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Long-term funding of community projects has contributed to mitigation of illegal activities within a premier African protected area, Bwindi impenetrable National Park, Uganda

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Abstract

At Bwindi Impenetrable National Park (hereafter Bwindi), illegal activities often provide major challenges to park management. In 1994, an Integrated Conservation and Development Program (ICDP) was introduced in Bwindi as a novel park management approach that included among others, funding of community projects in park adjacent communities. This study assessed key drivers of illegal activities and the impact of long-term funding of community projects on illegal activities reduction in Bwindi. We used a 21-year-old illegal activities dataset, environmental drivers' dataset; a 21-year-old dataset of funded community projects and interviews data of 2734 households located around Bwindi for the study. A total of 3383 illegal activities and 338 funded community projects were recorded. Key drivers of illegal activities in Bwindi were accessibility and the number of funded community projects. Parishes with the highest number of community projects experienced fewer illegal activities. The number of illegal activities was negatively correlated with the number of funded community projects. Water and sanitation and household income-generating projects were the most funded. In conclusion, long-term funding of community projects contributed to reduction in illegal activities. A targeted approach of increasing community projects in those parishes that showed high incidences of illegal activities is recommended.

KEYWORDS

drivers of illegal activities, funding community projects, illegal activities in protected area, integrated conservation and development

1 | INTRODUCTION

The establishment of protected areas (PAs) is central to biodiversity conservation strategies but has often failed in meeting expectations due to human pressure on PA resources (Ponta et al., 2021). Globally, especially in the tropics, PA managers often grapple with the mitigation of illegal activities in the PAs. Increasing demand for PA

resources partly driven by human population growth and poverty has often made securing the PAs and their biological resources most difficult (Shova & Hubacek, 2011). Illegal resource extraction from the PAs is a threat to biodiversity conservation as evidenced by the pertaining negative impacts on biological, ecological, economical, and sociological resources (Denninger Snyder et al., 2019; Shova & Hubacek, 2011). Studies by Kumar and Shahabuddin (2005) and Thapa and Chapman (2010) have shown that anthropogenic resource extraction from the PAs negatively impacts the composition and diversity of flora and fauna. For example, the leading cause of defaunation and extinction of tropical mammals has been attributed to illegal hunting (Ahumada et al., 2011; Dirzo et al., 2014; Rija & Kideghesho, 2020). Often less spoken is the impact illegal resource extraction has on tourism and ecosystem services, which are critically important for many communities (Chapman et al., 2006; Naughton-Treves et al., 2005).

The roles of local communities in PA management were probably first emphasized in 1982 at the Bali Congress where it was recognized that people living near PAs can support conservation if they get appropriate benefits accrued from the PAs (McNeely et al., 1984). Other subsequent World National Parks Congresses (Caracas in 1992, Durban in 2003 and Sydney in 2014) have also emphasized the importance of local communities in PAs management. During the past three decades, novel approaches such as Integrated Conservation and Development Programs (ICDPs) for PA management have emerged. The ICDPs arose in response to the failure of the so-called fortress conservation approaches in reducing anthropogenic pressure on the PAs (Harrison et al., 2015). The ICDPs aim at addressing local development priorities and linking/funding community projects with the PA conservation outcomes and successes (Blomley et al., 2010; Sandker et al., 2009; Shova & Hubacek, 2011). After almost three decades, the ICDP strategy has had its successes, e.g., involving local communities in PA management and reduction in illegal activities, but is without doubt, not void of challenges (Blomley et al., 2010; MacKenzie et al., 2017). For example, assessments of some ICDPs have shown the prevalence of corruption and elite capture which have resulted in the exclusion of the poorest local people (Adams & Hutton, 2007; Tumusiime & Vedeld, 2012; Twinamatsiko et al., 2014). Furthermore, Blomley et al. (2010) note that law enforcement is a primary factor limiting illegal resource use, rather than the presence of ICDP interventions. This is mainly because in most tropics as is noted by several authors, illegal activities in the most PAs are mainly carried out by the poorest local community members, who have no or are limited in accessing other sources of income for their livelihoods and in most cases have benefited less from the ICDP interventions (Harrison et al., 2015; Twinamatsiko et al., 2014). As such, the poorest local community members inadvertently opt for "illegal" resource access from the PAs for survival. Most ICDPs that focus on reducing poverty have been criticized for failing to reduce threats to the PAs because of their failures in discerning better, the drivers of biodiversity loss and the costs of conservation faced by local people adjacent to those PAs (Adams & Hutton, 2007; Twinamatsiko et al., 2014). Furthermore, in some cases, the implementation of the ICDPs has been hampered by inequity, incentives being inappropriate, too low, or not reaching the right people (Harrison et al., 2015). This, therefore, has resulted in some cases of the alienation of the poorest park adjacent local community members from the ICDPs leading to the ineffective ICDPs.

In southwestern Uganda, the ICDP strategy was introduced in Bwindi Impenetrable National Park (hereafter referred to as Bwindi) in 1994 (Blomley et al., 2010). It involved introducing tourism benefits and funding local community projects by Uganda Wildlife Authority (UWA) and Bwindi Mgahinga Conservation Trust (BMCT), respectively (Bitariho et al., 2020; Blomley et al., 2010). The UWA and BMCT have been funding various community projects in park adjacent community areas since 1997 with the aim of improving local community incomes while at the same time contributing to mitigating illegal activities in Bwindi. The extent to which such funding of community projects contributes to the reduction in illegal activities within Bwindi remains poorly understood. Furthermore, no study in the region or in Bwindi has investigated the most important drivers of illegal activities in the PAs, and therefore the illegal activities drivers remain poorly understood. Longitudinal data on ICDPs such as the one used by this study are rarely collected and published since there are only few or no long-term data on illegal activities and funded community projects available in most PAs (Bernhard et al., 2021; Denninger Snyder et al., 2019). This study is based on a 21-year dataset of illegal activities and funded community projects available for Bwindi.

