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Research article

Changing perceptions of protected area benefits and problems around Kibale National Park, Uganda

Catrina A. MacKenzie [a, b, *], Jonathan Salerno [c], Joel Hartter [c], Colin A. Chapman [d, e, f], Rafael Reyna [e, g], David Mwesigye Tumusiime [f], Michael Drake [c]

[a] Department of Geography, McGill University, 805 Rue Sherbrooke West, Montreal, Quebec, H3A 2K6, Canada
[b] Department of Geography, University of Vermont, 200 Old Mill Building, 94 University Place, Burlington, VT, 05405-0114, USA
[c] Environmental Studies Program, University of Colorado, Sustainability, Energy, and Environment Complex, 4001 Discovery Drive, Boulder, CO, 80309, USA
[d] Department of Anthropology, McGill University, Montreal, Quebec, Canada
[e] Wildlife Conservation Society, Bronx, NY, USA
[f] Makerere University Biological Field Station, P.O. 409, Fort Portal, Uganda
[g] El Colegio de la Frontera Sur, ECOSUR, Avenida Rancho Poligono 2A, Lerma, Campeche, 24500, Mexico

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ABSTRACT

Local residents' changing perceptions of benefits and problems from living next to a protected area in western Uganda are assessed by comparing household survey data from 2006, 2009, and 2012. Findings are contextualized and supported by long-term data sources for tourism, protected area-based employment, tourism revenue sharing, resource access agreements, and problem animal abundance. We found decreasing perceived benefit and increasing perceived problems associated with the protected area over time, with both trends dominated by increased human-wildlife conflict due to recovering elephant numbers. Proportions of households claiming benefit from specific conservation strategies were increasing, but not enough to offset crop raiding. Ecosystem services mitigated perceptions of problems. As human and animal populations rise, wildlife authorities in Sub-Saharan Africa will be challenged to balance perceptions and adapt policies to ensure the continued existence of protected areas. Understanding the dynamic nature of local people's perceptions provides a tool to adapt protected area management plans, prioritize conservation resources, and engage local communities to support protected areas.

1. Introduction

Conservation policies in East Africa, particularly those for national parks, have favoured the protectionist approach. This approach is viewed by many conservationists as the most effective means of biodiversity conservation (Chapman et al., 2016; Gray et al., 2016). However over the past four decades, the conservation narrative has evolved to recognize that poverty in communities near protected areas (PAs) may constrain conservation (Adams et al., 2004), and that communities near PAs disproportionally accrue the costs of conservation (MacKenzie, 2012a; Brockington and Wilkie, 2015). As a result, conservation policies have evolved, calling for benefits to incentivize local residents to support conservation while alleviating poverty (Brockington and Wilkie, 2015), partnering with stakeholders (Liberati et al., 2016), and providing payments for ecosystem services (Suich et al., 2015). Although PAs can exist without support from local communities (Holmes, 2013), compliance with PA regulations, conservation attitudes, and support for PA existence are enhanced if needs of local communities are met, if local communities benefits from conservation and tourism, if community members participate in PA decision-making, and if conservation strategies are adapted based upon perceptions of local people (Tessema et al., 2010; Allendorf et al., 2012; Andrade and Rhodes, 2012; Mutanga et al., 2015). Adopting this adaptive community-conservation strategy requires an on-going commitment to local engagement to understand the

* Corresponding author. Department of Geography, McGill University, 805 Rue Sherbrooke West, Montreal, Quebec, H3A 2K6, Canada.
E-mail addresses: catrina.mackenzie@mail.mcgill.ca, camacken@uvm.edu (C.A. MacKenzie), Jonathan.salerno@colrado.edu (J. Salerno), joel.hartter@colorado.edu (J. Hartter), Colin.chapman@mcgill.ca (C.A. Chapman), rreyna@ecosur.mx (R. Reyna), tumusid@yahoo.com (D.M. Tumusiime), Michael.Drake-1@Colorado.edu (M. Drake).

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changing dynamics of local perceptions about the PA (Allendorf et al., 2012). In this paper we examine shifting local perceptions of benefits and problems associated with living next to a Ugandan national park from 2006 to 2012, and the associated implications for PA management.

Despite burgeoning efforts by conservation managers to manage landscapes for both biodiversity and human wellbeing, people perceive widespread negative effects of living near PAs (Sarker and Røskaft, 2011; Namukonde and Kachali, 2015). The creation of PAs can force the displacement of people, resulting in hardship and loss (Brockington and Igoe, 2006; Salerno et al., 2014), and restrictions on resource access can limit livelihood activities (West et al., 2006). Wildlife roam outside PA boundaries, damaging and eating crops, attacking livestock, and even maiming or killing local residents (Dickman et al., 2011; Sarker and Røskaft, 2011; Namukonde and Kachali, 2015). There can also be benefits to living next to a PA that may help offset the costs incurred, such as ecosystem services (Namukonde and Kachali, 2015; Suich et al., 2015) and tourism. Tourism is becoming a promising revenue source for many developing countries and may provide employment and marketing opportunities for communities near tourist destinations (Ferraro and Hanauer, 2014; Naidoo et al., 2016). Other PA benefits include payments for ecosystem services (Suich et al., 2015), sharing hunting and tourism revenues (Naidoo et al., 2016), negotiated access to PA resources (Sarker and Røskaft, 2011), employment as research assistants and planting trees for carbon sequestration (Dempsey and Suarez, 2016), and non-governmental organizational aid for schools, medical clinics and income generation projects (Chapman et al., 2015; MacKenzie et al., 2015).

The extent and magnitude of problems and benefits that PAs confer upon local communities vary (Brockington and Wilkie, 2015), with local geography and PA proximity contributing to varying perceptions of costs and benefits (MacKenzie, 2012a). Close proximity to park boundaries increases the likelihood of crop raiding and livestock predation (Salerno et al., 2016), yet closer proximity may afford greater access to employment or PA-associated services, and access to PA resources, officially sanctioned or not (MacKenzie et al., 2011; Baird, 2014). While conservation strategies typically account for changing forest ecology, wildlife populations, and biophysical conditions, far less consideration is given to changing perceptions of PA neighbors (Berkes, 2004; Allendorf et al., 2012).

The Ugandan Government has made remarkable steps to conserve biodiversity in a country where human population density is increasing at one of the fastest rates in the world (Hartter et al., 2015). Conservation policy in Uganda has evolved from pure protectionism to a PA-neighbor strategy. While the shift in strategy includes efforts to provide benefits to neighboring households, the increasing population densities, declining resource availability, and recovering wildlife populations of some species may serve to exacerbate existing tensions and outweigh benefits. It remains unclear how perceptions and experiences parallel shifts in conservation policy. To address this uncertainty, we combine three data sources to quantify changes in perceptions over time. Although not initially designed for temporal comparison, we compare data from three household surveys collected in 2006, 2009, and 2012 and triangulate that comparison with long-term data to understand the changing perceptions of local people about the benefits accrued and problems encountered as a result of living next to Kibale National Park (hereafter Kibale). We ask: (1) how are household perceptions of PA-based benefits and problems distributed over space, time, and household wealth categories? and (2) what factors are influencing the changing perceptions of benefits and problems? We discuss the implications of our findings for conservation management and how adaptive management at the people-PA interface must be incorporated into conservation planning.

