



## **Human-wildlife conflict mitigation and community well-being: Evidence from predator-proof bomas**

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### **ABSTRACT**

Human wildlife conflict (HWC) occur when wildlife requirements encroach on those of human populations, with costs both to residents and wild animals. As a result, there is a growing recognition that solutions focused on wildlife alone limit managers ability to effectively resolve conflicts. This has necessitated a focus on management solutions on humans as well. Various interventions have been used to mitigate the HWC. Here, the focus is on the predator-proof bomas (PPBs), with the aim of answering the question: Do PPBs improve well-being of local people? 25 PPBs were constructed and monitored for a period of six months in Amboseli ecosystem. The livestock predation incidences, time spent guarding at night and people's perceptions before and after the construction of the PPBs was compared to determine the social and economic changes. Results yielded a very strong significant change in the hours spend per week gurading, with some respondents spending only a day per week ( $t = 30.01$ ,  $n = 25$ ,  $p = 0.00001$ ). An additional paired  $t$  -test revealed a significant change in the numbers of livestock attacks inside the homestead after the construction of the PPB ( $t = 10.258$ ,  $n = 25$ ,  $p = 0.00001$ ). Generally, livestock killing cases and injuries went down by 87.3% and 50% respectively. Although there are opportunity costs associated with the installation of PPBs, on comparison the PPBs contributed positively to the well-being of the livestock keepers in Amboseli ecosystem.

**Keywords:** Human-Wildlife Conflict; Predation; Livestock; Predator-Proof Boma; Mitigation

### **1. INTRODUCTION**

The International Union for Conservation of Nature (IUCN) (2005) considers Human wildlife conflict (HWC) to occur when wildlife requirements encroach on those of human

populations, with costs both to residents and wild animals [5], [20] defines HWC as the challenges of coexistence of humans and wildlife while [14] notes that HWC manifests when humans encroach onto wildlife areas and/or when human safety and/or property such as farm-fields, livestock or infrastructure are threatened by wildlife. [14] further points out that human-wildlife conflict (HWC) impacts on species conservation, jeopardizes human livelihood and safety, and requires increased resources from managers. And as such, there is a growing recognition that solutions focused on wildlife alone limit managers ability to effectively resolve conflicts. This has necessitated a focus on management solutions on humans as well [2]. [1] emphasises that this is imperative move because the loss of life, crops or livestock to wildlife has significant consequences for people's livelihoods, their food and agricultural security. Moreover, the HWC has been documented to occur mostly in areas where the poor people are dependent on natural resources that conservationist are keen to protect. [26] phrases this scenario succinctly:

“Habitat destruction and fragmentation is occurring at an increasing rate meaning that wildlife such as apes are coming into ever more contact with people – often poor people living subsistence lifestyles.....”

It is for these reasons that human-well-being has to be addressed. According to [21], human well-being has several key components: the basic material needs for a good life, freedom and choice, health, good social relations, and personal security. Well-being exists on a continuum with poverty, which has been defined as “pronounced deprivation in well-being.” [21] further asserts that:

Human well-being can be enhanced through sustainable human interaction with ecosystems with the support of appropriate instruments, institutions, organizations, and technology. Creation of these through participation and transparency may contribute to people's freedoms and choices and to increased economic, social, and ecological security.

The causes of HWC have largely been attributed to the human factors. [22] identifies the requirements of human development such as land, migration of peoples for reasons of security or food safety, attitudes and perceptions as key factors behind HWC in Africa. The common reaction to the HWC by communities is retaliatory killings of wildlife, and this is particularly true for predators such as lions (*Panthera leo*). For example [11] reported that lions and other carnivorous species are in decline throughout most of their range in Africa due to persecution by humans due to livestock depredation, diminishing prey-base, and human encroachment into the suitable hunting habitats. The Kenya Wildlife Service (KWS) reported in its Conservation and Management Strategy for lions and spotted hyenas in Kenya-2009-2014, that lion population had gone down to 1975 individuals from an estimate of about 10,000 lions that existed in 1970s and 80s. The strategy proposed different mitigation measures to control the human-lion conflicts, particularly the livestock predations and retaliatory killings. One of the proposed measures was the construction of predator-proof bomas (PPBs) in pastoralists' homesteads around conservation areas considered as hot spots for conflicts. Amboseli ecosystem is one of the areas identified as hot spot area. Since 2010, the Born Free Foundation together with other organizations among them Africa Expeditions

