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Conservation implications of wildlife utilization by indigenous communities in the southern Western Ghats of India

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ABSTRACT

Wildlife utilization in the tropics is massive, with nearly 5 million tons of bushmeat consumed by local communities. In India, a megadiversity nation, hunting—although illegal—is widespread among indigenous communities. However, the extent, frequency, and rationale for hunting, and factors influencing wildlife utilization are poorly known. Our study, based on 19 different indigenous communities in the Western Ghats region, revealed the utilization of 54 wild species/taxa. Although freshwater fish, herpetofauna, and small mammals were most frequently utilized, enforcement by the Forest Department was largely focused on large mammals. Gender, land ownership, number of domestic meats consumed, distance to markets, time spent hunting, and distance to hunting areas were major factors that affected wild meat utilization in the region. Although conservation needs to be focused on the most utilized groups, increasing access to domestic meats at remote settlements and integrating utilization of common, culturally prominent species can improve conservation of threatened fauna.

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Introduction

Forest-dwelling communities have relied on wildlife as a source of protein and income, and wild meat continues to support the subsistence of numerous indigenous communities worldwide (Cowlshaw et al 2005; Mfunda and Røskaft 2010). In at least 62 countries, fish and wildlife contribute to about 20% of animal protein in rural diets (Nasi et al 2008), sometimes reaching 67–80% as in Sarawak and Central Africa (Peres 2000; Bennett et al 2002). Wild meat is also rooted within the culture of indigenous communities (Brown and Marks 2007; Chinlapianga et al 2013).

The scale at which wild meat is laundered from the tropics is massive, with several thousand tons being harvested annually from the forests of Africa, Asia, and South America (Fa and Peres 2001; Corlett 2007; Nasi et al 2011; Abernethy et al 2013). Data

collected in the 1990s revealed that local communities consumed more than 5 million tons of meat in Neotropical and Afrotropical forests (Fa and Peres 2001; Fa et al 2002). Such massive scale of overhunting for meat has resulted in local extirpation of numerous species (Milner-Gulland and Bennett 2003; Harrison 2011). However, wild meat also has significant impacts on the livelihoods of human communities that subsist on this resource (Bennett et al 2002; de Merode et al 2004). For example, in the Democratic Republic of Congo, 90% of the hunted meat is traded for vital commodities, medical supplies, or equipment to enhance the income-generating capacity of rural households (de Merode et al 2004).

In India, a megadiverse nation harboring four biodiversity hotspots, the Wildlife Protection Act (WPA) was formulated in 1972 to protect wildlife and their related habitats. Various taxa are listed in six schedules of the Act, with those listed in Schedule I and Schedule II (Part II) being accorded absolute protection. Hunting, collection, or trade of trophies and animal articles derived from species listed in all the schedules of the WPA except Schedule V is prohibited or controlled. Only the indigenous communities living in the Andaman and Nicobar Islands are allowed to hunt as per the WPA, whereas the Forest Rights Act of 2006 enables indigenous

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communities throughout the country to sustainably harvest minor forest products such as honey, lac, cocoon, herbs, and freshwater fish. In reality, numerous indigenous communities in the North-eastern and southern regions of India continue to hunt wild meat for consumption, and for supply to eateries and markets near their settlements (Madhusudan and Karanth 2002; Aiyadurai et al 2010; Kanagavel and Raghavan 2013).

The Western Ghats region in peninsular India, comprising a major portion of the Western Ghats–Sri Lanka Biodiversity Hotspot, harbors exceptional diversity of flora, fauna, and fungi (Myers et al 2000; Bawa et al 2007; Molur et al 2011). Apart from its rich biodiversity, the Western Ghats is also known for its very high human population density and pressure (Cincotta et al 2000; Shi et al 2005). This high demographic pressure, coupled with macroeconomic factors, poverty, and poor governance have contributed to increasing anthropogenic impacts on the biodiversity of this region (Bawa et al 2007). Hunting driven by tradition, culture, subsistence, and demand for wild meat occurs across the Western Ghats (Madhusudan and Karanth 2002; Bawa et al 2007; Kanagavel and Raghavan 2013), with a recent study observing that 34 species are hunted in and around a protected area in the region (Gubbi and Linkie 2012). There is, however, a severe lack of understanding regarding the use of wildlife by indigenous communities (Velho et al 2012).

Through this study, focusing on the forests in the state of Kerala, which encompasses the southern region of the Western Ghats (Figure 1) and is one of the most biodiversity-rich regions in the Western Ghats–Sri Lanka hotspot, we aimed to (1) understand the extent, magnitude, methods, and rationale for wildlife utilization among indigenous communities; (2) examine the dynamics of meat consumption (wild vs. domestic); (3) generate information on the factors that influenced wild meat consumption; (4) assess the response to potential measures to reduce wild meat utilization; and (5) explore the existent law enforcement by the Forest Department (FD) towards wild meat utilization by indigenous communities.

