Human–wildlife interactions and people's attitudes towards conservation: a case study from Central Kerala, India

S. K. Govind, E. A. Jayson

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Abstract

Human–wildlife interactions and people's attitudes towards conservation: a case study from Central Kerala, India. This paper studies the human–wildlife interaction in Central Kerala, India, and attempts to understand local people's attitude toward wildlife and conservation. Data were collected from April 2009 to March 2014. A structured questionnaire survey was carried out among people living in the fringe areas of the forest (n = 210). Self–reported household crop loss was modelled as a function of agricultural, demographic and environmental factors. Wild pig (*Sus scrofa*) (57.1 %) was the main crop foraging species, followed by Asian elephant (*Elephas maximus*) (12.9 %). It was reported that 36 % of farmers' annual income was lost due to crop foraging by wild animals. Leopard (*Panthera pardus*) (69.76 %), Indian rock python (*Python molurus*) (13.95 %), dhole (*Cuon alpinus*) (9.3 %) and stray dogs (6.97 %) were responsible for the attacks on livestock. The factors that influenced crop loss according to the farmers were the extent of agriculture land that they owned (coefficient = 0.968), the distance to reserve forest from crop fields (–0.009), and age of respondents (0.78). Due to people's awareness concerning the importance of wildlife, reports on human–wildlife interaction in the newspapers and strict enforcement of wildlife laws, people's attitude towards conservation of wildlife was good, and they were not taking any negative precautions against wild animals.

Key words: Human–wildlife interaction, Wildlife conservation, Wildlife management

Resumen

La interacción entre los humanos y la fauna silvestre y la actitud de las personas en relación con la conservación de la fauna silvestre: un estudio de casos en Kerala central, en la India. El presente artículo estudia la interacción entre los humanos y la fauna silvestre en Kerala central, en la India, y trata de entender la actitud de las personas en relación con la conservación de la fauna silvestre. Los datos se recopilaron entre abril de 2009 y marzo de 2014. Se llevó a cabo una encuesta estructurada entre la población que habita en los márgenes de las zonas forestales (n = 210). Se elaboró un modelo de la pérdida de cultivos comunicada por los hogares como una función de factores agrícolas, demográficos y ambientales. El cerdo (*Sus scrofa*) era la principal especie que se alimentaba de los cultivos (57,1 %), seguida del elefante asiático (*Elephas maximus*) (12,9 %). Se comunicó que el 36 % de los ingresos anuales de los agricultores se perdió a causa de los animales silvestres. El leopardo (*Panthera pardus*) (69,76 %), el pitón de la India (*Python molurus*) (13,95 %), el perro salvaje asiático (*Cuon alpinus*) (9,3 %) y los perros callejeros (6,97 %) atacaron al ganado. La superficie de tierra agrícola propiedad de agricultores que habitan en los márgenes (el coeficiente es de 0,968), la distancia de la parcela de cultivo a la reserva forestal (–0,009) y la edad de los encuestados (0,78) fueron los factores significativos que influyeron en la pérdida de cultivos comunicada por los agricultores que habitan en los márgenes del bosque. Debido a la concienciación de la población acerca de la importancia de la fauna silvestre, los artículos de prensa sobre la interacción entre los humanos y la fauna silvestre y el cumplimiento estricto de la legislación en materia de vida silvestre, la actitud respecto de la conservación de la fauna silvestre era buena y no se estaban tomando precauciones negativas contra los animales silvestres.

Palabras clave: Interacción entre humanos y fauna silvestre, Conservación de la fauna silvestre, Gestión de la fauna silvestre

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Suresh K. Govind, Department of Psychology, Christ College, Irinjalakuda, Thrissur, Kerala, 680 125 India.– E. A. Jayson, Department of Wildlife Biology, Kerala Forest Research Institute, Peechi, Kerala, 680 653 India.

Corresponding author: Suresh K. Govind. E–mail: sureshavinissery@gmail.com

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Introduction

Negative interaction between humans and wildlife (human–wildlife conflict) occurs "when animals pose a direct and recurring threat to the livelihood or safety of people, leading to the persecution of that species" (http://www.hwctf.org). Concern for such interaction in India is growing. This human–wildlife conflict and people´s attitudes towards conservation is a multi–disciplinary area of research that deals with the dimensions of both humans and wildlife (Conover, 2002). Resolving this negative interaction depends not only on the biology of wild animals, but on the perceptions of local people and their attitude towards wildlife (Treves et al., 2006; Sillero–Zubiri et al., 2007; Jacobs et al., 2012). Data are needed on human dimensions such as political, social, cultural, historical, economic and legal problems (Madden, 2004). Awareness programmes on the importance of wildlife will increase tolerance (the ability to suffer the economic loss incurred by farmers due to wild animals) among people, and reportedly reduce the frequency of conflict (Sutherland, 2000; Mishra et al., 2003). Naughton–Treves et al. (2003) stated that human–wildlife interaction is also influenced by the lifestyle of people in forest fringes. As wildlife conservation is a major problem worldwide, fostering the co–existence (the state of being together in marginal areas) of humans and wildlife is mandatory to ease the situation (Madden, 2004). In Kerala, negative interaction between humans and wildlife is a contentious issue, with crop foraging by wild animals representing a major problem (Veeramani and Jayson, 1995; Veeramani et al., 2004; Jayson and Christopher, 2008). Due to activities such as the large–scale conversion of forest into monoculture plantations, shifting cultivations, hydroelectric projects and encroachments, the accessible habitat of wild animals is reduced in the State (Report of the Western Ghats Ecology Expert Panel, 2011). This has increased the risk of conflict where humans and wildlife co–exist. Recently, Govind and Jayson (2018a) identified the species of wild animals involved in crop foraging in Central Kerala, and estimated the actual economic loss incurred by the farmers due to these animals. To manage the conflict, data on people's attitudes towards wildlife conservation is also required. In this paper, we attempted to study the human–wildlife interaction in Central Kerala, India, and to understand the people's attitude to the conservation of wildlife.

