Global Environmental Change 33 (2015) 122–130

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Beyond compensation: Integrating local communities' livelihood choices in large carnivore conservation

Abishek Harihar [a,b,*], Diogo Veríssimo [a], Douglas C. MacMillan [a]

[a] Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, University of Kent, Kent CT2 7NZ, UK
[b] Wildlife Institute of India, PO Box 18, Chandrabani, Dehradun 248001, India

ARTICLE INFO

Article history:
Received 3 July 2014
Received in revised form 22 December 2014
Accepted 11 May 2015
Available online

Keywords:
Choice experiment
Coexistence
Gujjar
Resettlement
Tiger
Western Terai Arc Landscape

ABSTRACT

Conserving biodiversity in human-dominated regions of the world is complex, particularly in case of large carnivores where perceived conflicts exist with economic development, expanding human populations and livelihoods. Using a systematic 'bottom-up' consultative framework, based on a choice modelling approach that accounts for heterogeneity in the population, we explore alternative strategies that meet conservation and human development goals. Focusing on the Gujjars, a pastoralist community in northern India our research identifies the community's preferred government support measures to encourage coexistence with tigers. We find that direct losses from predation are secondary concerns compared to development measures despite these losses being comparable to other tiger landscapes. Further we found that almost all sampled households (283/292) preferred resettlement over any form of coexistence, with positive preferences for larger land-sizes, the immediate and permanent transfer of property rights, a government-built house and the potential to generate a living from agro-pastoralism. As resettlement would avoid conflict with tigers and lead to habitat and prey recovery, it follows that tiger conservation and human development goals could be best realized by securing vast areas of inviolate tiger habitat through community resettlement to acceptable locations away from tiger habitat. Although Gujjars in our case study prefer resettlement as the way forward, we highlight the need for a responsive policy and institutional framework that can accommodate local needs and ensure there are adequate opportunities for the creation of sustainable livelihoods within tiger habitats. More generally, we show how different outcomes for tigers and humans can be explored empirically to generate better outcomes for carnivores and people at a landscape scale.

1. Introduction

Reversing the worldwide decline in large carnivore populations is one of the biggest contemporary challenges facing biodiversity conservation (Ripple et al., 2014; Treves and Bruskotter, 2014). Considered a classic "market failure" (Nelson, 2009; Nelson et al., 2010), global high value species such as the tiger *Panthera tigris* impose diverse and pervasive costs on local communities in poor countries and regions that include loss of human life and livestock and associated opportunity costs (Barua et al., 2013; Dickman et al., 2011; Inskip and Zimmermann, 2009; Macdonald et al., 2010). With a rapidly increasing human population and intense competition for resources, conservationists and policy makers are divided about the best approach to conserve these species (Creel et al., 2013; Dickman et al., 2011; Packer et al., 2013).

Displacement of local people to create 'inviolate' reserves is highly controversial, and has been strongly criticized on the grounds of both fairness and cost (Agarwal and Redford, 2009; Brockington and Igoe, 2006; Cernea and Schmidt-Soltau, 2006; Lasgorceix and Kothari, 2009; Rangarajan and Shahabuddin, 2006). Nevertheless, it can lead to more favourable outcomes for carnivore conservation (Packer et al., 2013; Walston et al., 2010) as coexistence requires sustained engagement with local communities (Wikramanayake et al., 2011). However achieving this relies upon intensive management regimes, resilient governance arrangements and sustainable financing to maintain the cost of coexistence to acceptable levels (Dickman et al., 2011; Garnett et al., 2011; Leader-Williams and Albon, 1988; Walston et al., 2010), none of which are easy to guarantee in the context of a developing country (Smith et al., 2003).

In the field of systematic conservation planning it has proven difficult to incorporate more complex human dimensions of this

* Corresponding author at: Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, University of Kent, Kent CT2 7NZ, UK. Tel.: +91 9902088555.
E-mail address: harihar.abishek@gmail.com (A. Harihar).

http://dx.doi.org/10.1016/j.gloenvcha.2015.05.004
0959-3780/

debate, with fairly crude and arbitrary measures of welfare changes such as 'lost production' or threats to livelihoods being used in a narrow policy framework (Ban and Klein, 2009; Margules and Pressey, 2000; Wilson et al., 2007). As a consequence, the deeper concerns and more strategic aspirations of local people are inadequately captured and solutions tend to favour outcomes that have underestimated human well-being (Di Minin et al., 2013; Knight et al., 2008). Therefore, there is a pressing need for research that reconciles ecological requirements of carnivores with the preferences, priorities and aspirations of people and their communities to create sustainable landscape-level policies for large carnivores.

