Addressing the conservation challenges of human population growth: the case of the Ugalla ecosystem in Tanzania

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Abstract

Background and Aims: The human population in Africa is predicted to more than double by 2050, making up half of all births worldwide during this period. Such growth will present critical challenges for conservation across Africa if no efforts are made to actively reverse it. Unfortunately, practical steps to address these challenges are rarely discussed. We use the Ugalla ecosystem in Tanzania to explore the relationships between human population and conservation outcomes. **Methods:** This paper draws on our long-term experience as researchers working in Ugalla. We also performed a thorough online search of available literature to identify relevant reference materials, incorporating key words such as population, sub-Saharan Africa, conservation crime, and wildlife. **Results:** Ugalla is experiencing a significant increase in demand for land and other natural resources from a growing human population. Both farmers and pastoralists compete for land, and pressures on protected areas from unauthorised resource use have escalated. Current rates of population growth around Ugalla must reduce, to preserve wildlife and to ensure food availability for future generations. Ensuring access to modern contraception, advocating family planning, discouraging early marriages and unplanned pregnancies, land-use planning, enhancing capacity for entrepreneurship and livelihood diversification, and facilitating access to economic opportunities for young people are important for addressing population-driven conservation challenges. **Conclusion:** Changes in the size and composition of human populations present challenges for conservation. Addressing these challenges requires a strong understanding of local livelihoods and socio-ecological contexts. **Implications for Conservation:** While appropriate measures to ensure local people can live prosperously alongside wildlife will vary according to context, we argue that limiting population growth, despite its perceived controversy, is a key part of the solution. If done in an equitable and socially acceptable way, it can contribute to better conservation policy and practice across Africa.

***Keywords*:** protected areas, unauthorised activities, family planning, urban, hunting, sub-Saharan Africa, agriculture, livelihoods, Ugalla, Tanzania

Introduction

Although the relationship between human population growth and biodiversity conservation has long been debated (*e.g.* Wittemyer et al., 2008; Joppa et al., 2009; Crist et al., 2017; Tilman et al., 2017; Barnard et al., 2021), genuine commitment and meaningful discussion of policies and approaches to address the impacts of rapidly growing human populations on resource conservation or highlight the urgency of reversing this trend have largely been absent from conservation circles (Cafaro et al., 2022; Delacroix & Owoo, 2023).

Since the beginning of the twenty-first century, Africa's population has been the fastest growing in the world (Kaba, 2020). While some studies suggest that populations in parts of Africa could be stabilising (Sanderson et al., 2018; Mehring et al., 2020), the human population in sub-Saharan Africa is expected to quadruple by 2100, with projections indicating that it may reach nearly four billion people (Lindsey et al., 2022; Delacroix & Owoo, 2023). Considering the challenges to conservation efforts already posed by the proximity of human populations to areas of high biodiversity importance, this projected growth will result in even greater exploitation of natural resources and the conversion of more natural areas into farmland and settlements, causing biodiversity loss, and increased land use and human-wildlife conflicts (Lindsey et al., 2022; Bezeng et al., 2025; Storch et al., 2025). The literature suggests that rapid human population growth in sub-Saharan Africa requires urgent and serious attention, especially given the increasing risks associated with climate change (*e.g.* Ezeh et al., 2020; Martens et al., 2022; Gayo, 2025).

Studies show that population growth is already affecting conservation areas and people across sub-Saharan Africa. For example, the growth in the number of smallholder farmers has contributed to increased clearance of forested land for agricultural activities, exacerbating biodiversity loss in the Congo Basin (Tyukavina et al., 2018). Human population growth in the Serengeti-Mara ecosystem has increased settlements, farming and livestock herding activities, which have intensified human-wildlife conflicts and undermined the ecological integrity in and around Serengeti National Park and Masai Mara National Reserve (Veldhuis et al., 2019). Human population growth and agricultural expansion threaten the resilience of the Namibian component of the Kavango-Zambezi Transfrontier Conservation Area, as wildlife becomes increasingly restricted to protected areas, human-wildlife conflicts intensify,

and dispersal areas and migration routes are progressively degraded (Stoldt et al., 2020). Elsewhere, for example in Zambia, Ghana, and Equatorial Guinea, growing human populations and their resource demands drive livelihood-related encroachments toward protected areas, human-wildlife conflicts, isolation of protected areas, and loss of wildlife population viability (Watson et al., 2015; Amankwah et al., 2021; Tella et al., 2026).

The present human “population explosion” in Sub-Saharan Africa has been driven primarily by relatively high fertility and birth rates, and increased life expectancy (Bongaarts, 2020; Kaba, 2020; Abramova, 2022). Sub-Saharan Africa has many of the nations with the highest fertility rates in the world, particularly low- and lower-middle income countries (Chapman et al., 2022; Tesfa et al., 2023), such as the Democratic Republic of the Congo and Tanzania (UNDESA, 2022), which are also among the most biodiverse countries globally (Chapman et al., 2022). Other exogenous factors influencing immigration and emigration also contribute to population growth (Salerno et al. 2014; Mercandalli et al., 2019). Migration may result from people fleeing conflict, limited economic opportunities, droughts, declining soil fertility, and poor governance on a broader scale (*e.g.* Ezeh et al., 2020; Li & Samimi, 2022).

Different methods are marshaled to slow human population growth and mitigate its impacts depending on the reason for the growth, communities in which they are used, and contexts, but each case enhances our understanding of more effective solutions. For instance, high birth rates are addressed by prioritising education and increasing awareness of and access to birth control and family planning services (*e.g.* Doctor et al., 2013; Bongaarts, 2020); nonetheless, this is not feasible everywhere. For example, in a rural area in Sierra Leone, the community has been educated and is aware of the use of contraceptives; however, many people still resist using them (Koroma et al., 2022). In another case, Muluneh et al. (2024) suggest that women from Ethiopia’s pastoralist communities largely do not use family planning and recommend promoting women’s health and education, raising awareness, engaging men and local leaders, and improving access to contraceptives.

The conservation impacts of human population growth are mitigated through such activities as: investing in conservation education and raising awareness of environmental sustainability among different groups in society, including rural and urban populations, religious leaders, and politicians (Chapman et al., 2022; Lindsey et al., 2022). Other approaches include

involving people living near core and lightly protected areas in conservation efforts so as to improve local livelihoods while protecting ecological integrity in the face of population growth (Martens et al., 2022); and developing quality participatory land use plans and enforcing them effectively to help mitigate human-wildlife conflicts in areas where encroachment pressures on protected areas are high (Bamford et al., 2014; Lindsey et al., 2022). For example, land-use planning is advocated as a mechanism to facilitate coexistence between wildlife and expanding human populations engaged in agriculture in game management areas surrounding protected areas in Zambia (Subakanya et al., 2018).

Tanzania is among the eight countries projected to account for more than half of global population increase by 2050 (UNDESA, 2022). Pragmatic proposals are required on how to sustain natural ecosystems and wildlife population viability in the face of this trend, which interacts with, and exacerbates, other stressors on human welfare and natural ecosystems such as climate change. We address the issue of human population growth for conservation through the lens of a particular landscape in western Tanzania, the Ugalla ecosystem, to stimulate and inform constructive debate on the implications of rapid human population growth for the future of protected areas and natural resources in the country. We illustrate how interacting drivers of population growth translate into on-the-ground realities and highlight the importance of taking a context-specific view. We then suggest practical steps forward for addressing these challenges around Ugalla.

Review Approach

Study area

The Ugalla ecosystem, in western Tanzania (Fig. 1), is dominated by miombo woodlands, and supports a diverse range of wildlife. Much of this wildlife is now found within protected areas (UGR, 2006; Wilfred & MacColl, 2016). Wildlife occurring outside protected areas is mainly found in wildlife management areas (WMA), and lightly protected forest reserves, and game controlled and open areas, where regulated hunting and other resource-use activities (e.g. subsistence fishing and beekeeping) occur (UGR, 2006; Wilfred, 2018). Poverty and the need to improve living standards tend to intensify resource use (Wilfred, 2012). Demand for land for agriculture and human settlement is also increasing (Wilfred, 2012). Agriculture, the primary source of local livelihoods, is practised extensively, partly

due to the characteristically low fertility of miombo soils (Hazelhurst & Milner, 2007: Wilfred, 2018). Consequently, despite ongoing conservation efforts, protected areas are facing increasing pressure from a rapidly growing human population.

