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The pattern of poaching signs in Ugalla Game Reserve, western Tanzania

Paulo Wilfred[1]* and Andrew MacColl[2]

[1]*Department of Life Sciences, Faculty of Science, Technology and Environmental Studies, The Open University of Tanzania, P.O. Box 23409, Dar es Salaam, Tanzania and* [2]*School of Life Sciences, The University of Nottingham, University Park, NG7 2RD, Nottingham, U.K.*

Abstract

Illegal harvesting of wildlife resources is an important challenge facing protected areas in Africa. A better understanding of its nature would improve the way in which it is managed. We investigated the degree of poaching into different types of natural resources and its management implications in Ugalla Game Reserve, western Tanzania, using data on spatial distribution of poaching signs. Poaching signs were distributed nonrandomly through the reserve, which suggested that poachers targeted particular resources at certain areas of the reserve. Logging was the predominant illegal activity, followed by bushmeat hunting and illegal fishing. Logging signs were widespread at Ugalla east and Ugalla south. The latter also contained the highest encounter rate of bushmeat signs. Illegal fishing was extensive around the main rivers in the reserve. For improved conservation enforcement in western Tanzania and similar ecosystems, conservation efforts should take into consideration the distribution and composition of different types of poaching.

Key words: antipoaching, poaching, poaching signs, poaching types, Ugalla Game Reserve, western Tanzania

Résumé

La collecte illégale de ressources de la vie sauvage est une difficulté majeure pour les aires protégées d'Afrique. Une meilleure appréhension de sa nature permettrait d'améliorer la façon de la gérer. Nous avons étudié l'ampleur du braconnage de différents types de ressources naturelles et les implications qu'il a sur la gestion de la Réserve de Faune d'Ugalla, dans l'ouest de la Tanzanie, en utilisant des données sur la distribution spatiale des signes de braconnage. Ces signes n'étaient pas dispersés de façon aléatoire dans la réserve, ce qui suggère que les braconniers visaient des ressources bien particulières dans certaines zones de la réserve. Les coupes de bois étaient la principale activité illégale, suivies par la chasse pour la viande de brousse et par la pêche illégale. Les traces de coupes de bois étaient nombreuses dans Ugalla-est et Ugalla-sud. Ce dernier montrait aussi le plus fort taux de prélèvements de viande de brousse. La pêche illégale était très répandue dans les principaux cours d'eau de la réserve. Pour améliorer le respect des lois en matière de conservation dans l'ouest de la Tanzanie et dans des écosystèmes comparables, les efforts de conservation doivent tenir compte de la distribution et de la composition des différents types de braconnage.

Introduction

Illegal harvesting of wildlife resources such as timber, fish and bushmeat (hereafter, 'poaching') is one of the conservation challenges facing many protected areas in Africa, and a better understanding of its nature would be useful to local conservation management (Davies & Brown, 2007; Abernethy *et al.*, 2013; Gandiwa *et al.*, 2013; Lindsey *et al.*, 2013). Unfortunately, our knowledge on the local patterns of poaching – needed to address the root causes of the problem – is still limited.

A number of studies have attempted to assess the nature of poaching and consequent implications for conservation. For example, it has been reported that illegal loggers may also hunt for bushmeat (Guariguata *et al.*, 2009). When logging and bushmeat hunting co-exist in a protected area, wildlife population declines are more severe (Redford, 1992; Corlett, 2007). The co-existence of illegal fishing and bushmeat

*Correspondence: E-mails: paulo.wilfred@yahoo.co.uk, paulo.wilfred@out.ac.tz

hunting in the Savé Valley Conservancy of Zimbabwe has decimated wildlife populations (Lindsey *et al.*, 2011). In Liberia, a study by Barrie *et al.* (2007) recommended active control of illegal mining, logging and wildlife poaching for bushmeat in some of the national forests.

