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Full Length Research Paper

Field foot patrol effectiveness in Kafue National Park, Zambia

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Field foot patrols effectiveness for wildlife protection in a large vegetal mosaic Kafue National Park (22,400 km^2) was assessed for two successive periods of different duration. The relationship between patrol days spent in the field by patrol teams and resultant outcomes was determined. Using trained patrol scout teams, field data was recorded on prescribed patrol forms. Prosecution data was populated into database and analysed for their spatial coverage. Study findings showed that 2 to 8 day foot patrols were more effective than protracted patrols. By changing field patrol duration the Wildlife Agency significantly reduced events of "serious and minor offences" and saved at least 46.67% of its conservation funds for foot patrols. Most of the offenders (69.13%) of environmental crimes originated from adjacent areas to the Park. It was proposed that wildlife managers explore and implement effective pragmatic foot patrols on site specific basis. In addition, it was postulated that community based conservation programmes in peripherals of Kafue National Park, if strengthened, could greatly contribute to biodiversity conservation. Future studies would be required to further investigate drivers of environmental crimes, elucidating attitudes of poachers and reasons for their involvement in illegal wildlife trade vis-á-vis local demands of natural products.

Key words: Environmental crimes, effectiveness, community based conservation, Kafue National Park, Zambia.

INTRODUCTION

In Africa, loss of biodiversity is an eminent environmental and natural resource management challenge, and protected areas (refugia) are viewed as panacea to biodiversity loss in the long run (Balmford et al., 1995; Pimm et al., 1995; Terborgh and van Schaik, 2002). Bushmeat hunting for instance remains a major threat to biodiversity conservation. Though wildlife off-take rates could be caused by a number of changes in environmental conditions (Roffe et al., 1996), poaching for bushmeat and commercial use is probably the most prominent threat. Poaching is often non-selective, harvesting even productive members of wildlife populations (Bennett et al., 2007). Kafue National Park (KNP) experienced extirpation of Black rhinoceros (*Diceros bicornis minor*) and reduction in African elephants (*Loxodonta africana*) populations in the1970s and 1980s due to excessive poaching. Such loss of biological diversity was attributed to anthropogenic causes (Lamarque et al., 2009). Poaching despite causing loss of biological diversity, however, supplies needed revenues and animal proteins to impoverished rural communities (Edderai and Dame, 2006), though in unsustainable manner. Continued livelihood vagaries in rural areas, therefore, are a recipe for heightening Hardin's (1968) tragedy of the commons, which promotes open resource access tendencies if not regulated. Two complimenting approaches to biodiversity conservation are applied in natural resource management in protected areas: one, being the implementation of robust exclusionary punitive law enforcement inside core protected areas and the other, being the collaborative community based conservation in areas outside the core protected areas.

Field foot patrols are widely employed biodiversity conservation strategy in Southern Africa (Bell, 1985; Jachmann and Billiouw, 1997; Leader-Williams, 1996). As a conventional measure, foot patrols have aimed at

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ransacking protected areas, resulting in deterring and regulating poaching. They are also strengthened by effective water and aerial patrol surveillances, road blockades,intelligence information and prosecution. In KNP, foot patrols aim at reversing declining animal populations caused by illegal anthropogenic actions.

Few attempts to quantify and assess the effectiveness of foot patrols have been documented. Performance monitoring of law enforcement elements in wildlife management is rarely documented, yet according to Jachmann (1998) and Leader-Williams (1996) it is critical. It is imperative that resource managers pay attention to systems pragmatism, which applies adaptive management.

Davey (1998) postulates that enhanced planning and management as an integrated system, applicable to protected area management, may be essential. In protected areas, apparent link between financial resource allocations and effective law enforcement has been elaborated by Jachmann (1998). However, the planning of law enforcement elements such as number of patrol days has not been emphasised in much of operations. Consequently, effects of patrol duration remained uncertain and associated costs unregulated amidst financial paucity. As such, operations effectiveness is eluded. Financial resources for biological conservation are usually inadequate (Leader-Williams and Albon, 1988; Myers et al., 2000) and require effective planning and strict accountability. Therefore, cooperating institutions emphasise on developmental projects performance effectiveness (McNeely et al., 1994; Hockings, 2003). According to Reilly and Reilly (2003), effectiveness can be viewed as a measure of productivity in utilising the undertaking's resources and in terms of long term profitability.

Considering that deployment of foot patrols requires much investments in terms of logistical support, finances and human capital, it is necessary to evaluate the impact of the investment on resource protection. Low budgets towards biological conservation pose high risk of losing biological content of protected areas (McNeely, 1994), even when habitats are pristine (Bennett et al., 2002). In this study, we explored and validated effectiveness of field foot patrol strategies in KNP based on empirical data. Furthermore, we carried out prognostics of offenders' origins to understand likely impacts on protected area system.

