WILDLIFE HUNTING PATTERNS, TECHNIQUES, AND PROFILE OF HUNTERS IN AND AROUND PERIYAR TIGER RESERVE

Sanjay Gubbi[1,2] and Matthew Linkie[3]

[1]Wildlife Conservation Society-India Program and Centre for Wildlife Studies, 1669, 31st Cross, 16th Main, Bengaluru 560 070, Karnataka, India.
[2]Present Address: Nature Conservation Foundation and Panthera, 3076/5, IV Cross, Gokulam Park, Mysore 570 002, Karnataka, India. Email: gubbi@ncf-india.org
[3]Fauna and Flora International, Jupiter House, Station Road, Cambridge CB1 2JD, UK. Email: matthew.linkie@fauna-flora.org

Hunting is believed to threaten the survival of many important wildlife species in India. However, few studies have documented this threat because hunting is prohibited under the Indian law and is therefore conducted covertly. In this study, we interviewed community members of a conservation project, who were currently or had previously hunted wildlife in and around Periyar Tiger Reserve, southern India. We documented the species hunted, hunting methods, and the profile of hunters to know the demographic and socio-economic drivers of illegal hunting. Of the 183 respondents, 32.8% had previously hunted and 7.1% were still engaged in hunting. Of the 20 different methods identified, hunters mainly used guns (33.4%), scavenged kills (30.0%), or set snares (26.7%). From 19 mammal, 12 bird and/or 3 reptile species hunted, the most commonly taken of any species were medium to large-bodied mammals (68.5%), especially Sambar *Rusa unicolor* (56.7%) and Wild Pig *Sus scrofa* (45.0%). These were mostly for household consumption or local trade. The respondents were more likely to hunt if male, married, and with a primary school education or none. For the Periyar Tiger Reserve, projects offering access to higher education**,** promotion of alternative protein use, and stricter law enforcement should strengthen efforts to reduce wildlife hunting

Key words: hunting, community-based conservation, mammals, law enforcement, Periyar Tiger Reserve

INTRODUCTION

The extraction of wild animal and plant species for subsistence and trade is widespread across the tropics and most often conducted at unsustainable levels (Bennett *et al.* 2002). Various strategies have been employed to tackle unsustainable, and often illegal, hunting of wildlife, such as increasing law enforcement effort and reducing consumer demand. Nevertheless, whether inside or outside of protected areas, hunting remains one of the principal causes of wildlife population declines (Bennett 2011; Redford 1992).

Data on spatio-temporal hunting patterns, capture techniques, species taken and hunter profiles are important sources of information for enabling a better understanding of the demographic and socio-economic drivers of illegal hunting (Milner-Gulland *et al.* 2003). These data also help conservation managers and field staff to better detect illegal hunting locations and deliver more appropriate community outreach programs that would mitigate the impacts of hunting (Eliason 1999). Such data and their patterns are well-documented for Latin America, Africa, and Southeast Asia, and tend to depict medium to large-bodied mammals as being the preferred target species and which are harvested at unsustainable levels (Bodmer *et al.* 1997; Fa *et al.* 2002; Milner-Gulland *et al.* 2003). However, for South Asia, especially India, which has some of the highest abundances and diversity of these mammals, the availability of scientific literature on illegal hunting is relatively poor and has been highlighted as a priority area for conservation research (Velho *et al.* 2012)

