

**Title:** Resource managers' and users' perspectives on factors contributing to unauthorised hunting in western Tanzania

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44 The data that support the findings of this study are available from the corresponding author upon  
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## **Abstract**

Unauthorised use of natural resources is one of the challenges facing protected areas in Africa. Understanding factors influencing this behaviour can help improve the efficiency of conservation efforts. We conducted focus group discussions with authorised resource users and managers in the Ugalla ecosystem of western Tanzania to determine factors facilitating and motivating unauthorised hunting. The two groups of study participants had different perspectives on the subject. Resource managers dwelt on factors facilitating hunting, for example, inadequate patrol resources and impassable patrol roads. On the other hand, resource users discussed both motivating factors, for example limited income-generating opportunities; and facilitating factors, some of which were also mentioned by resource managers (for example, poorly managed hunting cases). There was also variability in how study participants perceived the importance of different factors. Some factors were perceived as highly important but mentioned less frequently and others were mentioned often but ranked low. Some were mentioned by both resource managers and users with the same frequency but ranked differently (for example, the management of unauthorised hunting cases). Overall, we suggest considering the views of people with different interests in natural resources to comprehensively understand the factors that influence unauthorised hunting for improved conservation outcomes.

**Keywords:** focus groups, rainy season, ranger patrols, poverty, unauthorised hunting, Ugalla

## 1 INTRODUCTION

Unauthorised hunting of wildlife is a common phenomenon in many African countries. It can take different forms, including: *a*) local people entering protected areas illegally to hunt wild animals for bushmeat, cultural reasons, medicinal purposes, and the small-scale bushmeat trade (Griffiths, 2018); *b*) high level commercial hunting for domestic and international wildlife trades (Price, 2017); and *c*) invisible unauthorised hunting in legal hunting systems as a result of poor supervision, abuse of hunting quotas by hunters who deliberately remove animals over and above their specific quotas and shoot animals that do not meet the specified quarry attributes (Caro & Davenport, 2016; Wilfred, 2019).

Unauthorised hunting is not usually carried out in accordance with the practices of sustainable hunting. For example, it is characterised by significant levels of overhunting that can deplete species to very low numbers and drive others to extinction (Bouche' et al., 2011; Chase et al., 2016). It is also said to cause behavioural disruptions and sex biases in target species (Corlatti et al., 2019). Therefore, controlling unauthorised hunting has remained at the centre of efforts to achieve sustainable conservation (Henson et al., 2016; Massé, 2020). Various approaches have been employed to deter unauthorised hunting; the most common ones include ranger patrols where wildlife rangers search and hold unauthorised hunters accountable for their illegal behaviours (Henson et al., 2016; Moore et al., 2018; Belecky et al., 2019), and integrated conservation and development interventions where conservation efforts take into account interests of local people (Harrison et al., 2015a; Jones et al., 2019). In order to target these approaches and ensure their effectiveness, conservation research has sought to identify factors underlying unauthorised hunting (Harrison et al., 2015a; Travers et al., 2019). Generally, to better understand factors driving unauthorised behaviours, it is advisable to classify them into those which motivate people to perform a particular unauthorised behaviour and those that facilitate or create opportunities for the behaviour (Oyanedel et al., 2020).

A great many researchers have had a long-standing interest in understanding the nature of unauthorised hunting (e.g. Ndibalema & Songorwa, 2008; Moore et al., 2018; Milner-Gulland et al., 2020). The focus has been on understanding which factors contribute to unauthorised hunting mostly from the point of view of communities around areas of conservation importance. However, when such factors are also sought from the viewpoint of people who are responsible for preserving, guarding, and protecting wildlife, and those who directly and legally use it, this could be highly conducive to understanding different views of the causes of the problem, and contributing towards a body of knowledge that seeks to strengthen conservation governance in Africa (for example, Moreto & Lemieux, 2015).

Research on factors driving unauthorised hunting in Tanzania has paid little attention to the western part of the country despite the fact that the area has a number of key protected areas. The

national parks (e.g. Katavi and the newly created Ugalla River National Park) are fully protected through the Tanzania National Parks Authority (TANAPA); the game reserves (Ugalla, Rukwa, Luganzo, and Lwafi), for trophy hunting and permitted subsistence use, are administered by the Tanzania Wildlife Management Authority (TAWA); and partially protected areas surrounding protected areas where both subsistence activities—e.g. resident hunting, fishing, beekeeping and restricted human settlements—and trophy hunting take place under the permitting system of TAWA and the district governments. Previous studies in western Tanzania have explored local community perceptions of illegal behaviours in conservation (Wilfred et al., 2017). Therefore, the present study sought to build upon these earlier studies by identifying factors contributing to the persistent unauthorised hunting from natural resource managers' and authorised users' perspectives. Specific objectives of the study were two-fold: first, to determine the distribution pattern of unauthorised hunting using ranger patrol data generated by Spatial Monitoring and Reporting Tool (SMART); and second, to identify facilitating and motivating factors for unauthorised hunting as described by resource managers and users.

## 2 METHODS

### 2.1 Study area

Ugalla Game Reserve (hereafter Ugalla) spans the Tabora and Katavi regions and was gazetted as a game reserve in 1965 (Fisher, 2002). In 2019, the government of Tanzania redefined Ugalla's boundaries and expanded them to include partially protected areas to the south-east of the reserve, a decision that was justified on the basis of establishing a new protected area—Ugalla River National Park (3,865 sq. km.; Supplementary Material). As a result, Ugalla has increased from 5,000 to 7,646 sq. km. even though about one-third of the original reserve (the northern section) was taken by the national park (Fig. 1, Supplementary Material). One of the key reasons for establishing a new national park and extending Ugalla's boundaries was to enhance the protection of wildlife, habitat, and corridors. Western Tanzania hosts some crucial wildlife corridors in the country (Riggio & Caro, 2017). The area is also a vital part of the Malagarasi-Muyovosi Ramsar Site—a wetland of international importance (Kalumanga, 2015) which provides habitats for the endangered shoebill *Balaeniceps rex* and wattled crane *Bugeranus carunculatus* (John et al., 2013). Other habitat types in the area include the floodplains and relatively flat, grassy plains, and riverine forests (UGR, 2006). Ugalla is dominated by miombo woodland characterised by *Brachystegia* and *Julbernardia* (UGR, 2006). Rainfall is seasonal, with a wet season from January to May. The annual rainfall is approximately 700-1,000 mm, and the average temperature ranges from 15-30 °C (Mbwambo, 2003; Hazelhurst & Milner, 2007). Ugalla supports a variety of wildlife including African elephant *Loxodonta Africana*, African wild dog *Lycaon pictus*, hippopotamus *Hippopotamus amphibious*, and concentrations of other types of wildlife species (Wilfred & MacColl, 2016).

The human population in western Tanzania is increasing rapidly, and this intensifies pressure on wildlife and their habitat (Wilfred, 2018). Unauthorised hunting is the most important challenge (Piel et al., 2015; Wilfred et al., 2017). This has led to a decline in populations of different wildlife species in the area (Caro & Davenport, 2016; Wilfred & MacColl, 2016), and is also a key source of conflicts between conservation authorities and local communities (Wilfred et al., 2017). Ranger patrols have been the main approach to addressing unauthorised hunting (Wilfred et al., 2019); where rangers perform activities like searching for unauthorised hunters, investigating unauthorised hunting incidents, preventing and mitigating human-wildlife conflicts, and community engagement activities. TAWA rangers along with trophy hunting company rangers conduct patrols and supervise all types of permitted resource use within Ugalla. District game officers in collaboration with village game scouts (poorly trained and unarmed), and rangers from TAWA and trophy hunting companies, oversee legal resource use activities in partially protected areas.

## **2.2 Data collection**

To determine the distribution pattern of unauthorised hunting, we examined law enforcement data collected using SMART software from March 2016 to March 2019. Ugalla staff, in collaboration with trophy hunting companies, gathered information on unauthorised hunting while on patrol, including direct observation of signs of hunting (spotted or arrested hunters) and indirect observations (fresh hunting incidents and signs; for example, carcasses, hunter camps, bushmeat smoking racks, snares, aggregations of footprints), and time and Global Positioning System (GPS) coordinates of all observations. The observations reported in this study are only those encountered and recorded by patrollers in the course of tracking or searching for unauthorised hunters and other rule breakers in Ugalla. Further information about people arrested for unauthorised hunting included their names and villages. Locations of rangers during patrols were recorded at irregular time intervals to determine patrol coverage.

We conducted focus group discussions from May to July, 2019 with 4 groups of natural resource managers (Ugalla game officers and rangers, district game officers, and trophy hunting company rangers) and 6 groups of permitted resource users in Ugalla (fishers, beekeepers, and trophy hunting company staff) and adjacent partially protected areas (resident hunters) to determine factors influencing unauthorised hunting from a management and authorised user standpoint (Supplementary Material). Each type of resource user had a locally recognised association for defending their rights and interests and for managing membership. For ethical reasons, names of the hunting companies and local resource user associations have been removed from the main document and Supplementary Material. We asked resource managers to tell us factors that were responsible for the persistence of unauthorised hunting and what could be done to address the problem, based on their experiences in administering the management and use of natural resources. On the other hand, our interviews with natural resource users, who were

themselves local people, dealt with any factor that they thought motivated unauthorised hunting. This enabled us to appreciate the significance of the factors given by resource managers, and understand the resource users' perspective on hunting deterrents because their activities interacted with both the managers and unauthorised users. With the exception of the trophy hunting staff, almost all of the other types of resource user came from the villages surrounding Ugalla. Trophy hunting companies had their staff in Ugalla on long-term contracts thus making them highly knowledgeable about villagers and conservation activities in the area. Some of the staff were local people hired from the villages to help with activities like building hunting camps, cleaning, cooking, and skinning.

The number of focus group participants ranged from 4 to 20. Participants were divided into separate focus groups considering their different roles to keep the discussions relaxed, minimise superiority and inferiority complexes, and promote participation. The meetings lasted approximately 1 hour. All identified factors motivating or enabling unauthorised hunting that emerged during the discussions were free-listed and then ranked by participants according to the perceived importance of the factor. Each factor was discussed by group participants until consensus was reached on an agreed ranking; and relevant follow-up probing questions were asked to glean more information. Participants further discussed activities that could be carried out to address each of the identified factors.

### **2.3 Data analysis**

Law enforcement records were entered into Excel spreadsheets for frequency and percentage calculations. We calculated percentages of patrols, observations, and individual signs of hunting in dry and wet seasons to appreciate seasonal changes in deterrence and observations of unauthorised hunting. We used ArcGIS v. 10.1 (ESRI, 2012, Redlands, CA, USA) to map spatial distribution of patrols and observations in dry and wet seasons (*see* Wilfred et al., 2019 for details).

