RESEARCH ARTICLE

# Beyond Ecological Success of Corridors: Integrating Land Use History and Demographic Change to Provide a Whole Landscape Perspective

*Sadie J Ryan and Joel Hartter*

## ABSTRACT

The performance of corridors has often been measured through ecological attributes, or the progress towards restoration of a notionally intact section of landscape. A corridor's ability to reconnect fragmented landscapes is of critical importance for biodiversity conservation. However, what remains understudied is how these corridors within protected area systems fit into the park-people rubric. It is important to learn from older corridors to provide baseline comparisons in terms of restoration, land use and conservation policy, and park-people dynamics. We present an analysis of the landscape of Kibale National Park in western Uganda, which has maintained a corridor with Queen Elizabeth National Park to the south since 1926. The purpose and use of this corridor region has varied over time, from hunting, to biodiversity conservation, to extractive use, to farming. We examined the history of politics and demography both in and around this corridor and used satellite imagery to describe forest cover and conversion in this corridor, prior to and after park establishment. This analysis is useful not only to understand Kibale within a domesticated landscape, but also as a lens into the future of corridors and their larger landscapes in the East African Albertine Rift.

**Keywords:** Albertine Rift, connectivity, Kibale National Park, land use history, Queen Elizabeth National Park, Uganda

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*"In 1983, soldiers burned hundreds of homes in the Kibale Forest Reserve Game Corridor, in western Uganda. Their homes destroyed and possessions stolen, the people that had been living in the reserve fled. (. . .) Most who left returned to their land in the game reserve within a few months, rebuilt their homes and replanted their fields" (Drennon, 1997).*

The Eastern Afromontane forest region has been identified as having the largest land area of the Conservation International biodiversity hotspots and is prone to conservation conflict induced by surrounding poverty and enormous population growth (Fisher and Christopher 2007). Within the Eastern Afromontane, the Albertine Rift is one of the world's biodiversity hotspots, supporting more threatened and endemic species than any other geographic region in Africa (Plumptre et al. 2003, Plumptre et al. 2007). It is also one of the most threatened ecosystems, due to dense intensive smallholder agriculture, high levels of land and resource pressures, and high rates of habitat loss and conversion, making it a high priority area for conservation. Within the transition between savannah and mid-montane forest in the Albertine Rift of western Uganda lies Kibale National Park (Kibale), a larger remnant forest (795 km$^2$) that was formed by combining a forest reserve and a game corridor connected to Queen Elizabeth National Park (QENP) to the south (Figure 1). Kibale was established by presidential decree in 1992, and at that time, all land use and settlement within the park was immediately banned, and up to 200,000 people were evicted from the corridor (Hartter and Ryan 2010). The Kibale-QENP corridor is an important story of park establishment, habitat restoration, and human displacement.

Parks and protected areas that have been established without local buy-in can lead to highly negative attitudes, and often pervasive hostility, by those currently or formerly living near or in them (Fabricius and de Wet 2002, Igoe 2004, Brockington 2006, Brockington and Igoe 2006, West et al. 2006, Schmidt-Soltau and Brockington 2007). These negative emotions occur particularly because of expulsions, exclusions, and restrictions that have been imposed on prior inhabitants and neighboring peoples, as well as the continuing capture of most of its financial benefits by

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national and local elites (Thompson and Homewood 2002). Together with the exclusions and restrictions that are imbedded in their policy, parks are seen as generators of economic inequities that emphasize biodiversity conservation over local livelihoods (Hartter and Goldman 2011). It is also often asserted that expulsions will lead to permanent hostility to these parks (Cernea and Schmidt-Soltau 2006). Particularly in areas of high human population density, corridors will be difficult to establish because of heavy social, political, and economic impacts, and therefore the definition of corridor success must be broadened to include considerations for land use history and local livelihoods.

While the corridor between Kibale and QENP has been successful in restoring native vegetation, this model of corridor design is unlikely to occur again in this area of the world. A complicated mixture of effects from past political upheaval, in-migration, devolution of government, and massive population growth means that establishing parks and corridors through exclusionary practices is highly contentious in densely settled agricultural landscapes. Therefore, we need to carefully consider land use history and demographic change along with measures of ecological change in evaluating the success of corridor establishment as we move forward in reconnecting and restoring natural landscapes.