& Safari; African Wildlife Foundation; Eden Wildlife Trust; Humane Society International Australia; HSH Princess Charlene of Monaco; John West; and Land Rover had implemented 226 PPBs in Amboseli- West Kilimanjaro Landscape (AWKL) by February 2016. A PPB consists of recycled plastic poles (4 inches in diameter and eight feet long) spaced 3 metres apart, a 2m high hexagonal steel rolls of wire mesh with recycled thorns bushes on either side, and a doors made of flattened oil drums.

This study is anchored on the evidence-based conservation concept. [12] explains that evidence provide conservation practitioners with opportunities to share the outcomes and impacts of the conservation interventions they carry out to enable other practitioners to learn about, replicate, improve upon successful , and avoid unsuccessful interventions.

[13] claims that most current conservation decisions are not based upon evidence, but upon subjective sources as very little evidence is collected on the consequences of current practice. As result future decisions cannot be based upon the experience of what does or does not work. [13] assertions are supported by [3] who affirmed that the field of ecosystem protection and biodiversity conservation lags behind most other policy fields when it comes to evaluation of conservation interventions. [8] stresses that the budgets for biodiversity conservation are thinly stretched, and therefore [3] insist on determining the success of conservation interventions in different contexts for the purpose of ensuring that that scarce funds go as far as possible in attaining conservation results. There has only been one other study on PPBs conducted in Amboseli part of Kenya by [10]. Unlike [10] study, which collected perceived data from already existing PPB, our study approach aimed at testing the before and after situations based on 25 newly constructed PPB that were monitored for a period of six months. Therefore, the baseline data for future comparisons was obtained rather than depending on the respondent's views only. In addition, this study focused on answering the question: Do PPBs improve well-being of local people?

