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Original research article

Tourism-induced disturbance of wildlife in protected areas: A case study of free ranging elephants in Sri Lanka

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ABSTRACT

Tourism-induced disturbance is a growing concern in wildlife conservation worldwide. This case study in a key protected area in Sri Lanka, examined the behavioral changes of Asian elephants in the context of elephant watching tourism activities. Observations of different age–sex-group classes of elephants were conducted focusing on the feeding activity of elephants in the presence vs. absence of tourists. Frequency and duration of alert, fear, stress and aggressive behaviors of elephants were significantly high in the presence of tourists and these behaviors occurred at a cost of feeding time. Tourist behavior, vehicle noise, close distances and time of the tours were closely associated with the behavioral changes of elephants. It is important to monitor tourism effects on endangered species such as Asian elephants and to take proper measures including controlled tourist behavior and vehicle activity in protected areas in order to reduce disturbance of wildlife behavior.
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1. Introduction

Protected areas are attractive settings and resources for wildlife-based tourism. However, the relationship of wildlife-based tourism to conservation has not always been a positive one and there are increasing concerns about the environmental sustainability of tourism in protected areas. Target species for wildlife-based tourism happen to be the most threatened or endangered species in many countries (Green and Higginbottom, 2001; Eagles et al., 2001; Wight, 2002; Constantine et al., 2004; Dyck and Baydack, 2004; Blanc et al., 2006). The immediate response of wildlife to disturbance is changes in behavior, and its long-term effects include altered behavior, altered vigor and altered productivity of individuals, changes in abundance, distribution and demography of populations and effects on species composition and interactions of communities (Knight and Cole, 1995).

This study aimed to investigate the tourism-induced disturbance on the feeding behavior of free ranging Asian elephants. Feeding is identified as highly important for large herbivores as they are required to spend a high percentage of their time on feeding to be healthy (Stockwell and Bateman, 1991). Disturbance from tourism activities can cause decrease in feeding time and increase in energy expenditure of animals, which degrade the health condition of animals and their reproductive ability (Reynolds and Braithwaite, 2001). Human impact on free ranging elephants is often studied and revealed based on elephant death or injury caused by human–elephant conflict because such impacts are extreme as well as recognizable and comparably easy to measure. Consequently, less attention is paid on issues of non-consumptive use of elephants such as tourism disturbance on elephants.

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Sri Lanka is home to 10% of the wild Asian elephant population (Perera, 2009) and elephants are flagship of tourism in the country (Buultjens et al., 2005). The number of foreign tourists to wildlife parks in Sri Lanka increased from 70,688 in 2009 to 325,153 in 2013 and the number of local tourists increased from 364,114 in 2009 to 719,069 in 2014 (SLTDA, 2014). However, these tourism activities have been carried out without monitoring the negative effects on elephant behavior even though some parks are already faced with issues such as overcrowding (Buultjens et al., 2005). Therefore, we examined the changes of feeding behavior of free ranging elephants in the context of elephant watching activities in Sri Lanka. The results of this study can be used as a baseline to understand tourism effects on elephant behavior and to plan strategies to reduce tourism-induced disturbance on elephants in protected areas.

2. Study site

The study site is Udawalawe National Park (UWNP), a key protected area located approximately between the latitudes 6″25″ and 6″35″ N and longitudes 80″45″ and 81″00″ E, an altitude of 118 above sea level in the southern part of Sri Lanka. UWNP was established in 1972 to provide habitat for wildlife displaced by the construction of the Udawalwe reservoir and to protect the catchment area of the reservoir. The land area of UWNP is about 308 square kilometers. UWNP provides habitat to a large number of wildlife species, out of these wildlife species Asian elephant (*Elephas maximus maximus*) is the predominant animal species. Recent records indicate that the elephant population of the park is over 1000 elephants (De Silva et al., 2011). UWNP is one of the best places to view wild elephants in Sri Lanka, because of its easy visibility and high probability of sighting elephants during any time of the year due to large open areas as well as high elephant population density compared to other parks in the southern region. The number of foreign and local tourists to UWNP and the revenue from tourism has increased in recent years. In 2012, about 76,077 local and foreign tourists visited UWNP and it is the third most visited wildlife park in the country (SLTDA, 2013). Several biological and ecological studies have been conducted in the park such as the demography of Asian elephants (e.g. De Silva et al., 2011), however, there is little research done on the tourism aspect of the park. Therefore, considering the conservation value, expansion of tourism and lack of research, UWNP was chosen as the research site to find out tourism effects on the elephant behavior in protected areas.

