*Human–Gelada Conflict and Attitude of the Local Community toward the Conservation of the Southern Gelada (*Theropithecus gelada obscurus*) around Borena Saynit National Park, Ethiopia*

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Human–Gelada Conflict and Attitude of the Local Community toward the Conservation of the Southern Gelada (*Theropithecus gelada obscurus*) around Borena Saynit National Park, Ethiopia

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Abstract
Understanding the extent of human–primate conflict in areas where habitat overlap reaches at maximum level between local farmers and primates is crucial to developing conservation and management strategies. One of the threats of southern geladas (*Theropithecus gelada obscurus*) is conflict with the local farmers due to cereal crop raiding. This study was carried out to compare the intensity of human–gelada conflicts and the attitude of local farmers toward the conservation of geladas among local communities neighboring Borena Sayint National Park (BSNP) and an unprotected site far from the BSNP. Data from 356 randomly selected respondents were collected using questionnaire interview method. Overall, 92.13% of the respondents considered southern geladas as cereal crop pests. Those major complaints against geladas did not differ significantly between the two study sites: crop raiding ($p = 0.435$) and competition with livestock for pasture ($p = 0.990$). Overall, 61.78% of the respondents surrounding the Park had positive attitude while 60.00% from the unprotected villages had negative attitude toward geladas, and the difference was significant ($p < 0.001$). Most of the respondents from both sites had labor bottleneck and station themselves in the sites to guard their cereal crops from being raided by southern geladas. Respondents from the Park boundaries had more interest on the conservation of geladas than those respondents from the unprotected site ($p < 0.001$). Conservation education program and better human–gelada conflict mitigation measures should be taken to change the negative conservation attitude of local famers toward the southern geladas.

Keywords BSNP · Community attitude · Human–gelada conflict · Human-modified landscape · Southern geladas · Conservation

Introduction

High rates of human population growth lead to expansion of agriculture, habitat destruction, and encroachment upon wildlife habitats. This decreases areas of natural habitat leading to human–wildlife conflict over resources (Treves and Karanth 2003; Strum 2010; Hardwick et al. 2017). When the areas of natural habitat decrease, the populations of wild animals become scattered and isolated, often increasing the potential levels of human–wildlife conflict. This occurs when the human needs and requirements overlap with those of wildlife resulting in resource competition (Hill 2002; Madden 2004; Riley 2007; Peterson et al. 2010). Human–wildlife conflicts have escalated in areas where habitat overlap reaches at maximum level between local farmers and wild animals shared limited resources.

Crop damage caused by primates is one of the most common causes of human–nonhuman primate conflicts in areas where the local farmers live at subsistence level (Hill 2000; Saj et al. 2001; Peterson et al. 2010; Priston et al. 2012). When habitat degradations and alternation of land intensify, primates consume more crops into their diets (Hill 2017). For many primates that lost their preferred habitats and live in small patchy habitats, feeding on cereal crops is a good strategy to increase their foraging efficiency and nutrient intake (Naughton-Treves 1998), resulting in conflict with the local farmers. Such crop raiding behaviors put

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primates in danger of extirpation in areas where conflict with local farmers reaches at very high levels (Oates 1996), and retaliation killing spreads at higher rate (McLennan 2008; Sinha et al. 2006; Hardwick et al. 2017). Primates that live outside protected areas are more exposed to conflict with local farmers than those that live in protected areas, and are more prone to injuries, kills, and starvations (Strum 2010). Such high level of conflict between local farmers and primates becomes threats to the long-term conservation of many species (Chapman et al. 2006; Dickman 2013) as well as becoming a conservation challenge for primatologists (Hill 2017).

Traditional farming and livestock rearing are the main livelihood activities in Ethiopia. These activities are resulting in environmental degradations as well as cause of conflicts with wild animals across the country (Stephens et al. 2001; Bekalo and Bangay 2002; Yirga et al. 2012). Southern geladas (*Theropithecus gelada obscurus*) are little known endemic subspecies of geladas found in the northern central highlands of Ethiopia. They live in dense human settlements areas where agriculture activities and environmental degradations reaches at maximum levels. Most of the habitats of southern geladas overlap and share with the local farmers and their livestock. They have developed strategies of adaptation to live in such degraded habitats by including farmlands in their daily ranges. Thus, as their range extremely overlaps with local farmers, they are forced to raid cereal crops resulting in potential conflict with the local farmers. In turn, the local farmers harass and stress them, and perform retaliatory killings to minimize crop raiding. As the result of this intense conflict with the local farmers, environmental degradations, and competition with livestock, southern geladas are vulnerable to local extinction as well as future decline throughout their ranges.