Information used

We report on human population growth and its implications for conservation in the Ugalla ecosystem, based on our long-term engagement with and knowledge of the area as researchers working in conservation and the sustainable use of natural resources. Borgerhoff Mulder et al. (2007) suggest that researchers who are working in a particular area over an extended period develop a strong understanding of on-the-ground realities and are therefore well positioned to devise practical recommendations that can improve conservation practice In addition, we conducted online literature searches using Google to identify relevant reference materials, incorporating the following key words: Tanzania, population, sub-Saharan Africa, conservation crime, wildlife, land use, family planning, protected areas, conservation education, WMA, ICT, contraception, population characteristics, livelihoods, human-wildlife conflicts, unauthorised resource use, and climate change.

The Relationship Between Biodiversity Loss and Population Growth in Sub-Saharan Africa

Biodiversity loss in sub-Saharan Africa is often associated in the literature with population growth. Particularly relevant factors include: growing demands for productive land near protected area edges; increased extraction of forest products; degradation of wetlands; degradation, isolation, shrinking and even degazettement of protected areas; and wildlife declines due to unauthorised and unsustainable offtakes (Estes et al., 2012; Salerno et al. 2014 Ryan et al., 2017; Munishi & Jewitt, 2019; Van Velden et al., 2020; Cafaro et al., 2022). These studies serve as useful yardsticks for understanding factors related to local and regional contexts and guiding targeted interventions (Salerno et al. 2014; Mercandalli et al., 2019). Other factors also influence resource use; for instance, cultural factors (Rizzolo et al., 2017), preference for particular resources (Chausson et al., 2019), presence or absence of livelihood alternatives (Wicander & Coad, 2018), agricultural land productivity (Salerno et al. 2014), food security (Jouzi et al., 2022), and limited capacity to adopt sustainable technologies (Sanderson et al., 2018). Further, at global scales, mega-consumers are responsible for

biodiversity loss, as increasing demand drives supply. For example, the international trade in agricultural commodities (Kastner et al., 2021) and wildlife (‘t Sas-Rolfes et al., 2019; Liew et al., 2021) have been important drivers of Africa’s biodiversity declines.

Population Growth Around Ugalla

The Ugalla ecosystem spans both the Tabora and Katavi administrative regions of Tanzania (Fig. 1; Supplementary Fig. S3). Tabora and Katavi are among the regions in mainland Tanzania experiencing rapid growth in human population (URT, 2024). Of the 26 regions of mainland Tanzania, Katavi recorded the highest average annual intercensal population growth rate between 2012 and 2022, at 7.1%. Over this ten-year period, the population more than doubled. According to national census data, the population was 410,452 in 2002, increased to 564,604 in 2012, and reached 1,152,958 by 2022 (URT, 2024). Tabora ranked fifth, with a growth rate of 3.9% (URT, 2024; Fig. 2). Nevertheless, in terms of absolute population growth, Tabora ranked higher than Katavi, with a population of 1,710,465 in 2002, rising to 2,291,623 in 2012, and reaching 3,391,679 by 2022 (URT, 2024). Tabora is the third largest contributor to the country’s total population, accounting for 5.7%, behind the two major cities of Dar es Salaam (9%) and Mwanza (6.2%) (URT, 2024). Tabora and Katavi both have population growth rates above the national average of 3.2%, with at least 80% of the populations in the two regions living in rural areas, where most conservation areas are found (Wilfred, 2012; URT, 2024). The combined population growth rates for the administrative districts neighbouring the Ugalla ecosystem, during the intercensal periods of 2002-2012 and 2012-2022, are more than half the corresponding growth rates of the respective regions (Fig. 2). The average household sizes in Tabora and Katavi are 5.6 and 5.3, second and third largest in the country, respectively (URT, 2024). Both Tabora and Katavi are among the five regions with the worst family planning services in Tanzania (URT, 2022)

Relationship Between Conservation and Population Growth Around Ugalla

For decades, the growing human population around Ugalla has intensified interactions between local livelihood activities and protected areas (Wilfred, 2012). Conservation challenges in the ecosystem can be traced back to the 1950s, when the area was designated as a game controlled area, in 1954, to protect concentrations of large game animals (Thomas,

1961; Fisher, 2002). Wildlife populations suffered substantial declines due to unauthorised hunting related to limited livelihood opportunities (Fisher, 2002). In 1965, Ugalla became a game reserve (Government Notice 281 & 282) to further strengthen the protection of wildlife. Ugalla Game Reserve protected approximately 5,000 sq. km. of land for wildlife until 2021. Other lightly protected areas both near and far from the reserve were vast expanses managed under different approaches, including open areas, game controlled areas, forest reserves, and WMA. In these areas, activities such as farming, cattle herding, settlement, beekeeping, fishing, and hunting were taking place. Legal subsistence hunting was also performed in open and game controlled areas under the supervision and cooperation of the national government and local authorities.

In 2021, a new national park, Ugalla River National Park, was established taking about half of Ugalla Game Reserve and additional land from a forest reserve to the north (Fig. 1; Supplementary Fig. S3). The remaining half of the reserve was extended southwards, bringing the total area of Ugalla Game Reserve to 7,577.36 sq. km. In the same year, other new Game Reserves (Luganzo-Tongwe, Inyonga, Igombe, and Wembere) were established in the previously lightly protected areas (*see* Supplementary Fig. S3). These protected areas increased the total land under protection to approximately 25,000 sq. km., compared with the 5,000 sq. km. of the former Ugalla Game Reserve. Only a few lightly protected areas were excluded from these changes, including wildlife management areas (Uyumbu and Ipole). The WMA were established in the 2000s as the main approach to community-based conservation in the area (IRA, 2007; Nelson, 2007).

Therefore, the local population in Ugalla is now largely excluded from the land and other natural resources they have been relying on. Owing to the increasing local population - from just over one and a half million to nearly three million in a ten-year period from 2012 and continuing to grow (Fig. 3) - the demand for natural resources and land for agriculture is also increasing. For example, recent surveys suggest a rise in unauthorised hunting, livestock herding, fishing, logging, and human-wildlife conflicts, and conflicts between pastoralists and farmers over limited land (Nachihangu et al., 2022; Wilfred et al., 2025).

Factors Affecting Conservation Effectiveness in Ugalla

Several factors affect wildlife conservation effectiveness in Ugalla. We address them in turn and highlight how they relate to population growth in the region.

Increasing demand for land and conflicts

In 2022, Wilfred et al. (unpublished data) conducted focus group discussions with local communities around Ugalla, and asked participants whether they had enough land for farming, and whether they had enough land for livestock herding. Nearly all focus groups suggested people have insufficient land for farming (Table 1) or herding (Supplementary Table S2). Common reasons given for this included population growth, establishment or expansion of conservation areas, and limited or less productive land (Table 1; Supplementary Table S2).

The high demand for land in Ugalla is driven by several factors. First, poor soil fertility and limited access to agricultural inputs (Fig. 4) mean that many people derive relatively low yields from their crops, which encourages them to practise extensive farming in the more fertile lightly protected areas (forest reserves, open and game controlled areas (Wilfred, 2018).

Second, Sukuma people, who are semi-nomadic agropastoralists originating from the north-western regions of Tanzania, have migrated to villages and lightly protected areas in Tabora and Katavi Regions, where they occupy extensive areas of land for cultivation, livestock herding, and settlement (Borgerhoff Mulder et al., 2007; Wilfred, 2012). Sukuma practice their traditional slash-and-burn shifting cultivation, which clears large areas of forest. They also keep large herds of cattle and other livestock, as they regard owning many cattle as a form of “bank” or wealth, and a symbol of status and prestige. Sukuma use cattle for paying bridewealth, and their families are characteristically polygamous and tend to have many children, who, they believe, provide them with labour for farming and livestock herding. Having large cattle herds in the area often puts Sukuma into conflict with other ethnic groups (e.g. Nyamwezi), who are predominantly subsistence smallholder farmers, especially when the herds graze on other people’s crops (Wilfred, 2018). Conflicts also occur when Sukuma use land that is already owned or cultivated by indigenous farmers. Clashes between farmers and pastoralists are common, contributing to food insecurity. The number of pastoralists, farmers, and new families has increased, all needing land. Although agropastoralism is

practised to secure land for both crop cultivation and livestock keeping, the large number of livestock often compels herders to seek herding lands far from their villages (Wilfred, 2012). Regardless, the land laws and regulations are more supportive of farming activities than pastoralism (URT, 1999; Mattee & Shem, 2006).