Hunting in India has existed since the early ages (3000 BCE), but precipitated during the Mughal rule (1526–1858 CE) and colonial periods (1757–1947 CE) (Divyabhanusinh 1999; Rangarajan 2001), and continued in one form or another after the leaving of the British, till the passing of the Wildlife (Protection) Act in 1972, which banned hunting of all forms of wildlife in India. Nevertheless, illicit hunting still continues for recreation, subsistence, trade, in retaliation to conflicts with wildlife, and as part of traditional ceremonies, especially of tribals (Aiyadurai *et al.* 2010; Datta 2007; Madhusudan and Karanth 2002). The hunters themselves range from indigenous forest dwelling communities to villagers at the forest edge, to government, army officials, and politicians (Aiyadurai 2007; Bhatnagar *et al.* 2006; Chandi 2006; Datta 2007; Hilaluddin and Ghose 2005; Kaul *et al.* 2004; Madhusudan and Karanth 2002; Mishra *et al.* 2006). Presently, hunting is considered to be more prevalent in the north-eastern states due to strong and long-standing customary traditions that are culturally similar to Southeast Asia (Datta *et al.* 2008; Aiyadurai *et al.* 2010). Studies from elsewhere in India, especially from the wildlife-rich Western Ghats, are relatively few even though hunting is documented as a serious threat to its wildlife (Kumara and Singh 2004; Madhusudan and Karanth 2002; Sukumar *et al.* 1998). Furthermore, hunting pattern characteristics are only known from a few studies (Aiyadurai *et al.* 2010; Madhusudan and Karanth
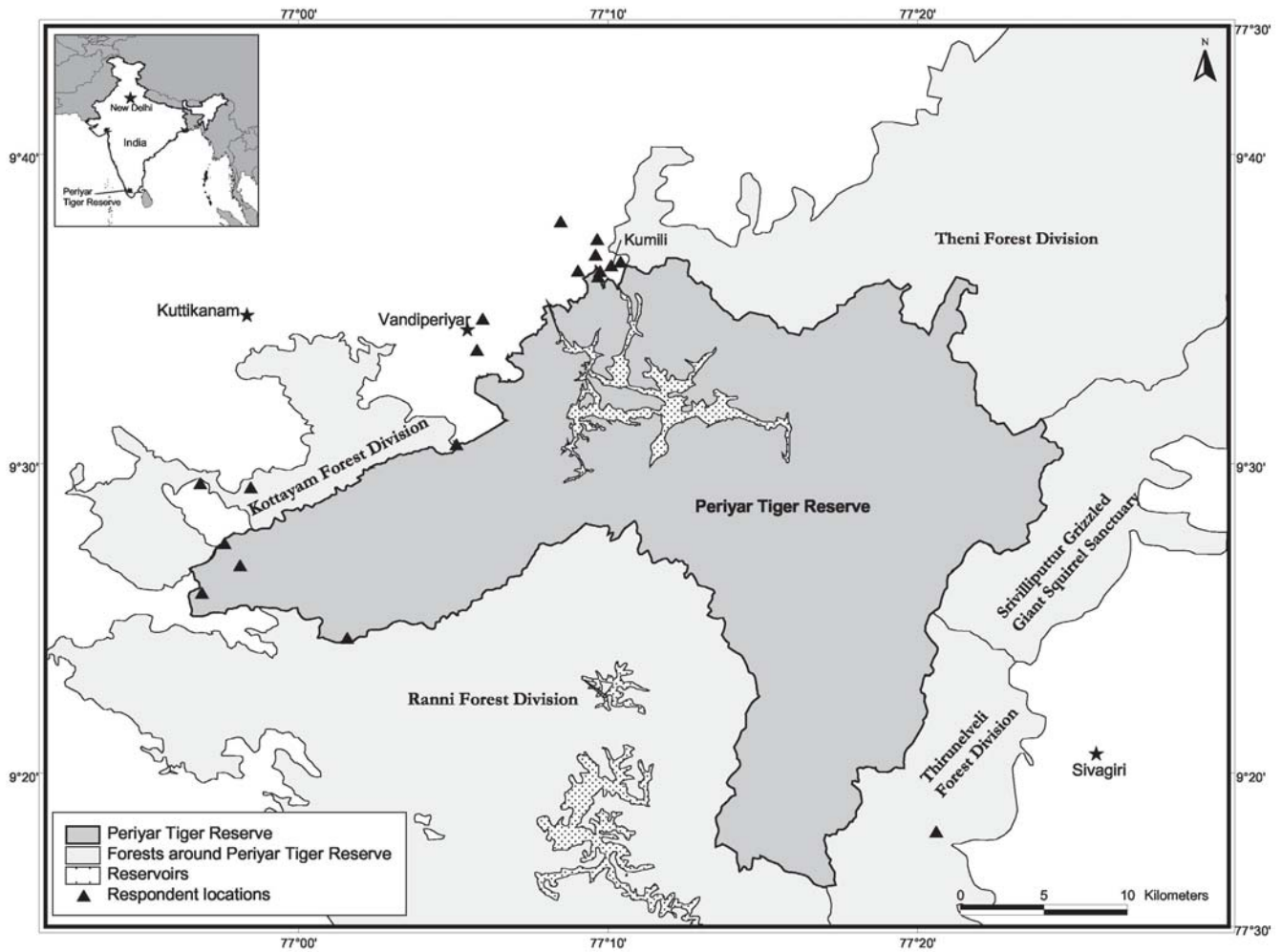
Fig. 1: Periyar Tiger Reserve, its adjoining forest divisions and locations of respondents

