EXPLORING DIFFERENCES AMONG ILLEGAL ACTIVITIES IN THE UGALLA GAME RESERVE OF WESTERN TANZANIA

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ABSTRACT

Conservation efforts in Tanzania rarely assess the extent to which different resource user activities are related. This study aimed to explore the differences among various illegal activities occurring in Ugalla Game Reserve, western Tanzania. The study used a combination of ranger–collected data, from 2003 to 2010, and foot surveys of illegal activity signs in the reserve. Illegal activity signs were recorded for five different types of offence: illegal fishing, bushmeat hunting, illegal logging, other activity (any sign that indicated any other type of unauthorised user presence) and honey gathering. The most frequent activity was logging (602 signs; 58% of offenders arrested), followed by bushmeat hunting (106; 25%). Illegal activity signs varied spatially across the reserve ($F_{4, 563.9} = 11.50$, $p < 0.001$; GLMM). For example, loggers seemed to concentrate their activities at East Ugalla more than West Ugalla, whereas hunters mostly performed their behaviour in the southern Ugalla. Saws, guns, fishing nets and other personal belongings were used for resource extraction. The analysis of confiscated illegal resource user belongings suggested little overlap between illegal activities. The first three axes of a canonical variate analysis clearly separated each of the types of illegal resource user belongings from every other type. On balance, different types of illegal activity are concentrated in specific areas within the reserve; and offenders used different methods to conduct these activities, which present a different level of threat to conservation efforts. Thus, anti–poaching patrols should consider the nature and distribution pattern of each illegal activity separately to devise more effective ways of controlling them. Indeed, more work is still needed to well understand key drivers of resources exploitation and the governance context framing the management of Ugalla.

Keywords: western Tanzania, illegal activities, illegal resource user belongings, illegal activity signs

INTRODUCTION

Illegal exploitation of natural resources presents a significant threat to Protected Areas (PAs) across Africa (Milner-Gulland and Rowcliffe 2007). In central/western Africa, for example, illegal bushmeat hunting has reached a crisis level and the wildlife populations cannot support sustainable off-take levels for different species (Noss 1998, Oates *et al*. 2000, Milner-Gulland *et al.* 2003, Wright and Priston 2010). Use of forest products (mostly through commercial logging and charcoal burning) has had a noticeable impact on miombo woodlands in Africa south of the Sahara (Mkanta and Chimtembo 2002). Illegal fishing is also common in PAs, for example, in the Gonarezhou National Park of Zimbabwe (Gandiwa *et al*. 2012). Quite often, resource exploitation is considered as a general use of whatever natural resources are perceived to be valuable by people living in poverty around PAs (Taylor and Dunstone 1996, Davies and Brown 2007). Nonetheless, it is important to be able to determine the level of organisation and/or the need for a particular resource such as protein or wood so that

appropriate measures may be taken to halt its use (e.g. Kaltenborn *et al*. 2005).

Across the world, law enforcement is considered one of the most effective ways of preventing illegal exploitation of natural resources within PAs (e.g. Hilborn *et al*. 2006). Here, the purposes of law enforcement are to deter illegal activities and to make offenders bear responsibility for their actions (Milner-Gulland and Rowcliffe 2007, Fischer 2008, Jachmann 2008). Deterrence may differ widely depending on the severity of the infraction (Holmern *et al*. 2007) and the type of illegal activity (e.g. illegal logging, bushmeat hunting, fishing and honey gathering). For instance, wildlife poaching within a protected area by villagers living on the periphery may require a very different policing and management response than the incidental hunting of bushmeat by organised illegal commercial loggers. However, ranger patrols are often generalised and rarely take into account differences between the different types of illegal activities. As a result, law enforcement efforts may fail to effectively control the underlying causes of the problem (Plumptre *et al*. 2014).