Third, the establishment of new protected areas has taken a substantial amount of land (Fig. 1; Supplementary Fig. S3) and brought human settlements and livelihood activities closer to or into protected areas. For example, pastoralists often find themselves herding within protected areas and are sometimes compelled to enter them in search of pasture. At times, people discover too late that their households, farms, and beekeeping and herding lands are within protected area boundaries where access is restricted, and find themselves without alternatives to replace the lost livelihoods. Just after the establishment of Ugalla River National Park, for example, people were given less than a month to cease their decades-long permitted beekeeping and fishing activities in the area. This close proximity to protected areas and land scarcity has increased the frequency of human-wildlife conflicts which have been common in western Tanzania (Hausser et al., 2009; Wilfred et al., 2025), causing local communities to have negative attitudes towards the conservation of protected areas. Human-wildlife conflicts arise from livestock predation, crop damage, and wildlife attacks on people. Other conflicts occur between community members and conservation authorities over frequent amendment of protected area boundaries, unauthorised resource use, and cattle herding within protected areas.

Communities living in relatively small rural villages in lightly protected areas have been involved in disputes with conservation authorities over their rights to use lands that have either been acquired or are planned for acquisition for inclusion into protected areas. Some of these communities even pressure the government for recognition of their villages and squeezing of protected areas to get more land (Wilfred, 2012). Such communities entered the forests decades ago as small families of fishermen, loggers, beekeepers, and hunters, gradually establishing permanent settlements and turning to agriculture and more commercial resource extraction. They also request infrastructure and services like local dispensaries, schools, roads, water, and electricity. These demands, and the presence of community development NGOs in the area, attract more people from outside looking for economic opportunities, contributing to rapid population growth.

Limited income generation activities

Most households in Ugalla rely on farming for the majority of their income (Wilfred & MacColl, 2010; Wilfred et al., 2025). The common cash crops are tobacco, maize and rice. Tobacco has been the dominant cash crop for a long time, but the input costs are high, and prices are weak in some harvesting seasons (Wilfred, 2012). Although tobacco companies have been supporting tobacco farmers with agricultural inputs to improve productivity, these inputs are insufficient, and many farmers continue to clear forests to create larger spaces for farmland so as to maximise profits. In the case of other cash crops, local communities often practice extensive farming, thereby increasing pressure on protected areas, particularly as population growth leads to an increase in the number of households dependent on agriculture. Our recent surveys in Ugalla suggest that agriculture, which has long been the backbone of local livelihoods, faces a number of challenges, including inadequate inputs, limited availability of agricultural land, and lack of reliable markets (Fig. 4; Wilfred et al., unpublished data).

Local community members also rely on other activities for income. These include carpentry, midwifery and traditional healing practices, small shops, local restaurants, day labour on farms, selling fruits and vegetables, selling soft and local alcoholic drinks, maize mills, tailoring, bicycle and motorcycle taxis, remittances, and technical work (e.g. house construction and repair of electronics, bicycles and motorcycles) (Wilfred & MacColl, 2010; Wilfred et al., 2025; Wilfred et al., unpublished data). However, incomes from these activities cannot meet household needs; thus, when crop yields are poor, the cost of living and food prices increase due to high demand for food. As a result, activities like unauthorised hunting, logging, honey hunting, fishing, charcoal burning also increase in order to supplement household incomes (Wilfred, 2012; Wilfred et al. 2017). For example, Wilfred et al. (2025) reported considerable levels of unauthorised hunting for income.

Unauthorised harvesting of natural resources

Most commonly extracted resources from Ugalla include bushmeat, timber, ivory, honey, fish, charcoal, building poles, and plant and animal products for traditional medicine. These are used for both subsistence and local trade, and are usually harvested illegally (Wilfred, 2012; Wilfred et al., 2017). Unauthorised hunting and consumption of bushmeat have been

reported as prevalent behaviours in Ugalla (Kisingo et al., 2022; Wilfred et al., 2025). A recent study suggests that around 25% and 30% households in Ugalla hunt for cash income and food or subsistence, respectively (Wilfred et al., 2025). The main driver of unauthorised use of natural resources is poverty, coupled with limited income-generating opportunities and a growing desire for higher income as standards of living rise (Kisingo et al., 2022; Wilfred et al, 2025).

Wilfred (2012) reported that the largest and most problematic group of unauthorised harvesters are young people, the majority of whom fail to attain post-primary education. Many aim to extract profitable resources like elephant tusks, timber, and bushmeat (*see also* Wilfred et al., 2025). The rising demand for these products and the accessibility of markets provide substantial motivation to work with traders from as far afield as Dar es Salaam who supply the necessary gear for poaching and logging in protected areas (Wilfred, 2012). As the number of young people in the area increases, this is likely to intensify the pressure on protected areas.

Ways Forward for Conservation in Ugalla

Table 2 summarises our recommendations for effective conservation of Ugalla, and presents the rationale, policy implications, and potential barriers associated with each recommendation. To address the conservation challenges facing Ugalla, and indeed similar ecosystems where rapid human population growth is occurring, in the subsequent paragraphs we recommend prioritising family planning, engagement with young people, livelihood diversification, promoting WMA, and sustainable agricultural practices alongside other forms of land use.

Family planning

Long-term family planning programmes can develop a more positive attitude towards smaller, more manageable and sustainable families (Özgür *et al*., 2000; Barnard et al., 2021). Their most important aspect is enabling people to decide for themselves when they want to have children. The first step would be to explore communities' family planning needs and priorities, and the barriers they face in accessing these services. Secondly, urgent action is needed to ensure access to modern contraception. This should go together with proper

education, awareness and access to information on the importance and benefits of contraceptives. These interventions have been shown to reduce fertility rates and prevent unintended pregnancies effectively and non-coercively (Barnard et al., 2021).

Conservation practitioners and other stakeholders in Ugalla can learn from other experiences both domestically and internationally. For instance, the Jane Goodall Institute has long integrated family planning with conservation efforts around Gombe National Park (Mavanza & Grossman, 2007). Blue Ventures provides family planning services in Madagascar through an integrated Population-Health-Environment (PHE) approach (Mohan & Shellard, 2014). Community-based family planning has been integrated into conservation-focussed PHE project in the Greater Mahale Ecosystem of western Tanzania, the Tuungane Project (Hardee et al., 2018). PHE projects are instrumental in addressing the conservation impacts of population growth by integrating voluntary and rights-based family planning services with community health, biodiversity conservation and local livelihood initiatives (*see* Barnard et al., 2021; Cafaro et al., 2022).

Interventions primarily targeted at women are key to achieving family planning objectives and improving household finances. For example, empowering women to make their own income can reduce household poverty and increase their participation in family decision-making, including family planning (Haley & Marsh, 2021; Wanjala, 2021). Encouraging women's participation in entrepreneurship and facilitating their access to savings and credit services would improve their financial capacity (Haley & Marsh, 2021). The empowerment of women must involve activities to instill knowledge about resource conservation, and make sure they consider sustainability in any income-generating activities they undertake. Regular training is essential to broaden their understanding of the income-generating opportunities and how to effectively make use of them. Prolonging women's education can remove the incentive for early marriages and unplanned pregnancies and give them a chance to mature and plan for their future (Schaffnit et al., 2019; Feyissa et al., 2023).

Land-use planning

Conservation authorities should support locally appropriate conservation practices agreed with local communities. Interventions that could work in Ugalla include: addressing soil fertility declines to reduce the need for land clearance, and maximise crop yields; allocating

designated areas to serve as rangelands and manage them in collaboration with local communities, while reducing livestock numbers to minimise conflicts between herders and farmers and reduce pressure on wildlife areas; implementing participatory land use planning to reduce overlap between incompatible land-use types; and building the capacity of local communities to defend their current land use rights.

Addressing protected area boundary disputes could foster positive attitudes towards conservation (Wilfred, 2018). One of the root causes of such conflicts is protected area extensions and frequent boundary amendments without involving the affected communities. Installing visible physical markers would make clear the current conservation area boundaries. Securing protected area boundaries, wildlife corridors and buffer zones should be done in collaboration with all stakeholders including communities, government and NGOs, so a balance is struck between various interests.