2 | METHODS

2.1 | Study area

Bwindi is located at the extreme end of southwestern Uganda at 0°53′ to 1° 08′S and 29° 35′ to 29° 50′E and occupies an area of 331 km^2 (Figure 1). It arguably ranks topmost as an important protected area for biodiversity

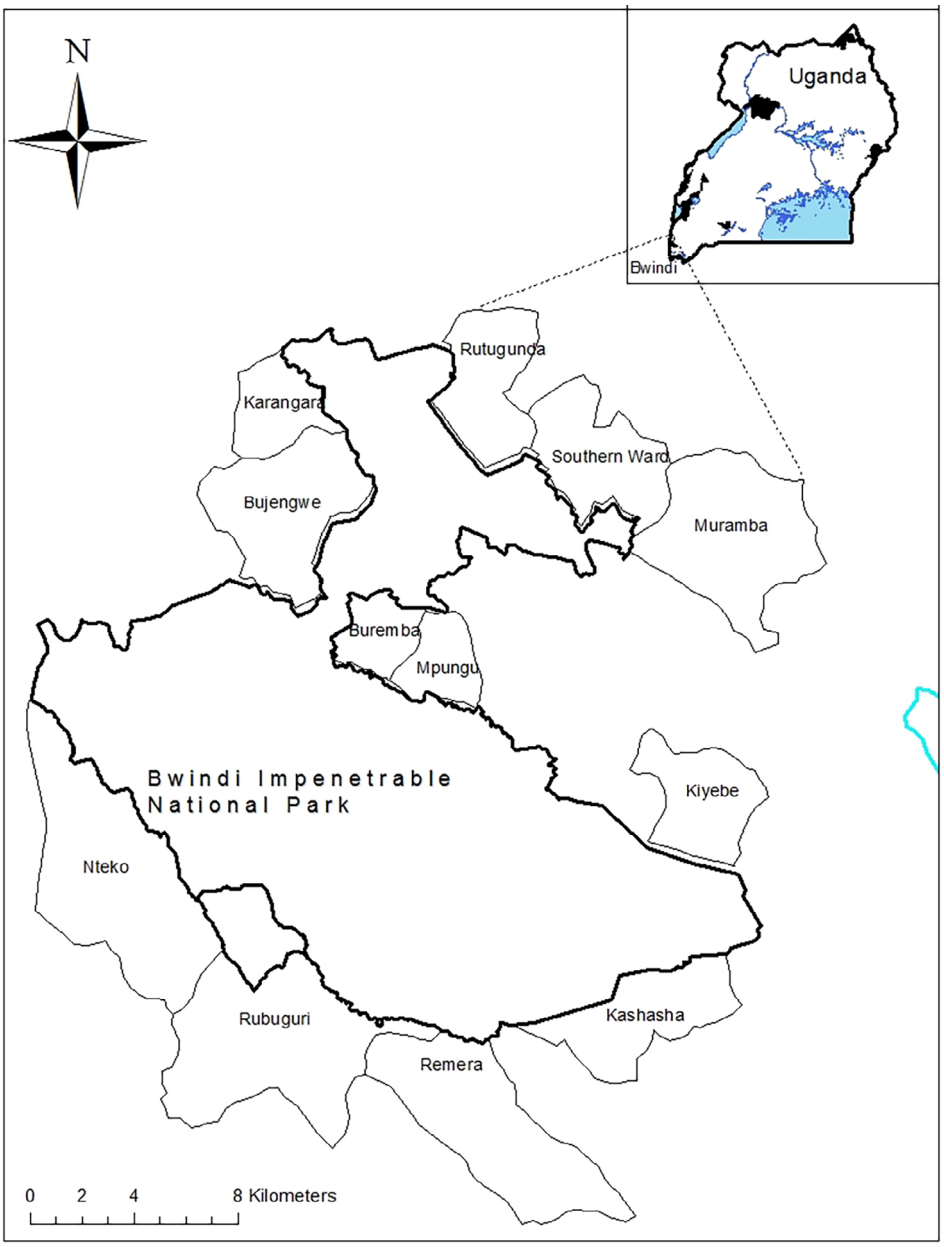


FIGURE 1 Location of the study area and the sampled parishes around Bwindi, southwestern Uganda

conservation (Bitariho et al., 2020; Plumptre et al., 2007). Bwindi's terrain is rugged with undulating hills, steep slopes, ridges, and narrow valleys with an elevation that ranges from 1190 to 2607 meters above sea level. The vegetation is of medium-elevation moist evergreen forest and high-elevation sub-montane forest. Bwindi is immediately surrounded by 25 community administrative parishes, occupied by a human population density of up to 300 people per km^2; 95% of whom rely on subsistence farming for livelihood (Bitariho et al., 2020; Plumptre et al., 2007). A parish is the second smallest administrative unit in Uganda's local government administrative structures comprising a range 8–12 villages, while a village is the smallest administrative unit that constitutes several households (Bitariho et al., 2020). These villages and parishes were the community units chosen for the study (Figure 1).

2.2 | Data collection

2.2.1 | Socioeconomic status of households and funded community projects

We used household interviews to assess the socioeconomic status of households, households' perceptions of illegal activities, and the number and types of funded community projects in the study parishes around Bwindi. Before the interviews, we stratified the households into three categories grouped by the districts and parishes'

local government administrative structures. The three categories of the districts were Kisoro, Rubanda, and Kanungu districts and the parishes were from all the 25 frontline parishes around Bwindi. The stratification helped to cater to study precision, considerations of study costs, and effectiveness of our sampling procedures in the study area (Bennett et al., 1991; Clark & Steel, 2007). We then used a simple random sampling procedure for the 25 frontline parishes from which 12 parishes were selected for the household interviews (Figure 1). The simple random sampling procedure was done by attaching, listing, and writing numbers of all the 25 frontline parishes on pieces of paper, placing them in a box, shuffling them, and then randomly selecting the first 12 parishes as shown in Figure 1. Household interviews were carried out in the 12 parishes by interviewing household heads using previously prepared semi-structured interview questionnaires. Together with local guides who we recruited per parish prior to commencement of the study, we administered and filled in the semi-structured questionnaires to the household heads. The interviews took 3 months and were carried out in the local language of Rukiga both we and the interviewees are well conversant in. When household heads were not found at home, the interviews would be rescheduled for another day/or where possible the next of household head kin interviewed (Bernhard et al., 2021). Information collected using the semi-structured questionnaires included key information on respondents (gender, age, and source of income), number of individuals per household, and their views on factors considered important in the reduction in illegal activities in Bwindi. We also recorded the locational Global Position System (GPS) coordinates of the sampled households after the interviews. Furthermore, data on the location, number, and types of funded community projects were collected using the semi-structured questionnaires and personal observations. The funded community projects were those funded by UWA and BMCT and were identified by the local community members during the interviews while others such as schools, health centers, and roads were easily identified by the labels/signposts tagged to the projects with information about the funding organizations and the year the projects were funded. Locational GPS coordinates of each funded community project in the study parishes were also recorded.

