Primates on display: Potential disease consequences beyond bushmeat

Michael P. Muehlenbein

Abstract
Human interactions with nonhuman primates vary tremendously, from daily cultural engagements and food commodities, to pet ownership and tourist encounters. These interactions provide opportunities for the exchange of pathogenic organisms (both zoonoses and anthroponoses). As exposures are not limited to areas where bushmeat usage continues to be a major problem, we must work to understand better our motivations for engaging in activities like owning primates as pets and having direct physical contact with wild primates within the context of nature-based tourism. These topics, and the theoretical potential for pathogen transmission, are reviewed in the present manuscript. This is followed by a case study utilizing 3845 survey responses collected from four international locations known for primate-based tourism, with results indicating that while a majority of people understand that they can give/get diseases to/from wild primates, a surprising percentage would still touch or feed these animals if given the opportunity. Many people still choose to touch and/or own primates, as their drive to bond with animals outweighs some basic health behaviors. Desires to tame, control, or otherwise establish emotional connections with other species, combined with the central role of touch for exploring our environment, necessitate the development of better communication and educational campaigns to minimize risks of emerging infectious diseases.

KEYWORDS anthroponoses, biophilia, bushmeat, companion animals, ecotourism, emerging infectious diseases, environmental attitudes, haptics, Monkeyland Primate Sanctuary, primates, pets, Saint Kitts, Sepilok Orangutan Rehabilitation Centre, Takasakiyama Monkey Park, zoonoses, zoos

1 INTRODUCTION

Contextualizing our relationships and interactions with nonhuman animals (referred to as animals from this point forward) is critical for understanding our place in nature. For many people, feeling like a part of the natural world has always been, and will continue to be, a normal state of being (Leopold, 1949). For those of us, we are captivated by the natural world (Fromm, 1964), and this "biophilia" according to some scholars may include innate tendencies to emotionally affiliate with other living organisms (Kellert & Wilson, 1993; Wilson, 1984). For other people, the commodification of nature provides a simple source of food, shelter, medicine, and other products, although people's attitudes about the environment appear to have changed over the past several decades, particularly in developed populations (the New Environmental Paradigm: Dunlap & Van Liere, 1978). Whatever the case may be, our species has been dependent upon other species for survival, and understanding the range of emotional responses we have toward these species is important for determining any risks associated with human–animal interactions. One of the most critical risks of these interactions is the potential for infectious disease outbreaks (see Muehlenbein, 2016 for a detailed review).

Pathogens are infectious organisms that parasitize other host organisms, resulting in host illness (disease). There are at least 1415 of these found in humans (Taylor, Latham, & Woolhouse, 2001), and combined they accounted for approximately seventeen percent of all global deaths in 2012 (World Health Organization, 2016). Many of these pathogens are considered emerging infectious diseases (EIDs) that are newly identified or evolved, or moved into new geographic areas or new host populations (Lederberg, Shope, & Oakes, 1992). Zoonotic diseases (those originating from animals) are common, accounting for
sixty-one percent of all known human pathogens and seventy-five percent of all EIDs (Taylor et al., 2001).

The present manuscript aims to contextualize the potential risks of pathogen transmission between humans and nonhuman primates (referred to as primates from this point forward). Given our phylogenetic relatedness, we are susceptible to many different zoonoses from primates, and primates can be very susceptible to our anthroponoses (reverse zoonoses) (Davies & Pedersen, 2008; Muehlenbein, 2016). We share susceptibility to many pathogens like Ebola virus (Formenty, Boesch, & Wyers, 1999), influenza (Karlsson, Engel, Feeroz, & San, 2012), and tuberculosis (Mycobacterium spp.) (Wolf, Sreevatsan, Travis, Mugisha, & Singer, 2013). This shared susceptibility has been of intense historical interest (Brack, 1987), and documenting these pathogen exchanges is important for predicting outbreaks in human populations as well as the potential negative impacts we can have on many endangered primate populations. For example, wild primates serve as reservoirs for a variety of malaria species that can infect humans (Baird, 2009; Galinski & Barnwell, 2009; Singh et al., 2004), and human tuberculosis (Mycobacterium tuberculosi) and herpes simplex virus can spread rapidly and be deadly in some primate populations (Mätz-Rensing et al., 2015; Schrenzel, Osborn, Shima, Klieforth, & Malalouf, 2003).