Materials and methods

Study area

Kerala State (38,863 km²), located in the southwestern part of the Western Ghats (Figure 1), comprises of tropical wet evergreen, semi-evergreen, and tropical moist deciduous forests. These forests are protected by the Kerala State Forest and Wildlife Department through a network of protected areas spread across 3,212 km² (KFD 2012). For the purpose of territorial jurisdiction, the FD is composed of 5 administrative circles—Northern, Eastern, Central, High Range, and Southern (Figure 1). A population of 484,839 individuals (Census of India—2011) belonging to 35 forest-dwelling indigenous communities, each with its own set of traditions and culture, are known from this region. Most of these communities are historically nomadic hunter–gatherers (Sathyapalan and Reddy 2010), and the practice of wild meat consumption for subsistence, medicine, and local trade is reported among them—with Sambar deer (*Rusa unicolor*), wild boar (*Sus scrofa*), Grey Junglefowl (*Gallus sonneratii*), and monitor lizard (*Varanus flavescens*) being the most utilized species (Yeshodharan et al 2011; Gubbi and Linkie 2012; Vijayakumar et al 2015). Chelonians, by contrast, are a delicacy among the suburban and indigenous communities that consume them locally at their households, toddy (locally brewed liquor) shops and hotels; with no interstate trade (Krishnakumar et al 2009; Gubbi and Linkie 2012; Kanagavel and Raghavan 2013). Hunting is thought to have reduced among most indigenous communities in the region, and many of the local inhabitants have taken up farming as an alternative livelihood (Sathyapalan and Reddy 2010). Whatever hunting that continues is practiced largely using traditional techniques such as snares, scavenging from Asiatic wild dogs (*Cuon alpinus*) and domestic hunting dogs, with guns and explosive baits being rarely used (Gubbi and Linkie 2012).

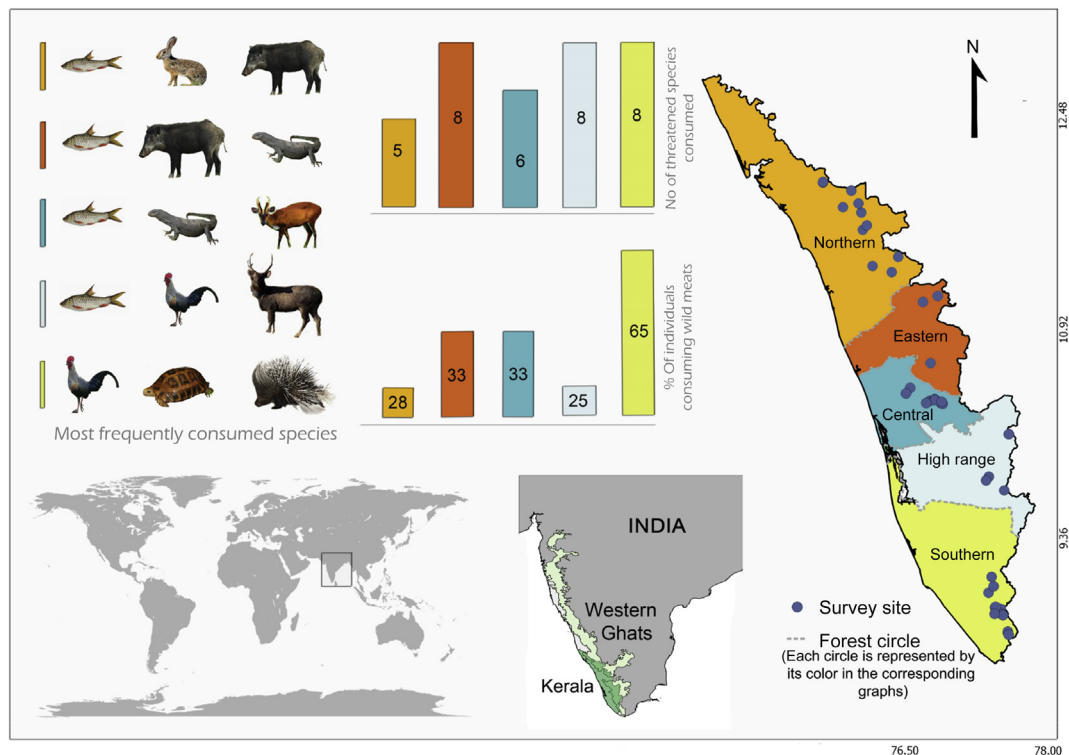


Figure 1. Map of the Kerala part of the Western Ghats with details of the frequently consumed wild species/taxa, number of threatened species consumed and extent of indigenous individuals consuming wild meat (mean percentage of all wild meat species/taxa consumed) in the five administrative forest circles.

Questionnaire survey

Because the information to be collected was of a sensitive nature, we carried out the survey at specific sites within the five forest administrative circles, where we had access to indigenous individuals who we were familiar with and trusted their information see [Madhusudan and Karanth 2002](#). A key informant from each indigenous community accompanied the interviewers (maximum of 2 individuals) to introduce them and the study to potential respondents at each site. Respondents from the indigenous communities at each site were selected based on the suggestions of these key informants. We attempted to reduce inaccuracy in the survey questions in this manner by allowing the key informants to choose respondents who they, in turn, were familiar with and considered trustworthy.