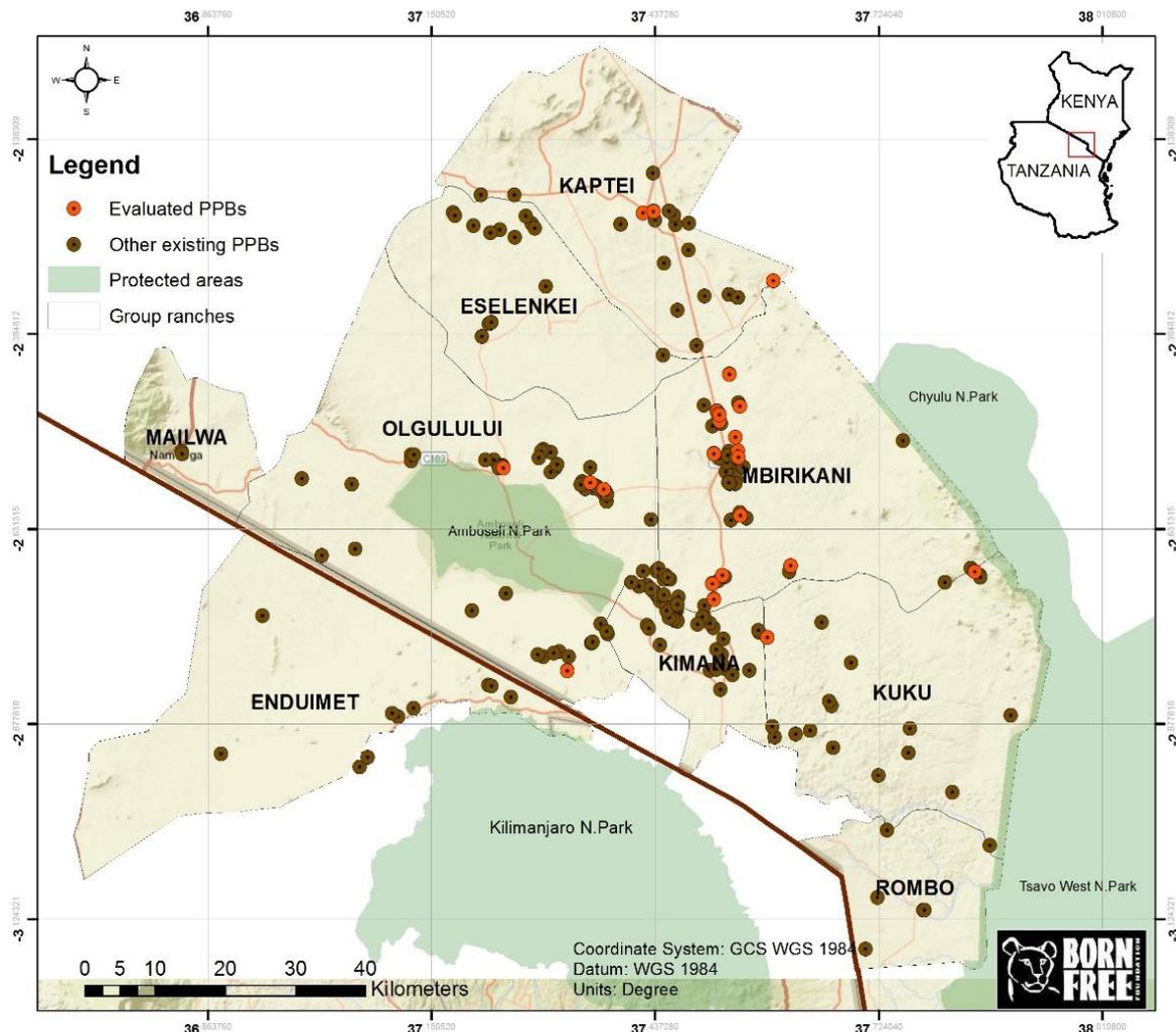
## **2. METHODOLOGY**

Amboseli ecosystem lies on the boarder of Kenya and Tanzania in the Loitokitok Sub-county of Kajiado County. This study was conducted in the community five group ranches that surrounds the Amboseli National park namely, Olgulului/Olorashi, Eselenkei, Kimana, Imbirikani, Kuku and Rombo (Figure 1). The ecosystem covers an area of some 8,000 km<sup>2</sup>, comprises part of the Ilkisongo region of southeastern Kajiado District in Kenya and the Longido region of northern Tanzania. Amboseli ecosystem is an arid rangeland, with low and unpredictable rainfall in time and space. The Amboseli national park covers an area of 392 Km<sup>2</sup> and forms the core of UNESCO Man and the Biosphere Reserve.

*Acacia*, *Commiphora* and *Balanites* species are the main type of vegetation, while the dominant grass is *Pennisetum* and *Chloris guyana* [4]. The main economic activity is pastoralism with over 75% of the population deriving their livelihood from livestock which accounts for 60% of the total labour force [11]. The ecosystem has a range of wildlife, but the most noteworthy are the elephants and predators perhaps because of being associated with HWC. According to [9], the ecosystem has 64 ±20.96 lions, 272 ±59.31 hyena and 25.56 ±3.53 jackals, which are part of the focus of this study.

There were 196 PPBs in the Amboseli West Kilimanjaro Land Scene located in different community group ranches. The PPBs are implemented on a cost-sharing basis,

where the applicants pay 25% of the construction cost. Besides, the applicants dig the holes, help with the overall construction, and are trained on how maintain the bomas (Figure 2 & 3).



**Figure 1.** Map of the study sites within the Amboseli Ecosystem.

In addition to the existing 196 PPBs, 25 new PPBs were constructed between February and July 2015 guided by the steps in Figure 2 & 3. The rate of PPB construction was directly proportional to the 25% cost share received from the beneficiaries. The first PPB was constructed on 23<sup>rd</sup> February 2015 and the last one on 26<sup>th</sup> July 2015, with each PPB taking about 2 days to be completed. During the construction exercise, the baseline data was obtained from the homesteads (also referred to as PPBs) using questionnaires, observations and measurements techniques. The key components of the questionnaire were the reference numbers, date of construction, GPS location, number of on livestock and people, predation incidents in the last six months, time spent guarding livestock at night, and perception on lion. Where, the head of the homestead could not understand English or Swahili, a locally trained research assistant was engaged to translate into Maasai language. To ensure that the answers

were credible, the questions were asked more than once and where necessary a break of 10 minutes taken before embarking on the interview. On average each interview took about an hour.