MATERIALS AND METHODS

Study area

Kafue National Park spans an area of 22, 400 km^2 (Figure 1), located in south-western Zambia between 14°03'' and 16°43'' South, and 25°13'' and 26°46'' East. It has eleven major vegetation types, which provide habitats to diverse sympatric species. Chidumayo et al. (2003), Leonard (2005) and Mwima (2005) provide detailed account of the biophysical aspects for Kafue ecosystem. ZAWA (2010) also describes the climatic elements of KNP. The Park experiences three climatic seasons: rainy, cold-dry and hot seasons. Mean annual rainfall ranges from 700 to 1, 100 mm. The annual mean temperature ranges from 19.4 to 21.7°C, with relative humidity of between 34.3% in September and 79.1% in February. Simpson (1967) delineates the KNP into three geomorphologic zones: low lying alluvial and Zambezi sand in the south, granite hills in the central and alluvial basin in the north. The geology of KNP consists ancient pre-cambrian basement granite, granite-gneiss and schist, later Precambrian quartzite, slate, Katangan grit and limestone, Karoo sandstone and shale and the young, lucustrine and aelian Zambezi formation sands (Moss, 1976). Based on 1983 Soil Map of Zambia, the key soils of KNP are the vertisols, fluvisols, arenosols, ferralsols, acrisols and luvisols. Illegal wildlife off-takes, wanton wild fires and human encroachment are among the major threats to sustenance of KNP (ZAWA, 2010). The Park boundaries are buffered by nine Game Management Areas (GMAs), with multiple land uses including human settlements. It is estimated that over 174, 796 people live around KNP (CSO, 2003), exerting pressure on it. KNP was selected in this study for its sustained foot patrols, with financial support from cooperating partners, coupled with monitoring and feedback system.

Data gathering procedure

Data on environmental crimes was gathered in 22, 553 man-days in 2005 (period 1) and 132, 307 man-days between 2006 and 2010 (period 2). Trained foot patrol teams randomly searched KNP to detect environmental crimes. Spatial data was geo-referenced based on a total of 299 constellations of 5.5 by 5.5 km grid squares over the entire Park. Environmental crimes were recorded by patrol teams on prescribed patrol forms. Foot patrol duration did not exceed 22 consecutive days prior to 2006. Between 2006 and 2010 new field patrol regime was adopted and did not exceed 15 consecutive patrol days. Field observations were categorised as either minor or major incidences. Minor wildlife crimes were those with relatively low impact on biological resources and included illegal fishing, tree cutting, burning, footprints and honey gathering. Major (serious) wildlife offences constituted those with high impact on biodiversity resources and comprised poacher-groups encountered, illegal camps found, gunshots heard, pairs of elephant tusks recovered, wild animal species killed and snares recovered. Nonetheless, tree cutting had potential for deforestation of KNP, but in this study it was locally categorised as minor because it was a rare incidence with relatively few trees or parts thereof taken out in each incidence identified. Environmental crime encounters, poacher-groups encounters and arrests constituted "events".

Patrol teams were composed of cohorts of Wildlife Police Officers, (WPOs) (also known as wildlife scouts), who were responsible for conducting field patrols of sections of KNP under leadership of an officer of the rank of Senior Wildlife Police Officer or higher. The patrol teams hauled from outposts or sector headquarters where Rangers-in-Charge, the Sector Rangers monitored patrols. Field data was gathered on standard forms and checked by patrol team leaders and Rangers-in-charge of law enforcement. Field data was then populated into law enforcement database for storage, retrieval and analyses. Effective patrol days constituted a measure of actual patrol days spent in the field by patrol teams ransacking the Park for environmental crimes away from operatives' stations as described by Bell (1985). The days did not, however, take into account of the days for the deployment and retreat. Areas of deployment were determined by crime intelligence information and historical perspectives of sections of the Park. Deployment was done by vehicle or boat based on the nature of the terrain, to as close as practical to environmental crime potential sites.

