Human casualties are the dominant cost of human–wildlife conflict in India

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Reducing the costs from human–wildlife conflict, mostly borne by marginal rural households, is a priority for conservation. We estimate the mean species-specific cost for households suffering damages from one of 15 major species of wildlife in India. Our data are from a survey of 5,196 households living near 11 wildlife reserves in India, and self-reported annual costs include crop and livestock losses and human casualties (injuries and death). By employing conservative estimates from the literature on the value of a statistical life (VSL), we find that costs from human casualties overwhelm crop and livestock damages for all species associated with fatalities. Farmers experiencing a negative interaction with an elephant over the last year incur damages on average that are 600 and 900 times those incurred by farmers with negative interactions with the next most costly herbivores: the pig and the nilgai. Similarly, farmers experiencing a negative interaction with a tiger over the last year incur damage that is on average 3 times that inflicted by a leopard and 100 times that from a wolf. These cost differences are largely driven by differences in the incidence of human death and casualties. Our estimate of costs fluctuates across reserves, mostly due to a variation of human casualties. Understanding the drivers of human casualties and reducing their incidence are crucial to reducing the costs from human–wildlife conflict.

human–wildlife conflict | human casualties | conservation | protected areas | megafauna |

> Most of the tales were about animals, for the Jungle was always at their door. The deer and the pig grubbed up their crops, and now and again the tiger carried off a man at twilight, within sight of the village gates. "Tiger! Tiger!" (Rudyard Kipling, *The Jungle Book*, Collins Classics, 2010)

India is home to the world's largest rural population (1) and some of the most diverse ecosystems of the world (2, 3). Living close to globally important populations of Bengal tigers, Asian elephants, Indian rhinos, and other unique species, many of its residents suffer material and physical damage from wildlife.* For example, India's cost of human–elephant conflict is estimated at 1 million ha of destroyed crops, 10,000 to 15,000 damaged properties, 400 human deaths, and 100 dead elephants per year (5–7). There is evidence that crop losses from noncharismatic species are almost as significant (8–11).

While there are advantages of being close to wild flora and fauna—pollination, pest predation, and other ecosystem services (12, 13)—the losses in human life and property can engender hostile human attitudes (14). In the face of dwindling populations and habitat,† local hostility can lead to local eradication (see ref. 19 for a survey of evidence) and sometimes global extinction.‡

We estimate the mean annual species-specific damage for a sample of households who suffer damage from wildlife.§ We disaggregate our estimates into damages from crop raiding and livestock depredation, human injury, and death. We investigate how these damages vary across regions.

This exercise is important for several reasons. First, human damages from wildlife are a credible proxy for attitudes toward wildlife in these areas. Second, a careful disaggregation can help us evaluate the costs of human injuries and death relative to the costs of livestock and crop losses. Third, many jurisdictions across the world compensate for damage from protected wildlife (21, 22). The associated expenses for such compensation are often significant—ref. 11 estimates that state governments in India spent over US $5 million in the year 2012 to 2013 for compensation of wildlife damage. Careful species-specific estimates of the damages from wildlife can inform and streamline such compensation policy. Finally, estimates of the damage from a negative interaction with wildlife can be used with estimates of probabilities of such an interaction, to determine the expected cost of living in proximity to wildlife in India.

Significance

Successful conservation of our dwindling wildlife involves a reduction in human costs—including human casualties, crops, livestock, and other property—from interactions with wild species. We analyze survey data from households incurring wildlife damage in India to illustrate that the cost from human casualties overwhelms all other property losses. Our results imply the following: 1) Considering the cost of human casualties while estimating costs from wildlife conflict is essential. 2) Compensation for damage incurred from interactions with wildlife in India is insufficient. And 3) conservation policies and organizations should refocus (if they are not already doing so) their efforts on reducing human death and injuries from interactions with wildlife.

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*The proximity between human settlements and wildlife habitats leads to competition and conflict over resources (4).

†More than a quarter of the globally known species are currently threatened with extinction (15), and the expansion of human activities—including agriculture, forestry, and fisheries—into natural habitat is cited as a primary reason (16–18).

‡See ref. 20 for an analysis of local mammal extinction in India.

§Also termed the species-specific cost conditional on conflict with wildlife. This should not be mistaken for the expected unconditional cost of conflict from the household's location. We do not incorporate the probability of experiencing conflict. In common usage, human–wildlife conflict typically includes human (material and immaterial) damages and losses to the species from human activity (including retaliation). In our data, species that cause conflict inflict material damage and/or human casualties to a surveyed household. From this point onward, our use of the term "conflict" reflects that specific definition.