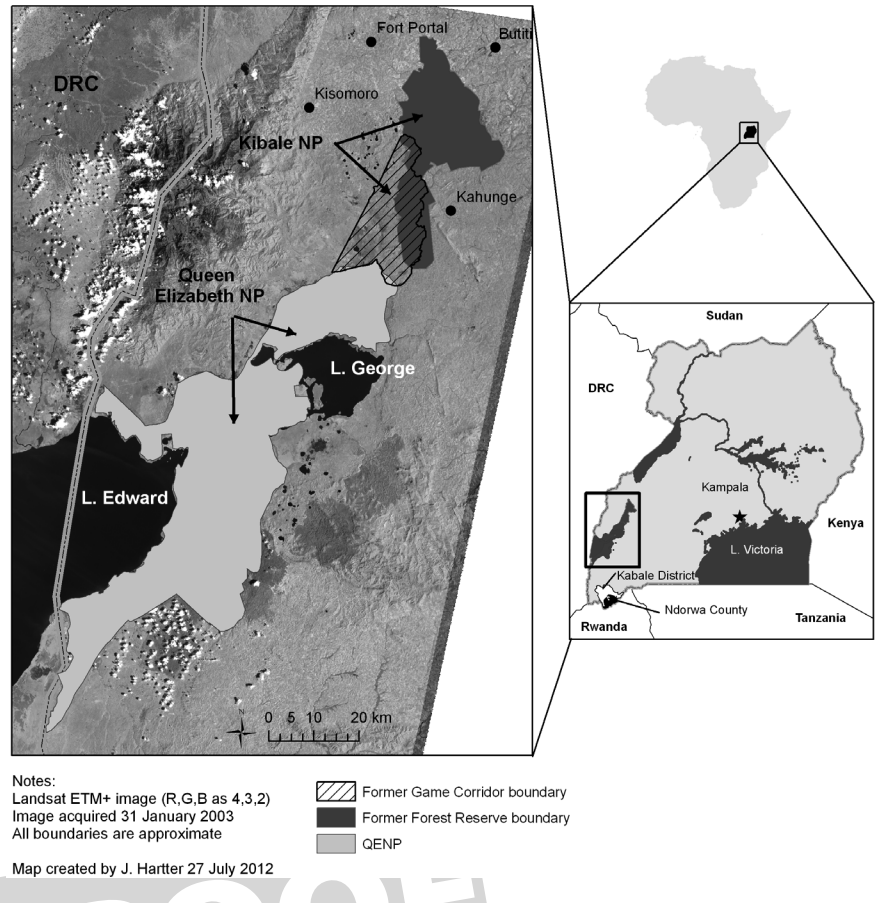


**Figure 1. Queen Elizabeth National Park and the former Game Corridor (hashed) and Forest Reserve (solid grey) that comprise Kibale National Park as of 1993. The corridor is shown as the former Game Corridor, and the former Kibale Forest Reserve is shaded to demonstrate the degree of overlap. Note the incomplete vegetation cover through the corridor, as shown on this Landsat imagery from 2003.**

## Two Parks and a Corridor

QENP was established in 1952, following the National Parks Act, 1952, and is managed by Uganda National Parks (Nampindo and Plumptre 2005). In 1996, the Wildlife Statute mandated the creation of the Uganda Wildlife Authority (UWA), which currently manages Uganda's national parks. QENP comprises approximately 2,080 km² in land area, abutting Kyambura and Kigezi Wildlife Reserves, bordering Lake George (a Ramsar site) and Lake Edward, and is Uganda's second largest national park (Figure 1). QENP habitats include wetlands, savannas, lowland and gallery forests, and support an estimated 95 mammal species, including leopards (*Panthera pardus*), lions *(Panthera leo)*, elephants *(Loxodonta africana)*, hippopotamuses *(Hippopotamus amphibious)*, Cape buffalo *(Syncerus caffer)*, and chimpanzees *(Pan troglodytes schweinfurthii)*, and over 500 species of birds. The Uganda-Tanzania war in the late 1970s decimated much of the wildlife in the QENP area, but many species have returned to moderately sustainable population sizes, despite the persistent and significant threat of bushmeat hunting. QENP was designated part of a Biosphere Reserve under UNESCO in 1979 and is a Man and Biodiversity (MAB) Biosphere, the goals of which are to harmonize man and nature (Taylor 2004). In 1999, an estimated 20,000 inhabitants in 10 settlements of the QENP MAB Biosphere relied on fishing and salt harvesting in the buffer zones, and it was acknowledged that the reserve's woodlots were already likely impacted by gathering of firewood for cooking, smoking fish, lime production, and handcrafts (UNESCO/MAB 2008).

