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Human-wildlife interactions in a major tourist destination: Manuel Antonio National Park, Costa Rica

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Abstract. *Porras-Murillo LP, Wong G, Chacón IS. 2022. Human-wildlife interactions in a major tourist destination: Manuel Antonio National Park, Costa Rica. Biodiversitas 23: 2417-2425.* This study characterized the interactions between tourists and wildlife in terms of the most common interactions and the species that interact the most. Interactions were observed during 65 sampling days between 2012 and 2020. In each event, the following data were recorded: date, time (hour), site, type of interaction, and species that participated. To characterize the interactions, the effects of the day of the week, the season, the daily period, and the site on the number of daily interactions were evaluated. Also, to understand the more frequent interactions, the effect of species and type of interaction on the number of daily interactions were evaluated. The results indicated more interactions in the dry season, between 10 am and 2 pm, at Manuel Antonio Beach, Costa Rica. Although interactions were recorded for 39 species, white-faced monkey and raccoon were the species with the most interactions. Raccoons had more interactions related to food than the tourists called or approached them; white-faced monkeys had a similar number of interactions in these categories. Interactions between tourists and wildlife in the Manuel Antonio National Park (PNMA), Costa Rica, coincide with the times and places in the park with the highest concentration of tourists. Therefore, there is evidence of the need to promote tourism with appropriate behavior of observation and respectful appreciation of wildlife, and the use of more sectors of the park is essential to avoid damage to fauna.

Keywords: *Cebus imitator*, conservation, feeding, *Procyon lotor*, protected area, raccoon, white-faced monkey

INTRODUCTION

Multiple social and ecological factors contribute to humans and wildlife interacting with each other (Higham and Bejder 2008; Lischka et al. 2018; Qomariah et al. 2019). One of these factors is the popularity of wildlife observation tourism in natural conditions (Higham and Bejder 2008; Ranaweerage et al. 2015). According to Reynolds and Braithwaite (2001) and Farber and Hall (2007), tourists feel more satisfied when they have greater control and closer contact with wildlife. Therefore, protected areas with high tourist visitation are ideal places to assess the possible effects of interactions between tourists and wildlife (Ranaweerage et al. 2015). This acquires special relevance in a global context, where most attractive species to tourism are usually threatened or in danger of extinction (Constantine et al. 2004: Dyck and Baydack 2004; Blanc et al. 2006).

The main problem of tourism in protected areas is overcrowding of people in areas of interest, which can generate stress on animals (Zal and Breda 2010). Some tourists are shocked at seeing a wild animal, which can cause them to get closer, generate loud noises, and even chase it (Dubois and Fraser 2013). Disturbances caused by tourism can generate immediate changes in the behavior of wildlife, with medium and long-term effects such as: increasing the aggressiveness of the animals, altering their activity and feeding patterns (Ferrera 2016), or even causing changes in their distribution and abundance (Knight and Cole 1995; Ranaweerage et al. 2015). Wild animals habituated to the presence of humans also can be vectors of diseases (Hall 2000; Crofoot et al. 2009; Muehlenbein et al. 2010).

In Costa Rica, the Manuel Antonio National Park (PNMA) has experienced rapid growth in annual tourist visitation, from approximately 25,000 tourists in 1982 (Wong and Carrillo 1996) to 524,835 tourists in 2018 (SINAC 2019). Visitation easily exceeds 1,000 people per day and sometimes until 3,000 on the weekends and holidays (Littlejohn 2018). Some studies have determined that this tourist visitation in PNMA has generated negative effects on the wildlife (Carrillo 1990; Hall 2000; Kauffman 2014; Ferrera 2016) for example, the presence of foods brought by tourists in the diet of the white-faced monkey (*Cebus imitator* Thomas, 1903) (Hall 2000; Kauffman 2014), and the raccoon (*Procyon lotor* Linnaeus, 1758) (Carrillo 1990; Ferrera 2016).

Wild animals that eat food from artificial sources are more susceptible to becoming dependent on these sources, becoming habituated to humans, reducing their range of action, suffering from malnutrition, and having a higher parasite load (Oramns 2002; Dubois and Fraser 2013). For example, for white-faced monkeys in the PNMA, 46% of their diet consists of food from tourists (Kauffman 2014), and their range of action has been compressed to the areas with the highest tourist presence (Rodrigues 2013; Ferrera 2016). Although feeding wildlife in PNMA was prohibited

by law in 1992 (Wildlife Conservation Law No. 7317), the problem continues (Kauffman 2014; Ferrera 2016).

