# Mitigating human-tiger Conflict: an assessment of Compensation Payments and tiger removals in Chitwan National Park, Nepal

Authors: Dhungana, Rajendra, Savini, Tommaso, Karki, Jhamak Bahadur , and Bumrungsri, Sara

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**Short Communication**

# Mitigating human-tiger conflict: an assessment of compensation payments and tiger removals in Chitwan National Park, Nepal

**Rajendra Dhungana[1,2*], Tommaso Savini[3], Jhamak Bahadur Karki[4] and Sara Bumrungsri[1]**

[1]Department of Biology, Ecology Program, Prince of Songkla University, Hat Yai 90110, Thailand
[2]Ministry of Forests and Soil Conservation, Environment Division, Singhadurbar, Kathmandu, Nepal
[3]Conservation Ecology Program, School of Bioresources and Technology, King Mongkut's University of Technology, Thonburi, Bangkhuntien, Bangkok 10150, Thailand
[4]Kathmandu Forestry College, Amarawatimarg, Koteshwor, Kathmandu, Nepal
[*]Corresponding author. E-mail address: rajendra.dhungana2@gmail.com

**Abstract**

Human-tiger conflict is one of the most critical issues in tiger conservation, requiring a focus on effective mitigation measures. We assessed the mitigation measures used between 2007 and 2014 in Chitwan National Park (CNP) and its buffer zone, which include: compensation payments made to human victims or their families, compensation for livestock loss through depredation, and the removal of tigers involved in conflicts. The data collected from the offices of CNP and the Buffer Zone Management Committee were triangulated during questionnaire surveys (n=83) and key informant interviews (n=13). A total compensation of US$ 93,618 ($11,702.3 per year) was paid for tiger attacks during the eight-year period. Of this, the majority (65%) was in payment for human killings, followed by payment for livestock depredations (29.3%) and for human injuries (5.7%). The payments on average covered 80.7% of medical expenses of injured persons, and 61.7% of the monetary value of killed livestock. Goats had the highest proportion of payments (43.5%) for livestock. A linear model suggested there was an increasing trend in total annual payments from $2,000 in 2007 to $21,536 in 2014, a jump of 976%. A total of 15 tigers were removed from the wild for conflict reasons: 11 by authorities, and four killed by local people in retaliation. Thirteen tigers were removed from the buffer zone alone. The majority of the removed tigers were adults (n=9) and healthy (n=9). Most (n=12) of the removed tigers were killed, or died after removal, indicating greater impacts of tiger-removal in CNP. We suggest that in order to encourage community engagement, compensation payments be paid quickly, an insurance scheme in the buffer zone be promoted, live-removed tigers be better managed, including radio-tracking of wild released individuals, and awareness programs be targeted at affected communities.

**Keywords:** buffer zone, human-wildlife conflict, *Panthera tigris*, tiger conservation, human killing

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## Introduction

Human-wildlife conflict is one of the most significant conservation issues in many areas, exacerbated by increasing human populations, loss of natural habitats, and in some cases, increased wildlife populations as a result of successful conservation programs [1]. Conflicts involve crop damage, property damage, livestock depredation, and human casualties [2]. Large carnivores, despite occurring in lower densities [3], are highly involved in conflicts with humans, who reduce carnivore populations through active persecution based on real or perceived threats to themselves or their livestock [4-6].

Human-tiger conflict (HTC) is prevalent in almost all parts of the tiger's distribution range [1, 6-9] already contributing to the extinction of Balinese *(Panthera tigris balica)* and Javan (*P. t. sondaica*) subspecies [10]. HTC generates hostile attitudes toward tigers, resulting in eroded public support, retaliatory killings by people, and opposition to establishment of sanctuaries and introduction of rescued animals [4, 7, 11]. As conflict-caused mortality is one of the greatest threats to persistence of tiger populations [6,12], resolving HTC is one of the keys to their survival [5, 6]. Historically, efforts to reduce HTC focused on lethal control, but as tiger populations declined through the 1900s, efforts began to shift toward managing HTCs in ways that reduced risks for both humans and tigers [7, 12, 13]. During recent decades, conflict mitigation measures such as compensation payments, tiger removal, zoning, insurance schemes, relocation of people outside core protected areas, and livestock husbandry improvement have been common in many areas [7, 12].