To develop effective conservation strategies for primates and other wildlife, it is essential to understand the magnitude of human–wildlife conflict of the area. Environmental conservation plans excluding the attitude of local farmers towards crop raiding primate as well as the need of local people in the primate habitat is difficult for devising better sustainable conservation strategies. Therefore, understanding of the level of human–primate conflict and the attitude of local farmer is vital to designing effective mitigation strategies (Hill 2000) and conservation plans (Heinen 1993; Dickman 2013). Conflicts between geladas and farmers have been reported in protected areas (Yihune et al. 2009) and unprotected area (Kifle et al. 2013). To date, no published paper is available on the magnitude of human–gelada conflict as well as the attitude of local farmers towards southern geladas on their crop damage behavior by comparing residents living in protected and unprotected areas to designing sustainable conservation management plan for the southern geladas and their habitats.

The specific aims of this study were to investigate the conservation interest and attitudes of local farmers towards southern geladas as well as the causes of conflicts, the hidden costs and the possible mitigation measures by comparing two different sites. In addition, to examine how settlement sites and different socioeconomic and demographic variables influence the attitude local farmers and which variables are significantly associated with the conservation of southern geladas.

Methods

Study Area

This research was conducted far away and bordering Borena Sayint National Park (BSNP), South Wollo, Amhara Regional State, Ethiopia (Fig. 1). These sites were classified based on the conservation status of the area. These two sites were ~20 km far apart. BSNP lies at coordinates between 10°51′8.12″–10°53′48.06″N and 38°40′16.42″–38°51′1.06″E. BSNP is the only protected area in the north central highlands of Ethiopia for the conservation of biodiversity and natural resources as well as for the water catchment system. It comprises afromontane forest in the lower and subafroalpine habitats in the middle and afroalpine vegetation types in the upper part. The park is surrounded by human settlements, agricultural activities, and livestock pastures. The unprotected site occurs south of the BSNP in Borena district. Its geographical location lies between 10°43′17.47″–10°42′2.44″N and 38°50′14.49″–38°39′43.67″E. The site comprises human settlements, agriculture fields, and livestock pastures, steep escarpments, steep rugged cliffs, gorges, valleys and strip of plateaus. It possesses an afromontane type of ecosystem and contains scattered trees, shrubs, bushes, herbs, and grass species that are drastically affected by human activity.

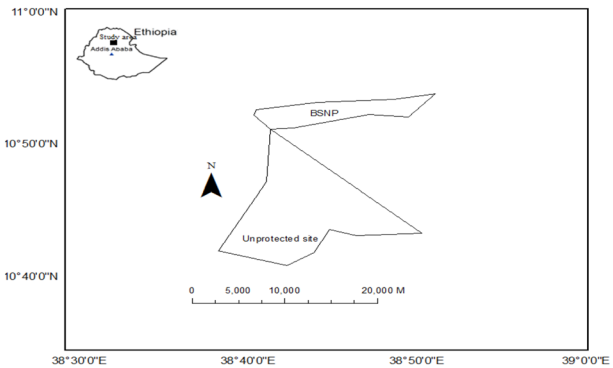

Fig. 1 Map of the study area showing BSNP and unprotected site in the central Ethiopian highlands

Local farmers cultivate several types of cereal crops on their farmlands like barley (*Hordeum vulgar*), wheat (*Triticum* spp.), teff (*Eragrostis tef*), sorghum (*Sorghum bicolor*), bean (*Vicia faba*), pea (*Pisum sativum*), chickling vetch (*Lathyrus sativus*), chickpea (*Cicer arietinum*), lentil (*Lens culinaris*), maize (*Zea mays*), and potato (*Solanum tuberosum*). Beside the southern geladas the sites support primates like olive baboons (*Papio anubis*), hamadryas baboons (*Papio hamadryas*), guereza (*Colobus guereza*) and grivet monkeys (*Chlorocebus aethiops*), and many other small, medium size, and large mammalian species as well as varieties of birds and other animals.

Data Collection and Analysis

Human–gelada conflict was assessed using questionnaire survey methods. The questionnaire had a combination of both open–ended and fixed response questions with different variables. It was designed to explore the attitudes of the local community towards geladas, the cause of conflicts, the hidden costs, the type of crop raided, the view of local community towards gelada conservation, the crop protection measures adopted, the possible mitigation measures, and other variables affecting the conservation of southern geladas. The socioeconomic and demographic variables, such as household size, age, sex, religion, level of education, source of livelihood, and household wealth status (farmland and livestock size), were also collected from each respondent. At the beginning of each potential interview, the aim of the research was briefly explained by the interviewer for each respondent. A pilot study was conducted in the area, before the actual data collection periods. During the pilot survey, 20 farmers were interviewed in the study site. Based on the results from the pilot survey, the questionnaire was revised as appropriate for the actual study.