2002), and for such a vast, culturally diverse, and hugely populated country these would be woefully insufficient as regional studies are unlikely to apply to other states or regions.

In this study, we documented the hunting patterns in and around one of India's flagship wildlife protected areas, the Periyar Tiger Reserve, investigating the prevalence of hunting, hunting methods, hunted species, and the hunters' demographic and socio-economic profile.

STUDY AREA

The 777 sq. km Periyar Tiger Reserve (PTR), in the southern Indian state of Kerala, was established in 1950 to conserve endangered wildlife, particularly the Asian Elephant (*Elephas maximus*), Tiger (*Panthera tigris*) and its prey such as Gaur (*Bos gaurus*) and Sambar (*Rusa unicolor*). The Reserve is surrounded by two forest divisions and one wildlife sanctuary forming nearly 2,000 sq. km of contiguous forest habitat, though varying in degree of status and protection (Fig. 1). These forests consist of a diverse array of vegetation

types, including tropical evergreen forest, moist and dry deciduous forest, and high elevation grasslands (Kerala Forest Department 2001). Other important wildlife species found in this area include Leopard (*Panthera pardus*), Dhole (*Cuon alpinus*), Sloth Bear (*Melursus ursinus*), Nilgiri Tahr (*Nilgiritragus hylocrius*), Lion-Tailed Macaque (*Macaca silenus*), Nilgiri Langur (*Trachypithecus johnii*), and Great Pied Hornbill (*Buceros bicornis*).

PTR is managed by the Kerala State Forest Department that carries out law enforcement activities, through permanent and semi-permanent staff, to primarily prevent wildlife poaching, illegal timber and forest produce harvesting, and forest fires. Regular foot patrols and strategically located anti-poaching camps are the most commonly employed threat mitigation strategies.

An estimated 225,000 people live within 2 km of the PTR boundary (Kerala Forest Department 2001), including forest-dwelling communities who were relocated to the periphery of the Reserve during the 1890s and 1940s (Arun *et al.* 2001; Gurukkal 2003; Kerala Forest Department 2002).

The Reserve has a 90 km inter-state boundary with Tamil Nadu, hence a large number of migrants belonging to distinct ethnic backgrounds and traditions have settled around it. These communities depend, to varying degrees, directly and indirectly on the natural resources of PTR, including through harvesting of non-timber forest products, wildlife poaching, timber smuggling, livestock grazing, and narcotics cultivation, and through legally sanctioned tourism and pilgrimage management (World Bank 1996). Much of the land surrounding PTR is intensively farmed, mostly as cash crop plantations for tea, rubber, cardamom, and coffee.