2.2.2 | Illegal activities in Bwindi adjacent study parishes

Every 5 years, mountain gorilla censuses are carried out in Bwindi, and during this activity, illegal activities data are also recorded concurrently with the census (Hickey et al., 2019; McNeilage et al., 2006). The illegal activity data (concurrently with gorilla censuses) have always been collected in Bwindi since 1997. Whereas 5-year period intervals are preferred for the mountain gorilla censuses, logistical and funding issues often affect the data collection intervals. For this study, data on illegal activities number, type, and locations within Bwindi were collected over a 21-year period (in a 5- to 6-year period intervals of 1997, 2002, 2006, 2011, and 2018). The illegal activities data for the years 1997, 2002, 2006, and 2011 were retrieved from the Institute of Tropical Forest Conservation's (ITFC) gorilla census data archives, while that of 2018 was kindly provided by the International Gorilla Conservation Program (IGCP) through a Memorandum of Understanding. During the Bwindi's mountain gorilla censuses, survey teams follow a "sweep" method, where an irregular network of reconnaissance routes across the entire park is walked while recording the number, types, and locations of all encountered signs of illegal activities (Hickey et al., 2019; McNeilage et al., 2006). The illegal activities observed during the censuses and used for this study were as follows: evidence of snares, pole cuttings, tree cuttings, firewood collection, wild honey/wild yams collection, and sights of hunting dogs/poachers. For this study and similarly to what Bernhard et al. (2021) did, these different types of illegal activities were all grouped or lumped into one entity of "illegal activities" to mean the human-induced livelihood park resource extraction activities.

2.2.3 | Illegal activities drivers and modeling in Bwindi

We selected spatially explicit drivers with importance to illegal activities based on our research experience, knowledge, and published literature, e.g., Denninger Snyder et al. (2019); Ponta et al. (2021); Shova and Hubacek (2011). The drivers included those related to the environment, i.e., accessibility, terrain ruggedness, elevation, friction, slope, aspect, and tree cover; and those related to anthropogenic covariates such as the funded community projects by BMCT and UWA, i.e., the number of funded community projects (ICDPs). We downloaded the environmental driver datasets important to illegal activities for Bwindi from various web sources in raster formats (see Table S1). The descriptions, units, and sources of these drivers are shown in Table S1. The drivers related to ICDPs were derived from the georeferenced funded community projects' locations recorded during household interviews. Furthermore, the ICDP locational data sets in vector format were converted to raster data formats for use in the modeling of the drivers of illegal activities in Bwindi.

The resultant geospatial data of illegal activities' drivers were then imported into the Geographical Information System (GIS) in the R statistical computing language for processing and modeling. Because the drivers' data originally had different projections, resolutions, and extent, we processed the drivers into a uniform projection, grid cell size, and alignment, and the spatial extent to ensure consistency across all driver data layers using the "raster" package (Hijmans & van Etten, 2014). This was done using the *projectraster* function of the same package to project all data to Latitude/Longitude projection with a grid cell size (resolution) of 1 km. We then used bilinear interpolation and nearest-neighbor resampling methods for continuous and categorical drivers, respectively. The number of community funded projects (ICDPs) was used for assessing the relationship between implemented ICDPs and illegal activities. We first summed up the number of ICDPs implemented in each of the 12 frontline parishes neighboring Bwindi, assigned the number of the ICDPs to each of the parishes, and then created a shapefile of the number of ICDPs for those parishes, which we later rasterized for use as a covariate using the *rasterize* function of the "raster" package.

2.3 | Sample size determination for household interviews

Using a list of the number of households found in each of the 12 parishes obtained from the latest Uganda household census data (UBOS, 2018), the sample size of the required households for interviews in each study parish was calculated using Slovin's formula as recommended by Susanti et al. (2019); Singh and Masuku (2014). The Slovin's formula used for sample size calculation of the households for interviews was as follows:

$$\boldsymbol{n = N / (1 + N e^2).}$$

Where $\boldsymbol{n}$ = Number of households to be sampled per parish, $\boldsymbol{N}$ = Total number of households per parish as determined by the UBOS (2018) data, and $\boldsymbol{e}$ = Error tolerance (level). We then used the confidence interval of 95% (margin error of 5%) for the households that were sampled in the study area.

2.4 | Data analysis

All data from household questionnaire interviews and illegal activities data were collated in Microsoft Excel spreadsheets, and then analyzed using appropriate statistical techniques as described below. We conducted the data analysis using R statistical software while assuming statistical significance at 95% confidence interval for two statistical tests used (Kruskal–Wallis chi-squared and F-test) (Bitariho et al., 2020; R Core Team., 2018).

2.4.1 | Socioeconomic status of households and funded community projects

The household interviews data were analyzed using Microsoft Excel and then tabulated to compare the social economic status of households in the different study parishes. The GPS data of the funded community projects in Microsoft Excel were exported (after conversion into csv file type) into ArcGIS 2016 version 10.5 software and then overlaid-on map of Bwindi and the study parishes to show the distribution of the funded community projects.

2.4.2 | Illegal activity data

The GPS data of the illegal activities entered in Microsoft Excel were exported (after conversion into csv file type) into ArcGIS 2016 version 10.5 software and then overlaid-on map of Bwindi to show the location and distribution of the illegal activities within Bwindi and the adjacent study parishes. Furthermore, comparisons of the distribution and abundance of illegal activities over the study years (1997, 2002, 2006, 2011, and 2018) were made using boxplots plotted using "ggplot2" in Rstudio 2021 version 1.4.1717 software. Statistical inferences to test for differences in illegal activities between the study years were made using a Kruskal–Wallis chi-squared test in Rstudio 2021 version 1.4.1717. The impact of funding local community projects on the number of illegal activities observed in the study parishes was tested and plotted using a simple linear regression relationship in Rstudio 2021 version 1.4.1717 software (Bernhard et al., 2021). This was after logarithmic transformations of the data to attain a normal distribution so as to meet the assumptions of linear regression analysis (Pek et al., 2017). After plotting the linear regression plot, the overall significance of the regression model was tested using a one-way ANOVA, F-statistic (Pek et al., 2017; Sureiman & Mangera, 2020).

