



Protected Areas as Frontiers for Human Migration

ZINTA ZOMMERS* AND DAVID W. MACDONALD

Department of Zoology, Wildlife Conservation Research Unit, University of Oxford, The Recanati-Kaplan Centre, Tubney House, Tubney, OX13 5QL, United Kingdom

Abstract: *Causes of human population growth near protected areas have been much debated. We conducted 821 interviews in 16 villages around Budongo Forest Reserve, Masindi district, Uganda, to explore the causes of human migration to protected areas and to identify differences in forest use between migrant and nonmigrant communities. We asked subjects for information about birthplace, migration, household assets, household activities, and forest use. Interview subjects were categorized as nonmigrants (born in one of the interview villages), socioeconomic migrants (chose to emigrate for economic or social reasons) from within Masindi district (i.e., local migrants) and from outside the Masindi district (i.e., regional migrants), or forced migrants (i.e., refugees or internally displaced individuals who emigrated as a result of conflict, human rights abuses, or natural disaster). Only 198 respondents were born in interview villages, indicating high rates of migration between 1998 and 2008. Migrants were drawn to Budongo Forest because they thought land was available (268 individuals) or had family in the area (161 individuals). A greater number of regional migrants settled in villages near Lake Albert than did forced and local migrants. Migration category was also associated with differences in sources of livelihood. Of forced migrants 40.5% earned wages through labor, whereas 25.5% of local and 14.5% of regional migrants engaged in wage labor. Migrant groups appeared to have different effects on the environment. Of respondents that hunted, 72.7% were regional migrants. Principal component analyses indicated households of regional migrants were more likely to be associated with deforestation. Our results revealed gaps in current models of human population growth around protected areas. By highlighting the importance of social networks and livelihood choices, our results contribute to a more nuanced understanding of causes of migration and of the environmental effects of different migrant groups.*

Keywords: Africa, livelihoods, population growth, refugees, resource use, Uganda

Áreas Protegidas como Fronteras para la Migración Humana

Resumen: *Las causas del crecimiento de poblaciones humanas cerca de áreas protegidas han sido muy debatidas. Realizamos 821 entrevistas en 16 aldeas alrededor de la Reserva Forestal Budongo, Distrito de Masindi, Uganda, para explorar las causas de la migración humana hacia áreas protegidas y para identificar diferencias en el uso del bosque entre comunidades de migrantes y no migrantes. Recabamos información sobre el lugar de nacimiento, migración, bienes familiares, actividades familiares y uso del bosque. Los individuos entrevistados fueron clasificados como no migrantes (nacidos en alguna de las aldeas en las que se hicieron entrevistas), migrantes socioeconómicos (migraron por razones económicas o sociales) del interior del distrito Masindi (i. e., migrantes locales) y de afuera del distrito Masindi (i. e., migrantes regionales) o migrantes forzados (i.e., individuos refugiados o desplazados que migraron debido a conflictos, abusos de derechos humanos o desastres naturales). Solo 198 entrevistados nacieron en aldeas en las que se hicieron entrevistas, lo que indica altas tasas de migración entre 1998 y 2008. Los migrantes fueron atraídos al Bosque Budongo porque pensaron que había tierras disponibles (268 individuos) o tenían familia en el área (161 individuos). El número de migrantes regionales que se estableció en aldeas cercanas al Lago Albert fue mayor que el de migrantes forzados y locales. La categoría de migración también se asoció con diferencias en formas de vida. El 40.5% de los migrantes forzados obtenía salario mediante labores, mientras que 25.5%*

*email zinta.zommers@lmb.ox.ac.uk

Paper submitted February 14, 2011; revised manuscript accepted November 25, 2011.

de migrantes locales y 14.5% de migrantes regionales tenían salario. Los grupos migratorios produjeron diferentes efectos sobre el ambiente. De los entrevistados que cazaban, 72.7% fueron migrantes regionales. Los análisis de componentes principales indicaron que era más probable que los migrantes regionales se asociaran con deforestación. Nuestros resultados revelaron vacíos en los modelos actuales de crecimiento de la población humana alrededor de áreas protegidas. Al resaltar la importancia de las redes sociales y de la elección de formas de vida, nuestros resultados contribuyen a un mejor entendimiento de las causas de migración y de los efectos ambientales de diferentes grupos de migrantes.

Palabras Clave: África, crecimiento poblacional, forma de vida, Uganda, refugiados, uso de recursos

Introduction

Human population growth is a significant driver of global deforestation and species extirpations and extinctions (e.g., Mather et al. 1998; Cincotta et al. 2000; Geist & Lambin 2006). Protected areas are areas of land especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources (Locke & Dearden 2005). It is argued that protected areas are particularly vulnerable to changes in human demographics and deforestation. Wittemyer et al. (2008) reported that human population growth around protected areas is significantly higher than the average population growth in rural areas, largely as a result of immigration. Joppa et al. (2009) reject their claims and conclude there is no evidence of disproportionate population growth near protected areas. These contradictory results highlight unresolved questions (Joppa et al. 2010): do people migrate toward protected areas? If so, why? Do migrants contribute to deforestation and resource extraction? Deeper analyses of migration and its effects on protected areas are needed to resolve these questions (Ogelthorpe et al. 2007).

We sought to help resolve the controversy by examining migration patterns and resource use in Budongo Forest Reserve, Uganda. Budongo Forest has been designated a priority conservation site for the Eastern Chimpanzee (*Pan troglodytes schweinfurthii*), but it is affected by agricultural expansion, forest loss, and by increases in human population (Howard et al. 1996; Mwavu & Witkowski 2008; Plumptre et al. 2010). Migrants have been identified as a significant driver of deforestation and hunting (Reynolds 2005). We interviewed households in villages surrounding Budongo Forest to determine which groups of people are migrating to the area, whether migrants and nonmigrants pursue different livelihoods, and whether there are differences in forest use among migrants and nonmigrant groups.