In order to develop and implement effective law enforcement strategies, PA managers require in depth understanding of illegal resource users and the nature of their activities (Plumptre *et al*. 2014). This may include understanding the nature and distribution of signs left behind by illegal resource users to determine the presence and intensity of illegal activity (Campbell and Loibooki 2000, Blom *et al*. 2004, Milner-Gulland and Rowcliffe 2007). In the Neotropical forests of Panama, for instance, illegal activity signs like poachers' tracks, poacher sightings, shot-gun shells and poachers' camps were used to determine the presence and intensity of poaching activities (Wright *et al*. 2000). Ranger–collected data can also be used to explore the distribution and trends of illegal activities in PAs (Critchlow *et al*. 2015).

In the Ugalla Game Reserve of western Tanzania, law enforcement patrols, undertaken in collaboration with hunting companies, are the main approach to controlling illegal activities. These are carried out in three tourist/trophy hunting blocks, namely, East Ugalla, South Ugalla and North Ugalla, and record information about resource users and exploited natural resources. Despite significant law enforcement effort, illegal resource use still challenges protection of the reserve. Whilst studies elsewhere in Tanzania have shown how important ranger–collected data can be for informing law enforcement and monitoring programs (e.g. Holmern *et al*. 2007, Knapp *et al*. 2010), information collected by ranger patrols in Ugalla has remained largely unexploited. To inform anti–poaching efforts in Ugalla, this study combined ranger–collected data with foot surveys of illegal activity signs to determine the differences among illegal activities and their spatial distribution within the reserve. This would ensure more focussed law enforcement efforts, which in turn would help discern the magnitude of the impact suffered by different natural resources. The ranger–collected data used in this study were recorded as coming from the West Ugalla and East Ugalla hunting blocks (hereafter hunting sites), before the former was divided (during the period 2010 to 2012) to create the North and South Ugalla hunting blocks. Thus, the study analysed both ranger–collected data and illegal activity signs with respect to East Ugalla and West Ugalla hunting sites, for methodological convenience.

METHODS

Study area

This study was carried out in Ugalla Game Reserve (Fig. 1). The reserve (about 5000 km^2) lies between Urambo, Sikonge and Kaliua districts in Tabora Region and Mpanda and Nsimbo districts in Katavi Region in western Tanzania. The area has a tropical climate with rainy season (December – May) and dry season (June – November). Vegetation is predominantly miombo woodland; other natural resources are also present including fish, wildlife and wetlands. Uncontrolled natural resource use can be traced as far back as 1950s, when local people were allowed to extract natural resources to support their livelihoods. It was not until 1965 when the area was gazetted as Ugalla Game Reserve that human activities were restricted (Fisher 2002).