PubMed and Google Scholar were recently (November 2016) searched by the author using terms “primate” and “zoonosis” to identify papers reporting suspected and confirmed instances of pathogen transmission between humans and wild populations of primates. Eliminating cases of pathogens exchanged in zoos, sanctuaries, clinics, laboratories, and other facilities, a minimum of sixteen different pathogenic organisms are confirmed (using genetic, serological, and/or microbiological techniques) to have been transmitted from wild primates to humans (M. Muehlenbein, in preparation). These include simian foamy viruses, malaria, immunodeficiency viruses, and T-lymphotropic viruses, among others. Eight pathogenic organisms are confirmed to have been transmitted from humans to wild primates, and many of these have had devastating effects on ape populations, such as human metapneumovirus in gorillas and chimpanzees (Kaur et al., 2008; Palacios et al., 2011). Several of these organisms have been transmitted between the populations on multiple occasions, and many other organisms are suspected to have been transmitted, but lack appropriate laboratory confirmation. The true numbers of zoonoses and anthroponoses involving wild primates are probably much higher.

Arguably the majority of attention on primate-related zoonoses has focused on the acquisition of pathogens via the hunting, preparation, and consumption of wild animals (bushmeat). For many, many people, wild primates are hunted and sold for household income, or consumed as an important source of protein (Covey & McGraw, 2014). Primate bushmeat is often preferred over some other species by different people in different areas (Fa, Juste, Burn, & Broad, 2002). Particularly in West and Central Africa, primate bushmeat has been a source of a number of pathogen outbreaks, including Ebola virus disease (Muyembe-Tamfum et al., 2012). Exposure to primate fluids via hunting and butchering has led to the transmission of T-lymphotropic viruses (Calatini et al., 2006; Calvignac-Spencer et al., 2012; Filipponi et al., 2015; Kazanjii et al., 2015; Vandamme, Salemi, & Desmyter, 1998; Wolfe et al., 2005; Zheng et al., 2010) and simian foamy viruses (Mouinge-Ondé et al., 2010, 2012; Mouinge-Ondé & Kazanjii, 2013; Switzer et al., 2008, 2012; Wolfe, Prosser, et al., 2004; Wolfe, Sreevatsan, et al., 2004). And human immunodeficiency viruses originated from primate bushmeat in West Africa (Ayoub et al., 2013; Gao et al., 1992, 1999; Hirsch, Olmsted, Murphy-Corb, Purcell, & Johnson, 1989; Huet, Cheynier, Meyerhans, Roelants, & Wain-Hobson, 1990; Keele et al., 2006; Plantier et al., 2009; Van Heuverswyn et al., 2006; Yamaguchi, Devare, & Brennan, 2000). In general, markets selling wildlife are particularly prone to facilitating the emergence of zoonotic pathogens (Greatorex et al., 2016), and this infected primate bushmeat is even being shipped worldwide (Smith et al., 2012; Temmam et al., 2016).

2 | BEYOND BUSHMEAT

In addition to consumption and shared (sympatric) habitat overlap, animal exhibitions (including tourism) and companion animals (pets) present complex and abundant opportunities for pathogen transmission. The following review attempts to summarize what is known about the potential of pathogen transmission within these contexts, in particular the human attitudes and behaviors that place ourselves and other species at risk. The desire to tame or control other species appears central to our own species (Shipman, 2010). While there has always been and still remains significant cultural variation in how animals are treated and for what purposes they have been either bred or controlled (Gray & Young, 2011; Hurn, 2012), viewing animals on exhibit has a long history. This includes private animal collections, circuses, animal fighting, baiting, trophy hunting, racing, rodeos, bullfighting, and similar encounters, and of course permanent institutions like zoos and aquariums. Primates play a central role in these facilities and activities. Many people live with wild primates as part of their daily lives. Primates play central roles in a number of religious traditions, most prominent being the Howler Monkey God (Mayan Classic period), Sun Wukong (Chinese mythological Monkey King), Sarutahiko (Shinto monkey-like God of Crossroads), and Lord Hanuman (Hindu god of the epics Ramayana and Mahabharata). Primates represent important commodities in some cultures (Fuentes, 2013), and many of these animals are kept for utilitarian purposes, like pigtailed macaques (Macaca nemestrina) for picking coconuts in Thailand (Sponsel, Ruttanadakul, & Natadecha-Sponsel, 2002). To others of us who do not have primates as part of our daily lives, encounters with them may seem exotic. Primates exhibit social cognitive abilities greater than most other species. As frugivores and folivores (primarily), they seem approachable to us, particularly as they are portrayed in the media as jovial and neotenous. Some people may perceive their risks of injury as relatively low when interacting with non-carnivores; not accounting for contagious illnesses, most injuries are perceived to be minor (e.g., small scratches and bites).