2. Methods

2.1. Study site

Kibale (795 km^2) is located in western Uganda (Fig. 1), and contains the highest primate density of all PAs in East Africa (UWA, 2015), and one of the highest in the world (Chapman et al., 2010a). It provides critical habitat to eastern chimpanzees (*Pan troglodytes schweinfurthii*), 12 additional primate species, elephants (*Loxodonta africana*), and a diversity of other species (Chapman and Lambert, 2000). The authority to manage PAs in Uganda belongs to Uganda Wildlife Authority (UWA) as prescribed by the Uganda Wildlife Statute (1996). The Kibale management plan incorporates four conservation strategies (UWA, 2015). The **first** is resource conservation and management, enforcing boundaries, policing against illegal resource extraction, and restoring degraded areas within the PA. The **second** strategy focuses on research and ecological monitoring. Community conservation is the **third** strategy and includes a revenue sharing program where 20% of gate revenues are shared with local governments for community projects (MacKenzie, 2012b), negotiated resource access to non-threatened resources inside designated areas of the PA by community associations (MacKenzie et al., 2011), efforts to mitigate human-wildlife conflict, and community conservation awareness and education programs. **Fourth**, UWA supports development of tourism. Ranking fifth of ten in the most visited national parks in Uganda, visitor numbers to Kibale have grown, from 2125 in 1997 to 10,834 in 2013 (MTWA, 2014). The primary attraction is the opportunity to view habituated chimpanzees. Tourism accommodation is clustered in three tourism areas near Kibale: the urban center of Fort Portal, the Crater Lakes region on the western side of Kibale, and near the town of Bigodi close to the chimpanzee ecotourism site (Fig. 1).

Human population density has been increasing around Kibale due to immigration and natural increase (Fig. 1b, c & d; Hartter et al., 2015). Population density, estimated by averaging Worldpop United Nations adjusted data (Linard et al., 2012) in pixels located outside the PA but within 5 km of Kibale's boundary, increased from 160 people/km^2 in 2002 to 308 people/km^2 in 2015; almost doubling in 13 years. Most local people are smallholder farmers, with some earning income from cash crops and off-farm work on tea plantations, as research assistants, in the tourism industry, excavating elephant trenches for crop raiding protection, and planting trees for carbon sequestration (Hartter, 2010; MacKenzie, 2012a), as well as from trades and casual labour. Although the boundaries of Kibale remain intact, much of the surrounding forest cover has been reduced to fragments and small groves (Hartter and Southworth, 2009). As wood becomes scarce, households are planting trees, stopping neighbors from accessing trees on their property, and entering Kibale to harvest firewood and building poles (Hartter et al., 2011; MacKenzie et al., 2011). Some areas of Kibale were designated as timber concessions until the mid-1970s, but all commercial logging has now stopped, with the exception of limited paid agreements to extract exotic trees (MacKenzie et al., 2011). However, illegal wildlife poaching and tree harvesting continue.

2.2. Survey data collection

In 2006, the first of the three surveys collected data from 130 households in two areas bordering Kibale: a north-western sector and an eastern sector (Fig. 1b). This survey focused on the impact of Kibale on its neighbors, by examining the changes in wetlands and