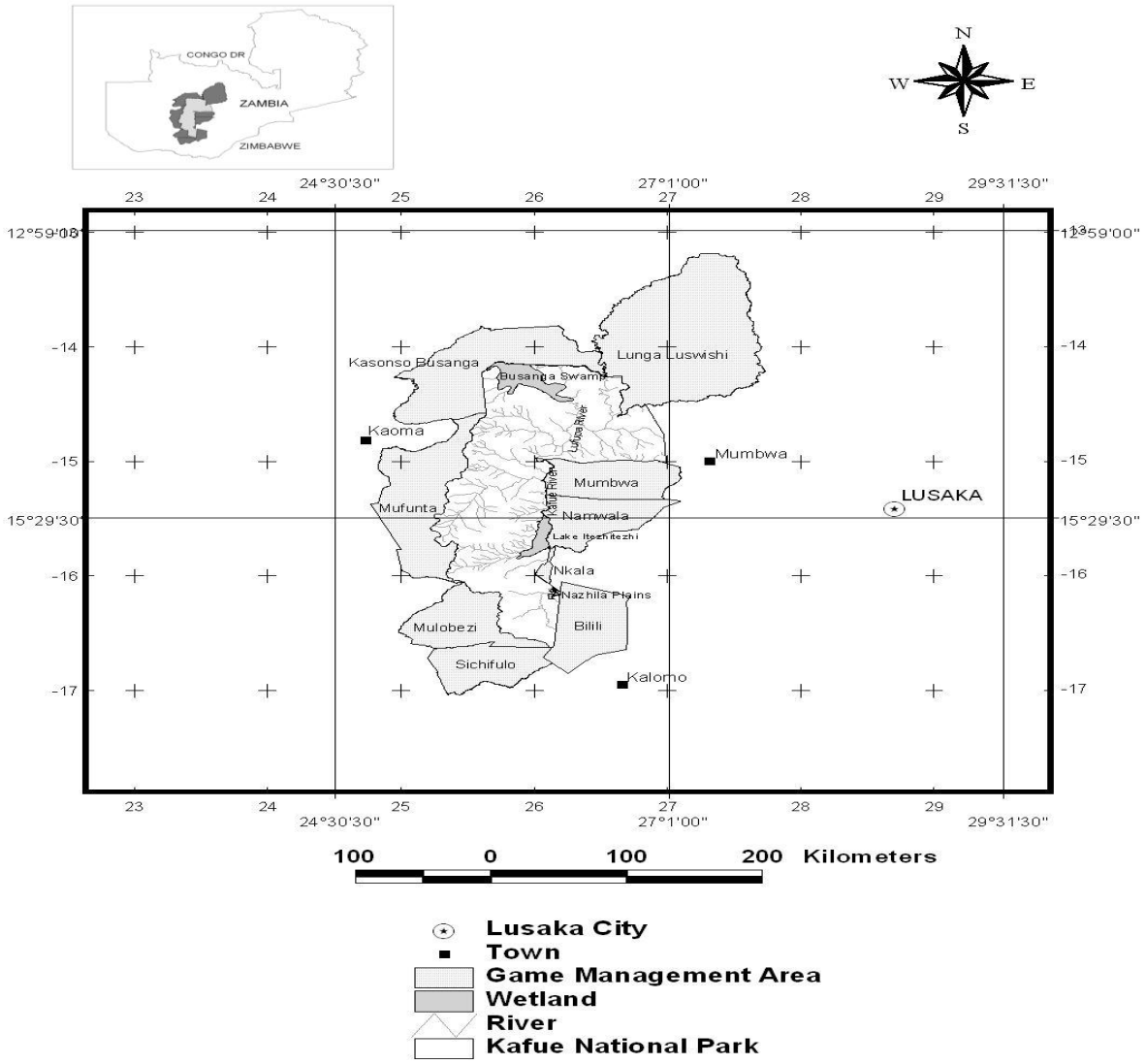

Figure 1. Location of Kafue National Park, Zambia.

The patrols were classified as: one-day patrols, short patrols lasting between 2 and 7 days, and long patrols lasting between 8 and 22 days in 2005 but lasting between 8 and 15 days during 2006 to 2010. Day patrols were undertaken by 2 to 4 WPOs while short patrols involved between 5 to 6 WPOs. Long patrols were conducted by 7 to 8 WPOs. Each patrol team was provided with food rations, communication and camping equipment, standard patrol forms and sets of Global Positioning System (GPS).

Thirteen focus-group interviews were randomly conducted in 2008 and 2009 to elucidate the underlying factors to the performance by various field patrol teams. Protocols suggested by Saunders et al. (2009) were employed, where diminishing returns on patrol effort were explored in respect to patrol duration. In addition, prognostics of offenders' origins associated with environmental crimes in KNP were conducted using prosecution data gathered between 2005 and 2010.

We also determined the impact of the patrol efforts using the dynamics in animal populations. It was assumed that poaching vis-à-vis field foot patrols had significant influence on animal population size and distribution in KNP and therefore poaching was a major limiting factor to population growth. Wildlife population data was obtained from previous aerial surveys conducted by same survey teams and methods during the period of the study. Detailed aerial survey methodologies applied in KNP were described by Chomba et al. (2012). They involved transect sample counts with sampling intensity of between 10 and 15%, based on animal density and block sample counts where the survey area was mapped and divided into quadrat squares of approximate 3 km^2 placed systematically to cover 10% sampling intensity of the survey area. Population status, whether stable, increasing or decreasing, was determined by considering variances in the population estimates.

Analyses

The quantum of events were compared using non-parametric Mann-Whitney U-test to determine statistical significance of events between periods 1 and 2, following test protocols previously described by Fowler et al. (2006). Patrol costs were computed based on the average daily patrol requirements, which included patrol food rations, fuels and backstopping expenses.