A pilot survey was undertaken to test a draft questionnaire and prepare a list of species that were commonly consumed across the region as revealed during our previous studies ([Kanagavel and Raghavan 2012](#); [Kanagavel et al 2013](#)). The final questionnaire was adjusted according to the feedback. Vertebrate groups, namely, mammals, birds, herpetofauna, and freshwater fish, were the groups targeted for the survey. Freshwater fish collected from within forested/protected areas have not been considered as wild meat/bushmeat, whereas non-domesticated terrestrial mammals, birds, reptiles, and amphibians gathered as food resources are considered as wild meat ([Nasi et al 2008](#)). However, given the fact that 60% of the native freshwater fish fauna in Western Ghats is endemic ([Dahanukar and Raghavan 2013](#)), one-third is threatened with extinction, and a large number of threatened species are harvested for subsistence ([Dahanukar et al 2011](#); [Raghavan et al 2011](#)), freshwater fish collected by the indigenous respondents from forest streams in this study have been considered as wild meat. After receiving the consent of respondents (names not recorded), face-to-face questionnaires with close-ended questions were administered in Malayalam, the local language of the region.

We requested details from respondents regarding the wild and domestic meat they consumed, including their favorite meat, frequency of consumption, rationale, source, and effort ([Table 1](#)).

Details on trade in wild meat were also recorded. Whether conservation mitigations of alternative domestic meat and livelihood opportunities would help in reducing dependence on wild meat was assessed. Socio-economic characteristics of the indigenous respondents were also recorded ([Table 2](#)).

A total of 311 questionnaires were administered between 2011–2013 among 19 indigenous communities in the five forest circles ([Table 2](#)), of which 11 were incomplete. Only 300 responses were therefore considered for further analyses.

Law enforcement by FD

We wanted to understand how the FD reacted to wildlife utilization by indigenous communities in terms of charging them as per the rules of the WPA. Towards this end, using the Right to Information Act (RTI), Government of India, 2005, we requested for information from the Kerala State Forest and Wildlife Department on violations of the WPA by indigenous communities for the period 2003–2012, including the status of these cases, and details of materials seized. A total of 44 responses were received, of which 23 were rejected because they stated that the requested information was unavailable as caste/religion was not recorded ($n = 10$), that no such offenses were recorded ($n = 4$), and that the RTI did not have a provision to provide consolidated data towards which the concerned office could be visited ($n = 4$). Of the 21 positive responses, which consisted of 125 individual cases, 75 were further processed as the rest of the cases did not provide details of the community type.

Analyses

All responses for the various questions and socio-economic characteristics were suitably coded for subsequent analysis ([Tables 1 and 2](#)). The different wild species/taxa consumed by the respondents were grouped under freshwater fish, herpetofauna, birds, small mammals, and large mammals. Mammals generally weighing less than 5 kg ([Bourliere 1975](#)) and those listed by the International Union for Conservation of Nature (IUCN) SSC Small Mammals

Table 1. Summary of responses received from indigenous communities in the Kerala part of the Western Ghats.

Query	Frequency (%) or mean \pm standard deviation
No. of meals per day	1–5 meals/d, 2.8 ± 0.6
Types of domestic meat consumed	98% = fish, 97% = poultry (egg, chicken, duck), 70% = livestock (mutton, beef, pork, rabbit)
Source of domestic meats	Market/hotel = 86.6%, Homegrown = 12.3%, Gift = 1.1%
Frequency of market visit	17.6% = twice or more times in a week, 52.3% = once in 2 weeks, 25.2% = once or twice a month, 2.1% = less than once a month, 2.8% = never visit
Does the vendor visit you?	73.4% = yes, 26.6% = no
Favorite domestic meat	54% = poultry, 28% = livestock, 24% = fish, 2% = all domestic meats
Wild meat type consumed	88% = freshwater fish, 75% = herpetofauna, 56% = birds, 76% = small mammals, 77% = large mammals
Time spent for a hunting event	0–1440 hours, 33.4 ± 121.2 hours
Distance of hunting	8.9% = close to settlement, 26.7% = moderately away, 63.4% = very far away, 1% = adjoining forest
Favorite wild meats	32% = herpetofauna, 31.3% = small mammals, 20.0% = large mammals, 8.3% = all wild meats, 6.7% = birds, 4.3% = freshwater fish
Wild meat purchased	14.3% = yes, 85.7% = no
Wild meat type purchased	85.5% = freshwater fish, 14.5% = barking deer, mouse deer, wild boar, porcupine, flying squirrel, mongoose, monitor lizard & wild hare
Wild meat purchased from	60% = same community or other indigenous communities, 40% = non-indigenous locals
Wild meat sold	20% = yes, 80% = no
Type of wild meat sold	Freshwater fish
Wild meat sold to	65% = village forest council stall, 29.5% = hotel, 5.5% = locals
Meat preference	58.2% = wild meat, 22.3% = domestic meat, 17.1% = wild & domestic meat, 2.4% = do not like meat
Interest in a Forest Department job	62% = yes, 30.7% = no, 7.3% = already working with Forest Department
If Government provided domestic meat, will you stop eating wild meat?	38.1% = will not stop, 18% = will stop, 19.2% = might stop, 8.2% = do not know, 16.5% = currently do not consume wild meat

Table 2. Socio-economic characteristics of indigenous respondents ($n = 300$) from the Kerala part of the Western Ghats.