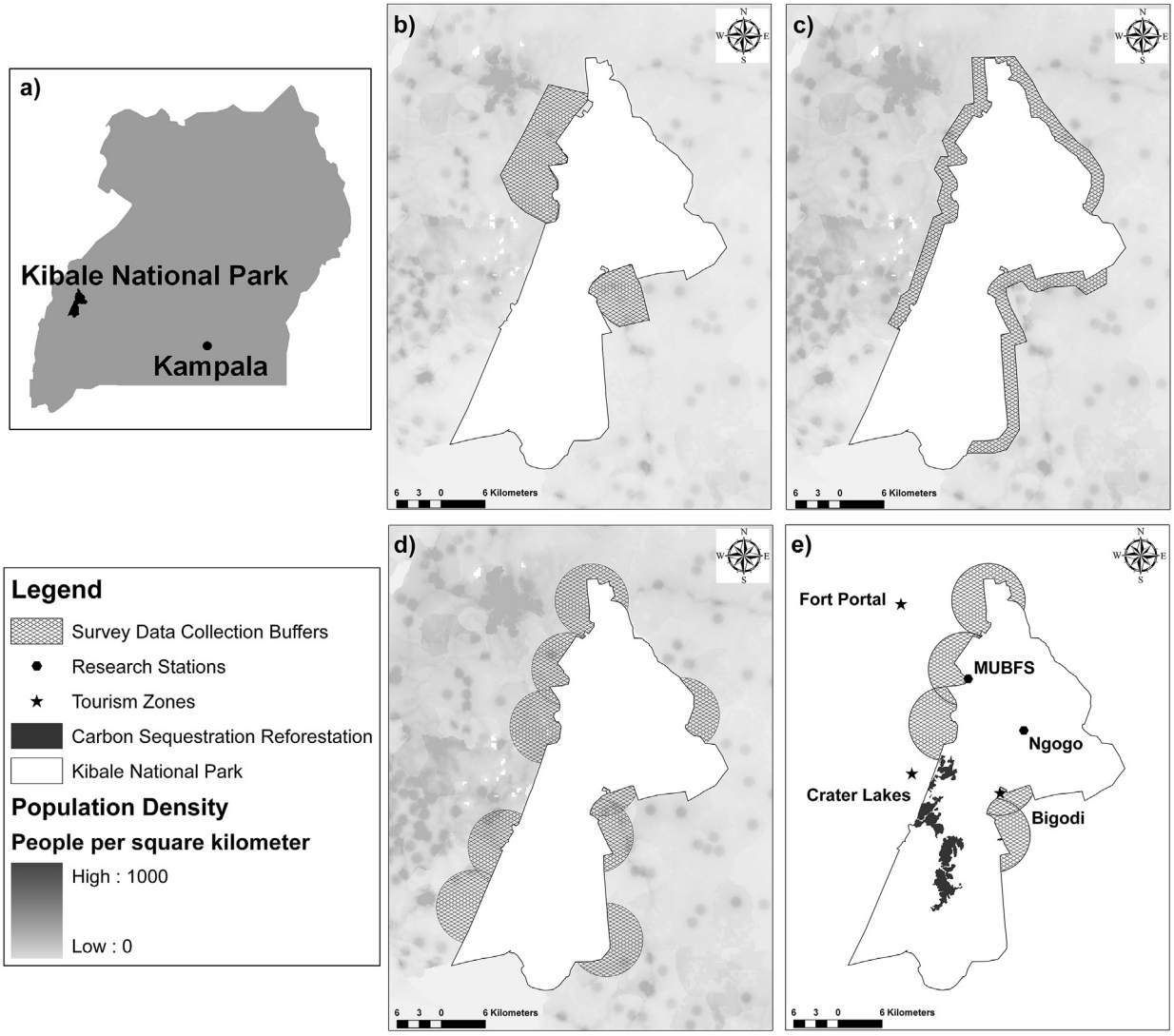

Fig. 1. Kibale National Park Site Map: a) Location within Uganda, b) 2006 Survey (N = 130) population density from 2002, c) 2009 Survey (N = 596) population density from 2010, d) 2012 Survey (N = 308) population density from 2015, and e) Three survey comparison zone (2006 N = 91, 2009 N = 235, 2012 N = 186) including tourism zones, research bases and carbon sequestration reforestation area.
Source: Population Density from Worldpop (formerly Afripop) dataset for Uganda (Linard et al., 2012).

forest fragments outside Kibale and the impacts of those changes on households as secondary effects of PA establishment. A set of 95 random geographic coordinates within these areas was selected, and those points became the centers of 9-ha areas (circles with radii of 170 m) termed 'superpixels' (Goldman et al., 2008). Survey respondents were randomly selected from landholders in each of the superpixels, and all surveys were conducted in person using a trained male interpreter (Hartter, 2009, 2010). Survey households were located up to 5.5 km from the PA boundary.

In 2009 the second survey was conducted to investigate the financial value and spatial distribution of PA benefits and losses accrued in villages next to Kibale. The survey collected data from 596 households in 25 villages (Fig. 1c). In each study village, 23–25 households were selected, and unlike the 2006 and 2012 surveys the household selection was wealth-stratified based on house construction standard; mud and wattle construction indicated a poorer household and brick construction a richer household (Supplementary material 1; Hartter, 2009). Surveys were interpreted and enumerated by four Ugandan assistants (one female and three male). All 2009 survey households were located within 3.3 km of the PA, no households overlapped between the 2006 and 2009 surveys, and the two surveys were conducted by different enumerators.

In 2012, the third survey was conducted to investigate the influence of population growth, climate change, and conservation policy on household livelihoods, focusing on household adaptive decisions made in response to perceived risk. This survey was part of a larger effort that included data collection adjacent to Queen Elizabeth, Murchison Falls, Rwenzori Mountains, and Mgahinga Gorilla National Parks, as well as Kibale. Here we consider only data from Kibale, which were collected from 308 households located in nine 5 km radius circular areas centred on Kibale entrance gates (Fig. 1d). Given the proximity of the gates, some of these circular areas overlapped. Households were selected randomly within the area covered by these circular areas using the same superpixel sampling strategy used in 2006 and were located within 4.2 km of the PA boundary. Surveys were interpreted and enumerated by three Ugandan assistants (one female and two male; two were enumerators for the 2009 survey). The 2012 sample included 16 households surveyed in 2006 and 48 households surveyed in 2009.

These three surveys were not designed for longitudinal comparison, but parts of each survey focused on perceptions of problems and benefits accrued living next to Kibale, and recorded geographic locations of households and used the same household construction standard as a proxy for wealth. Since perceptions of benefits and problems vary with location around Kibale (MacKenzie, 2012a), and the spatial extent over which each survey was conducted was different, we chose to limit our comparison to areas where all three surveys collected data, which corresponded to five of the nine 2012 circular areas (Fig. 1e; 2006 n = 91, 2009 n = 235, 2012 n = 186, total = 512). In addition to questions about benefits and problems accrued from Kibale, the surveys asked about specific sources of benefits and problems, including: ecosystem services, PA-based employment, tourism, revenue sharing, resource access, and human-wildlife conflict. Although these questions do differ in precise language (Supplementary material 2), their shared focus on households' relationship with the PA nevertheless elicits insights into the changes in perceptions of benefits and problems from Kibale.

2.3. Analysis

Combining data from all three surveys in the common spatial extent shown in Fig. 1e, binary logistic regression models for the likelihood of claiming benefit and the likelihood of claiming trouble from Kibale were built. Binary responses for perceiving benefit from ecosystem services, PA-based employment, tourism, revenue sharing and resource access, and for perceiving problems from wild animals and lack of resource access were used as independent variables to determine which benefits and problems were informing the respondents' decision to claim benefit or trouble from Kibale. Similarly, a model was built for the likelihood of claiming trouble from Kibale as the dependent variable to determine the benefit/problem drivers of perceived trouble from Kibale.

Additional binary logistic regression models were fit to predict perceived benefit from Kibale, and separately perceived trouble from Kibale, from the covariates time, radial distance from the PA boundary, and wealth category in order to determine key factors influencing perceptions. The same binary logistic model was fitted for each specific source of benefits and problems, with the exception of the percent of households benefitting from ecosystem services for which a viable model was not possible due to a lack of data variance in 2009 and 2012; almost all households claimed benefit from ecosystem services.

2.4. Contextual data and substantiating evidence

Additional sources of data were used to contextualize the survey comparison. These data came from multiple sources, including our own research. Revenue sharing fund disbursement data, lists of projects implemented, and records of resource access agreements were provided by UWA. Researcher and research employee numbers for 2006, 2009, and 2012 were provided by the Makerere University Biological Field Station (MUBFS). Tourism facility data were acquired from Adiyia et al. (2014), and average employees per facility was calculated from 2010 interviews with tourism managers (MacKenzie, 2012a). Revenue sharing funds are often used to build trenches to deter elephants from crop raiding. Using GPS points recorded at the beginning and end of trenches constructed between 2005 and 2012, coupled with actual employment numbers from trench excavation in 2008 and 2009, we used the length of trenches excavated in a given year to estimate the number of seasonal jobs provided. Finally, UWA, in partnership with corporate entities, has been reforesting an area of Kibale for carbon sequestration, and reforestation employment data were available from the project report (Project Design Document, 2015).