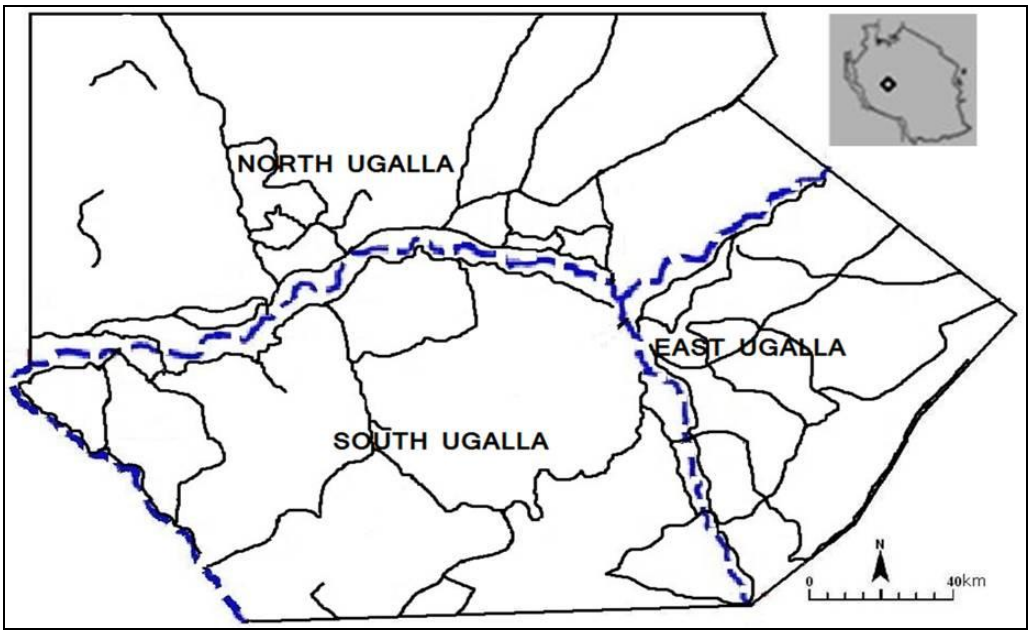

Figure 1: Ugalla Game Reserve showing major and minor roads used by enforcement patrols. Approximate locations of the tourist hunting blocks, namely North Ugalla, South Ugalla and East Ugalla are shown. Meandered broken lines show the main rivers. Insert shows the location of the reserve in Tanzania

Offence records

Data on offenders arrested for illegal resource extraction in Ugalla Game Reserve were obtained from the Ugalla Game Reserve Project Office based in Tabora. All data were collected by ranger patrols at the time of arrest. The dataset spans the period from 2003 to 2009, and captures the following information: description of the offence (e.g. illegal logging, hunting, fishing, and illegal entry (resource users arrested for illegally entering Ugalla reserve, but not associated with timber, bushmeat or fish exploitation)), date of incident, offenders belongings and offence location (usually recorded at the level of site). No

data were collected on patrol effort, however, law enforcement strategies did not change in any substantial way between 2003–2009 (Sembejo, F., pers. comm.).

Foot surveys of illegal activity signs

Line transects to survey for illegal activity signs were conducted from early June to late October 2013 in the East Ugalla and West Ugalla hunting sites. Five roads were randomly selected from patrol roads in each hunting site. Six pairs of transects were marked at 3000 m intervals along each road. Transects began at the centre of the road and extended 1500 m in opposite directions at an angle perpendicular to the road. Transects were walked from 0800 hrs to 1700 hrs with a one hour interval from 1200 to 1300 hrs. Only illegal activity signs less than five years old were recorded. This was to ensure surveys only captured data on current exploitation pressure. All surveys were carried out by Ugalla game rangers. Each ranger had experience finding and identifying illegal activity signs in the reserve and was able to competently recognise and discard older signs. Illegal activity signs were recorded for five different types of offence: illegal fishing, bushmeat hunting, illegal logging, other activity or unauthorised human presence (any sign that indicated any other type of unauthorised resource user presence) and honey gathering. The location of each illegal sign was recorded using a handheld global positioning system unit (Garmin GPSMAP® 60Cx). When signs of the same illegal activity were less than 10 m apart, the location was recorded at the approximate geometric centre of the signs, but each individual sign was counted except signs sighted as piles; for example, piles of sawn timber.

Statistical analysis

All statistical analyses were conducted in GenStat Discovery Edition 4 (VSN International Ltd., Hemel Hempstead, U.K.). A generalised linear model with normal errors was used to test for the effect of factors associated with offenders arrested for illegal resource use. The response variable 'number of offenders was square root transformed in order to achieve normality. The tested predictors were: illegal activity, year, hunting site, month arrests were made, hunting site x illegal activity, month x illegal activity, and year x illegal activity. The fixed terms were dropped in the ascending order of their F-values until the minimum adequate models were obtained. To examine the differences among illegal activities, a canonical variate analysis (CVA) was used (Shaw 2003). Only the first three axes or dimensions (canonical variate (CV) 1, CV2 and CV3) were extracted, representing much of the variation in the types of illegal activities. Then bi-plots were generated using resulting scores of the dimensions along with co-ordinates or loadings of selected illegal resource user belongings. The bi-plots were useful in showing the degree with which certain illegal resource user belongings or resource extraction gears were related to their respective illegal activity types, and whether there was a distinct separation between them.

A generalised linear mixed model with a binomial error structure and a logit link function was used to examine variation in the number of illegal activity signs across illegal activities and hunting sites. The binomial total was the number of illegal activity signs per road. The fixed model included the effects hunting site, illegal activity and their interaction (hunting site x illegal activity), predictor variables. To account for non–independence in spatial location for the 'illegal activity signs'

variable, 'transect' was nested within 'road' to form the random effect model road/transect. Significance of the random effect was assessed using a likelihood ratio (LR) test (Galwey 2006). The LR test enabled the comparison of the difference in the deviance of the reduced model, without the random effect, and the deviance of the full model to a Chi-square distribution with the appropriate degrees of freedom. The minimum adequate model was obtained by the sequential elimination of non-significant effects. Significance of fixed effects was assessed by Wald F tests. The significance level for all statistical tests was set at 5%.

