted responses following exogenous adrenocorticotropin hormone treatment.[8] Similarly, tourist-exposed marine iguanas in the Galápagos exhibited reduced stress responses to capture and restraint compared to more isolated animals.[9] Attenuated acute stress responses in habituated animals could be potentially detrimental because acute responses are necessary for normal 'fight-or-flight' reactions.[10,11] Although a substantive study on non-human primates using endocrinological indicators of stress in response to habituation and tourism is not yet available,[12] gorilla tourism has been associated with increases in self-directed behavioral indicators of stress (e.g., self-grooming and scratching).[13]

Arguably the most significant impact that tourists may have on wildlife is through the transmission of infectious diseases. This is particularly the case for primates that share a number of common infections with humans.[14–16] Recent reports demonstrate the transmission of human respiratory syncytial virus and metapneumovirus to wild chimpanzees in Côte d'Ivoire,[17] and intestinal pathogens *Giardia* and *Escherichia coli* to wild mountain gorillas and chimpanzees in western Uganda.[18–20] Numerous other gastrointestinal parasite and bacterial infections in wild non-human primates are suspected, but unproven, to be of human origins.[21–25] Additional suspected transmission events include: polio in chimpanzees[26,27]; measles in gorillas[28]; pneumonia in chimpanzees[26,29,30]; scabies in gorillas and chimpanzees[30,31]; and yaws and schistosomiasis in baboons.[30,32]

Although these infections most likely originated from local human populations and/or researchers in the regions, the risk of infection transmission from tourists is still likely significant. A large proportion of travelers to tropical and developing countries do not seek pre-travel health advice and do not use chemoprophylaxis, including proper vaccinations.[33–35] Traveler compliance is surprisingly low, even in regards to avoiding certain dangerous food items such as salads, shellfish and tap water.[36] Perceived immune status, as reported in surveys, is often found to be very different from actual current immune status, as verified by reference to vaccination certificates[37] or serological testing.[38] Consequently, illness during travel is very common, particularly gastrointestinal and respiratory infections.[39] The stress of travel due to dysregulation of biorhythms, unfamiliar diets and climate, and exposure to novel pathogens are all exacerbating factors.

Risk assessment in travelers to wildlife sanctuaries (which may include both wild and rehabilitated/released animals; not zoos) is also likely low, despite their recognized travel itinerary to view endangered animals. Ecotourists and other travelers concerned about environmental protection may be largely unaware of the impact they may directly have on animal health. We have previously reported that a significant proportion of ecotourists at the Sepilok Orangutan Rehabilitation Centre, Sabah, Malaysia, are not adequately protected against vaccine-preventable illnesses.[40] 67.1% of those surveyed *with* medical-related occupations reported not being currently vaccinated for influenza, despite the fact that the majority of visitors to Sepilok are from temperate regions where influenza is relatively more prevalent. In the present study, we utilize data based on self-perceived health status of visitors at Sepilok to suggest that a significant proportion of travelers at wildlife sanctuaries are concurrently ill and potentially infectious, creating unnecessary risk of infection transmission to endangered species.

Materials and methods

The Sepilok Orangutan Rehabilitation Centre (SORC) is located on the northern edge of the 5529 ha Kabili-Sepilok Virgin Jungle Forest Reserve, 22 km outside of the city of Sandakan in the Malaysian state of Sabah, northern Borneo (05′51.841″N, 117′57.003″E). The forest is bordered by oil palm plantations, poultry farms and fruit orchards, and at least six hotels are located within 1 km of the SORC. The Centre functions to rehabilitate orphaned, injured and/or confiscated orangutans (*Pongo pygmaeus morio*) and other endangered species. Following a six month quarantine period, orangutans are taught how to transverse the forest and forage for food. Following extensive health inspections, these animals are eventually relocated or released into the surrounding forest.

To facilitate public education and generate operational funds, the public is allowed to view two daily feedings (10 AM and 3 PM) of the previously rehabilitated, free-ranging animals. In 2006, 97,367 visitors (55,889 foreign) attended these feedings. A multilingual information sign indicates that smoking, eating and spitting are not allowed, that visitors should keep their distance from the animals,

should not bring medications, bags or insect repellant, and other miscellaneous information. Park rangers are present during animal feedings, and the visitor viewing area is separated from the actual feeding platforms by approximately 10 m. Although the visitations are relatively short (approximately 30 min), the number of tourists at any given feeding is not restricted.