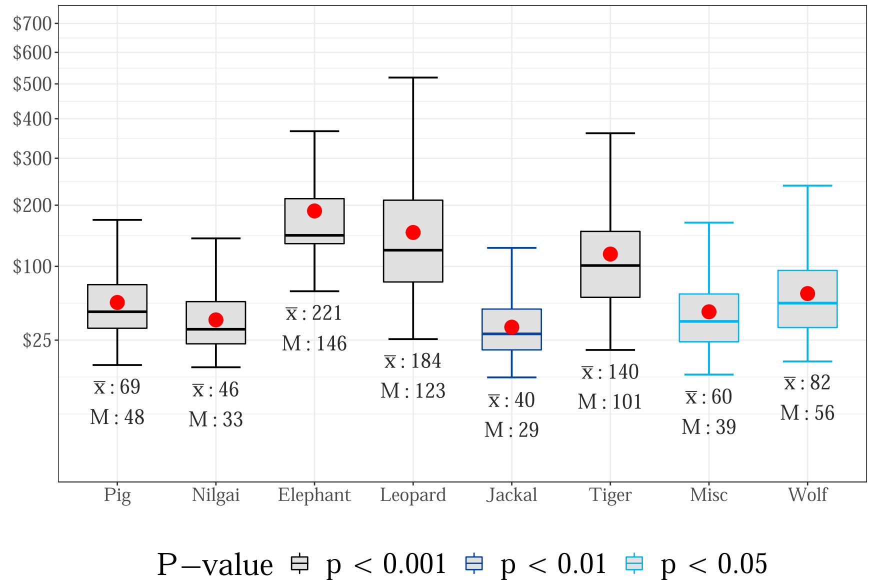

Fig. 1. Crop and livestock damages by species.Predictions, based on the median regression described in *Materials and Methods*, are depicted for crop and livestock damages by species. The eight species presented here demonstrate statistically significant effects on damages incurred by the households surveyed (*Materials and Methods*). The whiskers indicate the 95% confidence interval for the predicted damage for a household in our sample assuming that the household incurs livestock or crop damage from the corresponding species. At the bottom of the plot, $\bar{X}$ denotes the predicted mean, and M denotes the median. The box plots and summary statistics reported are based on the sample of observations for reserves where the species is found. Hence, the elephant's distribution of damages is for 5 of the 11 reserves surveyed, while damages from the pig are for all 11 reserves.

Our estimates come from a survey of over 5,000 households living in a 10-km buffer around 11 protected areas in four states of India: Karnataka, Rajasthan, Madhya Pradesh, and Maharashtra. These reserves span a range of habitats and contain some of India's most iconic and endangered species. Households report aggregate crop and livestock damages from wildlife over 1 y. In a yes/no fashion they report whether an individual species was responsible for any damage (conflict) over the last year. They separately report human casualties associated with individual species. We use this information in a median regression to estimate a species-specific marginal damage from the 15 most commonly named wildlife species.[¶] Our estimate of the marginal damage for a species takes into account the variation in household characteristics, agricultural patterns, and other social and geographical differences across protected areas. We quantify losses to human lives and injuries in economic terms, using the value of a statistical life from the recent literature on the health impacts of climate change (23).

Our study is an assessment of the household-level damage incurred from conflict with a wild species due to three primary reasons: 1) We employ a large survey over a diverse geographical area, analyzing a wide array of species. 2) We explicitly value, incorporate, and compare the costs of human casualties in addition to standard measures of losses in human property. And 3) we are able to disaggregate our measure of damages by species and region. Among these, the valuation of the costs of human casualties is our main contribution to the literature. Human costs from wildlife are detailed in many analyses (4, 24–32)—however, the cost of human casualties is often omitted. Even when human casualties are considered, such as in refs. 33 and 34, they are not assigned monetary values, making a comparison with other components difficult. By incorporating the value of human life into our estimates, we show that human casualties contribute overwhelmingly to the overall damages from wildlife interactions. Our results suggest that the economic damage from negative interactions with large mammals is likely much greater than what is typically reported in the literature.

Results

We present the species-specific mean annual damage for households who incur damage from wildlife in the previous year. Our first set of results reports crop and livestock damages (Fig. 1). The second set of results illustrates the costs of human casualties (injury and death) (Figs. 2 and 3). The third and final sets of results demonstrate the heterogeneity of these damages across species and reserves (Figs. 4 and 5).[#] We convert all values to US$ using average yearly exchange rates obtained from the World Bank.[‖] We also adjust for nominal price changes using an average US inflation rate of 2% (for years 2000 to 2018, also obtained from the World Bank) to set the year 2013 as our uniform base year for all results reported.

Losses in Crop and Livestock by Species Are Substantial. In Fig. 1 we illustrate the distribution of household-level crop and livestock costs from conflict for eight species having a statistically significant effect on self-reported annual crop and livestock damages. Fig. 1 demonstrates that these costs are substantial. For example, if a farmer has livestock damage from a tiger over the last year, the mean loss is approximately the asset value of an eighth

¶For common and scientific names for the species, see *SI Appendix*, Table S8. Results from the corresponding ordinary least-squares regression are also presented there.

#As our data derive from survey responses on household damages, we acknowledge that errors are possible as respondents may not recall accurately, or they may have systematic biases from perceptions toward individual species, or they may have a desire to influence surveyor empathy or government compensation policies. Please see *Discussion* for a deliberation of the impact of this uncertainty or bias.

‖All data are from the World Bank data site (https://data.worldbank.org/), using the local currency unit per US$, period average. In general, we use the 2013 exchange rate of $58.598; for some results, we use the 2001 exchange rate of US $47.186 to $1.

