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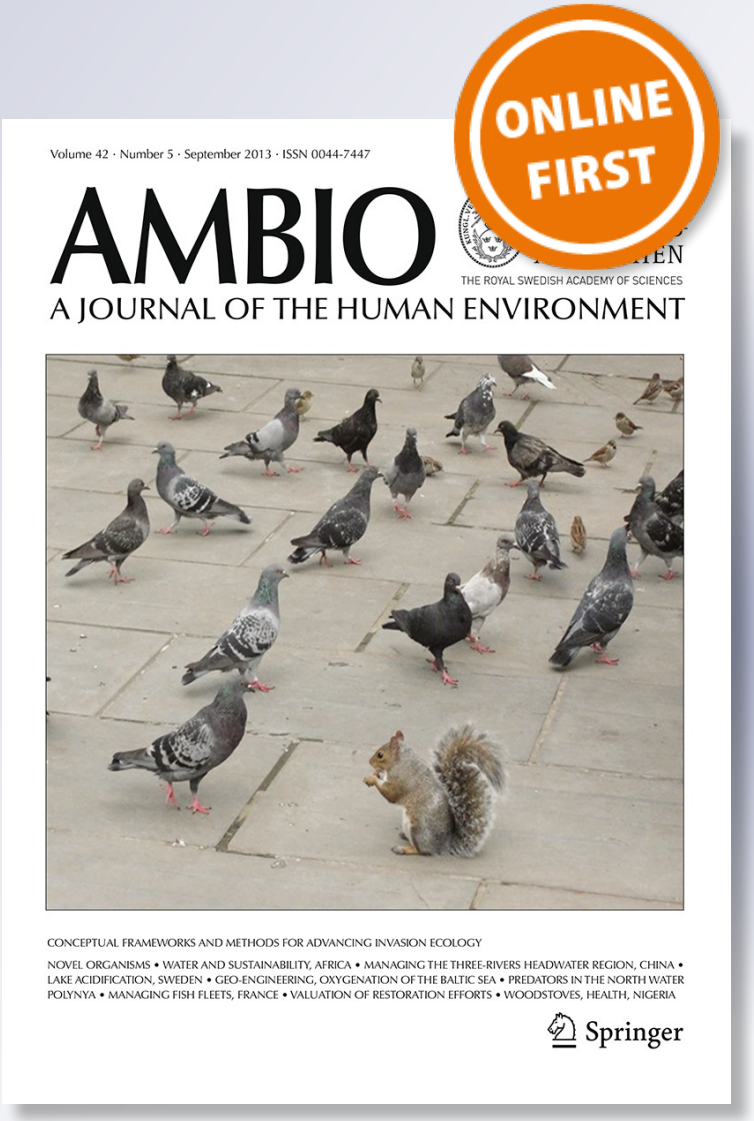

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REPORT

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Abstract In many regions around the world, wildlife impacts on people (e.g., crop raiding, attacks on people) engender negative attitudes toward wildlife. Negative attitudes predict behaviors that undermine wildlife management and conservation efforts (e.g., by exacerbating retaliatory killing of wildlife). Our study (1) evaluated attitudes of local people toward the globally endangered tiger (*Panthera tigris*) in Nepal's Chitwan National Park; and (2) modeled and mapped spatial clusters of attitudes toward tigers. Factors characterizing a person's position in society (i.e., socioeconomic and cultural factors) influenced attitudes toward tigers more than past experiences with tigers (e.g., livestock attacks). A spatial cluster of negative attitudes toward tigers was associated with concentrations of people with less formal education, people from marginalized ethnic groups, and tiger attacks on people. Our study provides insights and descriptions of techniques to improve attitudes toward wildlife in Chitwan and many regions around the world with similar conservation challenges.

Keywords Coexistence · Conservation · Coupled human and natural systems · Human dimensions · Human–wildlife conflict

INTRODUCTION

Where people and wildlife live in close proximity, wildlife can negatively affect human livelihoods (e.g., depredate livestock, raid crops), health (e.g., transmit disease), and safety (e.g., attack people) (Ogada et al. 2003; Woodroffe et al. 2005; Chardonnet et al. 2010). These impacts, in turn, often encourage people to kill wildlife (Woodroffe et al. 2005; Kissui 2008), degrade wildlife habitat, or not comply with regulations designed to protect wildlife (Nyhus et al. 2005). Such activities contribute to declines of many wildlife populations, especially those of large herbivores and carnivores, and hinder the success of species conservation programs in many regions around the world (Woodroffe 2001; Romañach et al. 2007; Milliken et al. 2009; Linderman et al. 2005; Lepczyk et al. 2008).

Attitudes are a strong predictor of a person or group's intentions to behave in a particular manner (e.g., comply with wildlife protection regulations) (Fulton et al. 1996). As such, assessing attitudes toward wildlife provides insights on the degree to which people are willing to cohabit with wildlife. Attitudes toward wildlife are seldom uniform across space because factors affecting attitudes, such as interactions with wildlife, are spatially heterogeneous (Sitati et al. 2003; Naughton-Treves and Treves 2005). Consequently, spatial pattern exists to human-caused mortality of wildlife, which creates wildlife population sinks that negatively affect wildlife population persistence (Woodroffe and Ginsberg 1998; Liu et al. 2011). Information on the spatial distribution of attitudes can thus inform managers and conservation agencies on where best to focus their interventions, thereby mitigating human–wildlife conflict and advancing conservation efforts. Such information will be increasingly important as the world is expected to add approximately 1400 million more people over the next two decades (United Nations 2010), which will likely result in people and wildlife having closer and more frequent interactions.

Numerous studies have examined attitudes toward wildlife (Kellert and Berry 1987; Saberwal et al. 1994; Naughton-Treves et al. 2003; Wang et al. 2006; Morzillo et al. 2010); however, few have examined the spatial distribution of attitudes toward wildlife (Bowman et al. 2004; Karlsson and Sjöström 2007; Morzillo et al. 2007). To help

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fill this information gap, we evaluated determinants and spatial properties of attitudes toward tigers (*Panthera tigris*), a globally endangered species, near Chitwan National Park, Nepal.