Raccoons of PNMA have decreased their range of activities within the park between 1990 and 2016 (Carrillo 1990; Ferrera 2016) and mostly gather in the areas most used by the tourists (Ferrera 2016). A change in the raccoon activity pattern has been identified, from a twilight behavior (Carrillo 1990) to a diurnal, with activity peaks in the hours of the greatest tourist presence (Ferrera 2016). Monkeys and raccoons in PNMA are habituated to the presence of visitors that they often steal food from tourists and have even learned to open tourists' bags and backpacks in search of food (Rodrigues 2013; Ferrera 2016; Littlejohn 2018). The interactions between tourists and wildlife have led to aggressive behaviors of monkeys and raccoons towards humans and vice versa (Hall 2000; Rodrigues 2013; Kauffman 2014; Ferrera 2016).

Interactions between tourists and wildlife are recognized for their complexity (Higham and Bejder 2008), so characterizing them is crucial for protected areas managers to have tools that help them better manage their visitors (Zal and Breda 2010). This study describes the interactions between tourists and wildlife in PNMA and identifies the types of interactions that occur most frequently, the species that interact the most, and whether the different types of interactions are related to a particular species or not. It is hoped that this study will serve to illustrate the problems that tourist visitation can generate excessively in a protected area and provide recommendations that serve both the PNMA and other protected areas with similar situations.

MATERIALS AND METHODS

Study area

Manuel Antonio National Park is a protected area located on the Central Pacific coast of Costa Rica (Figure 1). The park was established on November 15, 1972 (Boza 1992) and is located 7 km southeast of the city of Quepos, in the province of Puntarenas. It protects 1,983 ha of forest area dominated by humid tropical forest and an additional 55,000 ha of marine extension (Broadbent et al. 2012). The average annual rainfall is 3,820 mm, the rainiest months are from June to November, and the driest months are from December to May (Kauffman 2014). The park consists mostly of secondary forests in different stages of succession (Kauffman 2014). Among other reasons, PNMA is important because it is the only protected area in the country that protects the natural habitats of the critically endangered subspecies of squirrel monkeys (*Saimiri oerstedii citrinellus* Thomas, 1904) (Boinski and Sirot 1997).

Despite being the smallest national park in Costa Rica, it is the one that attracts the most tourists (Kauffman 2014; SINAC 2019). From December to March and in July, the PNMA receives more than 40,000 tourists per month, while between April and June, then between August and November, the visitation does not exceed that number (Ferrera 2016). The park has a system of trails that stretch through the rainforest to several white-sand beaches. Until September 2021, it was open to the public from 07:00 to 16:00 from Tuesday to Sunday.

One of the park's greatest attractions is the ease with which you can observe wildlife species, particularly monkeys (Primates) and sloths (Pilosa). Manuel Antonio Beach is the main tourist destination within the park and is the place where people can eat their food due to the presence of picnic tables (Kauffman 2014; Ferrera 2016).

Data collection

Interactions between tourists and wildlife

Interactions between tourists and wildlife were observed in April 2012; June and December 2015; February, June, July, and August 2016; September 2017; June, July, November, and December 2018; April, June, September, and November 2019; and January 2020. The data were taken in periods of 2 to 3 consecutive days, in at least two moments each of the dry season and the rainy season. Surveys were made along all the tourist trails and beaches of the PNMA (Figure 1), between 07:00 and 16:00 hours (hours the park is open). During the surveys, each observed interaction was recorded. In the points with a higher concentration of tourists, the observation time was prolonged to maximize the registration of interactions. During each observation, the following data were recorded: the site, the time (hour), the date, the type of interaction, and the species that participated in the interaction.

For this study, a tourist is anyone who does not work at PNMA, including national and foreign visitors and tour guides. Three types of interactions, and several subtypes, were defined for this study: feeding (direct, indirect, dubious, theft, attempt, looting of a garbage dump), approach (photography, harassment, aggression to human, aggression to the physical animal contact), and calling (calling, predator vocalization). Types and subtypes are described in Table 1.