Chitwan National Park (CNP) including Parsa Wildlife Reserve in the east and Valmiki Tiger Reserve (India) in the south, forms one of the Priority Tiger Conservation Landscapes of the Indian subcontinent [14]. Harboring the largest (125) and increasing tiger population of Nepal, CNP serves as the source population for surrounding landscapes of Nepal and India [15]. In 2004, as many as 19 people were reported killed by tigers in and around CNP [9], indicating that the impact of HTC is substantial. To cope with this issue, the park authority has adopted two measures: (i) payments for tiger attacks on humans and livestock, and (ii) removal of conflict-related tigers. In addition, retaliatory tiger killings by local people have been reported [9].

The compensation scheme in CNP, which began in 1998 after the declaration of the buffer zone, is an attempt to reduce animosity toward wildlife and economic hardship among the local communities. More systematic compensation payments, however, began with the promulgation of compensation guidelines in 2009 [16]. Despite wider global implementation [4], compensation payment schemes in general have met with mixed results [17], the failure being mainly attributed to inadequate and delayed payments, verification problems, false claims, logistical challenges, corruption, and unsustainably high payout costs [2, 11]. Systematic removal of conflict-related tigers is intended to prevent further attacks to humans and livestock, to protect the tigers from retaliatory killings, and to gain public approval for protection of remaining tigers in the wild. However, tiger removal and management decisions in CNP have often been made arbitrarily [9], mainly to address the immediate crisis. Such removals can cause unnecessary tiger mortalities and may even escalate conflicts [4, 12]. The lack of proper documentation on tiger removals has added complexity to the problem.

Despite such efforts and the issues identified, systematic review of mitigation measures is lacking in Chitwan. Any attempt to mitigate conflict and improve science-based conservation of culprit species requires a thorough review of existing mitigation measures [7, 18]. Therefore, we assessed the scales and temporal patterns of compensation payments (and claims) made for human killings, injuries, and livestock depredations by tigers; we also examined the scale and details of tigers removed for conflict reasons by both authorities and local people in retaliation (*e.g.,* killed or live-removed, tiger characteristics, removal context, fate of live-removed ones). Our assessment of compensation payments will help to revise the compensation scheme and evaluate government investments, and the assessment of tiger removals will help managers to make decisions about tiger removal and their subsequent management. Overall, our study will help reduce HTC and unnecessary tiger mortalities.

## Methods

*Study site*

The study was conducted in Chitwan National Park and its buffer zone in the southern part of Central Nepal (Fig. 1). The park was gazetted in 1973 as the first protected area of the country, with an area of 544 sq. km. In 1977, it was extended to the present area of 932 sq. km. The park is one of the last surviving natural ecosystems of the Terai region that provides critical habitat for several globally endangered species, notably: tiger (*Panthera tigris tigris*), one-horned rhinoceros (*Rhinoceros unicornis)*, and gharial crocodile (*Gavialis gangeticus)* [16]. The CNP is dominated by Sal (*Shorea robusta*) forests and has no human settlements. The buffer zone, with an area of 750 sq. km surrounding the park, was gazetted in 1996 with the primary goal of protecting a core area of the park through community-based natural resource management in its periphery. The buffer zone has a human population of 260,352 [16]. The majority of the inhabitants depend highly on forest resources for farming and livestock rearing. The buffer zone has been divided into 21 user committees and one sub-user committee as management units, which together form the Buffer Zone Management Committee as an apex body. These committees are instrumental in mobilizing funds and involving people in conservation.

*Compensation payments*

We collected available data on compensation payments from the offices of CNP and the Buffer Zone Management Committee, which maintained the compensation applications [8, 18] and payments disbursed from higher government institutions to tiger victims. The data collected for the period 2007-2014 include: claimed (loss) and paid (compensated) amounts for each human killing, human injury, and livestock depredation (goat, cattle, buffalo, sheep or pig), as well as date of incident. Additionally, we

triangulated and augmented the data on human casualties by conducting questionnaire surveys with victims, victims' family members or other witnesses (n=54). We surveyed livestock depredations by questioning 10% of the livestock owners who had lost livestock (n=29), which were selected randomly from a numbered list of all such owners by using a table of random numbers. The consistency of interview information with their corresponding official records enhanced our confidence to use the remaining data of livestock depredations without further checks. Other information, such as time taken to receive payments, procedural problems faced, and responses to the compensation scheme were also collected during questionnaire surveys. A mechanism with clear methodologies has been established in CNP to validate attacks and process compensation applications to avoid false claims and exaggerations. Though compensation payments are usually made for incidents occurring inside the buffer zone, we found (and included) some compensated cases of human casualties that occurred inside the national park (n=10).