2.4.3 | Modeling drivers of illegal activities in Bwindi

We used the free MaxEnt software (version 3.4.1) and R packages "dismo" (version 1.4.1717) and ENMeval (version 0.3.0) to model the illegal activities drivers in Bwindi (Denninger Snyder et al., 2019). This was by the construction of separate models for a 5-year illegal activities data of

TABLE 1 Family size and source of income for study households

Parish	Average number of individuals per household	% subsistence farming	% small business	% formal employment	% informal employment (casuals, etc.)
Bujengwe ($n = 226$)	7.4	87	1	8	4
Buremba ($n = 150$)	7.2	92	5	1	2
Karangara ($n = 215$)	6.8	88	2	6	4
Kashasha ($n = 254$)	7.1	94	0	2	4
Kiyebe ($n = 213$)	6.9	93	3	1	3
Mpungu ($n = 169$)	6.9	93	5	1	1
Nteko ($n = 293$)	7.8	88	7	1	4
Remera ($n = 284$)	7.1	85	2	3	10
Rutugunda ($n = 223$)	6.9	84	5	4	7
Southernward ($n = 211$)	6.8	81	5	6	8
Muramba ($n = 202$)	7.1	92	4	1	5
Rubuguri ($n = 294$)	7.1	91	5	2	2
Average ($n = 2734$)	7.0	89	3	3	5

1997, 2002, 2006, 2011, and 2018. The MaxEnt models used were multivariate and implemented using the maxent function in the "dismo" package of R (Denninger Snyder et al., 2019; Hijmans & van Etten, 2014). The ENMevaluate function in the "ENMeval" package was used to identify optimal parameter settings needed to maximize model predictive ability while avoiding overfitting (Muscarella et al., 2014). This was done using feature types, the maximum number of iterations, and regularization parameters identified by the model with the lowest Akaike information criterion (AIC) value as returned by the ENMevaluate process (Denninger Snyder et al., 2019). We assumed models with an AUC value of 0.70 to be of good model fit (Muscarella et al., 2014). Furthermore, we used the AUC jackknife to assess variable importance and identify the most important drivers of illegal activities in Bwindi based on the permutation importance above. The jackknife test of variable importance was used to tease apart the importance of each individual driver. The driver with the highest AUC value, when used in isolation of others, was the one considered most important by itself. The driver which decreased the AUC value the most when omitted was the one with the most information that is not present in the other drivers.