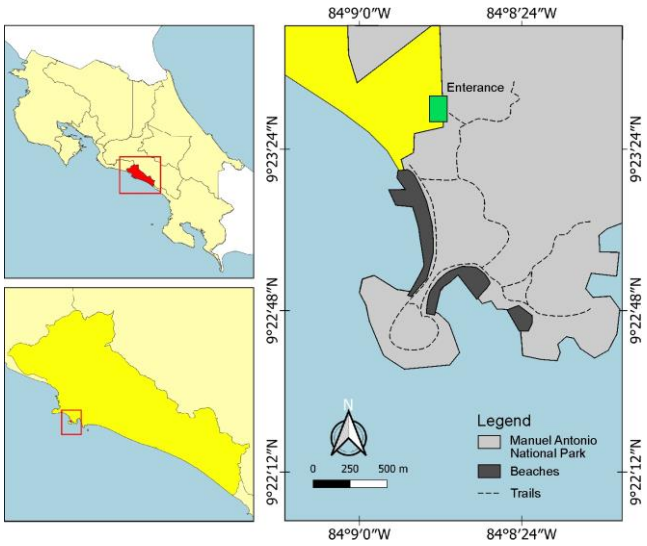

Figure 1. Location of the beaches and trails of the Manuel Antonio National Park, Puntarenas, Costa Rica

Data analysis

To analyze the interactions, the number of daily interactions was used as the response variable and as explanatory variables, i.e., day of the week (Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday), season (dry, rainy), time (morning from 07:00 to 10:00 hours, noon from 10:00 to 14:00 hours, afternoon from 14:00 to 16:00 hours), and site (trails, Espadilla Beach, Manuel Antonio beach and Gemelas beach; Figure 1). The dry season includes the months with less rainfall, from December to April and July. These are the best months to visit the park and coincide with the school vacation periods in the country.

The analysis was done using generalized linear models (GLM), designing five a priori models, one for each explanatory variable and a general model. Negative binomial distribution was used for the dependent variable (number of daily interactions). The models were compared using the corrected Akaike Information Criterion (AICc) (Burnham and Anderson 2002). After selecting the model that best fit the data, the statistical significance of each variable and its effect on the number of daily interactions were evaluated.

To identify the types of interactions that occur most frequently, and if any type is more associated with any species, only the two species with the highest number of interactions with tourists were considered, i.e., the white-faced monkey (*C. imitator*) and the raccoon (*P. lotor*). The effect of the explanatory variables (species and type of interaction) on the number of daily interactions was evaluated. The same GLM analysis described above was done, including a model to determine if there is a relationship between the species and the type of interaction. All statistical analyzes were done in R 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS AND DISCUSSION

Data were collected during a total of 65 days, 35 correspond to the dry season and 30 to the rainy season. During the study period, 2,895 registered interactions. Thirteen subtypes of interactions related to three main types of interactions were identified, i.e., feeding, approaching, and calling (Table 1). During the study, tourists interacted less than 40 times with 37 species of wildlife, 1,572 and 521 times with white-faced monkeys and raccoons, respectively for this reason, some analyzes were made for these two species.

The model involving all the predictor variables, i.e., day, season, time, and place, explained the best number of daily interactions (ΔAICc = 0, AICw = 1; Table 2). The model's coefficients indicated that, on Tuesdays, Thursdays, Fridays, and Saturdays, there were respectively 59%, 35%, 41%, and 39% more daily interactions than on Sundays and Wednesdays (Table 3, Figure 3). There were 47% more daily interactions in the dry season than in the rainy season (Table 3, Figure 3). There were 62% more daily interactions at noon than in the morning (Table 3, Figure 3). In Playa Manuel Antonio, there were 58% more daily interactions (Table 3, Figure 3).

The average daily interactions related to food were decreasing from 32.3 in 2012 (95% CI = 19.7 to 45.0, n = 3), to 15.5 in 2016 (95% CI = 5.2 to 25.8, n = 17), 17.7 in 2018 (95% CI = 11.7 to 23.8, n = 27), to 13 in 2020 (95% CI = 3.9 to 13.3, n = 3) (Figure 2).

Interactions related to approach and call were higher in 2012 compared to subsequent years, with an average of 19.7 (95% CI = 9.10 to 30.2, n = 3) and 35.5 (95% CI = 22.6 to 48.4, n = 3) respectively. The average of interactions related to contact in all the years was less than 15 and the average of interactions related to calls in all the years was less than 19 daily interactions (Figure 2).

The model that included the predictor variables, i.e., species and type of interaction (ΔAICc = 0, AICw = 0.37; Table 4), better explained the number of daily interactions between tourists and white-faced monkeys and raccoons. The variables species and type of interaction significantly affect the number of daily interactions in models 1 and 2 (Table 5). In model 2, the interaction between the variables species and type of interaction is marginally significant (Table 5), which suggests that the effect of one variable depends on the value of the other variable.