Kibale National Park is a remnant of a transitional forest between savannah and mid-altitude tropical forest surrounded by a large agricultural population. Kibale is home to one of the largest populations of chimpanzees in East Africa and to 12 other primate species (Chapman and Lambert 2000, Plumptre et al. 2003), making it one of the most diverse primate communities in the world. Habituated chimpanzees attract over 7,000 foreign tourists per year (UWA 2009). Contrasting this rich intact faunal community,

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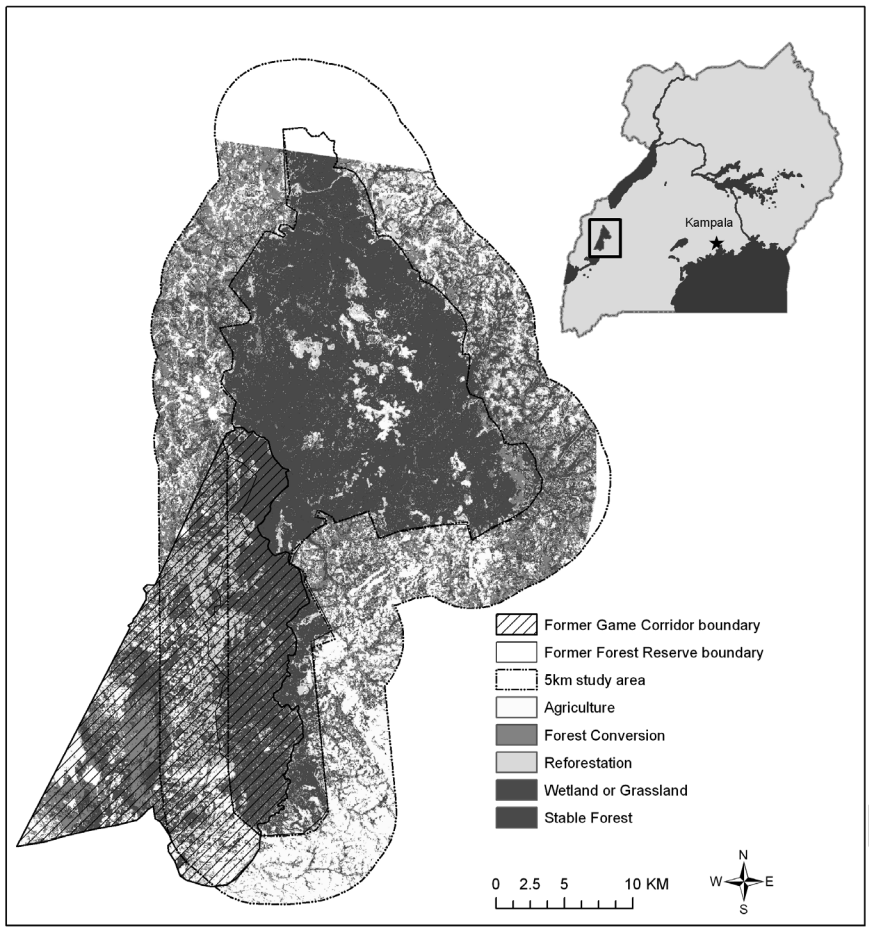


**Figure 2. Changing land cover over 25 yr in Kibale National Park and the Kibale-Queen Elizabeth National Park corridor (adapted from Figure 2 in Hartter et al. 2011). Note both the formerly logged area within the park and the corridor as described in 1993, after park establishment.**

Kibale is situated in one of the most densely human-populated areas in Sub-Saharan Africa (Lepp and Holland 2006). The population around Kibale increased by more than 300% between 1959 and 1990 (Naughton-Treves et al. 1998), and in 2006 the population density within 5 km of the park boundary was estimated to be over 260 individuals/km² (Hartter 2010), ranging as high as 600 individuals/km² in some locales by 2009 (Mackenzie and Ahabyona 2012).