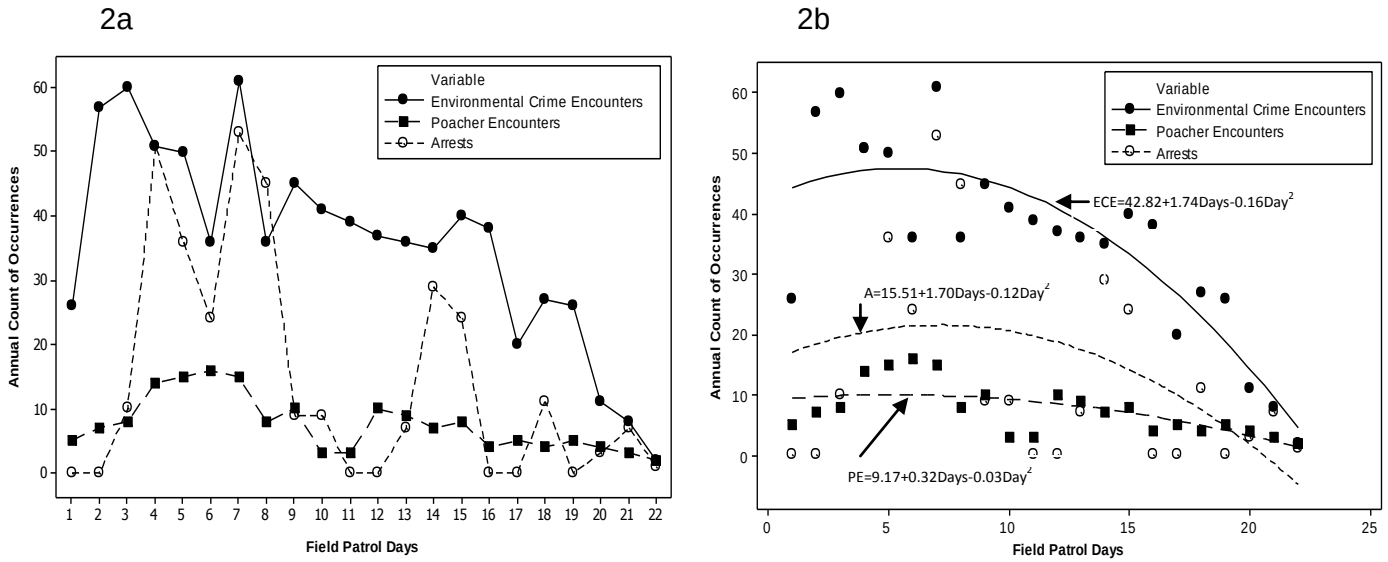

Figure 2a and b. Effects of number of field patrol days on patrol events in Kafue National Park, Zambia, 2005. ECE-Environmental Crime Encounters; A-Arrests; PE-Poacher-groups Encounters.

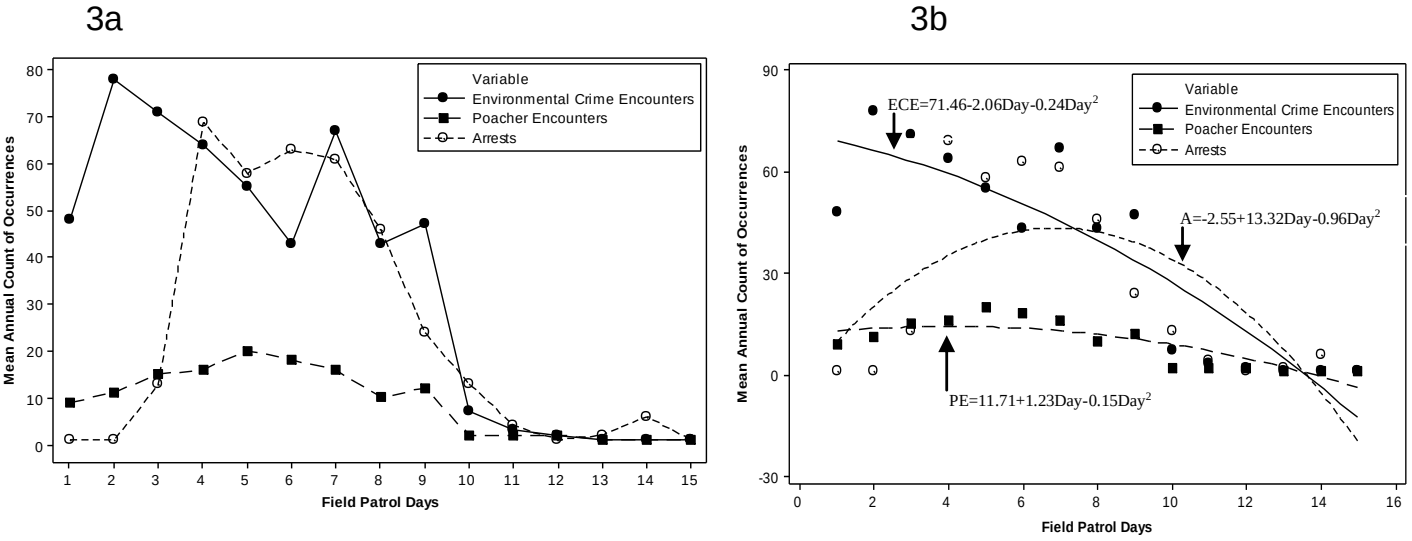

Figure 3a and b. Effects of number of field patrol days on patrol events in Kafue National Park, Zambia, 2006 to 2010. ECE-Environmental Crime Encounters; A-Arrests; PE-Poacher-groups Encounters.