Material and methods

Study area

Thrissur district (10º 46' to 10º 7' N and 75º 57' to 76º 55' E) spans an area of 3,032 km^2 in the central part of Kerala, India (fig. 1). The district has a tropical humid climate and a plentiful seasonal rainfall from the south–west monsoon (June to August) and the north–east monsoon (September to November). Different types of soil, namely laterite, sandy loam, alluvial, clayey and black soil, are found. The district is comprised of 11 forest ranges within three forest divisions, namely Thrissur (210.64 km^2), Chalakudy (279.71 km^2) and Vazhachal (413.94 km^2), and three wildlife sanctuaries (213.44 km^2). Nearby vegetation types are moist deciduous (52.86 %), riverine (10 %) and plantations (37.14 %), including teak (*Tectona grandis*), rubber (*Hevea brasiliensis*) and cashew (*Anacardium occidentale*). Agriculture is the main occupation of people living in the fringe areas of the forest. Coconut (*Cocos nucifera*), arecanut (*Areca catechu*), rubber, cocoa (*Theobroma cacao*) and plantain (*Musa paradisiaca*) are the major cultivated crops. Multiple crops are cultivated in the private farms adjacent to the forest. Asian elephant (*Elephas maximus*), wild pig (*Sus scrofa*), leopard (*Panthera pardus*), chital (*Axis axis*), sambar (*Rusa unicolor*) and Indian giant squirrel (*Ratufa indica*) are the wild animals most commonly found in the forest.

Methods

A structured questionnaire survey (see supplementary material) was carried out among the people living on the fringe to identify the wild animals involved in the interaction with people, and to understand the people's attitude towards conservation of wildlife (Christopher, 1998). Data were collected from April 2009 to March 2014 as a part of a detailed study on human–wildlife conflict in Central Kerala. The study area was divided into grids of 2 km x 2 km (fig. 1). From each forest range, 10 % of the total grids were selected using the simple random method (table 1), and the houses within these grids were selected non–randomly. From each grid, ten houses were selected for the survey. A total of 210 houses were surveyed from six forest ranges. Non–forest areas towards the western side of the district, wildlife sanctuaries (Peechi–Vazhani and Chimmony) and some selected forest ranges (Athirapilly, Charpa, Vazhachal, Kollathirumedu and Sholayar) were omitted from grid selection as the human–wildlife interaction was negligible. These omitted protected areas, however, were visited to understand the type of control measures adopted to dissuade wild animals from approaching human habitation. Sixty questions were included in the questionnaire pro–forma (see supplementary material), mainly focusing on the details of the area, respondents characteristics, crops cultivated, crop foraging animals, methods for controlling crop foraging, livestock–lifting by carnivores, human–casualties due to wild animals, people's degree of dependence on agriculture, local beliefs regarding wildlife, local knowledge about wildlife laws, local people's opinion to mitigate human–wildlife interaction, and importance of conserving wildlife. Interviews were conducted primarily with the head of the household. If a household member over 30 years of age was absent during the survey, that house was skipped and the next house was approached. The questions of the survey sheet were prepared in English but were presented in the local language.

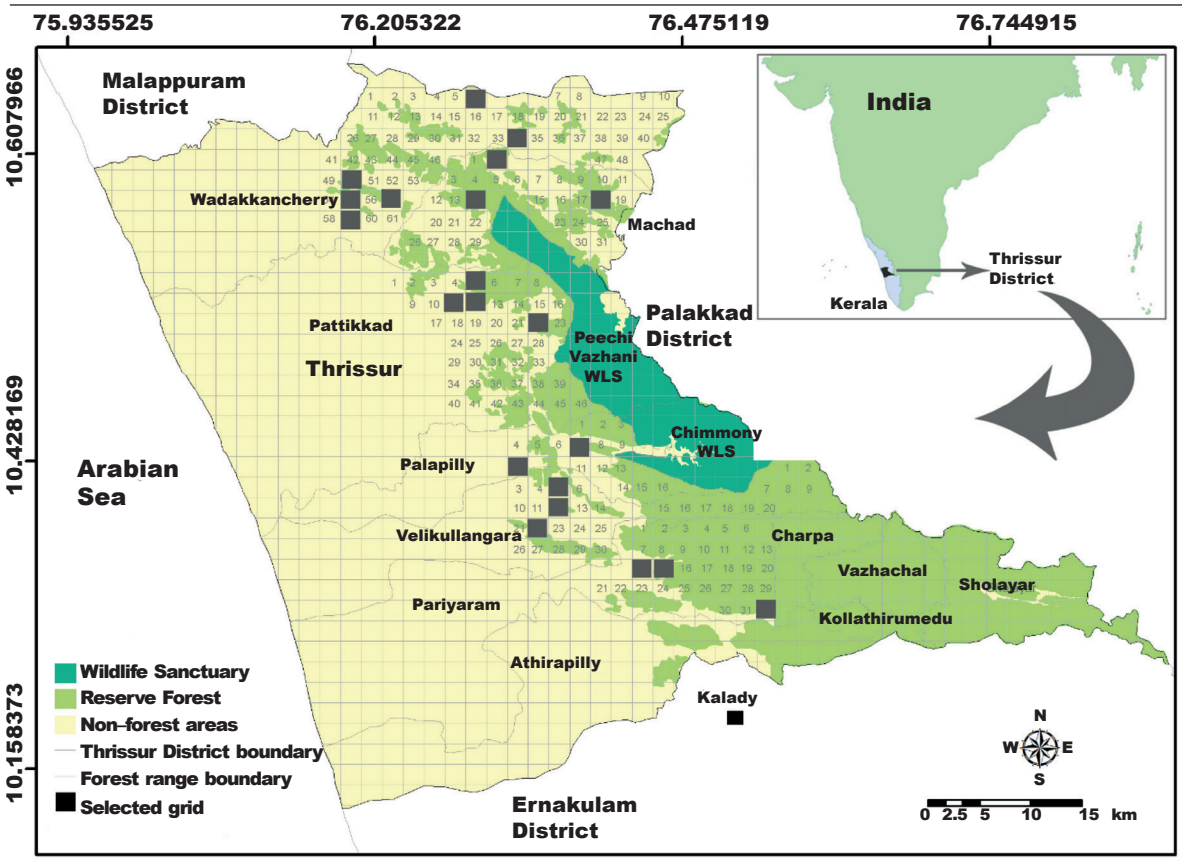

Fig. 1. Locations of the grids selected for the questionnaire survey. (Grid size 2 km x 2 km).