Kibale National Park was created by combining the Kibale Forest Reserve (455 km²) and the Kibale Forest Corridor Game Reserve (340 km²) in 1993 (Figure 1). The game corridor was established in 1926 as a controlled hunting area and to maintain and facilitate animals, particularly elephants, in their passage between forested areas to the north (which became Kibale Forest Reserve in 1932) and savannah areas to the south (which became QENP) (Baranga 1991, Drennon 1997). The forested areas were gazetted 6 yr later in 1932 as a Crown Forest Reserve to provide timber, and commercial logging was allowed but limited to the northern section of the park (Figure 2). The Kibale Forest Corridor Game Reserve covered 340 km², overlapping the forest reserve by 134 km², with habitat consisting primarily of elephant grass (61%, *Cenchrus purpureus*) and medium altitude forest (39%) (Figure 1) (Kingston 1967). Each entity was managed separately by colonial and then Ugandan government agencies (though the 134-km² overlap had dual status and lay within the Forest Reserve and a Game Reserve until these 2 entities were combined in 1993 to create the National Park (van Orsdol 1986, Aluma et al. 1989, Howard 1991, Struhsaker 1997).

The formerly logged compartment recovered considerably, both in tree cover and avifaunal richness (Dranzoa 1998), and shows evidence of persistent and stable forest for the past 25 yr, essentially indistinguishable from the original intact forest (Hartter et al. 2011). Recovery in the southern portion of the park is also underway (Figure 2). At the time of park establishment, encroachment was widespread, particularly in the corridor. Estimates vary widely, but abandoned farms (10.3%) and degraded forest (8.7%; largely representing secondary forest associated with agricultural encroachment) covered 146 km² (Chapman et al. 2011), with 76% of these degraded lands found in the corridor. This corridor does not have an exclusive name, as it is a former game corridor now considered part of Kibale by UWA. We will refer to it as the K-Q corridor in this study, to describe its unique history, and illustrate where it fits, or does not, into the rubric of corridors and future connectivity goals.

## The Role of Corridor Goals

A major component of corridor establishment, maintenance, and even restoration, is establishing and understanding the goals of the corridor. The K-Q corridor represents a multiuse area that arose through a series of historic and political events, with multiple actors, yet identifiable goals and challenges exist. Another important component is measuring corridor function; this requires development of measurements or benchmarks of success to assess whether goals are being met, and how to manage for those goals and for additional objectives or

challenges. Given that ascertaining the goals of this corridor are a multidisciplinary effort at many scales, both temporal and spatial, the metrics of success must also accommodate this.

The conservation goals of corridors in biodiversity hotspots such as this are often directed at maintaining biological connectivity (Taylor et al. 1993), ensuring persistence and sufficient habitat to maintain existing fauna and flora. The specific metrics of connectivity goals will be dictated by larger conservation goals, such as species-specific needs, or perceived needs. Particularly in the Albertine Rift, the role of charismatic megafauna in both the perceived and actual needs of habitat connectivity is considerable (Nampindo and Plumptre 2005, Reynolds 2005, Cordeiro et al. 2007, Plumptre et al. 2007, Basabose et al. 2010). Chimpanzees, gorillas (*Gorilla gorilla berengei*), elephants, lions, many smaller endemic primates, and enormous endemic avifaunal richness are of high conservation and tourism value. Larger fauna tend to have larger habitat needs—quite literally, they have larger ranges for foraging and hunting. If one is to protect and maintain those large home ranges and allow for movement between parks, corridors are necessarily required to be large (Newmark 1993). In addition, the type of ecological habitat needed—undisturbed old growth forests, connected canopies, sufficient feeding resources—may be a specific requirement of the corridor (Jason and Taylor 1998), and many considerations may contribute to design or planning goals (Dobson et al. 1999, Tewksbury et al. 2002, Rudnick et al. *in press*). Additionally, the tradeoffs between corridors as passage or extended core habitat for wide-ranging species will influence design and planning goals (Beier and Noss 1998, Haddad et al. 2000). Faunal connectivity remains a high priority from a conservation perspective in the K-Q landscape and will likely continue to be the primary driver in management of this landscape.