Data were collected in comparative approach from the villagers near the BSNP and from the unprotected area far from the BSNP. Questionnaire surveys were conducted from a total of 11 villages. Six of the villages were found within the periphery of the BSNP and were directly connected to the Park, whereas the other five villages were found far away from the BSNP and had no connection to the Park. All of the villages had direct encounter with southern gelada through crop raiding and other related issues. Interview was conducted from January to March 2016 in the unprotected site and from April to May 2016 in the Park surroundings. The respondents were selected on the basis of chance encounter by the interviewer (Newmark et al. 1993). The interviews were undertaken on either the household head or wife head or other adult ≥18 years.

All statistical analysis was performed using SPSS version 20 and data were presented with p values and confidence intervals set at 95%. The chi-squared test for goodness of fit was used to examine the proportion of cases that fitted into different categories of a particular variable, while the chi-square test for independence was employed to assess whether the categorical variables were related. A logistic regression model was performed to investigate the attitude and conservation variations on geladas using age, settlement site, gender, and educational level as predictors.

Results

Demographic and Socioeconomic Characteristics of the Respondents

A total of 356 individuals participated for questionnaire survey (Table 1). From the total respondents, 53.65% ($n = 191$) were from the BSNP surroundings, while 46.35% ($n = 165$) were from the unprotected site, far from the BSNP. The majority of respondents 89.33% ($n = 318$) were males, while 10.67% ($n = 38$) were females. There was no significant difference in the proportion of genders interviewed between BSNP and unprotected village sites (Chi-square test of independence: $\chi^2 = 0.044$, df = 1, $p = 0.833$). Age of the respondents ranged from 18 to 90 years, with a mean of 48.88 and standard deviation of 16.05 years old. The family sizes of the respondents ranged from 1 to 12 with a mean of 5.73 ± 2.35. The respondents were the followers of Orthodox Christians (54.78%, $n = 195$) and Muslims (42.22% $n = 161$). There was no significant difference between the total number of Orthodox and Muslim respondents (Chi-square goodness of fits: $\chi^2 = 3.25$, df = 1, $p = 0.072$).

Respondents from the unprotected site generally were more educated than those respondents at the periphery of the BSNP, and the difference was significant (Chi-square test of independence: $\chi^2 = 29.92$, df = 3, $p < 0.001$). All of the respondents lived on subsistence farming, and grow diversified type food crops like wheat, teff, barley, bean, pea, chickpea, sorghum, chickling vetch, lentil, and potato. Out of the respondents, 77.53% had their own farmland while 22.47% did not. Most of the respondents (96.07%) had livestock including cattle, sheep and goats, and pack animals. Among the total respondents of both sites, 59.83% harvested enough cereal crops for their yearly consumption whereas 40.17% of the respondents did not produce a yearly round cereal crop to cover for their family consumptions.

Frequency and Kind of Cereal Crop Raiding by Geladas

The frequency of crop raiding by the southern geladas was high in both sites. Respondents reported that southern geladas raid most type of crops that the local farmers cultivated on their farmlands like barley, wheat, teff, sorghum,

Table 1 Summary of socioeconomic and demographic profile of the respondents around Borena Sayint National Park, Ethiopia

Characteristics	Sites, *n* (%)	
	Unprotected	BSNP
Sex		
Male	148 (89.69)	170 (89.00)
Female	17 (10.31)	21 (11.00)
Age		
18–35	32 (19.39)	55 (28.80)
36–50	50 (30.30)	59 (30.89)
>50	83 (50.31)	77 (46.31)
Education		
Uneducated	96 (58.18)	148 (77.49)
Primary	49 (29.70)	25 (13.09)
Secondary	17 (10.30)	5 (2.62)
Religion education	3 (1.82)	13 (6.80)
Religion		
Orthodox	25 (15.15)	170 (89.00)
Muslim	140 (84.85)	21 (11.00)
Land tenure		
Yes	143 (86.70)	133 (69.63)
No	22 (13.30)	58 (30.37)
Source of livelihood		
Crop and livestock	155 (93.94)	187 (97.91)
Crop production	10 (6.06)	4 (2.09)
Other source of income		
Yes	39 (23.64)	72 (37.70)
No	126 (76.36)	119 (62.30)
Harvest yearly food		
Yes	112 (67.88)	101 (52.88)
No	53 (32.12)	90 (47.12)
Livestock size		
≤10	155 (93.94)	117 (61.26)
>10	10 (6.06)	74 (38.74)
Family size		
≤5	85 (51.52)	89 (46.60)
>5	80 (48.48)	102 (53.40)

bean, pea, chickling vetch, and chickpea. However, geladas are reluctant to raid nigerseed (*Guizotia abyssinica*), fenugreek (*Trigonella foenum*), rapeseed (*Brassica* spp.), flax (*Linum usitatissimum*), and potato (*Solanum tuberosum*). Respondents indicated that geladas raided different type cereal crops at different developmental stages from sowing up to harvesting. Geladas raided barley, bean, pea, and wheat starting from sowing to harvesting stages. Respondents reported that the intensity of crop raiding by geladas reached the highest point during their fruiting and drying stages. Geladas preferred to consume teff at the seedling and vegetative stages over the other types of cereal crops. In addition, they preferred to raid monocots by ignoring dicots crop like beans and peas during the seedling and vegetative stages. Respondents reported that during fruiting stages geladas preferred to raid beans and peas followed by sorghum, barley and wheat and lastly teff when they grow side by side.