We performed salience analysis following Quinlan (2005) to determine the relative importance of the free-listed factors influencing unauthorised hunting as identified by the focus groups. We calculated a salience score for each factor according to focus groups, as follows; factors from each group were re-ranked in descending order of their previous ranks. The new ranks were divided by the total number of factors per group to obtain salience scores. Then the overall or cultural salience score ( $S$ ) for each factor was determined by averaging its salience scores across the number of focus groups depending on whether it was mentioned by resource users or managers. The overall scores ranged from 0 to 1. Whereas the factor that appeared to be the most important in each focus group received a salience score of 1, the opposite was true for the factor that was either less important or was not mentioned by every group. To gain more insight into the significance of the factors, we carried out a visual comparison by plotting the



frequency of mention of each factor against the rank when mentioned (Supplementary Fig. S6). We grouped common factors into facilitating, motivating, and intermediate factors (Fig. 2). Facilitating factors were factors that contributed to resource managers' inability to deter unauthorised hunting effectively, motivating factors were the ones which encouraged unauthorised hunting, and intermediate factors involved both types of process.

### 3 RESULTS

#### 3.1 Ranger patrols

Overall average days per patrol were 16.8, ranging from 5 to 39. Dry and wet season patrols had an average length of patrol per outing of 17.8 and 14.3 days, respectively. The number of days ranged from 5 to 19 (dry season) and 11 to 39 (wet season). Fifty-one patrols were recorded in the period from March 2016 to March 2019. Of these, 26 encountered signs of unauthorised hunting. Eighteen of the 31 patrols which were conducted in the dry season, and 8 of the 20 patrols in the wet season encountered signs of hunting. There was no significant difference between the seasons in the proportion of patrols that encountered signs ( $\chi^2 = 0.94689$ ,  $df = 1$ ,  $p = 0.3305$ ). Key informant interviews revealed that dry season patrols covered at least 90% of Ugalla. There were almost no patrols in the southern part of the reserve during the wet season, and patrol activities were instead concentrated along the rivers (*see* Supplementary Figs S2–S5).

#### 3.2 Observations of unauthorised hunting

A total of 98 observations of unauthorised hunting were made during the study period (Table 1); 7 were direct sightings of unauthorised hunters and 91 were indirect observations. The dry season had 69 observations of unauthorised hunting (6 direct and 63 indirect), and the wet season had 29 observations (1 direct and 28 indirect). The highest percentage of observations involved fresh hunter footprints which were tracked by rangers during patrols, followed by poaching trails, and poaching camps (Table 1). Unauthorised hunters normally set up temporary camps (identified by the presence of wooden hut and a meat smoking rack) where they spend hours or a few days to smoke the meat and get it ready for transportation from the reserve. Fresh smoking racks encountered without huts were recorded as separate observations. In almost all cases, there were more observations of a given type during the dry season than the wet season, but these differences were not statistically significant (Table 1).

##### 3.2.1 Factors contributing to unauthorised hunting as described by resource managers

Resource managers' focus group discussions dwelt heavily on factors that undermined ranger patrol efforts (Table 2). Inadequate equipment and lack of technology received the highest salience, followed by poor patrol roads, and fewer wildlife rangers. Resource managers stated

that not having enough resources like patrol cars, tents, modern communication equipment, cameras, computers, firearms, and global positioning system units undermined the efficiency of patrol activities in Ugalla (Supplementary Material). Other advanced equipment like drones were deemed important to keep pace with the rising unauthorised hunting rate. Equipment and technology dominated district game officers' focus groups due to the widespread hunting in the partially protected areas around Ugalla. The discussions centered around the issues of budget deficits that led to poorly managed partially protected areas.

Resource managers were greatly concerned about the limited patrol coverage in the rainy seasons as roads became flooded or impassable; and thought that unauthorised hunters walked or used bicycles and, rarely, motorcycles to reach areas where rangers could not reach (Supplementary Material). As one focus group participant stated, "Lack of good infrastructure leads to rangers failing to reach certain areas thus providing loopholes for poachers."

Shortage of wildlife rangers was the factor with the third highest salience score. According to focus group participants, the shortage of rangers was due to two factors; firstly, the limited capacity of the relevant authorities to recruit more rangers, and, secondly, the job itself did not attract young people who dreamt of becoming wildlife rangers one day. The ranger salary rates and other benefits were relatively low and left some of them unable to make ends meet (Supplementary Material). "Not enough wildlife rangers" was discussed passionately by district game officers' focus groups.

Poor incentives ( $S = 0.313$ ) and motivational strategies (0.236) for rangers were largely discussed during focus group meetings with rangers from Ugalla and trophy hunting companies. These factors were perceived to be the leading causes of low rangers' morale. Other key factors that were apparent from the discussions with Ugalla officers and rangers included concerns about the poor management of unauthorised hunting cases. Participants realised that some of the cases were dismissed or lost for lack of reliable or enough evidence to prove guilt beyond reasonable doubt or sometimes the accused were released unconditionally without regard to the seriousness of the case. Participants considered that not acting on patrol reports in a timely manner contributed to untargeted patrols, as unauthorised hunters tended to change their tactics based on perceived patrol efforts. Mistrust among rangers during patrols was believed to undermine communication among patrollers and cause them not to work as a team. Poor cooperation between Ugalla and district staff was discussed by district game officers who perceived it as one of the key factors for ineffective law enforcement outside Ugalla (in partially protected areas).

### **3.2.2 Factors contributing to unauthorised hunting as described by resource users**

Of the top factors affecting unauthorised hunting discussed by resource users (Table 3), five were facilitating factors, two of which were also mentioned by resource managers, namely poor

patrol roads in the rainy seasons and unauthorised hunting cases. Corruption and poor ethical standards by wildlife rangers featured strongly in the resource user groups but was ranked low by resource managers (Supplementary Material). Resource users reported that some corrupt rangers received bribes from dishonest hunters (trophy and subsistence hunters) to deliberately turn a blind eye or cover up knowledge of instances of abuse and misuse of hunting permits. In addition, village game scouts who often accompanied resident hunting trips in the partially protected areas were not paid salaries instead they were tipped at the will of the hunters; something which discouraged them from exercising appropriate conduct when tempted to engage in wrongdoing.

Many of the subsistence hunting challenges in partially protected areas were raised by resident hunters, who believed that the increase in unauthorised hunting within Ugalla was due to a failure to properly administer legal subsistence hunting in these areas (Supplementary Material). They noted two key factors resulting from the poor administration of permitted resource use schemes, which were weak cooperation between resource users and managers and abuse of resource use permits. Resident hunters expressed anger at the hunting scheme and rangers' behaviour. The issues discussed included harassment during the inspection of hunting permits, and the fact that the hunters were perceived as undeserving and that they were either colluding with unauthorised hunters or directly involved in unauthorised hunting. Furthermore, study participants discussed about authorities giving preference in hunting to foreign hunters over resident hunters around Ugalla. One hunter noted: "There is no fair-play in decisions to ban legal hunting. For example, when resident hunting was temporarily banned in 2015, trophy hunters were allowed to continue hunting. These kinds of decisions drive local people to poaching." A few financially capable people usually from other places were given higher hunting quotas leaving local hunters with a small number of animals permitted to be hunted under the resident hunting scheme in a specific hunting season. Additionally, resident hunting quotas issued by the government for districts in western Tanzania did not meet the needs of hunters, nor were the hunters involved in hunting quota decisions at the district level, and there was not enough transparency in the whole process.

At least half of the resource user focus groups acknowledged the existence of permitted resource users, in particular fishers and beekeepers who deliberately abused their permits by participating in unauthorised hunting. They pointed out that such resource users used their permits to enter Ugalla not only to carry out the activities they were allowed to do but also to carry out unauthorised bushmeat hunting or learn about the intensity of ranger patrols in places and look at the possibility of a later return for hunting. Other resource users were believed to collude with unauthorised hunters after the expiry of their permits, or inform them about the presence of patrols in different parts of the reserve so they avoided those areas. Poor roads in the rainy season as a facilitating factor constraining patrol coverage was also discussed by resource users, but received a lower salience score than resource managers. Likewise, inefficiency in

handling unauthorised hunting cases was pointed out by resource users but lowly ranked. The absence of permanent ranger posts in Ugalla concerned more trophy hunting company staff than other types of authorised resource users (Supplementary Material). This was considered to be an important factor that led to limited patrol coverage and lack of permanence of rangers in the reserve.

Of the factors motivating unauthorised hunting in Ugalla discussed by resource users' focus groups, poverty was the most important. Resource users perceived that limited jobs and other income-generating opportunities contributed to poverty, which meant people were unable to afford food and other basic necessities and so motivated to perform unauthorised hunting. Study participants pointed out that at times villagers were willing to perform unauthorised resource use activities in the reserve on behalf of wealthy outsiders in order to earn a living; one of the participants stated that "...for example villagers are being hired by wealthier people from distant areas to carry out illegal logging in Ugalla because of their need for cash." Another aspect discussed by resource users was the existence of secretive bushmeat black markets, which was the fourth most important factor for unauthorised hunting. Focus group participants perceived that such underground markets actively sold illegal bushmeat, and thus perpetuated unauthorised hunting activities. The availability of locally made guns (muzzleloaders), and modern firearms—mostly from neighbouring countries with frequent political unrest—was among the key causes of widespread hunting in Ugalla discussed by resource users.

#### **4 DISCUSSION**

Our study demonstrated that unauthorised hunting at Ugalla still deserves attention. We recorded about 25% more observations of unauthorised hunting in this study than in Wilfred et al. (2019); however, no inferences about trends should be drawn because we have not been able to correct for patrol biases (Dobson et al., 2020). The focus groups uncovered a range of factors influencing unauthorised hunting but had quite different perspectives. For example, resource managers largely discussed factors affecting the effectiveness of protection, such as the need for capacity building (equipment, technology, and number of rangers) and better working conditions and welfare for rangers. By contrast, resource users discussed factors both facilitating and motivating hunting. Most of the facilitating factors they identified focused on weaknesses or challenges faced by resource managers, while motivating factors were related to local communities around Ugalla. Only 1 out of the top 10 factors was about them ("unauthorised hunting behaviours among permitted resource users"; *see* Fig. 2). This may be because resource users did not want to be perceived as contributors to unauthorised hunting but also could be because they have different views about what are the most important factors in influencing unauthorised hunting (for example, Wilfred et al., 2017). Some factors were mentioned similarly often by the two groups but ranked differently (for example, rainy seasons and unauthorised

402 hunting cases), while others had the same rank but different numbers of mentions. Further study  
403 is needed to determine other factors that may influence these differences.