Variables	Description, grouping in frequency (%) or mean \pm standard deviation
Age	Respondent's age (y): <18 y = 2.3%, 18–30 y = 24.3%, 31–50 y = 47%, >50 y = 26.3%
Gender	63.7% = male, 36.3% = female
Particularly Vulnerable Tribal Group (PVTG)	Respondents belonging to primitive tribal groups (Ministry of Tribal Affairs 2012); 21% = yes, 79% = no
Income	Monthly income earned by the respondent in US\$. US\$0–804.31, US\$89.84 \pm 78.06
Land ownership	Whether the respondent owned any land or not. 80.3% = yes, 19.7% = no
Forest circle	Kerala State Forest and Wildlife Department is composed of five administrative circles. Northern = 19%, Eastern = 17.3%, High Range = 18.3%, Central = 23.1%, Southern = 22.3%

Specialist Group were classified as small mammals, whereas the rest were classified as large mammals. In cases where only one species/taxon within a group was recorded as being consumed, the entire group was considered to be consumed. With regard to frequency of consumption, the highest frequency among the different species/taxa within the group was considered as the frequency of the entire group. The frequency at which each wild species/taxa were consumed was further analyzed to understand whether or not the respondent currently consumed them. If the respondent stated that the species/taxa had only been consumed ≥ 15 years ago, it was assumed that species/taxa was not consumed currently. Instead, it was included as being consumed over the respondent's lifetime. Whether the wild species/taxa were specifically targeted for consumption or were captured incidentally was extrapolated to the entire group by calculating the mean of the coded values, which was rounded off to the closest whole number. Domestic meat consumption was similarly coded and grouped under fish, poultry, and livestock (Table 1). The coordinates for the markets visited by respondents for domestic meats were derived from Google Earth (Google Inc., Mountain View, CA, USA), and Quantum GIS (QGIS Development Team) was used to compute the linear distances (km) between the markets and indigenous settlements. Statistical analyses were performed using SPSS version 13 for Windows (IBM Corp., Armonk, NY, USA). Frequencies, percentages, and related means and standard deviations for the responses were first calculated to understand overall trends in the data. We expected a decrease in wild meat consumed currently to that consumed over the respondents' lifetime owing to the effect of urbanization and increased enforcement effectiveness of FD (Sathyapalan and Reddy 2010), which was calculated using Mann–Whitney U test. Consequently, the total number of species/taxa within each group that were not currently consumed was calculated, and Kruskal–Wallis test was used to understand whether consumption had reduced only in specific groups. We also tested (using Mann–Whitney U test) this hypothesis among individuals who were employed with the FD, assuming that such a job could have led to a reduction in wild meat consumption. Multinomial logistic and multilinear regressions were carried out to understand the socio-economic and hunting-related factors (Tables 3 and 4) that influenced the current consumption of wild meat and the total number of wild species/taxa consumed.

Results

Wild meat

A total of 54 species/taxa were consumed; their local names, endemism to Western Ghats, IUCN Red List status, consumption in the forest circles surveyed, and the rationale for utilization are provided in Appendix 1. Of the 39 identified species (nine endemic to Western Ghats) whose conservation status has been assessed by the IUCN, four were “Endangered,” six were “Vulnerable,” and five were “Near Threatened” (Appendix 1). The most widely consumed faunal group among the sample was freshwater fish followed by

Table 3. Multinomial logistic regression results that explain the correlates of the current consumption of wild meat by indigenous communities in the Kerala part of the Western Ghats (model $\chi^2 = 36.7$, $df = 10$, $p < 0.0001$, $-2 \log$ likelihood = 88.1; pseudo R^2 (Nagelkerke) = 0.36).

Variable	Estimate	Std. error	Wald	p
Intercept	15.65	4.5	12.4	<0.001
Forest circle	−0.73	0.4	3.3	0.07
Age	−0.02	0.4	0.003	0.96
Gender	−1.91	0.8	6.3	0.01
Monthly income	0.00	0.0	0.3	0.59
Land ownership	−1.95	0.6	10.2	0.001
PVTG	−1.63	1.2	1.7	0.19
Market distance	−0.12	0.1	3.8	0.05
Market visit	0.28	0.3	0.8	0.39
Seller visit	−0.48	0.7	0.5	0.50
Meat preference	−0.43	0.3	1.6	0.20

PVTG = Particularly Vulnerable Tribal Group; Std. = standard.

large mammals, small mammals, and herpetofauna (Table 1), whereas freshwater fish followed by herpetofauna and small mammals were the most frequently consumed groups (Figures 1 and 2A). The majority of respondents rated herpetofauna and small mammals as their favorite wild meats (Table 1).

Although there was no significant difference between the extent of wild meat consumed currently, and over the respondent's lifetime (Mann–Whitney U test, $Z = -1.25$, $df = 1$, $p = 0.21$), there was significant difference between the total number of wild species/taxa currently consumed and over the respondent's lifetime (Mann–Whitney U test, $Z = -9.7$, $df = 1$, $p < 0.0001$). Respondents consumed fewer wild species/taxa currently (7.9 ± 6.5) than during their lifetime (9.2 ± 6.4), and this reduced consumption varied among the different groups of wild species/taxa (Kruskal–Wallis test, $\chi^2 = 51.4$, $df = 4$, $p < 0.0001$). Small mammals (0.61 ± 1.7) and large mammals (0.29 ± 0.8) were the groups within which the total

Table 4. Multilinear regression results that explain correlates of the total number of taxa/species currently consumed as wild meat by indigenous communities in the Kerala part of the Western Ghats ($F = 16.97$, $df = 12$, $p < 0.0001$).