In this study we develop such an approach for the western Terai Arc Landscape (TAL) in northern India, a global priority Tiger Conservation Landscape (Sanderson et al., 2006). In this region, as in much of India, there is a rather contentious history of conflict over tiger conservation (reviewed in Rastogi et al., 2012), with early conservation efforts to save the dwindling tiger population focused on the establishment of inviolate tiger reserves where people were excluded. Initially hailed a success (Panwar, 1982), the credibility of this antagonistic policy was further undermined by the emergence of large scale tiger poaching that extirpated populations from Sariska and Panna Tiger Reserves in 2004 and 2005, respectively (Narain et al., 2005). Following this debacle the Indian Government proposed a strategy that envisions a managed tiger landscape comprising "core or critical tiger habitats" free of human presence ('inviolate') and "areas of coexistence" where local communities reside in a landscape permeable to tiger movement. Adoption of this more inclusive strategy was facilitated by the incorporation of elements within the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act as amendments to the Wildlife (Protection) Act in 2006.

With this policy background and working with the Gujjars – a forest-dwelling, pastoralist community in the tiger rich western TAL, we developed a 'willingness to accept' framework for alternative conservation measures to identify potential options that will enhance the well-being of the community and support recovery in the tiger population at the landscape scale. Specifically we explore two strategies – (a) coexistence, whereby livelihood needs of the community are sustained in return for minimizing any deleterious impacts on tigers, and (b) the creation of inviolate conservation areas through resettlement of the local Gujjar population.

2. Gujjar resettlement and tiger conservation in the western TAL

Gujjars (also called *Van Gujjars*) are a pastoralist community, based on dairy buffalo herds, who reside in the foothill forests of the western TAL. Historically, they have practiced transhumance with their livestock, between the foothill forests during the winter months and alpine meadows of the Himalayas in summer. However, socio-political changes both before and after Indian independence have affected traditional summer migration with the result that the vast majority now reside year-round in the foothill forests (Gooch, 2009). Previous ecological research has shown that reduction in grazing pressure and other practices deleterious to forest habitat such as lopping can lead to significant recovery in principal tiger prey such as the chital (*Axis axis*) and consequently in tiger density (Harihar et al., 2009). Minimizing such pressures can, therefore, help attain and further enhance the carrying capacity of tigers across a landscape that already has the potential to support 381 (313–480) (Harihar et al., 2014b).

There is a long history of resettlement in the landscape beginning with the creation of Rajaji National Park (RNP) in 1983, when several Gujjars were forced to resettle outside the forest. Conducted in two phases, around 1390 families from RNP were resettled at two sites (*Pathri* and *Gaindikhata*) at a cost of 360 USD per household (Mishra et al., 2007). In the initial resettlement plan (at *Pathri* in 1987), 0.05 ha land was allotted for the construction of a house and livestock-holding facility and additional 0.1 ha land was earmarked for raising fodder crops. Non-traditional concrete houses were provided on lands with no secure tenure and many in the community, unable to adapt, abandoned these holdings. Being non-participatory, top-down and 'forced' rather than voluntary, the first phase of resettlements met with severe opposition (Gooch, 2009; Mishra et al., 2007). In 1994, the scheme was upgraded to provide 0.02 ha land for the construction of a house of traditional style and 0.8 ha land towards agriculture at both *Pathri* and *Gaindikhata*. Although more generous than the first phase, there was little community consultation and no grazing land was provided. Consequently, resettled Gujjars sold or sent their buffaloes back to relatives remaining in the forest with no net decrease in grazing pressure in tiger habitat.

3. Choice experiments as a means to evaluate policy relevance

There have been widespread calls for a broader integrative approach to conservation under the heading of socio-ecology (Ban et al., 2013; Cowling and Wilhelm-Rechmann, 2007; Knight et al., 2008), but integrating social and economic needs and aspirations with ecological and behavioural requirements of large carnivores has proven challenging at the landscape level. To date, most modelling studies have limited the human dimension to the incorporation of estimated damage costs to livestock and related costs (e.g. Mishra et al., 2003; Zabel and Holm-Muller, 2008). However, this approach risks seriously misjudging the scale and extent of social and economic impacts and could lead to inappropriate conservation policies being adopted as it can potentially underestimate negative social, psychological costs, for example, bereavement associated with losses of both humans and livestock (e.g. Inskip et al., 2013), as well as the opportunity costs of livelihood choices that are prevented or hindered by the presence of large carnivores (e.g. Barua et al., 2013).