A brief questionnaire was distributed at the registration desk, cafeteria and video presentation room at SORC. Questionnaires were distributed to adults (≥18 years) in English and Malay only, participation was voluntary and anonymous, and no compensation was provided. The questionnaire recorded age, occupation, region of origin, history of recent travel, recalled recent contact with livestock, domestic and wild animals, recent diagnoses and symptoms of various infections (cough, sore throat, congestion, fever, diarrhea and vomiting), and recalled current vaccination status (tuberculosis, influenza, hepatitis A and B, rabies, polio, measles and chickenpox). Contact with zoo animals and familiar domestic pets outside of Malaysia were not included in analyses. This protocol was approved by the Human Subjects Committee at the University of Wisconsin-Milwaukee. Permission to conduct this work was granted by the Sabah Wildlife Department.

1503 tourists viewed the animal feedings at SORC during the nine-day observation in June 2007 (mean of 167 visitors per day; range 91–205). Surveys were originally obtained from 773 of these individuals. However, 140 of these individuals did not report information regarding current health status (on the reverse side of the questionnaire). Thus, for presentation here, 633 surveys were utilized, representing 42.1% of all visitors during this observation. The only other similar survey previously reported data on 62 ecotourists in Uganda.[41]

Adjusted odds ratios (aOR), associated 95% confidence intervals (CI), and their statistical significance were calculated by using SAS software (SAS Institute, Cary, NC, USA). The odds of reported health status were obtained for participants reporting a medical occupation relative to those reporting a non-medical occupation, and for participants reporting recent contact with animals relative to those reporting no animal contact. Logistic regression was used to adjust the ORs for the effects of potential confounding factors, including age, sex, and region of origin. Goodness of fit for each global logistic regression model was assessed using the likelihood ratio test. 95% confidence intervals were estimated to show the range of values consistent with reported odds ratio point estimates.

Results

Mean age of the surveyed population was 38 years (range 18–84 years) (Table 1). Most participants were under the age of 50 (76.6%), and were female (55.1%). Over half of the sample listed Europe as their region of origin. The regions with the next highest representation were Australia and New Zealand (22.5%) followed by Malaysia (11.6%).

Recalled current vaccination status is reported elsewhere.[40] 15% of the sample self-reported at least one of the following *current* symptoms: cough, sore throat, congestion, fever, diarrhea, and vomiting. 10.8% of the sample self-reported at least one symptom associated with respiratory tract infection (cough, sore throat, or congestion). The frequencies of symptoms were not significantly associated with participant age, sex or region of origin.

20.1% of those surveyed reported some type of significant recent animal contact (e.g., livestock, wildlife at other sanctuaries, unfamiliar domestic pets). The participants with recent animal contact were more likely to report current respiratory symptoms compared to individuals with no such animal contact (aOR 2.4; 95% CI 1.3–4.4; $p < 0.01$) (Table 2).

Participants were asked to report their occupation, which was later categorized into medical or non-medical groups for analysis. The medical category included such occupations as veterinarians, physicians, and nurses as well as students preparing to enter these fields. 12.7% of participants were categorized as having a medical-related occupation. Participants with a medical-related occupation were more likely to report current respiratory symptoms while at SORC compared to participants with non-medical occupations (aOR 2.2; 95% CI 1.1–4.4; $p = 0.02$) (Table 2).

Table 1 Characteristics of survey participants.

	N (%)
Number of completed surveys	633
Age, mean (range), years	38 (18–84)
Age, years	
18–29	234 (37.2)
30–39	172 (27.3)
40–49	76 (12.1)
50–59	63 (10.0)
60–69	61 (9.7)
≥ 70	23 (3.7)
Sex	
Male	284 (44.9)
Female	349 (55.1)
Occupation	
Medical	76 (12.7)
Non-medical	524 (87.3)
Region of Origin	
Africa	4 (<0.1)
Asia	38 (6.0)
Australia, New Zealand	142 (22.5)
Europe	323 (51.3)
Malaysia	73 (11.6)
Middle East	8 (1.3)
North America	42 (6.7)
Contact with Animals	116 (20.1)
Any Symptoms	95 (15.0)
Any Respiratory Symptoms	68 (10.8)
Participants experiencing individual symptoms[a]	
Cough	44 (7.0)
Congestion	16 (2.5)
Sore throat	37 (5.8)
Diarrhea	31 (4.9)
Fever	10 (1.6)
Vomiting	10 (1.6)

[a] Many participants reported more than one symptom.