RESULTS

Patrol duration

Field patrol coverage in 2005 (period 1) was 81.0% while the median patrol coverage between 2006 and 2010 (period 2) was 86.5% (range: 83.5 to 88.7%). There were 4, 258 operations (mean: 709.67, range: 499 to 807) conducted in KNP between 2005 and 2010. Each foot patrol lasted for a duration not exceeding 22 days in 2005, averaging 9.13 ± SE 0.23 days per foot patrol (Figure 2a and b). Environmental crime encounters escalated from day 1 to day 7, thereafter down trend ensued. Poacher encounters also declined from day 7 onward, with improvement in day 12 but slid downward to day 22. Similarly, arrests improved from day 3 through to day 8 and decreased onwards. Beyond day 21, patrol effort yielded no events.

Between 2006 and 2010, a new policy was executed where foot patrols lasted not more than 15 days and consequently they averaged 8.18 ± SE 0.46 days per foot patrol (Figure 3a and b).

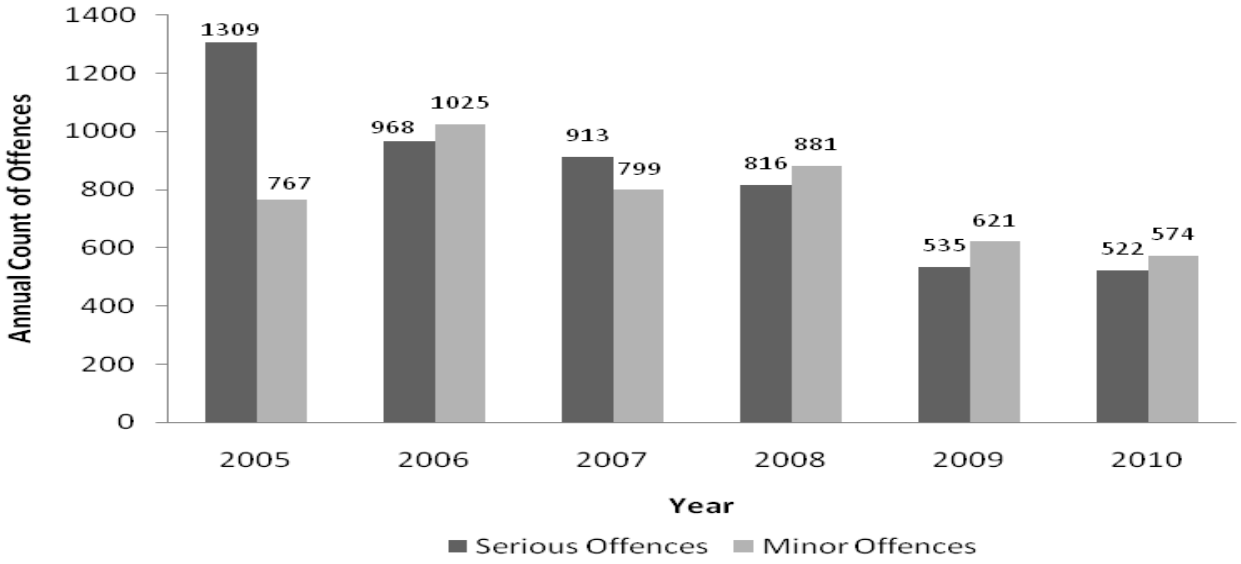

Figure 4. Serious and minor offences occurrences between 2005 and 2010 in Kafue National Park, Zambia, 2005 to 2010.

The new policy further validated that field patrol teams were more effective during patrol episodes from day 2 to day 8 of each foot patrol. Environmental crime encounters, poacher-groups encounters and arrests declined with increasing patrol effort after day 8. During the 2 to 8 day field patrol episodes, field patrol teams detected and conducted ameliorating actions, constituting 89.33% (n = 921) of mean annual events in 2006 to 2010 which was an increase from 51.58% (n = 653) in 2005. All the three parameters had significantly improved in quantum of events with the change of foot patrol policy (non-parametric Mann-Whitney test, $U_{(8, 22)}$ test = 273.0, $p < 0.001$ with respect to environmental crime encounters; $U_{(8, 22)}$ test = 269.0, $p < 0.001$ with respect to poacher-groups encounters; $U_{(8, 22)}$ test = 282.5, $p < 0.006$ with respect to ensuing arrests made). Patrol efforts resulted in progressively higher 'returns' on foot patrol investments in initial days and thereafter, patrol groups experienced diminishing returns in form of patrol outcomes. The shorter the patrol periods (2 to 8 days) the more the desired results in terms of environmental crime encounters, poacher-groups encounters and arrests parameters as extended patrol periods yielded increasingly poor results. Although there were fluctuations on annual basis in the count of events, serious and minor offences decreased by 60.12 and 25.16% respectively from 2005 to 2010 (Figure 4). The decline in total number of events between 2005 and 2010 was 47.21%.

Focus group discussions with 13 patrol groups evinced that a combination of factors were responsible for performance of a particular foot patrol team during patrol undertaking. Key factors identified included stress, tiredness and fatigue by patrol groups as they carry heavy logistical loads comprising food rations, water, firearms, camping equipment and materials for data recording; reliability degree of intelligence information, and leakage of information of presence of patrol teams in the Park to 'poacher' groups and other persons with ulterior motives in the nearby communities through staff collusion. In the case of stress, for instance, recovery loop depicted in day 8 to 13 during the traditional long patrols lasting 22 days culminated in arrests (Figure 2a).