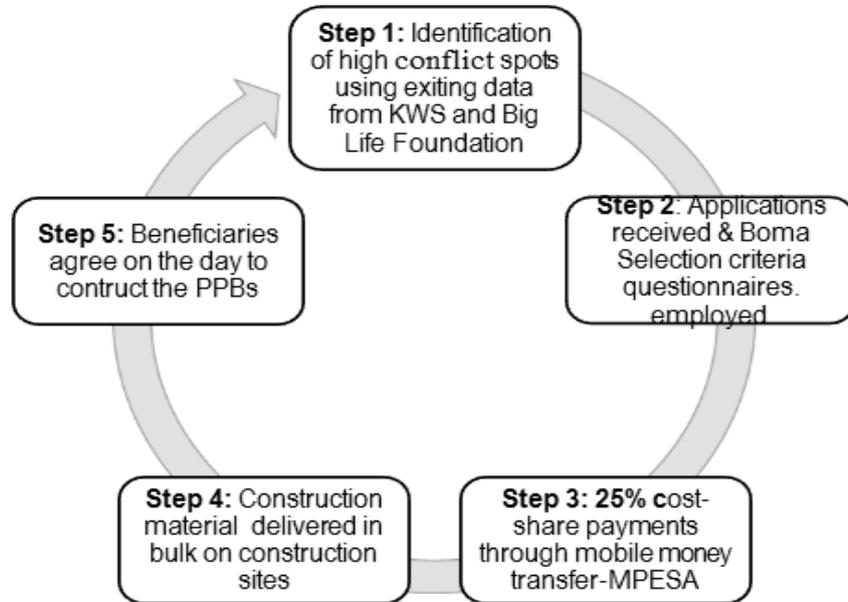


Figure 2. PPB planning cycle.

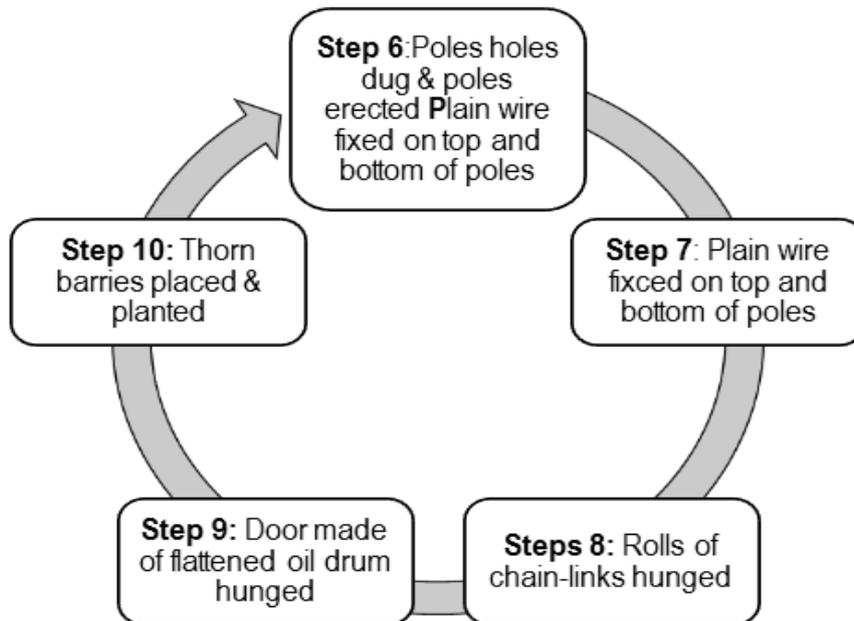


Figure 3. PPB construction steps.

Using the GPS coordinates and a map of the PPBs constructed, a purposive study design was used to do a follow up in February 2016. Four respondents were interviewed each day between 15<sup>th</sup> and 23<sup>rd</sup> February 2016. From the pretesting experiences with some of the respondents whose boma were constructed before 2015, interviews were rescheduled to either be in the morning or evening when livestock was back from the field grazing. This enabled the researcher to physically count the number of people and livestock in each homestead either before they left in the morning or after arriving in the evening for comparison with the figures obtained from the respondents. The actual number of people and livestock obtained was used for analysis.