Riggio & Caro (2017) suggest that Ugalla is an important area for conservation of wildlife in the country as it contains potential corridors that connect wildlife populations between protected areas in western Tanzania and other parts of the country. Ugalla is also included among areas of high conservation value for wildlife corridors in the National Wildlife Corridors Assessment and Action Plan (MNRT, 2022). To realise the conservation of corridors, and indeed protected areas in Ugalla in practice, there must be effective local law enforcement and regular monitoring to keep conservation authorities informed about the level of compliance with land-use planning. Failure to afford proper protection for corridors, buffer zones, and dispersal areas through well-executed land-use planning means that even the newly established protected areas around Ugalla are unlikely to be sufficient to safeguard wildlife. The Katavi-Rukwa ecosystem, also in western Tanzania, is a good example, where the growing human population and their unsustainable agricultural activities pose serious threats to the ecosystem and the elephant corridor connecting it to Mahale Mountains National Parks (Giliba et al., 2022).

Promoting WMA

Tanzania’s model of community-based conservation, WMA, could in principle increase local buy-in to conservation as WMA seek to ensure fair and equitable benefit-sharing so that local people benefit from leaving some land and resources for wildlife (Kiwango et al., 2015). Recent

studies report success in some WMA in northern Tanzania (Nelson et al., 2021; Raycraft, 2023). However, considerable work remains to be done to ensure that WMA nationwide achieve their desired outcomes (Keane et al., 2019). For example, Ipole and Uyumbu WMA within the Ugalla ecosystem have largely failed to fulfil the purpose for which they were established (IRA, 2007; Nelson, 2007; Wilfred, 2010). Together, the two WMA cover approximately 3,500 sq. km of village lands that would otherwise have been allocated to livelihood activities (e.g. farming, grazing, and beekeeping), but member villages get little to no benefit from these lands (IRA, 2007; Wilfred, 2012). We suggest that WMA be reformed to provide tangible conservation benefits, keep members actively engaged, and inspire them to feel a sense of ownership of wildlife. This would prevent them from becoming short-term fixes for conservation problems, which require the constant presence of donors and NGOs to remain effective.

Reducing youth involvement in unauthorised activities

Measures to deter unauthorised behaviours in Ugalla (e.g. law enforcement) should be supplemented with interventions targeted at preventing young people from engaging in unauthorised use of natural resources in the first place. For example, the need for active engagement of young people in conservation law enforcement (e.g. as village game scouts and/or confidential informants) expressed by Ugalla communities in a recent study (Wilfred et al., 2025) presents an opportunity to empower them to combat poaching, while also serving as a potential source of income. The local communities have also expressed a desire for their youth to receive training as wildlife rangers, and to be given priority in employment opportunities in protected areas within Ugalla, rather than conservation authorities relying primarily on rangers from outside (Wilfred et al., unpublished data). Conservation practitioners in Ugalla could also draw lessons from a youth engagement initiative – “Vijana na Mazingira” (VIMA) - run in the nearby Katavi ecosystem (Milner-Gulland et al., 2020). VIMA aims to build the capacity of young people aged 12 to 35 through local projects (e.g. beekeeping) that can improve their living standards and discourage them from engaging in poaching. VIMA also raises conservation awareness among youth through organised visits to protected areas.

Conservationists could further draw on theories from the criminological literature to inform their practice (*e.g.* Nation et al., 2003; Greenwood & Turner, 2009; Weisburd et al., 2017).

For example, some approaches that could be relevant to Ugalla include raising awareness among young people of the impact of unauthorised activities on biodiversity and livelihoods, in settings that influence their lifestyle choices (e.g. parents, community leaders, peers, schoolteachers); engaging them in the initial stages of crime-prevention interventions; and ensuring that interventions address their specific needs so to increase their receptiveness and relevance (*e.g.* Nation et al., 2003; Flanagan, et al., 2019). The tendency of youth to follow in the footsteps of non-complying family members and friends must be addressed in order to stop the "intergenerational transfer" of unauthorised behaviours (Bijleveld & Wijkman, 2009; Van Dijk et al., 2019).

Diversifying livelihoods based on ICT

Livelihood diversification can help people out of the vicious cycle of resource degradation (Ellis & Allison, 2004; Gashu & Muchie, 2018). But this requires better infrastructure to facilitate access to economic opportunities in urban and peri-urban centres. The wide use of mobile phones in many rural areas of Tanzania has potential to contribute to local livelihoods. For example, mobile networks facilitate access to agricultural technologies, inputs and related services that increase crop yields (Quandt et al., 2020). Mobile phones also enable local communities to access information about opportunities for income generation (Bahia et al., 2021). Rural development officers could raise awareness of, and provide appropriate training on, the use of the internet to access relevant and reliable information. Furthermore, reliable and affordable internet connectivity is vital for effectively taking advantage of relevant opportunities (Ruiz-Martínez & Esparcia, 2020; Rolandi et al., 2021).

An internet connection and basic training in information and communication technology (ICT) by teachers in local schools and colleges can enable youth to access remote-working jobs while staying in their villages (Ruiz-Martínez & Esparcia, 2020; Matli & Wamba, 2023). ICT presents an opportunity that can be unlocked through improved basic education. For example, youth can work as agents with companies and institutions that use digital platforms, such as transport and communication companies, and banks. They can also participate in the agribusiness industry while staying in their villages (*e.g.* Arthur et al., 2024); for instance, they can generate income by working remotely with digital agriculture companies based in cities or urban centres. With ICT skills, and capacity building by the government and NGOs, youth can also work as agricultural entrepreneurs; promoting common cash crops (e.g.,

maize, rice, and tobacco) through digital markets, and networking with other stakeholders in the agricultural business. Such activities could reduce issues related to in-migration into areas where natural resources are still abundant enough to support income-generation (for example around protected areas), and address issues of rural depopulation in which younger people move away and older people cannot then maintain their livelihoods (*e.g.* Wright, 2021). Targeted investments could help integrate ICT into livelihood diversification in western Tanzania, linked to support for young people to gain the ICT-based skills needed for their future careers. Enhancing the capacity of youth for entrepreneurship and income diversification could reduce their motivation for unauthorised resource use.

Taking advantage of urban economic opportunities

Although a common strategy to reduce human pressures on protected areas has been to relocate people or deny them access to natural resources (Brockington & Wilkie, 2015), such relocations in the name of conservation have a very bad history of human rights abuses (Agrawal & Redford, 2009; Brittain et al., 2021; Weldemichel, 2022). Like other countries in Africa, areas designated for wildlife conservation in Tanzania have historically involved the relocation or resettlement of people from those areas (*see* Chatty & Colchester, 2002). For example, Ugalla Game Reserve exists today because the people who had been living in the area were resettled in the 1920s following a sleeping sickness epidemic (Fisher, 2002).

Here, we argue that if appropriately managed, programmes providing opportunities in urban areas could serve as "incentives to relocate" voluntarily for communities living near areas of conservation importance (Wright, 2021). Urban communities have comparatively high living standards, better access to health and family planning services, and opportunities for economic and educational advancement (Lindsey et al., 2022). However, their demand for food and natural resources is usually higher than in rural areas. This can result in agricultural expansion and unsustainable extraction of resources in rural areas, particularly when birth rates are also high (Cafaro et al., 2022; Chapman et al., 2022). Therefore, other measures to safeguard wildlife and natural areas, as detailed in this article, are also necessary; for example, providing access to contraception and female education in urban areas as well as rural areas to reduce rapid population growth (*see also* Chapman et al., 2022), and strengthening local law enforcement against unauthorised resource extraction and encroachments in and around conservation areas. The need to control bushmeat supply to and consumption in urban areas cannot be overstated (*e.g.* Andimile & Floros, 2021). Bushmeat consumption in urban areas is also a problem elsewhere in Africa, and studies have been conducted to find solutions, for example in Cameroon (Nana et al., 2025) and the Democratic Republic of Congo (Fa et al., 2019). In the case of

Tanzania, effective enforcement of the recently introduced game meat selling scheme, which specifies alternative sources of wild meat like wildlife farms, ranches, and problem animal control (URT, 2020), can discourage bushmeat black markets in urban areas where game meat butcheries mostly operate (Kadigi et al., 2023). However, game meat in these butcheries should be affordable for low-income urban dwellers (Kagembe et al., 2024). As a measure to control bushmeat transported to urban areas, the Tanzania Wildlife Management Authority (TAWA), in collaboration with other security organs, can install checkpoints (Andimile & Floros, 2021). The government, NGOs, and other stakeholders can also raise awareness among consumers about the impact of bushmeat consumption on wildlife and implement additional interventions to reduce demand for bushmeat in urban areas, as recommended in other sub-Saharan African countries (Chausson et al., 2019; Cisse, et al., 2025).