Variable	Regression coefficient	Std. error	β	t	p
Constant	12.52	2.66		4.70	<0.001
Forest circle	−0.59	0.27	−0.33	−2.24	0.027
Age	0.68	0.33	0.11	2.08	0.039
Gender	−1.41	0.66	−0.15	−2.15	0.033
Monthly income	0.00	0.00	−0.11	−1.92	0.057
Land ownership	−0.19	0.57	−0.02	−0.34	0.738
PVTG	−1.52	0.74	−0.14	−2.06	0.041
Market distance	−0.08	0.04	−0.15	−2.26	0.025
Market visit	−0.45	0.32	−0.08	−1.41	0.160
Seller visit	0.61	0.55	0.06	1.11	0.269
Total domestic meats consumed	0.60	0.23	0.16	2.64	0.009
Time spent hunting	0.01	0.002	0.24	4.46	<0.001
Hunting area	−0.83	0.17	−0.33	−4.93	<0.001

PVTG = Particularly Vulnerable Tribal Group; Std. = standard.

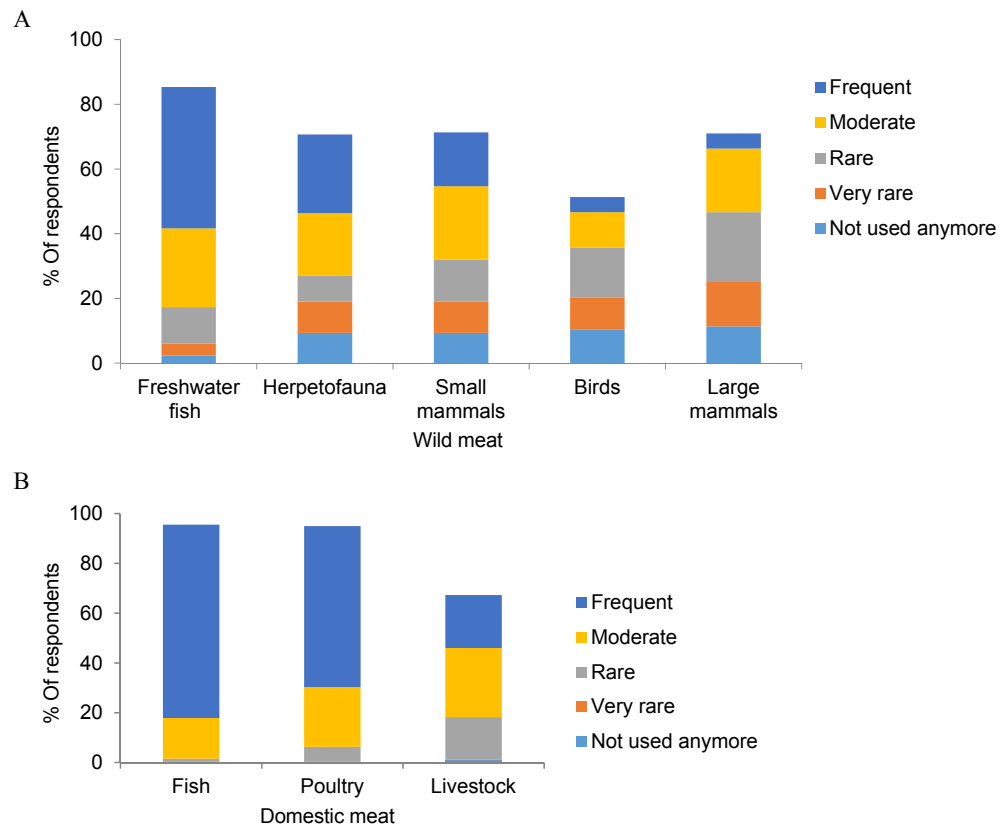


Figure 2. Frequency of utilization by indigenous communities in the Kerala part of the Western Ghats. A, Wild meat groups. B, Domestic meat products. Frequent = once a week or more; Moderate = once to thrice a month; Rare = from once in 2 months to once a year; Very rare = less frequently than once a year.

number of species/taxa consumed had reduced to a greater extent than the other groups (herpetofauna = 0.2 ± 0.6 , birds = 0.13 ± 0.5 , freshwater fish = 0.02 ± 0.1).

Locally fabricated traps followed by direct capture and non-gunpowder based weapons were the most frequently used hunting methods (Figure 3). Although most groups were specifically targeted for consumption, large mammals and herpetofauna to a greater extent were also captured co-incidentally (Figure 4). Wild meat (13%) was associated with medicinal properties to a greater extent than domestic meat (1%), and was used to treat a wide range of diseases and ailments (Appendix 1). They were also used to make musical instruments and used during cremation with wild meat portions being buried/burned along with the deceased (Appendix 1).