RESULTS

Offenders arrested for illegal natural resources use

Nine hundred and forty-four arrests were made in Ugalla Game Reserve for illegal activities between January 2003 and October 2009. Most of arrests were for logging, followed by bushmeat hunting, and fishing (Table 1; Fig. 2). The type of illegal activity for which offenders were arrested for varied between hunting sites (Table 1). For example, at East Ugalla more arrests were made for illegal logging than West Ugalla. Conversely, West Ugalla had more arrests for bushmeat hunting than East Ugalla (*see* Fig. 2).

Table 1: General linear model output showing factors associated with numbers of offenders arrested in Ugalla Game Reserve (western Tanzania) in the years 2003 to 2009.

	F-value	d.f. (change, residual)	Probability
Illegal activity	5.24	3,182	0.002
Year	6.46	1,180	0.012
Hunting site	1.44	1,179	0.232
Hunting site x Illegal activity	4.21	3,178	0.007
Month	1.64	11,175	0.091
Year x Illegal activity	0.47	3,164	0.702
Month x Illegal activity	0.79	31,169	0.779

Offenders' belongings and gears

Offenders' belongings were grouped into 12 categories (Table 2). The loadings (coordinates) of the 12 categories of offender belongings along the first three dimensions (axes) from the canonical variate analysis are shown in Table 2. The two dimensional ordinations from the analysis show distinctly different aggregates, with offenders arrested for each illegal activity likely to have specific belongings (Fig. 3). For example, people arrested for hunting were more likely to possess automatic or modern guns, muzzleloaders, and knives (Fig. 3*a*), whereas illegal fishers possessed knives, and specialist fishing gears including nets and hooks; whilst loggers usually carried saws (Fig. 3*b*). The first axis (canonical variate 1 (CV1)) in Fig. 3*a* separates loggers from bushmeat hunters, and offenders arrested for illegal entry into the reserve, most of whom had digging equipment (hoes and spades). The second axis (CV2) represents the difference between hunters and others, namely loggers and those arrested for illegal entry into the

reserve. In Fig. 3*b*, the third dimension (CV3) separates illegal fishers from other types of resource users, and CV2 separates loggers from people who poached for protein (fish and bushmeat users).

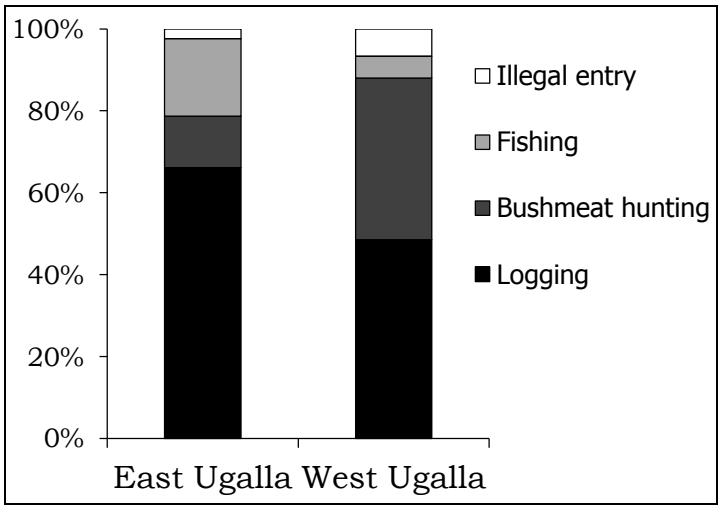

Figure 2: Percentage of arrests in each hunting site, determined by illegal activity (n = 944).

Table 2: The main classes of belongings confiscated from offenders arrested for illegal resource use, with their contribution to latent vectors (loadings) for the first 3 axes. Ugalla Game Reserve (western Tanzania); 2003–2009.