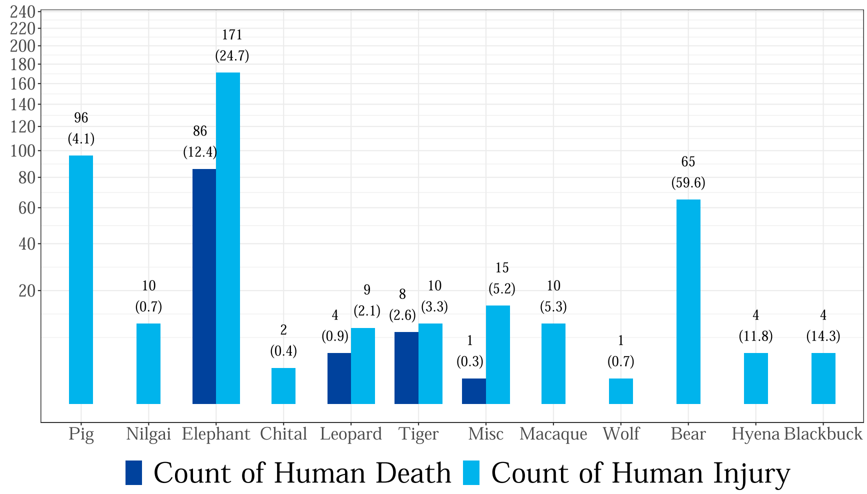

Fig. 2. Counts of human injuries and deaths (and conflict severity: injury or death). All 12 species associated with human casualties are depicted, with misc being the residual category that includes snakes. The numbers in parentheses are the number of fatalities or injuries for every 100 counts of conflict (defined as the occurrence of material damage and/or human casualties to a surveyed household). We term these indexes the conflict severity index (death) and conflict severity index (injury), respectively, following the convention in the literature studying traffic accidents (41). These indexes are equivalent to the sample probability of injury or death, conditional on conflict.

of a healthy cattle or a little more than a goat.[**] Note that our estimate does not account for the number of times a farmer suffers damage in the previous year from the species. For example, the pig or nilgai raids crops in some fields several times a day. In contrast, livestock depredation events by tigers are less frequent. Using a similar approach, we calculate that on average, the leopard inflicts damages that are equivalent to losing a goat to an affected farmer; the elephant, damages equivalent to a fifth of the farmer's yearly crop income; and the pig, damages equivalent to the farmer's monthly crop income.[††]

The Value of Human Casualties by Species. Human casualties are a major consideration in health (36), transportation (37), and environmental policy (23). Consequently, there exist well-developed methods for evaluating the loss of human life. The most common economic measure is the value of a statistical life (VSL), a method that estimates a population's revealed valuation of life through choices made (see ref. 37 for a survey). Alternatively, interview-based (contingent valuation) methods also exist, allowing the researcher to focus on the perceived risk of mortality (see ref. 38 for an application to environment and transportation). Valuing life has also been used to evaluate human–wildlife conflict, where applications are almost always limited to assessing wildlife-related traffic accidents (39).

The US Environmental Protection Agency (EPA) estimates of VSL are widely used. In what follows, we use two baseline VSL estimates: one from the EPA and another from a study of wage rates for workers in Mumbai. We use methods suggested by ref. 40 to deflate EPA estimates for the United States to make them relevant for India. We also compare the results from these estimates to local governments' compensations for fatalities. The latter can be seen as a proxy for the local valuation of human life. These methods are described in greater detail in *Materials and Methods*.

The elephant is responsible for significantly more casualties than any other species in our data (Fig. 2). The tiger and the leopard are the next deadliest animals in our surveyed population, but responsible for less than 10% and 5% of the deaths caused by the elephant, respectively. Conditional on a negative encounter with the species, it is most likely that the elephant will cause a human fatality, followed by the tiger, and then the leopard. This ranking based on their conflict severity index (death) is consistent with the ranking based on their respective absolute counts of human deaths (Fig. 2). The sloth bear is an exception with the highest conflict severity index (injury) of 60, almost 3 times higher than that of the elephant and 15 times higher than that of the pig, despite the latter two causing the most human injuries in our sample. This implies that although encounters with the bear are rare, the probability of human injury when an encounter occurs is much higher than for other species.

Using the VSL, we monetize the risk of injury or death on experiencing conflict (defined as the occurrence of material damage and/or human casualties to a surveyed household).[‡‡] We find that conditional on experiencing conflict with the tiger (in the 7 parks), the expected cost of human casualty is $8,866; with the leopard (for all 11 parks), $3,204; with the elephant (for 5 parks), $42,236; and with the pig (for 11 parks), $5. Note that these are the mean, or average, costs. As the distribution of these costs exhibits a strong right skew, and conflict with most species (besides the sloth bear) does not result in a human casualty, the median cost is by definition zero. Greater detail on these numbers by species is presented in *SI Appendix*, Table S6.

Aggregate Losses on Experiencing Conflict: Human Casualties Dominate. Using the EPA's VSL estimate, any probability of death from conflict implies that the value of death will overwhelm crop and livestock losses. This is best illustrated with the common leopard. Because of four human fatalities associated with conflict, the probability of death is 0.9%. This probability is sufficient

[**] A healthy head of cattle costs approximately $1,036 per head—the average price of cattle in Rajasthan is ₹66,700 per head, in Madhya Pradesh ₹62,600 per head, in Maharashtra ₹42,750, and in Karnataka ₹47,800. And a goat costs approximately $131—with the average price in Rajasthan ₹6,400, in Madhya Pradesh ₹7,700, in Maharashtra ₹5,500, and in Karnataka ₹8,300. All livestock prices are from the 2017 to 2018 state-wise master unit cost data from ref. 35, adjusted to 2013 US$.