Population Growth around Parks

There are several models proposed to explain population growth around forested protected areas (Scholte & de Groot 2010). Existing human population centers may coincidentally expand toward protected forests (Joppa et al. 2009). Alternatively, the population outside a protected

area may grow as a result of logging occurring around the park. This is often subsequently followed by farming, in a process called “frontier engulfment,” which is occurring in the Brazilian Amazon (Scholte & de Groot 2010). In the “attraction model,” people settle near protected areas specifically because conservation efforts provide economic and social benefits and infrastructure (Wittemyer et al. 2008). The “incidental” model describes population growth near protected areas that does not fit into any of the other models, including migration as a result of conflict or forced emigration during the creation of the protected area (Joppa et al. 2010). Distinguishing which of these models best describes population growth around particular protected areas is critical to successful conservation. If the attraction model is correct, the creation of protected areas may only increase human population pressure. Policy makers may wish to determine whether protected areas should be made less attractive to settlers and, if so, how.

Data on local households may help resolve the debate. National household data sets cover too large an area to test the attraction model at the small scale of protected areas (Joppa et al. 2010). Although there is a positive correlation between population growth and deforestation at large temporal and spatial scales, evidence at the local extents is scant (Carr et al. 2005). Remotely sensed data and small-scale changes in land cover may be used to monitor immigration (Joppa et al. 2010). Yet, such data cannot highlight population growth around protected areas where the adjacent land is already deforested. Furthermore, they reveal little about drivers of change. Rather, data at the household or community level are needed (Walker et al. 2002).

Effects of Migrants on the Environment

For conservation policies to be effective, it is critical to distinguish whether human migrants contribute to environmental change within protected areas. Different types of migrants may have different effects on protected areas. People who are forced to emigrate as a result of armed conflict, violations of human rights, or natural disasters, including refugees and internally displaced people, have few assets and depend heavily on the environment for their livelihoods. Forests are attractive sources of income because they are renewable, widespread, and accessible

(Cavendish 2000; WRI 2005). Concern therefore exists about the potential for forced migrants to harvest a range of forest resources at unsustainable levels (Black & Sessay 1997; Black 1998). However, socioeconomic migrants, which we define as individuals moving to an area as a result of social or economic factors, may also contribute to environmental change. Without traditional forms of land tenure, they rely on physical evidence, including deforestation, to claim rights to land (Unruh et al. 2005; Ogelthorpe et al. 2007).

Despite these assertions, there is little evidence that migrants have a significantly larger effect on the environment than nonmigrant households (Tukahirwa 2002; Cassels et al. 2005; Birendra & Nagata 2006). Migrants may be blamed for preexisting problems (Jacobsen 1997). By attributing environmental damage to migration, governments can legitimize restrictions on asylum claims and limit land-ownership claims (Black 1998). In reality, migrants may bring socioeconomic and environmental benefits to an area, such as cheap and skilled labor, new agricultural techniques, and increased international aid (De Haas 2001; Birendra & Nagata 2006).

We examined the environmental effect of different migrant groups by comparing household characteristics commonly associated with deforestation. Relations among household characteristics and environmental outcomes are mediated by local variables, including markets, institutions, and culture (Dolisca et al. 2007; de Sherbinin et al. 2008; Boyd Kramer et al. 2009). However, general trends are evident across sites. Large households are associated with higher rates of deforestation (Bilsborrow 1992; Toole 1998). This reflects higher household consumption, greater demand for subsistence crops, and increased number of people clearing the forest (Chayanov 1986). Length of residency, income, social ties, remittances, and education are associated with lower rates of land clearing and deforestation (Deacon 1994; Rock 1996; de Sherbinin et al. 2007). By identifying differences in household factors, we sought to identify groups that may have different effects on the environment. On the basis of such information, conservation programs could be developed to meet the needs of these individuals and encourage sustainable livelihoods.

Budongo Forest

Budongo Forest Reserve has undergone large environmental and human-population changes in the past century. The forest is in Masindi district in western Uganda (between 1° 37' N–2° 03' N and 31° 22' E–31° 46' E), approximately 39 km west of the town of Masindi. The reserve is 435 km², has an average elevation of 1100 m, and the vegetation is moist semideciduous tropical forest (Reynolds 2005).

The population of the Kingdom of Bunyoro, in which Budongo Forest is located, declined from the 1880s until

1920s (Doyle 2000). These demographic changes were driven by disease, warfare, and forced emigration (Doyle 2000). During the second half of the 20th century, trends reversed. Human population grew rapidly as a result of an influx of economic migrants (i.e., individuals who moved to the area for employment) (Lauridsen 1999). The first sawmill was established in Budongo Forest in 1926 (Paterson 1991). By the 1960s, 4 sawmills were in operation (Reynolds 2005). Workers were imported to carry out logging operations (Eggeling 1947). When logging ceased, migrants remained in the area (Lauridsen 1999). Since the 1990s, the presence of a sugar factory, Kinyara Sugar Works Limited, has resulted in new employment opportunities.

Forced migrants have also settled in the area. Sudanese and Congolese refugees arrived at different times since the 1960s (Johnson 1993). Substantial migration has occurred within Uganda as a result of a 20-year conflict with the Lord's Resistance Army. As of January 2009, 1,627,479 people within Uganda were considered "people of concern" (i.e., refugees, asylum seekers, or internally displaced people) (UNHCR 2009). Several refugee camps are located in Masindi district, including the Kiryandongo refugee settlement, which has over 30,000 people (UNHCR 2009).

The population density of Budongo Forest area is low relative to other districts in Uganda (54 inhabitants/km² vs. a national average of 124 inhabitants/km²) (Uganda Bureau of Statistics 2002; Lung & Schaab 2010). Nevertheless, human encroachment and population pressure in the Budongo Forest area has drawn national attention. The Ugandan military recently deployed troops to evict people from the Forest Reserve and Murchison Falls Park (Mukasa 2008). By identifying factors that encourage and discourage migration, reviewing migrant livelihood practices, and examining the environmental effects of these practices, we may help protected-area managers determine options for addressing population pressure in Budongo Forest and similar reserves elsewhere in East Africa.