Most respondents hunted very far away from their settlements and spent an average 53.8 hours during a single hunting event

(Table 1). In terms of trade, wild meat was largely neither purchased nor sold by the respondents, except freshwater fish, which was the major wild meat traded (Table 1).

Domestic meat

A total of 8 domestic meats were consumed (Table 1) at an average of 4.3 ± 1.5 items during the respondents' lifetime and currently. There was no overall change in domestic meat consumption (Mann–Whitney *U* test, $Z < 0.0001$, $df = 1$, $p = 1$) or the total number of domestic meats (Mann–Whitney *U* test, $Z = -0.40$, $df = 1$, $p = 0.69$) being consumed currently and over the respondents' lifetime. Fish was the most widely and frequently consumed domestic meat followed by poultry and livestock (Table 1, Figure 2B). A majority of the respondents rated poultry as

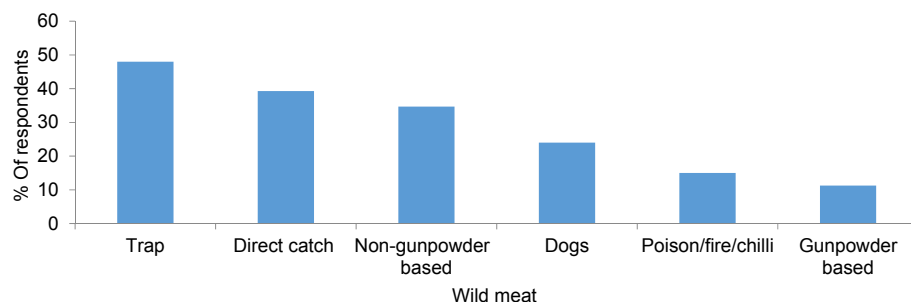


Figure 3. Hunting methods practiced by indigenous communities for capturing wild animals in the Kerala part of the Western Ghats. Direct catch = catch physically, dig burrow, steal kills of other animals; Gunpowder-based weapons = gun, firecrackers, bomb; Non-gunpowder based weapons = throw stones, axe, bow, catapult.

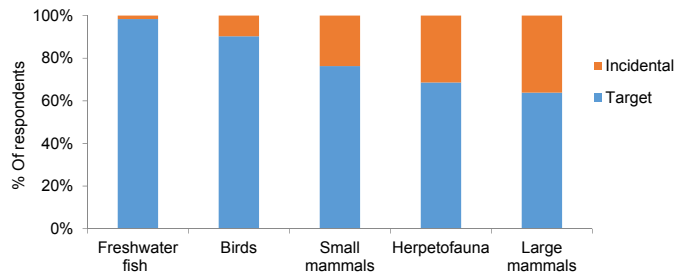


Figure 4. Relative percentage of wild vertebrate groups targeted and those co-incidentally captured during a hunt by indigenous communities in the Kerala part of Western Ghats.

their favorite domestic meat (Table 1). Domestic meats were mostly sourced from both markets and hotels, and most respondents visited markets at least once every 2 weeks (Table 1), which were located at a mean linear distance of 9.2 ± 9.7 km from their settlements. Additionally, most respondents were also visited by a vendor who sold fish (Table 1).

Factors affecting wildlife utilization

Land ownership followed by gender and market distance influenced the current consumption of wild meat (Table 3). A larger number of respondents who owned land (97.1%) consumed wild meat than those who did not own land (78%), whereas fewer women (85.3%) consumed wild meat compared to men (97.9%). Respondents living farther away from markets were more involved in wild meat consumption than those closer.

The total number of wild species/taxa currently consumed by indigenous communities were influenced by forest circle, gender, age, Particularly Vulnerable Tribal Groups (PVTG) (Ministry of Tribal Affairs 2012; Table 2), total number of domestic meats consumed, distance to markets, time spent hunting, and distance to hunting areas (Table 4). Respondents from the southern circle, men, younger age groups, PVTG communities, and those who hunted everywhere or far away from settlements consumed a larger number of wild species/taxa than the other associated groups (Table 5). Those respondents who lived far away from markets, who spent more time hunting and consumed a larger variety of domestic meats, also consumed a greater number of wild species/taxa.

Conservation mitigations

A majority of the respondents' preferred wild meat and a plurality stated that they would not stop consuming wild meat in case the Government supplied domestic meat (Table 1). Most respondents were willing to work with the FD while, a few were already doing so (Table 1). No significant difference was observed among those that had different perceptions toward working with the FD in relation to whether they currently consumed wild species/taxa.

Law enforcement by FD

The cases registered against indigenous respondents because of violations of the WPA were mostly focused on large mammals (Table 6), especially Sambar deer (*Rusa unicolor*) and wild boar (*Sus scrofa*). Most of the cases were still undergoing trial and, seizures from the accused included wild animal parts followed by gunpowder- and non-gunpowder weapons (Table 6).