METHODS

From May to July 2006, a structured questionnaire survey was administered to people living in and around the PTR, with the primary aim of assessing local attitudes towards wildlife conservation and participation in an US$6.0 million Integrated Conservation and Development Project (ICDP) that was implemented from 1996 to 2004 (Gubbi *et al.* 2009). From this questionnaire survey database, 183 randomly selected respondents were interviewed and their background information collected for eight demographic factors (gender, age, religion, whether local or migrant, forest dwelling or non-forest dwelling, household size, whether a nuclear or extended family unit, and the highest level of formal education in the family) and five socio-economic factors (occupation, land ownership, issues related to human-wildlife conflict, dependency on forest products, and ICDP participation). Distance of a respondent's household from the forest boundary was also measured using digitised topographic maps.

Interviews were conducted through a local informant network and trusted community members (acting as interpreters in Malayalam and Tamil, where needed) who were aware of the local issues. Here, a section from the unpublished dataset from the questionnaire survey that focussed on hunting patterns is used. We were able to obtain feedback to questions that may normally be considered sensitive because the survey team members were selected for their strong social skills and high acceptance amongst the local communities (being from the community or having spent many years successfully working with the community). All interviews were conducted with the full willingness of the respondents, who were assured of full anonymity and on the assurance that the data was being collected for scientific research for an international university (Kent) and not for the Kerala Forest Department.

Through the questionnaire, respondents were asked whether they had previously (within the past 10 years) or were currently hunting wildlife, and if so, the species targeted and the trapping techniques used. For respondents unsure of

the species name, pictures from field guides were shown (Daniel 2002; Grimmett *et al.* 1999; Menon 2003). To investigate hunting preference, species were classified by taxa (mammal, bird, or herpetofauna) and for the mammal species by their body mass (small <10 kg, medium 10–100 kg, or large >100 kg). Mean species body mass was obtained from several sources (Ali and Ripley 1987; Daniel 2002; Menon 2003; Prater 1971). The reason for hunting a species was also recorded (consumption for food, consumption as medicine, locally sold or kept as a pet). The IUCN Red List and endemic status of each species was also assigned (IUCN 2011).

The main occupation of respondents was categorised as hunter, collector of forest produce (non-timber forest product, fuelwood, thatch grass harvesting, or timber and sandalwood smuggling), self employed (small business or taxi driver), and labourer (agricultural or small non-agricultural business).

The respondents consisted of various religious groups, including Hindu, Muslim, Christian, Ezhava, Nair, Pallar, and others. Mannan, Paliyan, Oorali, Malampandaram, and Maleariyas were the former forest dwelling communities. Currently, Malampandaram is the only group that are partially nomadic and are largely dependent on natural resources for both food and cash incomes. All the respondents were residing in or around the forests of the PTR.

All questionnaire data were imported into SPSS v.14.0 statistical software (SPSS Inc., Chicago, IL, USA). After controlling for collinearity between independent variables, binary logistic regression analyses were performed to determine which variables, individually or in combination, best explained the socio-economic and demographic factors of those who had hunted medium to large bodied mammals. These candidate models were ranked by their delta Akaike Information Criterion values adjusted for small sample sizes (AICc) and by their Akaike weights (*wi*) (Burnham and Anderson 2002). For the final, top-ranked model, its performance was evaluated by calculating the area under the curve of the receiver operating characteristics (ROC) plot (Pearce and Ferrier 2000).

RESULTS

Hunting species preference and techniques

A total of 34 species were recorded to be previously or currently hunted; 19 mammal species (6 small, 9 medium, and 4 of large body size), 12 bird species and 3 reptile species (Table 1). Most of the respondents (90%) hunted mammals, in comparison to birds (66.7%) and reptiles (45%). Ungulates were the most commonly hunted mammal (31.5%), especially Sambar (56.7%), and Wild Pig (45.0%). Only two respondents

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Table 1: Wildlife species hunted in Periyar Tiger Reserve based on reports of respondents