The data on compensation claims and payments were totaled for each year (considering incident date) and converted to US$ by taking the average value of currency conversion from Nepalese Rupees to US$ for that particular year [18]. We performed linear models with R 3.2.3 [19] to investigate the total annual compensation payments as well as annual payments for human killings, human injuries, or livestock depredations.

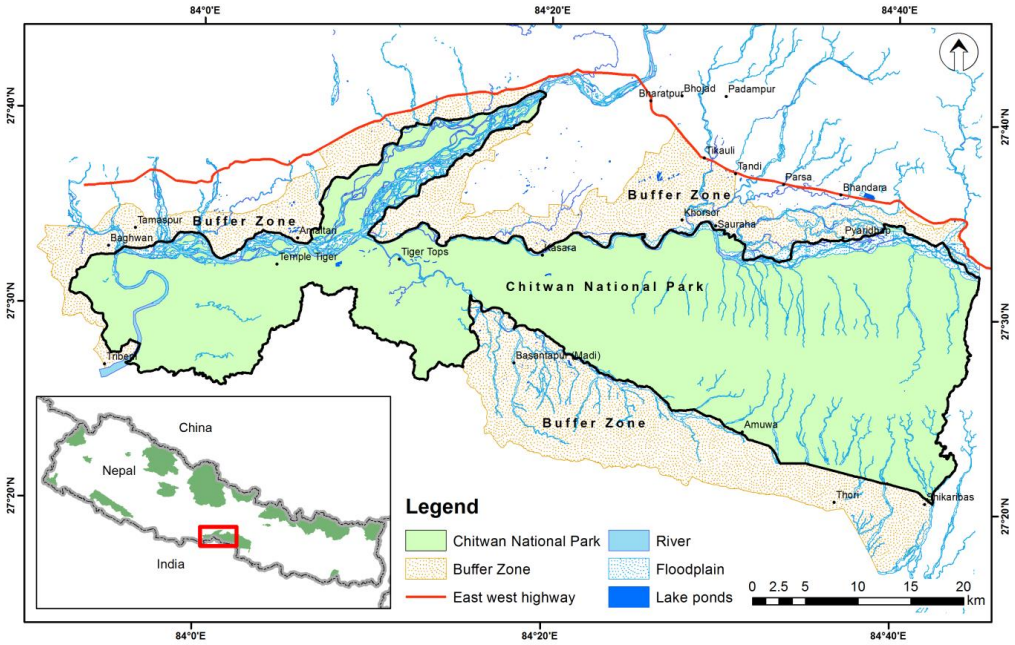


**Fig. 1. Map of Chitwan National Park and Buffer Zone**

*Tiger removals*

From the CNP office and anecdotal records, we collected data on tigers removed from the wild for conflict-reasons by both authorities and local people (in retaliation) for the period 2007-2014. We triangulated and augmented the data by key informant interviews (n=13) with veterinarians, rangers, game scouts, and buffer zone people who were directly involved in tiger removals. The data collected include: specific cause of removal (human/livestock attack or perceived threat), killed (by authorities or local people) or

live-removed, tiger characteristics (*e.g.,* age-class, physical condition), area occupied (national park/buffer zone/outside buffer zone), habitat occupied (degraded/intact), date of removal, and management and survival of live-removed ones. Age-classes were defined as: adult (3-12 years), juvenile (1-2 years), post-dispersal floater(>2 years) and cub <1 year [20]. The management categories of live-removed tigers were defined as: release in CNP, translocation to another protected area, translocation to zoo, and dead in enclosure.