Discussion

Extent and rationale for wild meat utilization

Studies in Northern parts of India have revealed large mammals and birds as the most massively hunted groups (Arunachalam et al 2004; Hilaluddin et al 2005). Although these studies do not include freshwater fish from within protected areas as wild meat, our results reveal that indigenous communities in the Kerala part of Western Ghats mostly consumed freshwater fish, small-sized mammals, and herpetofauna. This was mostly in agreement with indigenous communities in the Karnataka part of the Western Ghats where a similar range of species were consumed (Madhusudan and Karanth 2002; Kumara 2007). The utilization of freshwater fish is consonant with that of wild meat, bound with tradition and medicine (Begossi et al 1999), and the indigenous communities in Kerala are known to depend on freshwater fish for their nutritional and livelihood needs (Dinesh et al 2010; Raghavan et al 2011). Because freshwater fish represents one of the most threatened faunal groups in the Western Ghats (Molur et al 2011), it would be crucial not to neglect threats from local utilization, especially toward endemic and restricted range freshwater fish species (see Raghavan et al 2011).

It is interesting to note that the most consumed meat is not necessarily the most desired, with fish being the most consumed and poultry the most preferred domestic meat, and fish being the most consumed and herpetofauna and small mammals the most desired wild meat. This suggests that the consumption of meat is influenced by costs (fish is cheaper than other meat), and ease of access (fish vendors frequently visit settlements, legal to capture fish). The increased popularity and consumption of small-sized mammals and herpetofauna could be attributable to the neglect of law enforcement personnel toward hunting of lesser-priority species and also because these are less detectable in comparison to large mammals. Hunting small-sized animals could also be a strategy used by the local communities to satisfy their inclination toward wild meat as most respondents in our study preferred wild over domestic meat. In addition, most hunting events took place away from settlements and the respondents spent more than a day hunting. This could be occurring during the collection of minor-forest produce or FD-related management initiatives (Kanagavel and Raghavan 2013). Because most threatened species were widely consumed across all the forest circles, a statewide social marketing campaign could be designed to change their preferences towards non-threatened and commonly occurring species. In

Table 5. Details of factors affecting the total number of taxa/species consumed as wild meat by indigenous communities in the Kerala part of the Western Ghats.

Factor	Mean \pm standard deviation
Forest circle	Southern = 15.9 ± 0.7 , Central = 7.9 ± 0.3 , Eastern = 6.3 ± 0.7 , Northern = 5.5 ± 0.7 , High Range = 2.3 ± 0.4
Gender	Men = 9.9 ± 0.5 , Women = 4.5 ± 0.5
Age (y)	<18 = 5.9 ± 1.3 , 18–30 = 5.8 ± 0.6 , 31–50 = 8.3 ± 0.5 , >50 = 9.4 ± 0.8
PVTG	PVTG = 8.3 ± 0.4 , Non-PVTG = 7.8 ± 0.5
Hunting distance	Adjoining forest = 10.5 ± 3.5 , very far away from settlement = 11.8 ± 0.5 , moderately far = 6.9 ± 0.6 , close by = 9.1 ± 1.4

PVTG = Particularly Vulnerable Tribal Group.

Table 6. Details of violations of the Wildlife Protection Act (1972) by indigenous communities from 2003 to 2012 in the Kerala part of the Western Ghats.

Detail	Frequency (%)
Forest circle	Northern = 26.7%, High Range = 33.3%, Eastern = 36%, Central = 4%, Southern = 0%
Faunal type	Large mammals = 81.4%, Small mammals = 11.8, Birds = 1.7%, Herpetofauna = 3.4%, Freshwater Fish = 1.7%
Violation type	Meat = 67.2%, Trade = 9.8%, Conflict = 4.9%, Hunting attempt = 18.1%
Materials seized	Gunpowder based weapons = 32.7%, non-gunpowder based weapons = 27.3%, Only wild animal meat & other parts = 40.0%
Status of case registered	Charged = 8.8%, Acquitted = 13.2%, Ongoing trial = 78.0%

Madagascar, a social marketing campaign has resulted in successfully reducing non-destructive harvest methods by fishers and helping them to follow laws set up by themselves (Andriamalala et al 2013). A similar campaign could be devised with the support of indigenous community leaders in the Kerala region of Western Ghats toward reducing hunting pressures on threatened fauna.

Hunting in India is most frequently undertaken using guns (Madhusudan and Karanth 2002; Kumara and Singh 2004; Aiyadurai et al 2010), as they are more effective than traditional techniques in capturing large mammals, and in larger quantities. However, information provided by indigenous communities in this study revealed that traps, direct capture, and non-gunpowder based methods were more frequently used than guns, as these methods were mostly used to capture small-sized wild animals and freshwater fish. The information derived from the RTI, however, reveals otherwise—i.e. a greater use of gunpowder based weapons that reflects a respondent reluctance in revealing sensitive information.

The main stimulus for hunting is nutrition, meat being a crucial source of protein (Kumara 2007; Aiyadurai et al 2010), which is also reflected in this study. The demand for wild meat has also been relevant for traditional healing practices (Madhusudan and Karanth 2002; Kumara 2007; Aiyadurai et al 2010), with communities in Northeastern and southern parts of India consuming wild meat to treat ailments such as malaria, typhoid, skin diseases, and asthma (Kakati et al 2006; Kumara 2007; Kanagavel and Raghavan 2013). In this study, the greater use of wild meat for medicinal purposes (further confirmed by Vijayakumar et al 2015) differentiates it from the use of domestic meat by indigenous communities. Although wild meat supports the sustenance of local livelihoods through income generation (Madhusudan and Karanth 2002; Kaul et al 2004; Kumara and Singh 2004), the communities that were the focus of this study hardly depended on wild meat as a means of income generation, but largely for self-consumption. This is further confirmed by the RTI-related information regarding the type of violations of the WPA (1972) by the communities.