404  
405 Resource managers may have a greater understanding of the effects of rain on patrols than  
406 resource users because the latter are only allowed access to the reserve during dry seasons when  
407 almost all the roads are usable. The influence of the rainy season on unauthorised hunting has  
408 also been reported in Selous Game Reserve (Kyando et al., 2017). Resource managers had ideas  
409 for how to improve wet season patrols in addition to improving patrol roads. For example, they  
410 proposed the use of helicopters, canoes, drones, and cameras. Such technologies can help to  
411 monitor infrequently patrolled areas (e.g. Henson et al., 2016; Hossain et al., 2016). The place of  
412 technology and equipment in curbing unauthorised hunting is reported in the wildlife  
413 conservation literature (Kamminga et al., 2018; López & Mulero-Pázmány, 2019). We suspect  
414 that the reason why resource managers considered inadequate equipment and technology the  
415 most important factor for unauthorised hunting is also because they face a very high patrol  
416 workload given the limited number of rangers and large area to cover (*see* Wilfred et al., 2019).  
417 The literature suggests a positive relationship between the number of rangers and patrol  
418 efficiency in protected areas (Plumptre et al., 2014; Moore et al., 2018; Singh et al., 2020); so, it  
419 is not surprising that resource managers were concerned that the number of rangers did not  
420 reflect the size of Ugalla, especially in the partially protected areas where patrols were rarely  
421 conducted. Consequently, two solutions were proposed; one is to ensure appropriate staffing, and  
422 the other is to promote community-based conservation to discourage illegal behaviours. The  
423 effectiveness of this approach is corroborated by a study in Uganda by Moreto & Charlton  
424 (2021).

425  
426 Low staff morale was deemed to cripple the effectiveness of patrols, and one suggested  
427 strategy was to motivate protected area staff through timely promotions, salaries, rewards, and  
428 allowances. This fits with other literature which suggests that monetary rewards and incentives  
429 improve rangers' morale and performance (Hötte et al., 2016; Moreto et al., 2016; Singh et al.,  
430 2020). Indeed, we acknowledge the existence of other factors related to working conditions,  
431 which may influence ranger motivations (e.g. Kuiper et al., 2020). Our findings indicate that  
432 corruption is also a negative consequence of low pay for rangers. Moreto et al. (2015) reported a  
433 similar observation concerning low pay as a key driver of corruption among rangers in Uganda.  
434 In contrast with Moreto et al. (2015), wildlife rangers in our study rarely discussed issues related  
435 to corruption. Nevertheless, resource users felt strongly that corruption promoted unauthorised  
436 hunting in two main ways; corrupt rangers conspired with local people in performing  
437 unauthorised hunting, and at times legal hunters (legal subsistence and trophy hunters) paid  
438 bribes to make rangers or game scouts escorting them keep any unauthorised behaviours from  
439 discovery. Wilfred (2019) reported these violations of the hunting laws and regulations in  
440 western Tanzania.

Our findings showed that weakness in handling unauthorised hunting cases was more important to resource managers than users, despite having the same number of mentions in both groups. This could be because resource managers get motivated when their efforts result in unauthorised hunters receiving appropriate punishments. Elsewhere, studies suggest that court decisions in conservation crimes may not be effective not only as a way of deterring unauthorised hunting but also as a way of granting justice based on the seriousness of the crime (Salum et al., 2017; Moreto & Charlton, 2021). To guarantee greater compliance with laws and regulations pertaining to hunting, our study indicates need for providing more realistic and adequate penalties for rule-breaking in conservation while ensuring effective and efficient law enforcement and providing conservation education.

Our finding about poverty as a strong driver of unauthorised hunting is also borne out by other studies (e.g. Wilfred, 2018; Hauenstein et al., 2019; Manyama et al., 2019). Resource user groups suggested that poverty was a result of limited income generating opportunities, which seems to be common among people living adjacent to protected areas (Knapp et al., 2017). Wilfred & MacColl (2010) found a negative relationship between sources of household income and unauthorised hunting, but this poses the question as to whether unauthorised hunting itself has a significant bearing on household wealth. Focus groups proposed that conservation efforts should aim to improve livelihoods and increase awareness about the importance of wildlife. Issues of local livelihoods and conservation have also been considered in other conservation areas (e.g. Ntuli et al., 2021).

We found that resource users, in particular resident hunters, were concerned about how they were marginalised in favour of foreign hunters, as Wilfred (2019) also found. Instances of resident hunters being seen as unworthy of hunting rights have been reported previously in studies on wildlife utilisation in the country (e.g. Holmern et al., 2004; Msoffe et al., 2007). Wilfred et al. (2017) suggest that foreign hunters benefit from Ugalla much more than the local communities who bear costs of conservation. The primary objective of legal subsistence hunting in Tanzania is to discourage unauthorised hunting (URT, 2009), but studies show that this behaviour is still common (Nuno et al., 2013; Wilfred et al., 2017; Hariohay et al., 2019). Although the literature suggests that efficient administration of hunting schemes is crucial to controlling unauthorised hunting ('t Sas-Rolfes, 2017; Nachihangu et al., 2018), this seems not to be the case in Tanzania where relatively few people participate in the resident hunting scheme (e.g. Nachihangu et al., 2018; P.W. Unpublished data).

Here, we have presented factors influencing unauthorised hunting at Ugalla based on the views of resource managers and users. We showed differences in perceptions of the factors between the two groups of study participants. This mismatch suggests the need for inclusive wildlife law enforcement, and bringing together perspectives among different groups of local conservation stakeholders through meetings, outreach, workshops, seminars, as has been done

elsewhere (e.g. in Mozambique; Massé et al., 2017). For example, previous surveys show that resident hunters are keen to support anti-poaching activities through providing information that would lead rangers to places with higher concentrations of unauthorised activities as they share hunting sites with unauthorised hunters (Wilfred, 2019). We acknowledge the possibility that resource users' understanding of unauthorised hunting may not necessarily mirror that of the local communities in which they live, in which case further study should consider incorporating the general population to enable cross-validation of the factors reported in this study. For instance, the role of poverty as a contributor to unauthorised hunting can be perceived differently by local communities and authorised or unauthorised resource users. By highlighting differences in perspectives between resource managers and users, we emphasised the importance of considering the views of people with different interests in natural resources to comprehensively understand the factors that influence unauthorised hunting for better conservation law enforcement.

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**TABLE 1.** Signs of unauthorised hunting activities encountered in Ugalla between March 2016 and March 2019 ( $N = 98$ )

Observation	Percentage ( <i>dry</i> <sup>*</sup> , <i>wet</i> <sup>¶</sup> )
Footprints	38 (23, 15)
Poaching trails	22 (16, 6)
Poaching camps	13 (11, 2)
Meat smoking racks	9 (7, 2)
Unauthorised hunters	7 (6, 1)
Shallow dug-outs	3 (3, 0)
Wire snares	2 (2, 0)
Animal carcass	1 (1, 0)
Bicycles	1 (0, 1)
Gunshots	1 (0, 1)
Muzzleloaders	1 (0, 1)

<sup>\*</sup>*The percentage of signs of unauthorised hunting observed during the dry season*

<sup>¶</sup>*The percentage of signs of unauthorised hunting observed during the wet season*

**TABLE 2.** Top factors contributing to unauthorised hunting in Ugalla and corresponding solutions based on 4 resource managers' focus groups

Factor	Saliency <sup>§</sup>	Proposed solution
Inadequate equipment and technologies for rangers	0.882	Donors and conservation partners should be sought to assist in conservation There should be income-generating activities to purchase equipment
Poor roads in rainy seasons limit patrol coverage	0.658	Government should intervene to improve infrastructure in the reserve Strengthen/build river crossings used during patrols Helicopters, canoes, and drones should also be used in the rainy season The network of patrol roads should be expanded
Not enough wildlife rangers	0.518	Tanzania Wildlife Management Authority (TAWA) should employ more rangers Wildlife management areas should be expanded to minimise pressure on the reserve
Low pay and other incentives for rangers	0.313	Improve the welfare of rangers, for example salaries and various allowances
Inefficiency in handling unauthorised hunting cases	0.253	Conservation laws should be enforced efficiently Code of conduct for employees and standard operating procedures must be strictly adhered to TAWA should be given the power and authority to administer wildlife crime cases Ensure decent penalties are imposed against the convicted hunters
Lack of motivational strategies for rangers	0.236	TAWA should ensure timely promotion of employees, and set up rewards and recognition programmes to show appreciation for performance and to offer motivation to rangers
Delays in working on patrol reports	0.222	Work on previous patrol reports in a timely manner
Limited budget allocated to district game	0.219	Conservation budgets at the districts level should be improved

officers		
Mistrust among rangers	0.167	-
Poor cooperation between the reserve and the district game offices	0.156	Improve the work relationships and trust between the reserve and the district game offices

*<sup>\$</sup>Salience scores; score 1 = factor ranked first in all the focus groups, and score < 1 = factor was ranked lower or not ranked in some groups.*

**TABLE 3.** Top factors contributing to unauthorised hunting in Ugalla and corresponding solutions based on 6 resource users' focus groups

Factor	Saliency <sup>§</sup>	Proposed solution
Poverty	0.545	Provide conservation education to the people around Ugalla Promote environmentally friendly income generating activities Hunting companies should protect and promote the livelihoods and welfare of local people
Lack of ethical standards and corruption	0.472	Wildlife rangers should perform their duties in accordance with the laws and regulations Improve wildlife ranger salaries and other benefits Examine the backgrounds and interests of rangers before hiring them
Poor administration of legal subsistence hunting	0.278	The relevant authorities should value citizens who use natural resources legally Hunting bans should not last long Official information concerning the resident hunting scheme should not differ from one source to another or from one area to another. Establish open legal bushmeat markets Improve the relationships between the district game offices and the hunters' association Increase district hunting quotas
Black markets	0.275	Control illegal markets Promote conservation education
Poor roads in rainy seasons	0.240	Improve infrastructure by building roads and bridges Build ranger posts within the reserve
Unauthorised hunting behaviours among permitted resource users	0.225	Educate resident hunters Punish law breakers Regular inspections of legal subsistence resource users during official harvesting seasons
Poor cooperation between resource users and wildlife rangers	0.222	Rangers should stop harassing legal resource users There should be regular meetings to improve relationships between rangers and villagers Establish a mechanism to provide the public with information relating to changes or amendments to laws and procedures for the resident hunting scheme