In this study we, therefore, eschew the conventional approach of estimating the costs of tiger coexistence as the primary socio-economic measure, and instead explore the willingness to accept alternative polices and measures that seek to conserve tigers at the landscape scale using a form of choice modelling known as choice experiments (CEs). CEs comprise survey-based methodologies, which elicit preferences of respondents in structured, hypothetical markets, where goods are described in terms of various attributes and their levels (Hanley et al., 1998). They have been widely used in environmental economics to value non-market benefits in monetary terms in the last two decades (e.g. Boxall et al., 1996; Wouter Botzen and Van Den Bergh, 2012). However, it has only recently featured in the conservation literature with application to ecotourism (Di Minin et al., 2013; Veríssimo et al., 2009), conservation flagships (Veríssimo et al., 2014a, 2014b), and natural resource conservation (Delibes-Mateos et al., 2014; Moro et al., 2013; Nielsen et al., 2014). Although the potential to deploy CEs to design wildlife conservation policy has previously been identified by Hanley et al. (2003), our study represents a novel extension of the methodology to explore the trade-off between livelihoods and conservation at a landscape scale for an endangered predator.

4. Materials and methods

Recognizing the need to offer people a range of relevant and practical choices as opposed to 'top-down solutions', we investigated coexistence and resettlement options sequentially

(Lasgorceix and Kothari, 2009). First, we asked respondents to choose their most preferred 'coexistence' policy from a series of choice alternatives differing in attribute levels (also including a 'neither' choice). Following this, we asked whether they would choose resettlement over 'coexistence'. Those who stated they would prefer resettlement, were asked to complete a second CE which focused on attributes of a resettlement policy package.

4.1. 'Coexistence' CE design

The first CE explored preferences for coexistence options designed to remove or alleviate severe impediments to traditional livelihoods and development inside the forests. We based the attributes and levels on factors which governed the Gujjars' desire to resettle outside, identified in a prior study of socio-economic status of the community (Harihar et al., 2014a) (Table 1). With ~60% respondents citing "forests are no longer productive enough to graze and raise livestock for milk" as the reason rendering their traditional lifestyle infeasible inside the forests, we assessed the willingness of the community to accept stall feeding practices or sustain their current grazing and lopping practices. Another 'push factor' identified was the lack of access to school education and health facilities (~33% respondents), which prompted us to introduce three alternative levels to this attribute (Table 1). Our prior study also identified the provision of access to veterinary services to potentially benefit the community as 73% of annual livestock losses were attributable to diseases, resulting in significant economic losses to this impoverished community (Harihar et al., 2014a). Finally, since most livestock were killed while unguarded (Harihar et al., 2014a), adopting practices such as guarding livestock using protective physical structure which have proved to be effective against depredation (Banerjee et al., 2013; Karanth et al., 2012), was also included (Table 1).

We did not include cost attributes since choices are often biased towards the most costly alternative in developing countries (Hope, 2006). Moreover, the attributes represent facilities/amenities which can be provided through reviving traditional systems or implementing existing state-sponsored schemes, at no cost to the recipients, a consideration Gujjars suggested was more realistic and appealing to the community than the suggestion of direct compensation (Harihar et al., 2014a). Each coexistence choice was conditional upon maintaining livestock numbers at current levels – a significant opportunity cost in terms of maintaining future livelihoods for this pastoral-based community. Hence, a rejection of both options in favour of the *status quo* would imply rejection of this condition.

Table 1
Attributes and corresponding levels used in the first choice experiment to explore potential coexistence mechanisms among Gujjars in the western TAL.

Attribute	Levels
Provision of feed to livestock holdings	Current situation (maintain graze and lop cycle) Change completely to stall feeding
Access to educational and health facilities	Vehicle access provided to schools and healthcare Current situation (remain living in the forest with current arrangements for access to health care and education) Establishment of local schools and regular visits by doctors
Providing livestock guarding structures	Current situation (maintain livestock in the current holdings) Provision of predator proof corral
Providing veterinary care	Current situation (no care) Bring veterinary doctor on regular basis to check livestock

4.2. 'Resettlement' CE design

In the second CE, we based our choice of attributes and levels on focus group discussions with resettled Gujjars in *Pathri* and *Gaindikhata* resettlements (Mishra et al., 2007) and the guidelines of the National Tiger Conservation Authority (NTCA, 2011). We selected area of land holding as this has proved a contentious point among resettled Gujjars – originally they were given less than 1 ha land per family (0.02 ha for housing and 0.8 ha for agriculture), but more recent NTCA guidelines mandate the distribution of 2 ha land (Table 2). Another major concern among the resettled families was tenure. Currently land holdings are provided under a 30 years lease period with permanent entitlement procured thereafter. We therefore included an option of immediate transfer which is available under current NTCA guidelines. Similarly, we included two levels for the housing attribute: construction of traditional huts (*Gaindikhata* model) and provision of concrete housing (*Pathri* model and NTCA guidelines), as this too has proven contentious in the past (e.g. resettled Gujjars at *Gaindikhata* have been unable to maintain traditional structures as access to forests was longer permitted to source timber and grass). All the above options are potentially fundable through existing resettlement policy that provide rehabilitation at the rate of 15,900 USD (or INR 10,00,000/-) per household (NTCA, 2011).