Interestingly, there appears to be little work to assess the current faunal use of the corridor. There is evidence suggesting that the corridor area can support wildlife, but it is unclear if these areas of elevated wildlife densities are due to immigration of remaining animals from more degraded forest (Chapman and Lambert 2000). There is also evidence that the reforested areas within Kibale are increasing in biomass and biodiversity (Omeja et al. 2011), suggesting that restoration and recovery in the corridor may achieve the faunal conservation goals. However, in 1989, there were only an estimated 500 elephants in the game corridor and QENP (down from historical estimates of 30,000), and it was suggested that the elephants had adjusted migration patterns around human use such that they might not return to using the corridor, even after cessation of human use (Aluma et al. 1989, Baranga 1991). From a biodiversity conservation goal perspective, we suggest that further faunal monitoring be implemented in this corridor.

Placed in direct conflict with these faunal connectivity goals is the reality of an occupied or highly utilized corridor, and questions about the scale at which benefits from restoration, or preservation, at a local scale are achievable. Facilitating the passage of animals that may raid crops and steal livestock is a complicated trade-off with local livelihoods. The history of the relationship between humans and this landscape adds a layer of complexity that must be considered in ongoing management.

## The History and Costs of the K-Q Corridor

The corridor was created in 1926, and although occupied, it was mainly limited to hunting camps. At that time, the population density of local people, the vast majority of whom were of Batoro, was very low. Most people were farmers, but the Basongora, who were pastoralists, moved seasonally between lands near Fort Portal and south towards Kasese. When the second major epidemic of Rinderpest swept through East Africa in the 1930s, it drastically reduced the number of cattle, and some ranchers gave up their pastoral lifestyle in favor of permanent agriculture.

Push and pull factors encouraged settlement near and within the corridor beginning in the late 1950s. In the early 1960s, population density in Ndorwa County in Kabale District in southwest Uganda (see Figure 1 inset) was nearing 350 people/km², but it ranged as high as 800 people/km² in the rural areas where many migrants originated (Turyagyenda 1964). In 1969, population density was only 43 people/km² in the Toro District, the administrative area that contained present-day Kibale National Park and much of present-day QENP (Drennon 1997). Faced with comparatively high population pressure and land shortage, the Ugandan government created resettlement schemes to alleviate the pressure. An agreement was reached between the Bakiga chief and the King of Toro in 1955 to move people to the area mainly east of Kibale near Bigodi town. By the late 1960s, settlement on the west side of the corridor increased markedly for a number of reasons. First, kingdoms were abolished in Uganda in 1966, so many who were originally drawn to this region for employment in tea estates and the copper and cobalt mines near Kasese could claim land that was once controlled by the King of Toro. Second, Kenyans, who had settled in the area to work on the railroad, gave up their land and returned to Kenya. Third, by around 1968, areas designated for resettlement filled up on the east side of the Kibale Forest Reserve, so Bakiga migrants came to the west side, near the corridor.

A similar climate, fertile soils, stories of abundant open land, and a growing population of friends and relatives in the area served as major pull factors for further migration (Baranga 1991, Marquardt 1994), and a large

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wave of Bakiga migrants came in the early 1970s. What they found was primarily bushy, wild land of forest pockets and vast expanses of elephant grass and sparse trees. Since land was plentiful, large parcels of land to clear were given to the Bakiga by Batoro chiefs. Initially, people were spread out and land was allocated both outside and within the corridor. Resources were plentiful, and wildlife, including the charismatic lion, Cape buffalo, elephant, Uganda kob (*Kobus kob thomasi*), impala (*Aepyceros melampus melampus*), spotted hyena (*Crocuta crocuta*), leopard, baboon (*Papio anubis*), monkeys, bushpig (*Potamochoerus larvatus*), and bushbuck (*Tragelaphus sylvaticus*) (Respondent #1 2011, *J. Hartter*), were abundant in the grasslands both outside and inside the corridor. The forest and corridor harbored wildlife, which were hunted, but the first migrants, like the Batoro, settled farther from these places because of the threat to crops, livestock, and humans. As more Bakiga came, the bigger parcels of available land, though less desirable, were nearer to the reserve boundaries. Over time, that land filled in; land was bought and sold, and enough land was cleared in domesticated landscapes to separate people from wildlife. Bakiga were allocated these lands first, including those inside the corridor, to serve as a buffer from crop damage by wildlife (Kabera 1983). Lions, Cape buffalo, elephants, and bushpigs were the most common threats to people and their way of life as late as the 1970s. During this time, Bakiga migration to the area had been steady, and virtually all arable land in and out of the corridor had been allocated, transforming it from grassland to farms (Aluma et al. 1989). Wildlife was either hunted and killed or driven away from the area.