3. Methods

This study observed elephant behavior in relation to elephant watching tourism activities in order to identify tourism disturbance on feeding activity of free ranging elephants. Four types of elephant behavior; alert, fear, stress and aggression were chosen as indicators of disturbance on feeding elephants because each behavior caused a cost on feeding. "Alert" was characterized as gaze fixedly at tourists, or adopt a guarding position. 'Fear' was defined as run away from the tourists. "Stress" was when elephants flap ears fast, toss soil, repetitively sway the head and shoulders, even the whole body from side to side while standing in one place or circling. 'Aggression' was defined as run towards the tourist vehicle/s, attack tourists or tourist vehicles. Thirty minutes focal animal sampling was initiated to record the frequency and length of the selected behaviors. The sample period of thirty minutes was decided based on the average elephant watching time of tourists, which was about 15–20 min per elephant group. Frequency of behavior was the number of occurrence of each behavior during a sample period and length was the duration that a behavioral indicator of disturbance lasted (for example alert duration means the time from the occurrence of an alert behavior until returning to feeding behavior or another behavior such as aggression). Vehicle-based observations were conducted because the park did not have any watch posts or allow getting off the vehicles. Individual elephants of different sex–age-group classes were targeted. Male and females could be identified from the body parts and body shape (males, especially adult males have a long body with a downward slant at the back and females have a flat or box-shaped body). Age was identified by the body size and in comparison to an adult female. The age classes chosen for this study were adult male, adult female, sub adult male and sub adult female. Male group categories include solitary, male pair, male group. Female group categories include small cow–calf group (<5 elephants), medium cow–calf group (5–10 elephants), large cow–calf group (10–15 elephants) and very large cow–calf group (>15 elephants). Further, individuals in male–female groups were also included in the comparison of elephant group categories. Photographs of elephants were taken in order to individually identify the elephants based on the various physical features of elephants. Observation of elephant behavior was carried out in the presence of tourists as well as in the absence of tourists. "Absence of tourists" refers to the situations when only the research vehicle was present. 100–150 m distance was maintained between research vehicle and elephants except for few occasions of 50–100 m. Minimum of a one-hour interval was kept between the samples.

Elephant behavior was compared with some assumed causes of tourism related disturbance, which included tourist behavior (calm-do not talk, loud-talk with each other, extreme-talk, clap, wave, try to feed, play music), distance, number of vehicles, vehicle noise (whether the engine was on or off) and the time of the day. Observations were conducted minimum of four days a month during 0600 h to 1800 h from January 2013 to August 2013.