Methods

We conducted 821 interviews in 16 villages around Budongo Forest between October 2007 and May 2008. We organized villages into 4 groups on the basis of geographic factors and distance to the forest (Table 1 & Fig. 1). Four villages, Zebra, Kibwona, Nyabisense, Kijweka, were south of the main forest near Kasokwa Forest and the Kinyara sugar factory. Nyabyeya, Nyakafungo, Maramu, and Karongo were along the southern edge of Budongo Forest, near the Budongo Conservation Field Station. Kanyege, Akim B, Busingiro, and Wudukuro were further west, closer to Lake Albert and

Table 1. Number of people interviewed and location of villages in Masindi district, Uganda, where interviews on livelihoods, forest use, and migration were conducted.

Village area	Village	Approximate distance to edge of Budongo Forest Reserve (km)	Number of people interviewed
Kasokwa Forest	Zebra	0.6	47
	Kibwona	1.1	66
	Nyabisense	0.7	50
	Kijweka	0.5	50
	Nyabyeya	0.8	50
Budongo Conservation Field Station	Nyakafungo	0.2	42
	Maramu	0.1	56
	Karongo	0.5	49
	Kanyege	within boundary	50
Busingiro, Lake Albert	Akin B	0.006	60
	Busingiro	within boundary	51
	Wudukuro	within boundary	60
	Kasenyi Bokwe	0.4	49
Murchison Falls Park	Kigaragara	0.6	51
	Kituka 2	0.9	45
	Kituka Central	1.2	45

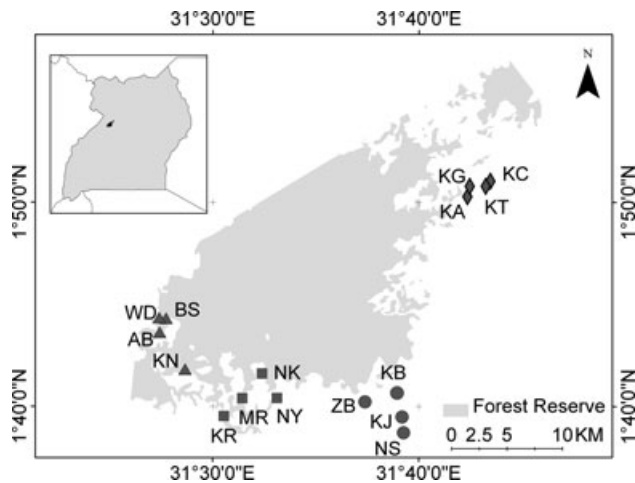


Figure 1. Map of Budongo Forest Reserve and location of villages where households were interviewed about livelihoods, forest use, and migration (outline of Uganda with the Budongo Forest shaded; circles, villages by Kasokwa Forest [ZB, Zebra; KB, Kibwona; NS, Nyabisense; KJ, Kijweka]; squares, villages by Budongo Conservation Field Station [NY, Nyabyeya; NK, Nyakafungo; MR, Maramu; KR, Karongo]; triangles, villages by Busingiro, Lake Albert [KN, Kanyege; AB, Akin B; BS, Busingiro; WD, Wudukuro]; diamonds, villages by Murchison Falls Park [KA, Kasenyi Bokwe; KG, Kigaragara; KT, Kituka 2; KC, Kituka]).

the border of the Democratic Republic of Congo, and Kasenyi Bokwe, Kigaragara, Kituka 2, and Kituka Central were north of the Budongo Forest near Murchison Falls Park.

Our research methods were reviewed and approved by the University of Oxford Research Ethics Committee and by the Ugandan National Council for Science and Technology. In each village, we sought permission to conduct interviews from the council chairman, the highest elected member of village government. After obtaining permission, an individual in roughly every third household was invited to participate. Subjects were informed of the purpose of the research and gave verbal consent before continuing.

Local field assistants administered multiple-choice questionnaires. Before interviewing subjects, they were trained in social-science interview techniques and use of geographic positioning system units. The questionnaire was pretested from June–August 2007 on a sample of households in Nyabyeya and Busingiro. The interview included questions on the daily activities, education and health of all household members, employment and sources of household income, household assets, agricultural practices, individual food choice, community relations, and questions about birthplace, migration, and use of forest resources (Supporting Information). Given the wide range of issues covered, questions about migration status or forest use seemed innocuous and were likely to be responded to truthfully (Warner 1965). Field assistants gained the confidence of the interview subjects by explaining that answers were confidential, by conducting interviews in private, and because they were Ugandans from the community (Warner 1965; Rist et al. 2010).

To identify migrants, we asked individuals their village, district, and country of birth. Individuals born in one of the 16 interview villages were classified as nonmigrants ($n = 198$). To distinguish different types of migrants, we asked respondents if they had been forcibly evicted.

Individuals forced to migrate as a result of armed conflicts or natural disasters were categorized as forced migrants ($n = 42$). Remaining individuals were classified as socioeconomic migrants, either as local migrants from within Masindi district ($n = 149$) or as regional migrants from outside Masindi district ($n = 393$). Individuals may have moved for a variety of reasons, and may not admit to causes of displacement for fear of stigmatization. Questions about displacement and migration appeared several times throughout the interview. This allowed us to identify inconsistencies in answers. Thirty-nine interview subjects could not be categorized because of insufficient information on their location of birth ($n = 4$) or on the causes of their migration ($n = 35$).