Microsoft Excel-Pivot Tables software 2013 and SPSS statistical package version 20.0 was used to process, tally and analyse data. A paired-sample t-test statistical technique was used to test significance difference before and after construction of PPBs. Qualitative data such as the perceptions and opinions toward lions were summarised in percentages and frequencies.

### **3. RESULTS AND DISCUSSIONS**

#### **3. 1. People and livestock characteristics**

The mean circumference of the PPBs constructed was  $213.28 \pm 83.148$  S. D, with the smallest boma being 110m and the largest 400 m. The average number of livestock before PPB construction were slightly higher (465.72, n = 25) compared to after the PPB construction (442.92, n = 25) (Table 1). The decrease in livestock numbers can be attributed to other factors which this study did not assess such as diseases, drought and sale of livestock to meet other basic needs. These findings support [15] assertions that livestock species play very important economic, social and cultural functions for rural households in developing countries as they improve income and wellbeing of the farm family. [15] further affirms:

Livestock helps on food supply, family nutrition, family income, asset savings, soil productivity, livelihoods, transport, agricultural traction, agricultural diversification and sustainable agricultural production, family and community employment, ritual purposes and social status.

Also, [16] in the Maasai Mara Ecosystem, found out that cattle are occasionally sold for cash, especially during drought, to purchase grains and to also meet other domestic needs such as fees and medical expenses while sheep and goats are also sold for quick cash, especially when the demand for cash is not much. This study was conducted in February, at time when parents were either taking or have already taken their children to school. Those who have children in secondary schools, the government recommends a capitation fee payment of at least Ksh 4, 687 for day school, Ksh 26,776.50 for boarding school, and Ksh 18, 605 for special school during the first term, based on the ratio of 50:30:20 for the three terms [19]. This does not include uniform, transport and other upkeeps. It can therefore be argued that, most of the people had sold some of their livestock to meet the school fee and other needs such as food and clothing. The possibility of the people having used their livestock to pay dowry and give present to their friends and relative cannot be ruled out. Majority of the respondents (52%, n = 13) were of the opinion that there had been an increase in the number of people in the boma since construction, with 19 people attributing it to

security offered by PPBs while 6 said it was due to the number of children born within the project time. A paired-t-test analysis showed no significant change in the number of people and livestock in the PPBs. However, the number of livestock shifted to other areas since the PPBs were constructed had reduced significantly, cattle ( $t = 2.740$ ,  $df = 24$ ,  $p = 0.011$ ), Shoats ( $t = 2.332$ ,  $df = 24$ ,  $p = 0.028$ ), and donkey ( $t = 2.831$ ,  $df = 24$ ,  $p = 0.009$ ). The averages changed from 100 to 2 cattle and 115 shoats to 4 shoats per homestead. These findings suggest that the PPBs may be offering better security to livestock compared to other places where the respondents used to shift their stock before the boma was reinforced.

**Table 1.** People and livestock numbers.

	<b>Before (n = 25)</b>		<b>After (n = 25)</b>	
	$\bar{x}$	$\pm SD$	$\bar{x}$	$\pm SD$
<b>Total no. of livestock in PPB</b>	465.72	464.009	442.92	<b>375.913</b>
<b>Total no. of people in PPB</b>	14.20	7.654	14.68	<b>7.105</b>

### 3. 2. Livestock predation and cost implications

This study found a positive non-significant correlations between the distance from the park boundary and the number of cattle ( $r = 0.29$ ,  $n = 25$ ,  $P > 0.05$ ) and goats ( $r = 0.150$ ,  $n = 25$ ,  $p > 0.05$ ) killed by predators, as well as the hyena attack incidents ( $r = 0.2044$ ,  $n = 25$ ,  $p > 0.05$ ), before the construction of the PPBs. [17] reported that in many parts of the world, HWC has been observed to occur in areas where people live in or near wildlife protected areas. A study by [24] in Maasai Steppe found that the optimum distance that hyena would be found from human settlement was 5 kilometres, while [10] concluded that human settlements and habitat type influence the distributions of predators, and the distribution determines the predation on livestock.