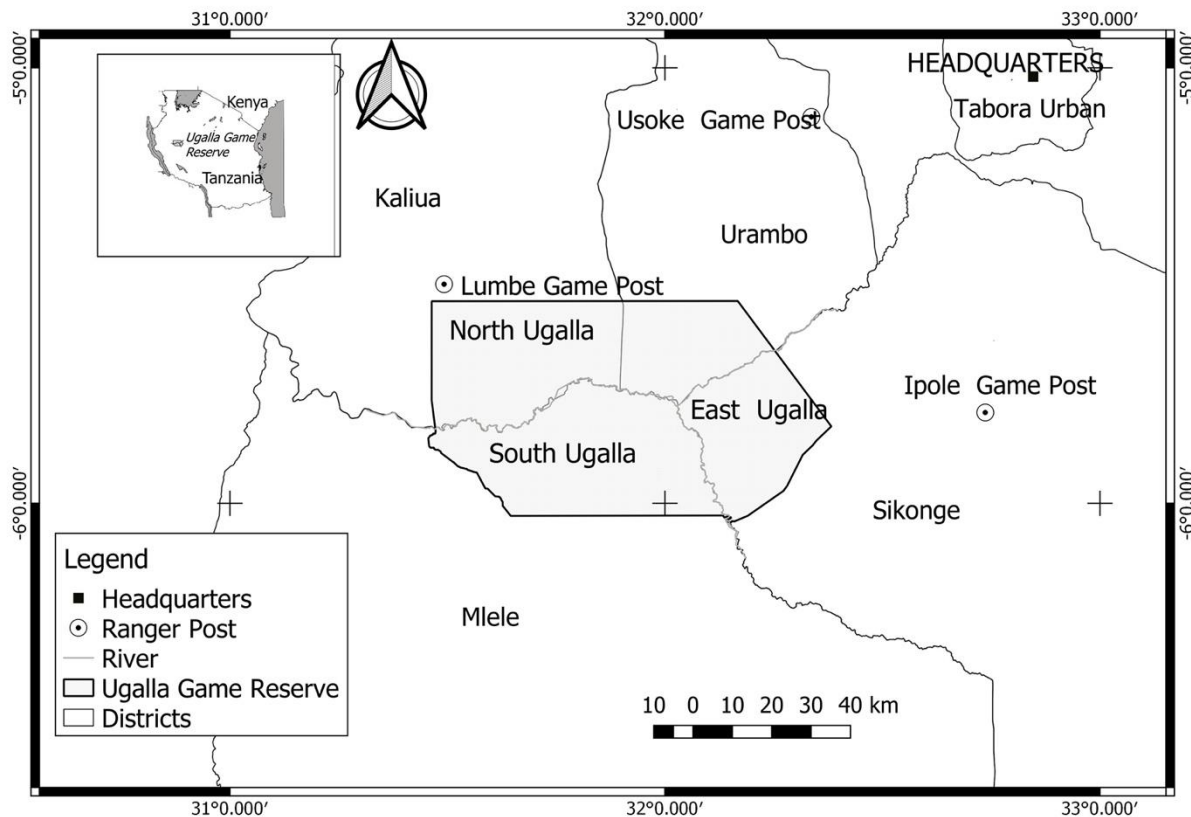
Inefficiency in handling unauthorised hunting cases	0.197	Laws should be amended to impose appropriate penalties to deter unauthorised hunting Conservation education should be given the highest priority
Access to muzzleloaders and other guns	0.167	Strengthen illegal weapons control Strengthen security at the borders to control illegal weapons
No permanent ranger posts in the reserve	0.152	Strategically distribute ranger posts within the reserve according to the intensity of illegal activity The reserve headquarters should be moved closer to the reserve

*<sup>§</sup>Salience scores; score 1 = factor ranked first in all the focus groups, and score < 1 = factor was ranked lower or not ranked in some groups.*



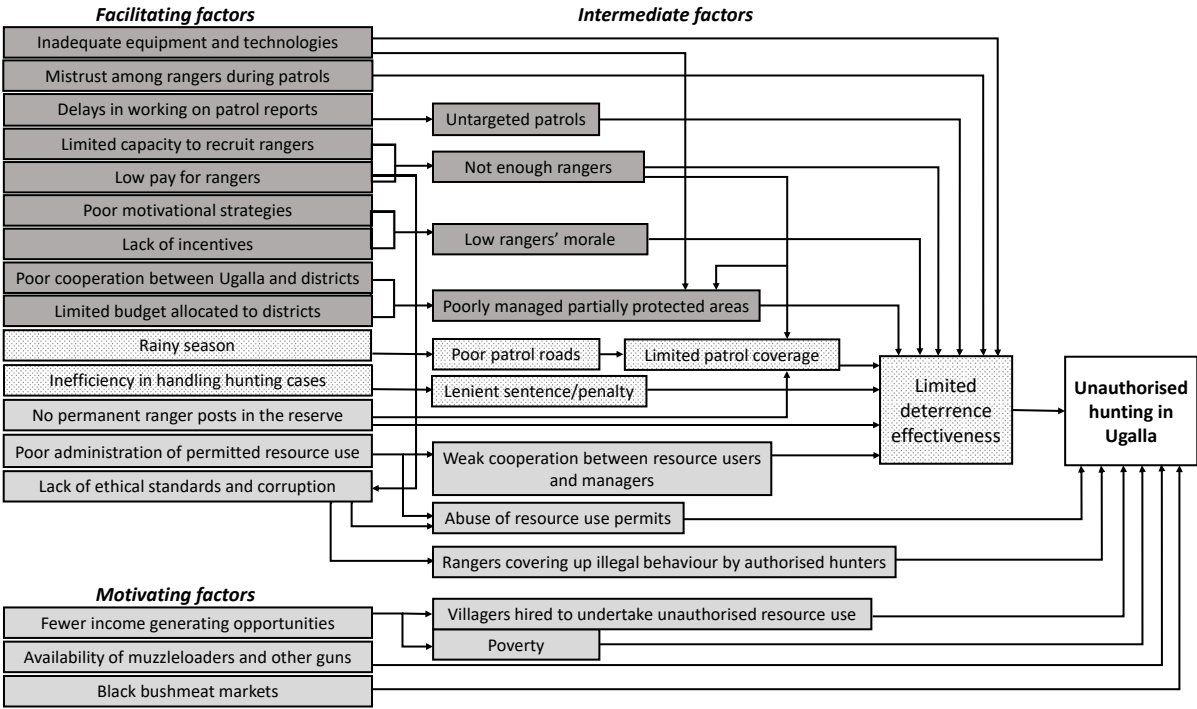
**FIGURE 1**

Ugalla Game Reserve, western Tanzania. Names within the reserve boundaries are hunting blocks, demarcated according to the river courses through the middle of the reserve, except North Ugalla which is now part of Ugalla River National Park established in 2019. Approximate locations of administrative districts, wildlife ranger posts, and Ugalla Reserve headquarters are also shown. Inset shows the location of the protected area in Tanzania



**FIGURE 2**

Causal diagram illustrating relationships between factors contributing to unauthorised hunting in the Ugalla Game Reserve of western Tanzania based on focus group discussions with resource managers (deep grey) and users (light grey). Factors in light grey pattern were discussed by both groups of study participants



**SUPPLEMENTARY MATERIAL**

**Resource managers' and users' perspectives on factors contributing to unauthorised hunting in western Tanzania**

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767 **TABLE S1.** Factors contributing to unauthorised hunting in Ugalla and corresponding solutions as ranked by 4 resource managers'  
768 focus groups

<b>Focus group 1</b>			
<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Shortage of tools/resources	▪ Lack of modern technological tools such as drones	▪ Look for donors/sponsors. ▪ There should be income generating activities so as to buy tools/resources. ▪ There should be identification of donors/sponsors and conservation stakeholders who can assist in buying modern technological tools.	1
Poor road infrastructure during rainy seasons	▪ Absence of reliable road infrastructure thus making game rangers unable to access certain areas of the Game Reserve hence providing a loophole for poachers.	▪ There should be ways to increase income/loans or the government should interfere so as to improve infrastructure which will facilitate access to areas which are currently inaccessible.	2
Not enough game rangers	▪ Inadequate number of game rangers during patrols. Standard ratio is one game ranger/25sqkm but now it is one game ranger/135sqkm.	▪ If Tanzania Wildlife Authority (TAWA) can increase its income, it can have capacity to recruit more employees.  ▪ Establishment of WMA in villages will also reduce pressure from the reserve hence minimizing TAWA's burden of patrols.	3
Weakness in law enforcement and management of prosecution of conservation lawsuits	▪ Weakness in enforcing conservation laws including weak witness which leads to lesser penalty to offenders.	▪ Stressing and adhering to laws as required. ▪ Currently, there is TAWA Act (TAWA General Ordinance, TGO) formulated, which will guide operation of employees (code of conduct).	4
Weakness in law enforcement and management of prosecution of conservation lawsuits		▪ In addition, there are standard operating procedures (SOP) applicable among Police Force, the Court, and TAWA but they are not effectively adhered to. ▪ Worse still, TAWA has no final powers on lawsuits. Thus, efforts are needed to make TAWA have ultimate powers to prosecute and manage lawsuits.	
Lack of integrity among law enforcers	▪ Lack of integrity including corruption among employees	▪ Employees should stop being desirous, and should adhere to TGO. ▪ Patrollers should be motivated.	5
<b>Focus group 2</b>			
<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Poor staff remuneration		▪ Improving staff remuneration, e.g. salaries and various allowances.	1
Lack of motivation	▪ Lack of motivation including promotion or rewards to those who have had outstanding performance.	▪ Motivating employees such as through rewards and timely promotions.	2
Failure to respond to previous patrol reports		▪ Previous reported patrol information should be responded to on time.	3
Poor road infrastructure during rainy seasons		▪ Improving road infrastructure such as building new roads and bridges.	4
Lack of resources/tools	▪ Lack of resources/tools such as tents, cars, cameras, and firearms.	▪ Improving tools such as cars, radio call, tents, and raincoats.	5
Not enough game rangers		▪ Increasing human resources.	6
Lack of trust among employees during patrols			7

Weakness in law enforcement and management of prosecution of conservation lawsuits	▪ Loss of lawsuits due to lack of prosecution knowledge and skills.	▪ Making close follow-up on lawsuits to ensure appropriate penalties are given to poachers.	8
Weak network of informers/whistle blowers		▪ Strengthening informer/whistle blower networks	9
Long standing lack of research		▪ Various studies on poaching should be conducted within and outside Ugalla Game Reserve	10
Lack of capacity building to patrollers	▪ Absence of various techniques to build employees' capacity.	▪ Capacity building among employees through various trainings should be implemented.	11
Weak cooperation between Ugalla Game Reserve and other government and non-government organizations	▪ Absence of cooperation among government institutions such as Police Force, Tanzania Forest Services, and ward and village executive offices.	▪ Strengthening cooperation with other governmental and private organizations	12
Neglecting reports shared by informers'/whistle blowers			13
Lack of innovation (working as business as usual)			14
Personal decisions by some leaders			15
Working in same stations for long time		▪ Timely changing of work stations for employees	16
Lack of integrity among law enforcers	▪ Lack of integrity (corruption)		17
Looking for personal gains			18

### Focus group 3

<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Poor road infrastructure during rainy seasons	▪ Lack of roads in some areas ▪ Water lodging in some areas during rainy seasons	▪ There should be air/water patrols during rainy seasons. ▪ Roads for patrols should be increased and should be in good condition all seasons to expand patrol coverage.	1
Lack of resources/tools			2
Weak cooperation among neighbouring hunting blocks	▪ This weakens efforts to combat poaching. For example, sometimes it is difficult for patrolling game rangers of one hunting company to cross through another hunting block for easy access to the poaching incident or to patrol the area within their block.	▪ There should be cordial relationship among trophy hunting operators with neighbouring blocks since all share similar objective which is conservation.	3
Poor staff remuneration			4