In *Pathri* and *Gaindikhata*, all Gujjars who resettled were forced to adapt to an agricultural lifestyle (Mishra et al., 2007), but many would prefer to practice agro-pastoralism to maintain links to their tradition as pastoralists. In addition to pure agriculture and agro-pastoralism, some could find employment with the forest department as a measure to encourage local participation in protected area law enforcement activities (NTCA, 2011). All three options were, therefore, included in the design. Finally, a local, context-specific attribute (i.e. government buy-back of livestock; Table 2), was explored to incentivise the sale of livestock to ensure there would be a real net reduction in grazing pressure in tiger habitat.

4.3. Administering the choice experiments

The CEs were administered through face-to-face interviews with the help of visual aids (Fig. 1a and b). We piloted our study in December 2012 using an orthogonal design formulated in SPSS v. 16.0 with choice alternatives being paired using a 'shifted

Table 2
Attributes and corresponding levels used in the second choice experiment to explore potential changes to existing resettlement packages for Gujjars in the western TAL.

Attribute	Levels
Land size	Current situation (1 ha land per family, similar sized land as in current package) 1.5 ha land per family 2 ha land per family
Property rights	Current situation (property rights transferred after 30 years) Immediate transfer of property rights
Housing	Current situation (build traditional hut by yourself) Government builds concrete house
Future livelihood	Current situation (strictly farming only) Farming with livestock Employment with the forest department
Sale of livestock	No buyback Buyback with additional premium on current prices of 50% Buyback with additional premium on current prices of 100%

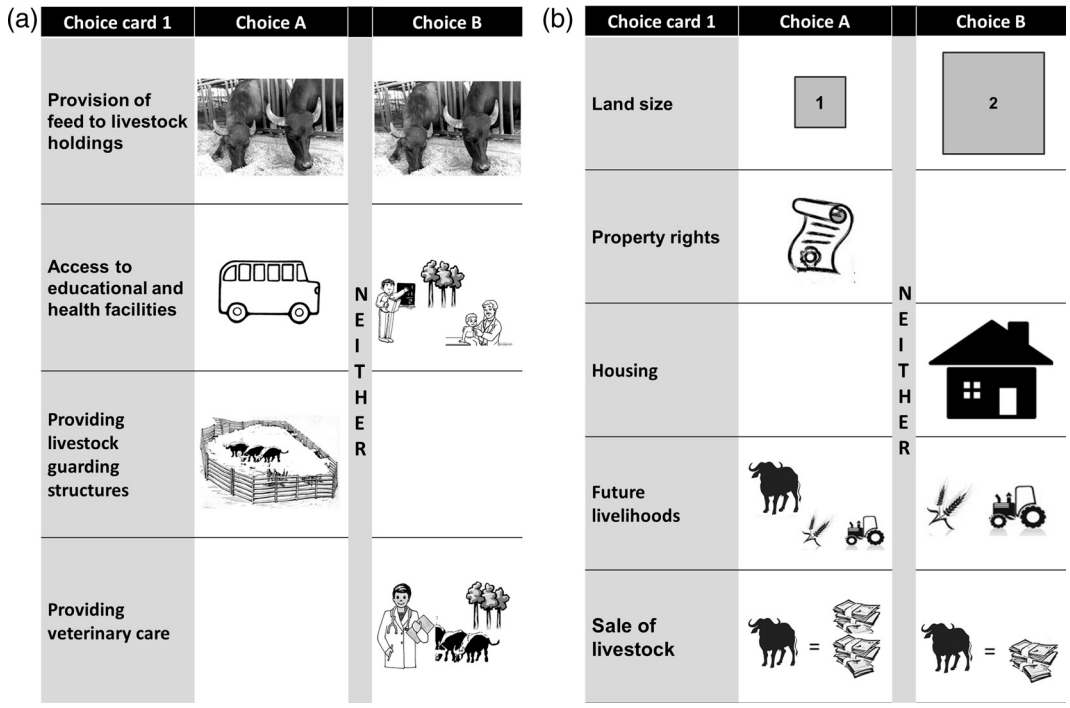

Fig. 1. Examples of (a) 'coexistence' and (b) 'resettlement' choice cards used during the survey conducted across the western TAL. The blank spaces represent current levels for the attribute. 12 choice sets were finally used for each CE, of which sets of four (chosen randomly) were administered to each respondent to reduce the potential cognitive burden on individuals.

technique' (Louviere et al., 2000). Eight choice sets for each of the two CEs were classed into two sets of four paired choices each and administered to 50 Gujjar heads of households, chosen across the landscape, and who were not considered in the final surveys. The resultant data were analyzed using a multinomial logit (MNL) model and parameter estimates of the main effects were used as priors in a D-efficient Bayesian design implemented in Ngene 1.0.1 (*see* Jaeger and Rose, 2008) to design the final choice sets. Using 500 Halton draws from normal prior distributions for each parameter, we compared the mean Bayesian D-error of over 30,000 designs and selected the one with the lowest error. The resultant designs with 12 choice sets for each CE were then blocked into sets of four to reduce the potential cognitive burden on the respondent.

