The impact of armed conflict on protected-area efficacy in Central Africa

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What determines the vulnerability of protected areas, a fundamental component of biodiversity conservation, to political instability and warfare? We investigated the efficacy of park protection at Garamba National Park (Democratic Republic of Congo) before, during and after a period of armed conflict. Previous analysis has shown that bushmeat hunting in the park increased fivefold during the conflict, but then declined, in conjunction with changes in the sociopolitical structures (social institutions) that controlled the local bushmeat trade. We used park patrol records to investigate whether these changes were facilitated by a disruption to anti-poaching patrols. Contrary to expectation, anti-poaching patrols remained frequent during the conflict (as bushmeat offtake increased) and decreased afterwards (when bushmeat hunting also declined). These results indicate that bushmeat extraction was determined primarily by the social institutions. Although we found a demonstrable effect of anti-poaching patrols on hunting pressure, even a fourfold increase in patrol frequency would have been insufficient to cope with wartime poaching levels. Thus, anti-poaching patrols alone may not always be the most cost-effective means of managing protected areas, and protected-area efficacy might be enhanced by also working with those institutions that already play a role in regulating local natural-resource use.

Keywords: conservation biology; protected areas; armed conflict

1. INTRODUCTION

The impact of human conflict on wildlife and habitats is complex. While stretches of depopulated 'no man's land' between warring forces can provide a sanctuary for wildlife, most war zones are more likely to act as population sinks through the proliferation of armaments and uncontrolled poaching by refugees and combatants (Dudley *et al*. 2002). Given the threat that warfare poses and the prevalence of armed conflicts, it is imperative to identify how wildlife and habitats can best be safeguarded (Shambaugh *et al*. 2001). Protected areas are a fundamental component of global conservation with a demonstrable capacity to protect biodiversity (e.g. Bruner *et al*. 2001), but relatively little is known about their efficacy during periods of armed

conflict. Evidence suggests that protected areas are often adversely affected by warfare (e.g. forest and savannah parks in both Rwanda and Democratic Republic of Congo; Kanyamibwa 1998; Inogwabini *et al*. 2005), but our understanding has been hampered by the difficulty in collecting systematic data before, during and after periods of conflict.

Here, we investigate the performance of a protected area during armed conflict in Central Africa, a region of high biodiversity value where conflict is common (Human Security Centre 2005). We focus on protected-area efficacy in relation to illegal bushmeat extraction, since bushmeat hunting is a major threat to wildlife, particularly in Central Africa (Milner-Gulland *et al*. 2003). Previous studies suggest that protected areas fail during wartime owing to a breakdown in park protection (e.g. Plumptre *et al*. 1997). We therefore test the hypothesis that protected areas can still provide conservation services during wartime provided that anti-poaching patrols remain operational.

2. MATERIAL AND METHODS

Our study took place in Garamba National Park (4900 km^2), and the adjoining Azande Hunting Reserve (3200 km^2), in Democratic Republic of Congo. The park is characterized by tall-grass savannah and contains large elephant and buffalo populations, while the reserve is a woodland-savannah/forest mosaic with human settlements. Hunting for bushmeat is illegal in the park, but legal for unprotected species (such as duikers and monkeys) in the reserve. We studied park protection and the bushmeat trade over three periods: seven months of stability prior to the Congolese civil war (Period 1: April–October 1996); four months of intense conflict when the rebel army arrived (Period 2: November 1996–February 1997); and four months of stability after the rebels gained control of the area (Period 3: March–June 1997).

Garamba National Park is managed by the government wildlife agency (the Institut Congolais pour la Conservation de la Nature) in conjunction with an international aid project (the Garamba National Park Project). To prevent illegal hunting, the park is protected by anti-poaching patrols of approximately 15 armed rangers on foot. These rangers, who are drawn from local communities, monitor all illegal activities using a recording system that allows subsequent patrols to be directed towards poaching hotspots. Since patrol frequency is a fundamental determinant of the successful protection of large mammals (Arcese *et al*. 1995; Jachmann & Billiouw 1997), we use it as our measure of protection effort. The Azande Hunting Reserve, in contrast, is not managed by the state nor is it protected by anti-poaching patrols. Hunting activity in the reserve comes under the jurisdiction of local traditional leaders and is predominantly legal. Bushmeat from the park is transported from the village of Mamba (approx. 1700 inhabitants) on the park–reserve boundary, through the reserve via the village of Kiliwa (3000 inhabitants; 50 km from Mamba), to the nearby town of Dungu (25 000 inhabitants) on the far edge of the reserve (90 km from Mamba).