In 1971 when Idi Amin came to power and government regulation on reserve land was relaxed, people (mainly Bakiga, but some Batoro) began to colonize the corridor and parks on a much larger scale. The land was often free, and it was expansive, with little administrative control (Marquardt 1994). As settlement in the corridor grew, little opposition was raised by the Game Department, and people seeking land were allocated parcels by local chiefs to clear and settle (Marquardt 1994). With the opportunity to acquire land that was underutilized, the collapse of local industries, including the Kilembe Mines and the Hima Cement Factory near Kasese town in the mid-1970s and the formal annexation of the corridor as Mpokya Sub-county in 1976 (retracted in the early 1980s), settlement in the corridor accelerated (Aluma et al. 1989, Drennon 1997). The Game Department's official 1977 survey estimate of 4,000 people grew to about 8,000 living in the corridor in 1982, with an average of 17 homesteads/km² (van Orsdol 1986). Because Bakiga continued to come seeking land, in the late 1970s land acquired a monetary value. Original plots were subdivided and sold, whereas previously, a handshake and discussion and a nominal sum were paid to the local chief (a practice known locally as "*embagwa*").

A second wave of Bakiga migration occurred in the 1980s; settlement in the corridor was so widespread (but still less than that outside the corridor) that a number of villages and trading centers were established and over 90% of the corridor was claimed (although only about 25% was cultivated) (van Orsdol 1986). This greatly diminished protected habitat, approaching a point of total loss (Baranga 1991); meanwhile, remnant forests outside the corridor were also converted into farmland. As a result, the big cat populations plummeted, and baboons, elephants, and small monkeys became the biggest threats to local livelihoods and food security. In 1983, the government revoked the official status of Mpokya Sub-County and deemed settlements in the corridor illegal. Settlers were forced out, often violently, as pointed out in the opening quote. Despite these actions, they returned. Estimates of the corridor population by the late 1980s varies, but between 42,000–57,000 people resided in the corridor at a density between 122 and 166 people/km² (Aluma et al. 1989, Baranga 1991, Muhwezi et al. 2004).

When eviction came in 1992, the government permanently and forcibly removed all 30,000–35,000 remaining settlers from within the area to become Kibale, with very limited compensation (Feeney 1998). Although there were serious social costs of eviction in the 1980s, the impacts of the 1992 evictions were a magnitude higher. By that time the land outside Kibale was farmed intensively, as the Bakiga had transformed the landscape into one similar to southwestern Uganda, where maize was grown in large quantities. As evictees, they could return to southwest Uganda with limited compensation (usually foodstuffs), go to areas far from Kibale and receive land, or try to find land near Kibale with no compensation. Not only did they lose their homes and land, but the area they called home had been occupied and converted to agriculture—without money, many who stayed in the area could only purchase small parcels from friends or relatives or acquire land in marginal areas. Further conflict ensued when a 1998 survey revealed inaccuracies in the 1992 boundary, and people once considered to be legitimately occupying their land were now shown to be living inside Kibale.

Displacement without compensation and absolute eviction has been termed 'fortress conservation' and creates animosity and hostility and therefore little support for parks (Brockington 2002). In the K-Q corridor, even though people may not have ancestral connections to the land, they feel that some concessions should have been made. They had been living there for as long as 20 yr and needed food and other resources. Most former residents of Mpokya Sub-county who now reside outside Kibale harbor resentment toward the park and view the corridor area differently than the forest reserve portion. A common sentiment

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is that a portion (or all) of the corridor should be opened up to settlement and farming. These factors all coincide with population explosion, enormous land pressure, and declining agricultural yields (Hartter et al. 2012).