	Axis		
Item	1	2	3
Gun	0.2186	-0.248	-0.3856
Fishing net and hook	0.0364	-0.1875	0.6933
Hoe and spade	0.9716	0.6355	-0.1513
Knives	0.3603	-0.373	0.3485
Muzzleloader	0.2478	-0.3853	-0.4525
Pots and buckets	-0.0297	0.0597	0.015
Saw	-0.5656	0.5887	-0.292
Sharpening equipment	-0.1061	0.0129	0.0173
Radio and watches	-0.0892	0.1346	0.0723
Torches	-0.0902	-0.2466	-0.3331
Bicycle	-0.3655	-0.0287	-0.0871
Axe	-0.0805	-0.1411	-0.2764
Eigenvectors	0.7816	0.473	0.1848
Percentage variation	54.30	32.86	12.84

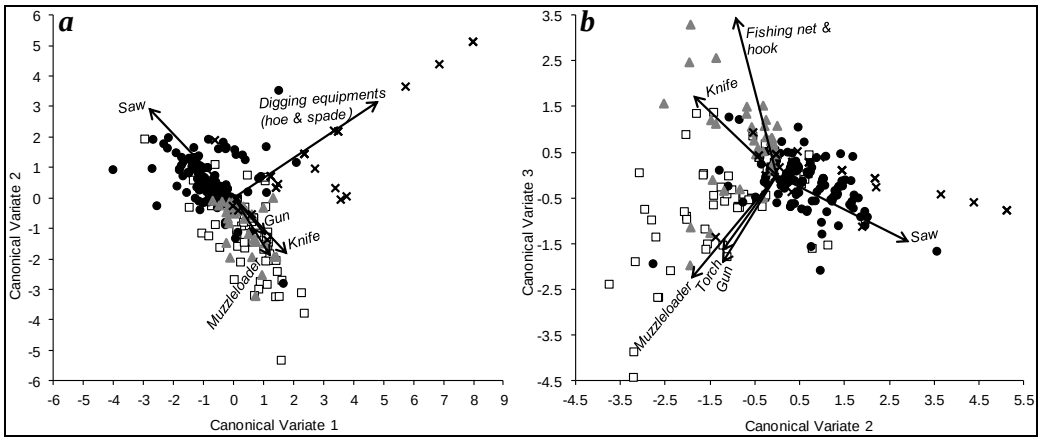

Figure 3: Biplots showing offenders' belongings with higher and lower loadings along axes 1, 2 and 3. Coordinates of belongings were multiplied by 5. Dark filled circles represent loggers, grey triangles represent illegal fishers, open squares represent bushmeat hunters, and crosses symbolise offenders arrested for illegal entry. Ugalla Game Reserve (western Tanzania); 2003–2009.

Spatial distribution of illegal activity signs

Nine hundred and seventy-four signs of different illegal activities were recorded during the line surveys (Table 3; Fig. 4). The number of illegal activity signs varied significantly between roads (LR test: χ^2_1= 8.13, P = 0.002, variance component estimate ± S.E. = 0.336 ± 0.164), but there was no significant effect of transect on the number of signs (LR test: χ^2_1 = 1.65, P = 0.099, variance component ± S.E. = 0.058 ± 0.063). Therefore, data from transects on each of the survey roads were pooled. Illegal activity predicted the number of signs ($F_{4, 563.9}$ = 11.50, P < 0.001; Fig. 5). Illegal logging (*n* = 602) consistently had the highest number of signs encountered relative to the other four illegal activities, whereas illegal fishing (n = 8) was lowest. Honey gathering (*n* = 151), other activity (*n* = 107) and bushmeat (*n* = 106) were somewhat intermediate between the other types of illegal activities. The variation in illegal activity signs between illegal activities was consistent across hunting sites (illegal activity x hunting site: $F_{8, 564.3}$ = 3.59, P < 0.001; Fig. 5). For example, although eastern Ugalla had the highest number of logging signs in the reserve, logging was the dominant activity at each of the hunting sites. There was no significant effect of hunting site on the number of illegal activity signs ($F_{2, 9.7}$ = 3.60, P = 0.068).