Table 2 Complaints of local farmers against southern geladas (*T. g. obscurus*) around Borena Sayint National Park, Ethiopia

Variables	Response of villagers, %						
	BSNP		Unprotected		χ^2	df	*p* value
	Yes	No	Yes	No			
Farmers' complain							
Crop raiding	91.09	8.91	93.33	6.67	0.61	1	0.435
Pasture grazing and digging	84.29	15.71	84.24	15.76	0.01	1	0.990
Theft from the compound	53.40	46.60	43.63	56.36	3.38	1	0.066
Kraal damage	16.23	83.77	–	–			

Complains of Local Farmers against Geladas

Crop raiding, grazing competition with livestock, and digging pasture lands are the major complains of local farmers against geladas (Table 2). Respondents across both sites (92.13%) reported geladas as notorious cereal crop raiders. Southern geladas competed with livestock and pack animals for pasture lands. They damaged the grazing pasture by digging the ground in order to collect subterranean diet items. In addition, villagers reported that southern geladas snatch their cereal crops from heaps of the threshing fields and grains (grains that were kept on the ground for drying) from their compounds. Some respondents (16.23%) from the Park site also complained that southern geladas damage kraals locally called "*Dereba*." These farmers construct kraals in the pasture field near the buffer zone of the Park for protecting their livestock from storm during the wet season. Southern geladas specially immature climbed those kraals to play on it or find some insects, thereby dismantling the thatch covers. The forms of human–gelada conflicts did not differ significantly between the two study sites (Table 2).

Hidden Costs of Local Farmer–gelada Conflict

In addition to crop damage, pasture grazing, and snatching from the compounds, geladas contribute to hidden costs on the local farmers. Most of the respondents from both sites had labor costs as the result of guarding their cereal crops throughout the daylight hours (Table 3). They keep their farmlands by shifting the family members or neighbor

Table 3 Hidden effects of the southern geladas on the local farmers around Borena Sayint National Park

Variables	Responses, %					
	BSNP			Unprotected		
	High	Low	No effect	High	Low	No effect
Hidden/opportunity effect						
Less sleep	43.98	34.03	21.99	55.15	29.09	15.76
Labor bottleneck	74.87	14.14	10.99	72.73	13.94	13.33
Travel restriction	73.30	13.09	13.61	71.52	15.75	12.73
Disruption students from schooling	35.08	26.18	38.74	32.73	24.24	43.03
Loss of energy during chasing	47.64	32.98	19.38	53.33	25.46	21.21
Accident	5.24	10.47	84.29	15.15	17.58	67.27

throughout the day starting from sowing till threshing the harvested crops. Guarding hinders family members from carrying out other activities. Guarding hinders students from going to schools, mothers and fathers from doing housework and other farming activities intensively in addition to hindering from some social activities like marketing, meeting, and mourning. Some respondents report that if a farm is near the sleeping cliff site of geladas, even burial of nearest relative is not possible specially during the cereal crop harvesting months. Respondents move up and down, throwing stones, bouldering, and slinging throughout the daylights to chase geladas far away from their farmlands. These cost energy. Some respondents rent their farmlands for others if they are not strong enough to keep their farmlands from being raided by geladas. The hidden effect of human–gelada conflicts did not differ significantly between the two sites: sleeping ($\chi^2 = 4.73$, df = 2, $p = 0.094$), labor ($\chi^2 = 0.46$, df = 2, $p = 0.795$), travel ($\chi^2 = 2.53$, df = 2, $p = 0.767$), schooling ($\chi^2 = 0.68$, df = 2, $p = 0.714$) and energy costs ($\chi^2 = 2.42$, df = 2, $p = 0.298$).

Crop Protection Methods Used by the Local Farmers

Respondents used varieties of deterrent methods to protect their cereal crops from being damaged by southern geladas. The most commonly utilized method was direct watching with chasing by standing in front of their farmlands throughout the cropping seasons. Respondents from both sites also used shouting, stoning, bouldering, sticking, slinging, and dog to chase geladas far away from the nearby farmlands. Adult male geladas usually fight with dogs overcoming the fight. As the result respondents do not consider dogs as an alternative way for guarding crops. They alarm through calling and yelling when geladas try to approach around their farmlands. But these methods were not effective. When the farmers chased geladas and return back, they follow behind them immediately. Some of these methods cause some accident and risk of death due to falling from the cliff. Some respondents also used horn to scare geladas. In addition, respondents erect scarecrow wrapping with clothes just in front of or inside their farmlands, but the effect is temporary.