## Making Corridors Work

Clearly in this corridor we see the collision of conservation goals and demographic and political history. The past model of exclusion and eviction is not likely one we will see in this century. However, it is important to note the language used to describe the evictions; in hindsight it is easy to say that agriculturalists were living illegally in the corridor, and the government enacted conservation goals which required them to leave. So the question remains whether the status quo is sufficient, sustainable, or manageable, and whether we can take any lessons into the future.

One way to make corridors work is to commoditize existing ecological processes and potential, or to make ongoing human-natural interfaces operate at a net balance. One popular means of doing this for forest restoration projects globally is marketing the carbon sink. Projects, such as the United Nations Reducing Emissions from Deforestation and forest Degradation (UNREDD) Programme, seek to demonstrate the positive impact of forest re-growth and can incentivize the process through marketing carbon offsets (UNREDD 2010). This is obviously a very appealing means to motivate forest restoration and recovery, while making it economically viable as an alternative to agricultural conversion. In the 1990s UWA, along with the Forests Absorbing Carbon dioxide Emissions (FACE) Foundation, initiated a reforestation program to restore forests in Kibale that were highly encroached upon in the 1970s and 1980s (Klomp 2009). The stated objective of this program was two-fold: to restore the park to its natural forest state prior to 1970, and to generate income by selling carbon credits, which are aimed at financing conservation efforts in Kibale (Klomp 2009). From an ecological perspective, the plantings (10,000 ha) have been successful, increasing forest biomass and faunal diversity (Omeja et al. 2011). By far the most positive social benefit of the FACE project is employment, but other modestly perceived benefits include improved climate, roads, and vegetation (EMA 2000). FACE employment is mostly seasonal, but up to 367 individuals are employed at a time for a total of US$132,463 in annual salaries (Mackenzie 2012, Mackenzie and Ahabyona 2012), generating cash that is put back into local economies. Whether or not these jobs will lead to permanent employment in the future remains to be seen.

Understanding the carbon credit component of projects such as FACE, and motivating ongoing and future carbon sequestration projects requires evidence of carbon storage. Large-scale assessments of the carbon absorption potential of these recovery projects are logistically complicated, which could hinder continuation. Connecting conservation goals to carbon storage goals may be a key to successful achievement of both objectives. So we sought to use remote sensing as a cost-effective metric. To assess both ecological restoration success in this area, and understand its possible relationship with the carbon storage question, we used a proxy for net primary productivity (NPP), the fast growing, rapid carbon-storing process of tree and shrub recovery, as a metric to measure success of recovered landscape in and around Kibale (Hartter and Southworth 2009, Hartter et al. 2011). The normalized difference vegetation index (NDVI), a derived index of the green reflectance of vegetation, often used as a proxy for NPP, is also frequently used in ecology as a measure of habitat quality for wildlife (Petorelli et al. 2011, Ryan et al. *in press*). We contrasted the NDVI signal in the primary, undisturbed forest within the park, with the fairly degraded and high-turnover agricultural landscape, recovered previously logged areas within the park and the corridor (Figure 2). We compared this in 7 separate Landsat images over 25 yr, using dates prior to park establishment (1984, 1986, 1989), soon after park establishment (1995), and dating through the past decade (2001, 2003, 2008). Perhaps unsurprisingly, the primary forest has the lowest NDVI value of all the forest types; the high turnover areas have the highest, and the corridor, with its patchy landscape, falls between the most fragmented habitat and the disturbed but recovering forest (Hartter et al. 2011). We suggest this measure is useful as a rapid and large-scale remotely sensed means to monitor forest recovery over the long term. Therefore, as forests become more stable over time, we hypothesize they will return to being dominated by larger, older trees with a connected canopy and reasonably low turnover. As such, the signal of recovery will be a decline in mean NDVI values with time, approaching the values given by the intact primary forests.