We focused on tigers because conflicts between tigers and people are some of the most severe in the world (Inskip and Zimmermann 2009). Chitwan was an ideal study site because interactions between people and tigers that give rise to human–tiger conflicts there are representative of human–wildlife dynamics occurring throughout many other regions of the world (e.g., South America, Asia, Africa). As it is the case for many developing regions (Bearer et al. 2008), most people in Chitwan depend on crops and livestock for their livelihood, and rely on nearby forests (including National Park forest) for thatch, reeds, fodder, fuelwood, timber, and other products to support their agricultural lifestyles (Sharma 1990). Tigers from inside the park, however, occasionally prey on livestock. Tiger attacks on people inside (e.g., when people are collecting forest resources) and outside the park are a growing concern: 65 local residents were killed during 1998–2006 compared to 6 during the 1989–1997 period (Gurung et al. 2008). Ensuring that people do not kill tigers in retaliation to these threats is imperative for tiger conservation because the park is one of only 28 reserves in the world that can support >25 breeding female tigers (Wikramanayake et al. 2011). Evaluating the spatial attributes of attitudes toward tigers in Chitwan will help foster human–tiger coexistence there and provide useful insights for other regions that face similar conservation challenges in coupled human and natural systems (Liu et al. 2007).

We had three main objectives in this study: (1) to evaluate the effects of several factors on attitudes toward tigers in a human-settled area directly adjacent to Chitwan National Park; (2) to use geostatistical techniques to identify and map spatial clusters of negative and positive attitudes toward tigers; and (3) to investigate possible causes of any patterns.

Conceptual Background: Attitudes Toward Wildlife

As a key step in understanding how people relate to wildlife, previous studies have assessed how socioeconomic and demographic variables affect attitudes toward wildlife (Kellert and Berry 1987; Gadd 2005; Naughton-Treves and Treves 2005; Romañach et al. 2007; Morzillo et al. 2010). For example, in an area adjacent to Tanzania's Selous Game Reserve, women—having less influence in public life and political activity than men—expressed more negative attitudes toward wildlife conservation than men (Gillingham and Lee 1999). In an area around Nepal's Kosi Tappu Wildlife Reserve, people from higher Hindu castes, with more political and economic influence in Nepal than lower castes, had more positive attitudes toward wildlife conservation activities of the reserve than lower castes (Heinen 1993). Furthermore, in central Kenya, commercial ranchers had more positive attitudes toward large carnivores than subsistence-oriented livestock farmers, because carnivores have a proportionally smaller impact on the wealth of commercial ranchers than subsistence livestock farmers (Romañach et al. 2007).

Previous research on an array of species in an array of geographical locations also indicate that negative interactions with wildlife influence people's attitudes toward wildlife (Riley and Decker 2000b; Naughton-Treves and Treves 2005; Wang et al. 2006; Romañach et al. 2007; Zimmermann et al. 2010). In the Pantanal of Brazil, for example, respondents whose cattle had been attacked by jaguars (*Panthera onca*) were more likely to view jaguars as a threat (Zimmermann et al. 2005). In addition to direct negative interactions, indirect negative interactions such as hearing or reading about wildlife attacks on livestock or people may also engender negative attitudes (Karlsson and Sjöström 2007; Zimmermann et al. 2010). For example, Karlsson and Sjöström (2007) attributed negative attitudes toward wolves (*Canis lupus*) in Sweden to exposure to negative information about wolves from friends, peers, and media.

Increased exposure to wildlife-related risks (e.g., long-term residency, collecting forest resources) has been linked to negative attitudes (Newmark et al. 1993; Naughton-Treves and Treves 2005; Arjunan et al. 2006). For example, villagers who had lived near Kalakad-Mundanthurai Tiger Reserve for a longer period of time were less likely to report positive attitudes toward tiger conservation (Arjunan et al. 2006). Nepal and Weber (1995) learned that villagers who frequently entered Chitwan National Park to collect forest resources tended to have hostile attitudes toward wildlife.

A few studies indicate that attitudes toward wildlife vary with location. For example, Bowman et al. (2001) found that respondents in Mississippi were more likely to support efforts to increase the black bear (*Ursus americanus*) population than respondents in Arkansas, where negative experiences with bears were more common. Karlsson and Sjöström (2007) indicated that having wolves in Sweden was more important to urban respondents than for rural respondents. Morzillo et al. (2007) found that positive attitudes toward restoration of black bears were spatially clustered in the most urbanized part of an area around Big Thicket National Preserve, Texas.

Based on past research, we hypothesized that (1) attitudes toward tigers will be associated with (a) one's position in society as measured by several socioeconomic and demographic variables, (b) direct and indirect negative interactions with tigers in the past, and (c) exposure to tiger-related risks; and (2) attitudes toward tigers will form non-random spatial clusters.

MATERIALS AND METHODS

Study Site

Situated in south central Nepal, our study site (Fig. 1) was the human-settled area in western Chitwan district to the north of Chitwan National Park. Chitwan district is located in a river valley basin along the flood plains of the Rapti and Narayani Rivers at altitudes of 150–815 m. The area is subtropical, with a summer monsoon from mid-June to late September, and a cool dry winter (Laurie 1982). In the late 1970s and early 1980s, a series of all-weather roads were built that linked Chitwan's city, Narayanghat (Fig. 1), to the rest of the country. Since then, Narayanghat has become a transportation hub in Nepal with new businesses, wage labor opportunities, commercial enterprises, and government services proliferating in and around the city (Axinn and Ghimire 2007). Chitwan National Park ($\sim$1000 km^2), established in 1973, is a globally important protected area for conservation of tigers (Walston et al. 2010). Approximately 30–50 % of park annual revenue was invested into the surrounding buffer zone, established in 1996, to support community development (e.g., infrastructure improvement) and forest protection programs (e.g., community forestry) (Government of Nepal 1993). At the time of our research the study site comprised a mosaic of land uses, including National Park, National Forest, community forests, agriculture, and urban development. In 2011, the human population in our study site was $\sim$275 000, and the total number of households was $\sim$68 000 (Nepal Central Bureau of Statistics 2012).

Attitude Survey

We designed a structured survey to record attitudes toward tigers and potential determinants of these attitudes. Local Nepali experienced in social survey research design worked with us to ensure internal validity of our survey measures. In December 2009, we pre-tested the survey ($n = 17$) in a site adjacent to our study area, to improve survey effectiveness. Attitudes toward tigers were recorded using three survey items: "Do you enjoy having tigers in your area?," "Would you be happy if no tigers existed in the nearby forests?," and "How many tigers would you prefer living in the nearby forests in the next 10 years compared to now?" The first two attitude questions were binary (i.e., yes, no), and future tiger preferences was based on a 5-point bi-polar scale (i.e., much less, less, same, more, and much more). We chose to record preferences for tigers 10 years in the future because it is a round number and a conceivable time-frame in which tiger population size can change considerably.