Table 1. Classification of interactions between tourists and wildlife in Manuel Antonio National Park, Costa Rica (2012-2020)

Type	Subtype	Description
Feeding (animals can access or try to access tourists' foods)	Direct	The tourists offer food from their hands to the animals
	Indirect	The tourists leave food in a place visible to the animals
	Dubious	The animals have food of tourist's origin, but it is not known how they got it
	Theft	Animals snatch food from tourists
	Attempt	Animals attempt to snatch food from tourists
	Looting of a garbage dump	Animals look for food in garbage dumps
Approach (tourists approach the animal)	Photography	With flash or selfie
	Harassment	A crowd gathers around the animals, or tourists chase the animals
	Aggression to human	Animals attack tourists
	Aggression to the animal	The tourists assault the animals
	Physical contact	The tourists touch the animals
Calling (Tourists make sounds to attract the animal's attention)	Calling	The tourists make sounds to attract the animals
	Predator vocalization	The tourists imitate a predator to attract the attention of the animal

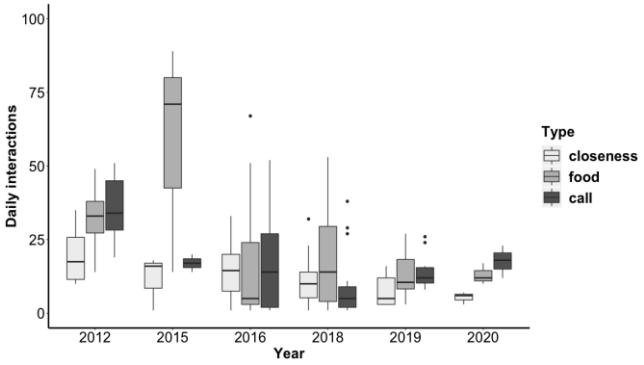

Figure 2. According to the year, mean numbers of daily interactions between tourists and wildlife; Manuel Antonio National Park, Costa Rica, 2012, 2015 to 2020. Box plots show median, 25th percentile (Q1), 75th percentile (Q3), interquartile range (IQR), maximum (Q3 + 1.5*IQR), minimum (Q1 + 1.5*IQR), and possible outliers

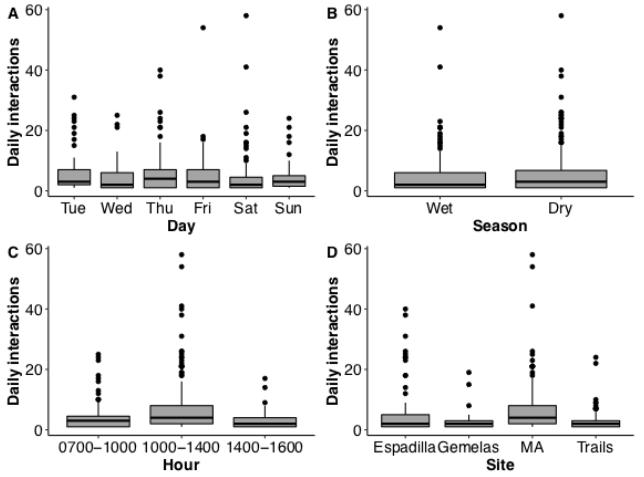

Figure 3. Mean numbers of daily interactions between tourists and wildlife, according to: A. the day of the week, B. the season, C. the daily period, and D. the site; Manuel Antonio National Park, Costa Rica, 2012 to 2020. Box plots show median, 25th percentile (Q1), 75th percentile (Q3), interquartile range (IQR), maximum (Q3 + 1.5*IQR), minimum (Q1 + 1.5*IQR), and possible outliers

The coefficients of model 1 indicated 52% more daily interactions between tourists and white-faced monkeys (*C. imitator*) than between tourists and raccoons (*P. lotor*). Also, the coefficients of model 1 indicated that for both species there were 100% more daily interactions related to food than approach (Table 5, Figure 4). The coefficients of model 2 indicated that, for raccoons, it is expected that there will be more daily interactions related to food than to call and approach, but for white-faced monkeys, it is expected that there will be a similar number of daily interactions of the three types (Table 5, Figure 4).