There was no significant differences in the number of livestock killed in the field grazing during the day before and after the PPBs ( $t = 1.0558$ ,  $n = 25$ ,  $p > 0.05$ ). However, a paired t –test revealed a significant change in the numbers of livestock attacks inside the homestead after the construction of the PPB ( $t = 10.258$ ,  $n = 25$ ,  $p = .00001$ ).

Table 2 indicates the changes in the reported cases of livestock killed and injured before and after the PPBs. Generally, livestock killing incidents and injuries went down by 87.3% and 50% respectively. This results indicates that the PPBs are helping the community to reduce livestock losses. [7] study in Amboseli found out that between 2008 and 2012, more than KSh28 million was spent on compensation for over 9,000 livestock killed in bomas only by the Big Life Foundation. [7] attributes the livestock loss to the poor Maasai homesteads and recommends an improved livestock husbandry, construction of predator proof fences, and vigilance at night by the Maasai as ways to deter livestock loss. Most of the livestock losses reported by respondents were linked to hyena (Before-68%, and After PPB-52%), lion (Before-12%, and After PPBs-24%). Studies by [7], and [10] documented hyena as the most problematic predator to the community in Amboseli ecosystem. In this study the most cited reasons by respondents as to why hyena remains problematic are, attack livestock while

grazing in the field (44%, n = 11), have capability to dig beneath the PPBs chain-links and attack livestock (24%, n = 6) and people living near the park and or conservancies (16%, n = 4).

[10] study, found out that the average livestock market prices at Kimana was sheep & goat (Ksh 5000 each), donkey (Ksh 10,000) and cattle (Ksh 20,000). The study estimated that homesteads lost Ks 3,225,000 compared to Ksh 195,000 lost after PPB construction. Similarly, the 25 homesteads in this study lost a total of Ksh 2,745,000 in one year Before PPBs compared to about Ksh 200,000 After PPBs. Although these cost do not include injuries to the livestock, some of which may succumb to injuries, it is lower than the overall 25% cost-share (Ksh 1,422,243.50) paid by the 25 respondents, and the anticipated long term benefits that can be derived from the PPBs structure. [7] suggest that more attention need to be put on maintenance of homestead and vigilance to deter predation in the constructed PPBs.

**Table 2.** Livestock killings and injuries Before and After PPBs.

Livestock	Killings			Injuries		
	Before	After	% change	Before	After	% change
<b>Cattle</b>	83	0	100.0	42	8	81.0
<b>Goat</b>	150	16	89.3	31	17	45.2
<b>Sheep</b>	67	21	68.7	5	14	-180.0
<b>Donkey</b>	0	1	89.3	0	0	0.0
<b>Total</b>	<b>300</b>	<b>38</b>	<b>87.3</b>	<b>78</b>	<b>39</b>	<b>50.0</b>

### 3. 3. People’s perceptions

The people’s perceptions on the lions gained some positive changes (Table 3) over the period of six months of the project. *Ala mayo* is Maasai traditional practices of young men (warriors) killing lions to demonstrate their courage and strength. Normally the lion hunt is organized early and the young men compete with the intention of each one of them wanting to be the first one to spear the lion. The first warrior to spear the lion is celebrated and given great honour by the community. This kind of cultural practice contributes to decline in lion populations. The 2013 large carnivore census in Amboseli-West Kilimanjaro revealed that lion population range was 43-85 individuals [9]. The number of the respondents who gained tolerant level and had communicated to their fellow community members was also positive. This is important as emphasised by [6] that HWC and people’s perceptions plays a critical role in influencing complaints, tolerances for wildlife, approval of management and cooperation in proposed conflict mitigation measures. The respondents knew more other people who own PPBs- significantly changed from an average of 4 to 6 people (t = 3.449, n = 25, p = 0.00104). This findings suggests that the people are keen to know the details of the project and this may initiate conversation about the project among the community members.