Although we tried to control for false information using a “familiarity” strategy, respondents could have still understated their dependence on wild meat. Another caveat of the study is that it does not compare the exact quantity of wild meats consumed, which would definitely change our current understanding of wild meat utilization in the Western Ghats. Our study provides a glimpse into the utilization of wild meat by indigenous communities in the Kerala portion of the Western Ghats. The results must be interpreted with caution because of the sampling strategy adopted such that it is not extrapolated to the entire biodiversity hotspot. Instead, it reflects on potential forest circles where further in-depth surveys could be undertaken to inform policy that would require implementation at the scale of each indigenous settlement.

Factors affecting wild meat use

The extent of wild meat utilization was greater among men than women, probably because hunting was largely undertaken by men—something also reflected by another study in the Western Ghats region (Gubbi and Linkie 2012). Market distance was found to

be directly proportional to wild meat utilization, similar to the trends observed in Africa (Brashares et al 2011), suggesting that making domestic meat available at remote locations could help in reducing wild meat utilization. Younger respondents were also found to depend on a fewer number of species/taxa, suggesting a change in current lifestyle. Nevertheless, indigenous communities classified as PVTG had a higher dependence on wild fauna than others.

Conservation mitigations

The issue of hunting has been linked to poor monitoring, governance, and defective land tenures at the local level (Barnett 2002; Nasi et al 2008; Blum 2009). Conservation strategies in continental Asia lean toward the preservation of the remaining wildlife that involves a complete ban on hunting and other sustenance activities involving forest resources (Mainka and Trivedi 2002). India has similar laws (through WPA), including imprisonment extending up to 3 years and a maximum monetary fine of INR 25000 (US\$415.89). The prohibition of hunting, improved law enforcement by the FD, and changes in livelihood could have reduced the consumption of wild meat by indigenous communities in this study. However, our results also emphasize that the majority of indigenous communities still consume and prefer wild meat to domestic meat. The increased conservation focus of the FD on large mammals has indeed led to their reduced utilization by indigenous communities who currently depend mostly on freshwater fish and herpetofauna. The FD would therefore also need to increase their conservation focus on threatened species belonging to these faunal groups. The long interval taken for a judgment to be passed for a registered “wildlife associated” case is of severe concern since most cases were still undergoing trial. Special fast track courts could be setup to dispose of these cases rapidly.

Provision of alternate livelihoods could be an effective strategy, and the FD has indeed provided such opportunities for numerous indigenous communities by employing them directly as forest watchers (temporary and permanent) and indirectly through the village forest councils.

The practice of adequately regulated subsistence hunting, wherein the local communities are allowed to hunt and utilize animal products for their sustenance, is an option. Currently in India, only the indigenous communities of Nicobar Islands and the Jarawas of the Andaman Islands are allowed to utilize wild meat as per the WPA. Common, non-threatened species with large distributions and populations, and associated with traditional indigenous culture could be allowed for hunting by specific communities that continue to practice it. For example, specific indigenous communities could be granted quotas for the utilization of wild species or allowed during the 3–4 day (annual) harvest festival in Kerala, when a few indigenous communities are known to participate in group hunts. Conservation could be further entailed with the prohibition of hunting by declaring “no-take areas” and formulating a list of species that can be hunted and hunting methods (including fishing gears) that can be used. This is practiced with the view that local management would be effective in defining the use and users of the resources, by drafting local rules that exclude outsiders and

thereby restrict wild meat utilization to the purpose of sustenance (Begossi et al 1999). Indigenous communities that would be allowed to hunt must be carefully selected such that only those subgroups/settlements among them that continue to practice it for sustenance and culture alone are eligible.

Our study highlights the dependence of indigenous communities on wild meat for cultural subsistence and their adaptive strategy of targeting small-sized species using traditional methods instead of guns in a strictly managed forest landscape (by the FD). Future policy on resource utilization by indigenous communities should also consider wild species other than freshwater fish and assess wild meat consumption on a case-by-case basis at every settlement with an aim to integrate wildlife conservation and indigenous culture.

Conclusion

Our study in the Western Ghats, a globally important ecoregion for both terrestrial and freshwater biodiversity, demonstrates the dependence of indigenous communities on wild meat including for medicinal and cultural purposes. It also highlights the subsistence nature of this dependence through mainly non-gunpowder based methods with negligible trade for income needs. Wildlife conservation could be improved through a dedicated social marketing campaign to reduce dependence on threatened species and making domestic meat available at remote locations. However, it is also critical that the livelihood rights and culture of indigenous communities are integrated by allowing for controlled consumption of common and non-threatened species.

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Appendix A. Supporting information

The list of wild species/taxa utilized by indigenous communities as wild meat (Appendix 1) is available online at <http://dx.doi.org/10.1016/j.japb.2016.04.003>.

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