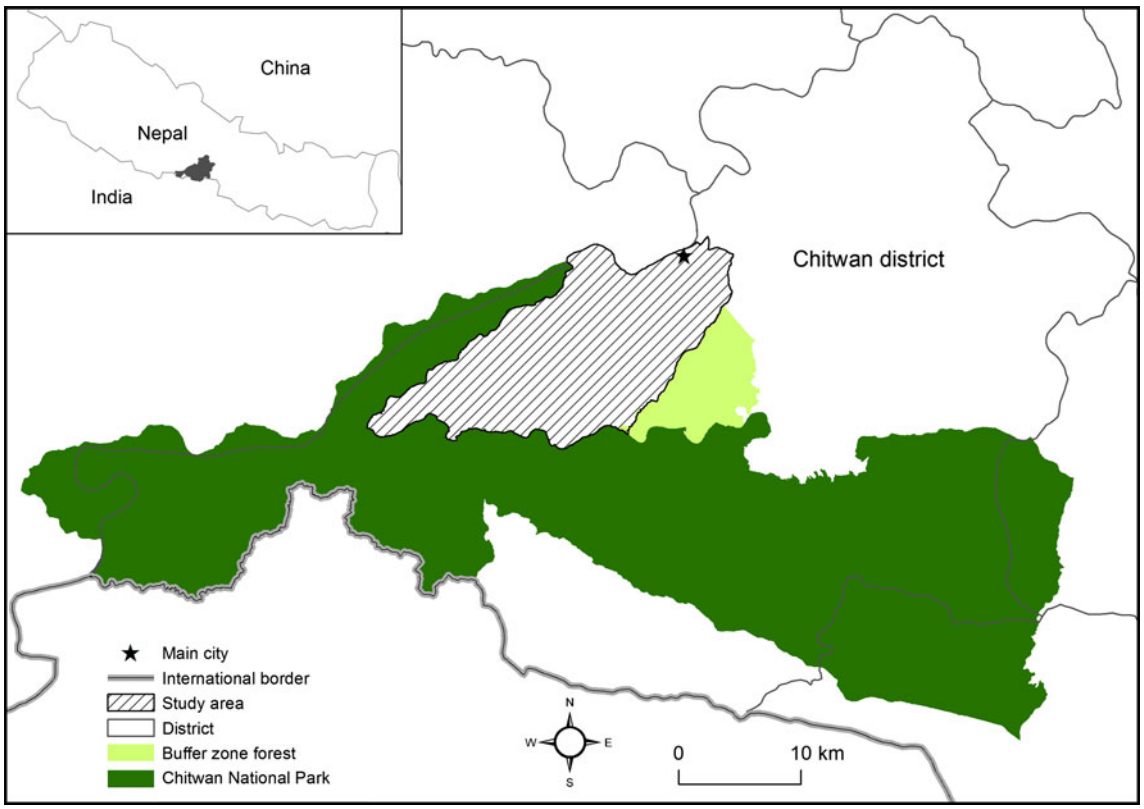

Fig. 1 Location of the study site in Chitwan. The *shaded area* on the *inset* indicates the location of Chitwan district in Nepal

Demographic information included age, gender, and ethnicity. Ethnicity was grouped into four categories for analytical purposes: higher caste Hindus, lower caste Hindus, Hill Tibeto-Burmese, and Terai Tibeto-Burmese (see Barber et al. 1997 for breakdown of ethnic groups in Chitwan). Socioeconomic information included respondent education level, occupation, and household livestock holding. Education level was determined by the number of years respondent received formal education. Occupation was grouped into six categories: crop farmer, mixed farmer (i.e., livestock producer and crop farmer), business owner (e.g., owns shop selling food, clothing, etc.), salaried employment (e.g., receives regular salary from government or non-government organization or private company), daily wage laborer (e.g., receives daily wages from work on farm or construction sites), and student. Respondent livestock information included number of cattle/buffalo and sheep/goats because these livestock are most important in terms of household economics (Gurung et al. 2009).

Exposure to tiger-related risks included the number of years that a respondent had lived in Chitwan and the amount of time spent in the nearby forests (i.e., tiger habitat) collecting forest products. Amount of time respondents spent in the forests was determined with the question "since last year till now, out of 365 days, approximately how many work days do you think you have spent in the nearby forest collecting fodder or firewood?" Negative direct experiences were recorded using two survey items: "Do you have a family member that has been threatened or attacked by a tiger?" and "Has a tiger ever killed your livestock?" Additionally, respondents indicated if they had been personally threatened by a tiger in the survey item "other types of experiences with tigers?" Negative indirect experiences with tigers were recorded using two survey items: "Do you know a friend or neighbor who has been threatened or attacked by a tiger?" and "Have you read or heard about farm animals being attacked nearby by a tiger?" The option "don't know" was provided on all questions.

Wards (the smallest administrative unit in the district) that had at least 50 % of their area within 1 km of Chitwan National Park or the buffer zone forest adjacent to the park, where the majority of human–tiger conflicts occur (Department of National Parks and Wildlife Conservation, unpublished data), were selected. Ward boundary data were extracted from 1996 digital topographic data obtained from the Nepal Survey Department (1996); these are the most recent data and little change in ward boundaries has occurred since. We randomly selected 500 residences within the wards based on residence locations in 1996 ($n = 5400$). The number of residences has increased since 1996 (the most recent data on spatial locations of residences). In February 2010, the name and age of all persons living in each of the 500 residences (inclusion criterion was that they must have been residing in the house during the week prior to the time when the survey would be administered) were recorded and compiled in a list. From this list, a single individual (age 15–59) was randomly selected for survey from each of the 500 randomly selected residences, resulting in a total of 500 possible respondents. From March to April 2010, trained Nepali interviewers contacted each possible respondent to administer the survey face-to-face. A verbal consent script was read to the subjects, because many adult subjects were not literate. Interviews and collection of respondent's exact household location with a hand-held global positioning system (GPS) unit proceeded only after the subjects gave their verbal consent. In case of non-consent, no further information was recorded. The study, including the verbal consent process and script, was reviewed and approved by the Institutional Review Board (IRB# 08-274) of Michigan State University.

Evaluating Determinants of Attitudes

For future preference of tiger population size, responses "less" and "much less" were recoded as 0, and responses "same," "more," and "much more" were recoded as 1. We combined responses to this measure to reduce bias, because respondents did not easily differentiate "more (less)" from "much more (less)" tigers. Responses to "do you enjoy having tigers in your area?" were recoded such that "no" = 0 and "yes" = 1. Responses to "would you be happy if no tigers existed in the nearby forests" were reverse coded such that "yes" = 0 and "no" = 1. Since the three attitude survey items are theoretically consistent, we created a single scale of all three using principal component analysis and Cronbach's alpha reliability test (Cronbach 1951; Ericsson and Heberlein 2003; Sirkin 2005). A single scale allowed us to assess general attitudes toward tigers and to map these attitudes across space.