Fig. 1. Ubicación de los cuadrantes seleccionados para el cuestionario. (Tamaño de los cuadrantes 2 km x 2 km).

Self–reported household crop loss (percentage crop loss/annum reported by a household member) was modelled as a function of agricultural, demographic and environmental factors. Several candidate models were prepared based on the variables of the questionnaire survey (Karanth et al., 2012, 2013). Various hypotheses about the characteristics of crop foraging reported in the survey were used to represent the models. Before we ran the models, we calculated Pearson's correlation coefficients to find the collinearity of variables involved in each model. The corrected Akaike's Information Criterion (AIC_c) was used to define the models and to assess and identify the variables. The models with substantial weight (cumulative weight > 0.95) were selected as the best models (Burnham and Anderson, 2002) to identify the factors that influenced the crop loss reported by the respondents. The reports on human–wildlife interaction in the print media (national, state and regional levels) were also collected from April 2009 to March 2012 and analysed. A case study was conducted at Ernakulam district (near Thrissur district), based on newspaper reports on human–wildlife interaction, and a discussion was held with key people of the area (n = 20) to understand the predator involved in the attack on livestock.

Results

Details of the respondents

Both males (76.67%) and females (23.33%) responded to the survey and their mean age was 54.4 ± 9.2 (range, 35–70) (n = 210). Most participants were native to the area (82.86 %) but others had migrated from urban areas (less than 10 years ago). The educational status revealed that 33.33 % of the respondents had completed lower primary school, 43.33 % had completed upper primary school, 12 % had passed the Secondary School Leaving Certificate (SSLC) examination, and 9.5 % had graduated. Only 1.9 % of the respondents were illiterate. Wells were the main source of drinking water (99 %) and wood from the forest was the main source of fuel (51.43 %). On average, the respondents in the immediate fringe areas of the forest owned 0.49 ± 0.48 ha of land.

Crop foraging and livestock–lifting

Coconut (95.71 %), plantain (85.24 %), rubber (62.38 %), arecanut (37.14 %), tubers (20.48 %),

Table 1. Grids selected using the simple random method: NH, number of houses surveyed.

Tabla 1. Cuadrantes seleccionados en los que se utiliza el método aleatorio simple: NH, número de casas encuestadas.

Forest ranges	Total grids	Grids	NH
Wadakkancherry	63	6, 34, 50, 55, 57, 59	60
Machad	31	2, 14, 18	30
Pattikkad	46	5, 11, 12, 22	40
Palapilly	16	7, 10	20
Vellikulangara	30	5, 12, 22	30
Pariyaram	32	14, 15, 32	30
Total numer of houses surveyed			210

vegetables (8.57 %) (*Cucumis melo* and *Cucurbita moschata*) and paddy (*Oryza sativa*) (11.42 %) were cultivated in the fringe areas of the forests. Other cultivated crops (7.14 %) were cocoa, pineapple (*Ananas comosus*), turmeric (*Curcuma longa*) and nutmeg (*Myristica fragrans*). Tubers, namely *Amorphophallus paeoniifolius, Colocasia esculenta, Manihot esculenta, Dioscorea alata* and *Ipooea batatas,* were the crops most vulnerable to foraging by wild animals (fig. 2). Arecanut palms were damaged only by elephants. Seventy–nine percent of the respondents were planning to cultivate rubber on their farms. Wild pig (57.1 %) was the main crop foraging animal among all forest ranges, whereas elephants (12.9 %) in the crop fields were seasonal in the forest ranges, namely Pattikkad, Palapilly, Vellikulangara and Pariyaram (fig. 3). Other crop foraging animals were Indian crested porcupine (10.5 %), Indian giant squirrel (4.8 %), Indian giant flying squirrel (*Petaurista philippensis*) (4 %), bonnet macaque (*Macaca radiata*) (3.1 %) and Indian peafowl (*Pavo cristatus*) (7.6 %). Feeding on coconuts by Indian giant squirrel was reported only from the forest ranges (Pattikkad, Machad and Palapilly) adjacent to Peechi–Vazhani and Chimmony wildlife sanctuaries. In the Pariyaram forest range, common palm civet (*Paradoxurus hermaphroditus*) was reported consuming cocoa (n = 2). Twenty percent of the respondents reported attacks on livestock by carnivores. The predators were leopard (69.76 %), Indian rock python (*Python molurus*) (13.9 %), dhole (*Cuon alpinus*) (9.3 %) and stray dogs (6.97 %).

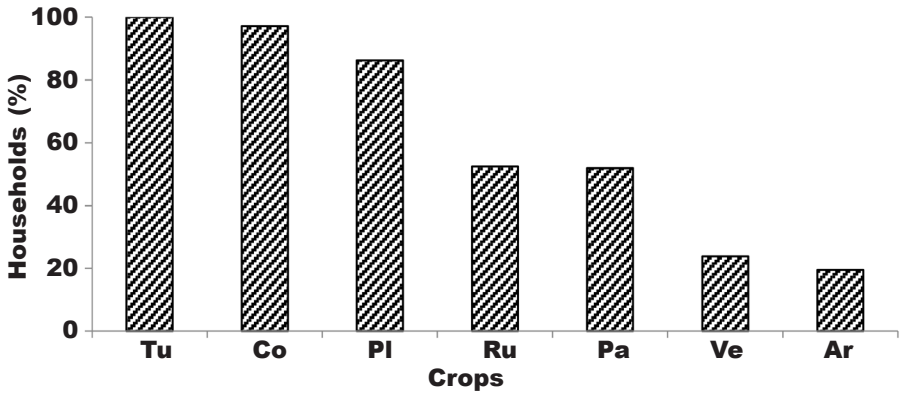

Fig. 2. Crops vulnerable to damage by wild animals in Thrissur District, Kerala: Tu, tubers, Co, coconut; Pl, plantain; Ru, rubber; Pa, paddy; Ve, vegetables; Ar, arecanut.