In general, people tend to develop an affinity for cute and furry animals; they fulfill the Japanese cultural concept of “kawaii” (quality of...
cuteness) without requiring much anthropomorphizing. For the most part, primates, particularly young animals, are beautiful creatures that may stimulate the human desire to touch. As a species, we have an innate urge to explore our environment through touch. There are a number of lines of evidence to support such a conclusion, from the roles of grooming and embracing in primates to form and maintain social relationships and coalitionary support, reconciling when disagreements happen, to the pervasiveness of stuffed animals in many cultures, and the almost autonomic urges to touch taxidermy specimens (Milgrom, 2010). It is long known that physical contact is an important part of normal development in many species (Harlow, 1958). Touch is so important that we must put signs throughout zoos and museums (and even on working dogs!) to remind us not to handle the animals or exhibits, and touch even remains an important part of the shopping experience, despite widespread adoption of online purchasing (Peck & Childers, 2003).

Touch certainly preceded language as a form of communication in our own species. We use our skin to express intimate emotional state, and external manifestation of affect dependent upon type, duration, frequency, intensity, and area of touch (Hertenstein, Verkamp, Kerestes, & Holmes, 2006). There is a rich literature on “haptics” (Gibson, 1966), the somatosensory system of identifying and communicating tactile information and the associated physiology of mechanical stimulation and correlated neurological processes (Gordon et al., 2013; Lederman & Klatzky, 2009; Vrontou, Wong, Rau, Koerber, & Anderson, 2013). Touch is used as an important therapeutic intervention to improve a variety of health outcomes (Bush, 2001). Animal-assisted therapy is associated positively with moderate improvements in autism spectrum symptoms (Nimer & Lundahl, 2007) and other behavioral and medical outcomes, including reduced anxiety (Barker & Dawson, 1998). In places where animal presence may be prohibited, like care facilities medical outcomes, including reduced anxiety (Barker & Dawson, 1998).

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There are various benefits to companion animal ownership. For example, pet ownership, particularly that of dogs, is associated with increased physical activity (Cherniack & Cherniack, 2015). As adults, those who experienced responsibility for pets as a child may be primed to express greater concern for wildlife and more compassion for other people as adults (Paul & Serpe, 1993). Having responsibility for a pet as a child even exposes children to the concept of death when the animal perishes (Dupré, 2006). Our desire to care for and support other dependent species is illustrated by examples ranging from the popularity of virtual pet products (e.g., Tamagotchi, Petz, Anipalz, and Nintendogs), to the practice of women of the Yanomami of Venezuela and Brazil, the Huaorani of Ecuador, and the Guajá of Brazil breastfeeding monkeys as surrogate children. Such alloparenting is common and unsurprising since neurologically we are capable of viewing our companion animals like our own children (Stoeckel, Palley, Gollub, Niemi, & Evins, 2014).