Some respondents use rope suspended cans to displace geladas when they hide on the steep cliffs. Respondents stated that to displace geladas from their sleeping cliff, it needs a lot of energy and manpower, and most of them failed. Geladas do not easily leave their permanent sleeping sites by using different displacement mechanisms. Local farmer construct small trapping huts and putting grains inside it to lure geladas. Geladas may enter the hut, and the door of the hut will be closed behind them. Then the farmers kill those geladas that enter the hat using spear. However, these practices were never used currently by the local residents of the study area, but these actions still practice in some other remote areas.

Southern Geladas as Cereal Crop Pests

Respondents from both sites stated that southern geladas are among the notorious crop raiders in the study area. Overall, 93.94% of the respondents from the unprotected site and 90.58% from the BSNP periphery consider southern geladas as cereal crop pests (Table 4). No significant difference was observed between respondents near the Park and unprotected sites on their view of geladas as cereal crop pest status ($p = 0.240$).

Attitude of Respondents towards Geladas

Many respondents (61.78%) surrounding the Park had positive attitude while 60.00% in the unprotected villages had negative attitude towards geladas, and the difference was significant ($p < 0.001$). The full model containing all predictors was statistically significant ($\chi^2 = 32.23$, df = 4, $p < 0.001$) indicating that the model was worthwhile, and able to distinguish between respondents who had negative and positive attitudes towards geladas. The Wald chi-square test criterion demonstrated that age, settlement site, and

gender made significant influences on the attitude of geladas (Table 5), while educational level were not significant predictors to the model. Nagelkerke's R^2 was 0.123, and correctly predicted percentage was 64.5%. The strongest predictor on the attitude of geladas was settlement site, recording as odd ratio of 2.68.

View of Respondents on the Conservation of Geladas

The majority (65.73%) of respondents from both study sites supported gelada conservation (Table 6). Those respondents who supported the conservation of geladas elaborated that it is ethical and they viewed them as esthetics. Those respondents who opposed the necessary of gelada conservation elaborated and claimed that geladas had no value other than creating a lot of problems like raiding crop and wasting unnecessary time and energy for guarding them. Respondents from the Park boundaries had more interest to conserve geladas than those respondents from the unprotected sites ($p < 0.001$; Table 6). Males significantly supported gelada conservation more than females ($p = 0.002$). In addition, young respondents were more interested to conserve geladas than adult and old age respondents, and the difference was significant among age categories ($p = 0.011$).

Cause of Crop Raiding and Mitigation Measures

Many of the respondents from the unprotected site mentioned that habitat contraction (56.97%) and degradation (58.18%) are the main causes for the frequent raiding of cereal crops by geladas (Table 7). However, respondents from the Park site reported that habitat contraction, habitat degradation, and lack of natural food were insignificant contributors for the reason of crop raiding by geladas. Many respondents (79.39%) from the unprotected site claimed that proximity of farmlands as the main cause of crop

Table 4 Respondents view on geladas as cereal crop pests based on the sites of villages and demographic variables

Variables	Gelada as pest, %		Chi-square association model		
	Yes	No	χ^2	df	p value
Village					
BSNP	90.58	9.42	1.38	1	0.240
Unprotected	93.94	6.06			
Gender					
Male	92.76	7.24	1.64	1	0.220
Female	86.84	13.16			
Age					
18–35	93.10	6.90	1.08	2	0.584
36–50	89.91	10.09			
>50	93.13	6.87			
Religion					
Orthodox	90.26	9.74	2.10	1	0.147
Muslim	94.41	5.59			
Education					
Uneducated	92.92	7.38	3.49	3	0.321
Primary	93.24	6.76			
Secondary	81.82	18.18			
Religion education	93.75	6.25			

Table 6 Respondent view on the need of gelada conservation around Borena Sayint National Park

Variables	Interest on gelada conservation, %			Chi-square association model		
	Yes	No	Neutral	χ^2	df	p value
Villages						
BSNP	75.92	20.42	3.66	19.94	2	<0.001
Unprotected	53.94	41.82	4.24			
Gender						
Male	67.92	29.25	2.83	12.56	2	0.002
Female	47.37	39.47	13.16			
Age						
18–35	78.16	19.54	2.30			
36–50	69.72	26.61	3.67	13.15	4	0.011
>50	56.25	38.75	5.00			
Education						
Uneducated	65.98	29.92	4.10			
Primary	64.86	31.08	4.06	0.77	6	0.993
Secondary	63.64	31.82	4.55			
Religion education	68.75	31.25	0.00			