Interviews were structured according to the livelihoods approach (Ellis 2000). The livelihoods approach focuses on identifying household survival strategies (i.e., the ways households acquire and manage resources) (Lautze 2008). Livelihoods can be assessed by examining: assets (including human, financial, natural, physical, and social capital); how access to assets is modified by social relations, institutions, and organizations; and how trends and shocks influence livelihood strategies (Ellis 2000). Although it was not possible to obtain exact income figures from respondents, locally relevant indicators were chosen as proxies for wealth (e.g., cattle, land or motorcycle ownership, fish and meat consumption) (Ellis & Bahigwa 2003; Pouw 2008). All forms of assistance (e.g., labor, food aid, mosquito nets), including remittances from others were recorded. Social relations were determined by examining participation in village activities. Respondents were asked whether they, or other household members, participated in a variety of community organizations. Answers were tallied to provide a civic participation score. Scores ranged from 0 to 14 (zero, no member of a household was involved in any organization; 14, at least 2 members of the household were each involved in 7 different organizations).

We entered data into Excel (Microsoft, Redmond, Washington) and analyzed answers with SPSS 19 (IBM, Chicago, Illinois). We summarized differences among the 3 groups and compared them with chi-square and Fisher's exact tests. We applied principal component analyses (PCA) to 15 livelihood variables associated with deforestation in an attempt to elucidate patterns in these variables among household migration types. We used the Kaiser—Meyer—Olkin measure to verify the adequacy of the sample for the PCA analyses ($KMO = 0.606$). Bartlett's test of sphericity ($\chi^2_{(105)} = 1576.90$, $p < 0.001$) indicated that correlations among items were statistically significant and appropriate for PCA analysis. The screen plot justified retaining the first 4 components. We compared factor scores of households with an analysis of variance (ANOVA) and Gabriel's post hoc test for unequal sample sizes.

Results

Human Migration

The majority (90%) of all respondents ($n = 816$) were born in Uganda. Nine and 6/10th percent were born in the Democratic Republic of Congo and 0.4% were born in Sudan. Most Ugandan-born respondents (63.9%) were born in a western district: Masindi (46.1%), Bulisa (8.9%), or Hoima (5.0%). A substantial minority (31.6%) were born in a northern district: Nebbi (12.3%), Arua (11.3%), Gulu (2%), Apac (1.7%), or Lira (1.6%).

Few respondents ($n = 198$) were born in one of the interview villages. The majority of respondents ($n = 393$) were classified as regional migrants. Eighty one percent of regional migrants were born in Uganda, and 18.2% were born in Democratic Republic of Congo. Of those born in Uganda, 59.7% were born in a northern district, 31.1% were born in a western district, and 7.6% were born in a central district. Forced migrants ($n = 42$) had similar locations of birth. The majority of forced migrants (83.3%) were born in Uganda. Of these, most were born in a northern (67.6%) or western district (26.5%).

Significant migration to Budongo Forest occurred between 1998 and 2008. Forty-nine and 5/10th percent of all interview subjects moved to their current village during this time. When examined according to migration category, 50.4% of regional migrants arrived between 1998 and 2008, 50.7% of local migrants arrived between 2000 and 2008, and 51.5% of nonmigrants moved to a different village in the Budongo area between 1998 and 2008. Forced migrants appeared to have moved to the area earlier. Arrivals of forced migrants peaked between 1994 and 1997, coinciding with an increased intensity of conflict in the north of Uganda (24.4% of refugees arrived during this time).

Local and regional socioeconomic migrants left natal areas primarily as a result of land shortages, nonproductive farming, lack of employment, or because they followed family members (Table 2). Motives for choosing the Budongo Forest area differed among groups ($\chi^2_{(9)} = 521.78$, $p < 0.001$). Nonmigrants moved to their current village predominantly to obtain land or to farm, but they also moved to be near family or because they married. Local migrants came for similar reasons, although a greater portion came to the Budongo area to be with family or to marry and fewer came to farm. Most regional migrants came to obtain land or for employment (Table 3). Forced migrants cited security as the main reason for migrating to the Budongo area, but 2.4% mentioned opportunities for illegal logging.

Categories of migrants differed among villages (Fisher's exact test, $p \leq 0.001$) and in different groups of villages ($\chi^2_{(9)} = 97.41$, $p < 0.001$). A greater number of forced migrants settled near Kasokwa Forest, especially in the village of Zebra, and near Murchison Falls Park toward

Table 2. Reasons for leaving village of origin reported during interviews in 16 villages in Masindi district, Uganda.

<i>Reason for emigrating</i>	<i>Local migrants^a (%)</i> (n = 67)	<i>Regional migrants^b (%)</i> (n = 175)	<i>Forced migrants^c (%)</i> (n = 42)
Conflict	0	0	100
Family left the region	7.5	16.1	0
Marriage	23.9	16.1	0
Lack of employment	18	10.9	0
Land shortage	28.4	25.8	0
Land disputes	7.5	7.5	0
Unproductive farming	7.5	23	0
Evicted	6	0	0
Lack of available education	0	0.6	0
Infant mortality	1.5	0	0

^a Individuals born within Masindi district.

^b Individuals born outside Masindi district.

^c Refugees and internally displaced people.

the north of the forest. Similarly, local migrants settled in greater numbers than expected by chance near Kasokwa Forest and near Murchison Falls Park. Regional migrants settled in villages around Busingrio, near Lake Albert to the west of the forest, whereas a higher proportion of nonmigrants settled in villages near Budongo Conservation Field Station (Table 4).

Across all categories most households were within 1–2 km of the forest edge. However, a larger proportion of regional migrants (46.6%) and forced migrants (50%) lived within 100 m of the forest edge than did nonmigrants (39.3%) or local socioeconomic migrants (33.6%). The association between migration status and proximity of the house to the forest was statistically significant (Fisher's exact test, $p = 0.05$). A greater proportion of regional migrants and forced migrants farmed land within 100 m of the forest than nonmigrants or local migrants. More nonmigrants than expected farmed land 1 km or more from the forest (Fisher's exact test, $p = 0.03$).