[††] See details in *SI Appendix*.

[‡‡] It is important to note that any estimate of the risk of injury or death is best calculated using data from several years. We have access to a single year's data; thus, our estimates might not be representative.

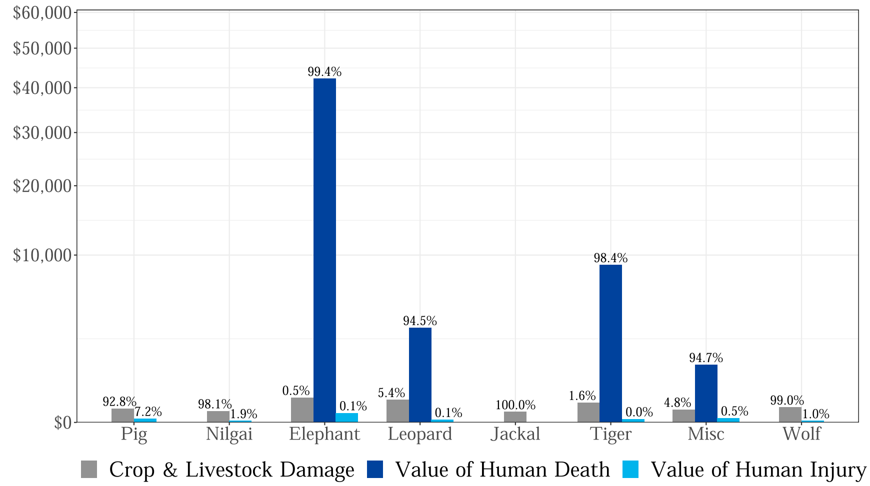

Fig. 3. Categorizing the species-specific human costs from wildlife: VSL. The three components that make up our measured human costs from wildlife are depicted here for the eight species,[##] whose regression coefficients are statistically significant and robust across all specifications. (Robustness is illustrated in *SI Appendix*, Fig. S3.) Following the method from ref. 23, we place a value of statistical life equal to $312,663 on a human fatality (see *Materials and Methods* for a description). The percentage value on top of each bar represents the proportion of the respective component in relation to the aggregate cost associated with each species.

to dominate all crop and livestock losses attributed to this species (Fig. 3).[§§] In *SI Appendix*, Fig. S4, we use the average compensation paid by Indian states as the value of human death and injury. With a low value ascribed to human death (only $3,432) (11),[¶¶] crop and livestock losses can be as large as, or even larger than, the loss associated with human death and injury (see species leopard, miscellaneous [misc], and tiger, for example, in Fig. 3). In *SI Appendix*, Fig. S5, we use the VSL from ref. 42 (see section 1 in ref. 42 for an explanation). Using this valuation, which is the lowest in the current VSL literature in India, the pattern repeats itself. Any probability of a human fatality dominates all other crop and livestock losses.

Heterogeneity Observed across Reserves. For most species, we observe significant variation in the overall damages from wildlife and its components across reserves (Figs. 4 and 5).

This variation is larger in means than in medians. Specifically, the mean and median damages to crops and livestock from a tiger over the last year range from $34 and $44, respectively, in Kanha in Madhya Pradesh, to $373 and $436 for Nagarhole in Karnataka. Similar variation across reserves can be seen among the costs for the leopard, the elephant, and the pig, where the highest costs are experienced by respondents living around Nagarhole National Park. (The median damage from a leopard over the last year ranges from $42 in Phulwari, Rajasthan to $723 for Nagarhole, in Karnataka. Corresponding means range from $48 in Phulwari to $767 in Nagarhole. The median damage from an elephant over the last year ranges from $102 in Kali in Karnataka, to $431 in Nagarhole, also in Karnataka. Corresponding means range from $119 in Kali to $502 in Nagarhole. The median damage from a pig over the last year ranges from $17 in Phulwari to $277 in Nagarhole, Karnataka. Corresponding means range from $21 in Phulwari to $317 in Nagarhole, Karnataka.)

The variation in the occurrence of human death and injury is more dramatic. For example, of the five reserves where elephants exist, we find that human death occurs in only two reserves, Nagarhole and Bandipur. The numbers of cases of human injury are the highest there. In the remaining parks of Karnataka, there are no deaths, and the conflict severity (injury) is less than 17. The leopard, found in all 11 reserves, is associated with human death only in one reserve, Kanha, Madhya Pradesh. Human injuries are attributed to the leopard in just two other reserves, Kumbalgarh, Rajasthan, and Tadoba-Andhari, Maharashtra. Similarly, the pig is plentiful in all reserves surveyed, but 64 of the 92 injuries occurred near Bandipur.

Heterogeneity Observed across and within Species. Farmers experiencing damage from an elephant over the last year incur damages on average that are 600 and 900 times those incurred by farmers experiencing damage from the next most costly herbivore over the same period: the pig and the nilgai. (Overall mean damages from a pig and a nilgai are US $74 and US $47 per household, respectively (SI Appendix, Table S6)). Similarly, farmers experiencing damage from a tiger over the last year incur damage that is on average 3 times that inflicted by a leopard and 100 times that by a wolf. These values do not account for the probability of experiencing damage by species. While some species may have low conditional damages, a high probability of conflict may make these species more costly to live in proximity of. We also find that the components of these losses vary. Some animals create losses mostly from crop and livestock damage, but some animals inflict significant damages due to their ability to cause human death or injury.