## Results

*Compensation payments*

Total compensation payments of US$ 93,618 ($11,702.3 per year) were made for tiger attacks during the eight-year period (Table 1). Of this, 65% was paid for human killings, 5.7% for injuries, and 29.3% for livestock killings. On average, the payments for human injuries covered 80.7% of medical expenses of injured persons and that for livestock losses covered 61.7% of the livestock's monetary value. Compensation payments covered full expenses of 63.6% of injured persons, but for livestock it covered full-monetary value of only 46.7% of depredated livestock. In the remaining cases payments only covered the losses (expenses) partly because the claims exceeded the maximum payable amounts specified. Notably, all livestock depredation cases that occurred during January 2007 - July 15, 2009 received only 50% of their monetary value as compensation.

**Table 1:** Details of compensation payments and claims (per year) made for human casualties and for livestock depredations by tigers in Chitwan National Park and Buffer Zone between 2007 and 2014.

| Tiger attack details | | Amount (US$) | Year | | | | | | | | Total (US$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | |
| Human casualties | Killed | Paid[a] | 0.0 | 1476.4 | 8485.6 | 4021.5 | 2106.7 | 13383.9 | 12540.5 | 18799.0 | 60813.6 |
| | Injured | Paid | 359.3 | 686.7 | 0.0 | 1075.8 | 612.4 | 1027.2 | 1397.2 | 208.9 | 5367.5 |
| | | Claimed | 535.5 | 896.3 | 0.0 | 1290.3 | 619.8 | 1070.2 | 1973.5 | 263.0 | 6648.5 |
| | Total | Paid | 359.3 | 2163.1 | 8485.6 | 5097.2 | 2719.1 | 14411.1 | 13937.7 | 19007.8 | 66181.1 |
| Livestock depredations | Goat | Paid | 638.3 | 1318.6 | 2918.0 | 2529.5 | 1924.2 | 752.8 | 423.2 | 1421.4 | 11926.0 |
| | | Claimed | 1275.8 | 2612.8 | 3378.8 | 2529.5 | 1931.2 | 752.8 | 423.2 | 1822.5 | 14726.6 |
| | Cattle | Paid | 692.2 | 483.5 | 1398.8 | 2647.5 | 758.4 | 334.6 | 940.5 | 501.3 | 7756.9 |
| | | Claimed | 1476.8 | 967.1 | 2356.4 | 3304.3 | 1264.0 | 948.0 | 2508.1 | 1180.2 | 14004.8 |
| | Buffalo | Paid | 188.4 | 420.8 | 817.9 | 938.3 | 983.1 | 223.1 | 1045.0 | 313.3 | 4930.0 |
| | | Claimed | 376.9 | 841.6 | 1531.3 | 1032.2 | 2457.9 | 412.7 | 4702.7 | 887.7 | 12242.9 |
| | Sheep | Paid | 84.6 | 0.0 | 0.0 | 181.0 | 0.0 | 0.0 | 0.0 | 94.0 | 359.6 |
| | | Claimed | 169.2 | 0.0 | 0.0 | 181.0 | 0.0 | 0.0 | 0.0 | 128.5 | 478.6 |
| | Pig | Paid | 37.7 | 110.7 | 1129.9 | 375.3 | 418.5 | 89.2 | 104.5 | 198.4 | 2464.4 |
| | | Claimed | 89.2 | 221.5 | 1394.6 | 415.5 | 489.5 | 89.2 | 135.9 | 198.4 | 3033.9 |
| | Total | Paid | 1641.3 | 2333.6 | 6264.6 | 6671.6 | 4084.3 | 1399.7 | 2513.3 | 2528.5 | 27436.9 |
| | | Claimed | 3387.9 | 4642.9 | 8661.2 | 7462.5 | 6142.6 | 2202.8 | 7769.9 | 4217.2 | 44486.9 |
| | Total amount paid | | 2000.6 | 4496.8 | 14750.3 | 11768.8 | 6803.4 | 15810.8 | 16451.0 | 21536.3 | 93618.0 |

[a]The payments for human killings were made on a fixed rate basis (per person killed). The amounts were fixed (including the maximum payable amounts for human injuries and livestock depredations) by the Buffer Zone Management Committee for incidents occurring January 2007-July 15, 2009, and specified by compensation guidelines (2009) and its revision (2012) for incidents occurring July 16, 2009-December 31, 2014.