Fig. 2. Cultivos vulnerables a los daños ocasionados por animales silvestres en el distrito de Thrissur, en Kerala: Tu, tubérculos, Co, coco; Pl, plátano; Ru, caucho; Pa, arroz; Ve, vegetales; Ar, nuez de areca.

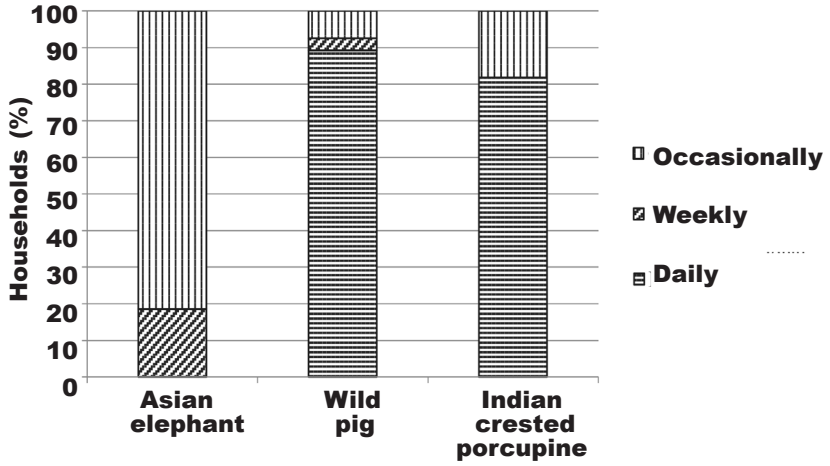

Fig. 3. Incidence of crop foraging by wild animals (n = 210).

Fig. 3. Incidencia de ataques a los cultivos por diferentes animales silvestres (n = 210).

Human dimensions

The respondents main occupation was agriculture (n = 182). The land tenure system showed that 94.29 % of the respondents legally owned their lands. A positive correlation was observed between the extent of agriculture land the farmers owned and the percentage of loss they reported (fig. 4). It was reported that 35.6 ± 16.99 percent of the people's annual income was lost due to crop foraging by wild animals. A negative relationship was observed between the extent of agriculture land possessed by the farmers and distance from the crop fields to the reserve forest (fig. 5). The respondents' awareness of wildlife laws was excellent (n = 210). A significant positive correlation was observed between respondents' age and self–reported household crop loss (fig. 6). They believed that conserving wildlife is an inevitable factor for a sustainable environment (n = 167) but considered that the government should protect crops from wild animals (n = 188). Hunting was a control method suggested to prevent wild pig from entering crop fields (n = 151). Delay on sanctioning ex–gratia by the wildlife authorities angered them (n = 99),

Fig. 4. Relationship between the extent of agricultural land (ha) and self–reported household crop loss (%) (n = 210) (r_s = 0.361, P < 0.05).

Fig. 4. Relación entre la superficie de tierra agrícola (ha) y la pérdida de cultivos comunicada por los hogares (%) (n = 210) (r_s = 0,361, P < 0,05).

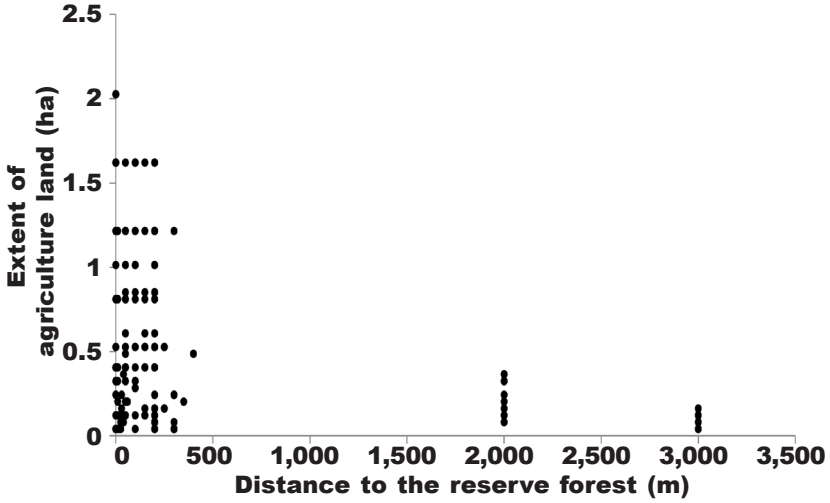

Fig. 5. Relationship between the extent of agricultural land (ha) and the distance to the reserve forest (m) (n = 210) (r_s = –0.346, P < 0.01).

Fig. 5. Relación entre la superficie de tierra agrícola (ha) y la distancia a la reserva forestal (m) (n = 210) (r_s = –0,346, P < *0,01).*

and ex–gratia payments did not entirely satisfy their requirements (n = 84). In the Kerala scenario, the farmers received only 75% of the total damages incurred due to wildlife till the year 2013. Moreover, 10,000 INR (Indian Rupees) (1 US Dollar = 60 INR) was the maximum amount given to a victim at a time, even if the perennial crops were damaged. As per the stipulations of the Kerala Forest and Wildlife Department, many certificates have to be submitted in order to receive the sanctioned amount. Another suggestion the participants made was to raise the amount of ex–gratia (n = 127).