To understand changes in crop raiding, we looked at problem animal abundance inside Kibale over time. The three surveys provided the percentage of households experiencing crop raiding from specific species, which in turn was compared with species abundance estimated from line transect surveys conducted in 1996, 2005, and 2014 inside the PA at three sites in the vicinity of MUBFS (K15, K14, K30; see Chapman et al., 2010a, 2010b). The time periods for the wildlife surveys and those of the people differ, but the wildlife surveys clearly indicate changes in animal abundance. At each of these sites, a 4 km transect was established to census common species known to raid crops. Censuses were conducted between 0700 h and 1400 h at a speed of approximately 1 km/h. The following primate species were noted from visual observations: redtail monkeys (*Cercopithecus ascanius*), blue monkeys (*Cercopithecus mitis*), mangabeys (*Lophocebus albigena*), red colobus (*Procolobus rufomitratus*) and black-and-white colobus (*Colobus guereza*). Other species, such as l'hoesti monkey (*Cercopithecus l'hoesti*) and chimpanzees, were too rare or too fearful of observers to obtain an accurate assessment. In addition to the above mentioned primates we noted tracks and defecations of bushpigs (*Potomochoerus porcus*), elephant, baboons (*Papio anubis*), and duiker (*Cephalophus* spp). The relative abundance of all of these latter species was assessed by counting tracks crossing the census line, recorded as tracks per kilometer walked. In total 138 transects were conducted along three routes for a total of 552 km. To reduce sources of error in temporal comparison, identical methods were used each year, including completion of identical transect routes once per month by the same individual; the time between repeat censuses was set to ensure independence. Animal abundance was estimated as the number of records seen by km.

3. Results

3.1. Benefits and problems of living near Kibale National Park

Across the three surveys (2006, 2009, 2012), the percentage of households claiming benefit from Kibale has decreased, while the percentage claiming problems has increased (Table 1). Some respondents claimed both benefits and problems from Kibale (2006 = 15%, 2009 = 25% & 2012 = 21%). The binary logistic model of perceiving benefit from Kibale is positively influenced by four of the specific benefits (PA-based employment, tourism, revenue sharing, and resource access), but not by ecosystem services (Table 2, column 2–4). However, being troubled by wild animals significantly detracts from the likelihood a respondent will claim benefit from Kibale. The binary logistic model of perceived trouble from Kibale (Table 2, column 5–7) is dominated by the problems caused by wild animals, however, the likelihood of claiming trouble

Table 1
Percentage of households claiming problems and benefits from Kibale National Park in 2006, 2009 and 2012.

	2006	2009	2012
Percentage of Households claiming trouble from			
Kibale National Park	40.7	79.6	83.1
Wild Animals	37.4	93.6	88.7
Lack Access to Resources	4.4	75.3	17.6
Percentage of Households claiming benefit from			
Kibale National Park	59.3	41.3	32.6
Ecosystem Services	38.5	99.1	96.8
Park-based Employment	8.8	29.4	9.1
Tourism	4.4	16.6	15.1
Revenue Sharing	5.5	17.4	22.0
Resource Access	5.5	12.3	2.7

Table 2
Influences of specific benefits and problems on overall perception of benefit and trouble from Kibale National Park.

Model variable	Benefit from Kibale			Troubled by Kibale		
	ß	SE	Log-odds	ß	SE	Log-odds
Troubled by wild animals	−0.919**	0.283	0.399	4.905**	0.534	134.896
Troubled by lack of resource access	−0.364	0.221	0.695	−0.115	0.307	0.891
Benefitting from ecosystem services	0.590	0.335	1.803	−0.997*	0.470	0.369
Benefitting from PA-based employment	0.926*	0.296	2.523	−0.352	0.448	0.703
Benefitting from tourism	0.660*	0.327	1.935	0.824	0.552	2.281
Benefitting from revenue sharing	0.814*	0.269	2.256	0.632	0.436	1.882
Benefitting from resource access	1.139*	0.390	3.123	0.729	0.636	2.073
Constant	−0.483			−2.138		
Percent predicted	70.0			88.4		

**Significant <0.001.
*Significant<0.050.

from Kibale is reduced by the perceived benefit of ecosystem services.

The likelihood of claiming benefit from Kibale in the logistic model decreases with time, and is not a function of distance from the PA (Table 3, column 2–4). The likelihood of being troubled by Kibale in the logistic model increases with time, but declines by over half for every kilometer farther away from the PA boundary (Table 4, column 2–4). Neither the likelihood of claiming benefit or trouble from Kibale is associated with wealth (Tables 3 and 4, columns 2–4).

3.2. Changes in perception of benefit and problems

3.2.1. Protected area-based employment

The model indicates the likelihood that a respondent claimed benefit from PA-based employment was higher closer to Kibale, decreasing by half for every kilometer the household was located farther from the PA (Table 3, columns 5–7). Climbing one wealth category increased the likelihood of claiming benefit from PA-based employment by a third (Table 3, columns 5–7); although only 16% of survey households were in the two highest wealth categories, 55% of households claiming benefit from PA-based employment were in these same higher-wealth categories. The 2012 survey allowed us to probe whether jobs in tourism were disproportionately attained by the higher educated, but a statistical relationship did not exist between years of education and employment (Mann-Whitney U test $p = 0.987$). The model indicates the likelihood that a respondent perceived benefit from PA-based employment was three times higher in 2009 than 2006, although in 2012 the likelihood had return to almost the same as 2006 (Table 3, columns 5–7).

Around Kibale, PA-based jobs tended to be seasonal or short-term. Researcher and employee records, maintained by MUBFS, documented an average of 63 employees per month in 2006, 60 in 2009, and 59 in 2012 (Fig. 2a). In line with increasing tourist numbers to Kibale (Fig. 2b; MTWA, 2014), the number of tourism facilities (excluding the urban center of Fort Portal), has grown from five in 2005 to 15 by 2012 (Adiyia et al., 2014). In 2010, tourism facilities averaged 15 employees, 87% of whom were local residents, resulting in estimates of 65 local tourism jobs in 2005, 169 in 2009, and 195 in 2012. Since 2005, 26 km of elephant trenches have been excavated (Fig. 2c), creating 53 short-term jobs in 2006, 63 in 2009, but no jobs in 2012. Finally, the reforestation project began planting trees in Kibale in 1995, averaging 267 ha planted per year (Fig. 2d), and employing on average 307 seasonal jobs per year between 2002 and 2010, and 258 seasonal jobs between 2011 and 2013 (Project Design Document, 2015). Summing these four sources of PA-based employment resulted in 488 fulltime, and/or seasonal jobs in 2006, 601 in 2009, and 512 in 2012. The increase in employment aligns well with the increase in the likelihood of claiming benefit from PA-based employment from 2006 to 2009 (Table 3, column 5–7). However, the likelihood of perceiving benefit from PA-based employment decreases to a greater degree from 2009 to 2012 (Table 3, column 5–7) than does the decrease in job numbers (Fig. 2e).

3.2.2. Tourism

A majority of survey respondents claiming benefit from selling produce and crafts to tourists resided in the Bigodi tourism zone. Those claiming benefit from tourism tended to live closer to Kibale, with the likelihood of claiming benefit from tourism increasing by three to four times in 2009 and 2012 relative to 2006 (Table 3, columns 8–10). Near Bigodi, respondents selling handcrafts to tourists rose from 0% in 2006, to 14.9% in 2009 to 18.2% in 2012,

Table 3
Binary Logistic Models of Perceived Benefits from Kibale National Park as a function of distance to Kibale boundary, year of survey, and house construction standard.