**Table 3.** Perceptions statements towards lions Before and After PPBs construction.

Perception statements	Frequencies	
	Before	After
I am very tolerant and have communicated this important message to my fellow community members	3	7
Moderately tolerant-I am open minded but think they should be killed for Ala mayo	6	1
Moderately tolerant-I am open minded but think they should be killed if they attack livestock	7	8
Very tolerant-I think lions are part of our cultural heritage and deserve our protection and that we must co-exist peacefully with them, not killing them	8	9
<b>Total</b>	<b>25</b>	<b>25</b>



**Plate 1.** PPB door with hinges made from old Maasai sandal.

Majority of the people (84%, n = 21) said their PPBs were still intact and need no repairs. The remaining 16% said they had done repairs on their boma with two mentioning the

door hinges and another two the posts. The PPBs uses old Maasai sandal as hinges for the doors and recycled plastic posts (Plate 1). The improvised hinges are easy to replace if they fall out. It was observed that the two respondents who had damaged posts had few acacia thorns in some sections of the PPBs, and this could have made it easy for the fighting bulls to get access to the poles and chain-links, thus damaging them.

### **3. 4. Time spend guarding and opportunity costs**

Time spend guarding livestock at night was tested to determine if there were any changes. Results yielded a very strong significantly change in the hours spend per week, with some respondents spending only a day per week ( $t = 30.01$ ,  $n = 25$ ,  $p = 0.00001$ ). [25] point out that guarding crops at night is the responsibility of men during the night, while during the day the children takes over. This bring in an opportunity cost to the family and therefore [25] argues that men forego the earning they would have got from engaging in other activities during the day due to loss of sleep. Similarly, guarding livestock can result to loss of alternative income, and mental health morbidity [25]. Studies by [10] in Amboseli found that out that the construction of the PPB reduced the time spent guarding livestock on daily basis with only two people still guarding their boma daily per week. [10] study further stresses that:

..the reduction in vigilance time at night have several positive implications: the community members can now be active during the day and participate in other social and economic activities, reduced chances of individuals being bitten by insects such as mosquitoes and scorpions, which can have a detrimental effect on one's health, families can also have an opportunity to sit together and bond in the evening and couples have a chance to share their matrimonial bed together and enhance their relationship..

The relative lack of research about both the economic “opportunity costs” defined as income that would have been earned if the presence of wildlife did not preclude particular activities and more broadly defined “indirect costs” or time and money spent in preventing wildlife damage incurred by local communities [18], makes HWC losses diverse. Since the PPB project is implemented on cost sharing basis, with the beneficiaries paying 25% of the total costs. The actual amount paid by the 25 homesteads was averaged, to arrive at Ksh 56,889.74 as the amount paid by each homestead to safeguard their livestock from depredation. The opportunity cost incurred here is the livestock products such as milk and meat that was lost to raise the amount. In addition, the ability to increase their stock was reduced especially for the goats and sheep. [16] study revealed that the rates of lambing and kidding for sheep and goats(Shoats) were naturally higher as their intervals are shorter and twinning is fairly common; for 50 mature females, 38 lambs or kids are given a year, which is equivalent to kidding rate of 76 per cent a year. [16] studies in Maasai Mara also revealed that very little of the milk and small stock produced were sold with the sale of cattle providing over 90% of the total sales proceeds. Majority of homes (80%) surveyed by [16] consumed milk as the main product.

When the average of 25% cost-share of Ksh 56,889.74 is compared with the average amount lost by each homestead for one year Before PPBs- Ksh 96,400 (predation on 3.32 cattle and 6 goats/sheep), it remains valuable to invest in the PPBs.

#### **4. CONCLUSIONS**

This study demonstrates that HWC can be controlled with simple structure such as PPBs that do not necessary interfere with the people's way of life. The PPBs have the potential to safeguard the people's source of livelihood-livestock and change their perception on lions. Although this comes with the opportunity costs resulting from sale of livestock to make the PPBs. The 'hidden cost' of guarding livestock at night was significantly reduced, thus giving people an opportunity to engage in other social and economic activities, and save the money that would have otherwise been used to treat diseases associated with insect bites at night, such as malaria. On a long term basis, it can be concluded that the benefits of the PPBs outweighs the costs of implementing and opportunity cost associated with the project.

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( Received 30 August 2016; accepted 14 September 2016 )