Control measures

Farmers employed 17 types of control measure in the study area, namely, watch and ward, sound from metallic objects, cracker, dog, trench, cable wire,

Fig. 6. Relationship between respondents' age and self–reported household crop loss (%) (n = 210) (r_s = 0.38, P < 0.01).

Fig. 6. Relación entre la edad de los encuestados y la pérdida de cultivos comunicada por los hogares (%) (n = 210) (r_s = 0,38, P < *0,01).*

Table 2. Various control measures adopted to deter wild animals from the crop fields in the marginal areas of the study area.

Tabla 2. Varias medidas de control adoptadas para impedir el acceso de los animales silvestres a las parcelas de cultivo situadas en los márgenes de la zona de estudio.

Mitigative measures	Forest range	Targeted species
Watch and ward	All forest ranges	All crop foraging species
Crackers	All forest ranges	All crop raiding species
Sound from metallic objects	Vellikulangara, Pariyaram	Wild pig and sambar
Dogs	Peechi, Wadakkancherry	Asian elephant and Indian peafowl
Trench	Kollathirumedu, Sholayar	Asian elephant
Cable wire	Wadakkancherry, Pattikkad, Peechi, Machad, Vellikulangara, Palapilly, Pariyaram	Wild pig
Bright coloured clothes	Wadakkancherry, Vellikulangara	Wild pig and Indian peafowl
Spot–light	Pattikkad, Pariyaram, Peechi, Palapilly, Charpa	Asian elephant
Loud–speaker	Pariyaram	Wild pig, sambar and Asian elephant
Fences		
Stone fence (small)	Palapilly, Pariyaram, Charpa	Wild pig and sambar
Barbed fence with concrete bar	Wadakkancherry, Pattikkad	Wild pig, Indian crested porcupine and sambar
Yellow plastic sheet fencing	Pariyaram	Wild pig and Indian crested porcupine
Bamboo fence	Wadakkancherry	Wild pig and Indian crested porcupine
Fish–net	All forest ranges	Wild pig and sambar
Arecanut sheath fence	Peechi	Wild pig, sambar and Indian crested porcupine
Electric fence	Peechi, Palapilly, Pariyaram, Athirapilly, Kollathirumedu, Sholayar	Asian elephant

bright coloured clothes, spot–light, loud–speaker and different types of fencing (table 2). Watch and ward, cracker and fish–net fence were recorded from all forest ranges.

Factors influencing crop foraging

Twelve priori models were prepared to identify the significant variables, including a global model with 12 explanatory variables (table 3). The variables, namely, the extent of agriculture land possessed by farmers, the distance to reserve forest from crop field, and age of the respondent, influenced crop loss reported by the farmers (table 4).

Newspaper media reports on human–wildlife interaction

Three hundred and ten newspaper reports on this topic were published from April 2009 to March 2012. They included crop foraging by wild animals (14.19 %), livestock–lifting by carnivores (10.32 %), human–casualties due to wild animals (22.26 %), sightings of wild animals in human habitation (27 %), household damage by wild animals (4.84 %), poaching (5.16 %),

Table 3. Models included in the model sets for predicting the factors influencing crop loss reported by the respondents: land, extent of the agriculture land; agripract, agricultural practice; elev, elevation; ncrop, number of crops cultivated; distrf, distance to reserve forest; nwildsps, number of wildlife species; settle, nature of settlement; age, age of the respondent; sex, sex of the respondent; edu, educational qualification; occup, occupation of the respondent; timraidbeha, time of raiding behaviour.

Tabla 3. Modelos incluidos para predecir los factores que influyen en la pérdida de cultivos comunicada por los encuestados: land, superficie de tierra agrícola; agripact, práctica agrícola; elev, elevación; ncrop, número de cultivos producidos; distrf, distancia a la reserva forestal; nwildsps, número de especies de fauna silvestre; settle, tipo de asentamiento; age, edad del encuestado; sex, sexo del encuestado; edu, calificación académica; occup, ocupación del encuestado; timraidbeha, hora de los ataques;

Models	AICc
distrf + elev + ncrop + land + nwildsps + agripract + settle + age + sex + edu + occup + + timraidbeha	1,361.348
distrf + elev	1,333.729
distrf + ncrop	1,329.014
distrf + land	1,336.362
distrf + nwildsps	1,338.215
land + ncrop + nwildsps	1,326.262
land + agripract	1,348.366
elev + ncrop	1,342.758
settle + age + sex + edu + occup	1,326.331
distrf + nwildsps + timraidbeha + agripract	1,342.111
distrf + ncrop + land + agripract	1,325.749
elev + nwildsps	1,339.050
distrf + land + age	1,319.259

Table 4. Best model and coefficients of the factors influencing crop loss reported by respondents (Standard errors in brackets; w_i is the AICc model weight).

Tabla 4. Mejor modelo y coeficientes de los factores que influyen en la pérdida de cultivos comunicada por los encuestados (errores estándar entre paréntesis; w_i es la ponderación del modelo basado en el criterio de información de Akaike, AICc).