Table 2. Negative binomial regression models predicting the number of interactions between tourists and wildlife according to different predictor variables, at Manuel Antonio National Park, Costa Rica, 2012 to 2020

Model structure	Number of parameters	ΔAIC_c[a]	AIC_{cw}[b]
Day + season + hour + site	13	0	1
Day	7	107	<0.001
Season	3	108	<0.001
Hour	4	54	<0.001
Site	5	61	<0.001

Note: [a]Difference between model's Akaike's Information Criterion (small samples correction) and the lowest AICc value, [b]AICc relative weight attributed to model

Table 4. Negative binomial regression models that take different variables into account for predicting the number of interactions between tourists and *Cebus imitator* or *Procyon lotor* at Manuel Antonio National Park, Costa Rica, 2012 to 2020

Model structure	Number of parameters	ΔAIC_c[a]	AIC_{cw}[b]
Type + Spp	5	0	0.33
Type + Spp + Type*Spp	7	0.3	0.34
Spp	3	21	<0.001
Type	4	26	<0.001

Table 3. Estimated parameter for the most parsimonious model explaining the number of interactions between tourists and wildlife in Manuel Antonio National Park, Costa Rica, 2012 to 2020. Estimated factor variables are shown along with their standard errors (SE), odds ratio, Z value, and *P* values

Parameter	Estimate	(SE)	Odds ratio	Z	P
Intercept	0.78	0.16	2.19	4.89	≤ 0.001
Day (Thursday)	0.30	0.14	1.35	2.17	0.03
Day (Tuesday)	0.47	0.15	1.59	3.12	≤ 0.001
Day (Wednesday)	0.21	0.15	1.22	1.36	0.18
Day (Saturday)	0.33	0.15	1.39	2.16	0.03
Day (Fryday)	0.34	0.16	1.41	2.18	0.03
Season (Dry)	0.38	0.09	1.47	4.27	≤ 0.001
Time (Noon)	0.48	0.10	1.62	5.03	≤ 0.001
Time (Afternoon)	-0.35	0.13	-0.71	-2.69	0.007
Site (Gemelas Beach)	-0.34	0.24	-0.71	-1.39	0.16
Site(MA Beach)	0.44	0.11	1.56	4.23	≤ 0.001
Site (Trails)	-0.40	0.12	-0.67	-3.21	≤ 0.001

Table 5. Estimated parameters for the most parsimonious model explaining the number of interactions between *Cebus imitator* or *Procyon lotor* with tourists at Manuel Antonio National Park, Costa Rica, 2012 to 2020. Estimated factor variables are shown along with their standard errors (SE), odds ratio, Z value, and *P* values

Parameter	Estimate (SE)	Odds ratio (95% CI)	Z	P
Type + Spp				
Intercept	2.07 (0.12)	7.96 (6.40-9.99)	17.99	≤ 0.001
Type (food)	0.73 (0.14)	2.08 (1.56-2.76)	5.06	≤ 0.001
Type (call)	0.25 (0.15)	1.28 (0.94-1.73)	1.61	0.11
Spp (*P. lotor*)	-0.70 (0.13)	0.49 (0.38-0.64)	-5.61	≤ 0.001
Type + Spp + Type*Spp				
Intercept	2.14 (0.13)	8.50 (6.65-11.03)	16.62	≤ 0.001
Type (food)	0.53 (0.18)	1.70 (1.20-2.41)	2.99	≤ 0.001
Type (call)	0.24 (0.18)	1.28 (0.89-1.82)	1.36	0.17
Spp (*P. lotor*)	-0.93 (0.24)	0.39 (0.25-0.63)	-3.96	≤ 0.001
Type (food): spp (*P. lotor*)	0.52 (0.30)	1.68 (1.67-3.03)	1.71	0.08
Type (call): spp (*P. lotor*)	-0.02 (0.34)	0.93 (0.51-1.91)	-0.05	0.96