From January to March 2013, Gujjar families across the landscape were surveyed using a previously established grid-based sampling design that ensured both adequate spatial coverage and representation across a gradient of tiger occupancy (Harihar et al., 2014a). Each survey started with an introductory conversation in *Gujjari* (by Imam Hussein, a Gujjar field assistant) and/or Hindi by AH explaining the context of the research. Given low literacy rates, the choice tasks were conducted by actively engaging with the respondents and spending an adequate amount of time with each respondent using pictorial choice cards to ensure that each respondent unambiguously comprehended the policy alternatives presented and the choices made were noted (by AH). Following this, the age and sex of respondents, the number of livestock they owned (as a measure of income), sources of income (pure-pastoralist or mixed-income), location of their household in relation to tiger occupancy (high, medium or low tiger occupancy), access to market (distance to nearest village or town) and familiarity with existing resettlement packages (binomial, whether any relative resettled) were noted.

4.4. Data analyses

First, we assessed the aggregate preferences of Gujjars to the policy options using MNL analysis, although this assumes identical preferences among respondents, which is an unlikely scenario (Louviere et al., 2008). Thereafter, to explore heterogeneity in preferences within the sampled population, we used random parameter logit (RPL) and latent class modelling (LCM) (Boxall and Adamowicz, 2002). In general, LCMs are considered to be the best approaches to partition the sampled population into relatively homogeneous classes (*see* Boxall and Adamowicz, 2002; Sorice et al., 2011). These analyses use a mixed logit form and assess the influence of various socio-economic characteristics of the respondents and choice attributes, which are unobserved by the analyst, while estimating the latent segments (Boxall and Adamowicz, 2002; Greene and Hensher, 2003). Analyzed using LIMDEP NLOGIT 4.0 (Greene, 2007), the optimal numbers of latent classes were decided based on a balanced assessment of statistics including Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) (Birol et al., 2006). We tested models including all permutations of socio-economic variables available and included an alternative specific constant (ASC) to account for the 'neither' responses. In the analysis of the second CE, LCM analysis identified no distinct groups among respondents based on their socio-economic attributes and therefore, heterogeneity in choice was assessed using RPL model (implemented in LIMDEP NLOGIT 4.0). For the RPL, all parameters except the monetary attribute (sale of livestock) were specified to be normally distributed (Carlsson et al., 2003; Train, 1998), and distribution simulations were based on 1000 draws. In all our analysis, ASC took a value of 1 when 'neither' choice was opted for, reflecting the utility derived from not choosing any of the offered choice options.

5. Results

5.1. Household characteristics

We administered the coexistence CE among 292 Gujjar households and the resettlement CE to 283 households. We targeted the head of household, of which 66% were male and

34% were females and with an average age of 45 years. Literacy rate among respondents was very low (~9%) and the primary source of income was pastoralism, based on sale of milk and milk-based products. The sample could be further classified into fulltime pastoralists (52%) and pastoralists who supplemented their livestock income with manual labour (46%) or agricultural production (2%). All the surveyed households in our study had relatives among the resettled Gujjars and were, therefore, familiar with the policy and all the livelihood and socio-cultural changes associated with the process. In both CEs, the coefficient for ASC was negative and significant which indicated that the *status quo* was associated with decreased utility. In other words there was a strong preference in favour of both policy options over the *status quo*.

5.2. Coexistence choice models

The MNL analysis showed that all attributes of the policy were positive and significant (Table 3), suggesting that the additional benefits associated with choosing alternatives outweighs their current situation. In general, respondents more often opted for a policy that increased their access to educational and health facilities and provided stall feed for their livestock. Regular visits by veterinarians also increased the likelihood of the policy being chosen, while provision of predator-proof corralling structures was the least favoured option (Table 3).

Our analysis identified that the optimal number of latent classes was two (Appendix A). The class membership was significantly influenced by the mode of income, and the optimal model also included livestock numbers as a non-significant factor (Table 3). The first group (86%), consisting primarily of 'pure-pastoralists' who preferred PEC policy options that provided vehicular access to educational and health facilities outside forests and improved amenities for livestock husbandry including stall feed for livestock, regular visits by veterinarians and corralling for their livestock. The second group (14%) were 'mixed-income pastoralists', who preferred options that established educational and health facilities within forests, regular visits by veterinarians and corralling for their livestock, but not provision of stall feed (Table 3).