The cost of patrols

In KNP, patrols cost USD 21 $scout^{-1}$ day^{-1}, expended towards patrol food rations, fuels and backstopping expenses. In 2005, USD 473, 613.00 was spent in 22, 553 man-days of foot patrols while between 2006 and 2010, USD 555, 689.40 was spent annually, covering mean 26, 462 man-days. By changing patrol policy from 22 to 15 days, the Wildlife Agency saved 31.82% of the patrol expenditure. However, reduction of patrol days to 8 effective patrol days would further save at least 46.67%. Therefore, based on the number of effective patrol days, the field patrol days can be cost effective.

Prognostics of areas of origin of offenders

The total number of arrests between 2005 and 2010 were 1, 785. Figure 5 depicts that a great deal of the offenders (53.7%) emanated from surrounding districts of Mumbwa (39.3%) and Kaoma (14.4%). Others originated from districts of Lusaka (7.9%), Itezhi-tezhi (5.8%), Kalabo (5.4%), Kasempa (3.7%), Mongu (2.4%), Kabompo (2.3%), Lufwanyama (2.3%) and Solwezi (2.1%). A total of 69.13% of offenders hauled from seven surrounding districts of KNP.

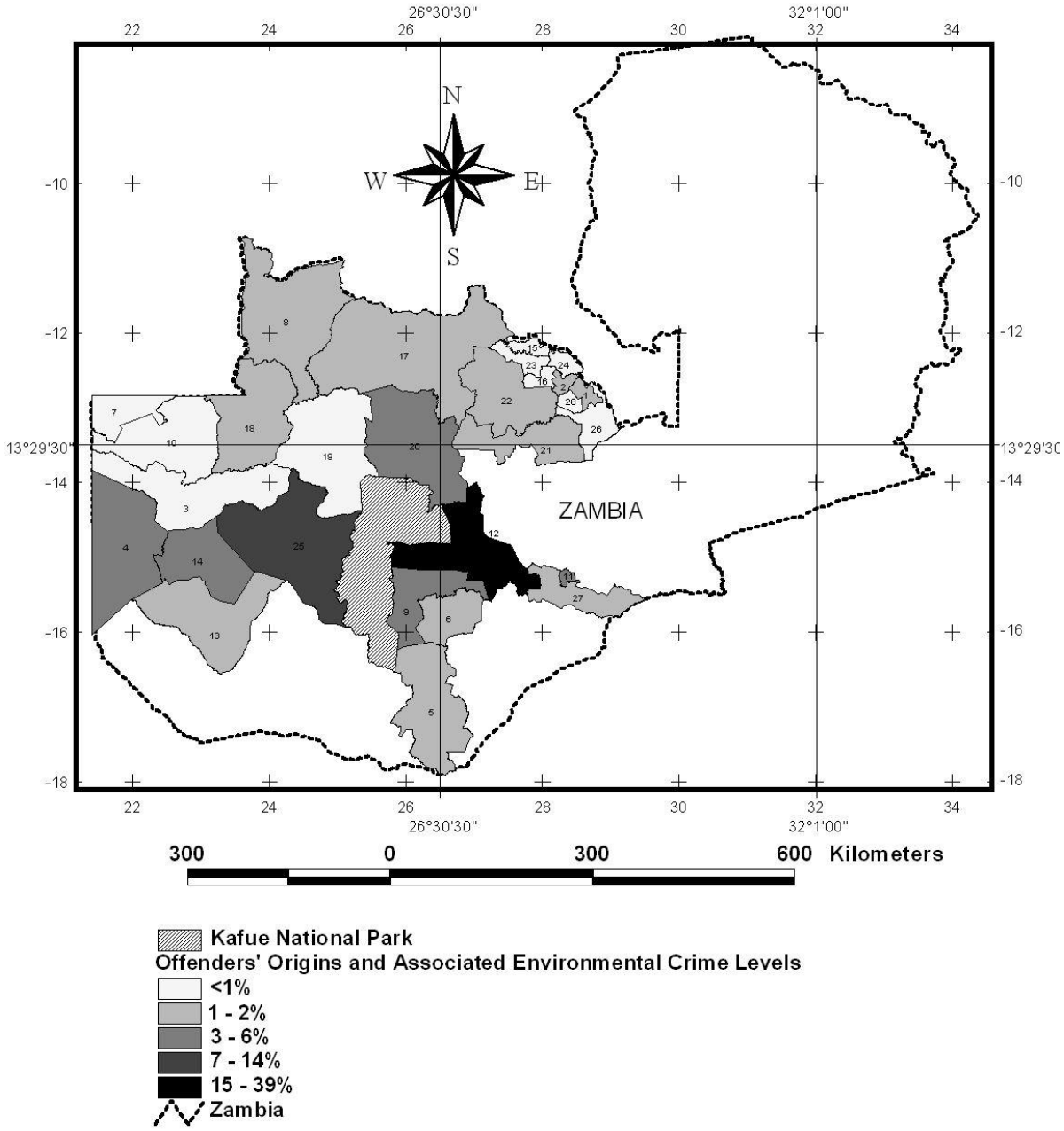

Figure 5. Areas of origin by district of the offenders in Kafue National Park, Zambia, 2005-2010. Numbers in the map represent districts: 15 Chililabombwe, 26 Masaiti, 27 Kafue, 10 Zambezi, 23 Chingola, 21 Mpongwe, 11 Lusaka, 3 Lukulu, 24 Mufulira, 22 Lufwanyama, 5 Kalomo, 14 Mongu, 16 Kalulushi, 17 Solwezi, 8 Mwinilunga, 13 Senanga, 2 Kitwe, 20 Kasempa, 19 Mufumbwe, 4 Kalabo, 1 Ndola, 12 Mumbwa, 18 Kabompo, 28 Luanshya, 9 Itezhi-tezhi, 6 Namwala, 7 Chavuma, 25 Kaoma.

DISCUSSION

Optimal field patrol duration and patrol costs

Six years' (2005 to 2010) data provided insights that foot patrols in KNP landscape would be cost effective if conducted within 2 to 8 days. The diminishing outcomes beyond the effective window of 2 to 8 patrol days increased operational and conservation costs. By its cost effectiveness and motivation given to field patrol teams by shorter patrols, more spatial coverage in ransacking areas for illegal activities, detecting and reacting to offences were achieved. Serious offences were reduced more than minor offences, which further provided evidence of effectiveness. Time lag between crime commission and detection coupled with corrective action gave lead to poacher groups to evacuate environmental crime scene in the Park. Tree cutting, wild fires, illegal

Table 1. Wildlife population estimates and status in Kafue National Park, Zambia, 2006 to 2011.

Common name	Scientific name	2006*	2008**	2011***	Status
Red lechwe	*Kobus leche leche*	5817	5494	8465	Stable
African elephant	*Loxondonta africana*	2506	2521	2280	Stable
Chacma baboon,	*Papio ursinus*	376	469	1057	Increasing
Common duiker,	*Sylvicapra grimmia*	115	184	222	Increasing
Hartebeest	*Alcelaphus lichtensteini*	2097	4048	3937	Increasing
Impala	*Aepyceros melampus*	5318	7207	12884	Increasing
Greater kudu,	*Tragelaphus strepsiceros*	195	695	913	Increasing
Puku	*Kobus vardoni*	3095	5700	11751	Increasing