### Focus group 4

<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Shortage of resources/tools	▪ Shortage of modern resources/tools for both district conservation authorities and Ugalla Game Reserve (e.g. cars and modern firearms).	▪ Increasing modern tools (e.g. cars and firearms).	1
Low conservation budget in districts surrounding Ugalla Game Reserve	▪ Budget allocated for conservation is not used for conservation activities as planned. ▪ Budget implementation does not	▪ Budget should be increased so that each departmental unit can fulfil its roles accordingly.	2

	prioritize conservation activities of forests surrounding Ugalla Game Reserve (e.g. patrols and conservation awareness campaigns).		
Not enough game rangers		▪ Adequate staff, especially rangers, should be recruited.	3
Poor cooperation between district conservation authorities and Ugalla Game Reserve		▪ Strengthen cooperation between district conservation authorities and Ugalla Game Reserve.	4
Poor protection of forests surrounding Ugalla Game Reserve		▪ Decisions should be implemented. ▪ Strengthen protection of forests surrounding Ugalla Game Reserve (e.g. joint patrols).	5
Absence of proper land use planning	▪ There is no proper land use planning; there are no clear Game Reserve borders.	▪ Re-survey villages and re-plan proper land use, especially the villages surrounding Ugalla Game Reserve.	6
Politics	▪ Politically motivated decisions (locally) affect conservation areas surrounding Ugalla Game Reserve. People get support from political leaders when they want to expand their settlements or increase their hamlets towards protected areas or buffer zones. Their political representatives present at the parliament people's wishes and demands even if they contradict with conservation laws just to please their voters.	▪ Political leaders (members of parliament and councillors) should be regularly educated on conservation issues especially on importance of buffer zones and open areas. ▪ There should be involvement of politicians in various conservation decision making meetings and conservation activities or projects (e.g. verification of borders).	7
Negative perceptions/attitudes on conservation among directors	▪ Administrative directors of the districts surrounding Ugalla Game Reserve prioritize conservation projects which they have personal interests, especially the ones they enjoy direct financial benefits (e.g. Wildlife Management Areas).	▪ Conservation education should be offered to district administrative directors. ▪ There should be a link between Ugalla Game Reserve Management and the district authorities, but not partial relationships such as only when someone from the district is needed for a certain task or involvement in certain patrol or special operation. ▪ District administrative directors should be involved in important decisions concerning Ugalla Game Reserve. There should be close communication between Ugalla Game Reserve Management and District administrative directors so that they are aware of challenges and growth of Ugalla Game Reserve. This will enable them to incorporate their knowledge and awareness in decisions made and efforts taken to protect areas surrounding Ugalla Game Reserve.	8

**TABLE S2.** Factors contributing to unauthorised hunting in Ugalla and corresponding solutions as ranked by 6 resource users' focus groups

**Focus group 1**

<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Lack of integrity among law enforcers	<ul style="list-style-type: none"> <li>▪ Rangers collude with some local people to engage in poaching (e.g. illegal loggers, fishermen)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Game rangers should carry out their tasks based on available laws and regulations.</li> </ul>	1
Challenges on permitted fishing	<ul style="list-style-type: none"> <li>▪ When permitted fishermen are found to have contravened laws or regulations (e.g. entering and fishing in Ugalla Game Reserve without permits), in addition to penalties, their permits are permanently cancelled, contrary to the previous days when such persons were being suspended to conduct fishing activities in the Reserve for 3 years, after which they were allowed to reapply fishing permits. This arrangement makes some fishermen whose permits are cancelled to continue entering the Reserve and conduct fishing activities illegally</li> <li>▪ High costs of permits and other expenses associated with preparations for fishing activities in the Reserve (e.g. paying for licenses at a district and permit application forms in the offices of Ugalla Game Reserve; fishing net costs, costs of game rangers escorting fishermen, and 10% of value of purchased fish, which can be paid by vendors entering the Reserve to buy fish). Vendors may decide not to enter Ugalla Game Reserve to buy fish to avoid high costs</li> <li>▪ Reducing number of fishing permits, and reducing number of people per single permit (previously, a single permit had four people, now a single permit has three people only). People who have been removed from permits are tempted to engage in poaching</li> </ul>	<ul style="list-style-type: none"> <li>▪ Penalties should be reduced (time limit) for permitted fishermen who are arrested/caught contravening laws/regulations.</li> <li>▪ Number of fishing permits issued by Ugalla Game Reserve should be increased.</li> <li>▪ When a fisherman is suspected or identified to have committed or involved in committing an offence, critical investigation should be conducted including giving them an opportunity to defend themselves before being arrested or their permit being cancelled.</li> <li>▪ Tariffs for vendors should be reduced to enable them enter Ugalla Game Reserve to buy fish. Vendors pay 10% of costs of bought fish from Ugalla Game Reserve. They also pay for annual fishing licenses at district authorities; they pay for transport costs to enter inside the reserve; and they pay for 24 hour permits to enter the reserve.</li> <li>▪ Tariffs should be reduced, such as costs for license application forms. Fishermen should be involved in setting tariffs such as for permits and escort game rangers.</li> </ul>	2
Poor cooperation between permitted fishermen and law		<ul style="list-style-type: none"> <li>▪ Relationships between permitted fishermen and law enforcers should be strengthened to facilitate game rangers getting information about</li> </ul>	3

enforcers		<ul style="list-style-type: none"> <li>poachers.</li> <li>When permitted fishermen give game rangers information about poachers, anonymity of informers/whistle blowers should be maintained to protect them and to cultivate environment where game rangers will continue to receive information in the future.</li> <li>Good arrangement should be set to enable permitted fishermen carry out fishing at night because it is the time fish are easily caught. This will also help in scaring away poachers (who mostly fish at night). Also, permitted fishermen can be better source of information of poachers' activities at nights.</li> <li>Harassment at the permitted fishermen camps should be minimized.</li> <li>Fishermen should be respected and recognized as Ugalla Game Reserve conservation stakeholders.</li> <li>Employees of private trophy hunters should be faithful.</li> </ul>	4
Game rangers illegally hunt during patrols			
Poor protection of forests surrounding Ugalla Game Reserve	<ul style="list-style-type: none"> <li>Poor protection of forests surrounding Ugalla Game Reserve. Community based organisations are so weak</li> </ul>		5
Poverty		<ul style="list-style-type: none"> <li>Conservation education should be offered to local people surrounding Ugalla Game Reserve through frequent meetings to help them know conservation laws.</li> </ul>	6
Water hyacinth	<ul style="list-style-type: none"> <li>Water hyacinth spread in rivers infesting them and destroy fish breeding areas. This situation increases poaching</li> </ul>	<ul style="list-style-type: none"> <li>There should be a strategic plan to combat water hyacinth</li> </ul>	7
<b>Focus group 2</b>			
<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Poverty	<ul style="list-style-type: none"> <li>Unemployment, hunger, and lack of self-employment opportunities. For example, poachers are hired by wealthy people due to their poverty.</li> </ul>	<ul style="list-style-type: none"> <li>Village governments should promote and oversee economic activities (e.g. people to have farms and work hard in farming).</li> </ul>	1
Illegal markets		<ul style="list-style-type: none"> <li>Controlling informal markets. Controlling business of timber, honey, etc., which is taking place during and outside harvest seasons.</li> </ul>	2
Challenges of permitted bee keeping	<ul style="list-style-type: none"> <li>Delaying permits; when they delay to go to the forests, they get late to harvest honey. As a result, poachers take chances to steal honey from their hives. The short remaining period on their permits makes them to harvest honey in a hurry, which causes them to leave other hives unharvested. The poachers then come and steal honey from the remaining hives. Poachers</li> </ul>	<ul style="list-style-type: none"> <li>Previous arrangement of a single permit for both fishing and honey harvest should be restored.</li> <li>There should be an arrangement to admit new members of the Ugalla Game Reserve Bee Keeping Association when a member dies or leaves an association, etc.</li> </ul>	3



	are also attracted by hives of the permitted individuals.		
	<ul style="list-style-type: none"> <li>▪ Honey harvesting seasons are June - August and October - November. However, they go to the forests late and the permits allow them to remain in the forests for few days in each season.</li> <li>▪ In the past, a single permit was issued to enter forests to harvest honey and fish. Now, each activity has a separate permit. This situation tempts people to engage in poaching resources when they do not get what they have been permitted to do.</li> </ul>		
Inadequate sources of income	<ul style="list-style-type: none"> <li>▪ Failure to provide entrepreneurship education which would help people increase their income</li> </ul>	<ul style="list-style-type: none"> <li>▪ There should be soft loans for residents to empower them economically.</li> </ul>	4
Challenges of permitted hunting by residents	<ul style="list-style-type: none"> <li>▪ Closing hunting licences for residents</li> </ul>		5
Poaching behaviour among permitted resource users	<ul style="list-style-type: none"> <li>▪ People given permits for bee keeping and honey harvesting in the forests surrounding Ugalla Game Reserve use that chance to enter Ugalla Game Reserve.</li> </ul>		6

### Focus group 3

<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Poor road infrastructure during rainy seasons		<ul style="list-style-type: none"> <li>▪ More efforts are needed to use alternative ways during rainy seasons (e.g. boats and helicopter/drones) for patrols.</li> <li>▪ Research should be conducted to identify ways to strategically establish game ranger posts within Ugalla Game Reserve, especially in areas which are not easily accessible during rainy seasons, such as Msima.</li> <li>▪ Road and other infrastructure networks should be improved to expand patrol coverage during rainy seasons.</li> </ul>	1
Absence of permanent ranger posts close to or inside Ugalla Game Reserve		<ul style="list-style-type: none"> <li>▪ Game ranger posts inside the reserve should be established depending on zones and intensity of crime.</li> <li>▪ Ugalla Game Reserve Head Office should be moved closer to the reserve.</li> </ul>	2
Inadequate number of patrols inside Ugalla Game Reserve		<ul style="list-style-type: none"> <li>▪ Tools and resources such as cars and fuel for patrols should be increased.</li> <li>▪ Both government and private companies' game rangers should be motivated.</li> <li>▪ Private hunting companies should put more efforts in patrols instead of depending on government alone, especially for East Ugalla Hunting Block.</li> </ul>	3
Poor relationship between private		<ul style="list-style-type: none"> <li>▪ Relationships between private company game rangers and government game rangers should be</li> </ul>	4