Well-planned and better-managed urbanisation has a place in reducing the impact of human population growth on conservation areas, with the assurance of strong and reliable institutions, sustainable infrastructure, and good governance (*see* Sakketa, 2023). As urban-based rural migrants in sub-Saharan Africa sustain their relationships with their villages of origin (Mercandalli et al., 2019; Wright, 2021), they can create economic opportunities for their rural communities through investing in farming, promoting "multi-spatial livelihoods", inspiring other community members, and contributing to diverting growing rural populations to off-forest livelihoods (Lohnert, 2017; Wright, 2021). Urban-to-rural cash remittances, via mobile phone banking, also have a role to play in rural economies (Batista & Vicente, 2023). These remittances can contribute to promoting food security, educational development, agricultural production, and livelihoods that are less dependent on natural resources (Sakketa, 2023). Conversely, they can also contribute to exacerbating unsustainable use of natural resources, if they are invested in further expansion of farm area or in hunting. It is important, therefore, to ensure that improvement in livelihoods and living standards does not lead to further unsustainable use of natural resources in the context of more people needing them. Support for communities is needed to help them move to a fewer-children future. In this way, they would be better off, improve their children's future prospects, and maintain healthier families with fewer dependent children (*see* Norrman, 2023).

There are some important caveats, though, when supporting rural economies through urbanisation, rural-to-urban migration, and externally-initiated entrepreneurship interventions in general. Firstly, people should be able to decide what they themselves need in regard to income-generating activities, training and mentorship needs (Brittain et al. 2020). Building household capacity can empower them to participate productively in the rural economy for more resilient and sustainable livelihoods (Sedlmayr et al., 2020). Secondly, rural youth out-migration should not result in depopulation and the long-run loss of people with attachments to their rural areas, as this can damage the social-ecological

system and leave areas exposed to land-grabbing and unsustainable extraction of natural resources by external actors (*e.g.* Hall, 2015; Mantero et al., 2020).

Conclusion and Implications for Conservation

The conservation impact of population growth in sub-Saharan Africa is one of the most contentious and sensitive topics in conservation, to the extent that many conservation scientists and practitioners have self-censored on the issue. This is not healthy, because changes in the size and composition of human populations are an important element of the complex, intertwined issues affecting conservation outcomes, human wellbeing, and rights. Here we have used the Ugalla ecosystem as a case study to explore some of these issues and suggest some practical ways forward.

The core issue that commentators often focus on is the contention that the natural resource-based livelihoods of many rural communities are incompatible with conservation in the face of significant population growth. Land-use pressures and unsustainable extractive use of forest resources have been central to this debate. However, the reality is complex and area-specific. In many places, conservation practitioners have been striving to achieve a balance between livelihood needs and sustainable conservation, but to no avail. In the Ugalla area, people are inherently and historically reliant on hunting, logging, peasant agriculture, beekeeping and fishing. Population growth in the area goes hand in glove with increased demand for land and forest resources. Therefore, the recent decision by the government to expand the network of protected areas could potentially help protect wildlife populations and corridors, but it may also negatively affect local livelihoods that previously relied on natural resources and land now designated as protected areas. Based on our long-term experience in Ugalla, we recommend that there should be no further expansion of protected areas; instead, the existing protected areas should be effectively managed to ensure that illegal activities are controlled (including poaching, grazing). Protected area planning also needs to ensure that enough land is available for farming, settlement, livestock herding and other activities for local populations. We further recommend taking measures to enhance family planning, implement participatory land use plans, diversify livelihoods, and get young people engaged in livelihoods that work better for them than illegal resource extraction (including potentially through better ICT, and more constructive and sustainable urban-rural linkages).

Conservationists could advocate for the importance of slowing and ultimately reversing population growth in order to save Ugalla's biodiversity in the long term. Additionally, further research would broaden our understanding of the interactions between population growth, effectiveness of conservation efforts, and sustainable use of natural resources, supporting better conservation outcomes in Ugalla and similar ecosystems elsewhere in sub-Saharan Africa. Discussions about population change need to be framed within broader debates on how best to reconcile human rights, conservation and livelihoods within real-world landscapes, rather than being based on unhelpful sweeping statements and generalisations (Newing et al., 2023). Commentators also need to be cognisant of the systemic external drivers of biodiversity loss, including climate change and global inequalities in wealth and consumption. Addressing the challenge of a growing human population requires a strong understanding of the local context and the needs of people living in those landscapes. Ultimately, a failure to plan for and end human pressure on natural ecosystems risks imposing negative outcomes on both people and biodiversity.

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Table 1: Reasons given by local communities around the Ugalla ecosystem who discussed the question of whether people had enough land for farming (Wilfred et al., unpublished data)

Response (focus groups)	Reason (frequency[a])	Selected quote
No (10)	The local population is growing, and so is the demand for land (9)	"…there are more farmers than available agricultural land"
		"…the village boundaries have remained the same since 1961"
		"…main reason for population growth is births, and then followed by immigration"
	Expansion and/or creation of conservation areas (7)	"Historically, our area was a game controlled area, and as a result, people here feel as though the land has been lent to them rather than belonging to them"
		"Conservation authorities are taking over, by force, village lands that had been set aside for the community. These areas had been reserved for future use in anticipation of increasing population and future land needs"
	Soil fertility declines quickly (1)	"…communities are forced to look for new farmland"
	Land is costly, while incomes are low (1)	
Yes (2)	There are farms (1)	"…there are many open spaces"
	There is a mixture of various income generation activities	
	Shortage of agricultural equipment and inputs (1)	"…reduces the capacity to cultivate large areas of agricultural land…"

[a]Number of times the reason was mentioned

1056

71 36

72

Table 2: Recommendations for and potential barriers to addressing conservation challenges of human population growth around the Ugalla ecosystem of western Tanzania

Recommendation	Rationale	Policy intervention needed	Potential barriers
Family planning and contraception services	Increase in unplanned and/or unintended births Population pressure on both livelihoods and protected areas	Education/awareness raising, and regular training workshops on family planning Ensure availability of family planning services, and remove barriers to accessing modern contraception	Limited political commitment, coupled with active resistance on religious grounds Limited resources (financial and personnel) to implement family planning programmes Larger families are often viewed as a source of labour Financial barriers to contraceptives
Women's academic and economic development	Many girls do not continue with their education beyond basic or primary education Child and forced marriages contribute to the rise in low-income households, particularly because they prevent women from fully participating in the family and local economy Reduced family sizes will reduce pressure on land and natural resources	More effectively prevent child and forced marriages Increase support for girls to stay in school Strengthen women's potential for effective participation in key decisions related to family size and finances Increase women's economic opportunities through affordable loans, entrepreneurship training, and markets for agricultural products etc.	Patriarchy Many incidents of child marriage remain hidden or unreported Poor quality of education in rural primary schools Many girls or teenage mothers face stigma and social isolation, which consequently affect their development and academic performance
Sustainable	Extensive slash-and-	Promote availability	Poor roads limit

farming practices	burn farming due to inherently low soil fertility Protected areas are threatened by expansion of farming activities Low crop yields relative to family sizes Conflicts between farmers and pastoralists Tensions between communities and conservation authorities over protected area extensions	of and access to agricultural technologies and inputs (equipment, seeds, fertilizers, and agrochemicals) Support interventions to prevent extensive farming Provide reliable markets and affordable loans to farmers Implement land use plans	transportation of agricultural produce Crop raiding animals Limited skilled personnel and financial resources to prepare, administer, and enforce land use plans Financial barriers to agricultural inputs
Sustainable livestock production and practices	Growth in pastoralist population places greater demand for grazing areas Grazing areas are limited as extensive farming converts grassland to crops Grazing occurs in conservation areas (game reserves, controlled areas, and national parks)	Set aside areas for pastoralists to graze their livestock (grazing zones) There should be a limit on the number of cattle a household can have	Wealthier livestock owners from other parts of the country hire locals to graze their livestock Pastoralist communities keep big herds of cattle as a sign of wealth and status Lack of political will, especially because local political representatives rely on the support of pastoralist communities
Effective wildlife management areas (WMA)	Many people have negative attitudes towards protected areas' conservation Widespread	Actively engage member villages Promote equitable sharing of benefits	Lack of willingness on the part of the government to fully decentralise the

	unauthorised resource use activities Local communities do not benefit from conservation	from WMA Build local capacity for innovative and sustainable use of WMA	management of WMA WMA are still highly dependent on donors
Youth economic development	Limited reliable income generating opportunities for youth Limited youth contribution to household income Youth perform illegal logging, hunting, and grazing activities in protected areas	Build the capacity of youth to actively participate in anti-poaching, and encourage them to engage in different short- and long-term income generation activities Youth who have been unable to continue with secondary or higher education should be allowed and supported to join institutions that offer basic training in skills they are interested in	Poor transport, electricity, internet, markets, and other key services, limit youth's access to different economic opportunities Many youth desire quick income and higher standards of living, often irrespective of the means they use to achieve them
Livelihood diversification	Livelihoods are commonly dependent on natural resources Income-generating opportunities are limited Subsistence farming does not adequately meet the basic household needs	Raise awareness and build local capacity to engage in off-farm sources of income Provide ICT infrastructure and services to facilitate access to relevant information on economic opportunities available in urban areas and elsewhere in the country	Slow pace of road and other types of development connecting urban and rural areas Low levels of literacy and education around Ugalla, so people require sustained capacity-building before they can effectively benefit from urban economies