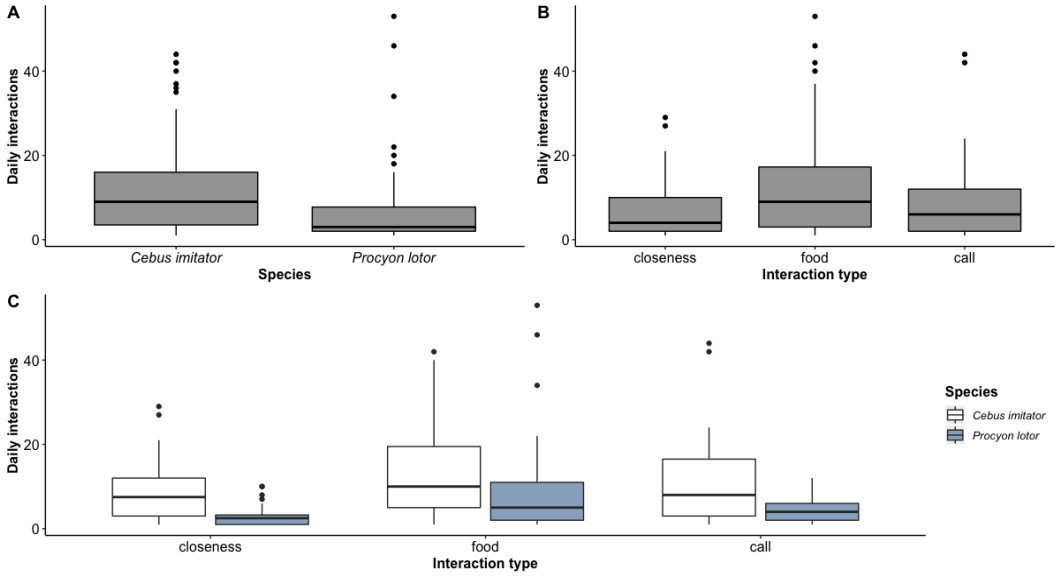

Figure 4. Mean numbers of daily interactions between tourists and wildlife, according to the species and the type of interaction, Manuel Antonio National Park, Costa Rica, 2015 to 2020. Box plots show median, 25th percentile (Q1), 75th percentile (Q3), interquartile range (IQR), maximum (Q3 + 1.5*IQR), minimum (Q1 + 1.5*IQR), and possible outliers

Discussion

The site with the highest number of interactions in the PNMA was Playa Manuel Antonio. This is the area with the highest tourist influx in the park, where tables are placed to facilitate the tourists eating meals (Ferrera 2016). There is evidence indicating that tourists favor the spatial pattern of interactions, animals arrive where tourists come since they get food from visitors, and wild animals tend to visit more areas with greater tourist activity (Oramns 2002). From Tuesday to Sunday, the White-faced monkey troops have reduced their range of action to the areas around Manuel Antonio Beach, while on Mondays (a day without a tourist visit), they use the forest areas (Rodrigues 2013). The area of action of raccoons is located between Playa Manuel Antonio and Playa Espadilla Sur, in response to the spatial congregation of tourists with food in these areas (Ferrera 2016).

Even though the PNMA has made several attempts to dilute tourism to other park areas (by creating new trails through the forest and mangroves), most tourists who enter this protected area are more interested in the beaches than in the forest (Koens et al. 2009). The tourist guides also influence this because they begin the tours at the park entrance, follow the path that leads to Playa Manuel Antonio in search of sloths and monkeys, and end up at the beach for tourists to spend their free time.

In this study, Tuesdays, Fridays, Saturdays, and Thursdays respectively, were the days with the highest number of interactions. This may be related to the absence of visitors on Mondays, limiting access to food provided by tourists. We observed animals accustomed to receiving food from external sources, and it has been shown that animals can experience stress when these foods are not available (Oramns 2002), leading them to seek more food

from tourists before and after Mondays. However, during this study it was observed that both, monkeys and raccoons, do not approach the park's beaches on Mondays, they remain within the forest where there are available natural foods (personal observation), which may indicate that, although they are habituated to being fed by tourists, they still maintain their innate ability to forage for natural food.

The relationship between the number of visitors and the number of interactions may not be as obvious as expected, this and other studies showed that the number of visitors is not the only factor that encourages interactions, but also the massive concentration of tourists in specific areas of the PNMA (Rodrigues 2013; Ferrera 2016). A previous study revealed that more tourist visits were recorded on Saturdays and Sundays (Rodrigues 2013); however, in recent years the PNMA receives more foreign tourists than nationals (SINAC 2019), who have the flexibility to visit the park any day of the week. In the Curú Wildlife Refuge, in the North Pacific of Costa Rica, a positive correlation was reported between the number of tourists and the number of interactions, and between the tourists and the howler monkeys (*Allouata palliata* Gray, 1849), while for the white-faced monkeys there was no correlation since this species tends to take advantage of any opportunity to interact if there is the possibility of a reward (Mckinney 2014).