Species	Hunting technique	Use	Red List status	Respondents who hunted (%)[+]	Body mass (kg)	Major ecological role(s) of the hunted species
Mammals				**90.0**		
Sambar *Rusa unicolor*	Gun, scavenging wild dog kills	Food – SU, SA	VU	56.7	Large	Seed disperser (Kitamura *et al.* 2002)
Wild Pig *Sus scrofa*	Gun, snare, explosives in bait, scavenging wild dog kills chase and catch	Food – SU, SA	LC	45.0	Medium	Seed disperser Seed predator (Ickes *et al.* 2001)
Mouse Deer *Moschiola meminna*	Snare, blind with torch and kill with stick, hunting dogs	Food – SU	LC	38.3	Small	Seed disperser and predator (Devy 2006)
Barking Deer *Muntiacus muntjak*	Gun, snare	Food – SU, SA	LC	30.0	Medium	Seed disperser (Kitamura *et al.* 2002)
Indian Giant Flying Squirrel *Petaurista philippensis*	Smoke out from roosting cavities or poke into roosting cavities using a sharp stick	Food – SU	LC	30.0	Small	Seed disperser and pollinator (Fujita and Tuttle 1991)
Gaur *Bos gaurus*	Gun	Food – SU, SA	VU	26.7	Large	-
Indian Giant Squirrel *Ratufa indica*	Gun, picking young ones from nest	Food – SU	LC	23.3	Small	Seed predator (Kitumara *et al.* 2002)
Nilgiri Langur *Trachypithecus johnii*	Gun	Food, MED – SU, SA	VU	13.3	Medium	Seed predator (Devy 2006)
Black-naped Hare *Lepus nigricollis*	Snare	Food – SU, SA	LC	13.3	Small	-
Nilgiri Tahr *Nilgiritragus hylocrius*	Circle the group and scare an individual down to a ditch	Food – SU, SA	EN	5.0	Medium	-
Indian Crested Porcupine *Hystrix indica*	Hunting dogs	Food – SU	LC	3.3	Medium	Seed predator (Ganesh & Davidar, 2005)
Indian Flying Fox *Pteropus giganteus*	Net, thorns stuck on branches	Food – SU	LC	3.3	Small	Long distance seed disperser (Corlett 1998, David *et al.* 2011)
Leopard *Panthera pardus*	Gun	Trade – SA	LC	3.3	Medium	Predator
Tufted Grey Langur *Semnopithecus priam*	Hunting dogs	Food – SU	NT	3.3	Medium	Seed disperser (Corlett 1998)
Indian Elephant *Elephas maximus*	Gun	Trade – SA	EN	1.7	Large	Long-distance seed disperser (Corlett1998; Kitamura *et al.* 2002)
Sloth Bear *Melursus ursinus*	Gun	Food - SU	VU	1.7	Medium	Large seed disperser (Corlett 1998)
Common Otter *Lutra lutra*	Caught in fishing nets	Food – SU	NT	1.7	Small	
Bonnet Macaque *Macaca radiata*	Gun	Food – SU	LC	1.7	Small	Seed disperser, Seed predator

Table 1: Wildlife species hunted in Periyar Tiger Reserve based on reports of respondents (*contd.*)