	Provide financial education, and facilitate access to formal financial services (e.g. savings, investment opportunities, government bonds, fixed deposits, credit facilities)

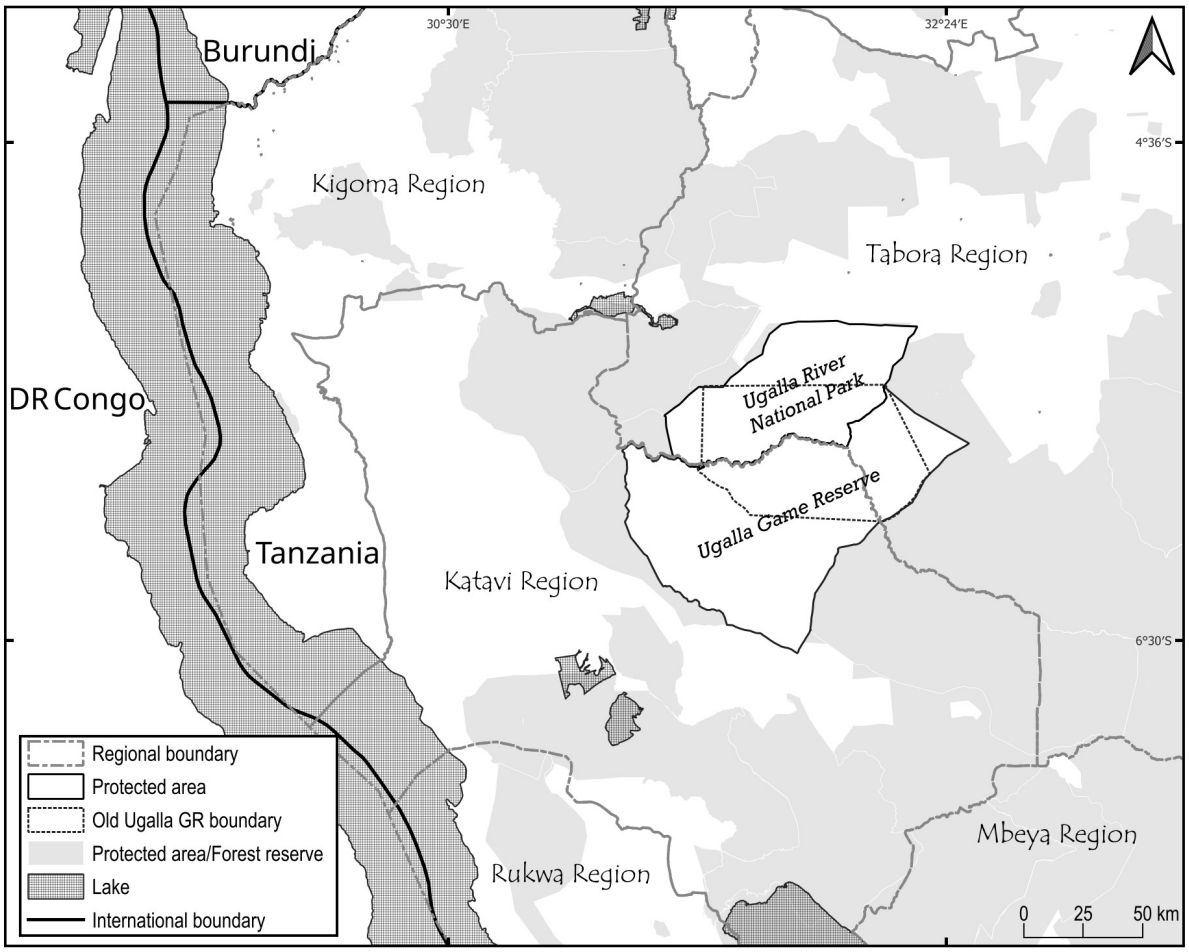

Figure 1: Western Tanzania, where the Ugalla ecosystem is located. Ugalla River National Park and Ugalla Game Reserve form an integral part of this ecosystem. These are surrounded by other conservation areas, namely game reserves, wildlife management areas, forest reserves, game controlled areas, and open areas. The former boundaries of Ugalla Game Reserve (old Ugalla GR) persisted from 1965 to 2021, prior to changes that involved the expansion of existing protected areas and the creation of new ones

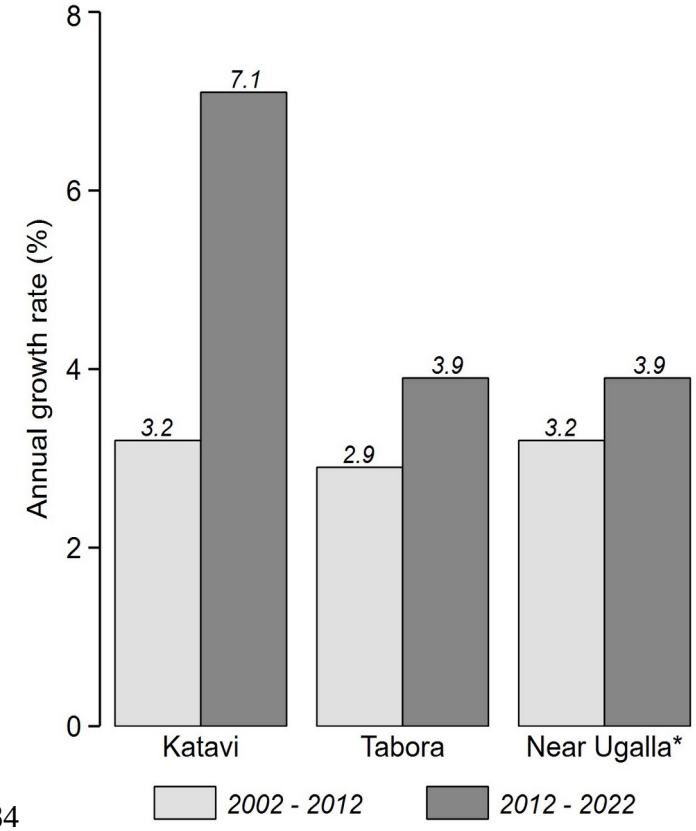

Figure 2: Human population growth rates for Katavi and Tabora regions, and districts around the Ugalla ecosystem of western Tanzania. *Combined districts within Tabora administrative boundaries (Kaliua, Urambo, Tabora Urban, Uyui, Sikonge), and Katavi (Mpanda, Nsimbo, Mlele). *Data source URL: https://www.nbs.go.tz/*