Discussion

Once the value of a human life is incorporated, total damages from negative interactions with large mammals are orders of magnitude larger than damages from crop and livestock losses alone. This can counter a growing belief that noncharismatic species such as the pig and the nilgai impose losses that are as significant as those imposed by iconic species such as the elephant and tiger (8–11). The dominance of the costs of human casualties also implies that reducing injury and death should be the highest priority for effective conservation. If we want to reduce the animosity (or increase the tolerance) of those living in proximity to wildlife in India, lowering the possibility of human casualties is crucial.

Furthermore, our results imply that authorities are not adequately compensating families for the true cost of conflict,

[§§] Overall losses from this species are $3,887 of which the cost of human injury and death makes up 99.5%.

[¶¶] Original estimate is $3,234, here adjusted to 2013 US$ using 2.0% inflation rate.

[##] For a detailed report, see *SI Appendix*, Table S6.

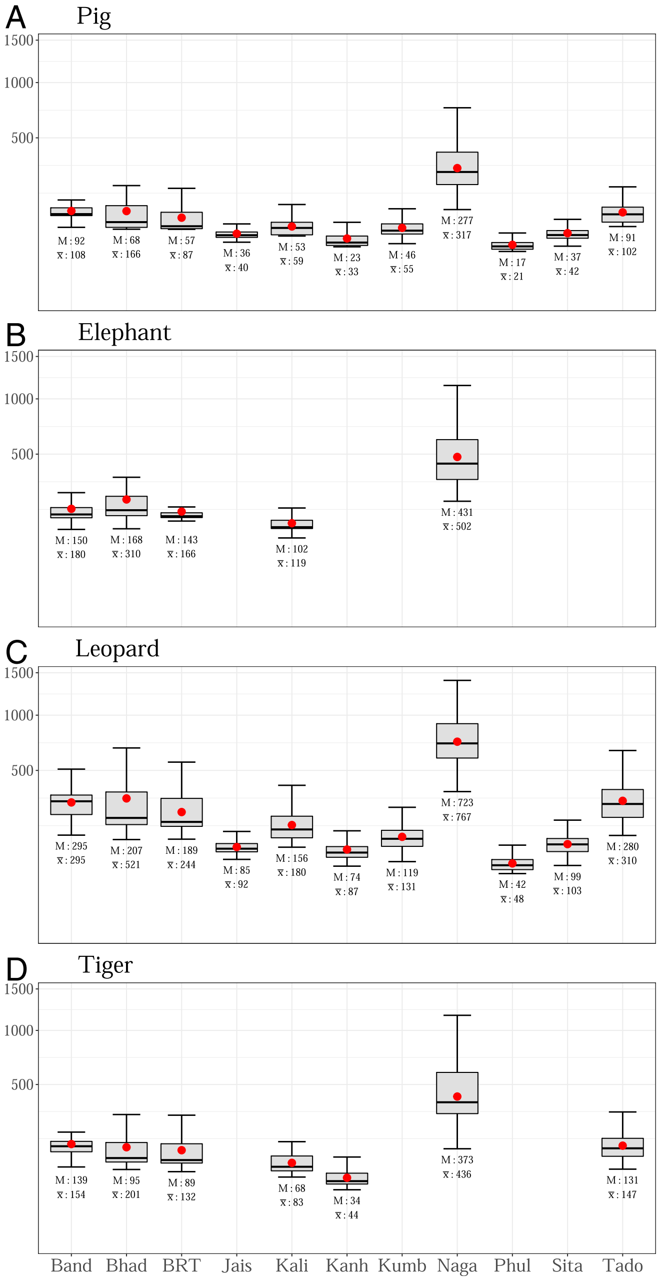

Fig. 4. Crop and livestock damages by park: pig, elephant, leopard, tiger. (*A*–*D*) The distribution of crop and livestock damages in US$ across 11 reserves, conditional on conflict of a household with (*A*) the pig, (*B*) the elephant, (*C*) the leopard, and (*D*) the tiger. (Refer to *SI Appendix*, Table S12, for a list of official names.) The pig is the species with most reports of conflict in our survey; the elephant is the species with the largest number of human deaths and injuries; while the tiger and the leopard are two iconic carnivores of India.

particularly when there is a loss of human life as the average payment for an incidence of human death across compensating states in India is almost 80 times smaller than a low but current value of statistical life in the literature—from ref. 42. This implication is consistent with the evidence provided by another case study of human–sloth bear interactions, where a majority of the victims found state compensation for human casualties inadequate to cover the actual cost of treatment for injuries (43). Overall, our exercise demonstrates the importance of the choice of the value of life in the valuation of the damages from wildlife.

Our demonstrated dominance of human casualties has parallels in the economics of air pollution. Focusing primarily on human health effects, studies valuing the impacts of local air pollutants find significant costs (44, 45). Analyses of the costs of carbon dioxide emissions (see ref. 46 for a survey) demonstrate the importance of human casualties; for example, ref. 23 estimates that the costs of excess mortality associated with a 2.5 °C increase in global temperatures constitute 75% of the social cost of carbon calculated by ref. 47.