There are two common approaches to productive antipoaching, namely, conservation-based local livelihoods improvement and law enforcement (Hilborn *et al.*, 2006). Practically, at a local level, law enforcement entails carrying out antipoaching patrols to search for, detect and apprehend offenders (Holmern, Muya & Roskaft, 2007; Milner-Gulland & Rowcliffe, 2007). However, resources (financial resources, equipment and trained personnel) for law enforcement are usually scarce (Hilborn *et al.*, 2006; Holmern, Muya & Roskaft, 2007). Appropriate law enforcement monitoring, using ranger-based information to understand the pattern of poaching, is also hampered by biased patrolling efforts, which lead to limited relationships between actual and observed illegal harvesting activities (Burn, Underwood & Blanc, 2011; Keane, Jones & Milner-Gulland, 2011). Rigorously analysed and interpreted data from surveys of poaching signs (e.g. tree stumps, snares, poachers' camps and poacher encounters) can be an appropriate approach in understanding patterns of illegal resource exploitation, for successful antipoaching (see Campbell & Loibooki, 2000; Wright *et al.*, 2000; Blom *et al.*, 2004; Milner-Gulland & Rowcliffe, 2007).

In Tanzania, poaching is common and jeopardizes the hopes for sustainable conservation (Odada *et al.*, 2004; Kaltenborn, Nyahongo & Tingstad, 2005; Madoffe *et al.*, 2006; Knueppel *et al.*, 2009; Nyahongo *et al.*, 2009; Knapp *et al.*, 2010). Studies on local patterns of poaching activities have been carried out in various protected areas (e.g. game reserves and national parks) (Kaltenborn, Nyahongo & Tingstad, 2005; Holmern, Muya & Roskaft, 2007; Knapp *et al.*, 2010), but the Ugalla Game Reserve of western Tanzania has remained largely ignored. The isolation of the reserve from other protected areas, pressure from the surrounding – rapidly increasing – human population, and the pressing need to protect elephants and wild dogs (Ugalla Game Reserve [UGR], 2006) are among the factors making wildlife poaching in Ugalla a matter of grave concern. Here, using data on spatial distribution of poaching signs in the reserve, we examine the extent to which poaching of different natural resources varies in space and the management implications.

Methods

Study area

This study was carried out in Ugalla Game Reserve (Fig. 1) situated between Katavi and Tabora regions in western Tanzania. The reserve (5000 km^2) lies between 5–6° South and 31–32° East and experiences a tropical climate defined by a distinct wet season from December–May and dry season from June–November. The rainfall varies between 700–1000 mm per year and mean maximum and minimum temperatures between 28–30°C and 15–21°C, respectively (Mbwambo, 2003; Hazelhurst & Milner, 2007). The main legal activity in the reserve is tourist hunting performed in two hunting blocks at Ugalla east and Ugalla west. Conservation is carried out at the level of the hunting blocks (UGR, 2009). Tourist hunting is legally allowed as it is sustainable and well controlled by the reserve management authority and Wildlife Division of Tanzania (UGR, 2006). The reserve is characterized by miombo woodland vegetation containing highly valuable timber species. Miombo is the vernacular term commonly used to describe the savannah woodlands of southern Africa, dominated by trees of the genera *Brachystegia*, *Julbernardia* and *Isoberlinia* (Williams *et al.*, 2008). A wide range of wildlife species including large mammals such as hippopotamus *Hippopotamus amphibius*, giraffe *Giraffa*

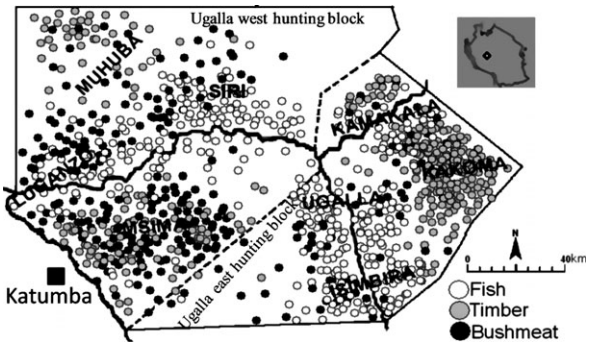

Fig 1 Map of Ugalla Game Reserve (UGR) showing locations of poaching signs encountered in the Reserve. Signs were classified into three main poaching types, namely, fish, timber and bushmeat. The names of the antipoaching units are at approximate centres for antipoaching units. Thick line denotes the reserve boundary. The dotted line demarcates the hunting blocks. Meandering lines show the main rivers. Katumba area in which the refugee camps (mentioned in the text) are located is also shown. Insert shows the location of UGR in Tanzania

camelopardalis and African elephant *Loxodonta africana* is found in Ugalla. The main rivers traversing the reserve support a diverse range of fish species including tilapia *Tilapia* spp., African butter catfish *Schilbe mystus*, African lungfish *Protopterus aethiopicus* and long-finned tetra *Brycinus longipinnis*. Due to high poaching incidence, antipoaching patrols are carried out very frequently both on foot and in vehicles by rangers (UGR, 2006) covering all delimited areas (see Fig. 1).