Mean household size was 4.44 people (SD 2.54). Forced migrants had significantly smaller households

(mean [SD] = 3.64 [2.48]) than local migrants (mean = 4.58 [2.60]), regional migrants (mean = 4.60 [2.60]), or nonmigrants (mean = 4.12 [2.37]) (Kruskal-Wallis test, $p = 0.02$).

Assets and Forms of Capital

In general, people were extremely poor: 98.2% of households did not own cattle, and 97.2% of households did not own motorcycles. Migration status was associated with land ownership ($\chi^2_{(3)} = 29.70$, $p < 0.001$). Only 45.2% of forced migrants owned land, compared with 84.3% of nonmigrants, 73.0% of local migrants, and 75.3% of regional migrants. Migration status was also significantly associated with ownership of goats ($\chi^2_{(3)} = 9.71$, $p = 0.02$), pigs ($\chi^2_{(3)} = 11.99$, $p < 0.01$), and chickens ($\chi^2_{(3)} = 10.28$, $p = 0.02$). Fewer forced migrants owned goats, pigs, or chickens than other migrant groups. More nonmigrants and local migrants owned animals than expected by chance. There was no difference in the consumption of meat or preferred foods, owner-

Table 3. Reasons for settling in current village reported during interviews in 16 villages in Masindi district, Uganda.^a

<i>Reason village selected</i>	<i>Nonmigrants^b (%)</i> (n = 70)	<i>Local migrants^c (%)</i> (n = 139)	<i>Regional migrants^d (%)</i> (n = 384)	<i>Forced migrants^e (%)</i> (n = 42)
To marry or be with family	37.2	44.6	25.8	0
To get land or farm	50	39.5	54.4	9.6
Employment at sugar factory	0	2.9	4.7	0
Employment in sawmill	4.3	2.2	6.3	0
Pit sawing	1.4	0.7	0.5	2.4
Employment in conservation sector	0	0	1.5	0
Other employment	7.1	8.6	6.0	2.4
Education	0	0	0.7	2.4
Lack of disease	0	0	0	0
Lack of war	0	0.7	0	83.4
Other	0	0.7	0.3	0

^a Sum of percentages is over 100 in some cases due to rounding to one decimal place.

^b Individuals born in Budongo Forest area.

^c Individuals born within Masindi district.

^d Individuals born outside Masindi district.

^e Refugees and internally displaced people.

Table 4. Settlement of different migrant groups across 16 villages in Masindi district, Uganda.^a

Village group	Village	Nonmigrants ^b (%) (n = 198)	Local migrants ^c (%) (n = 149)	Regional migrants ^d (%) (n = 393)	Forced migrants ^e (%) (n = 42)
Kasokwa	Zebra	1.5	5.4	5.6	31
Forest	Kibwona	13.6	11.4	3.8	2.4
	Nyabisense	10.1	11.4	3.1	0
	Kijweka	11.6	5.4	3.1	0
Sum		36.8	33.6	15.6	33.4
Budongo	Nyabyeya	12.6	4	4.1	7.1
Conservation	Nyakafungo	7.6	2.7	5.3	4.8
Field Station	Maramu	8.6	8.1	6.6	2.4
	Karongo	4	4.7	7.6	2.4
Sum		32.8	19.5	23.6	16.7
Busingiro,	Akin B	1.5	5.4	11.2	9.5
Lake Albert	Wudukuro	4.5	3.4	9.9	2.4
	Busingiro	0.5	4	10.7	0
	Kanyege	4	4	8.1	4.8
Sum		10.5	16.8	39.9	16.7
Murchison Falls Park	Kasenyi Bokwe	6.6	8.7	4.3	9.5
	Kigaragara	4	8.7	6.4	7.1
	Kituka Central	4	7.4	5.3	9.5
	Kituka 2	5.1	5.4	4.8	7.1
Sum		19.7	30.2	20.8	33.2

^aSum of percentages is over 100 in some cases due to rounding to one decimal place.

^bIndividuals born in Budongo Forest area.

^cIndividuals born within Masindi district.

^dIndividuals born outside Masindi district.

^eRefugees and internally displaced people.

ship of radios, or bicycles among the different migrant categories. There was a significant difference in ownership of mobile phones ($\chi^2_{(3)} = 9.83, p = 0.02$). Only 19.4% of regional migrant households owned mobile phones, whereas 31.5% of local migrant, 28.6% of forced migrant, and 24.9% of nonmigrant households owned mobile phones.

There was a significant association between migration status and the ability to cover household expenses (Fisher's Exact test, $p = 0.01$). A greater percentage of regional migrants (24.0%) had insufficient income and needed support from outside the household than local migrants (17.6%), forced migrants (14.6%), and nonmigrants (15.5%). Only 13.7% of households received remittances, such as money, goods, or labor. There was no difference among migrant groups.

There were no differences in the health or education level of the household heads of migrant and nonmigrant groups. The majority of household heads were healthy (95.1%) and had attended only primary school (76.2%). The number of school-aged children attending school did not differ among groups. Only 21.4% of households sent all their children to school, and 28.8% of households sent none of their children to school.

A significantly greater number of forced-migrant households earned wages through labor ($\chi^2_{(3)} = 21.57, p < 0.001$) or worked at the sugar factory (Fisher's exact test, $p < 0.001$). Forty and five-tenths percent of forced migrants earned wages through labor, whereas 14.5% of

regional migrants, 25.5% of local migrants, and 20.7% of nonmigrants earned wages through labor. Twenty-three and 8/10th of forced migrants, 4.6% of regional migrants, 10.1% of local migrants, and 7.1% of nonmigrants worked at the sugar factory. The number of individuals that had paid employment in the past did not differ among migrant and nonmigrant groups.

On average, households participated in 4.37 (SD 1.44) social activities or community groups. Participation among migrant and nonmigrant groups did not differ. The majority of interview subjects (77.5%) agreed or strongly agreed that people in the village knew each other. A similar percentage of respondents (75.5%) agreed or strongly agreed that people in the village got along well.