Roan antelope	*Hippotragus equinus*	1088	1193	1916	Stable
Reedbuck	*Redunca arundinum*	286	202	964	Increasing
Sable antelope	*Hippotragus niger*	3389	7753	7208	Increasing
Warthog	*Phacochoerus africanus*	6395	6328	9111	Increasing
Defassa waterbuck	*Kobus ellipsiprymnus crawshayi*	3798	2715	4135	Stable

*Simukonda C. **Frederick, H. *** Frederick, H.

entry into the Park and harvesting of honey were crimes associated with belated detections by patrol teams who were aided by sightings of a combination of precursors such as cut trees, presence of fresh human footprints and residue of the honey hives or honey combs, abandoned poacher camps, wire snares and animal carcasses or residues. The reduction of serious offences had tailing effects on minor offences, which was in line with objective of conducting field foot patrols, aiming at reversing the decline of wildlife populations especially for mega-fauna. However, whereas 2 to 8 days were appropriate duration and empirical basis for allocation of financial resources to the KNP, this insight on 2-8 days might not be applicable to other protected areas due to differences in biophysical and socio-cultural settings. Therefore, attention should be drawn to the framework of planning uses of the limited financial (for example, for rations, logistics and equipment) and human capital (for example, experiences and skills) on natural resource base.

Outputs of field foot patrols may improve with availability and access to quality and accurate wildlife intelligence information. Strong knowledge base of ecosystem, poachers' interactions with KNP's wildlife habitats and accessibility of illegal activity hotspots is crucial to the success of foot patrols. Therefore, retention of patrol teams on the long run could be the best practice. In addition, fire breaks that were established in 2004 and subsequently maintained throughout period 1 and 2, made it easier for improved spatial coverage and law enforcement by patrol teams.

Population trends

Wildlife populations were either increasing or stable, as depicted by some of the wildlife surveyed between 2006 and 2011 (Table 1). The wildlife aerial surveys were conducted in KNP by Fredrick (2008, 2011) and Simukonda (2006). Wildlife survey results during 2006 to 2011 were derived by consistent methodology and survey teams as opposed to those surveys that were done earlier, which could not be included for comparison purposes in Table 1. Confronted by poaching and other environmental pressures, the status of wildlife population alone is an indication of status of natural resource protection.

Effects on tourism

Number of tourist beds in operational tourism concessions increased from 104 in 2005 to 350 in 2010, with revenue increasing from USD 60,000 in 2005 to USD 480, 000 in 2010. Tourist arrivals into KNP grew by 97.25% between 2005 and 2010 (Table 2). The Park attracted foreign (international) and local tourists. The escalation in tourism activities was mainly due to improving animal populations and maintained access road infrastructure to and within KNP.