Table 5 Binary logit model regarding attitude of local farmers towards geladas (outcome variable: attitude (1 = positive, 0 = negative) around Borena Sayint National Park

Predictor variables	Estimate	Std error	Wald chi-square	df	p value	Odd ratio
Settlement (1 = Park)	0.985	0.241	16.76	1	<0.001	2.68
Age	−0.016	0.007	4.61	1	0.032	0.98
Gender (1 = male)	1.005	0.429	5.48	1	0.019	2.73
Educational level (1 = Educated)	0.434	0.263	2.72	1	0.099	1.54
Constant	−0.601	0.564	1.14	1	0.287	0.55

Table 7 Perceptions of interviewees on reason of crop raiding by geladas (Ind = indifferent) around Borena Sayint National Park

Variable	Respondents, %						χ^2	df	p value
	BSNP			Unprotected					
	Yes	No	Ind	Yes	No	Ind			
Cause of crop raiding									
Habitat contraction	12.04	86.91	1.05	56.97	38.79	4.24	89.68	2	<0.001
Habitat degradation	3.66	96.34	0.00	58.18	39.39	2.43	136.60	2	<0.001
Lack of natural food	2.62	97.38	0.00	49.09	49.09	1.81	110.14	2	<0.001
Proximate of farm	46.07	53.40	0.53	79.39	20.00	0.61	42.04	2	<0.001
Attraction by crop	96.34	2.62	1.04	94.55	4.85	0.60	1.44	2	0.487

Table 8 Mitigation measures proposed by the researcher to the respondents (Ind = indifferent) around Borena Sayint National Park

Variable	Respondents, %						χ^2	df	p value
	BSNP			Unprotected					
	Yes	No	Ind	Yes	No	Ind			
Mitigation proposal									
Guarding	89.01	10.47	0.52	96.97	3.03	0.00	8.45	2	0.015
Seasonal displacement	15.71	83.77	0.52	31.52	68.48	0.00	13.17	2	0.001
Government action	68.06	18.32	13.62	67.88	24.85	7.27	5.10	2	0.078
Change farming practice	11.52	87.96	0.52	7.88	90.30	1.82	2.57	2	0.277
Job opportunity	78.01	16.75	5.24	73.94	21.82	4.24	1.56	2	0.457
Compensation for loss	70.16	24.61	5.23	74.55	22.42	3.03	1.44	2	0.488

raiding by geladas. Local farmers from the Park site differed significantly from those of unprotected site in their opinion regarding causes of crop raiding by geladas. Overall, 95.51% of all respondents from both study sites reported that attraction by the nutritional contents of crops as the main reason for the cause of crop raiding. Opinions regarding the cause of crop raiding by attraction of crops did not differ significantly between the two conservation status sites ($p = 0.487$).

Most of the respondents (92.70%) from both study sites suggested that guarding method is the best adopted way for protecting cereal crops from being raided by geladas (Table 8). Most of the respondents wanted to guard their cereal crops alone and still other guarded their cereal crops by shifting system. Job opportunity, followed by compensation and government action are also suggested as the mitigation measures by most respondents in the study sites. Most respondents (76.12%) suggested that job opportunity should be taken into account for the young people to stop any further agricultural expansion and degradation within the habitat of geladas. Still many respondents (72.19%) suggested that they should be compensated for any crop loss even if they had doubt for earning compensation. Few respondents from both sites explained that if compensation is provided for crop loss, it would bring a lot of complications and conflict between wildlife managers and farmers. There was no significant difference among the respondents between the two sites on job opportunity ($p = 0.457$) and compensation ($p = 0.488$) as ways of mitigation measures.

Discussion

Southern geladas provide one of the best examples of commensalism with humans. They frequently contact with the local residential. They live very closely near the farmlands and villages by sharing the available resources with local farmers in love–hate type of relationships. This relationship invokes niche overlap between the two competitors over habitat use in a larger scale and results in intense conflicts. Many primates are known to raid crops (Naughton-Treves 1998; Naughton-Treves et al. 1998; Siex and Struhsaker 1999; Hill 2000; Warren et al. 2007). The present study showed that human–gelada conflict is a day-to-day interaction within the range of gelada's habitat specially at the time of cereal crop production months. The size and location of the farm relative to the habitats of primates and the type of primate in the area are important factors for the level of human–primate conflict (Naughton-Treves 1998; Saj et al. 2001; Hill 2000; Linkie et al. 2007; Warren et al. 2007).