Poaching signs

A survey of poaching signs was carried out on driven transects along existing roads in the reserve (Fig. 2) between June–September, 2009. The roads were the ones used for patrolling purposes by the game rangers. The sampling units were the eight antipoaching units within Ugalla Game Reserve (Fig. 1). A total of 36 transects were randomly selected, and at least three transects were surveyed at each antipoaching unit. All the surveyed transects covered a total of 782 km. Transects varied in length, and there was no fixed distance on either side of the transect within which poaching signs were searched.

The survey was conducted during the afternoon hours from 13 to 18 h in an open vehicle driven at a speed not exceeding 20 km h^{-1} to allow rigorous searches, with binoculars, for poaching signs on both sides of the transect. Owing to the low-lying or flat landscape characteristic of Ugalla Game Reserve, and the fact that the survey was conducted during the dry season (i.e. June–December) when much of the reserve was burnt for conservation purposes, visibility was generally high. All encountered poaching signs were recorded, whether structural, for example, fish- and bushmeat-smoking racks and poacher camps, abandoned poacher belongings, or animal remains. Positions were recorded for each poaching sign using a handheld Garmin GPSMAP® 60Cx (Garmin Ltd., Schaffhausen, Switzerland).

Data analysis

Statistical analyses were carried out in GenStat®10 (Payne *et al.*, 2007). A generalized linear model (GLM) with a normal error structure was used to test predictors of interest to poaching sign encounter rate (SER). The SER was calculated as [number of encounters of poaching signs on the transect]/[length (in km) of the same transect]. The fixed model included the effects of antipoaching unit and poaching sign type and their interaction. The fixed terms of the GLM were dropped in the ascending order of their *F*-values until the minimum adequate model was obtained. All statistical tests were two-tailed, and the significance level (α) was set at 0.05.

The spatial distribution of poaching signs across antipoaching units was determined using both canonical variate analysis (CVA) (Shaw, 2003) and GPS locations. The CVA was used for the ordination of poaching signs,

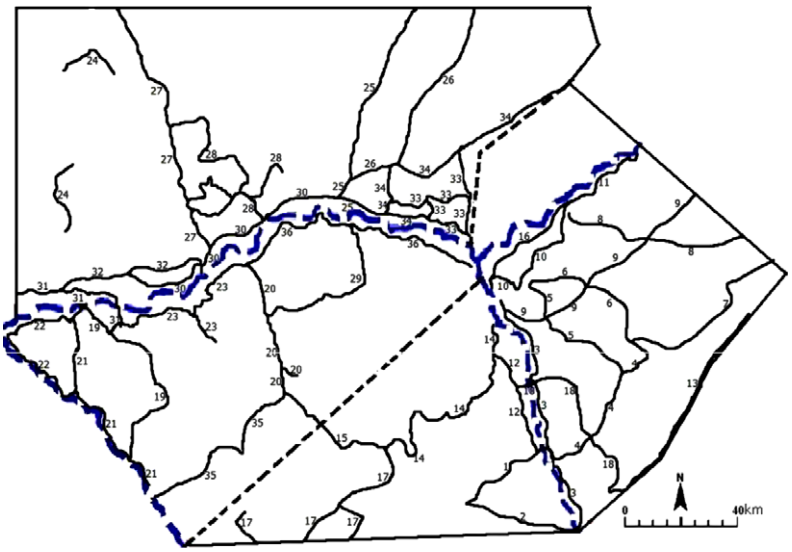

Fig 2 The distribution of surveyed roads in Ugalla Game Reserve. Meandering broken lines are rivers. Transects (numbered lines, repeating numbers show the continuation of the transect) represent a total of 782 km

based on square-root-transformed data. The technique was useful in showing how poaching signs in the reserve were spatially separated in relation to the antipoaching units. Only the first three axes or dimensions [canonical variate (CV) 1–3] were extracted as they represented much of the variation among the antipoaching units. Consequently, a biplot was generated using scores of the axes and co-ordinates of poaching signs. GPS co-ordinates of poaching sign locations were mapped using ArcGIS (version 9.3; ESRI 2008, Redlands, CA, USA) to determine their spatial distribution.