Primates are used as companion animals in many places (Malone, Purnama, Wedana, & Fuentes, 2002). Although it is difficult to determine accurately how many primates are kept as pets (Soulsbury, Lossa, Kennell, & Harris, 2009), the practice even in the US is long-running: those who read comic books back in the 1970s might remember seeing advertisements selling squirrel monkeys as affordable companions. Despite the fact that the US has prohibited the import of primates as pets (pursuant to the US Code of Federal Regulations, Title 42, section 71.53) since 1975, eleven states still allow private ownership of primates, including apes, without any permit: Alabama, Kansas, Missouri, Nebraska, Nevada, North Carolina, South Carolina, South Dakota, Virginia, Wisconsin, and Wyoming. The following US allows private ownership of primates with a permit: Idaho, Connecticut (although Great apes are prohibited), Florida (although Great apes and baboons are prohibited), Maine, Michigan, Mississippi, Montana, North Dakota, Oklahoma, Pennsylvania, Rhode Island, and Texas. Despite the

3 | ANIMALS IN THE HOME

When one loves animals and children too much, one loves them against human beings (Sartre, 1981, p. 30)

Worldwide, a majority of people seek companionship with some type of animal in their home (Serpell, 1986), and this began with the domestication of dogs as early as 32,000 years ago (Germonpré et al., 2009). As “pets,” these animals are named, intentionally bred, and usually allowed in the home (yet they are still castrated/neutered and otherwise physically altered). Many of us celebrate their birthdays and take them on vacation with us. The American Pet Products Association recorded more than $60 billion in industry expenditures in 2015, with most on food, supplies, and veterinary care (American Pet Products Association, 2016). Sixty-five percent of US households own a pet, with more than 77 million dogs and 85 million cats (American Pet Products Association, 2016).

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photography sessions often accompany these staged performances under water diving, boxing, dancing, and acrobatics, among others. (Lesser degrees) (Hasan et al., 2016), and some are known famously for home; Schillaci et al., 2005). These performing animals can be found in many places where primates are hunted for food, they are also kept as pets (Mossoun et al., 2015; Wolfe, Prosser, et al., 2004; Wolfe, Sneevesan et al., 2004).

Unfortunately, many people often underestimate the true conservation status of primates, and this seems to be a result due, in part, to the use of these species in movies, commercials, television shows, and online/print media (Ross et al., 2008; Ross, Vreeman & Lonsdorf, 2011; Schroepfer, Rosati, Chartrand, & Hare, 2011). Media portrayal of primates make them seem like suitable pets (Soulsbury et al., 2009), and in less need of financial contributions for conservation (Tisdell, 2006). The reality is that the International Union for Conservation of Nature’s Red List of Threatened Species currently (November 2016) lists 259 species of primates as either critically endangered, endangered, or vulnerable. Of these, 59 are critically endangered. In 2015, the US Fish and Wildlife Service ruled (US Code of Federal Regulations, Title 50, sections 17.11 and 17.40(c)) that all chimpanzees, wild or captive (including animals in zoos and research facilities), are considered endangered in accordance with the Endangered Species Act of 1973.

Ultimately, primates are not suitable as pets. Many of these animals are aggressive toward unfamiliar people (Soulsbury et al., 2009), and children are more likely to be bitten than adults (Ostrowski, Leslie, Parrott, Abelt, & Piercy, 1998). Although the actual number of cases of pathogen transmission from pet primates to owners is unknown, a significant risk of such pathogen transmission likely exists. For example, Klebsiella, hepatitis A, and rabies virus have been transmitted from some New World species (Favorotto, de Mattos, Morais, Alves Araujo, & de Mattos, 2001; Renquist & Whitney, 1987). Pet macaques in the US can harbor Mucacine herpesvirus 1 (Ostrowski et al., 1998), an alpha herpesvirus that can cause fatal meningocencephalitis in humans. Owners can also transmit pathogens, some with fatal consequences, to their pet primates (Huemmer, Larcher, Czedik-Eysenberg, Nowotny, & Reifinger, 2002; Jones-Engel et al., 2001; Pourrut et al., 2011). In general, animal trade for the purpose of exotic pet ownership will continue to facilitate the emergence of infectious diseases (Chomel, Belotto, & Meslin, 2001; Karesh, Cook, Bennett, & Newcomb, 2005).