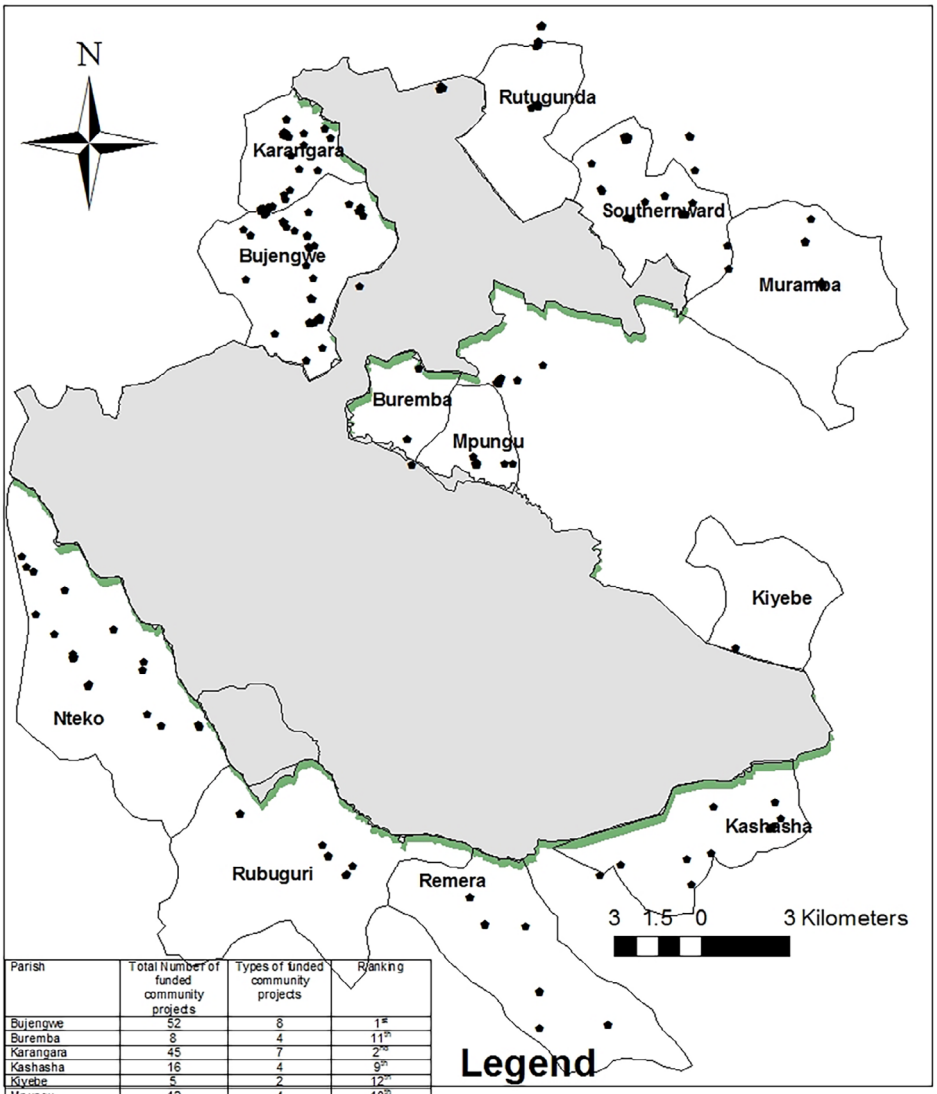
3 | RESULTS

3.1 | Demographic profiles and perceptions of interviewed households

A total of 2734 household heads from 12 parishes around Bwindi were interviewed (Table 1), 52% being females. Majority (56%) of the interviewed household heads were aged between 21 and 40 years, 42% aged above 60 years, and 2% below 20 years. Generally, 89% of the interviewed households derived their income from subsistence farming with only less than 3% being formally employed (Table 1). In the parishes of Kashasha, Kiyebe, Mpungu, Buremba, and Muramba, over 92% of the households depended on subsistence farming. The average family size in all the study parishes was 7 individuals per household (Table 1). The Parishes of Nteko, Bujengwe, Buremba, Kashasha, Muramba, and Rubuguri had the largest number of individuals per household in descending order while those of Karangara, Southerward, Rutugunda, Mpungu, and Kiyebe had the least in ascending order. Most respondents (~47%) felt that funding of community projects (ICDPs) was the most important factor in reducing illegal activities in Bwindi. The sensitization of communities by park managers was ranked second (25%), provision of employment in the park ranked third (22%), and the imposition of tougher penalties on the wrongdoers (poachers, etc.) ranked the least (6%) by respondents in reducing illegal activities in Bwindi.

3.2 | Community projects funded in the study parishes

In total, 338 community projects were funded by both BMCT and UWA in all the study parishes (Figure 2). These were nine distinct types, that is water and sanitation projects, tourism projects, school support projects, road construction projects, problem animal management



Parish	Total Number of funded community projects	Types of funded community projects	Ranking
Bujengwe	52	8	1st
Buremba	8	4	11th
Karangara	45	7	2nd
Kashasha	16	4	9th
Kiyebe	5	2	12th
Mpungu	12	4	10th
Nteko	34	8	5th
Remera	24	6	8th
Rutugunda	40	7	4th
Southernward	43	6	3rd
Muramba	25	5	7th
Rubuguri	34	5	5th
Total	338	NA	NA

FIGURE 2 Distribution and number of funded community projects in the study parishes around Bwindi

interventions projects, health centers and so forth. (Figure 3). Of these, the most funded community project types were the water and sanitation projects, individual household income-generating projects, and the school support project types in descending order, while the least funded were tourism and problem animal management project types (Figure 3). The water and sanitation projects included rainwater harvest tanks, gravity water schemes, and ventilated improved pit latrines (VIP), while the individual household income-generating projects were livestock farming (piggery and goat rearing), passion fruit growing, and beekeeping projects. The parishes with the highest number of funded community projects (ICDPs) and with the most varying/distinct community projects in descending order were Bujengwe, Karangara, Southernward, Rutugunda, and Nteko while those with the least number of funded community projects and the least varying /distinct ICDPs in ascending order were Kiyebe, Buremba, Mpungu, and Kashasha parishes (Figure 2).

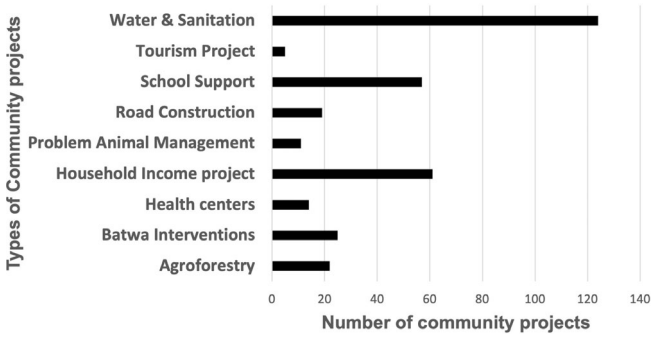
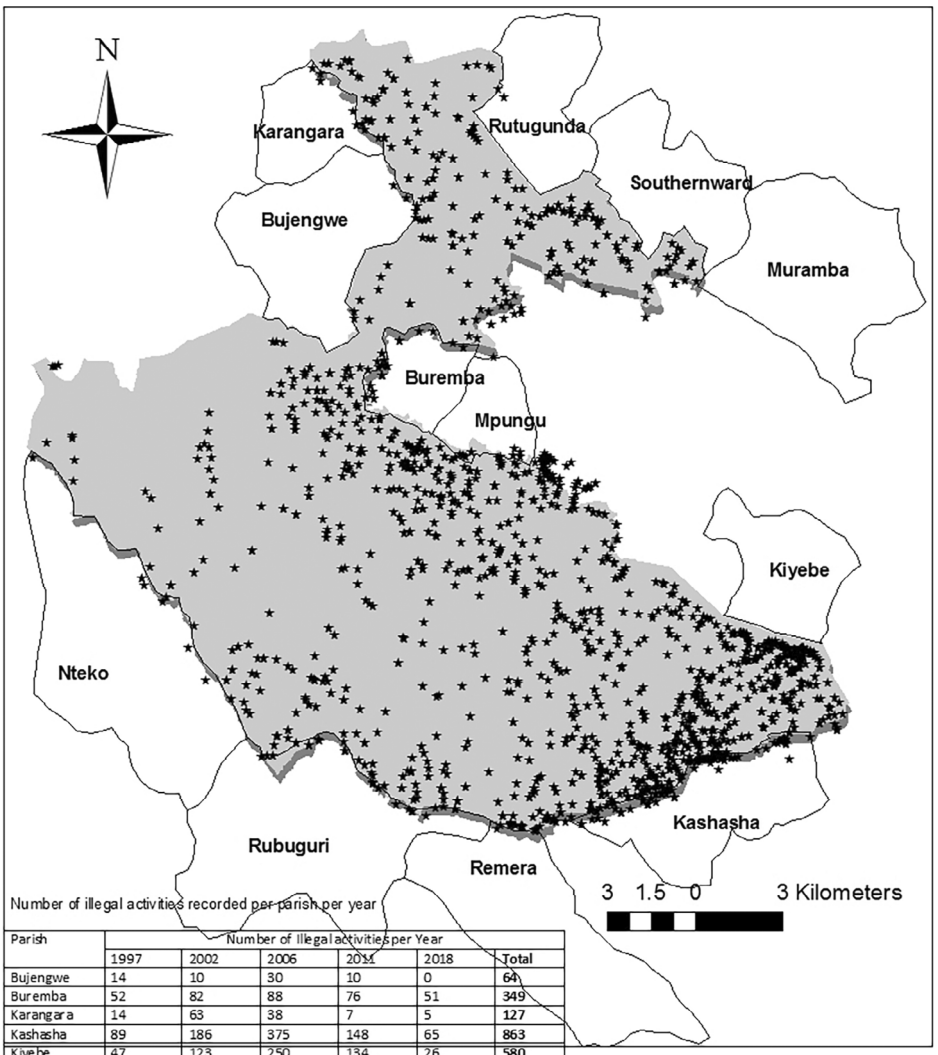