All groups agreed the forest is important (100% forced migrants, 98.8% regional migrants, 97.5% local migrants, 98.2% nonmigrants). A greater percentage of forced migrants (50.0%) said they did not to go into the forest than regional migrants (25.3%), local migrants (34.5%), and nonmigrants (28.9%) ($\chi^2_{(3)} = 13.49, p < 0.01$). Households gathered firewood (39.3%), building supplies (26.6%), and water (21.3%) from the forest. Few respondents said they hunted (1.1%) or conducted pit sawing (3.7%) in the forest. Of the respondents that said they conducted pit sawing, 52.8% were regional migrants, 22.2% were local migrants, 22.2% were nonmigrants, and 2.8% were forced migrants. 72.7% of individuals that said they hunted were regional migrants. The association between migrant type and pit sawing was not significant.

Table 5. Summary of results of principal component analyses in which 15 livelihood variables associated with deforestation were compared.

<i>Item</i>	<i>Component 1</i>	<i>Component 3</i>
Area of land farmed (acres)	0.87*	
Area of land owned (acres)	0.87*	
Household size (number of people)	0.51*	-0.13
Work for sugar factory (number of household members)		0.77*
Wage labor (number of household members)	-0.11	0.66*
Village group (1 of 4 classes)		0.67*
Meat consumed at least once a week (binary)	0.16	0.12
Preferred food consumed in last 24 hours (binary)	-0.13	-0.12
Mobile phones (number owned by household)		0.3
Chickens (number owned by household)	0.4*	
Health of household head (1 of 4 classes)	0.11	
Ability to pay expenses (1 of 3 classes)		-0.14
Level of education of household head (1 of 4 classes)		
Cash crop grown (binary)		
Sugarcane grown (binary)		
Eigenvalue	2.46	1.56
Variance (%)	16.37	10.3

*Factor loading over 0.40.

However, the association between migrant type and hunting was significant ($p = 0.03$).

Several household characteristics associated with deforestation clustered together in the PCA. Component 1 was associated with household size and agriculture, attributes positively associated with deforestation (factor pattern, Table 5). Component 3 was associated with employment and income, attributes negatively associated with deforestation. Scores for components 1 ($F_{3,570} = 2.70$, $p = 0.04$) and 3 ($F_{3,570} = 8.81$, $p < 0.001$) differed among migrant groups. Post hoc tests indicated regional migrants had significantly larger component-1 factor scores (mean [SD] = 0.07 [1.00]) than forced migrants (mean = -0.45 [1.19]). Regional migrants had lower component-3 factor scores (mean = -0.22 [0.73]) than nonmigrants (mean = 0.18 [1.26]) and local migrants (mean = 0.25 [1.14]).

Discussion

Out of 782 individuals who provided information about birthplace, 584 migrated to Budongo Forest. Socioeconomic migrants arrived continuously between 1998 and 2008, whereas the arrival of forced migrants peaked between 1994 and 1997. The majority of migrants came from outside the Masindi district, from heavily populated northern or western districts. Nearly 23% of interview subjects were born in Arua and Nebbi districts. These districts have population densities nearly 3 times that of Masindi (Uganda Bureau of Statistics 2002).

Reasons for leaving birthplaces and for choosing the Budongo Forest area differed among groups. Many local migrants from Masindi district moved to Budongo Forest because they had social ties to the area. A larger proportion of regional migrants (defined above) came to Budongo because land was available. Forced migrants moved to Budongo because security was better than in their districts of origin.

Regional migrants settled heavily near Lake Albert, by Busingiro, often within the boundary of the forest reserve, whereas many forced migrants settled in villages closest to the sugar factory. Within villages forced and regional migrants were more likely to live and farm land close to the forest edge. Forced migrants had smaller households, were more likely to engage in wage labor, and were less likely to own land or animals. A greater percentage of regional migrants had insufficient income to cover expenses and a smaller percentage owned mobile phones, an indicator of wealth. There were no statistically significant differences in health, education, past employment, or current social activities among groups. Natural capital was important to all households. However, a smaller percentage of forced migrants said they entered the forest, and regional migrants were more likely to hunt.

Our findings are consistent with those of previous studies of the timing and rates of migration. A survey of 6 villages near Budongo Forest, conducted in 2000, indicated that 35% of farmers had lived in the villages for <10 years (Tweheyo et al. 2005). We found that migration has continued since 2001, possibly at slightly higher rates. Results of a previous study of settlement patterns near Budongo Conservation Field Station show that new village members live closer to the forest edge than long established residents (Johnson 1993).

We think our most striking result was that different migrant groups appeared to earn income in different ways. Socioeconomic migrants pursued farming, owning land and farm animals, whereas forced migrants were more often engaged in wage labor. One plausible explanation for this finding is that different resources are available to individuals on arrival as a result of the circumstances surrounding the causes of migration. Because socioeco-

conomic migrants choose to relocate, it is reasonable to assume they may have access to assets with which to acquire land. Because forced migrants are, by definition, forced to resettle to escape war, they may have fewer resources with which to pursue agriculture. Alternatively, livelihood choice may be determined by location of settlement. Forced and local migrants lived close to the sugar factory and may have decided to pursue wage labor as a result of settling there.

Our results do not support the concept that refugees have large effects on natural resource extraction in the Budongo Forest area. Although forced migrants may settle closer to the forest edge, with greater financial resources from wage labor, they may not be dependent on forest resources. Regional migrants may have greater effects on the forest. These migrants scored high on household factors associated with deforestation (Table 5) and resided in villages within the boundary of the forest reserve. Local migrants also engaged in farming. However, they settled farther from the forest edge and may therefore be less likely to engage in deforestation.