Model variable	Benefit from Kibale			Benefit Employment			Benefit Tourism			Benefit Revenue Sharing			Benefit Resource Access		
	ß	SE	Log-odds	ß	SE	Log-odds	ß	SE	Log-odds	ß	SE	Log-odds	ß	SE	Log-odds
Distance to Park (km)	−0.084	0.107	0.920	−0.749*	0.228	0.473	−0.455*	0.203	0.634	−0.422*	0.174	0.656	−0.938*	0.377	0.391
Dummy 2009	−0.795*	0.262	0.451	1.130*	0.406	3.095	1.252*	0.547	3.496	1.056*	0.497	2.875	0.590	0.512	1.804
Dummy 2012	−1.101**	0.267	0.332	0.149	0.457	1.160	1.448*	0.554	4.254	1.726**	0.497	5.617	−0.620	0.652	0.538
Household Construction Standard	0.058	0.084	1.059	0.302*	0.110	1.353	0.077	0.117	1.080	0.193	0.108	1.213	−0.042	0.156	0.959
Constant	0.336			−2.410			−2.795			−2.900			−1.871		
Percent predicted	61.9			81.2			85.9			82.6			92.2		

** Significant <0.001.
* Significant <0.050.

Table 4
Binary Logistic Models of Perceived Problems from Kibale National Park as a function of distance to Kibale boundary, year of survey, and house construction standard.

Model variable	Troubled by Kibale			Troubled by Wild Animals			Troubled by Lack of Resource Access		
	ß	SE	Log-odds	ß	SE	Log-odds	ß	SE	Log-odds
Distance to Park (km)	−0.830**	0.139	0.436	−0.817**	0.153	0.442	−0.283	0.165	0.753
Dummy 2009	1.425**	0.283	4.159	2.971**	0.357	19.518	4.080**	0.537	59.165
Dummy 2012	2.302**	0.342	9.989	3.004**	0.376	20.170	1.546*	0.550	4.691
Household Construction Standard	0.012	0.107	1.012	−0.077	0.136	0.926	−0.035	0.106	0.966
Constant	0.530			0.591			−2.665		
Percent predicted	79.6			88.1			81.5		

** Significant <0.001.
* Significant <0.050.

with the percentage of households claiming benefit from tourism also rising from 0% in 2006 to 21% in 2009 to 61% in 2012. However, only 3% of respondents claimed benefit from tourism in the survey areas west of the park in 2012, where most survey respondents live outside a tourism zone.

3.2.3. UWA revenue sharing program

The likelihood of claiming benefit from revenue sharing was higher closer to Kibale and was 5.6 times higher in 2012 relative to 2006 (Table 3, columns 11–13), most likely due to increased monetary distributions (Fig. 3), and an unofficial shift in policy from UWA in 2008 to focus projects around Kibale on crop raiding mitigation (elephant trenches), or income generation projects such as the provision of beehives, piglets, or goats. The revenue sharing program seems to be equitably distributing benefit among wealth categories since the model indicates the likelihood of claiming benefit from revenue sharing did not vary significantly with household construction standard.

3.2.4. Resource access agreements and lack of access to resources

The predicted likelihood of perceiving benefit from resource access agreements and problems from lack of access to resources was much higher in 2009 than either 2006 or 2012 (Table 3 column 14–16 & Table 4, column 8–10). Perceiving benefit from resource access was predicted to be almost two thirds less likely for every kilometer farther from the PA, but was not a function of household wealth (Table 3, columns 14–16). Complaining about lack of access to resources was not predicted to be a function of distance to the PA or wealth (Table 4, column 8–10), and did not significantly contribute to respondents claiming problems from Kibale (Table 2).

3.2.5. Wild animals

Households claiming problems with wild animals rose even more over time than the perception of problems from Kibale, but showed a similar decrease with distance from the PA (Table 4, columns 5–7). In 2006, small primates such as red-tail monkey, vervet monkey (*Cercopithecus aethiops*), and black-and-white colobus were raiding crops in many households, while elephant raiding was less prevalent (Fig. 4). By 2009 and through 2012, elephant raiding had become more common with over 60% of households experiencing elephant crop raiding, similar to the percent of households reporting small primate raiding (53%–62%). The relative abundance of elephants has increased dramatically over time, while small primate abundance has stayed relatively stable with the exception of black-and-white colobus which declined (Table 5). Bushpig and baboon abundance has also increased from 1996 to 2014, but to a lesser extent than elephant (Table 5). The crop area damaged by elephants per raiding incident exceeds the area damaged by small primates by a factor of approximately 30 times (MacKenzie and Ahabyona, 2012). Therefore, the increased prevalence of elephant raiding infers considerably more crop loss in recent years, aligning with the increase in households reporting problems with wild animals (Fig. 4).

4. Discussion

Perceptions of people living adjacent to PAs can greatly impact conservation outcomes. For example, decisions regarding illegally taking resources from PAs or supporting wildlife authorities to protect PAs can be informed by the problems faced, and benefits accrued by local residents (Arjunan et al., 2006; Andrade and Rhodes, 2012). Although Kibale is a relatively small forested PA, the challenges faced by conservation management and local residents in many ways exemplify the challenges in other PA landscapes in Sub-Saharan Africa and elsewhere in the world. These challenges will increase in frequency and intensity as human population rapidly grows (Roberts, 2011), as food crops are increasingly cultivated near PA boundaries (Phalan et al., 2013), as habitat for wildlife is reduced, and as wildlife population recoveries increase the frequency of human-wildlife conflict (Taylor et al., 2015). Therefore, it is necessary to understand how the perceived benefits and problems of PA-adjacent households change over time, to understand the relative influence of specific benefits and problems on perceptions of the PA, and for conservationists and PA managers to dynamically adapt policies to improve local conservation attitudes and behaviors (Allendorf et al., 2012).