Relationships between the general attitude toward tigers (i.e., single scale) and potential explanatory variables (respondent age, gender, ethnicity, formal education, occupation, number of cattle/buffalo, number of sheep/goat, days in forest per year, years living in Chitwan, past tiger threats/attacks on respondent family member and respondent livestock, hearing or reading about tiger attacks on neighbor/friend and nearby livestock) were analyzed using Spearman's rho correlation coefficient, t tests, and analysis of variance (ANOVA). For the ANOVA tests, we also used Tamhane's T2 post hoc test (does not assume equal variances) to investigate pair-wise differences between levels of the explanatory variables. A generalized linear model was used to identify which combination of potential explanatory variables best predicted general

attitude toward tigers (McCullagh and Nelder 1989). Multicollinearity between explanatory variables was tested using variance inflation factors (O'brien 2007). We used Pearson χ^2 to compute the scale parameter, maximum likelihood to estimate model coefficients, and the Wald statistic to estimate the significance and relative effect of each explanatory variable on attitudes. We computed χ^2 goodness-of-fit statistic to determine if the model was significantly better at predicting negative attitudes than a null model. All model analyses were performed using SPSS v. 20 (Chicago, IL, USA). To explicate relationships among explanatory variables, subsequent bivariate analyses (i.e., ANOVA, χ^2) were performed.

Evaluating Spatial Distribution of Attitudes Toward Tigers

Our analyses of the spatial distribution of attitudes toward tigers were based on the spatial locations of the respondent's households. First, we mapped the factors affecting attitudes at the ward-level to visualize general spatial patterns. Next, we mapped individual respondent attitude scores. We used the global Moran's index I, a measure of spatial autocorrelation, to determine the nature of the spatial distribution of attitudes (Moran 1950) across the study site. A positive index indicates that respondents nearer to each other have similar attitudes. A negative index indicates that attitudes are dispersed in space, while an index value near "0" indicates a random distribution. The Moran's I statistic requires a weight matrix which defines how neighboring respondents are related to each other. We assumed that neighboring respondents within a threshold distance influenced each other equally. We did not have a priori information on what the threshold distance was, therefore, we calculated the global Moran's I at various threshold distances ranging from 1 to 7 km (1 km interval). We constrained threshold distances to 7 km because that is the minimum distance between respondents on opposite sides of the study site. As we did not have information from respondents in the interior of the study site, assessing spatial processes at distances that span the length of the study site may generate inaccurate results. Moran's I values at each of the threshold distances were standardized to z scores, so that the significance level of the index could be tested based on a normal distribution (Morzillo and Schwartz 2011; Aguilar and Farnworth 2012). The distance threshold where the global Moran's I z score was at its highest significant positive value (i.e., >1.96) indicated where the spatial process of interest (i.e., attitudes toward tigers) was most pronounced (Morzillo and Schwartz 2011; Aguilar and Farnworth 2012).

Although the global Moran's I is useful for determining whether the data is autocorrelated across the whole study site, it does not indicate if or where spatial clusters occur within the study site or which type of cluster (i.e., negative or positive attitudes) respondents belong to. Thus, we calculated the Getis–Ord local G_i^* statistic for each respondent to determine if respondents belong to local-scale clusters (Getis and Ord 1992). The statistic is given as

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}},$$

where x_j is the attitude score for respondent at location j, $\bar{X}$ is the mean attitude score for all respondents, n is equal to the total number of respondents, S is the standard variation of the attitude scores among all respondents, and $w_{i,j}$ is the spatial weight between locations i and j. A distance threshold reflecting maximum spatial autocorrelation, as determined by the global Moran's I procedure, was used for the Getis–Ord local G_i^* spatial weights (Aguilar and Farnworth 2012). A significantly positive G_i^* (>1.96) indicates that a respondent belongs to cluster of respondents with positive attitudes, whereas a significantly negative G_i^* (<−1.96) indicates that a respondent belongs to cluster of respondents with negative attitudes. Clusters of respondents with negative and positive attitudes were mapped. Global Moran's I and local G_i^* analyses were performed in ArcGIS 10.

RESULTS

Attitudes Toward Tigers

The survey was completed by 499 of 500 individuals contacted, while the remaining one individual opted to not participate in the study. Nearly, 30 % of the respondents did not enjoy having tigers nearby, and over 35 % would be happier if no tigers existed in the nearby forests. The distribution of respondents' preferences for future tiger population size was nearly uniform: 40 % preferred fewer tigers and 40 % preferred more tigers in nearby forests over the next 10 years compared to 2010.

The measurement of the three attitude items showed high consistency (Cronbach's alpha = 0.8). The principal component analysis produced a single factor solution that accounted for 72 % of the variation in the three attitude items. Thus, we kept the first factor to index the overall attitude toward tigers (eigenvalue = 2.15, eigenvalue of factors 2 and 3 = <0.48). The communality estimates of the attitude items ranged from 0.67 to 0.74, and the item loading of the retained factor was uniform (enjoyment toward nearby tigers = 0.86, happiness if all tigers

gone = 0.86, preference for future tiger population size = 0.82). The extracted factor ranged from −1.62 (i.e., more negative attitudes) to 0.87 (i.e., more positive attitudes) with a mean score = 0.

Demographic and Socioeconomic Characteristics

Average age of respondents was 33.7 (15–59) years and nearly 37 % was male (Table 1). Respondents were predominantly female since many men leave Chitwan to work in urban centers in Nepal or elsewhere (Bohra and Massey 2009). Respondents ranged in ethnic background with the majority being higher caste Hindu (57 %).

Respondents also had a range of education levels: 36 % of respondents had less than 4 years of formal education, whereas 11 % had at least 12 years of formal education (Table 1). Nearly, 90 % of respondents owned livestock. On average, respondents owned more sheep/goats than cattle/buffalo. The occupation for approximately 30 % of respondents was "off the farm."

Exposure to Tiger-Related Risks and Past Negative Experiences with Tigers

On average, respondents had been living in Chitwan for more than 20 years (Table 1). Approximately 60 % of respondents spent at least one work day per year entering nearby forests to collect natural resources. Nearly, 25 % of all respondents spent more than 20 work days per year collecting resources from the forest.