Among the different primate taxa that are engaged in crop raiding, terrestrial frugivores, and omnivores like

baboons and macaques are the primary culprits, topping the list (Cowlishaw and Dunbar 2000; Hill 2000; Linkie et al. 2007; Priston et al. 2012). The result of this study showed that there is intense conflict between the local farmers and geladas in Ethiopian highlands due to cereal crop damage throughout the growing months. This might relate with the grass feeding habits of geladas. Most of the respondents considered geladas as "crop pest" in their residents. Similarly, many other primates are considered as the dominant crop raiders in African and Asian reserves (Balakrishnan and Ndhlovu 1992; Naughton-Treves et al. 1998; Saj et al. 2001; Warren 2008; Marchal and Hill 2009; Priston et al. 2012). The notorious crop raiding behavior of geladas might be the closeness of farming activities in their sleeping cliffs and foraging areas. Naughton-Treves (1998), Saj et al. (2001), Linkie et al. (2007), and Warren et al. (2007) also noted that the location of the farm relative to the habitats of primates is an important factor for the level of human–primate conflict.

Almost half of the respondents from both study sites had negative attitude toward southern geladas. This negative attitude is the result of their crop raiding behavior that cause economic and opportunity costs. Similarly, Hill (2002), Marino (2003), Treves (2007), Yihune et al. (2009), and Campbell-Smith et al. (2010) reported that, farmers who had experienced crop damage by primates tend to develop negative attitude towards them. Naughton-Treves (1998) also noted that human–wildlife conflict can create intense hostility between poor farmers from rural areas and wild animals that destroy their crops and threaten their livelihoods. The economic losses related to crop raiding by geladas may affect food security for those farmers who live at subsistence level. Similarly, Hoffman and O'Riain (2010) and Kaplan et al. (2011) reported that primates cause economic losses related to crop raiding. Where agriculture is central to sustaining rural livelihoods, crop raiding may be perceived as a basic factor affecting peoples' livelihood (Studsrod and Wegge 1995; Hill and Wallace 2012; Hardwick et al. 2017).

The attitude of local farmers towards geladas differed significantly between the two sites. Local farmers who lived near the Park boundary had developed more positive attitude towards geladas than those farmers who lived in the unprotected site. Similarly, Khatun et al. (2012) pointed out that farmers from high conservation status areas had more positive attitude towards common langurs (*Semnopithecus entellus*). This might be due to a better conservation awareness of the respondents who live near the Park than those of the respondents from the unprotected site. Respondents from the Park might develop tolerance even if intense crop damage occurs in the area, and they may have better idea on the law of wildlife conservation. Similarly, in spite of high predation on sheep by the Ethiopian Wolf, more than half of the local people at Mount Abune Yosef had positive attitude towards this predator (Eshete et al. 2015). The availability of sufficient natural food items in the wild habitats help geladas to spend most of their time there, thus reducing crop losses and decreasing negative attitudes by local farmers. Similarly, Khatun et al. (2012) noted that sufficient food trees in the habitat of common langurs helped to spend most of their time in the forest. The present study suggested that perceptions and attitudes of local farmers on geladas depend on the level of damages, level of opportunity costs, and conservation awareness of the individual respondents. Positive perceptions of wildlife can decline if agricultural crops are damaged by wildlife (Campbell-Smith et al. 2010).

Similar to the earlier study on different large mammals that cause conflict with humans (Bandara and Tisdell 2003; Selebatso et al. 2008; Wang et al. 2006), the present study found that age is a strong predictor of local farmer's attitudes toward the conservation of geladas. In addition, in contrast to finding on the Ethiopian wolf (Eshete et al. 2015) and similar to the finding on orangutan (Campbell-Smith et al. 2010), this study found gender as strong predictor of the local farmer's attitudes toward geladas. However, similar to Eshete et al. (2015) on the Ethiopian wolf and Campbell-Smith et al. (2010) on orangutan, the present study did not find educational status to be strong predictors of local farmer's attitude. This study also found settlement site as a strong predictor of the local farmer's attitudes toward gelada conservation.

Respondents from the unprotected site believed that the reason behind passionate crop raiding behaviors of geladas is land constriction. As conversion of land for human use intensifies, primates increasingly incorporate crops into their diets (Hill 2017). When natural food resources are limited, easily digestible human food items provide an alternative source of nutrition for primates, intensifying the conflict (Horrocks and Baulu 1994). During crop harvesting months, geladas prefer to consume cereal crops more enthusiastically than wild grasses. This may be due to the nutritional quality (protein and carbohydrate) of cereal crops and easily digestibility compared with the blades of grasses. Earlier studies have also demonstrated that a close association with humans, pattern of crop cultivation, distance of farmland from the forest boundary, and temporal scarcity of edible foods are responsible for crop damage by wild animals (Naughton-Treves 1998; Hill 1998, 2000; Saj et al. 2001). As human populations increase, they use more agricultural land and then baboons compete for space with humans as a consequence of habitat alteration (Laurance et al. 2002). Similarly, as reported by Hill and Wallace (2012), field crops provide a reliable and readily accessible source of food for primates to compensate habitat loss.