FIGURE 3 Types and number of funded community projects in the study parishes around Bwindi



Number of illegal activities recorded per parish per year

Parish	Number of Illegal activities per Year					
	1997	2002	2006	2011	2018	Total
Bujengwe	14	10	30	10	0	64
Buremba	52	82	88	76	51	349
Karangara	14	63	38	7	5	127
Kashasha	89	186	375	148	65	863
Kiyebe	47	123	250	134	26	580
Mpungu	51	107	128	102	16	404
Muramba	41	81	105	12	4	243
Nteko	0	18	60	0	2	80
Remera	64	87	126	43	2	322
Rubuguri	68	62	88	23	5	246
Rutugunda	4	6	8	5	1	24
Southernward	6	16	58	1	0	81
Total	**450**	**841**	**1,354**	**561**	**177**	**3,383**

FIGURE 4 Distribution and number of illegal activities in the study parishes around Bwindi

3.3 | Distribution and number of illegal activities in Bwindi

The hotspot areas of illegal activities were at the park boundaries and in the southeastern part and the "neck" of Bwindi (Figure 4). These were areas close and adjacent to parishes of Kashasha, Kiyebe, Mpungu, Buremba, and Remera in descending order. A total of 3383 illegal activities were recorded in Bwindi over the 21-year study period. The number of illegal activities recorded in Bwindi significantly differed between the different study years (Kruskal–Wallis chi-squared = 10.729, $df = 4$, $p = .02978$ at 95% confidence interval). The highest number of illegal activities were recorded in the year 2006 (1354) while the least was recorded in 2018 (177) as shown in Figure 4 and Figure 5. The illegal activities increased from 1997 up to a maximum in 2006 and started decreasing immediately thereafter (Figure 5). The five parishes of Kashasha, Kiyebe, Mpungu, Buremba, and Remera accounted for 74% of all the illegal activities recorded in Bwindi. Parishes with the least number of illegal activities in ascending order were Rutugunda, Bujengwe, Nteko, and Southerward (Figure 4). Similarly, these were the parishes with the highest number and most varying funded community projects as discussed previously.

3.4 | Important drivers of illegal activities in Bwindi

Park accessibility was the most important driver of illegal activities in Bwindi over a 3-year period of 1997, 2006,

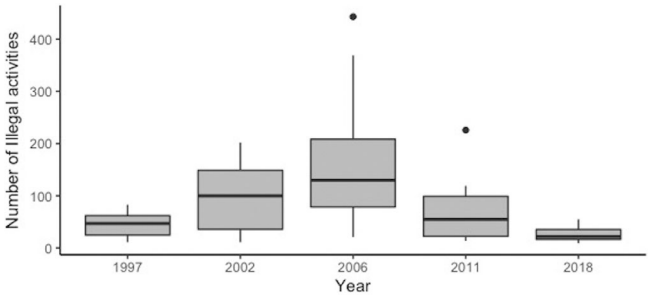


FIGURE 5 Boxplot comparing illegal activities recorded in Bwindi over the study years

and 2011 with increased park accessibility resulting in increased illegal activities (Figure 6). At the commencement of the study in 1997, the most important driver of illegal activities in Bwindi was accessibility (82.4%), which reduced when other drivers' importance increased in the subsequent years. By 2018, the number of funded community projects (ICDPs) was the most important drivers of illegal activities with increased funding of community projects resulting in reduced illegal activities and vice versa. In 2018, the number of illegal activities recorded was strongly negatively correlated with the