The proportional share of payments varied among livestock types, with goats bringing 43.5% of total livestock depredation payments, followed by cattle (28.2%), buffalo (18%), pig (9%), and sheep (1.3%). This pattern in general followed the population composition of livestock, where goats dominated the stock (58.7%), followed by cattle (18.7%), buffalo (18.4%), pig (3.2%), and sheep (1%); the total livestock population was 119,849 in 2011/12 (R. Dhungana, unpublished data). The payments for human injury (<$200 per person injured, for those occurred during January 2007 - July 15, 2009; and <$500 for July 16, 2009 - December 31, 2014) and livestock depredation (50% of monetary value for January 2007 - July 15, 2009; and <$100 afterwards) were made considering the maximum payable amounts as well as medical expenses of injured person or monetary value of killed livestock. The payment for human killing was made on fixed rate basis ($500 per person killed, for those occurred during January 2007 - July 15, 2009; $1,500 for July 16, 2009 - October 17, 2012; and $3,000 afterwards).The total annual payments ranged from $2,000 in 2007 to $21,536 in 2014, an increase of 976%.

Linear models suggested that total annual compensation payments (t=3.88, P=0.008, $R^2_{adj}$=0.67) and the annual payments for human killings (t=4.09, P=0.006, $R^2_{adj}$=0.69) increased significantly between 2007 and 2014 (Fig. 2(a, b), Table 2). However, neither the payments for human injuries (t=2.32, P=0.068) nor for livestock depredations (t= -1.15, P=0.303) varied significantly over the period (Fig. 2(c, d), Table 2).

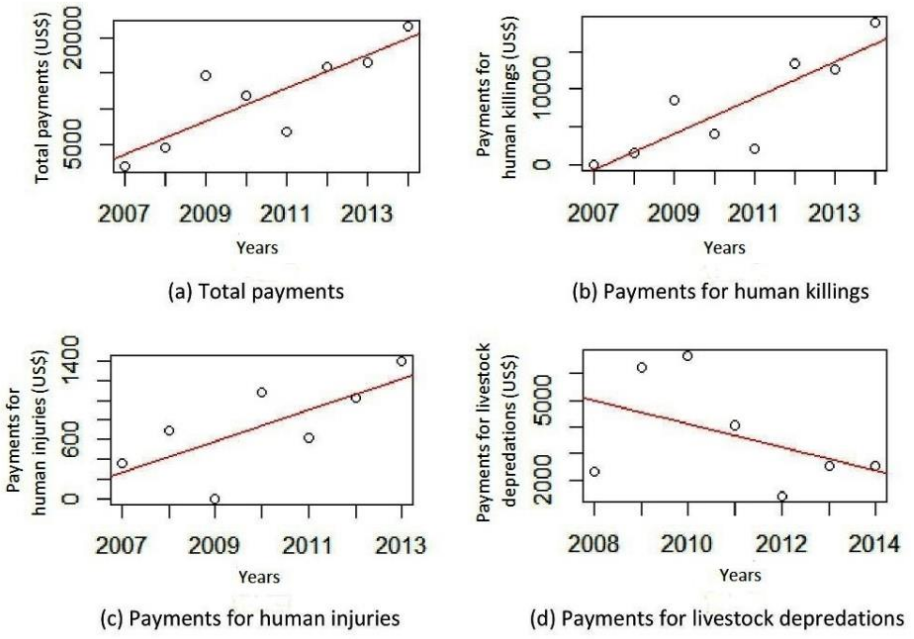


**Fig. 2. Temporal patterns of annual compensation payments (US$) in Chitwan National Park and buffer zone, 2007-2014; (a) Total payments, (b) Payments for human killings, (c) Payments for human injuries, and (d) Payments for livestock depredations**

*Tiger removals*

During the eight-year period, a total of 15 tigers were removed for conflict reasons: human and/or livestock attack (n=13), or posing potential threat (n=2). Eleven tigers were removed by authorities (including one killed), while four were killed by local people in retaliation. Nine of the removed tigers were adults, five were post-dispersal floaters, and the remaining animal was a juvenile. No cubs were removed during the period. The majority (n=9) of removed tigers were healthy, whereas five had injuries caused either by natural/unknown reasons (n=4) or by people (n=1), and the physical condition of one was unknown. Thirteen tigers were removed from the buffer zone, and one each from outside the buffer zone and inside the national park. Eight tigers had occupied areas with few or no wild prey