Our results are not consistent with current ideas about human migration to protected areas. The migration patterns we found did not show that population increase outside protected areas is associated with the expansion of existing population centers. If population increase were associated with natural growth of the population, one would expect the majority of respondents to be either nonmigrants or local migrants. In contrast, the majority of interview subjects specifically came to Budongo from other districts of Uganda. Although they were attracted to the area, very few settled near the Budongo Forest as a result of opportunities provided by creation of the protected area or current conservation programs. The availability of natural resources, such as forest products or wild meat, was not mentioned as a primary reason for settling near Budongo. Rather, Budongo Forest was primarily attractive because it offered space for agricultural expansion. This seems to support the frontier-engulfment model. While this model captures regional migration, it does not accurately capture local migration driven by family ties. It excludes human attraction. We found that friends and family were also important determinants of settlement patterns.

Our results indicate that migration to Budongo Forest is likely to continue. In a heavily populated country such as Uganda, protected areas are seen as providing space for human agriculture and settlement. Population growth around protected areas will likely continue to increase as land availability decreases elsewhere. For the Budongo Forest region, we suggest that a register of land titles along forest boundaries be completed so as to reduce population growth around protected areas (Fearnside 2008). Additional opportunities for wage labor, in migrant source and sink locations, also could reduce causes of migration and allow newly arrived migrants to pursue

livelihoods other than those that contribute to deforestation (Carr 2009). However, even if migration for the purpose of acquiring land decreases, migration to protected areas will continue due to social networks.

As indicated by the 2008 evictions of pastoralists from Murchison Falls and Budongo Forest area, the Ugandan government is working to reduce human encroachment in protected areas (Mukasa 2008). Such expulsions may temporarily alleviate population pressure, but are unlikely to offer long-term protection for forests. We suggest that managers identify ways to reduce local demand for natural resources, such as providing hydroelectric energy to reduce collection of wood or encouraging the creation of new homes away from ecologically sensitive areas (DeFries et al. 2010). We also suggest creating regional land-use plans that account for land-use change outside protected areas (DeFries et al. 2010). Because population growth will continue around protected areas, we suggest that the focus of conservation debates shift from causes of migration to the creation of sustainable livelihoods for migrants.

Acknowledgments

Permission to conduct research was granted by the Uganda Wildlife Authority, the Ugandan National Council of Science and Technology, the Office of the President of Uganda, Budongo Conservation Field Station, and University of Oxford. We thank A. Hannington Fani, A. Geoffrey, O. Katwesige, K. Grounds, and U. Zommers for their help conducting interviews and entering data. We are grateful for the advice provided by P. J. Johnson, L. A. Tallents, A. I. Zommers, and for the revisions suggested by reviewers. Research was supported by the Commonwealth Scholarship Commission, the Cleveland Metroparks Zoo, and the Canadian Centennial Scholarship Fund.

Supporting Information

The questionnaire used in the household surveys is available online article (Appendix S1). The authors are responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Literature Cited

- Bilsborrow, R. E. 1992. Population growth, internal migration and environmental degradation in rural areas of developing countries. *European Journal of Population* 8:125-148.
- Birendra, K., and S. Nagata. 2006. Refugee impact on collective management of forest resources: a case study of Bhutanese refugees in Nepal's Eastern Terai region. *Journal of Forest Research* 11:305-311.
- Black, R., 1998 *Refugees, environment and development*. Longman, London.