The white-faced monkey was the most interactive species with the tourists. These monkeys have a boisterous and playful demeanor that makes them very attractive to tourists and this can lead to a greater number of interactions (Mckinney 2014). Raccoons are common animals in urban environments (Demeny et al. 2019), so they can be less interesting to tourists. There is evidence to suggest that humans prefer animals that they perceive as intelligent, funny, and with a similar appearance or behavior (Woods 2000), but raccoons have specific characteristics such as their soft, furry appearance that make them conspicuous to humans (Woods 2000).

Most interactions in PNMA occurred with white-faced monkeys and raccoons, like in other Latin American countries, where tourists tend to have more close interactions with wild mammals than with other vertebrates or species from other taxonomic groups (D'Cruze 2018). Although from a conservation perspective, the white-faced monkey and the raccoon are classified as Least Concern species (IUCN 2020), this coincides with the status of the species in which tourists tend to interact, due to their abundance in nature, it makes them easy to see (D'Cruze 2018). Although it is difficult to quantify negative interaction between tourists and wild animals, the results of previous studies estimated that 50-60% of tourist attractions that involve interactions with wildlife may harm the well-being of individuals and the conservation status of the species (Moorhouse et al. 2015). Likewise, more than 60% of tourists who make their tourism activities in places where it is possible to interact with wildlife are detrimental to the species involved (Moorhouse et al. 2015).

In PNMA, the most frequent interactions, especially with white-faced monkeys and raccoons, were related to food. However, feeding wildlife is an activity that has been increasing in recent years, occurring around the world (Newsome and Rodger 2008) because of a growing interest of people to be in close contact with animals in wild areas (Newsome et al. 2005). For this reason, reports of this study in protected areas of Costa Rica have become more common, both in the PNMA and in other protected areas around the globe, for example, in the Curú Wildlife Refuge, where the interaction occurs between tourists and white-faced monkeys (Mckinney 2014), and in the Cahuita National Park (pers. obs.), while in the Irazú Volcano and Poás Volcano national parks, interactions occur between tourists and coatis (*Nasua narica*, pers. obs.).

In the case of PNMA, animals fail to obtain food from tourists in all interactions, sometimes only one attempt to steal food occurs. Also, this situation may cause other interactions between tourists and animals, for example, physical attacks. During the development of this study, it was possible to observe physical aggression by tourists towards fauna and vice versa. It is common for raccoons and white-faced monkeys to approach tourists in search of food, usually, the reaction of the tourist is fear, which can lead to an aggressive reaction on the side of the animal. Monkeys and raccoons were also observed trying to bite tourists as a defensive reaction to the tourists' attacks. Similar behaviors have also been reported in other studies (Hall 2000; Rodrigues 2013; Kauffman 2014; Ferrera 2016).

Aggressive interactions related to food can be dangerous for both wildlife and tourists, there is a risk of disease transmission from humans to animals or vice versa (Newsome and Rodger 2008; Carne et al. 2017). In Morocco, it has been observed that the probability of fluid exchange between macaques (*Macaca sylvanus*) and humans. This risk increases when tourists offer food to animals, or during aggressive interactions, especially when physical contact occurs (Carne et al. 2017).

Most tourists are aware that feeding wildlife is wrong (Kauffman 2014; Mckinney 2014), and that it is prohibited in the PNMA (Littlejohn 2018). Still, tourists were observed directly offering food to animals on 99 occasions, including in the most recent years (2019, 2020). Visitors have various motivations and ethical reasons for feeding wildlife, including the benefit that is believed to be being made to wildlife by supporting their conservation, and counteracting human actions such as habitat destruction (Howard and Jones 2004). They also gain personal benefits from feeding wildlife, such as the pleasure of being in nature, feeling useful, entertained, and photographing animals (Jones 2011; Horn and Johansen 2013).

Human-wildlife interactions may seem like an innocent practice, which brings some satisfaction to some tourists (Newsome and Rodger 2008). However, these interactions are not allowed due to serious unintended and cumulative consequences (Carne et al. 2017), such as inadequate food for fauna, the concentration of individuals in a certain site, contamination, risk of fauna attack on humans and among fauna, and the risk of disease transmission (Newsome and Rodger 2008).