Other captive primates function as “performance” animals, and occupy a niche somewhere between a personal pet and an exhibit animal (i.e., they interact with audiences but are also often cared for in a home; Schillaci et al., 2005). These performing animals can be found throughout Asia (and parts of Africa and Central and South America to lesser degrees) (Hasan et al., 2016), and some are known famously for Suo-Sarumawashi or “monkey dancing” in Japan (Ohnuki-Tierney, 1987). Staged interactions for monetary contributions may include underwater diving, boxing, dancing, and acrobatics, among others. Photography sessions often accompany these staged performances (Agoramoorthy & Hsu, 2005). These animals have acquired pathogens from humans (Mack & Noble, 1970; Schillaci, Jones-Engel, Engel, & Kyes, 2006), and they do often harbor pathogens that could be transmitted to humans (Schillaci et al., 2005). This is the same case for many animals in zoos and in the wild.

4 | ANIMALS ON EXHIBIT

Fifty-three species of primates are currently on display within most of the two hundred forty-four facilities currently accredited by the Association of Zoos and Aquariums in the US (Association of Zoos and Aquariums, 2016). 183 million people visited these facilities in 2014 (J. Wright, personal communication). Other organizations, such as the Pan-African Association of Zoos and Aquariums, the World Association of Zoos and Aquariums, Canada’s Accredited Zoos and Aquariums, Latin American Zoo and Aquarium Association, European Association of Zoos and Aquarium, Japanese Association of Zoos and Aquariums, and the Zoo and Aquarium Association Australasia, endorse hundreds of facilities worldwide. It is not possible to know precisely how many animal parks are both publically and privately owned. However, it is conservative to conclude that, at a minimum, these places bring together many exotic species, and this can facilitate pathogen exchange, even in the presence of biosecurity measures (Li et al., 2015). Petting zoos can be particularly problematic where children are allowed to feed animals (Bender & Shulman, 2004; Heuvelink et al., 2002). Many zoos and animal sanctuaries and (even theme parks, resorts, and restaurants) outside of the US offer interactive experiences like riding on elephants, playing with big cat cubs, walking hand-reared cheetahs on leashes, and holding and petting primates. These “pay-to-pet” practices arguably promote mixed messages about animal conservation (i.e., that it is acceptable to touch wild animals), as well as provide opportunities for pathogen exchange.

Recreational use of natural areas provides people with opportunities to interact with wildlife they might not normally encounter, and contributes significantly to the economies of biodiversity-rich countries (World Tourism Organization, 2004). International ecotourism is increasingly seen as a mechanism to facilitate species and habitat conservation by increasing public awareness of conservation issues and raising much needed funds (Balmford et al., 2009). These activities should attempt to educate visitors while minimizing modification of natural resources (Ceballos-Lascurain, 1996). However, there are often deleterious effects associated with the rapid, and often unmonitored, development of ecotourism programs. These can range from local pollution and the introduction of invasive species, and the habituation of animals that make them more vulnerable to poaching, to even accidental injuries and death of tourists taking photographs of themselves (Flaherty & Choi, 2016).

Primate-based tourism has a long history (Russon & Wallis, 2014). From the macaques at holy temples in Asia and on the Rock of Gibraltar, baboons at the Cape of Good Hope in South Africa, apes in protected forests of Africa and Southeast Asia, lemurs on Madagascar, and the New World monkeys in Central and South America, to the Yaen-koen monkey parks scattered across Japan, traveling to see wild...
or semi-wild (i.e., animals at rehabilitation centers or sanctuaries) primates continues to be a popular choice for many tourists. Of the more than 23,000 visitors to Volcanoes National Park, Rwanda in 2010, almost 19,000 went gorilla trekking, contributing over $10 million to the local economy (Rwanda Development Board, 2016).

Despite the benefits, there are some costs associated with this nature-based tourism. International tourists exhibit, in general, rather poor knowledge, attitudes, and practices about their health while traveling (Wilder-Smith, Khairullah, Song, Chen, & Torresi, 2004), with low compliance to physician advice (Steffen et al., 2004) and improper use of chemoprophylaxes (Van Herck et al., 2004). Gastrointestinal and respiratory tract infections during travel are very common (Rack et al., 2005), and many people travel without recommended vaccines (Hamer & Connor, 2004). While many choose to ignore the risks of travel, some are simply uninformed or misinformed. Health information is not currently available on commercial travel websites (Horvath, Murray, & DuPont, 2003).