5.3. Resettlement choice models

With the exception of 9 individuals, all the other respondents ($n = 283$) indicated that they would prefer resettlement over any coexistence package or the *status quo*. The results of the resettlement CE indicated that the best fit was provided by the RPL model specification (Table 4) and showed that respondents preferred options that corresponded to larger land size, immediate transfer of property rights, government-built house, higher premium (100%) on sale of livestock, and a future livelihood option that allowed agro-pastoralism (Table 4).

6. Discussion

This study evaluates the trade-offs a pastoralist community is willing to make towards implementing either a 'coexistence' or a 'resettlement' approach to tiger conservation using a systematic consultative framework in the human-dominated western TAL. Our approach was inspired by the ongoing debate concerning the relative efficiency of 'sharing' versus 'sparing' for securing and recovering the fast dwindling populations of large carnivores (Creel et al., 2013; Packer et al., 2013; Walston et al., 2010; Wikramanayake et al., 2011). In the past and largely informed by biological outcomes, the arguments on either side have ignored the social factors which determine conservation feasibility (Cowling et al., 2004; Knight et al., 2011; Polasky, 2008). Here, we show that providing specific developmental benefits to the local communities both outside and within tiger range could potentially help expand existing "source tiger populations" and assist in maintaining habitat permeability for dispersing tigers outside reserves. In this discussion, we assess their potential implementation with regard to funding, institutional aspects and other broader policy implications.

While a vast majority of Gujjars surveyed in this study preferred resettlement over coexistence benefits, current legislations facilitate and fund resettlement for inhabitants of protected areas, tiger reserves and critical tiger habitats, but not for those residing in multiple-use forests (NTCA, 2011). Hence, the heterogeneous preferences for coexistence mechanisms, as documented here, may be utilized to provide crucial livelihood and developmental

Table 3
Results of the multinomial logit model and the latent class model (LCM) with two segments to identify potential coexistence mechanisms. The two classes differ primarily by modes of income (pure and mixed pastoralism) and number of livestock owned by the household.

Attribute	MNL		Latent class 1 (86%)		Latent class 2 (14%)	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Stall feed provided	1.6008**	0.1517	3.8259**	0.3855	−0.5936*	0.3162
Access to facilities (vehicle)	1.6892**	0.1654	4.6641**	0.5672	−0.3522	0.4045
Access to facilities (provided inside forests)	1.3799**	0.1711	2.8157**	0.4424	2.0503**	0.3243
Corral provided	0.3687**	0.1076	1.1959**	0.2693	0.5077**	0.2576
Veterinary visit	1.3074**	0.9819	2.9426**	0.3489	1.7756**	0.2284
Alternate specific constant (neither = 1)	−1.4129**	0.3131	−29.494	0.1×10^7	−0.0744	0.4097
			Explanatory variables of class probability			
			Coefficients			SE
Constant			2.4452**			0.4921
Livestock numbers			−0.0022			0.0072
Modes of income			−1.0331**			0.5188
Model properties			MNL			LCM
Log-likelihood			−590.85			−455.4
McFadden's pseudo R^2 (ρ^2)			0.322			0.645
AIC/n			1.022			0.8055
n (observations)			1168			1168
k (parameters)			6			15

* $p < 0.1$.
** $p < 0.05$.

Table 4
Results of the multinomial logit (MNL) and random parameter logit (RPL) analysis to identify potential resettlement scheme.

Attributes and levels	MNL		RPL			
	Coefficient	SE	Coefficient	SE	Coefficient std	SE
Land size (1.5 ha)	3.56**	0.431	10.38**	3.213	–	–
Land size (2 ha)	6.34**	0.712	16.66**	4.721	–	–
Property rights	4.12**	0.378	14.00**	4.129	9.272**	2.872
Government-built house	2.62**	0.442	6.37**	2.400	–	–
Employment with FD	−2.15**	0.708	−6.13	3.462	–	–
Pure agriculture	−0.34	0.178	−2.56	1.360	–	–
Livestock sale (50% premium)	−1.93**	0.438	−3.30	1.696	–	–
Livestock sale (100% premium)	2.35**	0.702	6.25**	3.163	–	–
ASC (neither = 1)	−1.78**	0.378	−1.56	1.571		

Model properties	MNL	RPL
Log-likelihood	−412.8402	−401.1227
McFadden's pseudo R^2	0.669	0.677
AIC/n	0.745	0.726
n (observations)	1132	1132
k (parameters)	9	10

** $p < 0.05$.

benefits to those who continue to reside inside these forests, towards building a sense of co-responsibility for tiger conservation and maintaining permeability for tiger movement between inviolate habitats. Here, we found that conflict with tigers per se did not constitute a major concern among Gujjars relative to other livelihood and development issues (Table 3). As the economic losses suffered by Gujjars are comparable to most tiger landscapes where livestock depredation is the principal form of conflict (Goodrich, 2010; Harihar et al., 2014a; Wang and Macdonald, 2006), our findings suggest that Gujjars place far greater emphasis on developmental benefits that enhance wider well-being and future prospects than mitigating conflict with tigers.