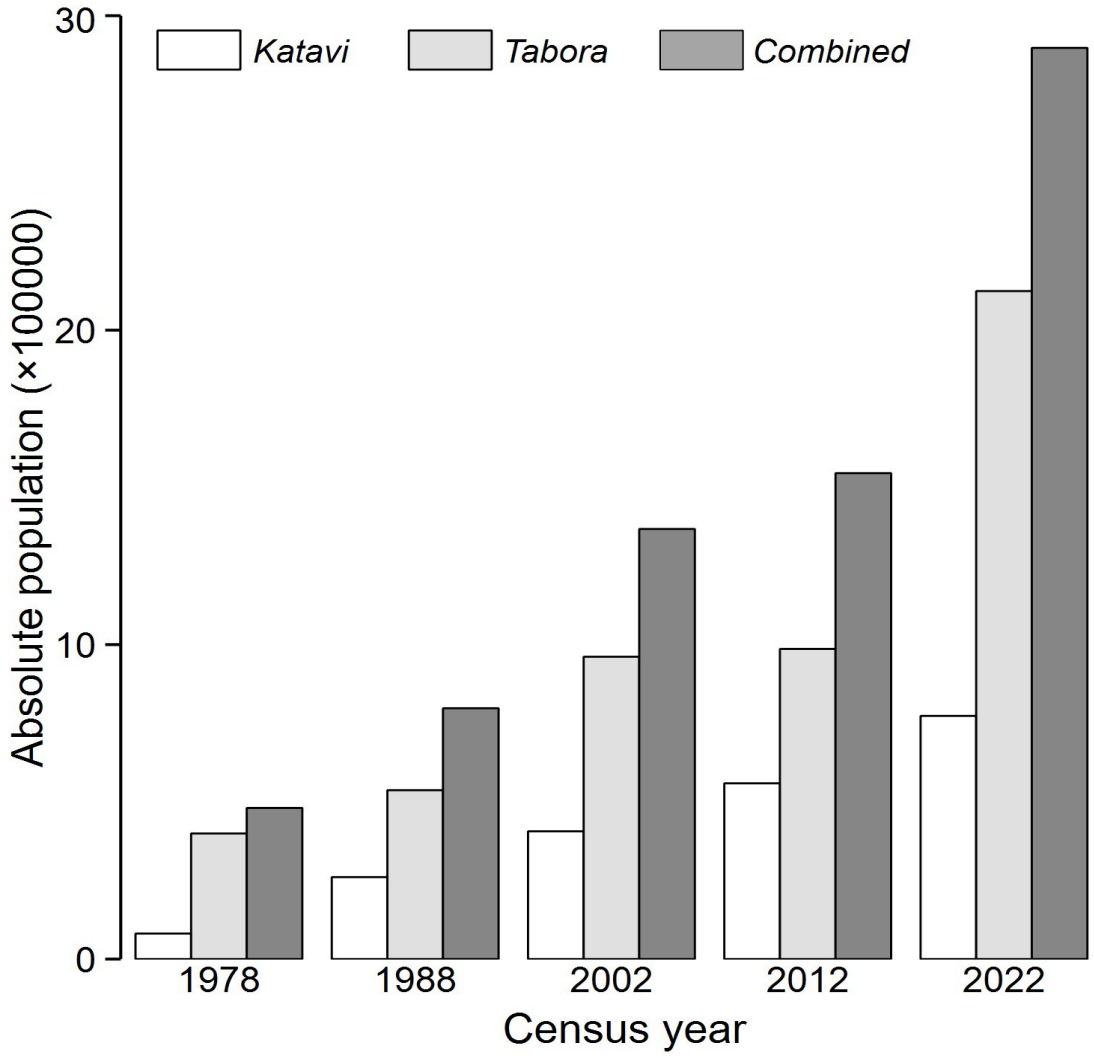

Figure 3: Human population sizes in census years 1978-2022 for administrative districts surrounding the Ugalla ecosystem. Tabora Region (Districts: Kaliua, Urambo, Tabora Urban, Uyui, Sikonge) and Katavi Region (Mpanda, Nsimbo, Mlele). *Data source URL: https://www.nbs.go.tz/*

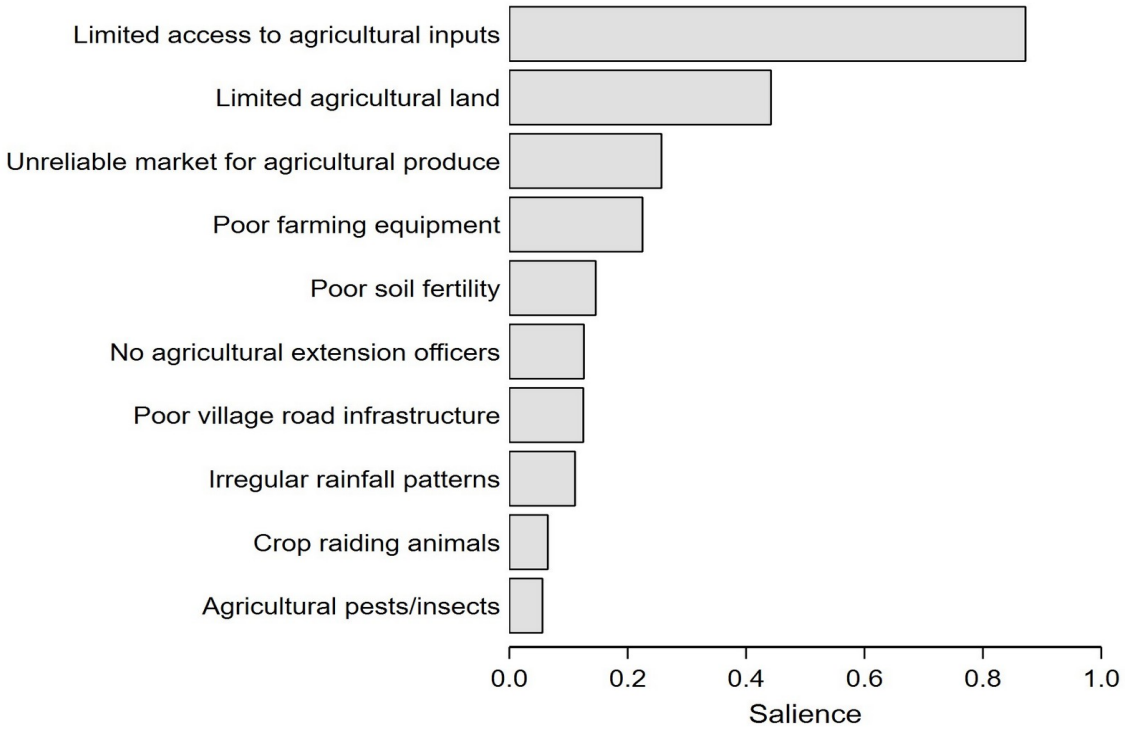

Figure 4: Salience score of the top agricultural challenges faced by the communities around the Ugalla ecosystem as ranked by 12 focus groups (score of 1 means that challenge was ranked first by all focus groups; score <1, challenge ranked lower or not ranked in every group) (Wilfred et al., unpublished data)

Supporting Information

Addressing the conservation challenges of human population growth: the case of the Ugalla ecosystem in Tanzania

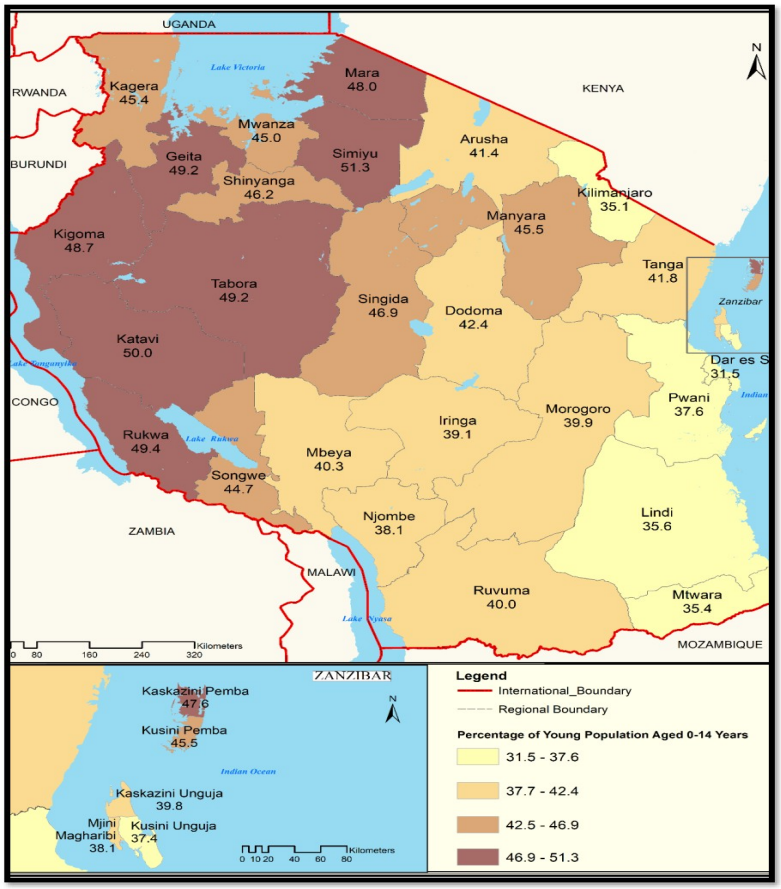

Figure S1: *Percentage distribution of total population below 15 years by region. Total population in Tanzania is 61,741,120 people*. Source: URT, 2022*b*