We monitored the bushmeat trade in the Kiliwa (rural) and Dungu (urban) markets. Given the subject of our study and local conditions, our data collection techniques were designed to maximize trust. Fieldwork was therefore carried out with trained local assistants and only after a pilot study and three months' local residence by Emmanuel de Merode. All data were also regularly triangulated between observers. Bushmeat sales were recorded by quantitative surveys. In Dungu, two of the five urban markets opened once a week, one opened three times weekly and two opened daily; seven out of these 19 market days were randomly selected each week for a sample of 456 days (37% of all market days). The two Kiliwa rural markets only opened once a week, enabling us to survey every market day ($n = 130$). We counted the number of bushmeat stalls every 2 h and recorded the weight of bushmeat sold and geographical origin of the meat (established from the vendor).

In a companion paper (de Merode & Cowlishaw 2006), we reported that 81% of Dungu urban sales (mostly elephant and buffalo) were illegally harvested from Garamba, and that these sales showed a massive increase during the armed conflict. In contrast, 82% of Kiliwa rural sales (primarily duikers and monkeys) were legally supplied from the reserve and remained stable throughout the study. We also documented the different sociopolitical
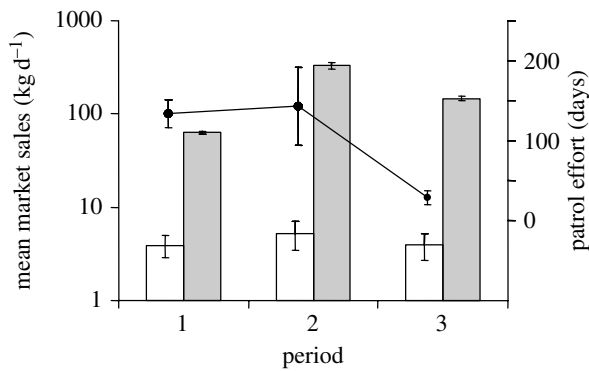
Figure 1. Park patrol effort (solid line, filled circles) and bushmeat sales in the urban (filled bars) and rural (open bars) markets before, during and after the armed conflict. Means and standard errors are shown.

Table 1. The influence of patrol effort, period and their interactions on urban bushmeat sales. (Note that although patrol effort is non-significant (n.s.) as a main effect in this model, it is highly significant in the absence of interaction terms (see §3).)

parameter	estimate	s.e.	Wald χ^2	d.f.	p
intercept	4.124	0.123	119.5	1	<0.0001
patrol effort	0.000	0.001	0.031	1	n.s.
period 2	2.429	0.156	243.6	1	<0.0001
period 3	1.256	0.160	61.62	1	<0.0001
patrol effort × period 2	−0.006	0.001	33.91	1	<0.0001
patrol effort × period 3	−0.015	0.003	20.82	1	<0.0001

structures that characterized the urban and rural bushmeat trade. The rural market, in which hunters sold directly to consumers, was controlled by the village chief. The urban market, in which bushmeat passed along a complex supply chain to consumers (involving hunters, porters, bicycle traders and market stall owners, all under the coordination of wholesalers), was controlled by military officers. These officers fled ahead of the rebels (at the end of period 1), leading to the collapse of the urban supply chain and an increase in the number of independent hunters operating in the park (period 2), until rebel officers re-established control (period 3). According to our hypothesis, we predict that the increase in independent hunters and illegal bushmeat offtake during the conflict was ultimately facilitated by a breakdown in anti-poaching patrols, and that their subsequent decline was due to a resumption of normal anti-poaching operations after peace had been restored.

We used generalized linear mixed models for repeated measures to analyse monthly patrol days and bushmeat sales. Our bushmeat sales dataset exhibited a hierarchical structure, with days nested within months within periods: these were entered as random effects, while explanatory variables were added as fixed effects. We employed Poisson models accounting for overdispersion using the RIGLS algorithm.