Geladas are successful crop raider because of their intelligence and adaptability to changing environments like

other primates (Strum 1994, 2010; Lee and Priston 2005). Geladas sit and wait the chasers. They hide themselves on the cliff faces from the chasers. When the farmers chased them and return, geladas follow them immediately and raid crops. Similarly, during crop harvesting season, local farmers try to perform seasonal displacement of geladas from their permanent sleeping cliffs and territories into remote areas. For displacement and chasing local farmers use a combination of throwing stone, shouting, bouldering, sticking, slinging and dogs, but most of them become unsuccessful. Geladas hide on the steeply cliff which is inaccessible by chasers. Chasing primates with a pack of dogs or with a weapon or throwing stones amplifies the perception of risk (Lee and Priston 2005).

Primate populations create indirect conflict with livestock that forage on similar resources (Lee and Priston 2005). Nearly all of the respondents from both study sites had experienced crop raiding, grazing competition with livestock, and digging pasture lands by the southern geladas. Local farmers complain that geladas exert competition upon livestock grazing pasture as well as digging the pasture to consume subterranean food items. In Ethiopian highlands, geladas and livestock are usually competitors over resources. They graze together in similar fields. Those complain against geladas over livestock grazing pastures affect the conservation issues. In addition, the competition over resources with livestock may affect the population viability of geladas in different areas. Where people increase stocking rates in relation to natural vegetation availability, primates may be squeezed out or suffer reduced reproductive rates by the far more (Lee and Priston 2005).

Guarding cereal crops from raiding by southern geladas is costly in terms of energy and time. Guarding property and taking protective measures are costly owing to the time (Studsrod and Wegge 1995). It hinders traveling, meeting, marketing, household chores, mourning, and schooling. It requires the availability of guards near their farmlands throughout the daylight hours. Children may be absent in many occasions from schools, and they may also record poor result in performances. Hill (2000) and Linkie et al. (2007) pointed out that, children miss schools to guard their family fields from crop pest species. Mothers may be tired as the result of workload of protecting cereal crop from geladas raiding during day time, and doing housework during the night time. Fathers may also devote their working time and energy for protecting their cereal crop from raiding rather than doing other chores. Similarly, Tchamba (1996) and Hill (2000) reported that, guarding fields from wildlife pest incur costs to household members. Even crop raiding might be the source of quarrel among the family members. The family leader might punish his children or wife if the crop damaged by geladas after ordering to keep the farm. Such opportunity costs and economic losses undermine the conservation interest of southern geladas by the local farmers. In addition, lack of awareness about wildlife species regarding their ecological value and absence of income generation from tourism sector may decline the conservation interest of local people in the study area. Similarly, Gillingham and Lee (2003) pointed out that conservation perception declines if wild animals show negative impacts to the livelihood of local farmers.

Conclusion

Geladas are charismatic primates, and considered as flagship species for the conservation of Ethiopian highlands. They are more successful in degraded and fragmented human-modified landscapes of the Ethiopian highlands than any other African primates. The findings conclude that human–gelada conflict has serious implications for both the local conflict-affected farmers and geladas. Both the local farmers and geladas suffer in the conflicts in the study area. Local farmer loss their crops and guarding consumes a lot of energy and time. Southern geladas are harassed by local farmers in every occasion. Geladas that live outside protected areas are more disliked and exposed to conflict with local farmers than those living in protected areas, thus are more prone to harassment and retaliation killing. Therefore, conservation of geladas in the unprotected sites requires attention to save the individuals. Thus, leaving mosaic grassland habitats and creating conservation awareness campaign among the local residents and local administrators in the human-dominated landscapes within the habitat of geladas may alleviate some of the pressures like diminished suitable habitats and harassments. In addition, our study suggests that to reduce friction between local farmers and southern geladas appropriate and affordable mitigation measures like collaborating or shifting types of active guarding system should be implemented for ensuring the coexistence of local farmers and southern geladas in the future. For effective human–primate conflict resolution multifaceted technical, social, and economic approaches are required for their long-term sustainability of coexistences (Hockings and McLennan 2016; Hill 2017). These can involve combinations of both short-term (e.g., guarding) and long-term (e.g., community conservation initiatives) approaches at different spatial and temporal scales (Hockings and McLennan 2016). Exponential increase in human population of Ethiopians demands more land for agricultural activities and livestock rearing which are the major threats to the conservation of Ethiopian highland ecosystems. Thus, our study suggests that job opportunities like small scale industries for youths as alternative employment mechanisms and community based conservation initiative approaches should be implemented to minimize pressure on

the ecosystems and to ensure the conservation of southern geladas and their habitats.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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