In our Kibale models, benefits from PA-based employment, tourism, revenue sharing and resource access improved overall perceptions of benefit from the PA, were more likely to be claimed by residents living closer to the PA, and with the exception of resource access, were more likely to be claimed over time. This counters criticisms of PA benefits as being short term, and not targeting those most affected by the PA (Tumusiime and Vedeld, 2015). Even though the likelihood of claiming benefit from employment, tourism, and revenue sharing rose over time, the likelihood of a respondent claiming benefit from Kibale decreased with time. Similarly, these specific benefits and the benefit of resource access increased closer to the PA but the likelihood of claiming benefit from Kibale was not a function of distance from the PA. Both of these apparent contradictions are due to the overshadowing influence of increasing human-wildlife conflict on perceptions of benefit from Kibale, supporting findings in Kenya and Ethiopia linking positive attitudes towards PAs to the absence of human-wildlife conflict (Gadd, 2005; Tessema et al., 2010). The likelihood of claiming Kibale as a source of problems was also driven by increasing human-wildlife conflict, however, negative perceptions about the PA were tempered by the perceived benefit of ecosystem services. The insignificant influence of ecosystem services on the perception of benefit from Kibale coupled with significant mitigation of perceptions of problems aligns well with

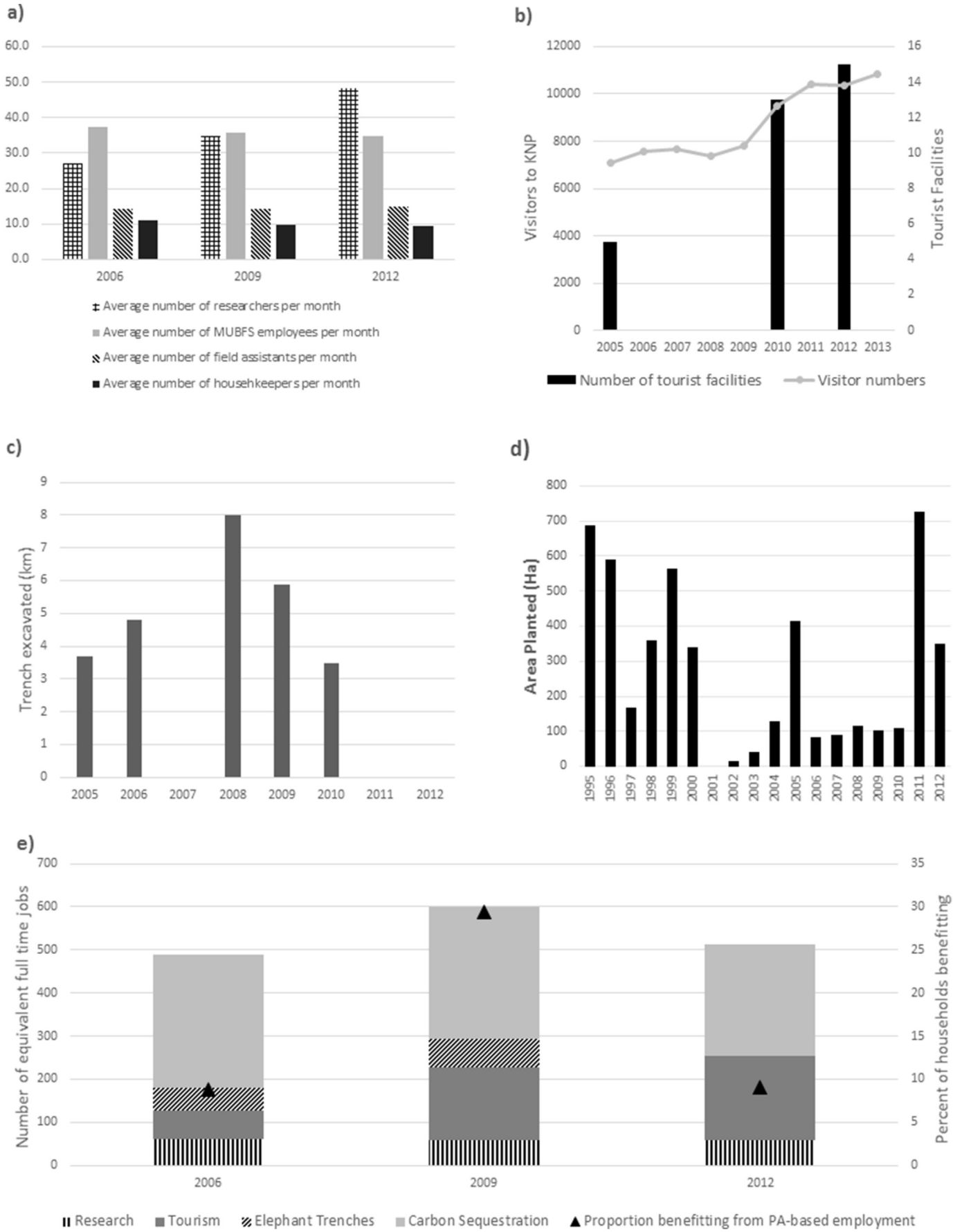

Fig. 2. PA-based employment (a) Research-based employment, (b) Tourism temporal growth, (c) Trench excavation from 2005 to 2012, (d) Area of trees planted by the reforestation project from 1995 to 2011, and (e) Comparison of PA-based job numbers and the percentage of households perceiving benefit from PA-based employment from the three surveys. Source: Tourist facilities in the Bigodi and Crater Lakes tourism zone (Adiyia et al., 2014).