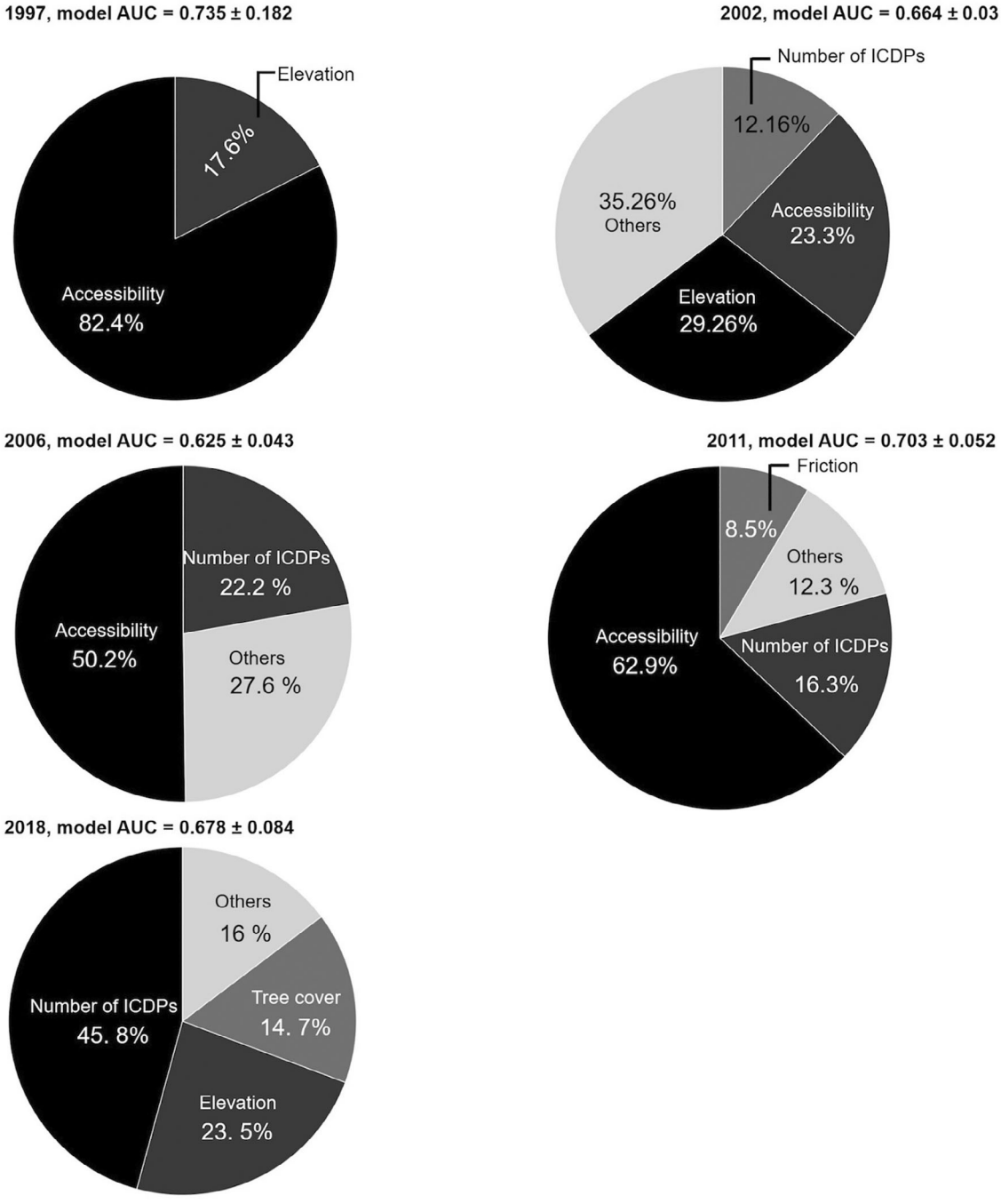


FIGURE 6 Importance of the key drivers of illegal activities in Bwindi for each study year (AUC values $\mp SD$)

number of funded community projects in the adjacent parishes (*F*-statistic: 111.1 on 1 and 10 DF, *p*-value: 0.0000 at 95% confidence interval**),** see also Figure S2. Bwindi areas with the highest number of illegal activities were adjacent to those parishes with less funded community projects and vice versa (Figure S3).

Overall, the most important drivers of illegal activities in Bwindi were as follows: accessibility, number of funded community projects (ICDPs), and elevation. These had the highest AUC values when used in isolation of all the study years' full models (Figure S4). Park accessibility, number of ICDPs, and elevation drivers reduced the AUC values of the full models the most when omitted from their respective year models, further signifying their importance as key drivers of illegal activities in Bwindi (Figure S4).

4 | DISCUSSIONS

4.1 | Drivers of illegal activities in Bwindi

The predictive performance of the MaxEnt models used for this study was satisfactory since on average, the model AUC value was ≥0.667. The AUC values for our models ranged from 0.62 (in 2006) to 0.73 (in 1997). The average model AUC value of 0.667 is slightly lower than our *a priori* set cutoff of 0.70, suggesting some uncertainty in some of our models. However, the models were particularly useful in identifying the most important drivers and specific areas of illegal activities in Bwindi. This study has shown that the most important drivers of illegal activities in Bwindi were park accessibility, the number of funded community projects (ICDPs), and elevation. These had the highest AUC values when used in isolation of all the years' full models, an implication of being the most important drivers of illegal activities distribution in Bwindi over the years. Furthermore, these drivers were not static but varied over the study years. At the beginning of the study (1997) and other subsequent 3 study years (2002, 2006, and 2011), park accessibility was the single most important driver of illegal activities with other compounding factors (ICDPs and elevation) also influencing the presence of illegal activities in Bwindi. The probability of illegal activities generally decreased with increasing travel time in minutes from the nearest village, with a clear inverse relationship. Similarly, other studies elsewhere have shown that park accessibility is the most important environmental driver of illegal activities (Denninger Snyder et al., 2019; Shova & Hubacek, 2011). Distance from the Bwindi Park edge is an important factor that influences illegal activities with an inverse influence of travel distance on illegal activities (Denninger Snyder et al., 2019). The high number of illegal activities recorded at the Bwindi Park boundary than in the interior highlights the positive relationship between accessibility and local community access to park resources. Harrison et al. (2015) observed that within a radius of less than 0.5 km of Bwindi and the southeastern part of Bwindi are the most densely populated human settlements depending on the forest for their livelihoods. These are the poorest communities and include the indigenous Batwa people (former forest dwellers). According to Harrison et al. (2015), overall, illegal activities are most common among poor households closest to the Bwindi Park boundary and farthest from trading centers since they have no other alternative livelihood means. Bitariho et al. (2016) and Wunder et al. (2014) have also noted that poorer households living closer to PAs tend to forage more in the PAs as a safety net/insurance than the well-off households who live far off the forest in the trading centers/towns. The poorer local communities living closest to the Bwindi Park boundary have easier and better accessibility to the park resources and therefore more/easily involved in the illegal activities.

The anthropogenic related drivers of illegal activities in the PAs include human population growth, poverty, and literacy levels (Denninger Snyder et al., 2019; Shova & Hubacek, 2011; Twinamatsiko et al., 2014). In particular, poverty is widely considered the leading driver of illegal resource extractions from the PAs (Knapp et al., 2017; Rija & Kideghesho, 2020; Shova & Hubacek, 2011). The anthropogenic drivers of illegal activities mentioned above are all further related to the ICDPs, and therefore the funding of community projects aims at addressing poverty, illiteracy, and human population growth. A number of studies have indicated that the poorest local communities have often benefited the least from Bwindi's ICDPs than their elite peers (Blomley et al., 2010; Harrison et al., 2015). This is because of the inequity and mismatch in the distribution and implementation of the ICD projects. Those poorest communities are less educated, rarely attend community meetings, and live far away from the trading centers/towns where such meetings are usually held. A revised ICDP plan for Bwindi has recommended targeting these particular poorest communities for the effectiveness of the ICDPs (Franks et al., 2017).