While NDVI demonstrates the changes in NPP, its interpretation was not straightforward. We found that the values of all the forest types appear to be on a common trajectory over the 25 yr, which may be a function of climate change over the period (Stampone et al. 2011, Hartter et al. 2012), although we have not identified a mechanistic explanation at this point. This means that establishing goals, or benchmarks, is complicated in this system, and we cannot know when we have arrived at success as a raw value. The other glaring problem is that these findings, that intact forest has the lowest NDVI signal and that recovery has a signal trajectory towards that lower value, contradicts the use of increasing NPP as a means to measure carbon sink based incentive programs. Early recovery efforts will appear to have greater success by this metric than the stable and older forests. If

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**Table 1. Measures of success in the Kibale-Queen Elizabeth National Park corridor that are subject to interpretation and impact; contrasting benchmarks of success and 'less than success.'**

| | Success | < Success |
|---|---|---|
| I | Reforestation of a formerly degraded area (Hartter, Ryan et al. 2011; Omeja, Chapman et al. 2011) | High forest cover turnover during 25 years, disturbed landscape (Hartter, Ryan et al. 2011). |
| II | Faunal passage? *(Needs more research)* | Reports of human-wildlife conflict; responses may be extreme (Hartter, Goldman et al. 2011); compensation may be insufficient (Mackenzie 2012; Mackenzie and Ahabyona 2012). |
| III | Less intensive human use—reverting to more intact landscape (Hartter, Ryan et al. 2011) | People were forcibly evicted; not a good model for future corridor plans. |
| IV | Now counted as park of Kibale National Park by the managing authorities | The unclear designation may hinder protection and enforcement; unclear which park management plan encompasses this area. |
| V | Multi-use area de facto—achieves UNESCO Man and Biosphere (MAB) goals | Is this a sustainable or goal-oriented plan, and not something that can be retracted later? |

restoration goals are to return forests to primary, stable, old-growth forests with low turnover, once restored, they may no longer be as valuable as carbon credit trades, and the economic incentive (and the restoration and planting jobs) may disappear. Therefore, the measure of ecological success may be in direct opposition to economic sustainability.

This is not meant as a dire prediction; given that the loss of resources ascribed to exclusion from parks is at least in part due to a lack of firewood and building poles, the notion of sustainable co-management of forested land is worth exploring. While this corridor is not strictly included in the MAB Biosphere with QENP, it may benefit from being managed as such. An explicit co-management plan could provide a compromise in terms of retention of carbon absorbing reforestation credits and sustainable resource access for local people.

## Conclusion

In conclusion, we suggest that while the K-Q corridor demonstrates some of the ecological measures of success from a tropical forest restoration and connectivity perspective—that is, we see evidence of reforestation in the corridor area—it is hard to assess and ascribe success in terms of human cost. It is also difficult to ascertain if the major conservation connectivity goals for fauna are being met. In Table 1, we present 5 metrics of corridor success, contrasted with the potentially less than successful outcomes. We suggest these as a means to look at goals of the corridor and guidance for future monitoring research.

The political history surrounding the existence and management of human impact to this corridor area is unique to Uganda and is unlikely to be a model for future corridor establishment, so we cannot establish this as a benchmark or policy recommendation. Exclusion and eviction of people in this landscape in the future will be sharply in conflict with high-density subsistence-level agriculture. Incentives for reforestation and compensation schemes for human-wildlife conflict exist in the current rubric (Klomp 2009, Mackenzie 2012, Mackenzie and Ahabyona 2012), with higher and lower degrees of acceptance and success. They are more likely to succeed as a model for corridor maintenance in contrast to previous extreme political acts of wholesale eviction and translocation. We think it is important to monitor 2 major aspects of the K-Q corridor in the future: First, how well are the biodiversity conservation goals of faunal and forest connectivity being met? Second, are carbon credits, compensation for wildlife conflict, and trickle-down tourism strategies going to be sufficient for maintenance of livelihood-oriented goals?

How these strategies for balancing livelihood and conservation needs will work in future corridor and connectivity plans for this biodiversity hotspot must be informed by both past experience and ongoing monitoring. This requires a multi-disciplinary approach to understanding and assessing the existing landscape pressures and institutional desires. We hope that this review will provide a basis for future research endeavors.

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*Sadie Ryan (corresponding author, Department of Environmental and Forest Biology, 134 Illick Hall, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210, sjryan@esf.edu)*

*Joel Hartter (Department of Geography, University of New Hampshire, 102 Huddleston Hall, 73 Main Street, Durham, NH 03820, joel.hartter@unh.edu)*