Statistical analysis

Wilcoxon rank sum test was applied to examine whether a difference of elephant behavior in the presence of tourist vehicles vs. absence of tourists existed as well as to determine a difference among male and female behavior in the presence
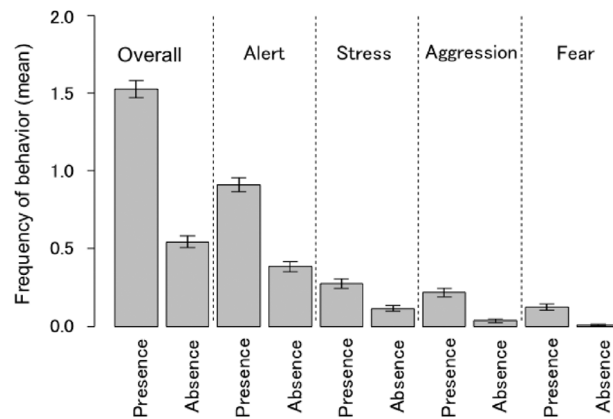
Fig. 1. Frequency of four behaviors in the presence vs. absence of tourists.
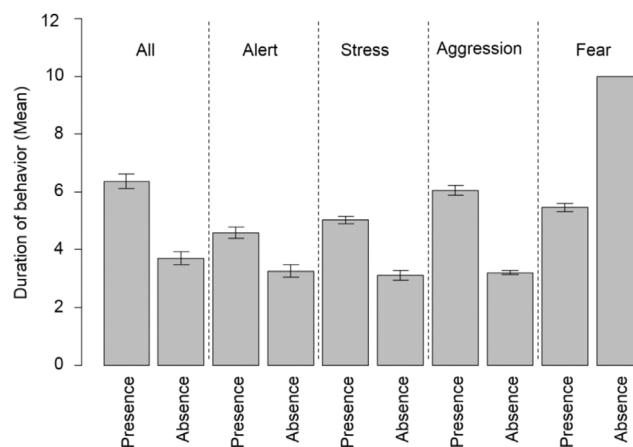

Fig. 2. Duration of four behaviors in the presence vs. absence of tourists.

vs. absence of tourists. Kruskal–Wallis rank sum test was used to determine differences of behavior among different age-group classes of elephants in the presence vs. absence of tourists. Binary logistic regression was used to compare occurrence and non-occurrence of four types of behavioral responses with the assumed causes of disturbance, and to determine the most influential tourism related factors on elephants feeding behavior.

4. Results

Total of 87 individual elephants were observed in which 40 elephants were males (19 adult males and 21 sub adult males) and 47 were females (28 adult females and 19 were sub females). There was a significant difference in all four behavioral responses as a whole and each separately in the presence vs. absence of tourists in terms of frequency of behavior (Fig. 1) as well as duration of behavior except for duration of Fear behavior (Fig. 2, also see Table 1 for significance values). Alerts were the most frequent (61%) among the four behaviors and fear was the least frequent behavior (7%). Other two behaviors; stress and aggression were 19% and 13% of the total number of behaviors. Overall, alerts were the shortest (average alert length 3 min) and aggression was the longest (average aggression length was 7 min) in terms of duration. In the presence of tourists, elephants spent 47% of the total observation time (142 h) on alerts, fear, stress, and aggression. On the contrary, in the absence of tourists, only 6% of the time was spent on alert, fear, stress and aggression out of the total observation time of feeding elephants (118 h). The occurrence of these behaviors was compared among male and female elephants. As shown in Fig. 3, both male and female elephants clearly showed a higher number of disturbance indicators and longer duration of such indicators in the presence of tourists compared to absence of tourists (Kruskal–Wallis rank sum test P-value for frequency = 2.2e−16 and for duration = 2.2e−16). Male elephants showed more stress and aggressive behaviors compared to female elephants in terms of frequency of behaviors (Table 2). The analysis of adult male elephants in different group types showed a low frequency of four behaviors in solitary adult males compared to adult males in other group types (Fig. 4, P-value for Fisher's exact test pairwise comparison Solitary-Male pair = 0.0005, Solitary-Male group = 0.019, Solitary-Group = 0.0175). However, the occurrence of the four behaviors in all group categories was considerably low in the absence of tourists (significant difference in the presence of tourists vs. absence of tourists Kruskal–Wallis rank sum test
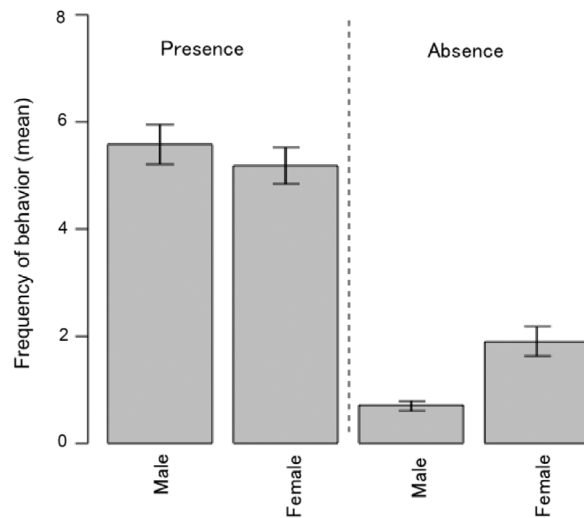
Fig. 3. Male and female behavior in the presence vs. absence of tourists.