Species	Hunting technique	Use	Red List status	Respondents who hunted (%)[+]	Body mass (kg)	Major ecological role(s) of the hunted species
Indian Pangolin *Manis crassicaudata*	Hunting dogs	Food - SU	NT	1.7	Small	(Corlett 1998; David et al. 2011) -
Reptiles				**45.0**		
Indian Oval-grain Lizard (Monitor Lizard) *Varanus flavescens*	Chased and caught or killed with stick, with hunting dogs, stoning.	Food – SU, SA	LC	35.0	Small	-
Indian Pond Terrapin *Melanochelys trijuga*	Opportunistic picking,					
Indian Star Tortoise *Geochelone elegans*	Caught in fishing nets, hunting dogs	Food – SU		40.0	Small	-
Birds				**66.7**		
Grey Junglefowl *Gallus sonneratii*	Snare, trap, picking eggs from nests	Food – SU	LC	55.0	Small	-
Malabar Grey Hornbill *Ocyceros griseus*	Catapult, gun	Food – SU	LC	13.3	Small	Seed disperser (Kitamura *et al.* 2008)
Green Imperial-Pigeon *Ducula aenea*	Gun	Food – SU	LC	5.0	Small	Seed disperser (Kitamura *et al.*2006)
Blossom- headed Parakeet* *Psittacula roseata*	Catapult	Pet – SU	LC	4.4	Small	Seed predator (Ali and Ripley 1987)
Great Pied Hornbill *Buceros bicornis*	Collecting young ones and eggs from nests	Food – SU	NT	3.3	Small	Seed disperser (Kitamura *et al.* 2002; 2008)
Malabar Parakeet* *Psittacula columboides*	Catapult, stoning	Food and Pet – SU	LC	3.3	Small	Seed predator (Ali and Ripley 1987)
Lesser Hill-Myna *Gracula indica*	Catapult, stoning	Pet – SU	LC	1.7	Small	-
Common Myna* *Acridotheres tristis*	Catapult, stoning	Food, pet – SU	LC	1.7	Small	Seed disperser (David *et al.* 2011)
Coucals* *Centropus sinensis* and *C. bengalensis*	Catapult, stoning	Food and MED – SU, SA	LC	1.7	Small	Predator (Ali and Ripley 1987)
Barbets* *Megalaima* spp.	Catapult, stoning	Sport – SU		1.7	Small	(David *et al.* 2011)
Sunbirds* *Nectarinia* spp.	Catapult, stoning	Sport – SU		1.7	Small	Pollinator (Ali and Ripley 1987)
Bulbuls* *Pycnonotus* spp. and *Iole indica*	Catapult, stoning	Sport – SU		1.7	Small	Seed disperser (Kitamura *et al.* 2002; David *et al.* 2011)

SU – Self use, SA – Sale, MED – Medicinal use

EN – Endangered, NT – Near Threatened, VU – Vulnerable, LC – Least Concern

Category of body mass: Small – <10 kg, Medium – 10–100 kg, Large – >100 kg

*caught as pets; [+]cumulative totals will exceed 100% as most respondents hunted more than one species

reported hunting leopard and elephant, for their body parts (pelt and ivory, respectively), and both were being prosecuted at the time of interview. The Red List threat status of the reported hunted species included three Endangered, four Vulnerable and two Near Threatened, with the remaining (25) being Least Concern. Nilgiri Langur and Nilgiri Tahr were the two endemic species reported to be hunted.

A total of 20 different hunting methods were reported and these were mostly (85%) traditional techniques (snares, scavenging dhole kills, hunting dogs, smoking from roosting cavities, etc.). Some (36.7%) respondents used modern hunting methods (guns, explosive baits, and blinding animals with a torch) for capturing high meat-yielding species (e.g. Gaur, Sambar, Wild Pig, Nilgiri Langur, Mouse Deer, Barking Deer, and Sloth Bear).

Hunter characteristics/profile

Of the 183 respondents, 32.8% had hunted wildlife species in the past and a few (7.1%) were currently involved in hunting, but the majority (60.1%) had never hunted. Of the respondents who reported to have hunted, most were male (83.3%), with 1.7% of the respondents in the age group of 18–25 years, 30% were 26–35 years, 33.3% were 36–45 years, 20% were 46–55, and 15% were above 55 years. Respondents from older age groups (26 and above) formed the majority (98.3%) of the hunters.

Both forest dwelling (60%) and non-forest dwelling (40%) respondents reported to have hunted in the past, with 62.7% being locals (from within the state) and 37.3% migrants who or whose parents had moved into this area, mostly from the neighbouring state of Tamil Nadu, in search of employment. Agricultural land was owned by 50% of the hunter respondents. Of the 60 respondents, 20% had no education, 45% had completed primary education, 33.3% had high school education, and only 1.7% had attained a tertiary level of education.

The respondents resided at a mean distance of 1.2 ±1.86 km (±SD) from the forest boundary. There was a clear difference between the sexes as only 16.7% of those involved in hunting (n=60) were women, and these were mostly involved in the collection of eggs from bird nests. Of these, only a few (5.6%) reported hunting methods using hunting dogs, catapults, and taking meat from Dhole (*Cuon alpinus*) kills. Only one female respondent reported to be currently active in hunting, whereas 21.7% of the men were still active.