Finally, the heterogeneity of costs across reserves implies that adequate and fair compensation policy must be location specific. This variation could result from the inherent distinction between reserves, in terms of species density, local human population density, prey abundance, etc. However, the mechanism by which this variation occurs is not the focus of this study.

Limitations

Direct vs. Indirect Costs. Our study estimates the direct costs from wildlife, while ignoring indirect costs such as those associated with mitigation. Mitigation has many components; it could be guarding, building of fences and other barriers, and altering the portfolio of crops and livestock in response to the threat of conflict. A study by ref. 48 shows that the average costs of lethal and nonlethal control for conflict species in South Africa were US $3.30 and US $3.08, respectively, per head of livestock. The opportunity costs for households living around Kibale National Park, Uganda, in terms of time spent guarding per week, were 5.2 d for men, 3.9 d for women, and 1.5 d for children (28). The indirect costs from conflict with wildlife also encompass other complex and hidden facets that are harder to untangle, such as food insecurity, gender inequality, and physical and psychological impacts on human health (49–51).

Conditional vs. Expected Damages. Our estimates are species specific and conditional on a household incurring damages. They are not the expected costs from living in proximity to wildlife reserves, which should be weighted by the probability of conflict with individual species. To our knowledge, these expected costs have not been examined deliberately in the literature. Michalski et al. (4) provide the closest example where the authors study both the losses to cattle ranches from large felid attacks and the probability of those predation events based on geographical variables. They were, however, analyzed separately in the paper. While our data have sample probabilities of experiencing conflict (*SI Appendix*, Fig. S2), we do not use them to calculate expected losses. Despite this, some suggestive interpretations can be made. The Asian elephant imposes the highest damages. It also has a high sample probability of inflicting damage at 35.1%. This makes it a particularly problematic species to live close to. On the other hand, almost 45% of our sample suffers damage from the pig, but with a relatively modest cost of $56.98, they are a less threatening species. The common leopard and the Bengal tiger inflict large costs while having a sample probability of experiencing conflict at 8 to 10%. Consequently, they are likely to induce significant fear of conflict in those living in their proximity.

Biases from Self-Reported Data. Our data are based on participant recall and self-reported estimates of losses from wildlife. Like all survey data, these likely contain measurement error. Our dependent variable is total wildlife damage, while our main independent variables are a list of fixed effects indicating whether a species contributes to overall damage. Survey participants might intentionally overreport wildlife damage in the hope of influencing a local government's decision on compensation (52). This would lead to an overestimation of wildlife damage across all

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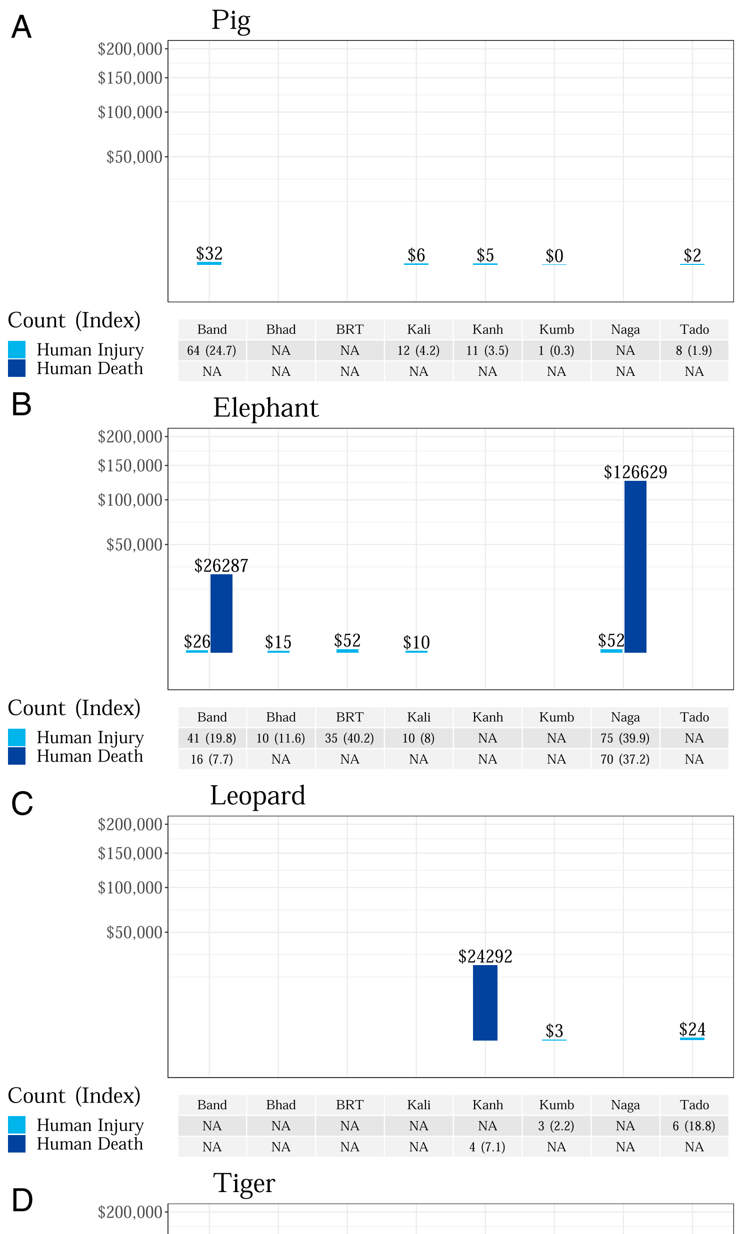