Discussion

The data presented here are consistent with the supposition that, despite their recognized travel itinerary to view endangered species, a significant proportion of visitors at Sepilok are ill and potentially infectious, creating potential risk of pathogen transmission to a) the non-human primates they came to visit, b) the local inhabitants in the surrounding area, and c) the animal caregivers at Sepilok. Pathogen transmission to the latter two groups might further function as additional sources of infection to the non-human animals at Sepilok.

Participants with a medical-related occupation were more likely to report experiencing symptoms associated with respiratory tract infection while at SORC compared to participants with non-medical occupations. This need not imply that participation in a medical-related occupation actually caused respiratory tract infections in these tourists. An alternative explanation is that these individuals were more likely to report health symptoms compared to others. However, we suggest that such results highlight the fact that currently ill and potentially infectious tourists were still visiting a wildlife sanctuary to view endangered species, despite having at least some basic knowledge about infection transmission (i.e., medical-related occupation).

Similarly, participants with a history of recent animal contact were more likely to report experiencing symptoms associated with respiratory tract infection while at SORC compared to participants with no such animal contact. Again, this need not imply that contact with animals actually caused respiratory tract infections in these tourists, although that is certainly a possibility. Instead, these results highlight the fact that currently ill and potentially infectious tourists were still visiting a wildlife sanctuary, despite significant animal contact prior to coming to Sepilok (e.g., contact with livestock, wildlife at other sanctuaries, and unfamiliar domestic pets) which may have exposed them to other sources of infection. This is particularly the case for intestinal pathogens like toxigenic *E. coli*, *Cryptosporidium parvum*, *Giardia*, *Campylobacter*, and *Salmonella*,[42] although the possibility of viral transmission cannot be ruled out.[43] While participants in nature-based tourism are generally concerned about environmental protection, the present analyses suggest that a significant proportion of ecotourists are either uninformed of the risks they may pose to non-human animal health, or chose to ignore such risks.

There are several limitations to the present project. Surveys collected over such a short time span (nine-days) do not likely record true prevalence of seasonal infections. In addition, length of time each person exhibited symptoms was not recorded, so it is not possible to determine whether these persons were still infectious at the time of the survey. However, poor recall of actual initiation of mild symptoms would likely yield inaccurate estimates of actual infectivity. Actual diagnoses for viral and bacterial infection are also absent from the tourist population. Future studies must utilize biological measurements (e.g., viral load, antibody levels, etc.) in efforts to better understand risks of anthropozoonotic infection transmission.

Previous health surveys of the orangutans at SORC have revealed that many of the semi-captive animals exhibit antibody titers indicative of past exposure from the viruses coxackie B-4, Ebstein-Barr, Foamy virus, mumps, parainfluenza 3, respiratory syncytial, rotavirus SA11, dengue, Japanese encephalitis, Langat, Tembusu and Zika.[44,45] Other infections include *Leptospira*, *Balantidium coli*, *Strongyloides*, *Enterobius*, and *Trichuris*.[45] It is unknown whether any of the infections are of human origins or whether these pathogens are endemic in the wild orangutan population. These orangutans certainly exhibit greater proximity to humans compared to their wild counterparts, which could explain the higher prevalence of malaria infection (*P. pitheci* and *P. silvaticum*) in these animals at

Table 2 Logistic regression analyses of reported symptoms of visitors with medical/non-medical occupations and with/without animal contact.