The heterogeneous preferences for coexistence mechanisms among Gujjars introduce some complexity in generating the necessary 'buy-in' for future policy. The majority (86%) of the Gujjars are pure-pastoralists, and their preferences differed from those with multiple modes of income (14%), primarily in terms of their greater readiness to desist from lopping trees for fodder and switch to stall feed (Table 3). This is encouraging as this intervention would be expected to lead to habitat recovery, benefiting wild prey and tigers (Harihar et al., 2009). In contrast, the absence of a positive preference for the stall feed option among mixed-pastoralists indicated a general reluctance to stop lopping fodder leaves, suggesting the need for more outreach to persuade this group about this issue. Overall, the underlying heterogeneity suggests the need to develop policy that is flexible and dynamic to reflect the changing socio-economic context.

A particular challenge with designing an effective incentive-based conservation approach is ensuring that it does not depend on significant external funding to sustain it (Dickman et al., 2011). In our case study, traditional institutions and state-run schemes could potentially be aligned to support the coexistence policy. For instance, provision of stall feed (dry hay), which was a traditional system associated with summer migration to alpine pastures when the Gujjars would obtain fodder from villagers in return for buffalo manure (Nusrat et al., 2011), could be renewed if agriculturalists living in adjoining villages were interested in such an exchange. Similarly, sustained funding required for providing vehicles to access schools and health facilities (or providing these inside forests) could be procured from the State Ministry of Health and Family Welfare (http://ukhfws.org) and the National Literacy Mission (http://www.nlm.nic.in/), which encourage schemes that seek to organize functional literacy components in environmental conservation programmes. To facilitate sustained visits by veterinarians to inspect livestock inside forests, active co-ordination with the State Department of Animal Husbandry would be required. Funds required for predator-proof corrals could ideally be jointly provided by the forest department and non-governmental organizations, which currently provide compensation to mitigate tiger–human conflicts in the TAL landscape (Bose et al., 2011). Linking compensation payments to accepting and maintaining these protective structures can also avoid the moral hazard problem (Dickman et al., 2011).

Contrary to the widely held presumption that indigenous communities do not wish to resettle, largely based on literature pertaining to forced eviction of communities to create protected areas in Africa (Brockington and Igoe, 2006; Cernea and Schmidt-Soltau, 2006), or evidence from mishandled and non-participatory processes in India (Kabra, 2009; Lasgorceix and Kothari, 2009; Rangarajan and Shahabuddin, 2006), the Gujjars demonstrated a strong preference for resettlement. However, it is likely that this view has recently been acquired by the Gujjars as there was strong resistance to such interventions only a decade ago (Gooch, 2009). This change is perhaps indicative of the economic decline of pastoralism as a primary livelihood globally (Fratkin and Mearns, 2003; Marin, 2008; McCabe, 2003) and a broader recognition that the Gujjar 'way of life', under pressure from political and economic forces, may no longer be viable.

Resettlement policies for tiger conservation (e.g. NTCA, 2011), provide a legal framework for ensuring an adequate rehabilitation package is provided and in case of the western TAL, funds exist to resettle families residing within protected areas (RNP and Corbett Tiger Reserve). Additional funds and support are also potentially available from federal and state agencies (e.g. NTCA and Compensatory Afforestation Fund Management and Planning Authority) to resettle Gujjars from "critical habitats" identified within multiple-use forests (Harihar and Pandav, 2012) to areas of low conservation value, but with livelihood potential. Some land has already been identified near *Pathri* consisting of ca. 2250 ha of exotic monoculture plantations which is sufficient to meet the needs of around 1125 families at 2 ha/family (Harihar et al., 2014a). However, it is critical that a successful resettlement package ensures the recognition of secure property rights, the construction of acceptable housing and opportunities for sustaining preferred livelihood options (Table 4).

Land area and tenure are critical factors in the choice of resettlement policies by Gujjars. Previous resettlements provided less than 1 ha land (Mishra et al., 2007), and given that Gujjars showed the highest preference for the largest land size

(2 ha), any future resettlement package should include this choice. In relation to tenure, in the past resettled families could only acquire the legal rights to settlement upon completion of a 30-year lease period. While immediate transfer of rights is feasible under the current legislation, the right to land-holding conferred shall only be inheritable and not alienable or transferable (Forest Rights Act 2006, Section 4.4). Ensuring compliance to this guideline, with immediate tenure rights, is particularly crucial to safeguard the interests of this socially marginalized community.