While 10 % of respondents indicated that a tiger had attacked their livestock in the past, over 25 % of the respondents stated that a tiger had threatened/attacked someone in their family in the past (Table 1). Just under 5 % indicated both that a tiger had threatened/attacked a family member and their livestock. While over half of the respondents indicated that a tiger had threatened/attacked a neighbor or friend in the past, nearly 60 % had heard or read about tigers attacking livestock in the nearby areas (Table 1). Nearly, 40 % stated both that a tiger had threatened/attacked a friend or neighbor and had heard/read about tiger attacks on livestock in the nearby areas.

Factors Affecting Attitudes Toward Tigers

Based on bivariate analyses, respondents were less likely to have positive attitudes toward tigers if they had <8 years of formal education ($F_{3494} = 48.95$, $P < 0.01$, Tamhane's, $P < 0.01$), were lower caste Hindu or Terai Tibeto-Burmese ($F_{3492} = 21.88$, $P < 0.01$, Tamhane's, $P < 0.01$), were female ($t_{442} = 7.24$, $P < 0.01$), were farmers (crop or mixed) or daily wage laborers ($F_{5483} = 10.26$, $P < 0.01$, Tamhane's, $P < 0.01$), owned fewer cattle/buffalo

Table 1 Descriptive results for survey items related to factors that potentially influence attitudes toward tigers in Chitwan, Nepal

Factor/survey response	Descriptive results
Age	Range = 15–59, mean = 33.69, SD = 12.95
Gender	
Male	36.67 %, $n = 183$
Female	63.33 %, $n = 316$
Ethnicity[a]	
Higher caste Hindu	57.38 %, $n = 280$
Hill Tibeto-Burmese	13.32 %, $n = 65$
Lower caste Hindu	13.11 %, $n = 64$
Terai Tibeto-Burmese	16.19 %, $n = 79$
Years of formal education	
0–3	35.67 %, $n = 178$
4–7	23.25 %, $n = 116$
8–11	30.06 %, $n = 150$
>12	11.02 %, $n = 55$
Occupation[b]	
Crop farmer	52.45 %, $n = 257$
Mixed (livestock and crop) farmer[c]	18.78 %, $n = 92$
Business owner	2.65 %, $n = 13$
Salaried employment	8.57 %, $n = 42$
Daily wage laborer	2.04 %, $n = 10$
Student	15.51 %, $n = 76$
Household livestock holding	
Cattle/buffalo	Range = 0–10, mean = 2.4, SD = 1.77
Sheep/goat	Range = 0–21, mean = 3.12, SD = 2.79
Days in forest per year	Range = 0–365, mean = 32.46, SD = 73.25
Years living in Chitwan	Range = 1–59, mean = 23.33, SD = 13.97
Tiger threatened/attacked family member	
No	72.95 %, $n = 364$
Yes	27.05 %, $n = 135$
Tiger attacked livestock	
No	86.97 %, $n = 434$
Yes	13.03 %, $n = 65$
Tiger threatened/attacked neighbor or friend	
No	47.29 %, $n = 236$
Yes	52.71 %, $n = 263$
Heard/read about nearby tiger attack on livestock	
No	40.48 %, $n = 202$
Yes	59.52 %, $n = 297$

[a] Category "other Indian castes" was omitted from analysis because number of respondents was very small ($n = 2$)

[b] Category "other occupations" was omitted from analysis because it lacks definition and the number of respondents was small ($n = 9$)

[c] Category "livestock producer" ($n = 2$) was combined with "mixed farmer"

($r_s = 0.15$, $P < 0.01$), and were older ($r_s = -0.12$, $P < 0.01$). These results support hypothesis 1a. Also, those who had reported that a tiger had threatened/attacked someone in their family at some point in the past ($t_{225} = 3.38$, $P < 0.01$) and had spent more days/year collecting forest products ($r_s = -0.26$, $P < 0.01$) were less likely to have positive attitudes toward tigers, which supports hypotheses 1b and 1c.

The single scale of attitudes toward tigers, derived from the principal component analysis, was used as our response variable in the generalized linear model. Significant collinearity was not detected between any of the explanatory variables. The model fit the data better than a null model ($\chi^2 = 217$, df = 22, $P < 0.01$). Education level had the largest effect on attitudes, followed by ethnicity, gender, and threats/attacks on family members (Table 2). Results from the multivariate model indicated that respondents were more likely to have negative attitudes toward tigers if they had less formal education, were lower caste Hindu or Terai Tibeto-Burmese, female, or a tiger had threatened/attacked someone in their family at some point in the past.

Subsequent bivariate analyses among explanatory variables indicated that higher caste Hindus were more likely than other ethnic groups to have >8 years of formal education ($\chi^2 = 82.26$, df = 9, $P < 0.01$) and to have salaried employment or be a student ($\chi^2 = 26.08$, df = 15, $P < 0.05$). While time spent in the forest and number of cattle/buffalo did not differ with respect to gender, higher caste Hindus and respondents with >8 years of formal education generally spent less time in the forests collecting forest products and had more cattle/buffalo than other groups (Tables 3, 4). Respondents with <3 years of formal education tended to be older (Table 3) and be a farmer ($\chi^2 = 150.62$, df = 15, $P < 0.01$). Reports that tigers had threatened/attacked a family member in the past did not significantly differ among ethnic group, education level, or gender (Table 5).

Table 2 Generalized linear model of attitudes toward tigers in Chitwan, Nepal. Variables listed in descending order of effect on attitudes

Variable	β	SE	Wald
Education (years)			
0–3[a]	0	–	–
4–7	0.21	0.11	3.4
8–11	0.73*	0.12	35.4
>12	0.85*	0.17	25.7
Ethnicity			
Higher caste Hindu[a]	0	–	–
Hill Tibeto-Burmese	0.12	0.12	0.91
Lower caste Hindu	−0.36*	0.13	7.82
Terai Tibeto-Burmese	−0.48*	0.12	17.37
Gender			
Male[a]	0	–	–
Female	−0.39*	0.09	18.8
Family member threatened/attacked			
No[a]	0	–	–
Yes	−0.28*	0.09	10.61
Occupation			
Crop farmer[a]	0	–	–
Mixed farmer	−0.06	0.1	0.34
Business owner	−0.06	0.23	0.07
Salaried employment	0.17	0.15	1.29
Daily wage laborer	0.29	0.27	1.2
Student	0.21	0.13	2.54
Respondent livestock attacked			
No[a]	0	–	–
Yes	0.21	0.12	3.33
Heard or read about nearby livestock being attacked			
No[a]	0	–	–
Yes	0.12	0.08	1.89
Number of cattle/buffalo[b]	0.03	0.02	1.34
Heard of read about other people threatened/attacked			
No[a]	0	–	–
Yes	−0.1	−0.09	1.25
Neighbor or friend threatened/attacked			
No[a]	0	–	–
Yes	−0.08	0.08	0.83
Number of sheep/goat[b]	−0.01	0.01	0.13
Days in forest per year[b]	0.01	0.01	0.83
Years living in Chitwan[b]	0.01	0.01	0.65
Age[b]	0.01	0.01	0.02

[a] Set to zero

[b] Continuous variable was standardized to have mean of zero and standard deviation of one

* $P < 0.05$

Spatial Distribution of Attitudes

All of the factors influencing attitudes in the generalized linear model, except for gender, display discernible spatial patterns. Respondents with an education level <8 years, from lower caste Hindu and Terai Tibeto-Burmese ethnic groups, and who reported that a tiger had threatened/attacked a family member in the past appear to be concentrated along the western portion of the study site (Fig. 2).