	Medical Occupation N (%)	Non-medical Occupation N (%)	Adjusted odds ratio[a] (95% CI)	*P* value	Likelihood ratio test	
					Chi-square	*P* value
Symptoms			1.4 (0.7–2.7)	0.29	20.3	0.005
At least 1 reported	15 (19.7)	78 (14.9)				
None	61 (80.3)	445 (85.1)				
Respiratory symptoms			**2.2 (1.1–4.4)**	**0.02**	17.8	0.013
At least 1 reported	14 (18.4)	52 (10.0)				
None	62 (81.6)	471 (90.0)				
	Contact with Animals[b] N (%)	No Contact with Animals N (%)	Adjusted odds ratio[a] (95% CI)	*P* value	Likelihood ratio test	
					Chi-square	*P* value
Symptoms			**2.2 (1.3–3.8)**	**<0.01**	24.8	0.0008
At least 1 reported	29 (25.0)	55 (12.0)				
None	87 (75.0)	405 (88.0)				
Respiratory symptoms			**2.4 (1.3–4.4)**	**<0.01**	18.3	0.011
At least 1 reported	22 (19.0)	38 (8.3)				
None	94 (81.0)	422 (91.7)				

[a] All estimates were adjusted for possible confounders (age, sex, and region of origin) with logistic regression.
[b] Excluding zoo encounters and familiar domestic pets.

SORC.[46] Although average distance between the feeding and viewing platforms is 10 m, direct contact between tourist and ape/monkey populations does happen occasionally (i.e., animals transverse in the trees overhead and frequently walk across the viewing platform when people are present). Direct contact, aerosolization through coughing and sneezing, in addition to spitting and bleeding (see Fig. 1) could all contribute to potential anthropozoonotic infection transmission here.

Humans are also at risk of acquiring pathogens from non-human animals. In fact, over half of all human pathogens are zoonotic in origin.[47] Wild primates function as the reservoirs for a number of human infections, including filariasis, yellow fever, and Chikingunya virus.[48–50] *Cryptosporidium* has been transmitted from gorillas to humans inhabiting the same African forest.[51] Similarly *Plasmodium knowlesi* from macaques can infect co-habitating humans.[52] Hunting, preparation and consumption of primates has lead to the transmission of human immunodeficiency virus, simian foamy virus and simian T-lymphotropic virus in West Africans.[53–55] Simian foamy virus has also been transmitted (most likely through a bite) from a macaque to a monkey temple worker in Bali, Indonesia.[56] Over eighty percent of macaques sampled at Balinese temples carry Cercopithecine herpesvirus 1 (B) virus,[57] which can be extremely pathogenic in humans.[58]

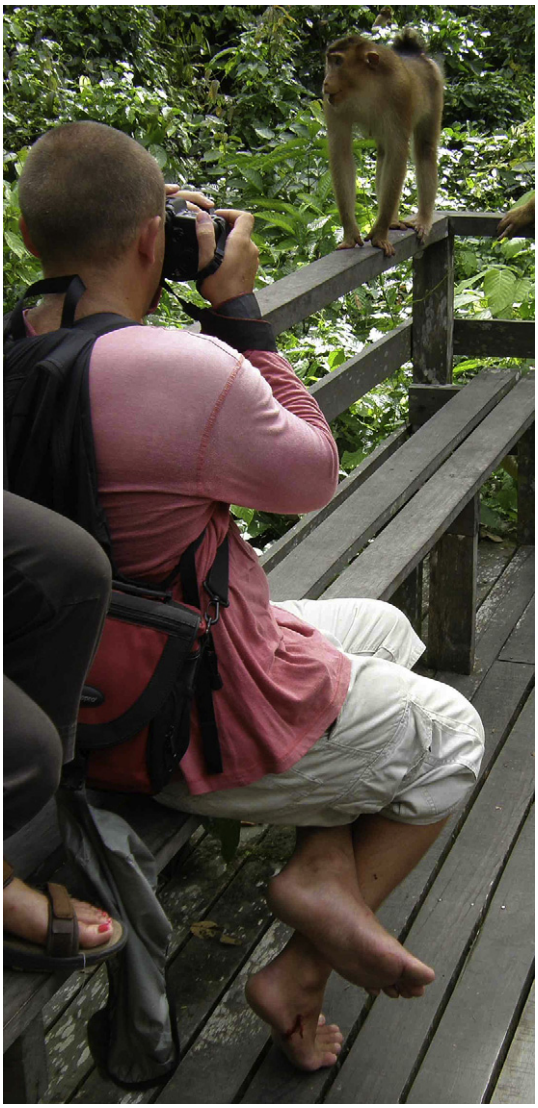

Figure 1 Visitors at Sepilok Orangutan Rehabilitation Centre frequently have open wounds due to mosquito and leech bites. This barefoot man had an actively bleeding leech bite on his ankle which left spots of blood across the viewing platform.