(*e.g.,*farmlands/settlements and degraded habitat), whereas seven were removed from good habitat with abundant wild prey. One tiger was removed in each of 2007, 2009, 2010, and 2014, two in 2008, and three tigers were removed in each of 2011, 2012, and 2013. Of the 10 live-removed tigers, five died in an enclosure (within 10 days to 14 months), two each were released in CNP and to another national park (Bardia), and one was translocated to a zoo. The fate of both tigers released in CNP was unknown. Both tigers translocated to Bardia National Park were reported dead within a few months of release (one poisoned and the other for unknown reasons). Of the five lethally-removed tigers, one was shot at the site by authorities after they failed to capture it, and local people poisoned three tigers and killed one more using home-made tools as retribution. Overall, at least 12 of 15 removed tigers died of conflict.

## Discussion

On the basis of people's responses to the questionnaire and economic judgements, our study found the scale of compensation payments in CNP insufficient to provide reasonable financial support (throughout the period) to families suffering human killing and also cover actual losses (expense) incurred from human injuries and livestock depredations. Yet, temporal analysis showed the increasing trend of the total compensation payments between 2007 and 2014, as well as the increasing financial burden to the government. The need is to maintain the balance between fair compensation payments and reduced financial liabilities. Our study also noted the issue of delayed payments reported in questionnaire surveys. Furthermore, despite a majority of the conflict-involved tigers (removed ones) being healthy, most of these tigers did not survive. We also report more removals of tigers from the buffer zone (13 out of 15), underscoring the need for proactive measures to minimize mortality of conflict-related tigers.

The scheme of compensation payments, although common in many areas, is not without shortcomings. Well-designed compensation schemes sufficiently addressing the weaker aspects of such programs would go far to promote positive park-people relationships and enhance tolerance of offending wildlife [2]. However, in countries like Nepal where the conservation sector is not a government priority, the availability of adequate resources is a serious constraint. Nepal's relatively lower financial support for human killings, with mean payments of $1,900 per killed person during 2007-2014, is less than a subsistence level of support for dependent families for a reasonable period of time (as expressed by almost all family members surveyed); it is also lower than the payments ($3,521) made for killings by elephants (*Elephas maximus)* in India [18]. Nepal's compensation is equivalent to 1.5 years' income of the victim, considering a mean GDP per capita (PPP) of $1,228 for 2007-2013 [21], much lower than compensation for traffic accident deaths ($5,250) by insurance companies in Nepal. The payments in CNP were made on a fixed basis, although health economists and insurance companies in most developed countries value human life based on variables such as duration of life, future life compared with the present life, and economic or social productivity [22], which might better address the socio-economic impacts of tiger conflicts. It is notable that inadequate compensation for the death or injury of the principal bread-earner, especially in low-income communities, leads to increased poverty and hardships, and might generate more animosity toward wildlife [18, 23]. Though annual monetary loss to livestock depredations in our study ($5,560 per year) is relatively lower in absolute terms than in other areas [24, 25], insufficient compensation for livestock losses may have significant impacts on poor communities, because livestock are the main source of cash income and socio-economic capital. For example, loss of one pair of ploughing oxen or buffalo is equivalent to 220 days of earnings for an unskilled man [26].

Unlike total annual payments (all combined) and the payments for human killings, which increased significantly over the study period, the payments for human injuries and for livestock depredations did not vary significantly, likely due to the fixed rates of maximum payable amounts of $500 and $100

respectively during 2009-2014. In many cases, compensation payments did not sufficiently cover monetary value of killed livestock or medical expenses of injured persons, which coupled with the fixed rates of maximum payable amounts, indicate insufficient concern of authorities for these incidents.