Wildlife feeding can affect both individuals and populations (Dubois and Fraser 2013). At the individual level, there may be a behavioral alteration, physiological changes, and even death, while at the population level it can affect distribution and abundance (Newsome and Rodger 2008). For example, a single event of direct feeding towards a monkey can negatively affect several individuals since this type of interaction attracts the attention of other troop members, and the stolen or supplied food tends to spread rapidly throughout the social group (Kauffman 2014). Another consequence is the perception that is generated in humans around wildlife, for example, in PNMA, 16% of tourists have a negative view of white-faced monkeys since they consider white-faced monkeys as aggressive animals (Kauffman 2014). This aggression and social stress are being caused by feeding (Lott 1996), as the case of the Amazon River dolphin (*Inia geoffrensis* Blainville, 1817), it became accustomed to receiving food from visitors, so the species has become more aggressive towards people and towards other individuals within the same species (De Sá Alves et al. 2011). Changes have also been reported in the abundance of populations, in their behavior and distribution, because of the intentional feeding of wild fauna (Clua et al. 2010; Corcoran et al. 2013; Ferrera 2016). Many of the interactions between wildlife and humans, and the conflict that may occur, are a consequence of tourists offering food to the animals (Carne et al. 2017).

Contrary to expectations, the restriction on food entry into PNMA that began in April 2015, did not result in a decrease in food-related interactions in the first months after it came into effect since 2015, it was the year with the highest number of daily interactions related to food. In 2016, a reduction in the number of daily interactions related to food was noted. Although there is not enough data from years before the year of restriction, it is known that the number of tourists year after year has been increasing, so it could be predicted that without any control of the number of daily interactions related to food, it would have continued to increase. There is not enough evidence to attribute the decrease in food-related interactions since 2016, but the restriction may apply as one of the reasons why interactions have been decreasing. This is consistent with the results of other studies that suggest food entering the PNMA has effects on the number of interactions that occur with white-faced monkeys and raccoons (Kauffman 2014; Ferrera 2016). Although there is a restriction, the availability and easy access that wildlife may eat food brought by the tourists continues to be one of the fundamental factors that favor negative interactions for wildlife.

In the PNMA, there were interactions at any time, but a combination of variables favors an increase, i.e., dry season, hours between 10:00 and 14:00, and Manuel Antonio Beach. Every day of the week was conducive to a significant number of interactions (30 or more) occurring in PNMA, showing that management measures to mitigate interactions should be active every day of the week. For example, having enough rangers to monitor the tourists every day of the week, since on some days the park only has three or four officials (an insufficient number to attend the entrance booth, security tasks, and other needs of a protected area). Mass tourism generates negative effects on the environment (Koens et al. 2009). The results of this and other studies showed that tourism had had a series of negative consequences for the fauna of the PNMA, especially for white-faced monkeys and raccoons (Rodrigues 2013; Ferrera 2016). In addition to the aggressive interactions reported here, both species have changed their diet, activity patterns, and ranges of motion to allow them to take advantage of the food brought by the tourists (Kauffman 2014; Ferrera 2016).

Tourism in protected wild areas is a very important activity at an economic level, but it has received little attention to the problems that may occur (Koens et al. 2009). The park managers must consider the impacts generated by tourism activities, in the case of tourism-related to wildlife, it is obvious that there are certain risks (Oramns 2002). The allowed activities for tourists in the protected areas must be evaluated with absolute care and under the obligation to attend and minimize the negative impacts they may generate (Oramns 2002). The reality is that many tourists seek a close interaction with animals and want to get a good picture of that interaction, but there are also tourists demanding authentic experiences that are part of sustainable and responsible tourism with wildlife (Newsomey and Rodger 2008).

It is necessary to incorporate, into education campaigns related to animal welfare, the negative effects that tourism can have on protected wild areas (Cox and Gaston 2018), and the importance of maintaining a safe distance from wildlife (Carne et al. 2017), to promote tourism that follows an appropriate behavior of observation and respectful appreciation of wildlife is strongly encouraged.

The main cause of negative interactions between wildlife and tourists in the PNMA is the food that the tourists bring, so management measures should be aimed at changing the amount and types of food that enter the park, the behavior of tourists, and the disposal of solid waste. Regarding the last point, the ideal plan can encourage all tourists to take the garbage generated during their stay in the park.

Many interactions between tourists and wildlife in the dry season suggest that tourist management and carrying capacity of the park should be improved, in addition to promoting the use of all trails throughout the day, to avoid saturation in the trail's sites where more interactions take place since animals are attracted to places where visitors gather with their food (Newsome et al. 2005).

A long-term study is required, with a greater monitoring effort to collect more data from concluding that the registered trends correspond to reality.

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