Recently, an online survey of the membership of the International Society of Travel Medicine aimed to assess the types of advice and treatment that travel health professionals provide to patients regarding risks of nature-based tourism. Responses from 311 participants (approximately 12.5% of the membership) reveal that tourists visiting international travel health clinics are not currently being informed adequately about the risks of zoonotic or anthroponotic disease transmission (Muehlenbein & Brink, 2013; M. Muehlenbein & G. Brink, in preparation). Whereas 82% do advise during pretravel consults about limiting contact with wildlife, this is almost exclusively in reference to preventing zoonotic diseases like rabies.

Those visiting wildlife sanctuaries underestimate the risks of becoming infected themselves as well as the contribution they may have to the health of other animals (Muehlenbein & Ancrenaz, 2009). For example, ecotourists concerned about environmental protection, and with recognized travel itineraries to view endangered species, are not adequately protected against many vaccine-preventable diseases (Muehlenbein et al., 2008). They are largely unaware of their true vaccination status, and they underestimate the risks they pose to other species. Furthermore, these same travelers to wildlife sanctuaries are oftentimes ill, showing specific signs and symptoms of infection.

**FIGURE 1** (A) A very happy tourist with a longtailed macaque (*Macaca fasicularis*) at the Sangeh Monkey Forest, Bali, Indonesia. Photograph by M. Muehlenbein. (B) Tourist with longtailed macaque (*M. fasicularis*) at the Ubud Monkey Forest, Bali, Indonesia. Notice the animal’s hands in the tourist’s mouth. Photograph by A. Klegarth. (C) Rather mixed feelings from a tourist with longtailed macaques (*M. fasicularis*) at the Phra Prang Sam Yot temple in Lopburi Province, Thailand. Photograph by A. Klegarth.
(particularly those associated with respiratory diseases that can easily be transmitted) (Muehlenbein et al., 2010).

While visiting these international locations, tourists can be exposed to potential zoonoses through animal bites. Biting is very common in certain places, as in Bali, Indonesia where tourists frequently interact with longtailed macaques (Macaca fascicularis) (Fuentes & Gamerl, 2005). Whereas Gautret et al. (2007) report only 320 cases of monkey-associated injuries (bites and scratches) between 1998 and 2005 to the GeoSentinel global surveillance network, a more recent and detailed analysis reveals 1051 cases of monkey bites of travelers reported between 1995 and 2016 (April) (M. Muehlenbein & M. Mendelson, in preparation). Many of these exposures happen at holy temples and shrines where monkeys are often tolerated as part of various faiths (Figure 1). There are many "monkey temples" found throughout Thailand, Indonesia, India, Nepal, China, and Taiwan. These areas are popular destinations for international tourists where hand feeding free-ranging animals (usually macaques and langurs) by tourists is a common occurrence. Despite advertisements to not feed the animals, as well as possible fines, visitors in Bali and other places frequently have physical contact with the animals, often as the result of local photographers encouraging them to do so (Fuentes et al., 2008). And many of these animals are known to carry Macacine herpesvirus 1, simian virus 40, and simian foamy virus (Engel et al., 2002, 2006; Jones-Engel et al., 2006). The actual number of past pathogen transmission events from wild primates to tourists is presently unknown.