However, compensation schemes might raise expectations and hostility, as a consequence of frustration when requests are poorly dealt with [2, 23]. Disbursement of inadequate payments along with perceived threats can even drive people to retaliatory killings and reduce support for conservation [7, 4]. This highlights the need to provide fair payments. Nevertheless, as the linear model showed significant increases in total annual payments, the scheme is incurring increasing liability to the government and might not be sustainable in the long-term. To minimize these counteracting problems, variation in payment rates to livestock depredations on the basis of their occurrence site (*e.g.,* forest area, grazing land, or cattle-shed), and reduced payments to farmers adopting poor husbandry practices (*e.g.,* leaving livestock unattended, failing to replace low-productive breeds with improved ones, not practicing stall feeding) could be important. Long-term measures should include promotion of an insurance scheme. Yet, in some areas provision of compensation payments (especially for livestock depredations) is debated and sometimes discouraged to avoid negative outcomes such as neglecting preventive measures and increased dependency [7, 11]. Depredations are often presumed to be caused by poor husbandry practices and human negligence rather than by tigers [4, 8]. However, the compensation scheme in CNP, though in need of improvements as noted above, did appear to have general support from both local people and park authorities.

Another shortcoming of the CNP compensation scheme is delayed payment. In most cases, it took months or even a year to receive compensation payments, underscoring the need for speedy payments. Training and allocation of resources to field staff, local awareness of claiming procedures, establishment of a compensation basket fund in CNP, and rapid release of funds from higher government institutions can address the issue of delayed payments. Unlike elsewhere [2], the extensive network of offices and roads in the CNP has removed the logistical challenges of processing compensation payments, but costs that are incurred by applicants from the claims process, such as travel and accommodation costs, should also be compensated for.

The largest share of livestock compensation payments in our study was for lost goats (43.5%) (55% of all kills; R. Dhungana, unpublished data). The payment share of other livestock species (cattle 28.2%, buffalo 18%, pig 9%, and sheep 1.3%) also followed the general pattern of killings by tigers (cattle 23.4%, buffalo 12%, pig 7.7%, and sheep 1.9%; R. Dhungana, unpublished data).

Historically, tiger removal (including their lethal control by the authorities) has been the most common HTC mitigation measure [7]. Though this method is necessary with injured or diseased tigers that are less likely to survive in the wild or with tigers that have killed several people [11], the majority of tigers removed from the CNP were healthy (60%), and at least 80% were confirmed dead or were killed in retaliation. The conflict and associated tiger removal therefore had a notable impact on the tiger population in the CNP. More tigers were removed from the buffer zone than from the national park, due to their greater proximity to people and livestock, especially in the forests of the buffer zone. The proportion of tigers removed from the buffer zone has increased (86.7%) compared to a previous report, in which 68% of the removed tigers had occupied the buffer zone [9]. This might be due to increased spillover of tigers from the core national park to the buffer zone, and farther to areas outside the buffer zone. Such spillover is also suggested by the removal of a tiger from outside the buffer zone in 2009, while in the past few decades tigers were rarely observed in that area [16].

While the removal of potentially dangerous tigers is considered necessary to reduce conflicts [6, 9], priority should be given to maintaining the wild population, and removal should involve the proper identification of the offending individual. Improper removals can reduce the reproduction rate through infanticides committed by immigrating males that fill the vacancies left by the removed tigers. Graham [4] cited the removal of predators to result in only a short-term reduction in attack rates, because other individuals rapidly re-establish themselves in such areas. The removal can disrupt social interactions and may even increase the rate of conflicts. Therefore, removal should be undertaken only when it is absolutely necessary, and it should follow proper management, preferably including translocation into the wild and follow-up monitoring by radio telemetry. Tracking by telemetry helps gather information on survival and further involvements in conflict. While translocations of carnivores have yielded mixed results [6] and may be controversial, translocation can succeed when the individual is released far enough away that it cannot return to the original site, and is placed in a suitable area with territorial vacancies [12] and devoid of human settlements. Likewise, more attention should be given to the proper handling and treatment of the tigers in captivity.

Other programs conducted in the CNP that have been considered helpful in mitigating the HTCs include: channeling back 50% of the park's annual revenue (*e.g.,* $835,509 in the fiscal year 2013/14) to the local communities for conducting conservation, development, awareness, and income-generating activities; the zoning of the national park and its buffer zone to spatially separate human and tigers; installation of a electric solar fence (180 km) to prevent tigers from entering human settlements and farmlands (especially designed against elephants*)*; the disbursement of scholarship grants to the children of tiger victims (US$ 7,547 during 2011-2014); and the establishment of four livestock health centers in the buffer zone.