company game rangers and government game rangers		improved.	
Low conservation awareness among villages surrounding Ugalla Game Reserve	<ul style="list-style-type: none"> <li>There is no enough education on conservation among villages surrounding Ugalla Game Reserve.</li> </ul>	<ul style="list-style-type: none"> <li>Efforts are needed to educate communities on conservation issues.</li> </ul>	5
Weak network of informers/whistle blowers	<ul style="list-style-type: none"> <li>There is no good and productive network of informers/whistle blowers.</li> </ul>	<ul style="list-style-type: none"> <li>Conservation authorities should be closer to local people to be able to get information about poaching.</li> </ul>	6
Poaching behaviour among permitted resource users	<ul style="list-style-type: none"> <li>Some individuals with permits to enter the forests for fishing and honey harvesting turn to be destructive. They use the opportunity to study environment inside the forest and establish ways in which they later return to do illegal activities. When they finish their legal activities, they cooperate with poachers. They also work with poachers by sending information to the villages about availability of timber or information regarding existence or non-existence of patrols in certain areas of protected forests.</li> </ul>	<ul style="list-style-type: none"> <li>Education should be offered during permits issuance, which should include laws/regulations and penalties that will be applied against offenders.</li> <li>Frequent inspections should be conducted for people who have been legally admitted into the forests to engage in fishing, honey harvesting, etc.</li> </ul>	7
Poverty	<ul style="list-style-type: none"> <li>Income poverty</li> </ul>	<ul style="list-style-type: none"> <li>Education should be offered on alternative income generating methods without ruining natural resources.</li> <li>Capital grants should be given to facilitate various income generating activities.</li> </ul>	8
Weakness in law enforcement and management of prosecution of conservation lawsuits	<ul style="list-style-type: none"> <li>People arrested for illegal fishing or honey harvesting are given lesser penalties.</li> </ul>	<ul style="list-style-type: none"> <li>Laws and regulations should be reformed to give appropriate penalties for people engaging in illegal fishing and honey harvesting.</li> </ul>	9
Human settlements being adjacent to buffer zones of the protected areas	<ul style="list-style-type: none"> <li>Some informal villages established close to Ugalla Game Reserve or in game controlled and open areas close to Ugalla Game Reserve were initiated by peasants or people whose activities depend on natural resources. Politics contribute to these villages being formalized. Villagers from these villages are tempted to enter the Game Reserve and engage in poaching.</li> <li>Informal villages along wild animal migration corridors</li> </ul>	<ul style="list-style-type: none"> <li>Government should refrain from engaging politics in conservation issues.</li> <li>When the government confirms that villages in buffer zones are the cause for animal killings and destruction of wild habitats, such villages should be removed.</li> </ul>	10
Poaching habit		<ul style="list-style-type: none"> <li>Harsh penalties should be given to poachers.</li> </ul>	11

- Frequent operations should be carried out to hunt down suspects of poaching in villages and towns.

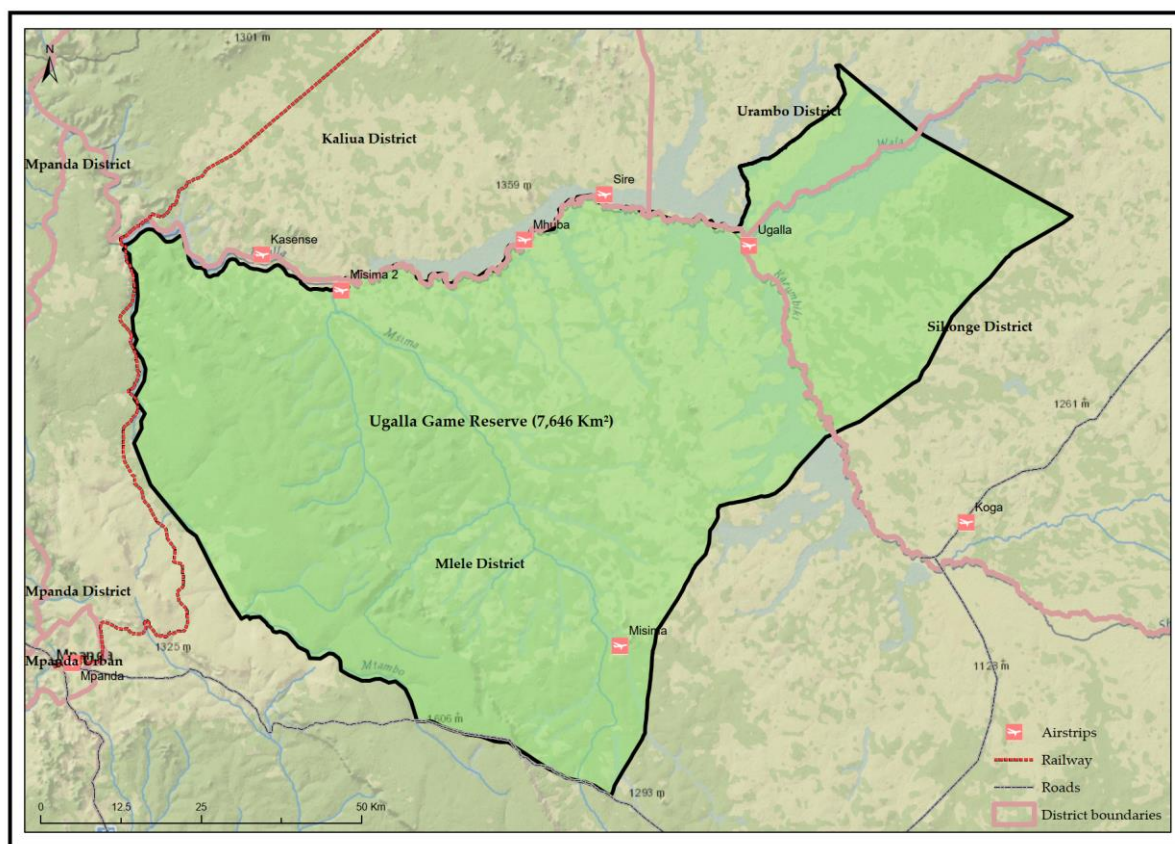
<b>Focus group 4</b>			
<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Lack of integrity among law enforcers	▪ Some employees, especially game rangers are not faithful; they sometimes collude with poachers.	<ul style="list-style-type: none"> <li>▪ Employees' remuneration/salaries should be improved.</li> <li>▪ Employees should be of integrity.</li> <li>▪ Tanzania Forest Service Agency should also conduct patrols inside the reserve.</li> <li>▪ Individuals who are to be recruited should first be subjected to rigorous vetting to ascertain if they are only looking to satisfy their personal financial interests.</li> </ul>	1
Weakness in law enforcement and management of prosecution of conservation lawsuits	▪ Legal challenges; some offenders are given lesser penalties or are released without considering weight of the offence or lawsuit.	<ul style="list-style-type: none"> <li>▪ There should be poachers' court.</li> <li>▪ Penalties should be equal to the size and seriousness of the offence/crime or lawsuit.</li> </ul>	2
Illegal markets	▪ Existence of natural resource markets is a motivation for poaching.	<ul style="list-style-type: none"> <li>▪ Conservation education to communities should be given high priority (e.g. flyers).</li> </ul>	3
Poaching behaviour among permitted resource users	▪ Some permitted fishermen and honey harvesters when are inside Ugalla Game Reserve tend to engage in illegal hunting or fishing.	<ul style="list-style-type: none"> <li>▪ Each person entering Ugalla Game Reserve for the purpose of assisting permitted fisherman or honey harvester should bear an identity card with a passport size photo. Identity cards should not be limited to the permit bearers only.</li> </ul>	4
Shortage of resources/tools	▪ Inadequate number of game rangers and tools such as cars, communication tools, and movement tracking cameras	<ul style="list-style-type: none"> <li>▪ Ensure there are adequate resources/tools.</li> </ul>	5
Politics	▪ Political factors; people who contravene laws by grazing cows inside Game Reserve, loggers, etc. are defended by political leaders/their political representatives.	<ul style="list-style-type: none"> <li>▪ Political leaders should not interfere with activities of law enforcers.</li> </ul>	6
Poverty		<ul style="list-style-type: none"> <li>▪ Education should be offered as well as loans; and projects focusing on economic empowerment of residents.</li> </ul>	7
Poaching habit	▪ People engage in poaching as an alternative employment or just habit.	<ul style="list-style-type: none"> <li>▪ There should be reform of conservation laws and regulations so that penalties given can deter recurrence of offences.</li> </ul>	8
Poor road infrastructure during rainy seasons	▪ During rainy seasons, road infrastructures become poor.	<ul style="list-style-type: none"> <li>▪ Abandoned game ranger posts inside Ugalla Game Reserve should be revived, so that game rangers can live inside the reserve rather than living outside or in towns as it is now. However, the living environment should be conducive for them to be able to live in those game posts.</li> </ul>	9
Inadequate sources of income		<ul style="list-style-type: none"> <li>▪ Since in large extent of communities depend on agriculture, the sector should be improved including looking for reliable markets for crops.</li> </ul>	10
Delay in responding to reports of occurrence of poaching incidents	▪ Game rangers do not respond on time to reports of existence of poaching incidents, especially among private companies.	<ul style="list-style-type: none"> <li>▪ Game rangers should respond in time to information about poaching.</li> </ul>	11

<b>Focus group 5</b>			
<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Uncontrolled access to firearms		<ul style="list-style-type: none"> <li>Control of illegal firearms should be strengthened (e.g. muzzleloaders), especially along the country borders where these firearms make their ways into the country.</li> </ul>	1
Lack of integrity among law enforcers	<ul style="list-style-type: none"> <li>Some high level staff collude with poachers.</li> </ul>		2
Challenges of permitted resident hunting	<ul style="list-style-type: none"> <li>Valuing foreigners enjoying natural resources than local people. For example, hunting is prohibited to residents but it is allowed to foreigners.</li> <li>Costs of animals for permitted hunters.</li> </ul>	<ul style="list-style-type: none"> <li>The country should value citizens enjoying natural resources in their areas instead of highly regarding foreigners only.</li> <li>Hunting restrictions should not be of long time.</li> <li>Formal information on traditional hunting issued by the government should not contradict from one leader to the other or from one place to the other.</li> <li>There should be licenses that allow for selling of wild animal meat in permitted markets.</li> </ul>	3
Poor relationship between permitted local hunters and law enforcers	<ul style="list-style-type: none"> <li>Harassing people accessing natural resources who are legally in the forests affects cooperation.</li> </ul>	<ul style="list-style-type: none"> <li>Rangers should be educated so that they stop harassing people engaging in legal activities in forests.</li> </ul>	4
Poor cooperation between district conservation authorities and Ugalla Game Reserve	<ul style="list-style-type: none"> <li>Poor communication between game rangers and district conservation authorities in order to share information about people with permits engaging in various activities, particularly in forests surrounding Ugalla Game Reserve.</li> </ul>		5
Poverty			6
<b>Focus group 6</b>			
<i>Reason</i>	<i>Additional information</i>	<i>Solution</i>	<i>Rank</i>
Poverty		<ul style="list-style-type: none"> <li>Trophy hunting companies should offer temporary employment opportunities to communities especially during hunting seasons.</li> <li>Education on wild animal conservation should be offered.</li> <li>Trophy hunting companies should put in place arrangements to offer wild meat to villagers surrounding their hunting blocks.</li> <li>Tourist hunting should help improving social services.</li> </ul>	1
Poor cooperation between permitted resident hunters and law enforcers	<ul style="list-style-type: none"> <li>There is no cooperation at all between hunters (who know very well the forests and who come across with many poaching incidents when in the forests) and game rangers. Hunters are seen as part of poachers and sometimes are harrassed. This situation leads to game rangers to miss on important information that can facilitate their duties.</li> </ul>	<ul style="list-style-type: none"> <li>There should be frequent meetings between law enforcers and villagers to strengthen cooperation.</li> <li>There should be arrangements to give permitted resident hunters information on changes or reforms of conservation laws and regulations.</li> </ul>	2