Results

Seven hundred and sixty-four encounters of poaching signs were recorded. These were grouped into 10 categories reflecting illegal fishing, logging and bushmeat harvesting (Table 1). Discarded elephant carcasses were put in a separate category because they were easily identified and attributed to illegal hunting. Poaching sign encounter rate varied significantly across different types of poaching signs ($F_{9,72} = 3.93$, $P < 0.001$, see Table 1) and among antipoaching units ($F_{7,70} = 2.36$, $P = 0.031$, Figs 1 and 3). Signs representing illegal logging such as tree stumps and sawpits were widespread (Table 1 and Fig. 1). The frequently encountered fish and bushmeat poaching signs were fishing nets and meat-smoking racks, respectively (Table 1).

The biplot from CVA of poaching signs across the antipoaching units shows a spatial association of the signs (Fig. 3). The loadings of the poaching sign categories along the first three axes (CV1, CV2 and CV3) are shown in Table 2. The first axis separates poaching signs associated with timber and bushmeat harvesting from illegal fishing. Along the second axis, timber poaching signs have higher values than illegal fishing and bushmeat harvesting signs.

Muhuba and Msima antipoaching units at Ugalla west contained most of the encountered bushmeat poaching signs (Figs 1 and 3), especially elephant carcasses and meat-smoking racks. They also had fish and timber poaching signs, but to a lesser extent. Timber poaching signs were dominant around Kakoma area at Ugalla east. The same part of the reserve had abundant illegal fishing signs at Siri and Isimbira antipoaching units.

Discussion

Poaching signs were distributed nonrandomly through the reserve, suggesting that poachers targeted particular subsets of natural resources at particular places. Such information is vital in studying poachers and their behaviours (Forsyth, 2008), as well as the scale of poaching activities, for effective law enforcement (Blom *et al.*, 2005; Holmern, Muya & Roskaft, 2007; Gavin, Solomon & Blank, 2009). Furthermore, evidence of poaching reflects the degree of exploitation associated with different natural resources (Wright *et al.*, 2000; Lwanga, 2006; Holmern, Muya & Roskaft, 2007; Waltert, Meyer & Kiffner, 2009). For example, in the present survey, large numbers of trees were cut for timber especially at Kakoma, Kamakala and Msima antipoaching units, whereas bushmeat hunting was prevalent in the southern part of the reserve. The observed poaching signs are indices of three common types of poaching, namely, illegal logging, bushmeat hunting and fishing.

Table 1 Categories of different poaching signs encountered in Ugalla Game Reserve with their respective mean sign encounter rate (SER) (km^{-1}). Signs are listed in decreasing SER

Poaching sign	Poaching sign description	SER ± SE
Sawn wood	Wood cut as a result of timber poachers' activities	1.53 ± 0.15
Sawpit	Dug-out pits over which wood logs are placed to facilitate timber sawing	1.01 ± 0.11
Fishing net	–	0.70 ± 0.18
Meat rack	Racks used for smoking bushmeat	0.50 ± 0.15
Fish rack	Wooden racks used for drying fish	0.31 ± 0.13
Boat	Traditional fishing boats made of tree bark or hollowed tree trunks	0.20 ± 0.06
Elephant	Remnants of African elephants killed by poachers	0.15 ± 0.07
Animal remains	Remnants of different animal species, other than elephant, killed by poachers	0.14 ± 0.11
Bicycle	Any bicycles abandoned by poachers	0.13 ± 0.05
Snare	Wooden or wire snares located across animal paths	0.11 ± 0.03