Table 1
Comparison of elephant behavior in the presence vs. absence of tourists.

Behavior	Wilcoxon rank sum test p-value	
	Frequency of behavior	Duration of behavior
Alert behavior	8.24E−13	3.81E−06
Stress behavior	0.000432	0.000364
Aggressive behavior	2.82E−06	0.008849
Fear behavior	0.000128	0.120900
Overall behavior	2.20E−16	5.98E−14

Table 2
Significance of difference−female behavior vs. male behavior.

Wilcoxon rank sum test P-value		
Behavior	Frequency of behavior	Duration of behavior
Alert	0.3842	0.0027
Stress	0.0012	0.0620
Aggression	0.0220	0.7838
Fear	0.3979	0.8243
Overall	0.0202	0.0321

p-value = 1.372e−13). Adult female behavior did not differ significantly among different female group types. Further, there was no significant difference in behavior among the selected age categories (adult male, adult female, sub adult male, sub adult female).

Results of the binary logistic regression identified tourist behavior (loud and extreme), close distance, vehicle noise (keeping the engine on) and the time of the day (morning hours) closely associated with the behavioral changes of elephants (Table 3). When the tourist behavior was "extreme", the elephant behavior was 91 times more likely to change from feeding to alert, stress, aggression or fear. Further, it was 132 times more likely that elephants change their behavior at situations when the vehicle engines were on. The negative coefficients for time and distance showed the association of these two covariates with the feeding behavior of the elephant. There was 27% of a decrease in the odds of elephant behavior against the feeding when the time changed from morning to afternoon. The odds of elephant behavior against the feeding decreased by 7% when the distance changed from level 1 (1–10 m) to level 2 (11–20 m) and further decreased by 4% when the distance changed from level 2 (11–20 m) to level 3 (21 m<).

5. Discussion

The results of the elephant behavioral observations showed a clear difference in elephant behavior in the presence vs. absence of tourists. When tourists were present, alert, fear, stress and aggressive responses of elephants were significantly high, and these behaviors occurred at a cost of decreased feeding time, which indicated disturbance of tourism activities on
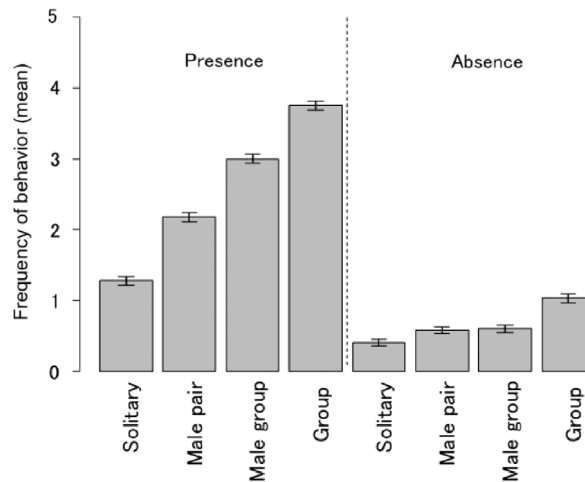
Fig. 4. Adult male behavior based on different male group types.

Table 3
Results of the binary logistic regression analysis.