Challenges of permitted resident hunting	<ul style="list-style-type: none"> <li>▪ There is no fair-play in decisions to ban legal hunting. For example, when resident hunting was temporarily banned in 2015, trophy hunters were allowed to continue hunting. These kinds of decisions drive local people to poaching.</li> <li>▪ Few people buying a large amount of hunting quotas leads to many hunters to miss on quotas.</li> <li>▪ Resident hunters are not involved when decisions on hunting quotas are made at district level. Also, there is not enough transparency during distribution of hunting quotas.</li> <li>▪ Animal quotas provided do not fulfill the needs. There is also monopoly in distribution of quotas of various animals to hunters.</li> </ul>	<ul style="list-style-type: none"> <li>▪ There should be fair-play in managing local and foreign hunters.</li> <li>▪ Hunters Association should have a say in distribution of quotas so as to hold accountable a person responsible with distribution of the quotas in the district wildlife offices. There should be cooperation and communication between a person responsible with quotas distribution and hunters' association. The association should know which hunter is allowed what and where to hunt.</li> <li>▪ Hunters' association should know number of hunters available, and how much quotas have been distributed.</li> <li>▪ Number of animals per gun should be increased; instead of 2 animals per gun as it is now.</li> </ul>	3
Human settlements being adjacent to buffer zones of the protected areas	Closeness and locality of forests surrounding villagers in the Ugalla ecosystem.	<ul style="list-style-type: none"> <li>▪ Trophy hunting companies should offer temporary employment opportunities to communities especially during hunting seasons.</li> <li>▪ Education on wild animal conservation should be offered.</li> <li>▪ Trophy hunting companies should put in place arrangements to offer wild animal meat to villagers surrounding their hunting blocks.</li> <li>▪ Tourist hunting should help improve social services.</li> </ul>	4
Village game scouts are not valued and given appropriate roles in law enforcement	<ul style="list-style-type: none"> <li>▪ Village game scouts (VGS) are not paid salaries; this leads to them engaging in sabotages.</li> <li>▪ They are not valued and recognized; something which can drive them collude with villagers and engage in illegal activities.</li> </ul>	<ul style="list-style-type: none"> <li>▪ VGS should be motivated; they should be enabled to work hard.</li> <li>▪ VGS should be valued and recognized in laws.</li> </ul>	5
Poor road infrastructure during rainy seasons	<ul style="list-style-type: none"> <li>▪ Poor road infrastructure during rainy seasons. Roads are water lodged.</li> <li>▪ Poachers use means of transport such as bicycles which can be used to access areas where game rangers cannot.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Game rangers should be given resources which will enable them access many areas during rainy seasons.</li> <li>▪ There should be alternative ways to carry out patrols during rainy seasons such as helicopters etc. so as to expand patrol coverage.</li> </ul>	6

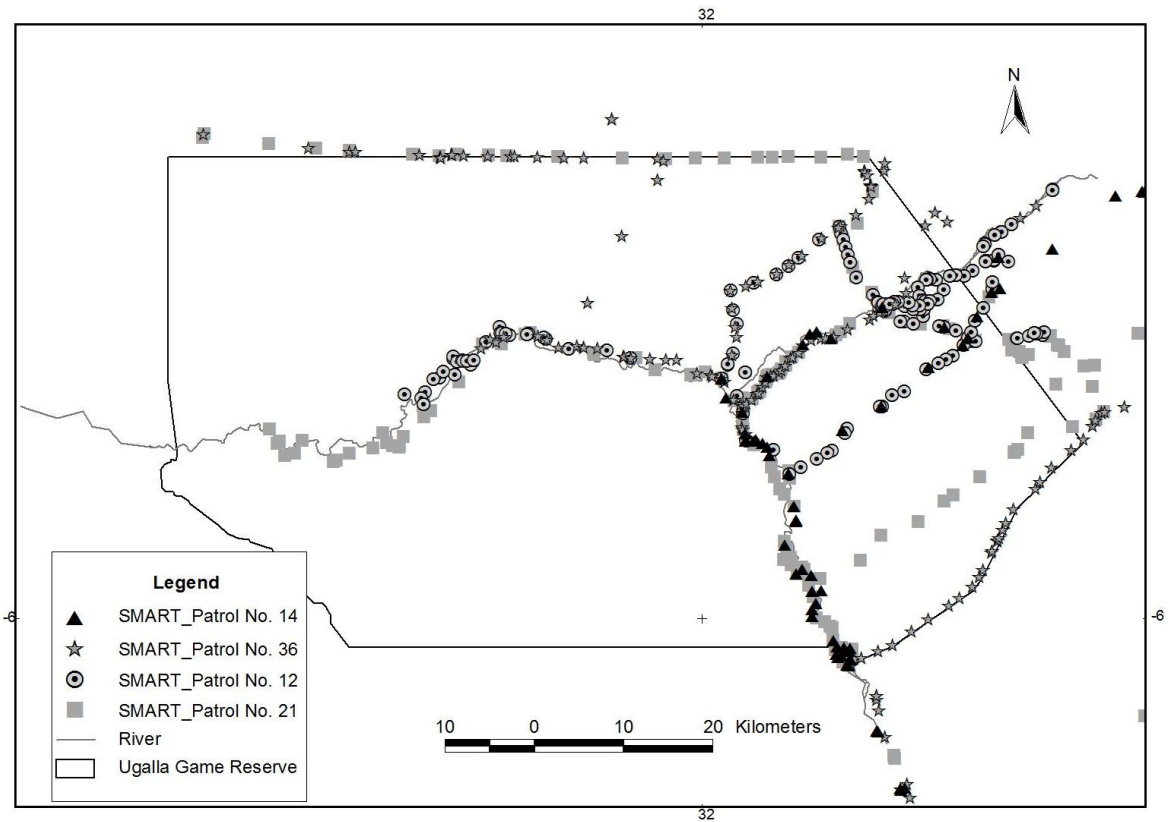
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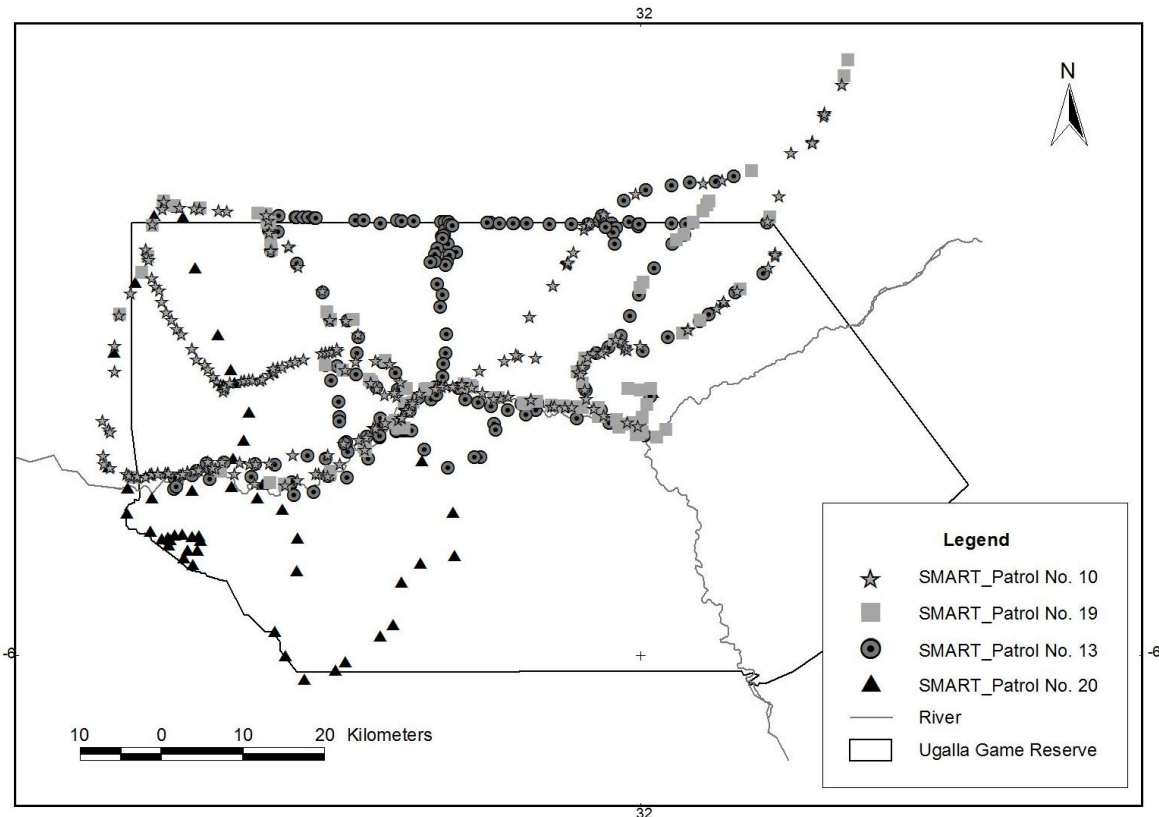


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**FIGURE S1** Ugalla Game Reserve in western Tanzania after the government separated the northern part of the former Ugalla in 2019 to form a national park