Table 3: Illegal activity signs encountered in Ugalla Game Reserve in western Tanzania in 2013. Activities are listed under broad categories of illegal activity in decreasing number of signs (*n*). Where signs have the same *n*, alphabetical order is followed.

Illegal activity	Description	*n*
Honey gathering		
Tree felling	Trees felled to extract honey from the tree trunk	69
Tree stump	Tree stumps of trees felled to extract honey	55
Debarked trees	Debarked tree trunks, barks used for bark hives	26
Bark hive	Piles of local beehives made out of tree barks	1
Other activity		
Young trees cut	Pole–sized trees cut for building camps or smoking racks	51
Track	Illegal resource users' footpaths and bicycle tracks	39
Bark–stripped trees	Trees bark–stripped by illegal resource users	10
Water ponds	Hand–dug shallow ponds	3
Fire place	Abandoned fire place	2
Human belongings	Collection of belongings other than exploitation gear	2
Logging		
		23
Tree stump	Tree stumps of trees cut–down by loggers	3
		18
Tree felling	Trees felled by illegal loggers	2
		10
Logs	Abandoned piles of logs	6
Sawpit	Dug–out pits to facilitate timber sawing	38
Planks	Abandoned piles of wooden planks	31
Timber	Piles of sawn timber	8
Illegal resource user camps	Abandoned timber illegal resource users' camps	4
Fishing		
Piles of boat material	Material for making traditional fishing boats	5
Illegal resource user camps	Illegal fishermen's camps	1
Fish basket	Locally made fish baskets	1
Fish rack	Wooden racks used for smoking fish	1
Bushmeat		
Meat rack	Wooden racks used for smoking meat	59
Illegal resource user camps	Bushmeat illegal resource users' camps	24
Elephant remains	Remains of African elephants killed by illegal resource users	16
Giraffe remains	Remains of Giraffes killed by illegal resource users	5
Barrier/Snare	Wooden animal barriers with snares set at the outlets	2
		97
Total		**4**

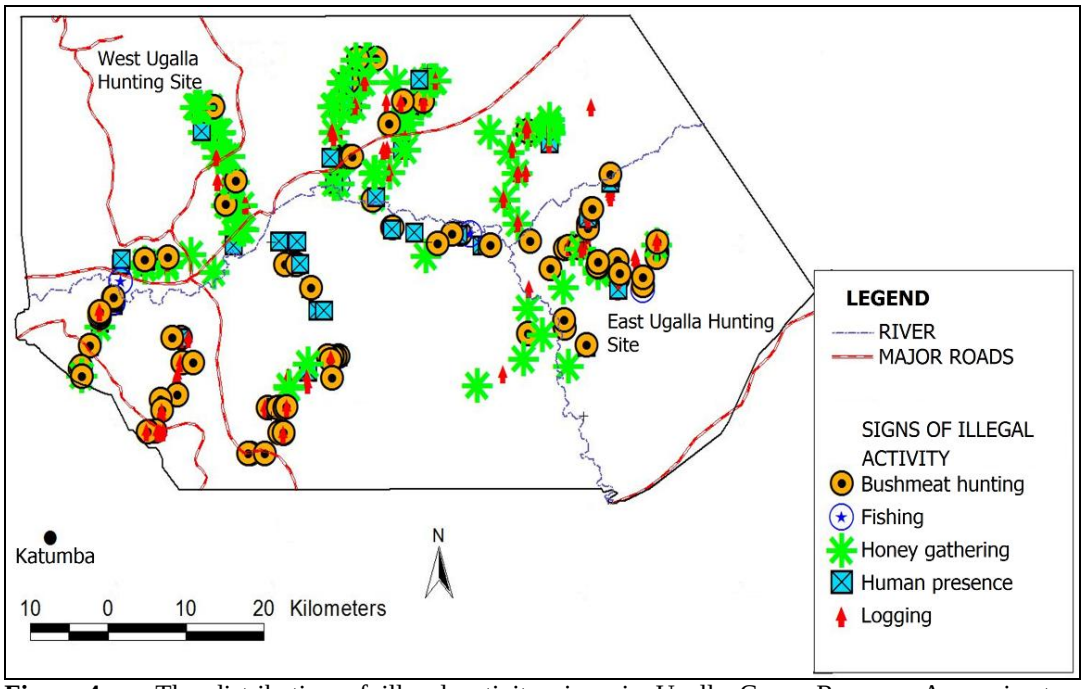

Figure 4: The distribution of illegal activity signs in Ugalla Game Reserve. Approximate locations of East Ugalla and West Ugalla hunting sites are shown. Katumba area in which the refugee camps (mentioned in the text) are located is also shown.