Model	distrf + land + age
	w_i = 0.98
Intercept	–4.399 (2.587)
Extent of agriculture land	0.96 (1.38)
Distance to reserve forest	–0.009 (0.002)
Age of the respondent	0.78 (0.18)
Model AICc	1,319.259

and public opinions on human–wildlife interaction (16.13 %). The mean number of reports published per month in the first year (April 2009 to March 2010) was 5.42 ± 2.84, in the second year (April 2010 to March 2011) it was 10.58 ± 6.04 and in the third year (April 2011 to March 2012) it was 9.58 ± 3.6 (ANOVA, $F = 4.73$, $P < 0.05$). The overall mean (reports published per month) was 8.53 ± 2.6 (n = 12). The highest numbers of reports were in May and September (fig. 7). Sixty–three percent of the published reports were on the human–wildlife interaction of the district, and of these, the highest number of reports was from Pattikkad forest range (27.09 %) (fig. 8). Asian elephant had the highest media coverage (32.58 %), followed by leopard (20.32 %) and wild pig (8.06 %). Reports included stray dog killing livestock (6.78 %), spotting of common barn–owls (*Tyto alba*) in houses (1.61 %), sambar (1.93 %) and chital falling into wells (2.26 %), and sightings of snakes (spectacled cobra *Naja naja*, Russell's vipers *Daboia russelii* and common krait *Bungarus caeruleus*) in human habitations (7.42 %). Other species included in the reports were sloth bear (*Melursus ursinus*) (2.26 %), tiger (*Panthera tigris*) (1.61 %), bonnet macaque (1.29 %), mugger crocodile (*Crocodylus palustris*) (1.29 %), Indian

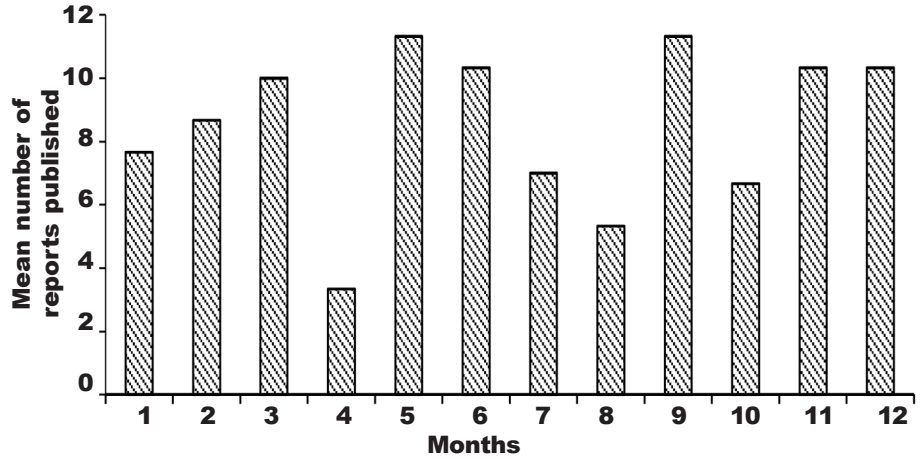

Fig. 7. Mean number of newspaper reports published from April 2009 to March 2012: 1, January; 2, February; 3, March; 4, April; 5, May; 6, June; 7, July; 8, August; 9, September; 10, October; 11, November; 12, December.

Fig. 7. Promedio de artículos de prensa publicados en diferentes meses (entre abril de 2009 y marzo de 2012). (Para las abreviaturas, véase arriba).

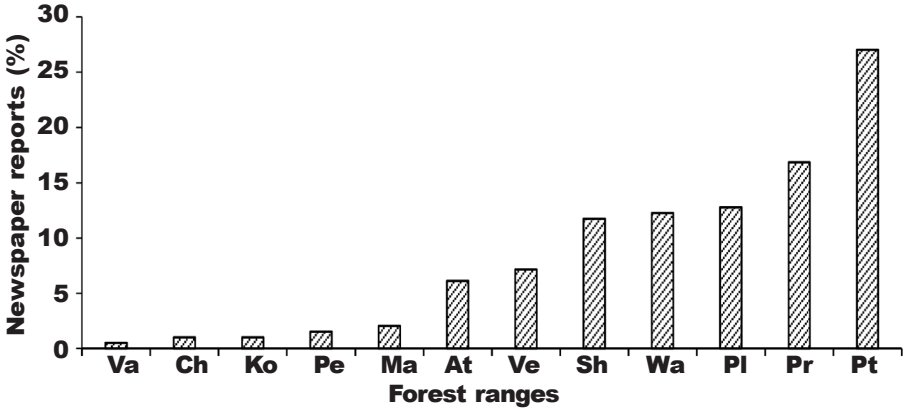

Fig. 8. Newspaper reports on human–wildlife interaction in forest ranges of Thrissur District (April 2009 to March 2012) (%) (n = 196): Va, Vazhachal; Ch, Charpa; Ko, Kollathirumedu; Pe, Peechi; Ma, Machad; At, Athirapilly; Ve, Vellikulangara; Sh, Sholayar; Wa, Wadakkancherry; Pl, Palapilly; Pr, Pariyaram; Pt, Pattikkad.

Fig. 8. Artículos de prensa sobre la interacción entre los humanos y la fauna silvestre en diferentes regiones forestales del distrito de Thrissur (entre abril de 2009 y marzo de 2012) (%) (n = 196). (Para las abreviaturas de las regiones forestales, véase arriba).

peafowl (0.97 %), smooth–coated otter (*Lutrogale perspicillata*) (0.97 %), dhole (0.32 %), jungle cat (*Felis chaus*) (0.32 %), common Indian monitor (*Varanus bengalensis*) (0.32 %), Indian crested porcupine (0.32 %), purple swamphen (*Porphyrio porphyrio*) (0.32 %), gaur (*Bos gaurus*) (0.32 %) and brown fish owl (*Bubo zeylonensis*) (0.32 %).

Reporting of unidentified wild animals killing livestock (3.26 %) created much anxiety among the people. Stray dogs killed livestock in the night hours, and the loss was blamed on 'unknown animal'. We visited Kalady (Malayattoor forest division, Ernakulam district) along with the forest officials on 14th August 2009 to identify the 'unknown animal' reported in the newspapers. A

discussion was carried out among the local people (n = 20), and a plaster cast of pugmarks was collected from the area of livestock–lifting. Local people had only a vague knowledge of the species involved in the attack. Two persons reported that it was a leopard that attacked, and the presence of a 'leopard–like animal' was identified in the dark hours by six persons. The Kerala Forest and Wildlife Department started operating a baited trap immediately after the attack. Plaster casts revealed that pugmarks of the stray dog were similar to leopard, but without any claws. Absence of claws was also observed in the captured stray dog from the site. The proliferation of stray dogs in the locality was triggered by the availability of carrion.