The global Moran's I z score peaked ($I = 0.14$, z score = 31.79, $P < 0.001$) when using 7 km as the threshold distance for the spatial weights, and demonstrated that attitudes toward tigers were spatially correlated across the study site. Local G_i^* values indicate that two statistically significant spatial clusters of attitudes exist, which supports hypothesis 2. Whereas negative attitudes toward tigers were clustered in the western portion of the study site, positive attitudes toward tigers were clustered in the eastern portion (Fig. 3).

Table 3 Mean time spent in forest, number of cattle/buffalo, and age for different education levels in Chitwan, Nepal

	0–3 years	4–7 years	8–11 years	>12 years
Time spent in forest (days/year)	$52.42^{A,B}$	34.84^{C}	$18.25^{A,D}$	$1.56^{B,C,D}$
Number of cattle/buffalo	2.05^{A}	$1.7^{B,C}$	2.31^{B}	$2.91^{A,C}$
Age	$42.83^{A,B,C}$	30.02^{A}	27.71^{B}	33.69^{C}

Like letters indicate a significant difference between groups (Tamhane's, $P < 0.05$)

Table 4 Mean time spent in forest, number of cattle/buffalo, and age for different ethnic groups in Chitwan, Nepal

	Higher caste Hindu	Hill Tibeto-Burmese	Lower caste Hindu	Terai Tibeto-Burmese
Time spent in forest (days/year)	$22.42^{A,B}$	55.91^{A}	58.81^{B}	29.35
Number of cattle/buffalo	$2.57^{A,B}$	1.55^{A}	$0.98^{B,C}$	2.03^{C}
Age	34.54	35.62	30.41	31.89

Like letters indicate a significant difference between groups (Tamhane's, $P < 0.05$)

Table 5 Proportion (%) of respondents from different socioeconomic and demographic groups indicating whether or not a tiger had threatened/attacked a family member in the past

	Family member threatened/attacked by tiger	
	No	Yes
Education (years)		
0–3	70.79	29.21
4–7	71.55	28.45
8–11	75.33	24.67
>12	76.36	23.64
Ethnicity		
Higher caste Hindu	75.43	24.57
Hill Tibeto-Burmese	73.85	26.15
Lower caste Hindu	73.44	26.56
Terai Tibeto-Burmese	63.29	36.71
Gender		
Male	71.58	28.42
Female	73.73	26.27

DISCUSSION

Despite being a region where human–wildlife conflicts are severe, factors in Chitwan characterizing one's position in society shaped attitudes toward tigers more so than negative experiences with tigers. In particular, people from marginalized groups in the region including lower caste Hindus and Terai Tibeto-Burmese, less educated, and women expressed more negative attitudes toward tigers.

Higher caste Hindus and hill Tibeto-Burmese enjoy the most socioeconomic and political power in the region (Massey et al. 2010). By being in positions of influence, higher caste Hindus and hill Tibeto-Burmese are perhaps more likely to obtain off-farm employment associated with the tourist industry (e.g., porter, cook, guide), and thus enjoy most of the economic benefits from wildlife tourism (Mehta and Kellert 1998). Money from tourist activities is one of the major values local people associate with having tigers in Chitwan (Carter et al. 2012a) and likely explain, in part, why these ethnic groups expressed more positive attitudes toward tigers. As education level varied by ethnicity, additional surveys are needed to separate the effects of ethnic or caste position. Nevertheless, it is possible that education broadens people's perspective on tigers and, perhaps, encourages greater awareness of the benefits of tigers (e.g., ecological importance) (Carter et al. 2012a). Williams et al. (2002) indicated that positive attitudes toward wolves in regions around the world were related to education likely because increased education often brings a greater awareness of wildlife and the environment. Similar relationships between greater education level and positive attitudes expressed toward large carnivores are a prevalent phenomenon (Riley and Decker 2000a).

In contrast to higher caste Hindu and hill Tibeto-Burmese ethnic groups, lower caste Hindus and Terai Tibeto-Burmese (a group indigenous to Chitwan) have fewer opportunities, receive less formal education, and typically own less land (Massey et al. 2010). By being more dependent on forest resources, lower caste Hindus and Terai Tibeto-Burmese may have elevated dread and risk beliefs toward tigers that inhabit those forests (Carter et al. 2012a). On the other hand, people from these marginalized ethnic groups may have more negative attitudes toward tigers because they resent the policies associated with tiger conservation, which restrict their access to forest products that they rely on for their livelihoods (Biddlecom et al. 2005). The lack of decision-making authority and control over one's environment may be key factors influencing attitudes toward tigers (Zinn et al. 2000; Carter et al. 2012a). For example, Bjerke et al. (2000) found that sheep