Given the possibility of zoonotic and anthropozoonotic infection transmission, various protection measures have been implemented at wildlife sanctuaries and ecotourism destinations, particularly those involving primates. Visitors are usually asked to keep a minimum distance from the animals, self-report any illnesses, avoid littering, smoking, eating, spitting and nose-blowing.[59] The number of tourists at any given time is limited, as is the length of visit. Those who have to sneeze or cough are asked to turn away from the animals, and human fecal waste must be buried. Park personnel may also be subject to varying requirements, such as current vaccinations, negative tuberculosis tests, annual health inspections and disinfection of clothing and footwear.[25,60]

Additional recommended prevention measures for these sanctuaries include the use of disposable facemasks and gloves, mandatory hand washing and shoe disinfection before and after visiting the animals, medical screening of tourists, required current vaccinations, and refusal of entry to visibly ill people.[16,30,40,41,59,61,62] Adoption of some of these practices may result in lower immediate revenue, but at the benefit of ensuring long-term utilization of these animals. If these rules are implemented, project operators should not be hesitant to enforce the rules and penalize visitors for disregarding them.

Education about local outbreaks and general risks should be provided to staff, tourists, tour operators, hotels, healthcare providers and surrounding community members.[30,59] While several organizations[63–66] provide some basic guidelines for nature tour operators, including how to minimize visitor impacts on the environment through proper behavior, health-related behaviors are not emphasized. Such information is also not available on commercial travel websites.[67]

Despite the current regulations at wildlife tourism locations, visitors typically violate the rules. Tourists at Bwindi typically stay longer and get significantly closer to gorillas than allowed, even though they are briefed of the rules beforehand.[68] Tourist ignorance over infection risks, particularly the risks they pose to the very same wildlife they are interested in protecting, cannot be justified, regardless of the large sums of money people spend to visit these exotic destinations. It is the combined responsibility of tourists to follow regulations, and the tourism personnel to enforce them. Physicians, veterinarians, and tourism personnel should play key roles in educating tourists on the risks of anthropozoonoses. Miscommunication about travel health and fear of disease from wildlife will be unproductive; engendering fear of wildlife and their potential zoonotic diseases will not facilitate the much-needed support from local human populations.[30] There is no foreseeable reason to eliminate tourism at SORC or other wildlife sanctuaries, as the benefits far outweigh the costs, to date.

However, the risks of negatively affecting endangered animal populations must be better understood and communicated to all concerned parties, particularly as the ecotourism industry continues its rapid expansion.

Infection transmission can threaten the survival of species and jeopardize the economic stability of regions that rely on revenue from these animals. Responsible health monitoring of human—wildlife interactions will function to ensure the sustainability and growth of ecotourism, and information regarding risk of transmission in these ecological hotspots will help to inform land-use policy and optimize responsible ecotourism for animal well-being and economic development.

Conflict of interest

The authors declare no conflict of interest.