Discussion

Crop foraging and livestock–lifting

Negative interaction between humans and wildlife is an emerging issue in Kerala. In the study area, eight species of wild animals consumed 17 species of crops. The mode of feeding on these crops was previously reported by Jayson (1999). Due to the high price of rubber during the study period, cultivation of traditional crops (e.g. coconut, arecanut and plantain) in the fringe areas was replaced by the cultivation of rubber. The price of rubber in Kerala during 2008 was 100.54 ± 30.05/– INR per kg, whereas, in 2011, it increased to 207.96 ± 17.77/– INR (Source–Rubber Board, Kerala, India). Marginal farmers were cultivating plantain in between the young rubber plants (Govind, 2015). While eating plantains, wild animals also destroyed young unpalatable rubber plants. Asian elephant mainly consumed plantain and perennial crops, namely coconut palm, arecanut palm and rubber tree, from August to November. A similar trend has been reported from the other States of India (Gubbi, 2012; Lingaraju and Venkataramana, 2016). Wild pig consumed tubers in all seasons. The same was reported in Kerala (Jayson, 1999), North India (Chauhan et al., 2009) and Central India (Karanth et al., 2012). Feeding of fallen coconuts by wild pig and Indian crested porcupine was recorded. As the price of the coconut was low, farmers did not protect the fallen coconut from these animals. However, it was noticed that they protected the nut when the price increased (Govind and Jayson, 2018b). Protecting tender coconuts from Indian giant squirrel and Indian giant flying squirrel was also observed when their price was high (Govind and Jayson, 2018a). People deterred these squirrels from their farms by pelting stones and making sounds. Indian peafowls consumed paddy near Chulannur Peafowl Sanctuary, and the mode of consumption was by stripping off the grain from the panicle with their beaks (Govind and Jayson, 2018c). As the peafowl is considered sacred in Hindu mythology, poaching of this species is not reported. In the buffer areas of Kitam Bird Sanctuary (Pradhan et al., 2012) and Kanha National Park (Karanth et al., 2012), crop foraging by peafowl was reported. Carnivores attacking livestock were recorded in the area, with leopard being the main predator, followed by Indian rock python. Goat and poultry were the main prey of Indian rock python. Previous studies recorded several human casualties due to elephant, leopard, sloth bear, tiger and gaur. In contrast, the carnivores that killed livestock were tiger, leopard and dhole (Jayson, 1999; Christopher, 1998). Tiger and leopard were the main predators of livestock in Central India (Karanth et al., 2012) and South India (Karanth et al., 2013). Livestock–lifting by dhole was reported from some areas of India (Karanth et al., 2013; Roshnath et al., 2017).

Human dimensions

Due to the stringent provisions of the Wildlife Protection Act of India, we found that people's response towards wildlife was generally good, and it was confirmed that the lack of public awareness was not a cause for increasing conflict. When we approached farmers with no legal documents for their lands, they reacted negatively towards us. These land–owners are not eligible for ex–gratia claims for crop foraging by wild animals. Furthermore, many farmers did not claim ex–gratia as they did not know the actual economic loss incurred due to wild animals. During the survey, they also suggested immediate sanctioning of ex–gratia. Studies indicate that speedy disbursement of ex–gratia is the significant factor in increasing co–existence between humans and wildlife (Madden, 2004; DeFries et al., 2010). Hunting of wild pig was encouraged in many areas to manage populations (Beskardes et al., 2010). In Kerala, hunting is not encouraged, even though an increase in their population is recorded (Wildlife Census Reports, Kerala Forest and Wildlife Department). As per the popular demand, the shooting of problematic wild pigs in crop fields was allowed by the Kerala Forest and Wildlife Department in 2012. Due to the stringent procedures before shooting, the farmers could not employ this method to reduce the population of wild pig so as to prevent crop foraging. It adversely affected the relationship between local people and wildlife officials. Nemtzov (2003) stated that people will turn against wildlife if the conflict is high or intolerable to humans. Due to fear and anger, many leopards were killed by local people in some regions of India (Karanth and Madhusudan, 2002). Poaching of Asian elephant and wild pig was reported when the study was being carried out in the area (Govind, 2015). Due to the awareness programs conducted, local people tolerated the intensive crop foraging species, namely nilgai (*Boselaphus tragocamelus*) and blackbuck (*Antilope cervicapra*) in north India (Sekhar, 1998; Karanth and Madhusudan, 2002). In our study area also, feeding on coconuts by Indian giant squirrel is restricted only to crop fields adjacent to the wildlife sanctuaries. Due to the stringency of wildlife laws around these protected areas, people are not taking any negative precautions towards the squirrels.

Control measures

Yellow plastic sheet fencing was an innovative control method used against crop foraging animals such as wild pig and Indian crested porcupine. It has been

used to protect the newly planted rubber in the fringe areas of the forest. It is a less expensive control measure than the solar–electric fence. White plastic sheet fencing has also been reported to dissuade wild pigs from entering crop fields (Gopakumar et al., 2012). To control the damage to rubber plants, solar–electric fencing has been installed by large–scale farmers. This control method is very effective if it is properly erected and maintained (Conover, 2002; Veeramani et al., 2004). Other control measures recorded in the study have previously been reported by Veeramani et al. (2004). Lethal control measures, namely shooting, poisoning and trapping, are widely adopted to control the wildlife population, and to mitigate human–wildlife interaction (Treves and Naughton–Treves, 2005). However, these control measures may also adversely affect untargeted species (Nemtzov, 2003). The 'hunting for fear' method is another mitigative tool practised in many countries to induce a behavioural change to crop foraging animals (Cromsigt et al., 2013).