Community participation in conservation

Autopsy of the origins of offenders revealing that majority of offenders originated from surrounding districts casts a question of whether or not Community Based Natural Resources Management (CBNRM) programmes in this region are effective. CBNRM programmes, aimed at involving local communities in natural resource management, were introduced in 1980s in the Game Management Areas (GMAs) surrounding KNP amidst heightened poaching scourge (Chabwela and Heller,

Table 2. International and local tourist arrivals in Kafue National Park, Zambia, 2005 to 2010.

Tourist arrival	Year						% Change
	2005	2006	2007	2008	2009	2010	
International tourists	1460	1955	1931	2798	2976	3658	150.55
Local tourists	2219	2563	3451	3045	3788	3599	62.19
Total	3679	4518	5382	5843	6764	7257	97.25

2010; Nyirenda, 2010). The concept of CBNRM hinges on changing local negative attitudes in favour of natural resource conservation. With the principles underlying CBNRM in Southern Africa containing proponents of free markets, social equity or inventive-led CBNRM, if well implemented, has a high probability to succeed (Child and Murshall, 2004). In Southern Africa, there have been some strides in selected areas in the implementation of CBNRM resulting in increased benefits such as increasing animal populations and land under resource protection (Roe et al., 2009). CBNRM in Zambia is legally legitimised and in practice, there has been mass support from stakeholders who view CBNRM as a viable strategy for conservation. In wildlife sector, co-management model has been adopted where local communities have been given latitude to actively participate in and benefit from natural resource management. The local communities are also governed by legally legitimised Community Resources Boards, which are local governance institutions, with partial rights and responsibilities in natural resource management. They also receive funds transfers from Zambia Wildlife Authority, accruing from safari hunting in the GMAs, which are ploughed back into resource protection, community livelihoods enhancement and community based projects such as infrastructure development, capacity building and environmental awareness. Local communities are also encouraged to engage in eco-tourism based on approved General Management Plans. Due to capacity constrains (mainly financial and human capital), there are currently limited community based sustainable eco-tourism activities outside KNP. Furthermore, for the purpose of social learning, there has been most often inadequate monitoring of CBNRM impacts in the areas around KNP.

Recognising the important role of CBNRM in natural resource management, there are also lessons that some areas surrounding KNP and others could draw from community based initiatives elsewhere such as in Annapurna Conservation Area (ACA), Nepal. Through community involvement, ecological integrity of ACA was protected, thereby increasing forest basal area, tree species diversity and wildlife abundance while reducing the density of cut tree stumps for fuelwood through changed pattern of resource utilization, human behavior, increased control of local communities over their local resources, increased conservation awareness among local communities from environmental education, and development and strengthening of local institutions (Bajracharya et al., 2005). According to Khadka and Nepal (2010), bottom-up conservation involving local communities in ACA plays a key role in seeking their participation in social development and biodiversity conservation, by transforming barriers and negative perception to positive participation in specified local circumstances. Further, the incentive based programs in ACA have resulted in benefit sharing equity among local communities, though with some areas for improvement as suggested by Spiteri and Nepal (2008), particularly relating to effectively targeting more vulnerable members of communities.

The findings in KNP are different from previous evidence from Luangwa Valley, eastern Zambia where offenders came from far flanged areas (Jachmann, 1998; Leader-Williams, 1996). Therefore, adjoining areas to KNP require strengthening of the community based conservation initiatives and garnering further community support to save the vast KNP from wildlife resources depletion. Multiple strategies for conservation that will involve law enforcement and community based conservation are hitherto critical to the effectiveness of biodiversity conservation in protected areas in the sub-region (Hilborn et al., 2006). However, such strategies needed to be accompanied by robust wildlife monitoring (Newmark and Hough 2000), rather than relying on public compliance of biodiversity law and regulations (Abbott and Mace, 1999, Rowcliffe et al., 2004).

Conclusion

This study suggests that patrol duration by field patrol teams and its associated financial resource allocation efficiency from dismal conservation funds were important factors for the performance of field foot patrols in KNP. Therefore, planning deployments based on scientific information coupled with monitoring of outputs from foot patrols could guide the optimum patrol duration for a particular area and consequently prove cost-effectiveness in utilisation of the scarce financial resources. By embracing data driven approaches, KNP management team was able to reverse loss of biodiversity, as reflected in wildlife population trends. It also developed sustainable tourism, through securing critical habitats and species.

The hallmarks of foot patrols for the KNP may not apply in all situations and areas and therefore, provides framework for foot patrols within KNP and elsewhere. We

acknowledge experiential input in law enforcement by field patrol teams but propose base-level systematic analyses and adaptive application of field data in wildlife management. By determining appropriate patrol duration and associated costs, protected areas management teams are likely to predict outcomes of their planning and implementation efforts. On the other hand, though foot patrols were an important conventional wildlife conservation strategy in the KNP, community based conservation initiatives would pragmatically deal with causes rather than symptoms of much of the loss of biodiversity in the region in the long run.

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