3. RESULTS

Park protection and bushmeat extraction showed unexpected patterns (figure 1). While urban sales increased in period 2 (relative to period 1: $\chi_1^2 = 171.9$, $p < 0.0001$) and declined again in period 3 (relative to period 2: $\chi_1^2 = 54.34$, $p < 0.0001$; relative to period 1: $\chi_1^2 = 4.72$, $p < 0.05$), this pattern was not associated with a corresponding decline and subsequent increase in protection effort. Rather, patrols in period 2 occurred at the same frequency (relative to period 1:
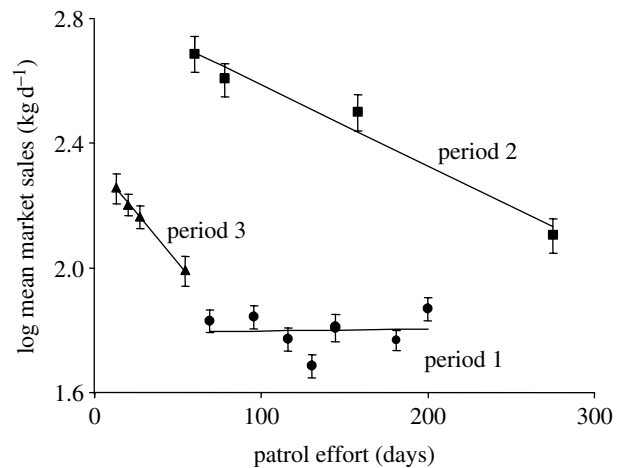
Figure 2. Urban bushmeat sales plotted against patrol effort for each month of the three periods (symbols), together with the predicted values (lines) from the fitted model. Means and standard errors are shown.

$\chi_1^2 = 0.07$, n.s.) and with the same spatial coverage as patrols in period 1. Patrol frequency only declined in period 3, when the park staff were disarmed by the rebel army (relative to period 1: $\chi_1^2 = 144.1$, $p < 0.0001$; relative to period 2: $\chi_1^2 = 11.19$, $p < 0.001$). In contrast, the volume of bushmeat sold in the rural market remained constant across all periods ($\chi_2^2 = 0.50$, n.s.).

Although changes in illegal bushmeat extraction were not associated with changes in anti-poaching patrols, this does not mean that park protection was completely ineffectual. To explore this further, we examined the interactions between period and patrol effort (table 1 and figure 2). We found that, across months within periods, an increase in patrol frequency was usually associated with a decline in illegal offtake. Under conditions of peacetime (periods 1 and 3), there was a threshold protection effort of approximately 70 patrol days per month, at which bushmeat sales did not diminish with additional patrolling, but did increase when patrolling was reduced. In contrast, in wartime (period 2), an increase in patrol effort always reduced bushmeat sales. However, the higher absolute levels of poaching during this period meant that even the observed fourfold increase in patrol effort (beyond 70 days) was insufficient compensation. Consequently, illegal extraction remained 2–8 times higher during the armed conflict than before it.

4. DISCUSSION

Previous studies on park protection have demonstrated that poaching declines in response to patrol effort (e.g. Arcese *et al.* 1995; Jachmann & Billiouw 1997). Our findings that poaching increased despite strong park protection, and then declined under weak protection, were therefore unexpected. They suggest that changes in the social institution that controlled the urban market, rather than anti-poaching patrols, were the crucial factor influencing the number of hunters and illegal offtake in the park (de Merode & Cowlishaw 2006). However, we also found that bushmeat extraction did decline as patrol effort increased during both these periods. These results

indicate that protected areas can provide conservation services during armed conflict, but that a substantial increase in protection effort, necessitating a significant investment of funds, may be required to compensate for increased poacher numbers.

Unfortunately, even the maintenance of effective protection during peacetime, identified as 70 patrol days per month in this case, is beyond the reach of most national parks in the developing world (e.g. Peres & Terborgh 1995). This is especially true in the Congo Basin, where protected areas are notoriously underfinanced (Wilkie *et al.* 2001). However, our study indicates that local social institutions—which played a key role in regulating bushmeat extraction in this study—may be able to help solve this problem. The importance of social institutions in controlling access to natural resources is well known in the fields of development and environmental management (e.g. Berry 1989; Mearns 1995; Sarch 2001), but is poorly known in conservation. Given the important regulatory role that social institutions can play, a more cost-effective approach to protected-area conservation may be to develop management models that incorporate these informal structures as a complement to conventional approaches.

Our focus here would be on the traditional administration of the village chief which maintained a stable legal bushmeat trade throughout the conflict. The Kiliwa chief achieved this outcome through an active programme of confiscating automatic weapons and discouraging military personnel and illegal bushmeat sales in the village. The chief thus minimized disruption to the village market and hence maximized the revenues that he derived from market stall taxes, some of which were invested back to the community: a local school was rebuilt and a dispensary established from these revenues (de Merode & Cowlishaw 2006). A combined strategy of collaboration with such social institutions and ongoing park protection might make protected areas both less expensive to manage and more effective in achieving conservation goals. This sort of approach has particular relevance in countries such as Democratic Republic of Congo, where armed conflict has been prolonged by conflict over illegally acquired natural resources (United Nations 2001).

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