Investigating the factors that best explained the characteristics of those previously involved in hunting, revealed a significant relationship with five factors (main occupation, gender, education, religion, and family type; Table 2, Model 1.1). Respondents were more likely to hunt if male, married, and with no formal education or with primary school education. Those working primarily as labourers were less likely to hunt. There was no effect from secondary occupation, age, household size, ownership of land, area of land owned and participation in the ICDP. Analysing the combination of factors that best explained the profile of an active hunter (n=13) was not possible due to the small sample size, and so this study makes the assumption that hunting patterns were similar to those that had previously hunted.

DISCUSSION

Our study provides the first insights into wildlife hunting patterns in and around the PTR, and it also responds to the recent call for quantitative studies of hunting patterns in India (Velho *et al.* 2012). The results were encouraging in that whilst hunting was prevalent in the past, with 32.8% of the respondents having previously hunted, it is less common today, with only 7.1% hunting. Nevertheless, although wildlife harvest levels were not recorded in this study, the

Table 2: Logistic regression models that best explained the characteristics of respondents who had hunted medium to large-bodied mammals in the past

Model	2log likelihood	K	ΔAIC	w_i	r^2
1.1 occupation+gender+education+religion+family*	40.09	6	0.00	0.665	0.709
1.2 occupation+gender+religion+family	44.64	5	2.55	0.186	0.671
1.3 occupation+gender+education+religion	46.32	5	4.24	0.080	0.657
1.4 occupation+religion+education	48.72	4	4.63	0.066	0.636
1.5 occupation+religion+gender	52.77	5	10.69	0.003	0.601

*ROC±S.E. = 0.977±0.01, indicating a good model fit

widespread use of guns in PTR and unsustainable hunting patterns identified from elsewhere in India offer a cautionary note for the future of PTR's endangered mammal populations.

A hunting preference for larger-bodied wildlife species in PTR, particularly high yielding meat species (e.g. Sambar, Wild Pig, and Gaur), is consistent with other studies in the Western Ghats region (Karanth 2007; Madhusudan and Karanth 2002) and the preference for hunting with guns and snares that can potentially off-take higher levels of biomass, especially for the preferred medium to large-bodied animals, suggests that law enforcement patrolling is still a necessary management strategy for PTR.

In this study, hunting patterns between the sexes were found to markedly differ. Women were mostly involved in collecting bird eggs for household consumption. This was an activity that was carried out opportunistically while collecting fuel-wood and other forest products. Women normally do not participate in hunting mammals as it is riskier, e.g. it involves walking through forests at night and the stigma of going to trial if caught is considered to be significantly worse for women. In contrast, men predominantly hunted medium to large-bodied wildlife, which was used typically for household consumption or for sale at local markets. Hunting was not part of a community ritual, as it is in some other Asian ethnic groups (Aiyadurai *et al.* 2010; Datta 2002; Hilaluddin and Ghose 2005). Thus, providing communities with inexpensive, culturally appropriate and alternative sources of protein (e.g., poultry) is predicted to yield important reductions in the consumption of protected species. Furthermore, there is a changing economic situation in southern India with domestic meat becoming widely available and at lower prices than wild caught animals (Hilaluddin and Ghose 2005). Many of this

study's respondents lived in places with good market access, so increasing awareness and strengthening market linkages in the rural communities should discourage wild meat use as a protein source.

Education was found to be an important determinant of hunting. Respondents with primary school level education or none were found to be more likely to hunt, probably because higher education enabled better paid and non-forest dependent jobs to be secured, as found in Northeast India (Hilaluddin and Ghose 2005). Though education levels in Kerala are among the highest in India, these benefits have not yet fully reached those living near PTR. Thus, it is anticipated that rural education programmes would be an effective way of delivering simultaneous conservation and livelihood benefits.

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