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References

1. Filion FL, Foley JP, Jacqemot AJ. The economics of global ecotourism. In: Munasinghe M, McNealy J, editors. *Protected area economics and policy: linking conservation and sustainable development*. Washington, DC: The World Bank; 1994. p. 235—52.
2. Munasinghe M, McNealy J, editors. *Protected area economics and policy: linking conservation and sustainable development*. Washington, DC: The World Bank; 1994.
3. Mowforth M, Munt I. *Tourism and sustainability: development and new tourism in the third world*. London: Routledge; 2003.
4. Schoene CUR, Brend SA. Primate sanctuaries — a delicate conservation approach. *South African Journal Wildlife Research* 2002;**32**:109—13.
5. Bruner AG, Gullison RE, Rice RE, da Fonseca GAB. Effectiveness of parks in protecting tropical biodiversity. *Science* 2001;**291**: 125—8.
6. Jaffe E. Good gone wild: sometimes, ecotourism hurts what it sets out to help. *Science* 2006;**170**:218—20.
7. Berman CM, Jinhua L, Ogawa H, Ionica C, Yin H. Primate tourism, range restriction, and infant risk among *Macaca thibetana* at Mt. Huangshan, China. *International Journal of Primatology* 2007;**28**:1123—41.
8. Walker BG, Dee Boersma P, Wingfield JC. Habituation of adult magellanic penguins to human visitation as expressed through behavior and corticosterone secretion. *Conservation Biology* 2006;**20**:146—54.
9. Romero LM, Wikelski M. Exposure to tourism reduces stress-induced corticosterone levels in Galápagos marine iguanas. *Biological Conservation* 2002;**108**:371—4.
10. Romero LM. Physiological stress in ecology: lessons from biomedical research. *Trends in Ecology and Evolution* 2004;**19**: 249—55.
11. Sapolsky RM, Romero LM, Minck AU. How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. *Endocrine Reviews* 2000; **21**:55—89.
12. Muehlenbein MP. The application of endocrine measures in primate parasite ecology. In: Huffman M, Chapman C, editors. *Primate parasite ecology: the dynamics of host-parasite relationships*. New York: Cambridge University Press; 2009. p. 63—81.
13. Muyambi F. The impact of tourism on the behaviour of mountain gorillas. *Gorilla Journal* 2005;**30**:14—5.
14. Brack M. *Agents transmissible from simians to man*. Berlin: Springer-Verlag; 1987.
15. Reinquist DM, Whitney RA. Zoonoses acquired from pet primates. *Veterinary Clinics of North America-Small Animal Practice* 1987;**17**:219—40.
16. Woodford MH, Butynski TM, Karesh WB. Habituating the great apes: the disease risks. *Oryx* 2002;**36**:153—60.
17. Köndgen S, Kühl H, N'Goran PK, Walsh PD, Schenk S, Ernst N, et al. Pandemic human viruses cause decline of endangered great apes. *Current Biology* 2008;**18**:1—5.
18. Graczyk TK, Nizeyi JB, Ssebide B, Thompson RCA, Read C, Cranfield MR. Anthropozoonotic *Giardia duodenalis* genotype (assemblage) a infections in habitats of free-ranging human-habituated gorillas, Uganda. *Journal of Parasitology* 2002;**88**: 905—9.
19. Goldberg TL, Gillespie TR, Rwego IB, Wheeler E, Estoff EL, Chapman CA. Patterns of gastrointestinal bacterial exchange between chimpanzees and humans involved in research and tourism in western Uganda. *Biological Conservation* 2007;**135**: 511—7.
20. Rwego IB, Isabirye-Basuta G, Gillespie TR, Goldberg TL. Gastrointestinal bacterial transmission among humans, mountain gorillas, and livestock in Bwindi Impenetrable National Park, Uganda. *Conservation Biology* 2008;**22**:1600—7.
21. Rolland RM, Hausfater G, Marshall B, Levy SB. Antibiotic-resistant bacteria in wild primates: increased prevalence in baboons feeding on human refuse. *Applied Environmental Microbiology* 1985;**49**:791—4.
22. Ashford RW, Reid GDF, Butynski TM. The intestinal faunas of man and mountain gorillas in a shared habitat. *Annals of Tropical Medicine and Parasitology* 1990;**84**:337—40.
23. Nizeyi JB, Mwebe R, Nanteza A, Cranfield MR, Kalema GRNN, Graczyk TK. Campylobacteriosis, salmonellosis, and shigellosis in free-ranging human-habituated mountain gorillas of Uganda. *Journal of Wildlife Diseases* 2001;**37**:239—44.
24. Graczyk TK, Nizeyi JB, da Silva AJ, Moura INS, Pieniazek NJ, Cranfield MR, et al. A single genotype of *Encephalitozoon intestinalis* infects free-ranging gorillas and people sharing their habitats in Uganda. *Parasitology Research* 2002;**88**:926—31.
25. Mountain Gorilla Veterinary Project 2002 Employee Health Group. Risk of disease transmission between conservation personnel and the mountain gorillas: results from an employee health program in Rwanda. *EcoHealth* 2004;**1**:351—61.
26. Goodall J. *The chimpanzees of Gombe: patterns of behavior*. Cambridge, MA: Harvard University Press; 1986.
27. 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**:9—10.
28. Byers AC, Hastings B. Mountain gorilla mortality and climatic factors in the Parc National des Volcans, Ruhengeri Prefecture, Rwanda, 1988. *Mountain Research and Development* 1991;**2**: 145—51.
29. Hosaka K. Epidemics and wild chimpanzee study groups. *Pan Africa News* 1995;**2**:1—4.
30. Wallis J, Lee DR. Primate conservation: the prevention of disease transmission. *International Journal of Primatology* 1999;**20**:803—26.
31. Macfie L. Case report on scabies infection in Bwindi gorillas. *Gorilla Journal* 1996;**13**:19—20.
32. Mueller-Graf CDM, Collins DA, Packer C, Woolhouse MEJ. *Schistosoma mansoni* infection in a natural population of olive