**Table 2:** Results of simple linear regression models that explain changes in compensation payments (US$) for tiger attacks in Chitwan National Park and buffer zone, as a function of the years 2007-2014.

| Dependent variable | Regression coefficient | SE | Intercept | t | P | $R^2_{adj}$ |
|---|---|---|---|---|---|---|
| Total payments (all combined) | 2318.3 | 596.8 | -4649253 | 3.885 | 0.008 | 0.67 |
| Payments for human killings | 2377.3 | 580.6 | -4771958 | 4.095 | 0.006 | 0.69 |
| Payments for human injuries | 157.4 | 67.88 | -315626.3 | 2.319 | 0.068 | |
| Payments for livestock depredations | -435.4 | 379.7 | 879185.4 | -1.147 | 0.303 | |

## Implications for conservation

The Tiger Summit in 2010 endorsed the doubling of tiger populations in each tiger range country by the year 2022. However, HTCs will likely hinder this goal unless well-designed mitigation measures are implemented. In the CNP, despite the limited compensation payments made in most cases, total annual rate of payments is increasing and current payment policies are becoming a financial liability to the government, while the efficacy and transparency of these policies are questioned. This creates an imminent need to improve the compensation scheme. The efficacy of the scheme would be improved by

simplification of claiming procedures, and by stricter control of corruption, of misplacement of funds, and of financial misconduct at all levels of the bureaucracy. The transparency could be improved by public audits and by more widely publicizing the details of compensations paid in each fiscal year. These improvements might ultimately also result in more funding to the CNP compensation scheme. Other long-term measures could be important as alternatives to direct compensation payments, such as promoting an insurance scheme (with a premium subsidy to subsistence farmers), which could reduce the perpetual dependency on the government. External funding might also be sought from international donors, if the government can ensure efficacy and widespread transparency of the operations.

Our study revealed the tendency for retaliatory tiger killings in the CNP (four tigers killed by local people), indicating animosity among communities toward the tigers. As animosity can erode public support and even drive people to engage in poaching [7], the gaps in the compensation scheme should be addressed. In the Corbett National Park India, the provision of immediate and effective monetary assistance to tiger victims drastically reduced the revenge killing of tigers, making this one of the most successful tiger conservation programs [27]. The CNP compensation scheme should therefore be revised to fully and promptly cover the depredated livestock's value, and the treatment costs of human injuries, on condition that the incident occurred in a shed/corral, farmland, public way, or other area not allocated to tigers. The payments for killed humans or disabled victims should be enough to prevent substantial economic crisis to the affected family. The children of victims could be provided with scholarships, and the dependent family members be provided with skill-development training and employment opportunities when possible. Importantly, a substantial proportion of the revenue channeled back to the buffer zone communities by the CNP should be provisioned to conservation activities, rather than to other infrastructure development, which is otherwise commonly done. The implementation of conservation activities (including awareness campaigns) should be prioritized with the main focus on communities most affected by HTC.

Our study noted an increase in the spillover of tigers from the core of the national park to its buffer zone, and farther outside the buffer zone, likely due to recent growth of the tiger population [15], and the availability of recovering forests in and outside the buffer zone [9]. The challenge ahead is to maintain the momentum of tiger population growth while minimizing the conflicts that might escalate with the spillover tigers. This necessitates improving prey species population density and reserving space to accommodate the larger tiger population. This might be possible through expanding the suitable tiger habitat (grassland and wetland) by management interventions in the national park, and by reforestation and protection of forested areas in the buffer zone and outside it. As the CNP suffers from the deterioration of the grasslands important for tiger prey, due to invasion of alien species *Mikania micrantha* and to the natural succession process [16], these issues also need to be addressed. Likewise, protection and establishment of functional corridors in the buffer zone are important, in order to facilitate tiger movement. Provided that negative influences (*e.g.,* poaching) are not substantial, the aforementioned activities could achieve the targeted outcomes, because tigers in the Indian subcontinent occur at densities as high as 20 tigers per 100 sq. km [20] while in Chitwan tigers are currently at much lower densities (4.5 tigers per 100 sq. km) [15]. Finally, the regulation of human and livestock activities in the forested areas (especially at night time) is important for minimizing interactions and conflict incidents with the tigers.

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