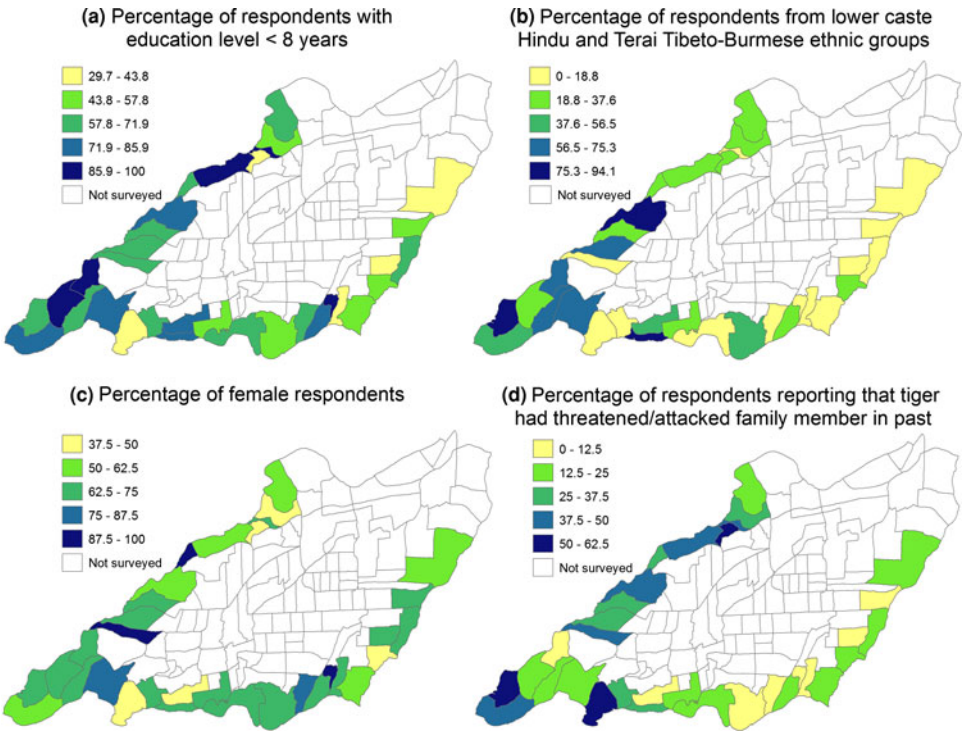

Fig. 2 Maps showing percentage of respondents per ward that **a** had <8 years of education, **b** were from lower caste Hindu and Terai Tibeto-Burmese ethnic groups, **c** were female, and **d** reported that a tiger had threatened/attacked a family member in the past. Percentage categories were defined by equal intervals

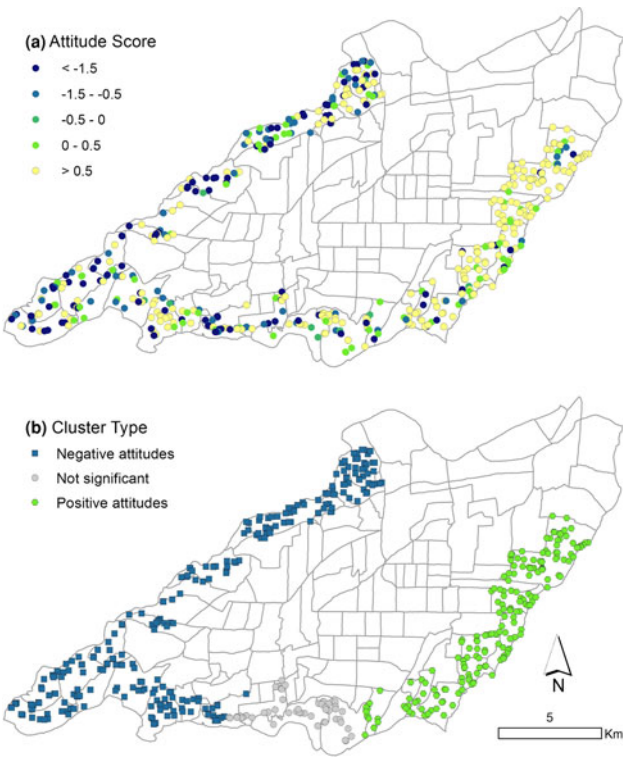

Fig. 3 Maps of **a** respondent attitude scores and **b** spatial clusters of negative and positive attitudes toward tigers in Chitwan, Nepal

farmers in Norway, who believed that land use was being increasingly controlled by central political authorities (i.e., external locus of control) were more likely to have negative attitudes toward large carnivores.

As with marginalized ethnic groups, women in Chitwan lack decision-making authority in most community contexts (Agrawal and Ostrom 2001). Furthermore, in most households in Chitwan, women's and men's roles and duties are segregated, with women being primarily responsible for taking care of children, preparing food, and carrying out specific agricultural tasks (Yabiku 2005). In south-east Tanzania, women were excluded from many aspects of public life and political activity, and as a result, tended to construct their views of wildlife based largely on their direct experience of wildlife-related costs and benefits in the spheres of domestic life and farmwork (Gillingham and Lee 1999). Similarly, in Chitwan, a lack of control over how they interact with tigers (e.g., having no choice but to enter forests to collect essential natural resources) and constrained perspectives on the benefits of living near tigers (e.g., tangible negative consequences vs less obvious benefits) may engender negative attitudes among women toward tigers. More research is needed in this region to evaluate the causal linkages among socio-cultural–economic factors, fear of tigers, loci of control, and attitudes toward tigers.

People with less formal education and from marginalized ethnic groups tended to live in the western portion of the study site, where negative attitudes toward tigers were clustered. This spatial distribution suggests that these marginalized groups lack access to and are unable to fully utilize (due to lower social class) the schools, universities, markets, and off-farm employment opportunities concentrated in the city, Narayanghat, located in the northeast. The spatial cluster of negative attitudes in the west is also likely influenced by the increased frequency of tiger attacks on people that have occurred there over the last 15 years (Gurung et al. 2008). The reason for the greater prevalence of attacks in the west is uncertain. It is probably not due to differences in human/tiger density ratios between the west and east, as human densities are comparatively lower in the west, while tiger densities are roughly equal in both (Nepal Central Bureau of Statistics 2012; Carter et al. 2012b). An explanation for the greater prevalence of attacks in the west proposed by locals is that tigers acquire a "taste" for human flesh after feeding on the remains of partially cremated bodies that wash up on the Narayani River bank after being sent afloat during traditional Hindu funerals. More recent tiger–human interactions likely have a comparatively greater role in shaping attitudes toward tigers (Eagly and Chaiken 1993). A program exists to monetarily compensate households where someone has been attacked, but as the psychological and economic impacts on family members can be tremendous, monetary compensation does not appear to completely offset the effects of these attacks on negative attitudes.