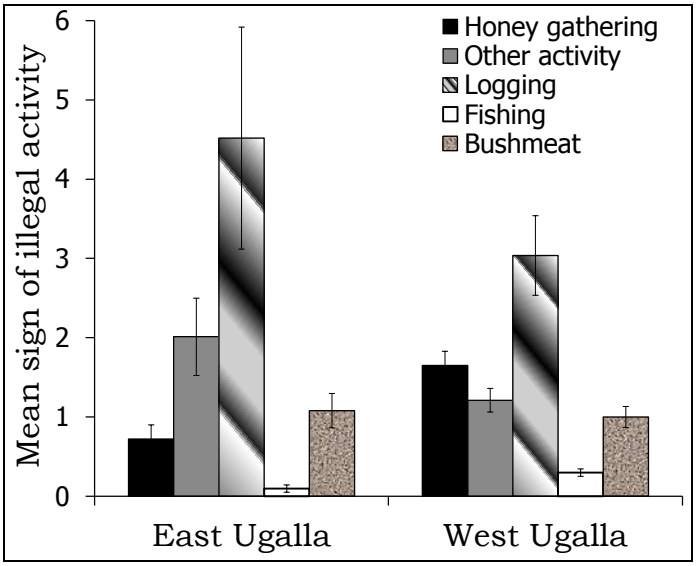

Figure 5: The mean number of illegal activity signs recorded for each illegal activity, displayed by hunting site. Error bars represent the standard error of the mean.

DISCUSSION

This study explored illegal activities in Ugalla Game Reserve, western Tanzania, through an extensive survey of illegal activity signs combined with ranger-collected arrest records. The study found that logging, bushmeat hunting and fishing were specialist activities that were largely independent of each other. The canonical variate analysis (CVA) showed a clear separation of the above illegal activities, based on confiscated resource user belongings. The first canonical variate accounted for 54% of the variation among the activities, the second 33%, and the third 13%. Bushmeat hunting equipment had noticeably high loadings along CVA1 (guns–CVA1 loading 0.2186, and muzzleloaders–CVA1 loading 0.2478), whereas logging equipment (saws) had the highest loading along the second canonical axis (0.5887) and fishing gears (nets and hooks) loaded highly on the third axis (0.6933).

Whilst no offenders were arrested for honey gathering in Ugalla between 2003 to 2009, the line survey of illegal activity signs suggested a significant level of honey gathering activity. This is worrying because often illegal gathering of honey involved felling the entire tree to extract the honey. The felled trees were seen with a hole on one side of the trunk made to facilitate the removal of honey (Fig. 6*a*). The trees constituted 23% of all illegally cut trees encountered. In other ecosystems in Africa studies have also shown that honey gathering destroys a considerable number of forest trees (e.g. Zolho 2005, Mandondo et al. 2008, Manyatsi and Mbokazi 2013). A rigorous socio-economic survey would estimate the prevalence of honey gathering and its relationship with other forms of illegal resource use.

Both offence records and line surveys suggest that offenders in Ugalla are knowledgeable about how and where to carry out their activities. For instance, more arrests were made for bushmeat hunting atWest Ugalla than East Ugalla suggesting bushmeat hunting opportunities are better here (18% of poachers arrested during 2003–2009). Most of the hunters used locally made guns (muzzle loaders), supporting findings from elsewhere in the region (Carpaneto and Fusari 2000). Discussions with game rangers revealed whilst logging was widespread among local communities and required little expertise, bushmeat hunting was conducted by relatively few local hunters (known as 'Fundi' in Kiswahili) who were experienced marksmen. Often hunters would be accompanied by their colleagues whose tasks were to smoke the meat and carry it outside the reserve. The use of guns as a dominant means of hunting makes poachers in Ugalla different from those in other ecosystems, for example, in the Serengeti bushmeat hunters typically use 'wire snares' (Hofer et al. 1996, Kaltenborn et al. 2005, Holmern et al. 2007). A study of discrepancies in wildlife poaching gears/techniques between Ugalla and other ecosystems, and resultant implications for conservation would contribute valuable knowledge towards lessening wildlife poaching activities in western Tanzania.