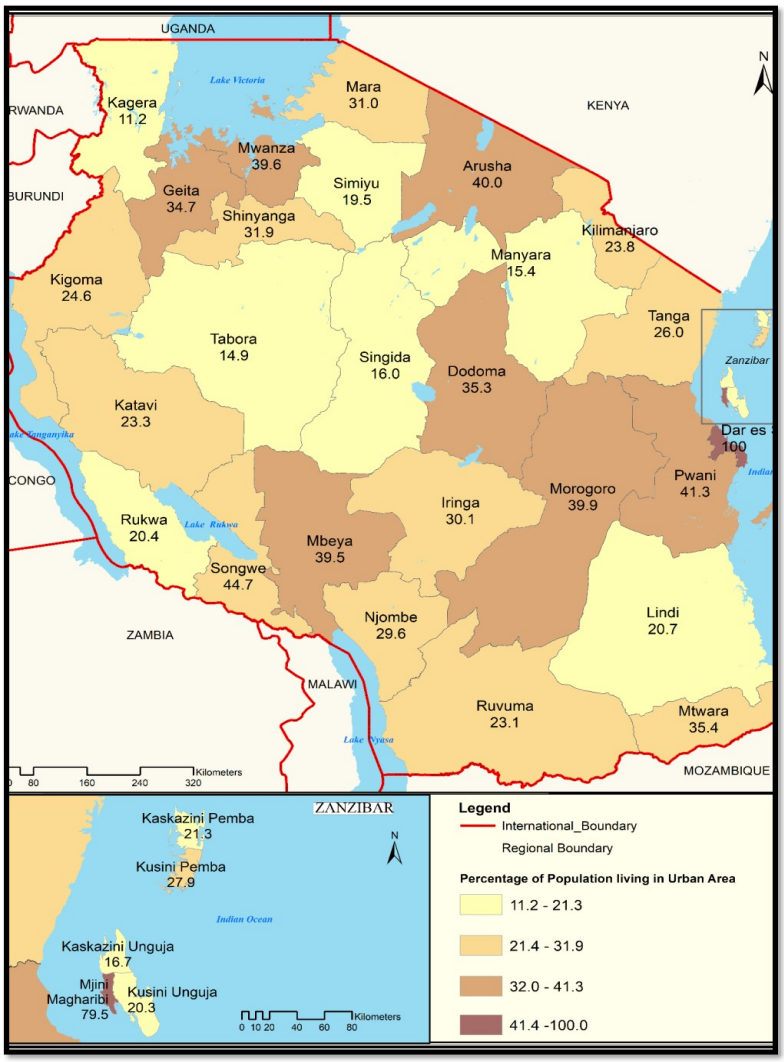

Figure S2: *Percentage distribution of population living in urban areas by region. Total population in Tanzania is 61,741,120 people*. Source: URT, 2022*b*

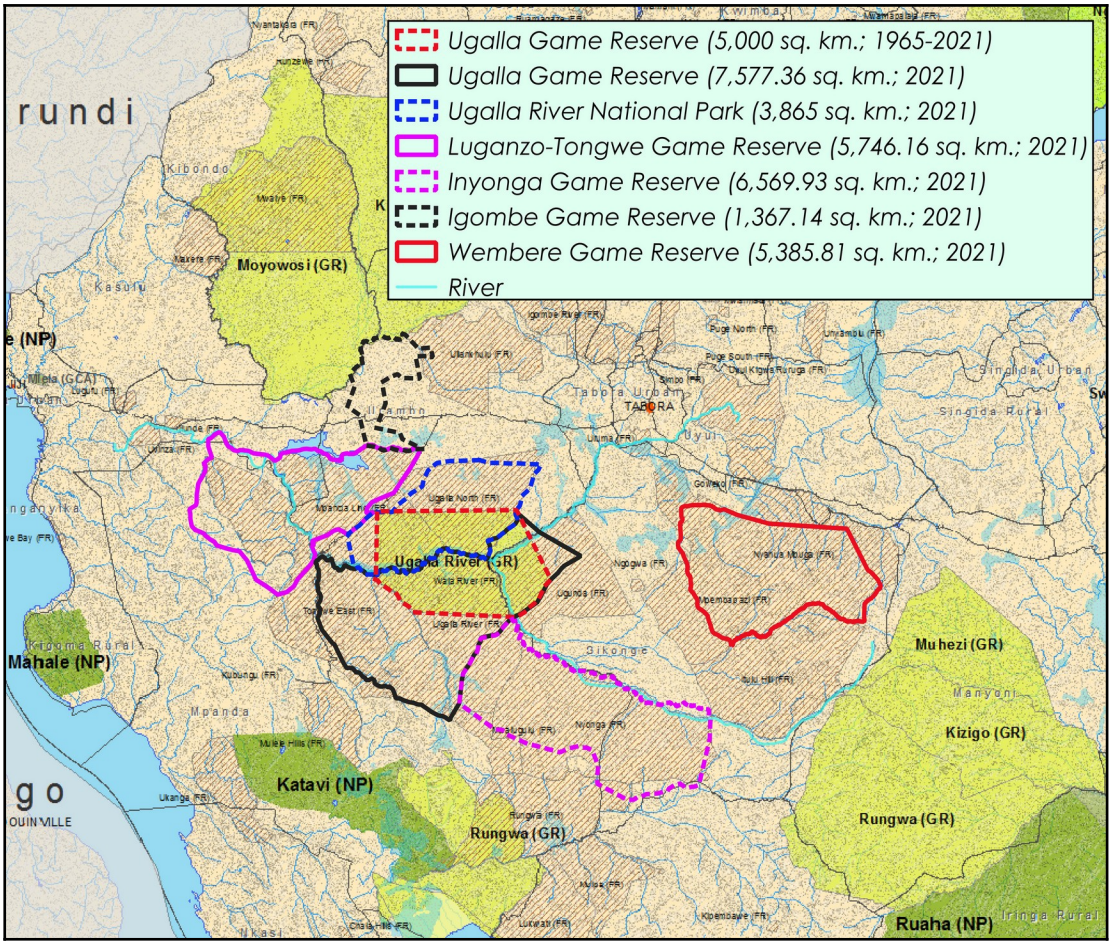

Figure S3: Western Tanzania showing changes to protected area boundaries in the Ugalla ecosystem. The boundaries became officially operational from 2021. The red dashed line in the middle shows the former Ugalla Game Reserve that lasted from 1965 to 2021.

Table S1: Human population growth rates for administrative regions near selected conservation areas in Tanzania. The administrative regions for Ugalla (Tabora and Katavi) are highlighted in bold.

Conservation area	**Region**	**Intercensal growth rate⁋**				
		1967/1978	1978/1988	1988/2002	2002/2012	2012/2022
Serengeti	Mara	2.6	2.9	2.6	2.5	3.1
	Simiyu§	*N/A*	*N/A*	*N/A*	1.8	3.0
Ruaha	Iringa	2.7	2.7	1.6	1.2	2.4
Katavi	**Katavi§**	***N/A***	***N/A***	***N/A***	**3.2**	**7.1**
Ugalla	**Tabora**	**4.4**	**2.4**	**3.6**	**2.9**	**3.9**
Muyowosi	Kigoma	2.9	2.7	4.8	2.4	1.5
Selous	Coast	1.7	2.1	2.4	2.2	6.1
	Lindi	2.1	2.0	1.4	0.9	3.2
	Morogoro	2.9	2.6	2.6	2.4	3.7
	Mtwara	2.0	1.4	1.7	1.2	2.5
	Ruvuma	3.2	3.3	2.5	2.1	2.9

§*Administrative Region established in 2012*

⁋*Data source URL: https://www.nbs.go.tz/*

NA = Not Applicable

Table S2: Reasons for people not having enough land for grazing as discussed by focus groups around Ugalla (Wilfred et al., unpublished data)

Response (focus groups)	Reason (frequency[a])	Selected quote
No (12)	Protected areas occupy a large portion of land (4)	
	The number of livestock is increasing (3)	"…grazing areas are few"
	Grazing areas have not been designated (3)	"…this causes conflicts between farmers and pastoralists"
	The available land is limited (3)	
	A large part of land is used for farming (2)	"…pastoralists do not have designated grazing areas"
	The number of farmers and pastoralists is increasing (1)	"…farmers and pastoralists are competing over the available land…"
	The human population is growing (1)	
	Pastoralism is predominantly practised in a migratory manner (1)	"…it causes conflicts between farmers and pastoralists"
Yes (0)	-	-

[a]Number of times the reason was mentioned

-No response