A. Pig – Count (Index)

	Band	Bhad	BRT	Kali	Kanh	Kumb	Naga	Tado
Human Injury	64 (24.7)	NA	NA	12 (4.2)	11 (3.5)	1 (0.3)	NA	8 (1.9)
Human Death	NA	NA	NA	NA	NA	NA	NA	NA

B. Elephant – Count (Index)

	Band	Bhad	BRT	Kali	Kanh	Kumb	Naga	Tado
Human Injury	41 (19.8)	10 (11.6)	35 (40.2)	10 (8)	NA	NA	75 (39.9)	NA
Human Death	16 (7.7)	NA	NA	NA	NA	NA	70 (37.2)	NA

C. Leopard – Count (Index)

	Band	Bhad	BRT	Kali	Kanh	Kumb	Naga	Tado
Human Injury	NA	NA	NA	NA	NA	3 (2.2)	NA	6 (18.8)
Human Death	NA	NA	NA	NA	4 (7.1)	NA	NA	NA

D. Tiger – Count (Index)

	Band	Bhad	BRT	Kali	Kanh	Kumb	Naga	Tado
Human Injury	NA	3 (5.4)	NA	NA	3 (3.6)	NA	2 (8)	2 (2.9)
Human Death	NA	1 (1.8)	NA	NA	7 (8.4)	NA	NA	NA

Fig. 5. Human death and injury by park: pig, elephant, leopard, tiger. (*A–D*) The costs of human death and injury and their respective counts and indexes across reserves for (*A*) the pig, (*B*) the elephant, (*C*) the leopard, and (*D*) the tiger are depicted. The dark blue bars represent the costs of human death and the light blue ones represent the costs of human injury. *Bottom* of each plot illustrates the number of cases and the corresponding conflict severity indexes of death and injury for each species by park. (Conflict severity indexes are enclosed in parentheses.) Note that only eight parks are represented here as there was no report of human death and human injury caused by these four species in Jaisamand, Phulwari, and Sitamata wildlife reserves.

species. Survey participants might also have a bias in their allocation of losses across wildlife species (53). This could be because of a different association of risk with different species, thus reflecting the extreme rather than the expected value of the damage (52); or they may have an emotive response to the species, which might arise due to negative experiences with a particular species (54, 55), especially when injury or death to a human is experienced (55). As a result, megafauna are often blamed for damage that was caused by less imposing species such as rodents or birds (56). We minimize this bias by asking farmers to report the total loss to crop and livestock caused by all wildlife species combined. We then use statistical methods to allocate damage to individual species. Our independent variables are fixed effects indicating whether a farm experiences conflict with a particular species. These reports can be subject to measurement error if respondents fail to identify species correctly or fail to recall certain species or if the enumerators tend to ask about particular species. This is especially problematic for unobtrusive or common species, such as mice or birds. Respondents may mention them only in extreme events. This type of measurement error would lead to an overestimation and upward bias of our results for these common and unobtrusive species. As our main regression includes only the 15 most named species, and none of them are common, unobtrusive, small species, we believe that such measurement error does not unduly influence our coefficients.

Bias from Organizational Affiliations. This bias could come from the affiliation or innate judgment of our volunteer surveyors. While each surveyor is trained (see *Materials and Methods* for a description) and initially accompanied by supervisors to ensure consistency, it is possible that social and organizational affiliations influence the responses noted (57). Our estimates are by species and averaged across respondents (and thus surveyors). This should minimize the impact of individual surveyor bias. To explore this further, we also include a robustness regression where we allow fixed effects for each surveyor by wildlife reserve (*SI Appendix*, *Robustness*). We now have a separate intercept for total losses recorded by surveyor, which reduces the surveyor's influence on each species' coefficients.

Materials and Methods

We surveyed 5,196 households across 11 wildlife reserves (*SI Appendix*, Fig. S1) between 2011 and 2014 in a three-step process, ensuring representation of the surrounding population (see *SI Appendix* for more information about the survey). The surveys were administered by research assistants and trained volunteers. Survey techniques were standardized. Human ethics protocols were separately approved by Columbia University and Duke University, United States, and by the Center for Wildlife Studies, India. All surveyors were conversant in English and the local language. Verbal consent was obtained in the local language before proceeding. All responses were transcribed into English. Surveyees answer structured and semistructured questions regarding 1) demographic characteristics—household composition, gender, and literacy; 2) nature and type of conflict (i.e., crop damage/livestock depredation/property damage/human injury, loss of income, history of recent and past conflict incidents, species involved in conflict incidents); 3) agricultural and livestock characteristics including major crops grown, livestock heads and breeds, and feeding practices (e.g., stall fed/grazing within forest); and 4) mitigation measures employed by households. (Summary statistics and illustrative figures for our surveyed farms are included in *SI Appendix*. In *SI Appendix*, Tables S1–S4, we include statistics on family size, literacy, crop and livestock losses, main crops grown, and animals most named in conflict. Note the large variation in crops grown across the reserves.) Data, code, and materials for reproducing all results in this paper are available in Datasets S1–S3.