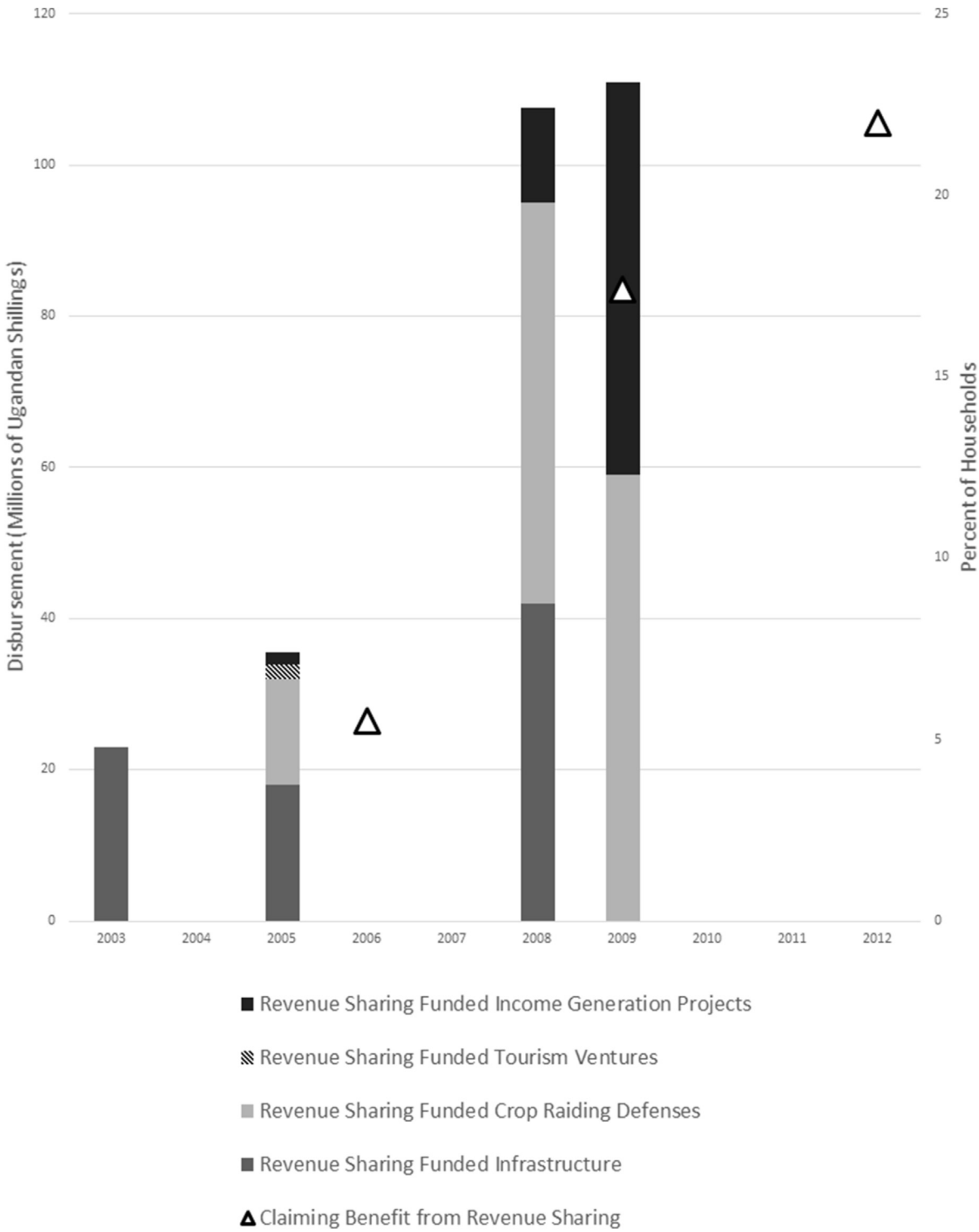

Fig. 3. Revenue sharing program disbursements, projects, and percentage of households claiming benefit.

research about the impact of ecosystem services on poverty alleviation, where ecosystem services were credited with sustaining, but not improving livelihoods, while reducing the vulnerability of households to poverty (Suich et al., 2015). Around Kibale, residents reported that they were protected against drought and experienced better crop yields due to the ecosystem services provided by the PA, seeing these services not as a benefit, but as offsetting losses caused by wild animals.

Given the strong role human-wildlife conflict plays in both the perception of benefit and problems, conservation policies that mitigate human-wildlife conflict should be prioritized by UWA to both reduce perceptions of the PA as a source of problems, but also to not detract from appreciation of existing benefit strategies. To the credit of UWA and local government, 45% of revenue sharing funds distributed around Kibale from 2003 to 2009 were used to build elephant trenches to protect crops (MacKenzie, 2012b).

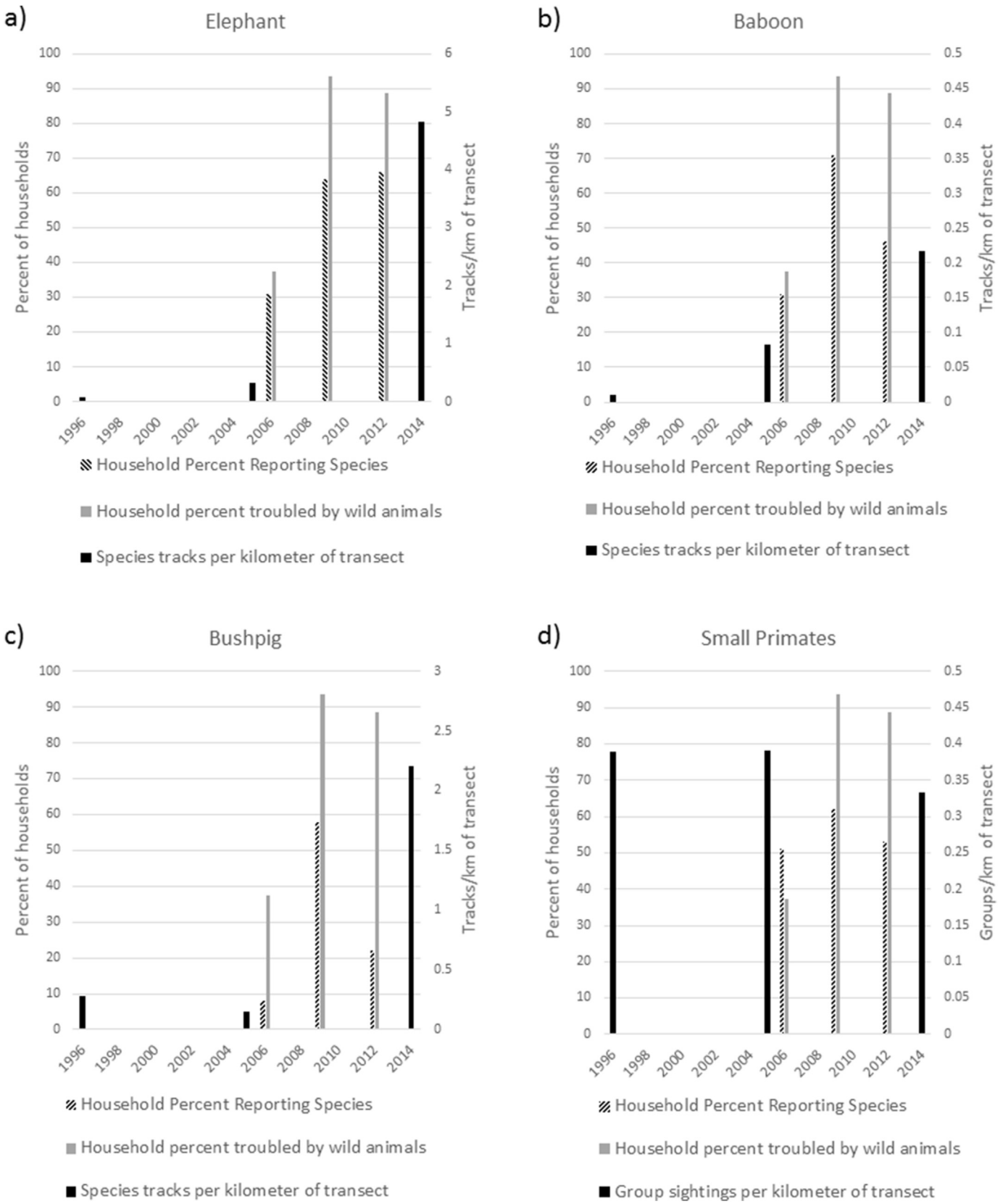

Fig. 4. Problem animal species abundance and perceived problems due to wild animals, (a) Elephant, (b) Baboon, (c) Bushpig, (d). Small primates. *Small primate data represent the average for all small primate species listed in* Table 5.

Table 5
The relative number of tracks or group sightings for various species per kilometer of transect observed in the Kanyawara area of Kibale National Park during three different time periods.