4.2 | Contribution to funding community projects in the mitigation of illegal activities

Community project incentives are vital for getting people to appreciate PAs and to mitigating or get involved less in illegal activities (Castro & Nielsen, 2001; Ostrom, 2000;

Shova & Hubacek, 2011). This study has shown that by 2018, the funding of community projects (ICDPs) had taken over the rest of the drivers as the most important driver of reducing illegal activities in Bwindi. At the beginning of the study in 1997, very few community projects had been funded, but over the study years, these increased in number. Indeed by 2018, the funded community projects had cumulatively increased and had a positive impact on reducing illegal activities in Bwindi. Van Vliet (2014) and Wicander and Coad (2018) noted that the provision of alternative livelihoods for households around PAs is one major development tool commonly applied to mitigate illegal activities within the PAs. Denninger Snyder et al. (2019) add that the diversification of these community livelihood projects, increasing direct benefits, and reducing the costs communities face from living near PAs are important components of mitigating illegal activities in PAs. Whereas as highlighted by Wicander and Coad (2018) that there are very few success stories of ICDPs, Shova and Hubacek (2011); Denninger Snyder et al. (2019); Bernhard et al. (2021), and this study have shown that the provisioning of alternatives and diversification of the types of community livelihood projects have a positive impact on reducing illegal activities within the PAs.

The nature and type of community livelihood projects is an important aspect for consideration in the mitigation of illegal activities within the PAs (Denninger Snyder et al., 2019; Shova & Hubacek, 2011). As this study has shown, water and sanitation and household income-generating projects were the most popular and funded community projects. These are the most preferred livelihood community projects around Bwindi since they provide livelihood alternatives (Bitariho et al., 2016; Harrison et al., 2015). Indeed, as reported by Muylaert et al. (2021), local communities in proximity to Bwindi and other tropical PAs frequently suffer from various diseases due to a combination of inadequate health facilities, the precarity of livelihoods, and food insecurity. The funding and provisioning of water and sanitation community projects and health facilities as shown by this study, therefore, plays a great role in improving local livelihoods in those communities. As such, the parishes with the greatest number of these community projects had fewer illegal activities than those without. The fact that parishes that experienced fewer illegal activities had the most funded community projects is a testimony that those parishes experienced improved livelihoods and income over the years. The funded community projects such as those of household income generation, water and sanitation, and healthy facilities had an impact on improving household income and livelihoods and therefore reducing demand for PA resources in those parishes. Forest access by local people in Bwindi is majorly centered on people's livelihoods requirements such as the need for food, water, housing, and medicines (Bitariho et al., 2016; Muylaert et al., 2021).

An underlying issue is that most development projects supported by donors are normally short term and lack monitoring and evaluation plans to monitor the success and failures of the funded community projects. What is required is for such projects to have long-term financial support with a well-thought monitoring and evaluation plans (Sandker et al., 2009). This provides a cumulative local community impact of forest "decoupling" as observed in Bwindi (Blomley et al., 2010). Forest "decoupling" as explained by Blomley et al. (2010) is the pathway to achieving conservation impact built around reducing or breaking the link between the people and natural resources extractions. These strategies can either be based on financial benefits (decoupling, e.g., park revenue sharing, income-generating projects, and health centers) or direct, natural resource benefits (coupling, e.g., plant resource harvests, honey collection, and fishing).

The long-term funding of community projects creates a long-term and sustainable behavioral change among the recipients of the projects as they become well off progressively during the funding and implementation phases of the projects. Long-term sustainable funding allows systematic and careful recruitment of local people into ICDP interventions without necessarily creating unrealistic expectations and facilitates gradual behavioral change. Furthermore, the long-term funding gives the opportunity to pilot interventions, monitor them, and address the potential challenges before being fully implemented, which is likely to improve success (Struhsaker et al., 2005). The BMCT trust fund was established by the World Bank in 1994 to among others have long-term funding for community projects, and this study has shown its positive impact in mitigating illegal activities within Bwindi. Although this study did not assess the contribution/impact of law enforcement in the mitigation of illegal activities, other studies in Bwindi and elsewhere indicate that law enforcement is a crucial factor in mitigating illegal activities as well (Blomley et al., 2010; Denninger Snyder et al., 2019). What is crucial therefore is that the law enforcement is synergized with long-term funding/implementation of the community projects for realization of better outcomes.

5 | CONCLUSION

Local communities immediately bordering Bwindi are the poorest in the region and have limited household

income alternatives as evidenced by this study. Their high dependency on subsistence farming is a manifestation of a lack of other household livelihoods and income sources. The illegal activities observed in Bwindi are probably a means by which those households are seeking other livelihood and income sources. As such, the key drivers of illegal activities within Bwindi are all related to anthropogenic factors. The easy accessibility to Bwindi increases illegal activities by those households seeking alternative livelihoods and income sources while the long-term funding of community projects contributes to the reduction in the illegal activities through the provision of alternatives. Long-term funding of community projects helps create sustainable household income and livelihood alternatives and therefore minimizes illegal activities within Bwindi (decoupling effect). Hence, we conclude that the long-term funding, well implementation, and monitoring of community projects are important factors in the mitigation of illegal activities within Bwindi and probably elsewhere. Finally, we recommend a targeted and increased funding of community projects in those parishes identified as hotspots of illegal activities within Bwindi. These were the five parishes of Kashasha, Kiyebe, Mpungu, Buremba, and Remera that accounted for over 74% of all the illegal activities recorded in Bwindi.

AUTHOR CONTRIBUTIONS

Robert Bitariho: Conceived and designed the study, planned and compiled the data collection tool for the manuscript, wrote the text, and did data analysis and the logical discussions and conclusions of the manuscript. Emmanuel Akampurira: Contributed to the study design and data collection tool, participated in the data collection for the manuscript, and contributed to the text of the manuscript. Badru Mugerwa: Participated in data analysis, and contributed to the text and logical discussions of the manuscript.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in this study.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available and can be accessed from the corresponding author after reasonable requests are made.

ETHICS STATEMENT

Ethical clearance and research approval were granted by the Uganda government. The Institute of Tropical Forest Conservation (authors' affiliate institution) has a long-standing Memorandum of Understanding (MoU) with the Uganda Wildlife Authority (UWA) to undertake research in Bwindi Impenetrable National Park and other national parks in southwest Uganda on behalf of UWA. Prior to the household interviews, the authors sought prior informed consent (PIC) from the local communities in the study area.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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