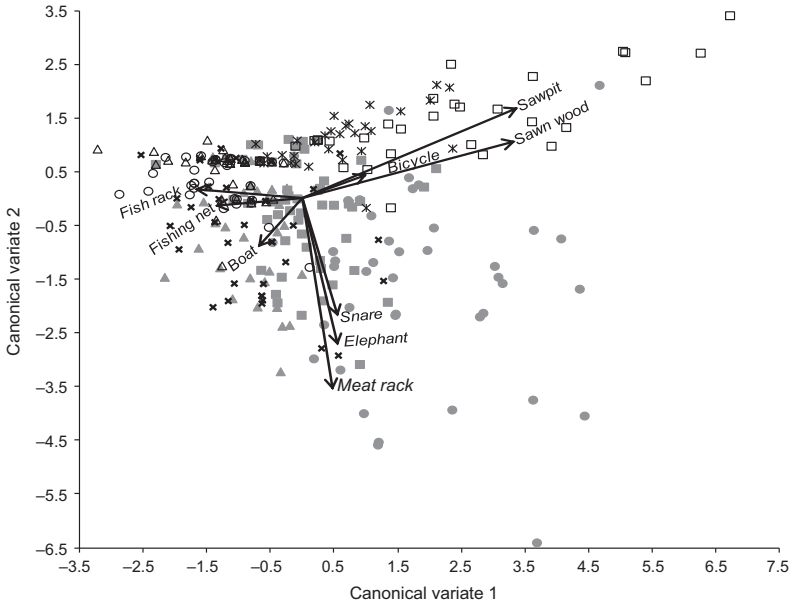

Fig 3 Biplot from a canonical variate analysis showing the distribution of poaching signs across different antipoaching units. Coordinates of poaching signs were multiplied by 5. Different symbols represent antipoaching units. Antipoaching units at Ugalla west hunting block: grey squares, Muhuba; grey circles, Msima; grey triangles, Siri and crosses, Luganzo. Ugalla east hunting block: open squares, Kakoma; open circles, Isimbira; open triangles, Ugalla and asterisks, Kamakala

Table 2 Latent vectors (loadings) of different poaching signs (for the first 3 axes) encountered in Ugalla Game Reserve

	Axis		
Item	1	2	3
Animal remains	0.0442	−0.2815	−0.119
Bicycle	0.2045	0.0874	−0.2804
Boat	−0.1384	−0.1822	0.2688
Elephant	0.1137	−0.5469	−0.0426
Fish rack	−0.3415	0.0361	0.4521
Fishing net	−0.2765	−0.0264	0.0169
Meat rack	0.0942	−0.7144	0.1351
Saw pit	0.6798	0.3368	−0.1242
Sawn wood	0.671	0.2142	0.0856
Snare	0.1131	−0.4391	0.0925
Eigenvectors	1.6048	0.8024	0.1479
Percentage variation	60.28	30.14	5.56

Illegal logging

Overall, logging signs were predominant in the reserve. Illegal timber harvesting is also a conservation problem in other miombo ecosystems in Tanzania (Luoga, Witkowski & Balkwill, 2000), and Africa as a whole (Matose, 1994; Colchester *et al.*, 2006). Much of the timber processing was performed by pitsawing as observed in Kitulanghalo Forest Reserve by Luoga, Witkowski & Balkwill (2000). Intensive logging can cause both forest fragmentation (Giliba *et al.*, 2011) and wildlife disturbance (Kinnaird *et al.*, 2003). Fragmentation creates habitat patches of different sizes, qualities and carrying capacities (Caro & Sherman, 2011). For instance, most of the wooded areas dominated by logging activities were fairly open and easily penetrable with our vehicle. Such openness is also likely to encourage bushmeat hunting through enhancing quarry visibility and poachers' access to areas with higher concentrations of wildlife.

Bushmeat signs

While all antipoaching units contained evidence of bushmeat hunting, a high concentration of the evidence was at Msima. This is probably because of the hunting pressure exerted on this part of the reserve by refugees from the Katumba camp on the periphery of the reserve and villagers most of whom reside close to the reserve's boundaries (UGR, 2006; Wilfred & MacColl, 2010). A study on the relationship between refugee livelihoods and bushmeat hunting by Jambiya, Milledge & Mtango (2007) acknowledged that refugees resettled near wildlife areas intensify poaching and increasingly jeopardize the survival of wildlife populations.