	1996	2005	2014
Tracks/km			
Bushpig	0.281	0.147	2.208
Duiker	0.521	0.402	2.832
Elephant	0.083	0.313	4.822
Baboon	0.011	0.082	0.217
Group sightings/km			
Red Colobus	0.507	0.533	0.587
Black-and-white Colobus	0.883	0.497	0.217
Redtail	0.267	0.600	0.440
Blue	0.180	0.123	0.137
Mangabey	0.113	0.203	0.287

Alternatively, management could help offset crop raiding costs by providing compensation. However, the cost of compensation schemes usually exceeds the funds available to wildlife authorities to manage human-wildlife conflict (Jackson et al., 2008), and as human density rises the number of claims for compensation is also likely to rise. In fact, village chairpersons around Kibale admitted people would try and profit from a compensation program. Given the lack of funds, rising human population, recovery of some wildlife populations, and the rapid conversion of surrounding land to agriculture (Ryan et al., 2017), compensation schemes to mitigate crop losses are becoming ever less feasible, requiring conservation authorities to focus on human-wildlife conflict mitigation and the provision of PA-based benefits (Tessema et al., 2010).

Supporting tourism is already a pillar of the UWA conservation strategy (UWA, 2013). Our findings confirm tourism growth around Kibale as more households claim benefit from PA-based employment and tourism, and this supports the findings of other researchers that tourism is a dominant mechanism to reduce poverty and provide employment near PAs (Ferraro and Hanauer, 2014; Naidoo et al., 2016). Around Kibale, PA-based employment was associated with better-off households, but not higher education, suggesting there may be elite capture of PA-based jobs; a problem also highlighted by other researchers in Africa and Asia (Sarker and Røskaft, 2011; Naidoo et al., 2016). Nepotism, corruption and politics can influence access to conservation benefits (Sarker and Røskaft, 2011), limiting the ability of tourist enterprises to raise more vulnerable households out of poverty. Alternatively, these 'elite' households around Kibale may have improved their wealth status as a result of having PA-based jobs.

Although PAs are often seen as providing employment opportunities in remote locations (Clifton and Benson, 2006), the growing human population in Sub-Saharan Africa means many of these PAs are no longer in frontier locations (Ryan et al., 2017), and PAs are no longer able to provide sufficient jobs to make a large difference in the local economy. Around Kibale, the increase of households claiming benefit from PA-based employment tracks the increase in employment opportunities from 2006 to 2009, but perceived PA-employment benefit declines more steeply than do jobs between 2009 and 2012. This may in part be due to population density within 5 km of Kibale growing at a faster rate than employment opportunities. However, given the steady increase of researchers and tourists between 2009 and 2012, local people may also be disappointed that the level of employment has not proportionally increased.

One potential employment opportunity that could be developed around PAs that would also help mitigate crop raiding is employing human-wildlife conflict guards and vermin control officers. Crop raiding by baboons is the most frequent form of crop raiding around Kibale (MacKenzie and Ahabyona, 2012), and baboons are listed as vermin, allowing them to be killed outside PAs (Uganda Wildlife Statute, 1996). District governments have proposed training vermin control officers to manage baboon populations and UWA has, on occasion, permitted baboons to be culled inside Kibale. To date, the cost of training and paying vermin control officers has been a barrier to implementation. However, employing local people as vermin control officers would not only help mitigate crop raiding, it would also signal to local communities that UWA is adapting their conservation policies to allow local people to participate in managing human-wildlife conflict, which could in turn engender trust between the local communities and UWA, potentially leading to improved conservation outcomes (Berkes, 2004; Allendorf et al., 2012; Andrade and Rhodes, 2012).

Our research clearly shows that perceptions about benefits and problems from a PA are dynamic. Therefore, adapting conservation management to changing perceptions needs to be a critical component of UWA policy going forward. Incorporating a feedback mechanism between residents' perceptions and PA management strategies has been shown to improve perceptions about PAs (Allendorf et al., 2012), and problems can be offset by changing how benefits are accrued by local communities (Muntifering et al., 2017). Cautious calls for more protectionism, citing higher species richness and abundance in strictly protected areas, indicate that more restrictive policies may be as important as protecting more area (Hutton et al., 2005; Chapman et al., 2016; Gray et al., 2016). Indeed if more protectionism could provide more separation of communities from wild animals, this might even be welcomed by local residents. However, it is unlikely that a traditional protectionist approach can scale with the increasing external pressures of population growth, poaching, and food production (Challender and MacMillan, 2014; Ryan et al., 2017). Not only will conservation managers need to focus on minimizing human-wildlife conflict – especially if animal numbers recover – but more effort will also be needed to increase benefits accrued by those living closest to PAs, to communicate with and educate local residents about conservation, and to police illegal resource extraction from PAs. However, since funding for biodiversity conservation remains well below required levels, and increased funding is unlikely to materialize in the near future (Dempsey and Suarez, 2016), creating partnerships with local communities to help protect PAs and including local communities in PA-management decision making are essential (Andrade and Rhodes, 2012; Liberati et al., 2016). Adapting conservation policy towards collaborative management between wildlife authorities and local communities would recognize that people are an integral part of the changing ecosystem within which PAs exist and that adaptive co-management may be the better long term solution to adapt to changing perceptions, and livelihood challenges (Berkes, 2004; Allendorf et al., 2012; Birgé et al., 2016).

5. Conclusions

Our findings provide evidence of decreasing perceived benefit and increasing perceived problems associated with the PA over time. However, both of these trends are dominated by increased human-wildlife conflict as a result of recovering elephant numbers. Although conservation policies to provide benefits to local communities, including PA-based employment, tourism development, revenue sharing, and resource access agreements, were effectively increasing the proportion of households claiming benefits, this was not sufficient to offset the increasing problems associated with wild animal crop raiding. Additionally, PA-based employment growth was not keeping pace with local population growth, leading to declining perceived benefit of PA-based employment in 2012. Although ecosystem services were not a significant factor in perceptions of benefit from the PA, these services did have a mitigating

effect on the perception of problems from the PA; most probably because these services help to limit vulnerability to climate change and crop raiding losses but do not necessarily improve local livelihoods relative to the status quo.

Understanding the dynamic nature of local people's perceptions provides a tool to adapt PA management plans to react to changing perceptions and externalities, as well as to prioritize limited conservation resources, be that to increase community-conservation initiatives, to rapidly grow tourism and other employment opportunities, to ramp up protectionism, or to engage in collaborative management with local communities. Based on our research, we recommend that feedback mechanisms between local perceptions and PA management strategies be incorporated into conservation policies. Ultimately, people will always hold both positive and negative perceptions about PAs, however, if wildlife authorities consider local perceptions and adapt conservation policies to engage local communities in conservation, this could lead to improved stability and prosperity of PAs.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jenvman.2017.05.078.

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