baboons (*Papio cynocephalus anubis*) in Gombe Stream National Park, Tanzania. *Parasitology* 1997;**115**:621–7.
33. Van Herck K, Castelli F, Zuckerman J, Nothdurft H, Van Damme P, Dahlgren AL, et al. Knowledge, attitudes and practices in travel-related infectious diseases: the European airport survey. *Journal of Travel Medicine* 2004;**11**:3–8.
34. Van Herck K, Zuckerman J, Castelli F, Van Damme P, Walker E, Steffen R. Traveler's knowledge, attitudes, and practices on prevention of infectious diseases: results from a pilot study. *Journal of Travel Medicine* 2003;**10**:75–8.
35. Wilder-Smith A, Khairullah NS, Song JH, Chen CY, Torresi J. Travel health knowledge, attitudes and practices among Australasian travelers. *Journal of Travel Medicine* 2004;**11**:9–15.
36. Steffen R, Tornieporth N, Costa Clemens SA, Chatterjee S, Cavalcanti AM, Collard F, et al. Epidemiology of travelers' diarrhea: details of a global survey. *Journal of Travel Medicine* 2004;**11**:231–8.
37. Toovey S, Jamieson A, Holloway M. Travelers' knowledge, attitudes and practices on the prevention of infectious diseases: results from a study at Johannesburg International Airport. *Journal of Travel Medicine* 2004;**11**:16–22.
38. Hilton E, Singer C, Kozarsky P, Smith M, Lardis MP, Borenstein MT. Status of immunity to tetanus, measles, mumps, rubella, and polio among US travelers. *Annals of Internal Medicine* 1991;**115**:32–3.
39. Rack J, Wichmann O, Kamara B, Gunther M, Cramer J, Schonfeld C, et al. Risk and spectrum of diseases in travelers to popular tourist destinations. *Journal of Travel Medicine* 2005; **12**:248–53.
40. Muehlenbein MP, Martinez LA, Lemke AA, Ambu L, Nathan S, Andau P, et al. Perceived vaccination status in ecotourists and risks of anthropozoonoses. *EcoHealth* 2008;**5**:371–8.
41. Adams HR, Sleeman JM, Rwego I, New JC. Self-reported medical history survey of humans as a measure of health risk to the chimpanzees (*Pan troglodytes schweinfurthii*) of Kibale National Park, Uganda. *Oryx* 2001;**35**:308–12.
42. Mawdsley JL, Bardgett RD, Merry RJ, Pain BF, Theodorou MK. Pathogens in livestock waste, their potential movement through soil and environmental pollution. *Applied Soil Ecology* 1995;**2**:1–15.
43. Cleaveland S, Laurenson MK, Taylor LH. Diseases of humans and their domestic mammals: pathogen characteristics, host range and the risk of emergence. *Philosophical Transactions of the Royal Society of London Series B* 2001;**356**:991–9.
44. Wolfe ND, Kilbourn AM, Karesh WB, Rahman HA, Bosi EJ, Cropp BC, et al. Sylvatic transmission of arboviruses among Bornean orangutans. *American Journal of Tropical Medicine and Hygiene* 2001;**64**:310–6.
45. Kilbourn AM, Karesh WB, Wolfe ND, Bosi EJ, Cook RA, Andau M. Health evaluation of free-ranging and semi-captive orangutans (*Pongo pygmaeus pygmaeus*) in Sabah, Malaysia. *Journal of Wildlife Diseases* 2003;**39**:73–83.
46. Wolfe ND, Karesh WB, Kilbourn AM, Cox-Singh J, Bosi EJ, Rahman HA, et al. The impact of ecological conditions on the prevalence of malaria among orangutans. *Vector-Borne and Zoonotic Diseases* 2002;**2**:97–103.
47. Woolhouse M, Gaunt E. Ecological origins of novel human pathogens. *Critical Reviews in Microbiology* 2007;**33**:1–12.
48. Mak JW, Cheong WH, Yen PK, Lim PK, Chan WC. Studies on the epidemiology of subperiodic *Brugia malayi* in Malaysia: problems in its control. *Acta Tropica* 1982;**39**:237–45.