- Black, R. and M., Sessay. 1997. Forced migration, land-use change and political economy in the forest region of Guinea. *African Affairs* **96**:587-605.
- Boyd Kramer, D., G. Urquhart, and K. Schmitt. 2009. Globalization and the connection of remote communities: a review of household effects and their biodiversity implications. *Ecological Economics* **68**:2897-2909.
- Cassels, S., S. Curran, and R. Kramer. 2005. Do migrants degrade coastal environments? Migration, natural resource extraction and poverty in North Sulawesi, Indonesia. *Human Ecology* **33**:329-363.
- Carr, D.L. 2009. Migration and deforestation: why rural migration matters. *Progress in Human Geography* **33**:355-378.
- Carr, D., L. Suter, and A. Barbieri. 2005. Population dynamics and tropical deforestation: state of the debate and conceptual challenges. *Population and Environment* **27**:89-113.
- Cavendish, W. 2000. Empirical regularities in the poverty-environment relationship in rural households: evidence from Zimbabwe. *World Development* **28**:1979-2003.
- Chayanov, A. V. 1986. *The theory of peasant economy*. D. Thorner, B. Kerblay, and R. Smith, editors. University of Wisconsin Press, Madison.
- Cincotta, R., J. Wisniewski, and R. Engelman. 2000. Human population in biodiversity hotspots. *Nature* **404**:990-992.
- Deacon, R. 1994. Deforestation and the rule of law in a cross-section of countries. *Land Economics* **70**:414-430.
- DeFries, R., K. Karanth, and S. Pareeth. 2010. Interactions between protected areas and their surroundings in human-dominated tropical landscape. *Biological Conservation* **143**:2870-2880.
- De Haas, H. 2001. *Migration and agricultural transformation in the oases*. KNAG, Utrecht, Netherlands.
- De Sherbinin, A., D. Carr, S. Cassels, and L. Jiang. 2007. Population and environment. *Annual Review of Environment and Resources* **32**:345-73.
- De Sherbinin, A., L. VanWey, K. McSweeney, R. Aggarwal, A. Barbieri, S. Henry, L. Hunter, W. Twine, and R. Walker. 2008. Rural household demographics, livelihoods and the environment. *Global Environmental Change* **18**:38-53.
- Dolisca, F., J. McDaniel, L. Teeter, and C. Jolly. 2007. Land tenure, population pressure and deforestation in Haiti: the case of Forêt des Pins Reserve. *Journal of Forest Economics* **13**:277-289.
- Doyle, S. 2000. Population decline and delayed recovery in Bunyoro, 1860-1960. *Journal of African History* **41**:429-458.
- Ellis, F. 2000. *Rural livelihoods and diversity in developing countries*. Oxford University Press, Oxford, United Kingdom.
- Ellis, F., and G. Bahiigwa. 2003. Livelihoods and rural poverty reduction in Uganda. *World Development* **31**:15.
- Eggeling, W. 1947. *Forestry working plan for Budongo and Siba Forests*. 1st revision period. Government Printer, Kampala, Uganda.
- Fearnside, P. 2008. The roles and movements of actors in the deforestation of Brazilian Amazonia. *Ecology and Society* **13**: <http://www.ecologyandsociety.org/vol13/iss1/art23/>.
- Geist, H. J., and E. J. Lambin. 2006. *Land-use and land-cover change: local process and global impacts*. Springer, Berlin.
- Howard, P., T. Davenport, and R. Matthews. 1996. *Budongo Forest Reserve: biodiversity report*. Forestry Department, Kampala, Uganda.
- Jacobsen, K. 1997. Refugees' environmental impact: the effect of patterns of settlement. *Journal of Refugee Studies* **10**:19-36.
- Johnson, K. 1993. *Local use of Budongo's Forest products*. MS thesis. University of Oxford, Oxford, United Kingdom.
- Joppa, L., S. Loarie, and S. Pimm. 2009. On population growth near protected areas. *Public Library of Science ONE* **4**:DOI: 10.1371/journal.pone.0004279.
- Joppa, L., S. Loarie, and A. Nelson. 2010. Measuring population growth around tropical protected areas: current issues and solutions. *Tropical Conservation Science* **3**:117-121.
- Lauridsen, M. 1999. *Workers in a forest: understanding the complexity of incorporating local people in modern management*. Institute of Anthropology, University of Copenhagen, Copenhagen.
- Lautze, S. 2008. Social dynamics in militarised livelihood systems: evidence from a study of Ugandan army soldiers. *Journal of Eastern African Studies* **2**:415-438.
- Locke, H., and P. Dearden. 2005. Rethinking protected area categories and the new paradigm. *Environmental Conservation* **32**:1-10.
- Lung, T., and G. Schaab. 2010. A comparative assessment of land cover dynamics of three protected forest areas in tropical eastern Africa. *Environmental Monitoring and Assessment* **161**:531-548.
- Mather, A. S., C. L. Needle, and J. Fairbairn. 1998. The human drivers of global land cover change: the case of forests. *Hydrological Process* **12**:1983-1994.
- Mukasa, H. 2008. Murchison Park encroachers evicted. *New Vision*, 16 May: Available from <http://www.lexisnexis.com/uk/nexis/>.
- Mwavu, E. N., and E. T. F. Witkowski. 2008. Land-use and cover changes (1988-2002) around Budongo Forest Reserve, NW Uganda: implications for forest and woodland sustainability. *Land Degradation and Development* **19**:606-624.
- Ogelthorpe, J., J. Ericson, R. Bilsborrow, and J. Edmond. 2007. *People on the move*. World Wildlife Fund, Washington, D.C.
- Paterson, J. 1991. The ecology and history of Uganda's Budongo Forest. *Forest and Conservation History* **35**:179-187.
- Plumptre, A., et al. 2010. Eastern chimpanzee (*Pan troglodytes schweinfurthii*) status survey and conservation action plan 2010 - 2020. International Union for Conservation of Nature, Gland, Switzerland.
- Pouw, N. 2008. Food priorities and poverty: the case of smallholder farmers in rural Uganda. *Journal of African Economies* **18**:DOI: 10.1093/jae/ejn010.
- Reynolds, V. 2005. *The chimpanzees of the Budongo Forest*. Oxford University Press, Oxford, United Kingdom.
- Rist, J., E. Milner-Gulland, G. Cowlishaw, and M. Rowcliffe. 2010. Hunter reporting of catch per unit effort as a monitoring tool in a bushmeat-harvesting system. *Conservation Biology* **24**:489-499.
- Rock, M. 1996. The stork, the plow, rural social structure, and tropical deforestation in poor countries. *Ecological Economics* **18**:113-131.
- Scholte, P. and W. T. de Groot. 2010. From debate to insight: three models of immigration to protected areas. *Conservation Biology* **24**:630-632.
- Tole, L. 1998. Sources of deforestation in tropical developing countries. *Environmental Management* **22**:19-33.
- Tweheyo, M., C. Hill, and M. Obua. 2005. Patterns of crop raiding by primate around Budongo Forest Reserve, Uganda. *Wildlife Biology* **11**:237-247.
- Uganda Bureau of Statistics. 2002. *The 2002 Uganda Population and Housing Census, Population Size and Distribution*. Uganda Bureau of Statistics Kampala.
- UNHCR (United Nations High Commission for Refugees). 2009. *Uganda: statistical snapshot*. UNHCR, Kampala. Available from <http://www.unhcr.org/pages/49e483c06.html> (accessed September 2010).
- Unruh, J., L. Cligget, and R. Hay. 2005. Migrant land rights reception and 'clearing to claim' in sub-Saharan Africa: a deforestation example from southern Zambia. *Natural Resources Forum* **29**:190-198.
- Walker, R., S. Perz, M. Caldas, and L. G. Teixeira da Silva. 2002. Land use and land cover change in forest frontiers: the role of household life cycles. *International Regional Science Review* **25**:169-199.
- Warner, S. 1965. Randomized response: a survey technique for eliminating evasive answer bias. *Journal of the American Statistical Association* **60**:63-69.
- Witemyer, G., P. Elsen, W. Bean, C. Burton, and J. Brashares. 2008. Accelerated human population growth at protected area edges. *Science* **321**:123-126.
- WRI (World Resources Institute). 2005. *The wealth of the poor: managing ecosystems to fight poverty*. United Nations Environment Programme, Nairobi, and World Bank and World Resources Institute, Washington, D.C.