The spatial concentration of positive attitudes in the east reflects, in part, the spatial distribution of those people with greater political and economic influence, who tend to live closer to the city in the northeast. The cluster of positive attitudes in the east is also likely related to management actions. Management intensity is greater in and near the buffer zone forest in the east as it is considered a crucial wildlife corridor to forested areas outside the park, as the forest in the west does not have the same function. For instance, beginning in 2001, a subsidized fence was constructed along the entirety of the boundary separating the human-settled area and the buffer zone forest in the east to mitigate human–wildlife conflict (UNDP 2007). In Sweden, subsidies for fencing to reduce wolf predation on sheep increased positive attitudes toward wolf presence (Karlsson and Sjöström 2011). Similarly, the fence in Chitwan likely has increased satisfaction in government policies and reduced risk from tigers. The World Wildlife Fund (WWF-Nepal), National Trust for Nature Conservation and other local non-government organizations have launched several conservation programs in the buffer zone forest area including wildlife education workshops, alternative income and eco-tourism projects, and community-based anti-poaching units (UNDP 2007). These efforts have perhaps enabled people living in the eastern portion of the study site to view tigers more in terms of their benefits rather than their costs. Our results are not unlike those from Heinen (1993), which found that people on the east side of Nepal's Kosi Tappu Wildlife Reserve had more positive attitudes toward the reserve than people on the west because people on the east had more access to management and a greater voice in managerial activities. As such, a concerted effort by wildlife managers to redistribute and tailor their activities toward the west may improve attitudes there. For example, programs ensuring equitable distribution of economic benefits from tourism to people in the west may engender more positive attitudes toward tigers. In addition, government-subsidized programs that reduce human reliance on natural resources from forests in the west (e.g., distributing improved livestock breeds, providing low-cost alternatives to fuelwood) may decrease the probability of negative human–tiger encounters there.

Our findings suggest that processes influencing attitudes toward tigers in Chitwan are occurring at spatial scales of at least 7 km. Information flow (e.g., dissemination of news regarding tiger attack) through social networks in Chitwan may be especially pronounced at these scales. Muter et al. (2013) revealed that social networks and the strength of dyadic ties between individuals influenced contagion effects of perceptions and risk attitudes toward a fish-eating predator, Double-crested Cormorants (*Phalacrocorax auritus*). Presumably, dyadic ties are strong in a rural community like Chitwan. Furthermore, previous research in Chitwan indicates that markets, schools, health services, and employers tend to be within a few kilometers of households (Dirgha and Axinn 2006), which suggests that 7 km is a conceivable distance in which interactions between local people are frequent. In addition, landscape features (e.g., topography) and infrastructure (e.g., paved roads) may facilitate or hinder information flow among people. Although Chitwan is flat, information flow may be constrained because most roads are unpaved and rugged and often flood during the monsoon season. Since the extent of our study site constrained our analysis to 7 km, broadening the extent of our study site would allow assessment of whether spatial patterns of attitudes occur at larger spatial scales. Assessing how social networks in Chitwan influence spatial patterns in attitudes and how spatial patterns in attitudes vary with respect to different landscapes and social contexts are also important avenues of future research.

Attitudes toward tigers may change as one's position in society shifts. Like many regions around the world, the socioeconomic and political contexts in Chitwan are rapidly transforming (World Bank 2011), and the capacity for people to cohabit with tigers may shift as well. Moreover,

attitudes toward tigers will likely shift in space as the landscape is modified through time. For instance, reforestation efforts outside Chitwan National Park may attract more tigers, potentially intensifying human–tiger interactions, and changing local attitudes accordingly. On the other hand, urban development may reduce negative direct experiences with tigers, but also may disassociate people from the benefits of having nearby tigers. However, we cannot make strong inferences on the effect of such changes on attitudes as our study is a "snapshot" of local attitudes toward tigers. A longitudinal analysis of attitudes toward tigers in Chitwan, based on this study, would help demonstrate these dynamics. In addition, similar research conducted in other areas facing similar human–wildlife conservation issues would provide additional insights on how to facilitate coexistence under varying conditions.

CONCLUSION

Our study has several implications for conservation policy and wildlife management. First, concentrating mitigation and conservation efforts at the specific locations where wildlife-related impacts occur will likely reduce negative attitudes toward wildlife within larger areas encompassing those locations. Second, complementing conventional mitigation measures, such as translocating or lethally removing "problem" animals, with a range of conservation actions will also likely reduce negative attitudes toward wildlife. Such actions depend on the context and include, among others, education and awareness programs, fencing, payments for ecosystem services, and conflict-response teams with a contingent of local people (Gurung et al. 2008; Dickman et al. 2011; Karlsson and Sjöström 2011). Third, our findings suggest that conservation policymakers and practitioners can anticipate attitudes toward wildlife in different contexts based on the linkages between attitudes and socio-cultural–economic variables, such as those evaluated in our study. Explicating these linkages will help direct resource and institutional support decisions of wildlife management authorities and conservation agencies. Fourth, spatially explicit maps of attitude clusters enable limited resources such as money and personnel to be efficiently and effectively allocated to those areas dominated by negative attitudes. Conservation actions informed by attitude research and focused in space may help increase local compliance with conservation policies and possibly decrease human-caused mortality of imperiled wildlife.

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AUTHOR BIOGRAPHIES

Neil H. Carter (✉) is a doctoral candidate in the Department of Fisheries and Wildlife at Michigan State University. His research interests include complexity of coupled human and natural systems, human dimensions of wildlife management, wildlife behavior and habitat use, and protected area management.
Address: Center for Systems Integration and Sustainability, Michigan State University, 115 Manly Miles Building, East Lansing, MI 48824, USA.
e-mail: cartern7@msu.edu

Shawn J. Riley is a professor in the Department of Fisheries and Wildlife at Michigan State University. He studies human–wildlife interactions, most recently focusing on tolerance of wildlife in various settings, wildlife health management, and how better to integrate insights from ecological and social science in decisions about wildlife management.
Address: Department of Fisheries and Wildlife, Michigan State University, 13 Natural Resources Building, East Lansing, MI 48824, USA.

Ashton Shortridge is an associate professor in the Department of Geography at Michigan State University. His research interests include representation and modeling of spatial data uncertainty, characterizing spatial dimensions of community health, and working with colleagues across the social and environmental sciences on problems with novel and challenging spatial elements.
Address: Department of Geography, Michigan State University, 118 Geography Building, East Lansing, MI 48824, USA.

Binoj K. Shrestha is a doctoral student in the College of Liberal Arts and Sciences at Arizona State University. He worked as a Research Associate in Institute of Social and Environmental Research-Nepal. His research interests include human nature interaction system, ecosystem ecology, ecosystem services, and biodiversity management systems.
Address: School of Life Sciences, Arizona State University, 427 East Tyler Mall, Tempe, AZ 85287, USA.

Jianguo Liu is the director of the Center for Systems Integration and Sustainability at Michigan State University. His research interests include household–environment interactions, complexity of coupled human and natural systems, wildlife ecology, landscape ecology, systems modelling, and the science of sustainability.
Address: Center for Systems Integration and Sustainability, Michigan State University, 115 Manly Miles Building, East Lansing, MI 48824, USA.