49. McIntosh BM. Antibody against Chikungunya virus in wild primates in Southern Africa. *South African Journal of Medical Sciences* 1970;**35**:65–74.
50. Monath TP. Yellow fever: an update. *Lancet Infectious Diseases* 2001;**1**:11–20.
51. Nizeyi JB, Sebunya D, Dasilva AJ, Cranfield MR, Pieniazek NJ, Graczyk TK. Cryptosporidiosis in people sharing habitats with free-ranging mountain gorillas (*Gorilla gorilla beringei*), Uganda. *American Journal of Tropical Medicine and Hygiene* 2002;**66**:442–4.
52. Singh B, Kim Sing L, Matusop A, Radhakrishnan A, Shamsul SS, Cox-Singh J, et al. A large focus of naturally acquired *Plasmodium knowlesi* infections in human beings. *Lancet* 2004; **363**:1017–24.
53. Gao F, Bailes E, Robertson DL, Chen Y, Rodenburg CM, Michael SF, et al. Origin of HIV-1 in the chimpanzee *Pan troglodytes troglodytes*. *Nature* 1999;**397**:436–41.
54. Wolfe ND, Henien W, Carr JK, Garcia AD, Shanmugam V, Tamoufe U, et al. Emergence of unique primate T-lymphotropic viruses among central African bushmeat hunters. *Proceedings of the National Academy of Sciences USA* 2005;**102**:7994–9.
55. Wolfe ND, Switzer WM, Carr JK, Bhullar VB, Shanmugam V, Tamoufe U, et al. Naturally acquired simian retrovirus infections in central African hunters. *Lancet* 2004;**363**:932–7.
56. Jones-Engel L, Engel GA, Schillaci MA, Rompis A, Putra A, Suaryana KG, et al. Primate-to-human retroviral transmission in Asia. *Emerging Infectious Diseases* 2005;**11**:1028–35.
57. Engel GA, Jones-Engel L, Schillaci MA, Suaryana KG, Putra A, Fuentes A, et al. Human exposure to herpesvirus B-seropositive macaques, Bali, Indonesia. *Emerging Infectious Diseases* 2002; **8**:789–95.
58. Ostrowski SR, Leslie MJ, Parrott T, Abelt S, Piercy PE. B-virus from pet macaque monkeys: an emerging threat in the United States? *Emerging Infectious Diseases* 1998;**4**:117–21.
59. Homsey J. Ape tourism and human diseases: how close should we get? *Report for the International Gorilla Conservation Programme Regional Meeting*. Rwanda; 1999.
60. Jane Goodall Institute. *Chimpanzee ecotourism health protocol manual*. Entebbe: Uganda: Jane Goodall Institute; 2006.
61. Leendertz FH. Pathogens as drivers of population declines: the importance of systematic monitoring in great apes and other threatened mammals. *Biological Conservation* 2006;**131**: 325–37.
62. Muehlenbein MP, Ancrenaz M. Minimizing pathogen transmission at primate ecotourism destinations: the need for input from travel medicine. *Journal of Travel Medicine* 2009;**16**: 229–32.
63. Ceballos-Lascurán H. *Tourism, ecotourism, and protected areas: the state of nature-based tourism around the world and guidelines for its development*. Gland, Switzerland: World Conservation Union; 1996.
64. Eagles PFJ, McCool SF, Haynes CD. *Sustainable tourism in protected areas: guidelines for planning and management*. Gland, Switzerland: World Conservation Union; 2002.
65. Ecotourism Society. *Ecotourism guidelines for nature tour operators*. North Bennington, Vermont: The Ecotourism Society; 1993.
66. World Tourism Organization. *World ecotourism summit — final report*. Madrid, Spain: World Tourism Organization and the United Nations Economic Programme; 2002.
67. Horvath LL, Murray CK, DuPont HL. Travel health information at commercial travel websites. *Journal of Travel Medicine* 2003;**10**:272–9.
68. Sandbrook C, Semple S. The rules and reality of mountain gorilla *Gorilla beringei beringei* tracking: how close do tourists get? *Oryx* 2006;**40**:428–33.