Frequently encountered bushmeat signs were meat-smoking racks. Smoking bushmeat is traditional bushmeat preservation for subsistence and commercial use as also reported in Central Africa, Cameroon and Congo (Alliance, 1998). The encountered animal remains belonged to those

animals escaped while injured (G. Mwanakusha, pers. comm.). Although we cannot discard the possibility that some of the animals may have died of natural causes, the remains were thoroughly inspected by experienced rangers to satisfy ourselves that the animals were actually shot by poachers. The case of elephants was easier as most of them had their tusks removed. Elephants are normally hunted for their ivory (Blake *et al.*, 2007) and sporadically for bushmeat (Barnes, 1996). When wildlife hunting in western Tanzania is considered to be mainly for subsistence (Carpaneto & Fusari, 2000), the observation of elephant remnants suggests that some wildlife species are hunted for commercial purposes.

The rate of encountering wire snares was the lowest in the reserve. Snares were usually concealed to prevent detection by rangers and animals (G. Mwanakusha, pers. comm.); therefore, we acknowledge the possibility that they might have been under-detected. Nonetheless, Carpaneto & Fusari (2000) reported that gun-hunting is the most preferred bushmeat hunting technique in western Tanzania. Elsewhere, for example, in Serengeti (Hofer *et al.*, 1996; Kaltenborn, Nyahongo & Tingstad, 2005; Holmern, Muya & Roskaft, 2007), Central African Republic (Noss,1998) and Gonarezhou National Park in Zimbabwe (Gandiwa, 2011), snaring is a preferred method of bushmeat hunting.

Illegal fishing signs

Fish poaching signs were encountered at Kamakala, Ugalla and Isimbira antipoaching units in Ugalla east, and Siri, Msima and towards Luganzo in Ugalla west. Fishing nets and boats were frequently observed within 500 m from the rivers, whereas fish-smoking racks were located at least 500 m from the rivers. Racks were placed far from the rivers to avoid detection by patrolling rangers (G. Mwanakusha, pers. comm.).

In Ugalla, illegal fishing is not challenging compared with bushmeat hunting (UGR, 2006; Wilfred & MacColl, 2010), but this study reported a relatively high rate of illegal fishing signs. One reason behind this could be a large number of fishing nets recorded, and each fishing net was recorded as a separate observation. In cases where fishing nets were spotted in clusters, a single GPS location was taken per cluster, but individual nets were counted. Elsewhere, however, illegal fishing is said to threaten fish stocks; for example, Kainji Lake National Park in Nigeria (Ijeomah, Ogogo & Ogbara, 2013) and Lake Victoria Basin (Mitullah, 1999; Henson, Brouder & Mitulla, 2000; Odada *et al.*, 2004).

Additionally, within the reserve, legal subsistence fishing was allowed in dry seasons as a way of minimizing illegal fishing and bushmeat hunting, and the conditions for obtaining fishing licences from the Ugalla Game Reserve office in Tabora were flexible (UGR, 2006). Legal fishing activities were taking place at few official camps adjacent to the rivers; thus, fishing signs around these camps were ignored.

Conservation implications

Results from the analysis of spatial distribution of poaching signs indicate that either different types of natural resources vary spatially, or some parts of the reserve are infrequently and inconsistently patrolled. For example, it has been reported that in rainy seasons, remote places suffer from poaching as antipoaching patrols are constrained by muddy and hardly passable roads (WD, 1998; FCF, 2008). While this study addresses patterns of spatial – but not temporal – variation of poaching signs, perhaps future studies should try to compare poaching signs against arrest locations of poachers in dry and wet seasons to address both the spatial and temporal factors influencing antipoaching efforts.

The distribution of poaching signs is also a reflection of socio-economic motives behind poaching. For example, the concentration of logging at Kakoma might be perpetuated by the distance from users' settlements, livelihood status of local communities, economic value of timber and demand for timber products. On balance, this survey acts as a preliminary effort towards tackling the following critical question: what should be done to control poaching in Ugalla?

Fishing as a viable alternative to bushmeat hunting has been acknowledged by a number of researchers (for example, Wilkie & Carpenter, 1999; Brashares *et al.*, 2004; Wilkie *et al.*, 2005; Nyahongo *et al.*, 2009). Therefore, the observed frequency of bushmeat signs regardless of the presence of legal subsistence fishing is suggestive evidence that bushmeat is one of the most important conservation problems Ugalla Game Reserve is facing. We think that further research is required to evaluate the relevance of legal fishing in bushmeat hunting.

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