Factors influencing crop foraging

Out of three variables that were found to influence the self–reported household crop loss, two variables, namely the extent of agriculture land possessed by the farmers and the distance to reserve forest from crop field were also reported to influence the buffer areas of Kanha National Park (Karanth et al., 2012). In the study area, farmers possessed large areas of land in the fringe areas of the forest, and a huge crop loss due to wild animals was reported. Sillero–Zubiri et al. (2007) reported that the conservation attitude of older generations towards wildlife was more positive than that of younger generations. Our study contradicts this hypothesis, as the perception of local people about the crop loss was slightly higher among older people and their attitude towards wildlife conservation was neutral. Kellert (1980) stated that the attitude of rural residents was more moralistic towards wildlife than urban workers. Another study revealed that the conservation attitude of people who migrated from urban areas was irreversibly negative towards wildlife (Loker et al., 1999). It was observed that 17 % of the respondents in the study area had migrated from urban areas.

Newspaper media reports on human–wildlife interaction

Leopards often entered human habitations and local people immediately informed such events to the newspapers. In May, several news articles on leopard sightings were episodically framed and reported. Most of these reports were from Palapilly and Sholayar forest ranges, and the sightings were recorded at the end of the summer (March to May) in Kerala. Damage to plantain by elephants was high during September in the Pattikkad forest range. This is because farmers were planning to harvest plantain in the immediate fringe areas of the forest during this month for the Onam festival in Kerala (Govind, 2015). Studies indicate that the impact generated when an elephant or a leopard or leopard enter human habitation is very high compared to the impact caused by other wild animals (Jhala and Sharma, 1997; Treves and Naughton–Treves, 2005). As wildlife conservation received much media coverage in the newspapers with good photographs, awareness of wildlife laws was excellent among the people, and their attitude towards the wildlife species was positive. Local people directly informed the highest forest officials about the intrusion of any wildlife species into human habitations. Local people became anxious when the media reported the predation of an 'unknown animal' on livestock. When the media amplifies uncommon events or attacks it creates a strong response from public (Crossley et al., 2014) and increases public anxiety (Sabatier and Huveneers, 2018). Stafford et al. (2018) examined the newspaper reports on human–wildlife interaction and reported that wild animals were more commonly blamed for the conflict than humans. Corbett (1992) stated that reports from the media mainly depend on bureaucratic sources, and in certain circumstances, human–human conflicts also exacerbate human–wildlife interaction (Dickman, 2010).

Conclusion

Eight species of wild animals are foraging crops in the study area, with the wild pig being the species most responsible for this activity. Thirty–six per cent of the annual income of farmers is lost due to crop foraging by wild animals. To deter such actions, 17 ypes of control measures are being used. Fencing made from yellow plastic sheeting are an innovative method for dissuading wild pig and Indian crested porcupine from crop fields. The predators involved in the attacks on livestock are leopard, Indian rock python, dhole and stray dog. The variables, namely, extent of agriculture land possessed by the marginal farmers, distance to reserve forest from crop field, and age of respondents influence the crop loss reported by the marginal farmers. Due to people´s growing awareness of the importance of wildlife, newspaper media reports on human–wildlife interaction, and strict enforcement of wildlife laws by the authorities, the conservation attitude of people towards wildlife is good, and they are not taking any negative actions against wild animals. Avoiding the cultivation of tubers and plantains in the immediate fringe areas of the forest is recommended.

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Supplementary material

Questionnaire survey sheet with 60 yes/no questions

Hoja encuesta del cuestionario con 60 preguntas de si/no

GPS data, date and time

Details of the area
- Name of the area/colony
- Name of the Panchayat and Ward
- Nature of settlement
- Type of nearby vegetation

Respondents' demography
1. Name
2. Age
3. Sex
4. Education
5. Occupation
6. Native or migrated
7. Are you thinking to migrate from this place again
8. Source of fuel wood
9. Is fuel wood usage during the monsoon
10. How many times do you collect the fuel wood in a week
11. How much time do you spend for this collection
12. Source of drinking water

Details about cultivation
13. Do you own land and how much
14. What are the crops cultivated
15. Location of the land or farm and how far from there
16. Quality of crops damaged
17. Other crops present but not damaged
18. Parts of the plant damaged
19. Whether neighboring field or garden damaged
20. Brief outline of the agriculture calendar
21. Farmer’s ranking of crops
22. Farmer’s ranking of crops with respect to their vulnerability to crop damage by wild animals
23. Type of agricultural practice
24. If modern, why this method is used
25. Do you find any advantage to modern cultivation
26. Do you use the total area of cultivation and if no, why
27. Is there crop raiding by wild animals
28. Name the wildlife species causing damage to crops
29. Mode of attack and damage
30. Time of raiding behavior
31. Frequency of raiding
32. Where the wild animals are coming from, ie. Specific areas such as Pas to enter field or are living around the field
33. How do the farmers ranking of raiding species
34. Approximate loss
35. Are you aware about the compensation for crop damage
36. Any compensation received for crop damage
37. What are the preventive methods used against the damage

Livestock–lifting
38 Any incidence of wild animals attacking domestic animals
39 What wild animals were involved in the attack
40 Mode of attack
41 Was any compensation received
42 How is the livestock maintained

Human casualties
43 Have any human casualties occurred
44 What animals are involved in the incident
45 How did the incident happen
46 Wan any compensation received

Social dimensions of crop raiding
47 Land tenure system
48 People's degree of dependence on agriculture for subsistence
49 Whether men or women take responsibility for control of resources such as land, crop, etc.
50 Local beliefs and taboo systems regarding wildlife
51 Traditional methods for controlling crop raiding
52 Local knowledge of wildlife laws and conservation issues
53 Number of households affected locally
54 Local perceptions of the severity of damage
55 Do local people use wildlife resource
56 Do local communities think that they will get benefits from the local wildlife
57 According to local communities, who should be responsible for protecting crop against the activities of wildlife
58 Do local communities consider conservation to be an important issue locally and if so why
59 Local expectations of benefits from conservation of wildlife
60 What are the local views on how to deal with crop raiding by wild animals