Illegal hunting was evident from the distribution of meat smoking racks (Fig. 6*b*), mostly in the southern Ugalla. Two possible explanations for this are: first, bushmeat hunting in Ugalla is more frequently conducted in wet season when there is poor anti–poaching patrol coverage. Patrolling the southern part of Ugalla is very hard in rainy seasons as the area becomes almost isolated

from the rest of the reserve as rivers flood and roads become impassable (Sembejo, F., pers. comm.). Secondly, southern Ugalla is vulnerable to illegal hunters, with automatic guns, from Katumba (one of the refugee–hosting areas in western Tanzania) (Wildlife Division 1998, Ugalla Game Reserve 2006). A study on the relationship between refugee livelihoods and bushmeat hunting by Jambiya et al. (2007) acknowledges that protected areas close to 'refugee–hosting areas' suffer higher wildlife poaching incidents.

Logging activity was most frequently concentrated at East Ugalla, a trend also reported by Wilfred and MacColl (2014). Presence of illegal logging was identifiable from cut tree stumps, which were most numerous at East Ugalla. This fits with offence records, which showed that the majority of arrests at East Ugala were for illegal logging (36% of arrests during 2003–2009). Spatial variation in the distribution of logging activities within a protected area has also been reported elsewhere in the Udzungwa Mountains of Tanzania (Marshall 2007). The scale of logging and the nature of the logging signs (Fig. 6*c*,*d*; pers. obs.) suggested the presence of organised commercial logging in the study area. According to Wilfred (2012) logging in Ugalla involves wealthy people from nearby Mpanda and Tabora town centres as well as other major cities in Tanzania, who provide equipment, transport and payment to local people to log trees.

Although it is known that illegal fishing is a problem in protected areas (e.g. Gandiwa et al. 2012), in this study it appeared far less common than logging and hunting. This disagrees with an earlier survey by Wilfred and MacColl (2014), which reported a high frequency of illegal fishing in Ugalla Game Reserve, particularly along rivers. Whilst a substantial number of arrests were made for other behaviours like illegal entry into the reserve (3% of all arrests), offenders could not be associated with specific types of illegal activities.

Figure 6: Sample illegal activity signs in Ugalla, western Tanzania: *a* = honey gathering (encircled is a hole made to remove honey from tree trunk); *b* = bushmeat smoking rack; *c* = sawpit and illegal loggers' camp (the game rangers were field assistants); *d* = cut logs. All photos were taken by the author in 2013.

Taken together, the preceding analysis leads to two broad conclusions. Firstly, different types of illegal activity occupy different spatial niches in the landscape, with certain activities concentrated in specific areas. Offenders used very different methods to conduct these activities which present a different level of threat to conservation efforts. This suggests ranger-patrols need to consider the nature of the activity and the habitat in which it is most likely to be carried out when developing future patrolling strategies.

Secondly, deterrence of some of the behaviours such as commercial logging may not be effective simply by confiscating resource user belongings or apprehending poor villagers hired to work as loggers in the reserve. There must be a means of identifying and dealing with 'power sources' or owners of such businesses.

It is, nonetheless, important to be explicit here that, from the present findings, it is quite clear that Ugalla still needs research. For example, further research should be ground truthed with socio-economic surveys to be able to estimate the drivers and prevalence of illegal behaviour and explore whether conservation authorities have the governance capacity to control the problem. In addition, exploration of factors determining the variations in the conservation enforcement patrol frequencies and efficiency in terms of spatial coverage, encounters, arrests or deterrence, would tell us more about what sort of conservation enforcement measures work best.

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