5 | CASE STUDY ON PRIMATE-BASED TOURISM

To understand travelers’ willingness to have contact with primates (wild, semiwild, and captive) and associated disease risks, travel health knowledge, attitudes, and practices (including health status and perceived risks), in addition to environmental values, opinions about eco-tourism and primate conservation, and opinions about potential preventative measures of pathogen transmission, Muehlenbein and team members have completed detailed surveys of adult tourists at four locations (Figure 2). First, 656 visitors were surveyed in May 2009.
at the Sepilok Orangutan Rehabilitation Centre, located 22 km outside of the city of Sandakan in the Malaysian state of Sabah, Northern Borneo. This facility functions as a center for the rehabilitation of orphaned, injured, and confiscated orangutans (*Pongo pygmaeus morio*) and other endangered species. To facilitate public education and generate operational funds, the public is allowed to view two feedings daily of the orangutans and macaques (longtailed and pigtailed; *Macaca fascicularis* and *Macaca nemestrina*). Touching and feeding of animals by the public are not permitted, but both do happen on occasion. Second, 615 visitors were surveyed in May 2012 at the Takasakiyama Monkey Park on Mt. Takasaki, located outside Beppu City in the Oita Prefecture of Kyushu island, southern Japan. Here visitors may view daily feedings of the approximately one thousand free-roaming Japanese macaques (snow monkey; *Macaca fuscata*). Touching and feeding of animals here are not permitted, but both do happen on occasion. Third, 1175 visitors were surveyed in November 2013, March 2014, and May 2015 at the Monkeyland Primate Sanctuary, a private facility operated by the South African Animal Sanctuary Alliance, just outside of Plettenberg Bay, South Africa. This twelve-hectare forest is home to eleven species of free-roaming primates. The facility operates guided tours and does not permit touching or feeding, with these rules enforced strictly. Fourth, 1399 visitors were surveyed in July 2015 and March 2016 on the beaches of Cockleshell Bay and South Friars on the Southeast peninsula of the island of Saint Kitts, Federation of Saint Kitts and Nevis, West Indies. This island is home to approximately 50,000 African green monkeys (vervets; *Chlorocebus aethiops sabaeus*). Touching and feeding these animals are encouraged by locals that solicit tourists for money.

Research protocols were approved by the Institutional Review Boards at University of Wisconsin-Milwaukee, Indiana University-Bloomington, the University of Texas at San Antonio, and Ross University School of Veterinary Medicine. Permissions to conduct research at each location were granted by the Sabah Wildlife Department, the Sepilok Orangutan Rehabilitation Centre, Takasakiyama Monkey Park, Ross University, and the South African Animal Sanctuary Alliance. Initial results presented here (Table 1) are to illustrate differences among respondent groups. It should be noted that the majority of tourists in Saint Kitts were from the US or Europe (and were almost all cruise ship passengers), most in Malaysia and South Africa were European, and nearly all in Japan were Japanese (within-country visitors).

While there is significant variation among respondents at different locations, detailed analyses regarding the impacts of education, environmental attitudes, and other factors on perceived risk are forthcoming. In brief, while a majority of respondents agree that we can give/get diseases to/from wild primates, a surprising percentage would still touch or feed these animals if given the opportunity. Almost half of the respondents in Saint Kitts reported touching a primate, with most of these encounters happening on the island itself during the present visit. Close to one hundred people have been scratched or bitten by a wild primate (not occupationally), and this number does not include the

### Table 1: Case study results from 3845 tourists

<table>
<thead>
<tr>
<th>(a) Attitudes on disease transmission</th>
<th>% that think people can GET diseases from wild primates</th>
<th>% that think people can GIVE diseases to wild primates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>92.4</td>
<td>85.8</td>
</tr>
<tr>
<td>Japan</td>
<td>54.0</td>
<td>53.2</td>
</tr>
<tr>
<td>South Africa</td>
<td>86.2</td>
<td>84.5</td>
</tr>
<tr>
<td>Saint Kitts</td>
<td>87.5</td>
<td>77.7</td>
</tr>
<tr>
<td>(b) Attitudes on touching and owning primates</td>
<td>% that would touch or feed a wild primate in given the chance</td>
<td>% that would own a primate as a pet</td>
</tr>
<tr>
<td>Malaysia</td>
<td>21.8</td>
<td>NA*</td>
</tr>
<tr>
<td>Japan</td>
<td>65.7</td>
<td>23.8</td>
</tr>
<tr>
<td>South Africa</td>
<td>54.8</td>
<td>10.4</td>
</tr>
<tr>
<td>Saint Kitts</td>
<td>56.1</td>
<td>17.7</td>
</tr>
<tr>
<td>(c) Experience with touching or bites/scratches</td>
<td>% that have touched a primate (wild or pet animal)</td>
<td>% that have been bitten or scratched by a primate (not occupationally)</td>
</tr>
<tr>
<td>Malaysia</td>
<td>NA*</td>
<td>NA*</td>
</tr>
<tr>
<td>Japan</td>
<td>17.7</td>
<td>2.5</td>
</tr>
<tr>
<td>South Africa</td>
<td>20.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Saint Kitts</td>
<td>47.6</td>
<td>3.8</td>
</tr>
<tr>
<td>(d) Experience at other locations</td>
<td>% that have visited another destination to specifically view primates</td>
<td>% that were made aware of health regulations at the destination</td>
</tr>
<tr>
<td>Malaysia</td>
<td>47.7</td>
<td>10.7</td>
</tr>
<tr>
<td>Japan</td>
<td>NA*</td>
<td>NA*</td>
</tr>
<tr>
<td>South Africa</td>
<td>31.1</td>
<td>29.4</td>
</tr>
<tr>
<td>Saint Kitts</td>
<td>10.8</td>
<td>17</td>
</tr>
</tbody>
</table>