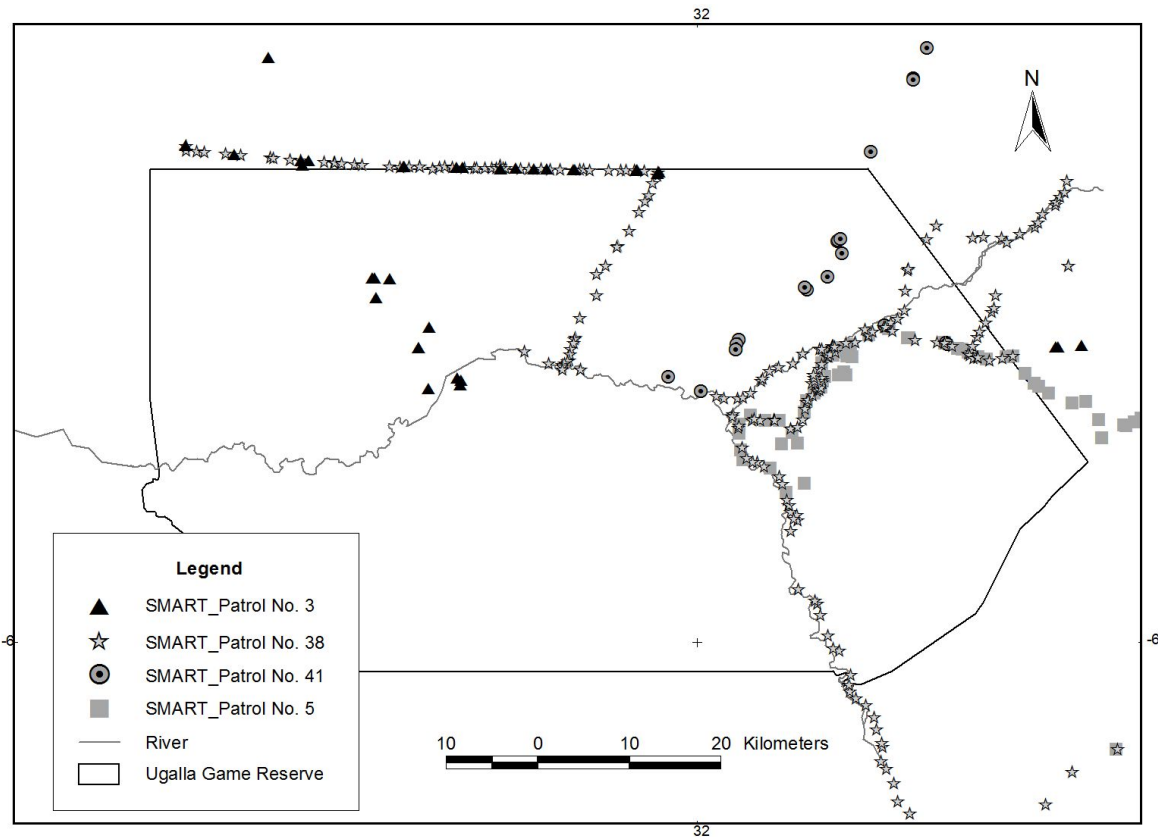


**FIGURE S2** Sample SMART patrols conducted by TAWA rangers in Ugalla Game Reserve during the dry season in the period from March 2016 to March 2018

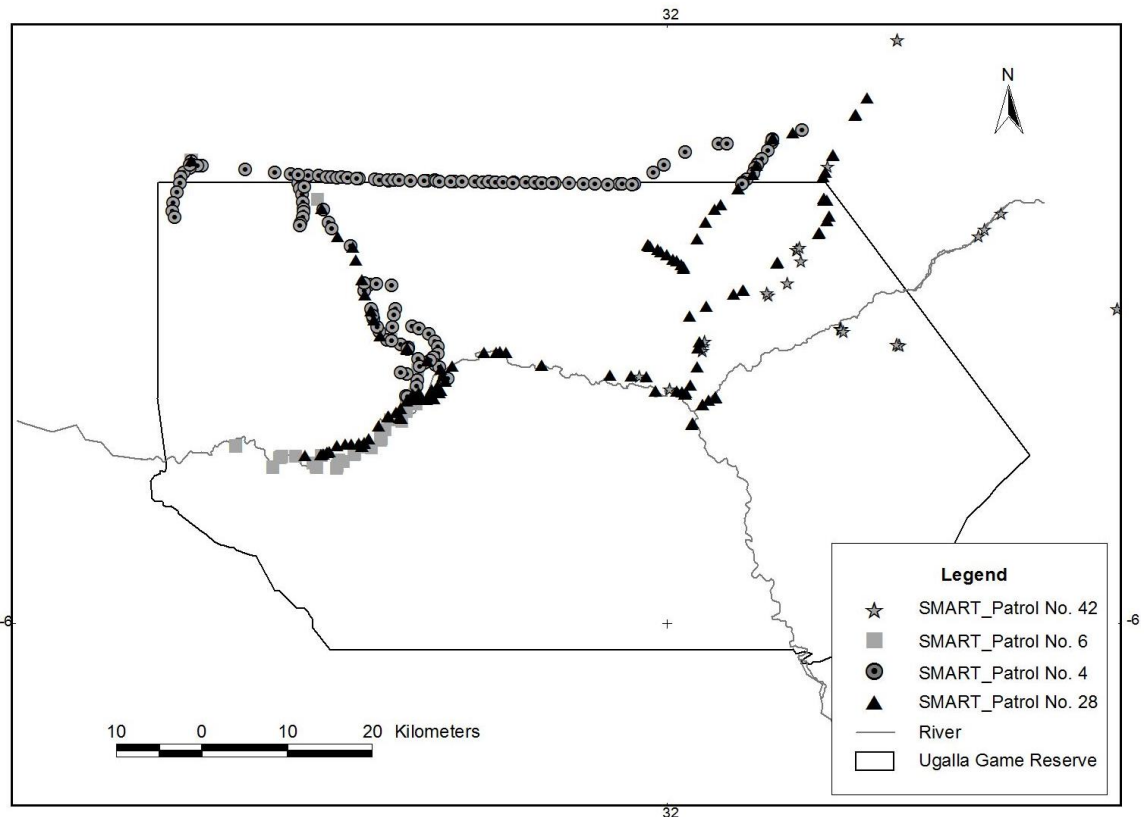


**FIGURE S3** Sample SMART patrols conducted by trophy hunting company rangers in Ugalla Game Reserve during the dry season in the period from March 2016 to March 2018.

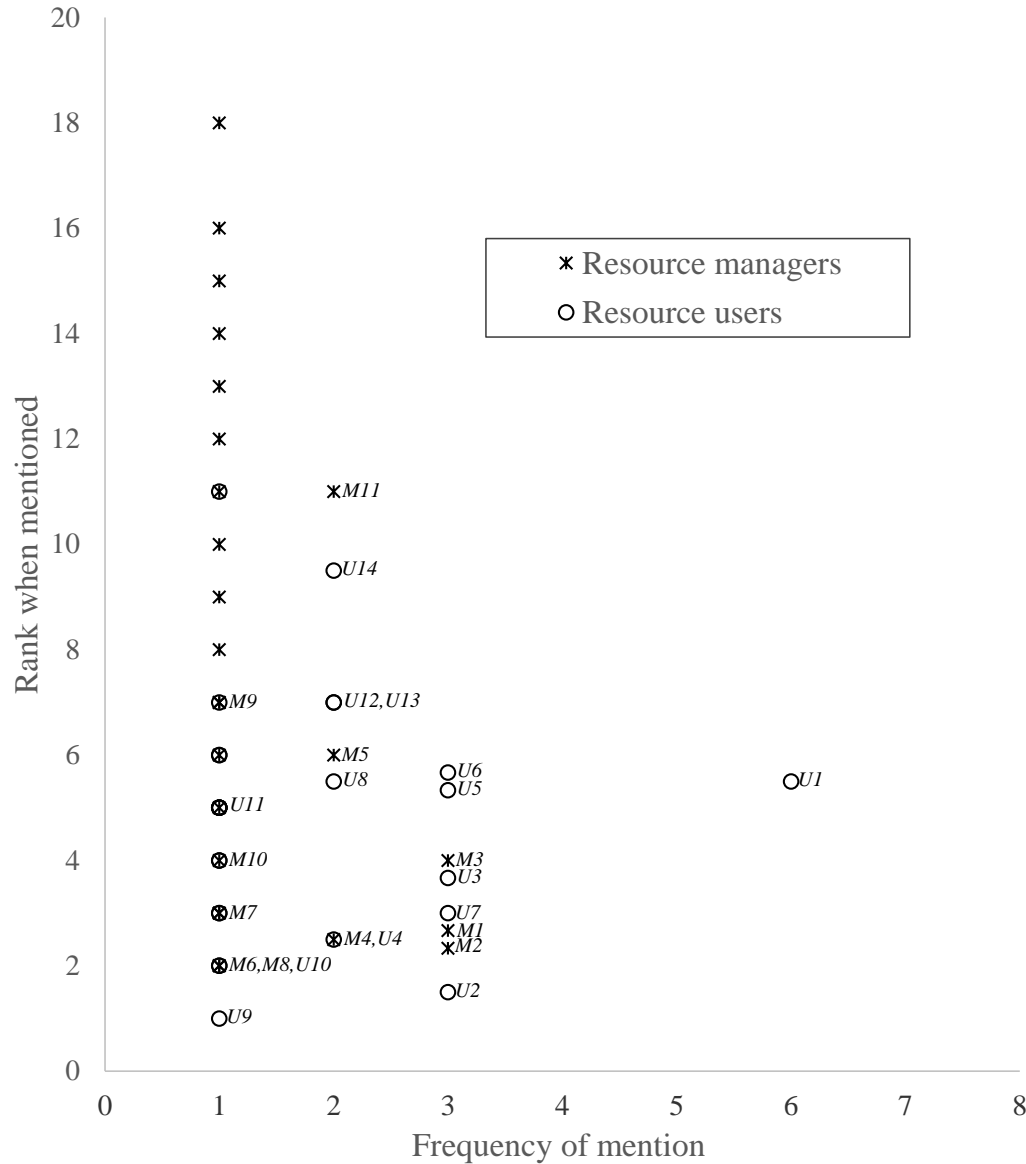




**FIGURE S4** Sample SMART patrols conducted by TAWA rangers in Ugalla Game Reserve during the rainy season in the period from March 2016 to March 2018



**FIGURE S5** Sample SMART patrols conducted by trophy hunting company rangers in Ugalla Game Reserve during the rainy season in the period from March 2016 to March 2018



**FIGURE S6** Factors contributing to unauthorised hunting in western Tanzania as mentioned and ranked by resource managers' ( $n = 4$ ) and authorised resource users' ( $n = 6$ ) focus groups. The higher values of the y-axis represent lower ranks and the lower values represent higher ranks. Factors mentioned in the main document are represented by **M** (factors discussed by resource managers) and **U** (factors discussed by authorised resource users). **M1** = inadequate equipment and technologies, **M2** = poor roads in rainy seasons, **M3** = not enough game rangers, **M4** = low pay and other incentives, **M5** = inefficiency in handling unauthorised hunting cases, **M6** = lack of motivational strategies, **M7** = reluctance in working on patrol reports, **M8** = limited budget allocated to district game officers, **M9** = mistrust among rangers, **M10** = poor cooperation between the reserve and the district game offices, **M11** = lack of ethical standards and corruption. **U1** = poverty, **U2** = lack of ethical standards and corruption, **U3** = challenges facing legal subsistence hunting, **U4** = black markets, **U5** = poor roads in rainy seasons, **U6** = unauthorised hunting behaviour among permitted resource users, **U7** = poor cooperation between resource users and wildlife rangers, **U8** = inefficiency in handling unauthorised hunting cases, **U9** = access to muzzleloaders and other guns, **U10** = no permanent ranger posts in the reserve, **U11** = inadequate equipment and technologies, **U12** = inadequate sources of income, **U13** = human settlements being adjacent to buffer zones of the protected areas, **U14** = poaching habit