In previous resettlements, Gujjars have returned to the forest due to the lack of technical support to assist their adaptation to a sedentary agricultural way of life and many Gujjars simply ended up leasing their land to enterprising farmers from adjoining areas and sending their livestock to graze in tiger areas (Mishra et al., 2007). Currently no funds have been earmarked for training and building capacity among the resettled Gujjars to successfully adapt to agriculture and this will have to be addressed if their livelihood security is to be ensured. Given resettlement had resulted in the intensification of grazing pressure elsewhere in the landscape, we decided to include a livestock buyback mechanism. Interestingly, Gujjars eschewed this option at a 50% premium over market value, but showed a preference for buyback at 100% premium (Table 4). Although their choice to resettle did not hinge upon this option (evidenced by stronger preference for larger land size, transfer of property rights and government built houses; Table 4), this preference presents an opportunity for governmental and non-governmental conservation organizations to ensure a sustained reduction in grazing pressure takes place across the landscape (Harihar et al., 2014b).

Gujjars in our case study prefer accessing developmental benefits by moving outside the forests, possibly encouraged by experiences from previously resettled community members and compelled by the historical socio-political changes very specific to the landscape which has rendered their traditional pastoral livelihood infeasible (Gooch, 2009; Harihar et al., 2014a). While our results imply that most tend to perceive previous resettlements in a positive light, no study has systematically addressed the socio-cultural impacts on the community post-resettlement in terms of changes in general well-being, their cultural practices and interactions with other communities. It is therefore essential that future research should address these issues to understand the broader consequences of such transitions for indigenous cultural diversity at large.

An unintended social consequence of such incentive-based interventions is often that local communities perceive themselves as recipients of external aid and are alienated from the conservation objectives, rather than becoming partners (Newmark and Hough, 2000; Turton, 2002). Hence, it is important that coexistence measures and resettlement schemes be actively branded as "incentives for people encouraging tigers", which is conditional upon people strictly regulating their livestock holdings and resultant pressures on the habitat, or foregoing their access to forests upon resettlement, respectively. Evidence from Europe also suggests that interventions can be more successful if incentives are directly linked to conservation success (MacMillan and Leader-Williams, 2008; Zabel and Holm-Muller, 2008). Similarly, clear social goals (e.g. "reducing poverty") and objectives (expand access to veterinary care to 80% of forest-dwellers) which are guided by the preferences of the community, should be linked to the stated conservation goals within a social-ecological framework (Ban et al., 2013; Ostrom, 2007). This framework will, however, require and depend on much greater inter-institutional collaboration (horizontal integration) in India than has hitherto been the case and more engagement of local communities with policy makers and budget holders (vertical integration).

7. Conclusions

Several lines of evidence suggest that our consultative approach from the western TAL could apply, in particular, to most human-dominated tiger landscapes, and more generally for incorporating social considerations to prioritize alternative conservation actions for large carnivores. Much of the remaining range of threatened large carnivores lies outside protected area networks in human-dominated lands: 90% for species such as jaguar *Panthera onca* and snow leopards *Uncia uncia* (Nowell and Jackson, 1996) and more than 76% in case of tigers (Walston et al., 2010; Wikramanayake et al., 2011). Moreover, arresting declines and sustaining populations near carrying capacity is achieved more efficiently in exclusion of humans (Packer et al., 2013; Walston et al., 2010). Therefore, while both coexistence and resettlement represent key conservation policies for large carnivore, our approach can help assess the conservation feasibility of these alternatives actions based on the site-specific social preferences identified in collaboration with local communities.

Finally, our research supports the adoption of a socio-ecological approach to conservation research and policy development at a landscape scale, where effective actions have to be appropriately embedded in the complex web of social, political, economic and ecological processes and their interactions (Ban et al., 2013; Folke et al., 2002; Mills et al., 2013; Ostrom, 2007). By providing empirical evidence of how outcomes for tigers and humans can differ across a landscape through the incorporation of human choice, we develop an approach that can be used to design sustainable socio-ecological systems that benefit both tigers and people.

Acknowledgements

We thank P.R. Sinha (Director), V.B. Mathur (Dean), K. Ramesh and Bivash Pandav of the Wildlife Institute of India and Forest Departments of Uttarakhand and Uttar Pradesh for research permits. This study was supported with grants from Kaplan Graduate Awards (Panthera), Kathryn Fuller Science for Nature Fellowships (WWF) and Rufford Small Grants Foundation (Grant 10691-2) to AH. We thank Imam Hussein for assistance in field and Mousumi Ghosh-Harihar for help in the preparation of the manuscript. Finally, we thank two anonymous reviewers for their comments on the earlier version of the manuscript.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.gloenvcha.2015.05.004.

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