*NA*: data not available because question was not asked on that version of the survey.
cohort of visitors to Malaysia. Perceived risk of disease transmission appears to be lower in the Japanese cohort, and a higher percentage of Japanese respondents report willingness to own a primate as a pet. There is significant variation in motivation to travel to primate-tourism destinations: many respondents in Malaysia would self-classify as “eco-tourists” traveling to specifically view wildlife, whereas almost all respondents in Saint Kitts were cruise ship passengers with much less interest in wildlife.

An additional interesting result follows from an additional survey collected in 2015 in Monkeyland, South Africa. 258 visitors completed an entrance survey into the facility, were then provided with a standardized, short conservation message (prior to their guided tour) about why contact with wild primates can compromise their health and safety, and then asked to complete an exit survey that asked questions identical to the entrance version. After their tour, respondents reported being more likely to believe that humans can give diseases to wild primates (generalized linear model: $z = 3.79, p = 0.00$) and were less likely to report wanting to touch or feed a wild primate ($z = 5.745, p = 0.00$) or own one as a pet ($z = 2.34, p = 0.02$). Remaining analyses for this and the other three locations are pending (Muehlenbein et al., in preparation).

6 | SUSTAINABLE RELATIONSHIPS

We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect (Leopold, 1949, p. viii)

Researchers have already characterized the risks of human–wildlife interactions and have provided detailed recommendations on how to minimize these risks, primarily through physical and behavioral barriers between ourselves and other species (Gilardi et al., 2015; Homsy, 1999; Macfe & Williamson, 2010; Muehlenbein & Wallis, 2014). Anthropologists are well suited to investigate cultural variation in motivations for engaging in contact with other species, primates in particular. Risks of pathogen exchange will vary by the contexts of these interactions, and we must continue to work to understand variation in risk perception associated with these different activities. Risk will remain from use of wild animal products until alternative protein sources are identified and accepted. Private ownership of primates and direct physical touch of wild primates must be discouraged. Unfortunately, humans often choose to participate in self-destructive behaviors if they believe they are pursuing a positive goal (Baumeister & Scher, 1988). This will be particularly the case if they believe the benefits to be large. For many, the drive to bond with animals, seeking a probable friendly encounter, a deeply personal and profound experience (Rose, 2011), can outweigh some basic health behaviors. Is it better for you to post a picture holding a monkey on social media, or to write that you saw one while on vacation? Which post will get the most ‘likes?’

Ignorance over the risks of wildlife contact cannot fully explain peoples’ continued desires to interact with primates. These desires to emotionally and physically engage with other species will continue to put themselves and members of other species at risk. These risks are of course context-dependent, just as are peoples’ attitudes toward the environment and other biota (see the value-based theory for environment concern: Stern & Dietz, 1994). In general, those expressing a kinship for or community with nature (the Connectedness to Nature Scale: Mayer & Frantz, 2004) should be less likely to harm it, and those who truly value their place in the biosphere (Schultz & Zelezny, 1999) should also respect the physical space of other animals. These attitudes must be cultivated for nature-based tourism to continue to exist. Risk communication must be customized and contextualized to different parties of interest if we are to minimize or prevent primate-based zoonoses and anthroponoses by understanding how and why different people are willing to engage in different emotional and physical interactions with these animals.

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