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Factor Information

Factor              Levels  Values
Tourist-Beh            3      1, 2, 3
Distance        3     1, 2, 3
Veh-On          2     1, 2
Time            2     1, 2
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Logistic Regression Table

						95% CI	
Predictor	Coef	SE Coef	Z	P	Odds Ratio	Lower	Upper
Constant	-1.85194	0.780951	-2.37	0.018			
Tourist-Beh							
2	2.29170	0.470502	4.87	0.000	9.89	3.93	24.88
3	4.51139	1.30407	3.46	0.001	91.05	7.07	1173.06
Distance							
2	-2.66150	0.604238	-4.40	0.004	0.07	0.02	0.23
3	-3.26643	0.798497	-4.09	0.000	0.04	0.01	0.18
Veh-On							
2	4.88715	0.593008	8.24	0.016	132.57	41.47	423.88
Time							
2	-1.30181	0.460873	-2.82	0.005	0.27	0.11	0.67
Veh-No	0.209864	0.308722	0.68	0.497	1.23	0.67	2.26

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Tourist behavior (Tourist-Beh above)1=calm 2=loud 3=extreme
Distance 1=(1-10m) 2= (11-20m) 3= (>21m)
Vehicle noise  1=vehicle engine off   2=vehicle engine  on (Veh-on above)
Time  1=6.30 a.m. to 11.00 a.m.  2= 2.30 p.m. to 6.00 p.m.
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feeding elephants. This pattern was consistent in the analysis of behavior in different age–sex-group classes of elephants in the presence vs. absence of tourists. Some differences among sex and group classes could also be identified. Adult male

elephants showed more aggressive behaviors than adult females. However, adult male behavior differed among different group types. Adult males in male pairs, male groups or male–female groups were more vulnerable for disturbance than solitary males.

Tourist behavior, vehicle noise, distance, time of the day were closely associated with the behavioral changes of elephants. It is important to guide tourists to remain calm during the elephant watching tours. It is also important to keep the vehicle engine off and avoid close distances such as less than 10 m between tourists and elephants. Elephants are large animals and can be seen even from 100 m distance in open areas. Close distances also cause threat to the safety of tourists when elephants become aggressive. Elephants were vulnerable to disturbance in the morning hours compared to the afternoon. Previous research has revealed that feeding of elephants is high during the morning hours, especially between 0600 and 1200 (De Silva and De Silva, 2007). Therefore, it is important to consider the activity patterns of elephants when planning tourism in the park. Number of vehicles did not show a significant association with elephant behavior and the threshold is one vehicle. The largest number of tourist vehicles at an elephant or elephant group was five vehicles during the observations of this study.

Research vehicle was present in the "absence of tourists", however, the occurrence of the disturbance indicators was significantly low compared to the presence of tourists. Research vehicle was kept at a distance of minimum of 100 m from elephants at most cases, and the engine was kept off and observers were calm at observations. Therefore, the behavior of research vehicle could be a model when considering the vehicle behavior to reduce disturbance on feeding elephants in the park.

6. Conclusion

Recent expansion of tourism, especially nature based tourism sector in Sri Lanka has resulted in higher visitation in protected areas by tourists. This is a desirable situation for a developing country to receive economic benefits of tourism for protected areas management and rural development. However, it is also crucial to reduce the tourism pressure on wildlife as majority of the target species for tourism in the country are endangered species. It is often assumed that non-consumptive uses of wildlife for tourism are environmental friendly and have no threat to wildlife. This study revealed tourism-induced disturbance on the feeding of free ranging elephants in a key protected area in the country. It is important to develop a set of guidelines for wildlife viewing such as a minimum distance. At the same time, awareness and proper management of guides and jeep drivers are also necessary. Volunteer guides in the park accompany the tourists inside the park. However, they receive very limited training or education related to conservation goals of the parks. Further, they work on a daily allowance by wildlife authority and a substantial amount of their salary depend on the tips from tourists. Consequently, the guides mainly aim to satisfy tourists by providing close encounters with wildlife to maximize the tips (Buultjens et al., 2005). As shown in the results, close distances cause disturbance to the feeding activity of elephants.

Tourism disturbance on free ranging elephants is a least studied aspect of human impact on elephants. Some initiatives have been taken in some parks in Sri Lanka to discuss about the tourism impact on wildlife among the stakeholders such as park management, guides, tour operators and drivers. It is also important to encourage scientific research on the impacts of tourism on wildlife to further guide decisions in tourism planning in wildlife areas in Sri Lanka.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at http://dx.doi.org/10.1016/j.gecco.2015.10.013.

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