Estimating and Predicting Crop and Livestock Losses on Experiencing Conflict. We isolate species-specific crop and livestock damage by using fixed effects for conflict with individual species in a nonparametric quantile regression evaluated at the median (58). Fifteen species with the highest counts of conflict (over all households in our sample) were included in the regression. (To see all species named and counts of conflict, please refer to *SI Appendix*, Fig. S2.) This is necessary as households report last year's damages to crops and livestock as an aggregate from all possible 33 species in Indian Rupees (₹), while conflict (yes/no) with each species is reported individually. Conditional on human–wildlife conflict this regression provides us an estimate of the marginal damage of each wildlife species. This method relies on the assumption that species-specific damages are independent of each other. (Given the large landscape and diversity of animals, this assumption is not particularly restrictive. If this assumption is violated, the presence of a particular species either substitutes or complements damage from other species. For example, if it substitutes, crop raiding by a peafowl might occur instead of by an elephant, and the presence of a peafowl reduces overall damage. If it complements, the presence of a chital deer might draw predators such as tigers and leopards and increase conflict with them.) Note that this assumption is implicitly made in the literature calculating average damage by individual species in isolation (for example, ref. 25). We also include fixed effects for the reserve nearby and for the crops grown at the farm. We control for heads of small and large livestock and farm acreage. (The estimating equation is detailed in *SI Appendix*.) Finally, our dependent variable is log-transformed. While our median regression method is relatively unaffected by outliers, we find that aggregate crop and livestock damages experienced in the farms on our sample have a right-skewed distribution with a measure of skewness of 12. Upon log-transforming this variable, the measure of skewness drops to 0.1, and the distribution is no longer classified as skewed (*SI Appendix*, Fig. S8). As we estimate conditional damages, there are no zeros in our dependent variable, and a log transformation implies no loss in observations.

We predict our dependent variable from our estimating equation for two cases, when 1) the household hypothetically experiences conflict with the species of interest and 2) the household hypothetically experiences no conflict with the species of interest. We assume that all other variables in the estimating equation remain at values reported in the data for each prediction. The difference between cases 1 and 2 is the predicted damage to the household on experiencing conflict with the species considered. We repeat this for all of the 15 species most named in conflict.

Valuing the Risk of Human Casualties from Experiencing Conflict. In our surveys, human injury and death are ascribed to a particular species, removing the need for a regression (more details on this process are provided in *SI Appendix*). The expected value of injury or death on experiencing conflict is the sum of two multiplicands. The first one is the conflict severity index (injury) multiplied by the value of injury, and the second one is the conflict severity index (death) multiplied by the value of a statistical life. While calculating the conflict severity indexes is relatively easy, ascribing value to injury and death is less straightforward. We consider three methods to value life and injury in India.

First, we use compensation paid by State Governments in India. States pay for human mortality and human injury in animal conflict—see ref. 11 for a careful analysis of these payments. We use the average compensation paid for death across India's 29 states in years 2010 to 2015 from ref. 11. Compensation for human death ranges from $1,046 in the state of Haryana to $11,956 in the state of Maharashtra. The average compensation paid for human death is Indian Rupee 191,437, or $3,234, and the average compensation paid for human injury is Indian Rupee 6,185, or $103. (We deflate those payments to our baseline year of 2013 using an inflation rate of 2%. For our calculations, we use $3,234 from the results section of ref. 11, while the abstract and discussion section state the average as $3,224.) One might consider government compensation as a reflection of the local valuation of human life.

The second value of human death and injury derives from ref. 42. The authors estimate a value of statistical life at ₹14.8 million for Mumbai using wage data from 2001, which translates to US $24,7878 in 2013. The value of a statistical injury for the workers in Mumbai is ₹9,000, which translates to US $150. This is the value estimated from a sample of workers in Mumbai.

The third value follows the method by ref. 23 using US EPA's estimate of the VSL of US $9.9 million for the year 2020 expressed in 2011 US$. We convert this value to a VSL in India for the year 2013 assuming an income elasticity of unity and using the gross national income (GNI) provided by the World Bank as suggested by ref. 40. An income elasticity of unity implies that VSL is a constant fraction of income. To convert the US VSL to a VSL for India in 2013 we first convert the US value into a value per life-year lost. (The number of life-years lost is the difference between the median age and the mean life expectancy. For the United States the difference is 40 y while for India it is 42 y.) We then calculate the VSL per life-year lost to income ratio for the United States using the GNI of 2017 expressed in 2010 US$ ($53,815). (The VSL per life-year lost/GNI ratio for the United States is 4.6.) In the last step, we multiply the number of life-years lost in India with India's GNI for the year 2013 expressed in 2010 US$ ($1,525), which is then multiplied by the VSL/GNI ratio for the United States and inflated to 2013 US$. Using these steps we arrive at a value of $312,663. (This can be compared to the reference range for these estimates for India in ref. 37 from US $50,000 to $700,000 (in the year 1995). Ref. 37's best estimate is US $60,000 (see table

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5 in ref. 37). Our estimate for 2013 is approximately a little over five times that and is consistent with India's gross domestic product (GDP) per capita growing over five times from 1995 to 2013 (see the World Bank's data site: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=IN).

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